

YELLOWSTONE SCIENCE



Archeology of Yellowstone



The Yellowstone Story

Little did Philetus Norris know that when he picked up Native American artifacts and sent them off to the Smithsonian Institution in the latter half of the 19th century, that he launched what would eventually be a complex and dynamic field of inquiry into the archeology of the world's first national park. For Yellowstone National Park (YNP), archeology provides a compelling counter narrative to the idea that Yellowstone is a wilderness, untouched by humans. John Colter, Osborne Russell, and later explorers didn't discover Yellowstone – paleoindian projectile points made from Obsidian Cliff material date to around 11,000 years ago. Today's Native American tribes from the Columbia Plateau to the Great Plains are the descendants of the earliest inhabitants of the park.

As archeology developed into a discipline, so too did our understanding of the human past of YNP. Radiocarbon dating has allowed us to understand the depth of human history in the park, and has given us a finer grained understanding of human occupation of the park. Geochemical sourcing of obsidian has helped us see the movement of obsidian and people in the park and across the North American continent. Residue analysis of stone tools has given us a window into the variety of plants and animals utilized by early residents, and tells a story of resourceful individuals who thrived in this landscape. Historical archeology tells the story of businesses and amenities that are now mere traces on the landscape.

The recent recognition of the scope of high elevation sites in YNP is a reminder that despite everything we have learned about the prehistory of this place, there are still many things to learn. Recent archeological research has provided new insight into the flight of the Nez Perce across the park in the summer of 1877, bringing into focus the collision of the nascent conservation movement with one of the last great acts of Native American resistance, playing itself out over a landscape soon to be reimagined as wild and untouched.

How much of our national mythology of this place should be reconsidered, given what we have learned over the last 60 years of archeology in Yellowstone? How can we believe that we have one of the last intact ecosystems in the continental U.S., when human beings are no longer part of the ecosystem in the manner they were for at least the last 11,000 years? How can this place be considered wilderness, when ancestors of today's Native tribes journeyed to and from here for thousands of years and traded stone from Obsidian Cliff across the continent? Ultimately, as much as archeology compels us to rethink how we define this landscape, it certainly makes the story of YNP deeper and richer, helping us understand that this place was important long before early European explorers came here. In that spirit I invite you to help us celebrate archeology in Yellowstone National Park!

A handwritten signature in black ink, appearing to read 'Tobin Roop'.

Tobin Roop
Chief, Cultural Resources
Yellowstone Center for Resources

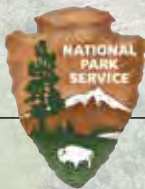
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FEATURES

- 4 A Brief History of Archeology at Yellowstone National Park
- 10 Obisidan: The MVP of Yellowstone's "Stones"
- 14 Historical Archeology
- 25 Debunking the Myth: America's Eden
- 28 Archeology along the Nez Perce National Historic Trail
- 38 Archeology Facts
- 40 Archeology & Adaptation to Climate Change in Yellowstone
- 51 Debunking the Myth: Seasonal Use of Yellowstone
- 53 Archeological Significance of Yellowstone Lake
- 63 Debunking the Myth: Fear of Yellowstone
- 65 A Volunteer's Impressions

DEPARTMENTS

- 69 Shorts
- 76 A Look Back
- 93 A Day in the Field
- 96 News & Notes
- 97 Sneak Peek

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A Brief History of Archeology at Yellowstone National Park

*Elaine Skinner Hale, Ann Johnson, and Marie Gore**



Carmen Clayton and Elaine Hale conducting field work at Nymph Lake prior to a road construction project.

The fact that Native Americans used the landscape of present-day Yellowstone National Park (YNP) for millennia was evident to the early European-American trappers, prospectors, and explorers, who encountered native peoples during their travels and noted ancient trails and chipped stone artifacts. The development of the park's archeology program vastly increased our knowledge of how the park's early inhabitants moved across and used the Yellowstone Plateau, giving us a more nuanced and thorough understanding of human occupation of park lands. Native Americans accessed the Yellowstone Plateau using trails from the north along the Yellowstone River; from the east following the Shoshone River; from

the south along the Snake, Bechler, Yellowstone, and Lewis rivers; and from the west along the Madison River. These riverine corridors facilitated Native Americans ability to hunt, camp, and obtain resources the Yellowstone Plateau offered, such as obsidian materials and use of geothermal springs. We know from the archeological sites that Native Americans used the lands of the now Yellowstone National Park for more than 11,000 years.

Development of Yellowstone's Archeology Program

In 1872, Yellowstone was designated the world's first National Park in part as an attempt to manage its geo-

The lead authors were the first two professional archeologists to be stationed in Yellowstone National Park. Marie Gore is an associate editor for Yellowstone Science.

logic wonders, with the dual purpose of protecting the unique geology and thermal features while providing opportunities for visitors to enjoy these wonders. The first superintendent appointed to the new park, Nathaniel Langford, only visited the park on a few occasions, and was primarily concerned with providing visitors access to the geologic wonders and curiosities (Langford 1905). The second park superintendent, Philetus W. Norris, had a great interest in Native Americans, even penning a message to workmen in the park requesting any Native American artifact discovered be brought to him. Between 1887 and 1897, Supt. Norris, with the help of the United States Geological Survey (USGS) and the Bureau of American Ethnology (BAE), removed many artifacts from YNP. This included a chipped stone spear, an atlatl, arrow points, stone knives and scrapers, stone drills, and shaft straighteners, as well as fragments of soapstone vessels, pipes, and tubes (Norris 1877, 1879). These items were sent to the Museum of Natural History, Smithsonian Institution in Washington D.C., where they remain available for study today.

For roughly 30 years after Supt. Norris departed, little was recorded about the park's archeology. Park development continued with the construction of roads, accommodations, and infrastructure needed to support increased visitation. Eventually, these places, such as lunch stations, permanent tourist camps, stage stops, a dairy, and corrals, were abandoned. These were later documented as part of YNP's history.

Starting in the 1930s, Lee Coleman, an NPS park ranger, collected artifacts during his backcountry patrols. Each time he returned with artifacts, he drew a map depicting where each was found and usually sketched an outline of one or more of the artifacts. These are of sufficient detail that we often can link his finds to archeological sites now formally documented. These artifacts and his records are now in the park collections. Wayne Replogle, a seasonal employee in the 1950s and 1960s, was also interested in artifacts. An excellent hiker, he traveled throughout the park looking for Indian trails. In addition to turning in the artifacts to YNP's museum collection, he drew a map showing what he believed to be the location of the Bannock Indian trail across park lands.

Professional archeologists made their initial efforts to document archeological sites in YNP during the late 1950s and early 1960s. Montana State University (now the University of Montana) Department of Anthropology sent students and professors into YNP to document

archeological sites and gather information, following leads from park employees, such as Replogle and Park Historian Aubrey Haines. This resulted in the first 170 archeological sites being professionally documented in the park. In the 1960s, scientists determined obsidian from different lava flows could be distinguished from one another by measuring the amount of specific trace elements contained within each flow. This led to the development of obsidian sourcing studies, which investigate the geological source of obsidian raw materials used to manufacture stone tools. This had a large impact on archeological studies in YNP, as obsidian traced to Obsidian Cliff was detected at archeological sites across the North American continent.

In 1966 the National Historic Preservation Act (54 USC §300101 et seq.) was passed; it required, among other things, inventory and evaluation of cultural resources prior to the initiation of projects on federal lands, supported by federal funding, and/or requiring federal permits. This legislation was followed in the 1970s and 1980s with additional laws and implementing regulations, clarifying and elaborating on how cultural resources were to be evaluated and protected. Very few NPS sites had archeologists on staff during this period, so service centers, such as the Midwest Archeological Center in Lincoln, Nebraska (MWAC), were created to house specialists who could assist parks with archeological services and projects, as well as legal and regulatory compliance support.

It was clear by the 1980s that the roads in the park were no longer adequate to accommodate visitation levels, and the NPS began to plan upgrades and maintenance to park transportation infrastructure in conjunction with the Federal Highway Administration (FHWA). As a part of a multi-decade program, FHWA has been funding a significant amount of archeological work in the park to ensure compliance with Section 106 of the National Historic Preservation Act and minimize impacts to archeological sites when roads are widened, straightened, or moved to new alignments. The park "Road Team" was formed during this time, growing out of weekly conference calls between Ann Johnson, who was then a staff archeologist in the NPS Rocky Mountain Regional Office, Chief of Maintenance Tim Hudson, Assistant Chief of Maintenance Nancy Ward, and Regional Archeologist Adrienne Anderson. Though roles and faces have changed through time, the Road Team still meets weekly and is responsible for the planning and implementation of highway reconstruction



Cultural Resources Staff circa 1997. Front row: Lee Whittlessley, Ann Johnson, Barbara Zafft. Back row: Elaine Hale, Beth Razz, Catherine Lentz, Laura Joss, Vanessa Christopher, Susan Kraft, and George Briggs.

and maintenance projects in YNP, including ensuring compliance with environmental and historic preservation laws and regulations.

The FHWA road reconstructions were planned in 10-to-15 mile sections; and initially all of the archeological work was performed by MWAC staff archeologists, who would come to the park to undertake cultural resource surveys and determine the significance of the archeological sites they found by performing limited test excavations. As time went on, the park also partnered with university archeology programs, such as the State University of New York at Albany, the University of Montana in Missoula, and the Museum of the Rockies in Bozeman, MT; the Office of the Wyoming State Archaeologist; and professional archeological contractors. Through this road program work, about +1% of the park's 2.2 million acres has been examined for archeological resources, forming a significant part of the park's archeological program.

To improve the park's in-house capacity to manage archeological resources in the park, Johnson began training YNP law enforcement rangers, trail crew members,

fire management personnel, and maintenance staff to recognize archeological sites and record their locations. With this information in hand, archeologists could return to formally document the sites. This approach gave park staff an understanding of what sites looked like, the importance of the sites, and provided them opportunities to assist with archeological surveys and excavations. This was the beginning of a nascent archeological program in YNP, which was solidified in 1994 when Laura Joss was selected to lead the Branch of Cultural Resources in the Yellowstone Center for Resources, newly created the year prior. In 1995, Ann Johnson transferred to YNP to lead the growing archeological program, and that year Elaine Hale was brought on by the Planning Department to manage archeological resources affected by the growing Federal Highways road program. This was the start of a park-wide archeological program managed from within the park itself.

Through the years, the park has benefited from having many of the same cooperators involved with the archeology program, as they were familiar with the wide range of historical and prehistoric archeological sites types in

YNP, as well as logistical and safety protocols used to work in areas frequented by the park's large mammals, such as bison, elk, bears, and wolves. Though most archeological research completed in the park was funded through regulatory compliance prior to construction and maintenance activities, the archeology program successfully competed for funding to complete an archeological inventory of the Yellowstone River corridor, the Nez Perce National Historic Trail, and the shoreline of Yellowstone Lake. Park funds also supported the archeology program to complete an inventory of utility corridors, trail segments, developed areas such as Old Faithful and Canyon Village, and the Snake River Headwaters Wild and Scenic River area, which includes the Lewis River in the park.

As the YNP archeology program matured, summers were filled with inventory and condition assessments of documented sites, while the off-season involved cataloging artifacts and preparing project reports. Volunteers played a critical role in supporting the archeology program, engaging in surveys to identify new sites and revisiting known sites to assess their conditions, and providing support with data management. In 1990, there were approximately 300 recorded archeological sites in YNP, but by the time Ann Johnson retired in December 2008 there were over 1,600 sites documented and over 1,750 sites when Elaine Skinner Hale retired in 2014. Through a university partnership, Robin Park conducted archeological surveys, monitoring and evaluations, and performed the park's archeology data management and artifact cataloging from 2009 to 2012, and now works with YNP's Museum Collections. Staffan Peterson served as Park Archeologist from 2012 to 2016 before moving on to Little Bighorn Battlefield National Monument. NPS Archeologists at YNP coordinate with law enforcement staff, assisting them in their investigations as subject matter experts when artifacts are illegally collected. The increased education and improved coordination between the archeological staff and other employees strengthens the protection of these nonrenewable archeological resources. Park staff have been, and continue to be, essential for supporting the archeological team's fieldwork, but most importantly, are invaluable for their contributed efforts from site identification and protection.

Notable Research Findings

Archeological sites in Yellowstone can also tell us what the prehistoric landscape and vegetation community

was like, which informs interdisciplinary study of the Greater Yellowstone Ecosystem. Geomorphology suggests the Gardiner Basin was once filled with a large lake created by damming of the Yellowstone River in Yankee Jim Canyon about 10,000 years ago (Good 1982; Pierce 1979, 2004, Gardiner Basin Restoration Workshop 2005, pers. comm. in Jaworowski 2005). Good (1982) estimated the maximum elevation of this lake at 5,225 ft. Fed by glacial runoff, this lake stretched south to two miles upstream from Gardiner, Montana, and lasted several thousand years. Archeologists working at the Malin Creek site excavated through multiple occupations, finding lacustrine sediments from the now-vanished lake at the base of the site (Jaworowski and Heasler 2005, Vivian et al. 2008). The deepest archeological materials, located at 5.5 ft. below the modern ground surface, were radiocarbon dated to 10,280 \pm 50 years before present (BP). This indicates prehistoric people camped roughly 9,400-9,800 years ago on the shore of a lake that no longer exists, supporting the geomorphologic studies from Gardiner Basin. Lacustrine sediments were also recognized in deep excavations near the Stephen's Creek corrals at 5,300 ft. above mean sea level (AMSL), similar in elevation to those at the Malin Creek site (Pierce 1979, Pierce et al. 2003, Jaworowski and Heasler 2005). Thus, archeological and geomorphological investigations resulted in clarifying the age of this YNP valley, the now-vanished lake and its elevation, and importantly, when people began using the Gardiner Basin.

Naturally-occurring wildfires in the park led to a unique opportunity to document the Obsidian Cliff archeological site. The unique geochemical signature of obsidian artifacts, mentioned above, posed an interesting research question once artifacts were found to be traded across the North American continent. Quite a few were sourced to Obsidian Cliff, including some used by the Hopewell Culture people in the Ohio River Valley, which date between AD 50 and 200 (Davis et al. 1995; Hughes 2007). In 1988, the NPS Rocky Mountain Regional Office provided funding to the Museum of the Rockies to inventory and evaluate the significance of this site. The day before fieldwork was to begin, one of the famous 1988 wildfires, the largest ever for YNP, burned over much of Obsidian Cliff, fortuitously removing pine needle duff and vegetation. Archeologists were able to record the extensive obsidian quarry pits and associated processing stations with onsite stone tool manufacturing. Obsidian Cliff site is an outstanding example of a quarry, used by native peoples throughout regional pre-

history, from the Clovis complex until the park was established (Davis et al. 1995). The scope and scale of the distribution of Obsidian Cliff materials makes this stone tool source one of the most significant archeological sites on the continent, and why the site was designated the Obsidian Cliff National Historic Landmark (NHL). To-date, it is the only NHL designation for an archeology site in YNP.

In the springs of 1996 and 1997, there was dramatically high water in all of the park's rivers and streams due to melting snow pack. The rushing meltwater washed out many prehistoric and historical sites located on river and stream banks, with the Black Canyon of the Yellowstone River particularly affected. Given the scope of erosional damage from the runoff events, and the rise and shift of the water level in Yellowstone Lake, the park successfully obtained NPS funding to assess known sites and document erosion damage and newly exposed areas. In addition, multi-year funding supported the inventory and evaluation of archeological resources around Yellowstone Lake. Hundreds of sites were identified which has significantly increased our knowledge of prehistoric use of the lake and the Yellowstone Plateau for the last 9,000 years (Johnson 2002, Sanders 2002, 2013, MacDonald, this issue).

The Nymph Lake site is another good example of how archeological research informs us about past human occupations. Located near Obsidian Cliff, this site dates to about 2,200 years ago based on radiocarbon dating and diagnostic projectile point analysis (Sanders et al. 2011). At this site, a small group camping on thermal soils processed food and manufactured obsidian tools and large flakes that could be carried for future use. Archeologists identified three distinct work areas: a roasting pit dug into the ground; an area where fire cracked rocks were strewn across the ground, possibly from "cleaning-out" the roasting pit; and a lithic reduction area. Analysis of blood and protein residue on selected tools at the Nymph Lake site showed scraping tools came in contact with bear, deer, bison, rat, sheep, rabbit, fowl, and pine. Projectile points tested positive for bison, rat, herbaceous flowering plants (*Chenopodiaceae*), and pine. A very large quartzite chopper brought to the site retained guinea pig (beaver, porcupine, or squirrel) protein residue. Residue analysis indicates the people at the Nymph Lake site subsisted on a wide range of animals (Sanders et al. 2011).

Thousands of flakes and discarded tools were recovered in one area associated with stone tool manufac-

turing. In one area, large usable flakes were knocked off of an obsidian core. These flakes are then reduced through flaking into a stone tool, such as a biface or projectile point. On the other side of the flake debris area, poorly formed flakes removed from much smaller cobbles were observed. There were also large flakes with notches on the side, suggesting that the expert knapper may have been trying to show the novice knapper how to make notches needed to attach projectile points to hafts (Sanders et al. 2011). Although the majority of obsidian was obtained from Obsidian Cliff, people also acquired obsidian from other quarries, such as Cougar Creek (east of West Yellowstone), Park Point (east shore of Yellowstone Lake), Conant Creek and Teton Pass (south of YNP), Bear Gulch (west of YNP), and from the Malad site south of Pocatello, Idaho (Sanders et al. 2011). The wide distribution of obsidian procurement sites indicates people traveled long distances using multiple routes to access and move across the Yellowstone Plateau; this demonstrates there were multiple ways to enter and exit what is now the park.

Conclusion

Despite all we have accomplished, there is more to do. With less than 3% of the park inventoried there are thousands of sites in Yellowstone that remain undocumented and unknown. We believe the archeology program we developed will build upon its strengths and continue to find, protect, and research archeological resources within the world's first national park.

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Elaine Skinner Hale received her BS from Montana State University and a MS from the University of Montana. After 14 years administering a social service program and various jobs in the motion picture industry, she joined the Cultural Resource staff in Yellowstone National Park in 1995. She retired 20 years later after participating in many archeological and historic structures projects. She now serves as the Treasurer of the Montana Archaeological Society, on the Historic Preservation Board of Gallatin County, and is the President of the Extreme History Project.



Ann Johnson was born and raised in Montana. Ann went to Montana State University (Bozeman) and University of Montana (Missoula), graduating with a BA in Zoology and Anthropology. She obtained her PhD in Anthropology (Archeology major) from the University of Missouri-Columbia. Ann worked for the Office of the Colorado State Archaeologist in Denver, Bureau of Land Management in Casper, National Park Service Regional Office in Denver, and the last 15 years in Yellowstone National Park. She retired at the end of 2008 as Chief of Cultural Resources. Her major archeological interests are prehistoric ceramic manufacturing cultures, prehistoric obsidian usage, and the last 3,000 years in the Northern Plains and Rocky Mountains.

Obsidian: The MVP of Yellowstone's "Stones"

Robin Park

Obsidian is a volcanic glass formed when magma is extruded from the earth's crust and cools very rapidly, with little moisture content or crystalline inclusions. It was generally the most popular tool stone material used by the ancestors of Native Americans in the Greater Yellowstone Ecosystem (GYE) and was prized as a tool stone material for practical (and potentially cultural) reasons. As a glass, the atomic structure of obsidian is "disordered," which means it has no "preferred direction of fracture" (Shackley 2005). This is the reason for obsidian's conchoidal fracture pattern and allows for easy flaking and sharp edges (up to 10 times sharper than surgical steel), qualities that make it an excellent tool stone. Obsidian was also abundantly available in the GYE, which was convenient for the highly mobile hunter-gatherers who called this land home prior to the arrival of non-Native people. In addition, some of the places where obsidian was collected or quarried were considered culturally significant to a number of tribes who historically inhabited this area,

perhaps further adding to the preference for obsidian as a tool stone material (Park 2010).

Obsidian is also "prized" by archeologists, for one key reason: this material and other rhyolites can be analyzed for their chemical composition, which provides a unique signature or "fingerprint" for each source. Thus, tools made of obsidian can be traced back to their source using this fingerprint, providing insight to archeological analysis of trade and travel routes and potentially even cultural significance for tool stone collection areas.

The source affinity of cherts and other cryptocrystalline materials (locally available and frequently used tool stones in Yellowstone) can also be determined at the trace elemental level. However, cryptocrystalline materials have a high degree of intra-source variability. The process is expensive, and the results are not always of a nature useful to archeological research questions.

Obsidian, on the other hand, is an ideal tool stone for determining source affinity to a degree that is archeologically applicable. Instrumental trace element analysis of obsidian can be performed and results obtained through energy dispersive x-ray fluorescence (EDXRF), which is a relatively inexpensive, non-destructive, and highly accurate technique for mapping a source's fingerprint. Intra-source variability in obsidian typically falls into a predictable range for those sources in the Yellowstone area.

When determining the geochemical "source" of an obsidian artifact, certain trace elements are assigned more analytical weight based on findings; elements Rubidium (Rb), Strontium (Sr), Yttrium (Y), and Zirconium (Zr) show the most consistent inter-source variability for the region (Dr. Richard Hughes, personal communication 2008). These elements are considered "diagnostic," signifying these trace elements are well-measured by EDXRF and show high variability between sources, while maintaining low intra-source variability (Hughes 2007). These diagnostic elements are, therefore, most useful in distinguishing between different geochemical sources. The trace elements Zinc (Zn) and Gallium (Ga) are also recorded but not considered diagnostic of distinct chemical groups because they "don't usually vary significantly across obsidian sources [in the Greater Yellowstone area]" (Hughes 2007).



Obsidian biface, sourced to Obsidian Cliff. NPS Photo - R. Park



Thousands of obsidian flakes cover the ground on Obsidian Cliff. Dozens of quarry pits and numerous tool making workshops were recorded in this area, used throughout history beginning around 11,500 BP (years before present). NPS Photo - R. Park

Obsidian Cliff (48YE433)

Through time, several Native American cultures had knowledge of and access to different obsidian sources in the GYE. There are 19 known obsidian sources used by prehistoric peoples in the Yellowstone region spread out to the south, southwest, west, and northwest, offering choice and opportunity (Park 2011).

Perhaps the most well-known obsidian source in the Greater Yellowstone Area is Obsidian Cliff. The glassy cliff exposure of this source visible from the road rises 60 meters from the ground; the flow itself covers an area of approximately 14.5 square kilometers (Davis et al. 1995). It is a highly significant source at both the regional, national, and international levels. Artifacts made from obsidian from this source are found as widespread as Texas, Washington, southern Alberta (Brink and Dawe 1989; Reeves 2003), and Hopewellian burial mounds in Ohio (Griffin et al. 1969; Hatch et al. 1990; Hughes 1992), indicating it was a prized material extensively traded/exchanged (and directly accessed) by people for thousands of years. Large-scale archeological reconnaissance and survey of this source in the late

1980s culminated in its nomination as a National Historic Landmark (Davis et al. 1995).

Thanks to extensive sampling of the Obsidian Cliff flow, the geochemical composition of this source is known to cluster within an expected range and the geochemical integrity of the source has been well established (Hughes 1990). The Obsidian Cliff source locality is in the northwestern region of the park, to the east of the Gallatin Range and adjacent to the modern-day Mammoth to Norris section of the Grand Loop Road. This locality consists of an exposed cliff face (which is the feature popularly known as Obsidian Cliff or the Obsidian Cliff Plateau) and the flow area immediately east of the cliff face. There is evidence for both the utilization of cobbles as well as direct quarrying of the bedrock obsidian (Davis et al. 1995). Fifty-nine quarry pits/tool workshop locations were documented on the Obsidian Cliff Plateau, along with thousands of flakes and tools (Davis et al. 1995).

When visually inspected, Obsidian Cliff obsidian is glassy and smooth with few inclusions, and ranges in color from black to brown, mahogany, gray, and even



Obsidian Cliff (ca. 1953), a National Historic Landmark. Obsidian from this source is found in Hopewellian burial mounds in the Ohio River Valley. Photo - V. Watson, courtesy National Park Service, Yellowstone National Park.

green. It is typically semi-translucent in opacity, but infrequently can also be opaque. It is considered to be high-quality obsidian for tool making, particularly for knives and projectile points.

Many of the Native American tribes with ancestral or cultural associations with Yellowstone have indicated Obsidian Cliff is a spiritually and ideologically significant place, and have oral histories describing ancestral collection of obsidian from this place (Park 2010). In addition, medicinal use of obsidian from Yellowstone by more than one culture has been documented (Park 2010). This ethnographic information contributes to the overall cultural significance of what is also an exceptional archeological site.

Past and Future Research using Obsidian

There are over 45 rhyolitic flows in Yellowstone containing obsidian; however, only about 15% have obsidian with the right qualities (such as absence of flaws in the material and usable cobble size) to be made

into tools (Dr. Ann Johnson, personal communication 2009). Geochemical Research Laboratory located in Portola Valley, California, (with Director Dr. Richard E. Hughes) has performed the majority of analysis of Yellowstone obsidian since 1988.

Currently a large dataset of sourced obsidian artifacts found within park boundaries exists and is continually being added to by ongoing archeological surveys. Dr. Leslie Davis pioneered the collection and use of obsidian sourcing information to gain insight to archeological questions in Yellowstone (Davis 1979). Others have made significant efforts to compile comprehensive datasets of sourcing results (Cannon and Hughes 1993), and to use these data to understand annual travel routes (Johnson et al. 2004) and analyze spatial and temporal trends in tool stone source selection (Park 2010). Recent archeological surveys by the University of Montana of the shoreline of Yellowstone Lake have significantly added to our dataset and further defined new obsidian source localities (such as the Parker Peak source,

McIntyre et al. 2013). Future research will likely focus on more fine-grained spatial and statistical analysis, in addition to continually building a comprehensive dataset of source localities of obsidian artifacts.

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Historical Archeology

Elizabeth Horton & Thomas James



Photograph of the original Tower Falls Soldier Station near Calcite Springs Overlook, 1905. U.S. Army Corps of Engineers photo from NPS Collection.

Public perceptions of archeological sites in the Northern Rocky Mountains are heavily geared towards prehistoric sites, such as lithic scatters, quarries, tipi rings, and bison jumps. Although these types of archeological sites are important in that they reflect the majority of human occupation in the area, there is much to be learned from the more recent past, also known as the historical period. What exactly is historical archeology and why is it important?

Historical archeology examines the remains from literate societies that could record their own histories (Deetz 1996, Little 2007). This is vastly different from prehistoric archeology, which studies all of human history before the onset of written records. In North America, this begins when European Americans entered the

region until roughly 50 years before the present. Unlike archeologists who focus on prehistory, historical archeologists must think on a global scale as objects were now part of a global economy, and cultural ideas were now being transported across vast oceans and around the world, often coming into conflict with one another. We use written records and oral traditions to better understand the meanings and functions of the artifacts we recover. Museum collections often retain the rarest and valuable objects which often accurately reflect the lives of important persons featured in history, not those of ordinary people and those underrepresented in the history books. Sometimes the smallest items can tell the biggest stories (Deetz 1996). We may not think much of a U.S. Army key in a museum; but when we find one at the

bottom of a privy, it relays to us an immediate story of how it got there and why it was left behind by a soldier.

Think about it - we do most of our daily activities without really thinking about them. Do we write down explicitly how we do the laundry or grocery shopping? No, we just do those things; and our explanations for why we do them a certain way, or use certain items, are passed on verbally through teaching them to others. When was the last time you read an account of where a person's favorite mustard was manufactured? What about knowing where a child's favorite toy was crafted or why different families use different things? Have you ever wondered what kinds of things and people you might have seen at a saloon 150 years ago? What exactly were they wearing, eating, drinking, and doing? Historical accounts answer in a general way, such as telling us they played cards and drank whisky, but which brands were the most popular? What types of meals did the saloon serve? Who frequented those establishments? Were they wearing the latest fashion trends as seen in nineteenth century magazine advertisements or their work clothes? What about their buttons and accessories, their hats, belts, and shoes? Was it the same at every saloon in town? What about through time and across the region, how did tastes change? These are the stories of the day-to-day lives of people like us, and their lives are fascinating.

These are the nuances that historical accounts often gloss over, but which we can learn much about through archeological research. We find that artifacts correlate with historical records, but can often conflict with those accounts as well. We sometimes find that wealthier people were eating cheap foods, choosing to spend funds on fancy dinnerware to show off at occasional meals through conspicuous consumption (Veblen 1896), not at all what we expect when reading of the sumptuous foods offered at their fancy dinner parties. We try to understand the meaning and importance of various items from the perspective of the people who originally used those objects, so that we may better contextualize our archeological findings. We use these patterns to better understand our historical trajectories or the journeys we took to arrive at our modern world.

There is a wealth of historical archeological resources in Yellowstone; and the development of the park is directly connected to larger social and economic changes occurring across America, including widespread settlement of the American West and a shift from an agricultural to an industrial economy. There is a diverse

range of historical sites and topics reflected in historical archeological sites related to the development of the park (Hunt 1993, 2010), such as European-American exploration and fur trapping, U.S. Army management, the National Park Service system, the rise of the tourism industry (camping companies, hoteliers, guide and transportation companies, as well as park visitors), construction of road and trails, changes in frontier health and sanitation, alterations in the cultural landscape, as well as research questions related to the daily lives of those who traveled through, worked, and lived in the park. This article explores how historical archeology has helped us better understand the park's historical period through the daily lives of ordinary people who lived in and visited this stunning wonderland.

European American Exploration

The first known European American person to visit the Yellowstone region was John Colter, a soldier with the famous Lewis and Clark expedition of 1804-1806. Although Lewis and Clark passed within 50 miles of the park's northern border, John Colter returned to the region and entered Yellowstone lands with a group of fur trappers in 1807, visiting at least one geyser basin (Cramton 1932, Mattes 1962). After the War of 1812, the fur trade in the central Rocky Mountains was monopolized by the British, but American trappers also visited the area. While within sight of the Teton Range in 1818, Alexander Ross of the North West Company, an American nineteenth century fur trading company, observed "boiling fountains having different degrees of temperature" (Ross 1855), but failed to describe nearby landmarks which could confirm he was in (what is now) Yellowstone. Credible reports suggest that Joseph Meek visited the area in 1829 (Victor 1871); and we know that Osborne Russell (Russell 1914) and James Bridger each visited Yellowstone in the 1830s, the latter extensively through the 1870s (Cramton 1932).

Currently, archeological evidence of fur trappers is relegated to historical observations. Superintendent Philetus W. Norris observed in 1881 near the Mystic River "J.O.R, August 29, 1819" carved into a pine tree that also contained small wooden pins inset into it, typically used by fur trappers. Hiram M. Chittenden observed the same carving 14 years later, but it was heavily obscured by overgrowth (Haines 1974). There are remains of trapper cabins in the park, and we work closely with NPS backcountry law enforcement rangers to protect these sites. These may have been erected by trappers us-



Artifacts from the site of the former Old Faithful Pub area. On the left are assorted bottles from the early 1900s. The pub was originally a dormitory; and the majority of these small bottles were identified as medicine bottles, which may have belonged to the men who lived there. We can extrapolate the time frame at which the shift from a residence to a pub was made, based on the dates of these types of artifacts versus later artifacts associated with pub nightlife. On the right is a perfume vial found at the old Stage Barn at Old Faithful. A fine powder is still present inside the sealed vial.

ing American Indian trails which travelled throughout the park, many of which are now trails used recreationally by visitors. While constructing the Norris Road near Obsidian Cliff, workmen found a cache of iron traps, noted by Supt. Norris as being manufactured by the Hudson's Bay Company more than 50 years earlier (Norris 1879).

Government exploration of the area began in 1860, with an expedition led by Captain William F. Reynolds of the U.S. Army Corps of Topographical Engineers. Jim Bridger was a member of that party as a guide, while Dr. F.V. Hayden served as geologist (Cramton 1932). They attempted to explore the Yellowstone Plateau and investigate reports of the natural features, but were unable to reach the park interior due to late spring snow (Haines 1974, Baldwin 1976). An 1863 expedition led by Captain James Stuart encountered many setbacks and was forced to turn back (Cramton 1932).

In 1869, David Folsom, Charles Cook, and William Peterson made the first major foray with the sole intent of exploration into Yellowstone. Leaving Bozeman, they made their way to the Yellowstone River and followed it past Tower Falls, up the Grand Canyon of the Yellowstone River to Yellowstone Lake. They then visited geyser basins at West Thumb, Shoshone Lake, and the Firehole River, publishing the wonders they observed in

Western Monthly (Haines 1974). The Washburn expedition of 1870 followed the route of the 1869 expedition, and conducted more exploration and scientific analysis of the geologic features of the park (Haines 1974). Hayden's 1871 Expedition truly cemented Yellowstone as a wonder in the public mind, partly due to the scientific results obtained by the expedition's biologists and geologists, but particularly due to the photography of William Henry Jackson and the magnificent paintings of Thomas Moran. Following these major forays into the park, the Yellowstone National Park Protection act was signed in 1872 and thus the world's first National Park was born (Haines 1974).

The Park's Formative Years

We have a great deal of information about the earliest park headquarters on Capitol Hill and the earliest Army encampment in the park, Camp Sheridan (1886-1891), which was located just north of the Mammoth Hot Spring Terraces on and surrounding Capitol Hill. Philetus Walter Norris became the second Park Superintendent in 1877, and soon afterwards he established the park's headquarters in Mammoth. Norris built a blockhouse atop Capitol Hill in 1878, accessed by a wagon road. At the base of the hill there was a reservoir, a barn, a blacksmith shop, and extensive fencing (Norris

1879). The blockhouse was raised in 1909 by the U.S. Army (Haines 1996a); however, archeological deposits are still present.

Through a partnership with the Office of the Wyoming State Archaeologist, the park completed archeological investigations of Capitol Hill in 2014 (Peterson and Clayton 2014). An irregular depression on top of the hill denotes the location of Norris' blockhouse, and foundation remains of his house are present. Analysis of associated scatters of historic glass, ceramics, and metals have informed on the types of materials available at that time, to both the initial administrators of the park and particularly of the later Army occupation of the area, with the majority of artifacts manufactured between 1879 and 1909. Some evidence of the fencing that Norris built remains, but the barn or blacksmith shop was not relocated (Peterson and Clayton 2014).

The U.S. Army

The U.S. military presence in Yellowstone is unique. In August 1886, to enforce regulations and prevent illegal harvesting of big game the U.S. Army took over administration of the park. While stationed at the park, troops routinely patrolled the roads and tourist areas and fought forest fires while maintaining military readiness, which included training and drills (Rust 2017).

Camp Sheridan was established near the Mammoth Hot Spring terraces, and consisted of a T-shaped barracks, a storehouse/warehouse, a guardhouse, a cavalry stable, and a quartermaster stable. An officers' quarters, a post hospital, and a headquarters office were added in 1887. The hospital and the officers' quarters were located at the base of the western slope of Capitol Hill, in close association with Norris' blockhouse. Soon after that, the army constructed five more buildings: a commanding officer's stable, an enlisted men's quarters, an ammunition and gunpowder magazine, and an ice house (Haines 1996b). All of the Camp Sheridan buildings were demolished in 1915 (Brett 1915). The U.S. Army officially ceded control of the park to the Department of Interior in 1918 (Battle and Thompson 1972).

Artifacts recovered during excavations held in 2014 (Peterson and Clayton 2014) reflect what the soldiers were using in their daily lives. Officers, considered part of the aristocratic class in Victorian society (Adams 2009), visited the hotels to call upon the guests (U.S. Dept. of the Interior 1907, Brett 1914). We can see how military personnel, many of whom were from the eastern part of the country, adapted to life in a remote out-

post, and what eastern luxuries they either procured locally or brought with them to their posting. For example, in the area of Camp Sheridan, Peterson and Clayton found a Curtice Brothers Ketchup bottle from Rochester, NY; several export-style beer bottles; a salt-glazed ceramic mineral water bottle from either Germany or the Netherlands; the remains of three domestic cats; an Ed. Pinaud perfume bottle from Paris, France; and numerous other glass shards, can fragments, ammunition casings, and so on (Peterson and Clayton 2014). We can also see what activities they were engaged in that may not have been authorized by military and post regulations, such as alcohol consumption. Through analyzing these materials we better understand how the soldiers were participating in regional and global economies through their purchases. The building remains, though somewhat sparse, help us understand the daily lives of the park and military personnel before Fort Yellowstone was established at Mammoth Hot Springs, and we work with NPS Law Enforcement to protect these important non-renewable archeological resources. The Camp was replaced by Fort Yellowstone in 1891, constructed on the northeastern side of Capitol Hill near Camp Sheridan (Haines 1996b). Dozens of buildings were constructed, and many of these buildings stand today and are used as park offices and residences.

During their tenure, U.S. Army personnel also established Soldier Stations across Yellowstone, including Lake Outlet, Mud Geyser, Norris Geyser Basin, Fountain Flats, Thumb Bay, Specimen Creek, Grand Canyon, Heart Lake, Riverside, Tower Falls, Lamar River, Sylvan Pass, Soda Butte, and Bechler. These buildings were either constructed or rehabilitated from the former park gamekeeper's cabin (Soda Butte), mail station (Riverside), or quarters for assistant superintendents (Haines 1977); and some were occupied year-round (Karsmizki 2001). Only two of these remain standing today (Haines 1996): the Bechler Soldier Station, now used as a Ranger Station, and the Norris Soldier Station which houses the Museum of the National Park Ranger. A network of back country snowshoe cabins were also constructed, from which the military could better protect the park's resources through regular patrols. Four of these cabins remain today: at Buffalo Lake, Thorofare, Fox Creek, and Harebell. Built in 1912, the Buffalo Creek cabin is the oldest in the park (Culpin 1997).

Little documentation on the daily lives of the soldiers at these stations survives, excepting weekly and monthly reports which are brief and narrowly focused, such as

daily patrol routes, game seen observed, and numbers of registered visitors (Karsmizki 2001). Soldiers were infrequently visited by officers and reported a sense of loneliness, particularly in the winter (Rust 2017). Alcohol bottles were recovered at the Fountain Flats Soldier Station, indicating that soldiers were able to procure it (Karsmizki 2001). As they were viewed in Victorian society as lower class citizens (Agnew 2008, Adams 2009), enlisted men were not allowed to go into the hotels unless invited by hotel managers to attend dances at the hotels, in their dress uniforms (Brett 1914, Park Orders 1914), and did meet young ladies staying at the hotels (Rust 2017).

Archeological resources are associated with occupation of these Soldier Stations, such as refuse dumps and sheet middens, a thin layer of debris scattered in a halo pattern around the buildings. Limited excavations at the Tower Falls, Fountain Flats, and Soda Butte Soldier Stations have provided important data. Fieldwork conducted between 1995 and 2002 at Tower Falls Soldier Station, including magnetometer survey and excavations, has identified potential locations of several structures, such as an officers quarters and cabin, as well as a well, corral, and refuse dump (Karsmizki 2000b; Sanders et al. 2003). Artifacts recovered include a plate, bowl, bottle fragments, tin can fragments, bullets, leather, comb fragments, buttons, and architectural materials such as square and wire nails, lumber, and mortar (Karsmizki 2000b).

The archeological site at Fountain Flats was identified in 1959, and excavated between 1992 and 1995 identifying the probable location of the station and its root cellar, stable, and corral (Taylor 1964, Cannon and Phillips 1993a, Hartley et al. 1993, Hunt et al. 1994, Hunt 1995, Karsmizki 2001). Numerous military items were collected during this work, including rock, brick, window glass, nails, mortar, ammunition, animal bones, and alcoholic beverage containers (Karsmizki 2001). At Soda Butte, two potential building foundations and seven refuse dumps as well as a sheet midden were identified, and more than 1,000 artifacts were collected by archeologists between 1995 and 1997 (Sanders 1995, Karsmizki 1998). Analysis of butchered animal bones reflect soldiers hunting elk and deer to supplement their military rations (Karsmizki 1998, Rust 2017).

By comparing materials collected at the Soldier Stations to those recovered at Mammoth, the archeological record reflects the lives of soldiers far away from

headquarters, providing insights that either support or disagree with historical documents. Today, we ensure that significant archeological deposits related to Camp Sheridan and Fort Yellowstone are protected during construction-related activities, so that we may preserve this part of our heritage for future generations.

Transportation Improves Visitor Access

The park was difficult to access in its early days. In the early 1870s, there were two options; by railroad to Corrine, Utah, and then overland by stagecoach to Virginia City, Montana, or by travelling up the Missouri River to Fort Benton, Montana, and then by stagecoach to either Bozeman or Virginia City. Visitors traversed the final leg of their journey by following the Madison River through what is now West Yellowstone or the Yellowstone River through Gardiner (Culpin 1994). Portions of these early wagon road routes either parallel or were incorporated into modern roads, such as North Entrance Road and the West Entrance Road. These early roads are considered important archeological resources and are designated National Historic Districts. Supt. Norris initiated construction on the general route for the Grand Loop Road, the park's major transportation corridor today, and built many bridges throughout the park which became important waypoints for the earliest tourists to visit Yellowstone.

Also in 1871, "Yellowstone Jack" Baronett constructed a toll bridge over the Yellowstone, near where the current Yellowstone River Bridge now sits. Baronett mainly served miners travelling to and from Clarks Fork of the Yellowstone River. Though partially burned by the Nez Perce during their flight from the army, it was rebuilt by the U.S. Army in pursuit, using materials from Baronett's own cabin as planking (Wilfong 2006). With these repairs, the toll bridge continued in operation until its eventual abandonment in 1880 (Culpin 2003). Remnants of this bridge are still visible today along the Yellowstone River.

Travel to the park improved with extension of railroad lines. In 1883, Northern Pacific built a line to Cinnabar (between modern Corwin Springs and Gardiner), extending it to Gardiner in 1903 with the depot located near Roosevelt Arch (Haines 1977, Butler 2006). Cinnabar was abandoned that year, and several buildings were relocated to Gardiner (Dick 2011). Union Pacific began operating a line to West Yellowstone in 1908, becoming the quickest route to the iconic Old Faithful and Upper Geyser Basin. This line ran until 1960 and was the last



Excavation of a root cellar (stones, center left) and the foundations of the Fountain Soldier Station (center right), 1995. After the Fountain Soldier Station was abandoned, it was burned and the debris was disposed of in the open root cellar hole. Artifacts found in the root cellar included bricks, nails, window glass, and bottles. The station was built in 1886 and destroyed in the 1930s when the Grand Loop Road was constructed in the area.

railroad line operating to a park entrance. Other lines offered access to the park, but not so directly, switching from train to stagecoach or bus in Lander or Cody, Wyoming, and Red Lodge, Montana (Butler 2006).

A series of building foundations and a dump site in Cinnabar were examined by archeologists from the University of Montana between 2007 and 2008. Through analyzing the functions of artifacts recovered, the team identified a hotel, blacksmith shop, and privy. In addition, domestic materials, such as tablewares and foods, and personal items, such as toiletries, clothing, and footwear are helping us learn about tourist behaviors in the early years (Dick 2011), such as what items did they bring, and how do they reflect their visitor experiences?

When automobiles were allowed into the park in 1915, a new era of tourism began in the park. Tourism shifted from mainly a group activity to allowing opportunities for individual travel (Hunt 1993, 2010). One of the earliest roads into the park was the Virginia City and National Park Free Road, which followed the Madison

and Firehole rivers to the Lower Geyser Basin (Hunt 2004). Soon after, Mary Mountain Road connected this geyser basin to the Hayden Valley (Hunt 2004), which General Howard utilized in his pursuit of the Nez Perce through the park in 1877. All of the major park roads, the North Entrance Road, West Entrance Road, Northeast Entrance Road, South Entrance Road, East Entrance Road, and the Grand Loop Road, are either listed on or eligible for listing on the National Register of Historic Places for their scenic character, individuals involved in construction, national significance as first of their kind, or a combination thereof (Culpin 1994). Many of these roads have been realigned to better serve visitors or protect natural resources, and many of the dozens of abandoned road segments are part of the current network of trails. Likewise, many of the road bridges, Fishing Bridge for instance, are significant works of artistic engineering that reflect the Park Service's ethos of laying lightly on the landscape.



The *E. C. Waters* afloat at Lake Dock in 1905 (top). The *Waters* was abandoned in a cove off of one of the islands in the lake, where it washed ashore and broke apart in 1926. It was used as a warming hut for skiers on the lake until 1930, when rangers burned the eyesore. Seen below is the wreck of the *Waters* along the shore in 1996.



Tourism Flourishes with Concessioners

Entrepreneurs also established businesses in these early years to take advantage of burgeoning tourism. Harry Horr and James McCartney were the first to build permanent developments in the park. Three bath houses and hotel were placed in Clematis Gulch at Mammoth close to Liberty Cap in 1871, the year prior to the establishment of the park, and catered to those who believed that the springs might have healing powers and to pleasure seekers (Peale 1999, Culpin 2003). The first in the park, McCartney erected a 25x35 ft., one-story, sod-roofed hotel, described by the Earl of Dunraven as a “little shanty which is dignified by the name of hotel” (Culpin 2003). Little development occurred in the Mammoth area beyond the bathhouses and hotel at this time (Rydell and Culpin 2006), and as of yet we have no archeological evidence of these bathhouses. Further north, McGuirk established his Medicinal Springs in 1871, but it only lasted three years as he failed to lodge a land claim prior to the establishment of the park. McGuirk’s buildings were used as government housing between 1874 and 1889, until razed by the Army in 1889 (Culpin 2003). We are planning upcoming archeological investigations to examine the remains of these buildings and associated archeological deposits to learn more about this period in its history.

Over the coming decades a wide variety of concessioners would continue with their efforts to service travel-

ers in the park. Construction on the Queen’s Laundry Bathhouse started in 1881, but due to a change in Superintendents the building was never completed (Culpin 2003). The remains of the 9x19 ft. structure are the oldest extant remains of a concessioner-built structure in the park and has been listed on the National Register of Historic Places since 2001. William Wylie established a very early camping concession in 1883, the Wylie Permanent Camp Company. In 1889, he began building permanent tent camps throughout the park, including near Apollinaris Spring, Swan Lake Flats, the Upper Geyser Basin, Lake Outlet (Fishing Bridge), Grand Canyon, and Camp Roosevelt, which is now home to Roosevelt Lodge (Haines 1996a, 1996b, Culpin 2003). Wylie abandoned his enterprise when motorized vehicle access to the park eliminated the need for places to stop for tourist traveling throughout the park (Haines 1996a, 1996b). Archeological investigations in the Swan Lake flats area identified refuse dumps, and historical artifact sheet middens at the camp which once had tents, privies, a pavilion hall, dining rooms, a kitchen, bath house, and staff office and quarters (Karsmizki 2000a). Metal grommets, used to fasten down the tents, as well as sanitary food cans, solder-dot milk cans, lard and other tin cans, bottle fragments—some manufactured by the American Bottle Company in Chicago, Illinois, (Sanders, Waitkus, et al. 1996), fragments of amethyst glass whiskey bottles, and a shoe buckle were collected. Most surprisingly,

an early sewage disposal system was found, consisting of ceramic sewer tile pipe leading into slit trenches, believed to capture and contain human waste (Karsmizki 2000a). It was installed by 1910 in response to concerns by the Post Surgeon at Fort Yellowstone and the Park Superintendent on the questionable sanitary conditions at the camp.

Another major development in the park was the Pleasant Valley Hotel or Wayside Inn Hotel. John Yancey had been in the area since 1882, and operated mail stops between Mammoth and Cooke City for two years. He established the hotel in 1884 at the halfway point between those stops, now known Yancey's Hole (Rydell and Culpin 2006). The business expanded to include a log saloon, barn and cattle feeding shed, and stage stop by 1893 (Dowd et al. 2005). The hotel operated after Yancey's death in 1903 until it burned in 1906. Although all remaining outbuildings were razed in 1960, parts of the foundations and stage coach access road are still visible today. Limited test excavations at the site revealed a flagstone foundation, and a variety of glass and ceramic tablewares, bottle glass, a tobacco tin, and animal bones (Dowd et al. 2005). These materials provide a glimpse into the activities at smaller early hotels in the park, such as what was on the menu and how meals were served. Sites such as the Wylie Camp and the Pleasant Valley Hotel are important as they shed light on the park's transition from an unregulated entity to a well-organized destination for tourists.

In 1882, major growth in tourist amenities at Mammoth began when the Yellowstone National Park Improvement Company, funded by the Northern Pacific Railroad, began operating in Mammoth. The National Hotel, which later became the Mammoth Hot Springs Hotel (Haines 1996a) was built in 1883, and the tourist boom was on. Portions of the hotel were removed over the course of the next fifty years, and the majority of the old National was torn down in 1936. The present Mammoth Hotel includes the north wing of the National Hotel; during renovations in 2016, portions of early water/sewer lines, including a manhole access with wood framing, were located and recorded. We will be working with project managers and construction teams as building rehabilitation continues, to ensure that any archeological deposits uncovered beneath the building during construction activities are carefully studied before they are covered over.

Refuse dumps are important sources of information, as they contain a variety of artifacts which provide in-

sight into various peoples living and working in the park (Ayres 1989; Hunt 1993, 2010). These are associated with 1920s road camps where workers lived while constructing the roads (Johnson 1989, Cannon and Phillips 1993b), Civilian Conservation Corps camps or early campgrounds (Cannon 1992, Cannon and Phillips 1993c), and especially with the grand hotels (Cannon 1992, Daron 1992, Cannon and Phillips 1993c, McCullen 2002, Hunt 2010, Horton 2017). The majority of artifacts in these refuse dumps often date to the early 20th century and primarily represent material culture related to tablewares, beverages (soda/mineral water, soft drink, beer, whiskey, bitters and other alcohols), and foods, identified through analysis of tin cans, similar to those served at park concessionaire hotels. Other items include those having a personal function, reflecting the needs of park tourists, such as medicines, toiletries, and footwear (clothing). Often early to mid-20th century soda water, soft drink, and alcohol bottles comprise the majority of these assemblages (Horton 2017).

Not all historical archeological sites in the park are terrestrial, some are underwater. Located along the Firehole River, the Marshall Hotel, built 1880 -1881, later replaced by the larger rustic Firehole Hotel, in operation from 1884 to 1891, was the first to receive an official Department of the Interior concession permit (Corbin et al. 2010). The building served several functions over time until its removal in 1910, including as a mail stage in 1880, a family-owned hotel to a corporate hotel run by the Yellowstone Park Association, and transfer to the Army for use as a large summer encampment. The short 30-year occupation of this area is important in that it gives us a relatively well contained microcosm of the park. Though the location of the hotel has long been known, formal archeological fieldwork was only initiated between 1992 and 2001 (Hunt 2004, Corbin et al. 2010). The full boundaries of the site were mapped which gave a rough-grained view of not only the hotel's blacksmith shop, saloon, two log residences, the log stable, the 1885 bathhouse, but also of the various use areas surrounding the former hotel. Water pipes, a hand-dug bathtub connected to a nearby hot spring, several building foundations, and historic artifact concentrations in the river were located (Corbin et al. 2010). Remains of this hotel not only present on the floodplain, but refuse had collected where it washed into the river over time (Corbin et al. 2010). The result of these investigations was a fuller picture of an early frontier hotel and of the cultural landscape which grew around it. The site

will continue to provide a glimpse of early life after the park was founded, without obfuscation by modern development activities associated with hotels and lodges currently in active use.

Beneath the waters of Yellowstone Lake are a number of archeological sites, such as dock remnants and shipwrecks. United States government-sponsored expeditions ran boats on the lake as early as 1870 (Bradford et al. 2003, Russell et al. 2010), with concessionaires beginning operations in 1875 (Russell et al. 2010). In 1996, the NPS undertook a marine (underwater) survey, which located the wrecks of several small pleasure craft in the lake, and docks at West Thumb and near the Lake Hotel. Excitingly, wreck of the 125 ft. long, wooden-hulled, single-screw passenger steamer *E.C. Waters* was identified, the largest to operate on the lake (Haines 1996, Russell et al. 2010). Launched in 1905, the *Waters* could carry up to 500 passengers, though it never had more than trial runs. Doomed to an idle existence, the *Waters* was secured in a cove on one of the islands, thought a safehaven from thick winter ice. After languishing unused for years, the *Waters* broke up in 1926, caught in heavy ice. Archeological remains of the *Waters* are still present (Bradford

et al. 2003, Russell et al. 2010) and give us insight to the history of maritime tourism in the park.

Many early concession buildings were removed as a part of the NPS Mission 66 building campaign, initiated in 1956 as the NPS prepared to serve increasing numbers of visitors over the next fifty years. Buildings deemed outdated or extraneous were either relocated or demolished (Culpin 2003). Through this process, many places that were once part of the park's built environment are now represented by the archeological record instead. The remains of these structures, associated outbuildings, and objects (now artifacts) dropped by their previous inhabitants are all important parts of Yellowstone's history.

The Importance of Historical Archeology

So why is historical archeology in Yellowstone important? Examining these types of sites helps us tell the story of the creation of the park and of the burgeoning tourism industry which made majestic nature accessible to the people of the United States and the world. The park that we enjoy today was shaped by Native Americans, early European American explorers, U.S. Army per-



Log cribbing on the Old Chittenden Road near the top of Mount Washburn. This structure was built to bridge a ravine along the Old Chittenden Road between Tower Junction and Canyon Junction, which was completed in 1904 and used until 1931, when the current road alignment was completed.

sonnel, entrepreneurs and concessioners, and National Park Service employees who came before us. These sites grant us a somewhat unique view of leisure and tourism development in a remote park environment over the past 140 years, a viewpoint that is unavailable in most other places in North America.

As the park moves forward over the next centuries, we will leave our own marks on the park, which in turn will be studied by a future generation of archeologists. It is our responsibility to learn about the past in a manner that preserves information. When we study archeological sites, we often leave the old bottles, tin cans, ceramic plates, saddlery remnants, building foundations, fenceposts, and nails in place for future generations of archeologists. They will be able to learn much more than we can today, with advancements in scientific methods that we only dream of today. So if you're lucky enough to come across some of these important historical archeology sites, take a moment and experience the connection to those who came before us, but leave the items in place for future generations.

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Thomas James is the Cultural Resource Specialist for Yellowstone's Road Program and works to balance preservation of archeological sites, historic structures and districts, and cultural landscapes with the infrastructure improvements necessary to accommodate ever growing visitation. Tom graduated from Mississippi State University with BA and MA degrees in Anthropology. Before coming to Yellowstone, he worked at the University of Chicago, the Federal Emergency Management Agency (FEMA), and the Bureau of Land Management (BLM). At the University of Chicago, he was an Assistant Curator at the Oriental Institute Museum and staff archeologist for the Oriental Institute Nubian Expedition in the Sudan. With FEMA, Tom was the Supervisory Archeologist for the Hurricane Katrina recovery mission at the Mississippi Recovery Office. With the BLM, he worked as the Field Office Archeologist at the El Centro Field Office in the California Desert District.

DEBUNKING THE MYTH: *America's Eden*

Excerpt from "Engineering Eden" by Jordan Fisher Smith

To early Euro-American visitors, in comparison to New England, Yellowstone certainly looked like a wilderness. But it had been under some kind of human influence for thousands of years before it became a nature-management kindergarten for an otherwise highly advanced civilization that had by then laid a telegraph cable across the bottom of the Atlantic between Ireland and Nova Scotia. In 1959 an eleven-thousand-year-old spear point was discovered during excavation for a new post office in Gardiner, Montana, on the park's north boundary. About four years later, a ten-thousand-year-old stone projectile point was recovered in southeastern Wyoming, and its mineralogy traced back to Neolithic toolmakers' quarries at Yellowstone. Along the shoreline of Yellowstone Lake, archeologists excavated extensive hunting camps aged at 9,300 years before the present. One recent chief archeologist at Yellowstone estimated there are 80,000 archeological sites in the park, of which only about 1,800 have been documented.

On stone tools recovered from the Yellowstone Lake sites, highly sensitive DNA technology found traces of the blood of bighorn sheep, elk, rabbits, and other game. Hunting pressure on Yellowstone wildlife was probably heavier before the 1700s, when the cold snap known as the Little Ice Age and epidemics of infectious disease reduced Indian use of the Yellowstone Plateau.

Above the Grand Loop Road south of Mammoth Hot Springs, a once-famous industrial zone known as Obsidian Cliff glints strangely in the sun. Formed by volcanic flows high in the mineral silica, volcanic glass from Obsidian Cliff was prized by native toolmakers for the production of razor-sharp knives, scrapers, and projectile points. Sourced from different deposits, obsidian looks about the same, but depending on where it comes from, its chemical makeup differs. This mineral fingerprint allows archeologists to trace stone implements back to where they were quarried.

In Ohio, over 1,400 airline miles from Yellowstone, hundreds of objects unearthed at a Hopewell culture site were made of Yellowstone obsidian. At another ex-

cavation in Indiana, blades made of Yellowstone obsidian were found over 1,200 straight-line miles from the park. By the eighteenth century the tribes that inherited Hopewell territory were decimated by European diseases. The trade routes by which their obsidian made its way from Yellowstone to the Midwest may have been, in the words of one archeologist, "vectors of death," transmitting obsidian east and deadly microbes west, ahead of white explorers. Contagion came in waves, first on foot, and later by steam. A smallpox epidemic spread into the northern plains between 1780 and 1782, and another in 1837, aboard a steamboat traveling up the Missouri River to Fort Union. In all, according to Yellowstone historian Paul Schullery, aboriginal North America suffered at least twenty-eight epidemics of smallpox, twelve of measles, six of influenza, and four each of diphtheria, plague, and typhus.

The first non-Indian we know of to visit Yellowstone was the fur trapper John Colter. On his return from service with the Lewis and Clark expedition, he was recruited by the Missouri Fur Trading Company to survey new sources of animal pelts and pass the word among the Blackfeet about the company's new trading post at Fort Union, later the source of contagion in the 1837 smallpox epidemic. In a remarkable five-hundred-mile solo trek in 1807 and 1808, Colter passed through Yellowstone. After 1826 the area was visited regularly during the fur trade, and according to accounts from that time, the Blackfeet, Crow, Sheepeaters, Bannock, and other Shoshone groups were sharing the area for hunting, fishing, and quarrying obsidian.

After microbes did their work, the founding of the national park took place against a backdrop of military mop-up operations. In 1877, some six hundred Nez Perce men, women, and children passed through Yellowstone, fleeing a massacre by Army cavalry with orders to kill them or force them onto a reservation. In a strange juxtaposition of Yellowstone's past and its ecotourism future, the Nez Perce encountered park visitors on camping excursions whom they took as hostages and, in some cases, shot. The following year the US



Army campaigned against the Bannock in the region, and in 1879 against the Sheepeaters in what is now the Frank Church–River of No Return Wilderness, to the west in central Idaho.

When this dark chapter in American history was over, by the twentieth century, visitors from Chicago or Great Falls could stroll up a Yellowstone trail and imagine themselves as the first humans in a wilderness that had never been entirely free of people since the end of the last ice age. Because Euro-Americans didn't witness the effects of Indian hunting until after Indian populations had been reduced by infectious disease, we can only conjecture about how they functioned in concert with cougars, bears, wolves, and coyotes in regulating the number of prey species, such as bighorn sheep, deer, elk, bison, moose, and antelope.

The Lamar Valley, an elongated basin of wide-open grassland and sage steppes in the northeast corner of Yellowstone, has long been known as one of the two or three best places in the park to observe wild animals. For most of the twentieth century the valley harbored America's largest herd of wintering elk. The two-lane road from park headquarters to the Northeast Entrance, which traverses the base of the hills on the valley's north side, is the only road open through Yellowstone in the winter. Not many years ago, when the elk came down from the high country with the first snows, people would drive out to the Lamar Valley to marvel at the mass of blondish-brown, furry backs shining in the winter light, the forest of antlers, and the sparkly dust of snow as the elk pawed around for something to eat. The northern elk herd, as they were called, were seen as one of the last great wild spectacles of North America, an intimation of how things had once been, before they were altered. Or so people thought at the time.

A short piece southeast along the road through the Lamar Valley from the cluster of log buildings known as the Buffalo Ranch, there is a paved turnout where visitors get out of their cars with their binoculars and spotting scopes to observe herds of bison and pronghorn antelope. From 1989 to 2013, a Park Service educational placard stood facing the road there at waist level. The text was laid out over a large photograph of what you would see on an average summer day from there: grasslands, a row of old cottonwood trees, and wild animals. The text explained that the Lamar Valley supported a remnant of the vast wildlife herds that once roamed North America" above which was the placard's title, in large letters: AN AMERICAN EDEN.

And so it seemed to any visitor who didn't know the place's history. To anyone who did, the Lamar Valley bore less resemblance to Eden than to the Civil War battlefields the Park Service takes care of back east. For decades it was probably the most scientifically contested piece of ground in America. The fight there was about how much scientists ought to manipulate and control nature in order to preserve it.

Arguments are rooted in uncertainty. There is little controversy about things we know for certain. In order to understand the disagreement that began at the Lamar Valley and spread to the rest of Yellowstone we must go back to the early nineteenth century, when what was about to happen to the western United States could be compared to the loss of knowledge of the ancient world when the Library of Alexandria burned to the ground in 48 BCE. But in this case, the "library" that was to be burned—and cut down, dug up, shot out, and sold off—was the information that could have been gathered, had there been anyone with today's ecological skills to do it, about what nature was and how it had worked before it was altered.

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Jordan Fisher Smith's *Engineering Eden* won a California Book Award and was longlisted for the PEN/E.O. Wilson Award for Literary Science Writing. His memoir of his strange life as a park ranger, *Nature Noir*, was an Audubon Editor's Choice and a Wall Street Journal Summer Reading pick. He appeared in and narrated a film about Lyme disease "Under Our Skin," which made the 2010 Oscar Shortlist for Best Documentary Feature, and is featured in a new documentary on quality of life, "Redefining Prosperity."

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Archeology along the Nez Perce National Historic Trail

Daniel H. Eakin & Elizabeth A. Horton

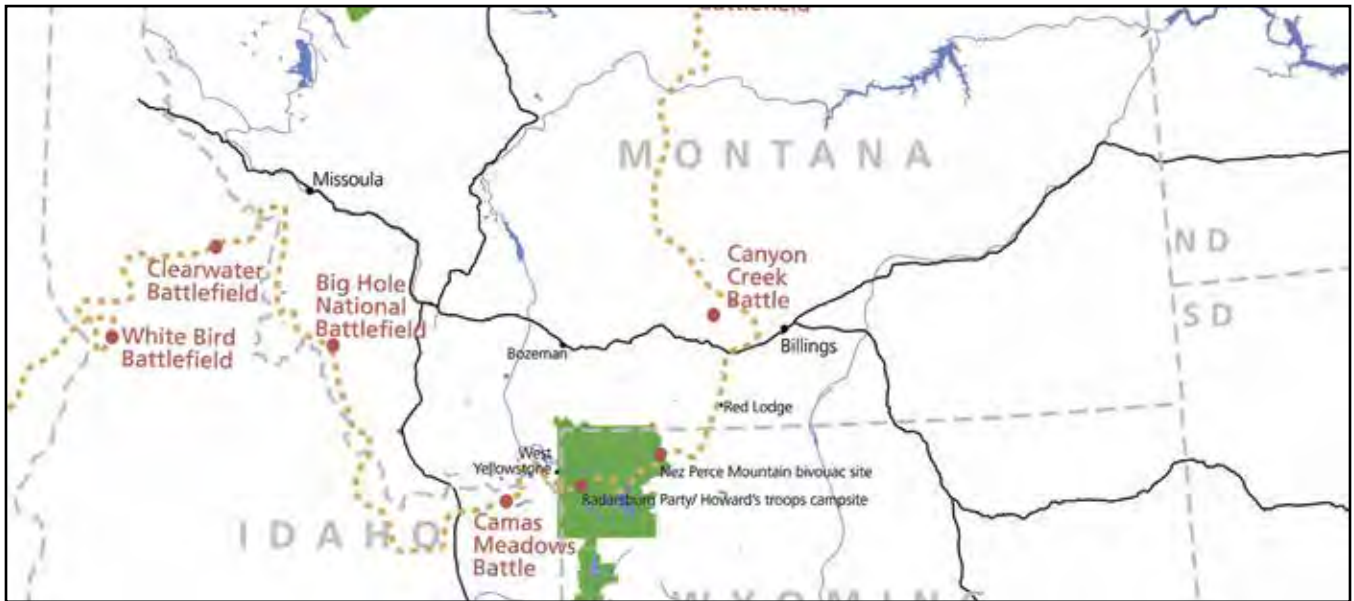


Figure 1. Map showing Nez Perce National Historic Trail.

When Yellowstone National Park (YNP) was created in 1872, much of the western Great Plains and Rocky Mountains remained uncharted wilderness still dominated by various Native American tribal groups, some of which were fighting for their own survival. Though the southern Plains Indian wars were winding down, Custer's defeat on the Little Bighorn was still four years away. Nonetheless, YNP quickly caught the imagination of the American public with accounts of steaming geysers, bubbling hot springs, and other geological wonders. By the mid-1870s, a few settlements had sprung up in surrounding mining regions; and although there were virtually no roads and mostly Indian trails to follow on horseback, a few adventurous citizens visited YNP on sightseeing and other excursions. The creation of YNP and its earliest "use" exemplifies the European American concept of a "park" as a place that must remain in a natural state. It was into this setting that the Nez Perce (Nimi'ipuu or Nee-Me-Poo) entered in the summer of 1877, and when they learned from white captives that they were in a National Park the idea of preserving such a small area must have been difficult for them to comprehend given their dependency on the natural world for their basic needs

and survival. Such collisions of culture and philosophy continue to shape the West and its people even today.

To commemorate the flight of the Nez Perce, Congress inducted the 1,170 mile-long Nez Perce Trail (NPNHT) into the National Trails system on October 6, 1986, through an amendment to the National Trails System Act of 1968 (figure 1). About 84 miles of the NPNHT is within YNP. Beginning in 2006, the National Park Service undertook a multi-year archeological inventory project along the Nez Perce trail through the park. These efforts not only identified locations of several Nez Perce, U.S. Army, and tourist encampments, but also clarified the general route the Nez Perce followed through the area.

The 1877 Flight of the Nez Perce

Summer 1877 brought inescapable change for the Nez Perce. The 1855 treaty of Walla Walla, ratified by Congress in 1859, established a seven million acre Nez Perce reservation on traditional lands in parts of what would become the states of Idaho, Washington, and Oregon. The discovery of gold in 1860 resulted in an uncontrolled influx of miners and settlers onto reservation lands, and in 1863 the U.S. Government elected to renegotiate the treaty and shrink the reservation to

approximately one-tenth its original size. This resulted in a schism within the Nez Perce leadership between those willing to sign the new treaty (treaty Nez Perce) and those who were not (non-treaty Nez Perce). Many of the treaty bands had been Christianized and stood to benefit from the new arrangement; whereas non-treaty bands, who were known for crossing the Bitterroots to hunt buffalo, often with the Crow, and retained much of their traditional culture, were unwilling to relinquish their traditional homeland. The new treaty was ratified by Congress in 1867. By 1877 Indian-white relations in the area had deteriorated to such a degree that an ultimatum was issued by the government that all non-treaty Nez Perce must relocate within the new reservation by June 14. On June 17 U.S. army and volunteer soldiers approached a Nez Perce camp on Whitebird Creek in western Idaho. When a party of six warriors bearing a flag of truce approached the soldiers, one of the volunteers fired at them, thus precipitating the Nez Perce War of 1877.

After the outbreak of hostilities, a group of roughly 250 warriors and 500 elders, women, and children, with over 2,000 horses embarked on what would become a 1,170 mile long trek that ended on October 5, 1877, at the Bear Paw Battlefield near Chinook, Montana, approximately 40 miles south of the Canadian border (figure 1). During this time the Nez Perce were led by chiefs Ollokot, White Bird, Toohoolhoolzote, Looking Glass, and Hinmst-owyahtq'it (Joseph) (figure 2). General O.O. Howard, Commander, Department of the Columbia, pursued the Nez Perce throughout their flight, although their final defeat was to forces led by Colonel Nelson A. Miles, Commander, Tongue River Cantonment, Department of Dakota. After their surrender, about 200-300 Nez Perce managed to avoid Miles' pickets and cross into Canada while the remaining survivors were sent to Indian Territory in present day Oklahoma. Today, descendants of non-treaty bands live among three groups: the Confederated Tribes of the Colville Reservation in Washington, the Confederated Tribes of the Umatilla Indian Reservation in Oregon, and the Nez Perce Tribe in Idaho.

The Nez Perce travelled through a wide array of environmental conditions and habitats: wetlands, riparian areas, open meadows, mountains, and plains. The journey included four battles and several skirmishes with the U.S. Army. Even though there were no major military engagements within YNP, several incidents did occur between the Nez Perce and civilian tourist groups

and ranchers, as well as Bannock scouts employed by the army.

On August 23, 1877 the Nez Perce entered YNP via the Madison River near present-day West Yellowstone. The main contingent followed the Madison and Firehole rivers to Lower Geyser Basin then crossed the Central Plateau and Hayden Valley, forded the Yellowstone River, continued around the north shore of Yellowstone Lake and traversed the rugged terrain through the Absaroka Mountain Range, probably exiting the park sometime between September 4-6. Their route likely followed pre-existing trails for much of the way. Howard's army followed essentially the same route as the Nez Perce and often occupied their same campsites until the Yellowstone River, at which point they turned north in an attempt to intercept the Nez Perce somewhere on Clark's Fork on the east side of the Absaroka mountains. Once reaching Barronett's Bridge, the army followed the road to the Cooke City mines through the Lamar Valley and then crossed the divide to the upper Clark's Fork. During this time, however, Nez Perce raiding and scouting parties were active and headed north into Mammoth Hot Springs, Stephens Creek, Lamar Valley, and the Clark's Fork. Twenty-two tourists also came into contact with the Nez Perce within the park. All were robbed, several were shot, two were killed and a number captured, including some who were used as guides.

Focus on Collaborative & Interdisciplinary Research

YNP consulted with descendants of the non-treaty groups who participated in the 1877 war. They shared oral histories of the ordeal and information on traditional knowledge and use of the Yellowstone region unavailable through other sources, such as areas their ancestors may have been selected as campsites. As archeologists, we use this information not only to assist in locating sites related to the 1877 events, but also to incorporate concerns of Nez Perce through proactive management and stewardship of these important places.

Nez Perce elders reported that prior to 1877, their people used the area that is now YNP to hunt, trap, fish, trade, and visit with other tribal groups, such as the Crow and Shoshone. Their leaders used routes that they had learned from their elders. They knew park terrain and deployed advanced scouting parties as well as rear guard to avoid capture by the army. They would read the land to determine where important resources were, and camp near water and grass for their horses (Sucec 2006).

In such situations only wikiups, a lodge consisting of a frame covered with matting or brush, would have been constructed and used by traveling Nez Perce (figure 3). They also stated that trees were stripped of their edible cambium if the group was short of food. Elders confirmed that several scarred trees near the Yellowstone River reflect cambium harvesting. Hydrothermal areas were used for their curative powers and to give an extra edge for success in their activities.

Working with the park archivist and park historian, NPS staff reviewed all potential sources of information and compiled relevant historical documents, maps, first- and second-hand army, civilian, and Nez Perce accounts; newspaper articles; soldiers' journals; photographs; and written collections. The information provided a rich historical background and context for events in YNP. These Nez Perce oral histories and historical accounts were analyzed to identify likely candidate locations for the 1877 events within the 84 miles of the trail within Yellowstone.

These data were valuable aids during archeological fieldwork and in several instances helped tie historical events to specific locations in the modern landscape. Archeological survey was conducted between 2006 and 2015 by the Office of the Wyoming State Archaeologist Survey Section, National Park Service archeologists and student interns, the University of Calgary, and members

of the Nez Perce Tribe and the Confederated Tribes of the Colville Reservation. Once designated search areas were identified, we looked for objects dating to an 1877 temporal context that could have been used by military, civilian, and/or Nez Perce. These included such items as horse tack, clothing items (military insignia, buttons, buckles, suspenders, etc.), mess equipment (forks, knives, spoons, etc.), and food remains (tin cans, etc.). Prehistoric sites composed of chipped stone and ground-stone tools were also recorded. Given the relatively late occurrence of the Nez Perce War, a vast array of metal objects had been incorporated into Nez Perce material culture, and an assortment of similar items would have been used by the U.S. Army and civilian participants as well. Park research permits allowed us to collect diagnostic artifacts for further analysis and conservation. Blaze marks, axe-cut stumps, hearth remnants, and other modifications to the local environment were also recorded.

Connecting the Past to the Modern Landscape

Although the team was able to identify several Nez Perce, U.S. Army, and tourist encampments, space requirements limit the discussion to the following sites associated with the 1877 events to provide us a glimpse into the material culture of the time.



Figure 2. Nez Perce Chief White Hawk (left) and Many Wounds in YNP in 1935. White Hawk was with the main group of Nez Perce in 1877.



Figure 3. Jackson Photo of Jackson Drawing Showing Nez Perce Village.

Radersburg Party Camp & Wagon Abandonment Site

Camped along Tangled Creek in the Lower Geyser Basin, the Radersburg Party (from Radersburg, Montana) consisted of George and Emma Cowan; Emma's brother and sister, Frank and Ida Carpenter; acquaintances, Charles Mann, Andrew Arnold, William Dingee, Albert Oldham, and Henry Meyers. The party used the area as a base camp for a couple of weeks from which they split into smaller groups to explore the geyser basins and the falls on the Yellowstone River. On the day before their capture, the party returned to this camp in preparation to leave. Nez Perce scouts sighted their campfire that night, but decided to wait until morning before approaching it.

At first light on August 24, 1877 a small party of Nez Perce led by Himiin Maqsmáqs (Yellow Wolf) approached the camp. After the initial encounter, Nez Perce numbers quickly multiplied; and the Radersburg party decided to pack the wagons, saddle the horses, and head north as quickly as possible. When they departed camp they did so under the escort of 40-50 warriors. One of the Radersburg tourists described the Nez Perce procession as three miles long and driving 1,000 to 1,500 horses up the trail. Near the mouth of what is today Nez Perce Creek, the party was informed that they could not continue and forced to accompany the main Nez Perce group up-valley. Above Morning Mist Springs, the Radersburg party had to abandon their two wagons and the majority of their equipage due to thick timber. Horses from the wagon teams were saddled and a few articles of

clothing were taken by the hostages before their captors confiscated their goods and made the wagons unusable.

The group then traveled up-valley to a large meadow complex at the base of Mary Mountain. After a short council, tribal leaders released the group and the party, now on foot, began their return trip to the Firehole River. After about a mile a group of warriors approached and recaptured them, although several of the tourists were able to escape at this time. After marching back to the council area, a melee ensued, and George Cowan and Albert Oldham were shot and left for dead. Emma Cowan and Andrew and Ida Carpenter were taken hostage but were released the following day when the Nez Perce crossed the Yellowstone River at Nez Perce Ford.

Howard's advance scouting party found Cowan and Oldham in the Lower Geyser Basin several days later and camped in the area from the afternoon of August 30 to the morning of August 31. This camp was later named Camp Cowan, as it is where George Cowan was rescued and given aid after his ordeal. Stanton Fisher, Chief of Scouts under General Howard, noted, "The Indians had cut up the harness, cut the spokes out of the buggy, and scattered things around promiscuously" (Fisher 1896). In the years that followed, surviving members of the Radersburg Party revisited these locations on several occasions in the late 19th and early 20th centuries.

Few artifacts were identified at the Cowan Party camp on Tangled Creek. The opposite holds true for Camp Cowan, which had high artifact densities representing later occupation which may be the result of it being used by many different parties over time, as well as a large

Civilian Conservation Corps camp in the 1930s. However, a cluster of temporally diagnostic historic artifacts located near Morning Mist Springs is consistent with the location where the Radersburg party was forced to abandon their wagons. Three roller buckles, a harness terret, and a snap hook could represent remains of the wagon harness observed by Fisher in 1877. Similarly, George and Emma Cowan's accounts by sketches and a journal indicate the party had writing implements, perhaps pens with extra nibs, and the nib found could have been one of these. A full length, brass Parker Brother's shotshell was recovered that possessed attributes indicating that it was made between 1874 and 1877. Cowan and Oldham later filed depredation claims against the U.S. Government and the Nez Perce tribe for losses they incurred during these events. A number of items recovered from this site may relate to specific items and property types listed in Cowan's claim. Items range from a breech loading shotgun to horse tack and breechings and other items specifically listed in their claims such as blankets and clothing, as well as unspecified items probably grouped under "provisions" likely confiscated by the Nez Perce. These actions reflect the severe lack of material goods that the Nez Perce were suffering due to the conditions of open warfare, with no source of re-supply.

The Nez Perce Mountain Bivouac Site

Another success of this project was identification of perhaps the only known intact Nez Perce campsite within the park related to the 1877 war. Located near the headwaters of the Lamar River 25 miles into the back country at an elevation of nearly 10,000 ft., this site probably represents the last bivouac of the main group of Nez Perce within YNP. P.W. Norris's 1880 account of an Indian camp is the earliest written record describing this site:

"Just above . . . were still standing the poles of one Indian lodge, while there were more than forty others that had fallen, but which evidently had been used the previous year; many still older also remain . . . this Indian perch commands a fair view of all approaches. Abundant pasturage for game and domestic animals was had in the notches of the numerous adjacent canyons . . . Fragments of china-ware [sic], blankets, bed clothing, and costly male and female wearing apparel here found, were mute but mournful witnesses of border raids and massacres" (Norris 1880).

The site was first investigated in 1961 by Aubrey Haines, Ken Feyhl, and Stuart Conner, who found numerous flaked stone tools and debitage, historical artifacts, and evidence of bark stripping and axe-cuts on a number of trees, interpreted as possibly resulting from harvesting pitch wood for kindling. Period artifacts recovered include an assortment of metal objects as well as brass, iron, and wood components of a pre-1874-pattern McClellan saddle, culturally modified trees, and preserved lodge poles.

Artifacts collected from the site were found in two distinct areas (A and B) that lie about 380 ft. (115m) apart. Selected artifacts in Area A include a tinkler and tinkler preform, an Indian-made iron projectile point, iron ring and foot staples, brass pommel shield and brass cantle guard plates to a pre-1874 Pattern McClellan saddle, a possible canteen spout fragment, a probable handle from a Pattern 1874 U.S. Army tin cup, a handle from a probable Pattern 1874 meat can, a .44-40 Winchester Center Fire (WCF) cartridge case, a brass grommet possibly from a U.S. Army rubberized pancho, a brass bar-buckle, several Ausable, type horseshoe nails, and at least two Richardson and Robbins solder-patch and side seam cans (figure 4). Tinklers (also known as bangles, dangles, v-cones, and tinkling cones) were cone-shaped pieces of rolled metal attached to clothing edges as decorations and sound producers. Both the tinkler and tinkler preform possessed remnants of tinning on their surface that allowed speculation they were manufactured on-site from food cans. All of the military-related items are basically of a post-Civil War or early 1870s temporal context. The Richardson and Robbins brand of the 1870s was considered by some as "luxury goods" (in this case the can was for plum pudding) and their advertising specifically targeted "excursionists and travelers for their luncheons" (Smith 1976, Heite and Heite 1989, Heite 1990).

Additional McClellan saddle parts were found in Area B in 2013. Efforts to recover the saddle were undertaken in 2015, requiring materials necessary to safely stabilize and transport the saddle remnants back for conservation and study. A total of 29 saddle parts were recovered from a 1x2-m excavation unit. Portions recovered include most of the iron reinforcing and fastener hardware from a pre-1874 Pattern McClellan saddle along with numerous pieces of wooden saddle tree and several remnants of leather strapping (figures 5 & 6). In addition, three .44-40 WCF cartridge cases were found a few meters from the saddle parts.

The McClellan saddle parts found in areas A and B are viewed as pieces of the same saddle that was likely manufactured around either a Pattern 1858 or 1864 saddle tree. The saddle hardware is consistent with a pre-1874 McClellan saddle pattern that was in common use during the Indian War period of the 1870s. No evidence was found that would provide an explanation for the presence of the saddle or the fact that it was broken apart prior to abandonment. The disarticulated condition and distribution of the saddle parts indicate the saddle was broken into pieces prior to abandonment. Neither the brass pommel shield or cantle guard plates were found in association with the other saddle parts, indicating these pieces were taken from the saddle prior to abandonment. The McClellan saddle was not considered a highly desirable prize by Native Americans, probably due to the fact that many tribes designed and manufactured their own saddles. In many cases when an army saddle was captured by Indians, it was stripped of its leather covering, hardware, and stirrups after which it would sometimes be salvaged; but in many cases it was merely abandoned.

Several .44-40 WCF cartridge cases were also found in areas A and B. The .44-40 WCF was chambered for the model 1873 Winchester and was introduced that same year. By 1877, the Model 1873 Winchester had become a

popular weapon among various tribes of the Plains and Rocky Mountains. Considering .44-40 WCF cartridge cases were at the Big Hole and Bear Paw battlefields, it is safe to assume this particular type of weapon and ammunition were in possession of the Nez Perce during the Nez Perce War.

Culturally modified trees are trees possessing physical alterations that reflect human utilization of forested ecosystems, and many were observed within the forests near the site. These include both axe-cut (pole size) stumps and a number that had been stripped of large sheets of bark, probably for cambium recovery. Approximately 110 standing axe-cut stumps were observed in timbered areas around the site. Typically 30-42 inches tall and 3-6 inches in diameter, these stumps only become obvious after close inspection due to their similarity to other deadwood accumulations. Many axe-cut stumps still retain bark, while some have totally shed the bark layer. It is believed that the axe-cut stumps represent the harvest points for poles composing the standing and collapsed lodges mentioned by P.W. Norris in 1880. Dendrochronological analysis of a sample (n=6) of axe cut stumps revealed that three died prior to 1877 while three died during the late growing season of 1877 (see sidebar, page 35). The specimens dating prior to 1877 could have been harvested as standing dead, while harvest of the other



Figure 4. Artifacts collected from the Radersburg Abandoned Wagon site (48YE2020): a pen nib, shotshells, snap hook, buckles, and harness terret (Eakin 2012a). Photo - Office of Wyoming State Archaeologist.

three would have occurred in late August or September, the same time as the Nez Perce would have occupied the site. The axe-cut stump dates are considered some of the strongest evidence for interpretation of this site as a bivouac occupied by the Nez Perce during the 1877 war. The presence of 1870s-period military and non-military artifacts at the site further corroborates the tree-ring analysis, indicating the site likely functioned as a Nez Perce bivouac during the 1877 Flight.

Remains of the 40 lodges described in the 1880 Norris account may also be present at the site. These took the form of clusters of highly weathered pole-sized pieces of wood up to 1 m in length located in hollows situated well away from the present tree line. Modern NPS accounts indicate that unauthorized out-of-bounds campers may have been using pole remnants for firewood during the last 50 years. If so, unauthorized firewood collecting impacted our knowledge of the site with a devastating loss of information, potentially including lodge locations and their distribution which could have provided information on residential patterns during the flight.

The few camp descriptions provided by survivor accounts suggest the Nez Perce often stopped for lunch; that fires were kindled for breakfast, lunch, and supper; and that shelters were constructed nightly. Emma Cowan's observations from the night of August 24, while being held captive in the Hayden Valley, provide import-

ant insights, "The Indians were without tepees which had been abandoned in their flight from the Big Hole fight but pieces of canvas were stretched over a pole or bush" (Guie and McWhorter 1935). Cowan's account implies that in the absence of their usual equipage, the Nez Perce had adopted expedient practices relating to not only fast travel, but also a basic need for shelter amounting to little more than a stretched rope or a few joined poles over which a covering was placed. This account implies that rather than transporting lodge poles, the Nez Perce harvested them nightly (probably close to camp) and abandoned them when camp moved.

Four cambium-harvested trees, typically larger than 12 inches in diameter, are also present at the site. One of these was sampled for dendrochronologic analysis which indicated the cambium was peeled during the early growing season of 1826. Preserved axe or other tool marks show the outline of the bark sheets removed during the peeling process when the trees were still alive. Cambium peeling involves removal of usually semi-circular sheets of bark from living trees for different purposes. Cambium harvest and consumption was a relatively common practice among native people of the Columbia Plateau as well as groups inhabiting other areas of the Rocky Mountains. Historic and ethnographic accounts indicate cambium harvest and consumption was a normal part of the annual cycle of some native



Figure 5. Artifacts identified as part of a pre-1874 McClellan pattern saddle. Clockwise: cante plates, pommel ornament, front ring staple, foot staple, and rear ring staple.



Figure 6. McClellan saddle cantle arc and plate from a McClellan saddle, recovered from the Nez Perce Mountain Bivouac Site (48YE506). Photo - Office of Wyoming State Archaeologist.

people, especially during the spring months. Lewis and Clark report bark peeling and consumption of sap and the soft part of the wood among the Northern Shoshone: “[T]he natives had peeled [*sic*] the bark off the pine trees about this same season. This the indian [*sic*] woman (Sakakawea) with us informs that they do to obtain the sap and soft part of the wood and bark for food” (Thwaites 1904). Nez Perce elders have also reported the practice in times when the group was short of food.

Although none of the artifacts found during the investigations at the mountain bivouac site can be associated with any particular Native American group, it remains highly likely that these items were brought to the site by the Nez Perce and abandoned upon their departure. Similarly the McClellan saddle parts probably originated as property stolen from the army, as such instances were common during the Indian War period. The association of these items with cans and other goods would also be consistent with property the Nez Perce obtained through raiding of both civilian and military sources. Some Nez Perce may have possessed canned and other goods procured by scouting and raiding parties actively foraging for needed items. Some items, however, such as chinaware, “costly male and female wearing apparel,” and Richardson and Robbins plum pudding, might have been relatively rare in the region at the time. One potential source for such items is listed as “A quantity of provisions and clothing belonging to claimant and his wife,” of the value of \$350.00 on lines 12 and 15 of the depredation claim filed in 1892 by George Cowan (Radersburg tourist party) for property losses incurred on August 24, 1877.

The mountain bivouac site could have been occupied by the main group of Nez Perce or a splinter group, or it could have been a rendezvous point for multiple groups after taking different routes through YNP. Archival information indicates the Nez Perce camped in this area sometime between September 4 and 6, 1877. Considering the number of people and horses that would have comprised the main group, it is quite possible (especially if they occupied the area for several days) that the Nez Perce were spread over a fairly large area to assure ready access to water, wood, and grass, with the current site area representing only a fraction of the area actually occupied. When P.W. Norris first rode through the camp in 1880, there was evidently an intriguing pattern of standing and collapsed lodges with a noticeable amount of debris of European American origin that he attributed to raids by Indian groups. The association of the

Dendrochronology: The Study of Tree Rings

The science of dendrochronology can be used to estimate when a tree was felled or naturally died, if the calendar year dates of tree growth rings can be determined. A tree’s annual growth changes throughout the year in response to seasonal climate changes. At the beginning of each growing season, a layer of thin-walled cells called earlywood grow between the older wood and outer bark. As growth slows toward the end of summer, smaller, thicker-walled cells known as latewood are produced; and these usually appear darker in color in a tree cross-section. Combined with cells formed during the normal growing season, these two cell types compose one annual ring representing one year of growth. Tree growth is sensitive to fluctuations in atmospheric conditions, such as moisture, temperature, and sunlight. Broad rings reflect a good growing year, while narrow rings may reflect lower moisture, temperature, or other environmental stress.

Tree rings are important data banks when one considers that trees often live for hundreds of years and therefore, may contain a long record of environmental conditions. Matching tree ring width patterns in living and well-preserved dead trees can be correlated among different tree ring series and tree ring chronologies extending far beyond the range of living trees that can be constructed. This process, called crossdating, is the fundamental principle of dendrochronology and allows the precision necessary to help date archeological sites. It can even link these sites to specific events in history, such as the Flight of the Nez Perce in 1877.



Using the principle of crossdating and pattern-matching morphological and statistical techniques, dendrochronologist John King of Lone Pine Research determined this axe-cut stump was cut late in the growing season of 1877 (Photo-©J. King).

stolen goods and perishable material with the standing and collapsed lodges undoubtedly conveyed a feeling of tragedy to the situation. Today the site lies in wilderness that has changed little since the Nez Perce camped there in 1877.

Moving Forward

Archeological research enabled the identification of a segment of the route taken by the Nez Perce as they crossed the Absaroka Mountains to continue on their journey northward. Working with the Nez Perce National Historic Trail managers in 2017, the NPS formerly incorporated this segment of their journey into the pedestrian Commemorative Trail Route so visitors can honor the experience of the Nez Perce. The park looks forward to continuing to tell the story of the 1877 Flight of the Nez Perce, including the multiple routes used by the various U.S. Army units; Nez Perce scouting parties led by Hímiin Maqsmáqs (Yellow Wolf) and Kosooyen and other Nez Perce splinter groups; and the civilian Radersburg and Helena parties, as well as other civilian encounters in the park.

There are many cultural resources along the trail, and it is up to us to preserve and protect the trail and its sites for those who come after us. Archeological sites are non-renewable, in that once disturbed they cannot be replaced or repaired and when damaged, important information is lost forever. Natural and historic sites should be left undisturbed for all who visit, as it is an important part of our heritage.

Acknowledgments

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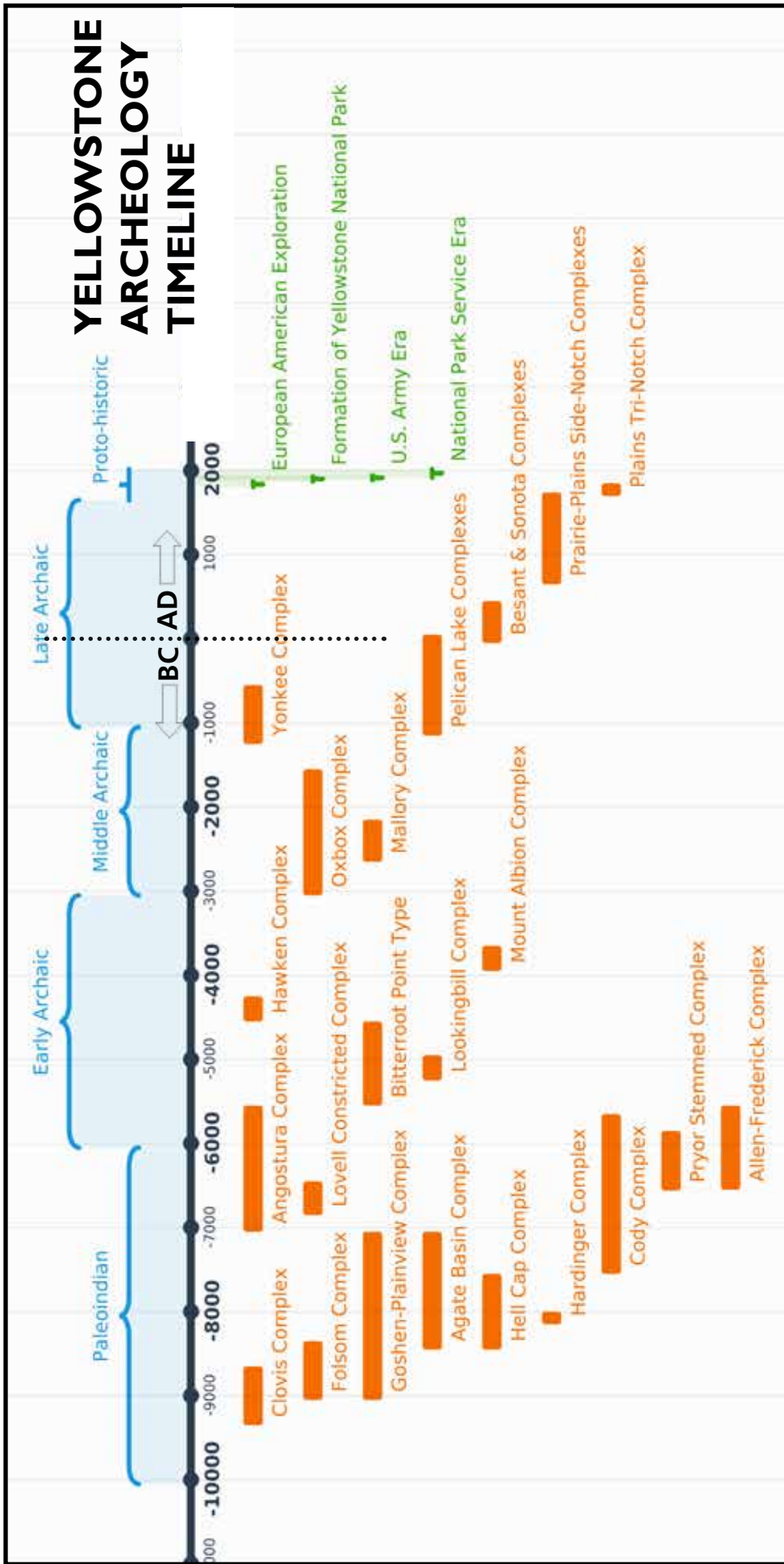
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Dan Eakin retired as a Senior Archaeologist after 38 years with the Archaeological Survey Division of the Office of the Wyoming State Archaeologist. He has spent much of the last decade conducting archeological investigations along the Wyoming segment of the Nez Perce (Nee-me-poo) National Historic Trail and painstakingly reviewing and dissecting historical accounts of the Nez Perce War of 1877.



Beth Horton see page 24.

YELLOWSTONE ARCHEOLOGY TIMELINE



Archeologists use a dating system that refers to dates that are BP - before present. To calculate dates to a more familiar timeline (BC/AD), the BP date is subtracted from the number 1950. This date reflects the time when radiocarbon dating became reliable. All dates on this timeline are uncalibrated; uncalibrated dates are raw dates in radiocarbon years.



YELLOWSTONE ARCHEOLOGY FACTS

Bead detail from a decorated wood and leather stirrup; may have Crow affiliation.

- The Heritage & Research Center in Gardiner holds 611,196 cultural and natural history objects, as of October 2017.
- There are 954 buildings, historic roads, historic bridges, and constructed features in YNP.
- 1,935 archeological sites have been identified in the park, as of November 2017.
- Only about 3% of the park has been surveyed for archeological sites.
- If site density over the whole park is similar to the currently surveyed portion, the park potentially contains 60,000 archeological sites. It's unlikely that the actual number is this high, as much of the park is on steep slopes; but the current density still shows that Yellowstone is a very archeologically rich area.
- Yellowstone contains six National Historic Landmarks: the Northeast Entrance Station; Fort Yellowstone (which includes the Roosevelt Arch); Lake Hotel; Old Faithful Inn; the Norris, Madison, and Fishing Bridge museums (joint NHL group containing all three); and Obsidian Cliff.
- Obsidian Cliff is one of the few archeological National Historic Landmarks. For at least 11,000 years, people have been extracting incredibly high quality toolstone from the cliff. Ancient tools sourced to Obsidian Cliff outcrops have been found as far away as Maine.
- In addition to the National Historic Landmarks, the Grand Loop Road Historic District (HD), Lake Fish Hatchery HD, Mammoth Hot Springs HD, North Entrance Road HD, Lamar Buffalo Ranch HD, Obsidian Cliff Kiosk, Old Faithful HD, Queens Laundry Bath House, Roosevelt Lodge HD, and Mammoth Post Office are currently listed on the National Register.
- A lithic scatter is a collection of stone debris usually seen on the ground surface here in Yellowstone. Occasionally there may be other artifacts present, such as bone, hearths, or fire cracked rock. These are the most common types of prehistoric sites in the park and can be difficult to accurately date. They are usually the result of people spending a short-amount of time in an area doing things such as sharpening tools, butchering an animal, or staying in an overnight camp.
- Tipi rings are circles of stones that were used to hold the walls of tipis to the ground. They are found throughout the Great Plains and into the Rocky Mountains.
- Wikiups are timber-cribbed dwellings that are usually conical. Resembling a tipi but made of wood, these are semi-permanent homes that would protect the inhabitants from the elements in Yellowstone's harsh environment. Though 13 wikiups sites have been reported throughout the park since its formation, most or all of the wikiups in Yellowstone have collapsed over the years.
- Game drives are rows of stone cairns or wooden fences that were used in hunting. The structures were used to funnel game herds into areas selected by hunters for more efficient kills.
- Rock art sites are located throughout the area surrounding Yellowstone, but have not been identified in the park. In surrounding areas, both pictographs and petroglyphs have been found.
- Quarries are sites where Native Americans extracted stone for use in tools. The various obsidian quarries in the park have attracted the most attention from archeologists, but quarries for other materials such as chert are also found within the park.
- Stratigraphy is one tool that archeologists have to determine relative ages of different artifacts. Typically, as artifacts fall to the ground, older deposits are lower in the soil column and newer ones are closer to the surface. We call this relative dating. We can tell which artifacts are older and which are newer without having an exact age.
- Absolute dating is more precise than relative dating. There are a wide variety of absolute dating techniques, but the most commonly used in Yellowstone is radiocarbon dating.
- High elevation sites around ice patches are usually the remnants of hunting expeditions following game into cooler elevations during summer.
- Radiocarbon dates measure the different ratios of radioactive Carbon 14 and stable Carbons 12 and 13 in an organic substance. Ordinarily charcoal is used for radiocarbon dates; however, many things, including bones, teeth, and wood or plant materials, can be radiocarbon dated. After an organism dies, including a plant which may have been burned into charcoal, the ^{14}C begins the process of radioactive decay. By measuring the $^{14}\text{C}/^{12}\text{C}$ ratio in an organic object we can get a fairly accurate date of death. The oldest current radiocarbon date from an archeology site in Yellowstone comes from a site near Gardiner, dating from $9,690 \pm 50$ years before present.
- President Theodore Roosevelt signed the Antiquities Act into law on June 8, 1906, thus establishing the first general legal protection of cultural and natural resources in the United States. This, and other laws, prohibits the collection of any archeological materials on public lands, including Yellowstone National Park.



Paleoindian

Archeology & Adaptation to Climate Change in Yellowstone

Staffan Peterson

The effects of climate change may pose the greatest threat to the integrity of natural and cultural resources that Yellowstone National Park (YNP) has ever experienced (NPS 2010). Protection and preservation of these resources requires park managers to understand potential threats using the best available research, and that they act in the long-term public interest. The causes and consequences of climate change, including how climate affects ecosystems and how humans have adapted to climate change, are critical research areas. This article focuses on how probable climate-driven changes in land cover and disturbance regimes may be impacting archeological resources in YNP, and how park managers use science to respond and adapt to emerging challenges.

YNP encompasses over 2.2 million acres in north-west Wyoming, southern Montana, and eastern Idaho, between 5,000 and 11,000 ft. above sea level. The surface geology is primarily volcanic plateaus of Quaternary rhyolitic rock surrounded by Eocene mountains. The park's highly variable ecosystem is home to diverse flora, fauna, and microorganisms, some of which are uniquely found in Yellowstone (Despain 1990). The climate in the Greater Yellowstone Ecosystem (GYE) includes long cold winters, short cool summers, with precipitation of 10-70 in. annually. Summer droughts help sustain the normal fire regime. Because climate is a determining factor for the presence and distribution of all life, understanding climate change can explain how past peoples adapted to life in Yellowstone over several millennia.

Today, we are faced with a paradox. Evidence of adaptation to past climate change can explain different aspects of past lifeways, but current and future climate change can threaten or erase that very evidence. It is a critical part of the mission of the NPS to protect, preserve, and interpret this record for this and future generations. Given the agency mission of resource preservation, we have to understand and anticipate critical

vulnerabilities to meet our preservation mandate, including new threats from a changing environment.

Potential Climate Change in the GYE

The truism that the climate has been changing since the end of the Ice Age does not speak to the fact that the climate has changed significantly faster in just the last few decades than over the prior 12,000 years. Globally, an increase of 6°F-13°F may occur over the next 80 years, or within the lifetime of today's preschoolers (Collins et al. 2013). These changes can have cascading effects on ecosystems and park resources. For example, a 2°F increase in average annual temperature may result in a 600% increase in area burned each year (Peterson and Littell 2014). Snowpack may decrease by 3-4 in. per year (Chang and Hansen 2015), while spring rains may increase. Effects of climate change can also impact park infrastructure, visitation patterns, and visitor experiences in the park and its resources in unpredictable ways. Parks across the United States are responding to these challenges by developing mitigation and adaptation strategies, including increased monitoring of ongoing impacts, predictive modeling of climate change scenarios (e.g., sea level rise, increased storm surges, flooding, wildfires, and drought), and modeling predicted impacts to vulnerable cultural resources.

In the western U.S., most climate change scenarios suggest higher summer temperatures and earlier spring snowmelt, creating conditions for increased wildland fire frequency and intensity (Flannigan 2006, Littell et al. 2011, Gross 2016, Halofsky et al. 2017). Burned acreage has increased significantly over the past 20 years, and is projected to double by 2040 and triple by 2080. Drought and hotter temperatures also weaken trees, making them more susceptible to infestation by mountain pine beetle, Engelmann spruce beetle, and western spruce budworm. Insect-killed trees provide fuels that further increase the risk of wildland fire. Federal and academic researchers have linked these trends to climate change (e.g., Littell et al. 2016, Loehman 2017).

Climate Change

Climate change is defined as long-term atmospheric trends recorded over Earth's history.

- **Climate Variability** refers to the annual or decadal variation in atmospheric patterns we experience over a lifetime.
- **Weather** is the daily or seasonal changes about the atmosphere we talk about all the time.

Winters that seem warmer or springs that seem wetter need to be put in the right time frame. Droughts or flooding may be connected to climate change, but a few bad years do not on their own point to a changing climate. Only long-term monitoring provides the context needed to understand observed changes.

Climate change studies in the GYE have been published in dozens of articles and books, including a recent issue of this journal (NPS 2015). The study of modern climate change in YNP began in 1992, when Romme and Turner (1992) explored the logical consequences of rising global greenhouse gas emissions on Yellowstone's ecosystem. They predicted that high elevations would experience upward shifts in the elevations of upper and lower tree lines, and fire regimes would become more severe (Romme and Turner 1992, 2015). Paleontological studies of pollen provide a model for how forest composition and treelines in the GYE changed with climate changes over the last 12 millennia (Whitlock 1993). Thirty years have passed since these early forecasts, and current data support the 1992 study in its broad outlines. Present conditions and near-term projections include changes in temperature, precipitation, humidity, wind speed, sunshine duration, and evaporation (Hartmann et al. 2013), resulting in earlier snow melts, warmer summers, and longer growing and fire seasons (Romme and Turner 2015, Tercek 2015). In YNP, average temperatures over the last three decades are 3°F warmer than in the preceding three decades (Tercek et al. 2015).

Shifts in the type and location of land cover, hydrology, and fire disturbance regimes will likely impact cultural resources in destructive and irreversible ways. Distinct and serious threats to the record of our collective past exist in the form of climate driven drought, desertification, erosion, flooding, and other environmental im-

pacts (Curry 2009). High elevation ice is being lost at significant rates globally. Ice cores from Mt. Kilimanjaro show that these ice fields are on the verge of disappearing entirely (Thompson et al. 2009). Glacier National Park is projected to lose many of its iconic glaciers within 12 years (Hall and Fagre 2003, USGS 2017). Similar changes are occurring or are projected for high elevations from Alaska to the Andes. Impacts to coastal wetlands are highly vulnerable to climate change in the form of sea-level rise and coastal subsidence.

Climate change impacts may mean changes to many aspects of the resources of Yellowstone. Federal agencies have in recent years begun efforts to anticipate and prepare for new impacts to the cultural and natural resources they are charged with protecting (Melnick 2015; NPS 2010, 2016). These efforts broadly seek to understand climate variability, analyze and quantify resource vulnerabilities, develop and implement adaptation plans, and measure and communicate success. Current research can serve as a tool for identifying a range of management options available for anticipating and mitigating impacts to these critical resources.

Evidence of the Human Past in Yellowstone

Cultural resources, broadly conceived, are things that help us remember the human past and help shape our current identities. They include tangible items such as buildings, historic districts, archeological sites, and artifacts, and intangibles such as ceremonial and traditional observances and values. This article focuses on archeological resources—a subset of Yellowstone's cultural resources. Over 1,900 archeological sites have been documented in the park, an astounding number given that less than 3% of the park has yet been surveyed. Archeological resources in the GYE represent almost 11,000 years of continuous human presence. Sites from all periods have been recorded, in all kinds of physiographic settings. Native American tribes historically connected to YNP include the Arapaho, Assiniboine, Bannock, Blackfeet, Cheyenne, Chippewa, Comanche, Crow, Flathead, Kiowa, Lakota, Nez Perce, Salish, Sioux, and Shoshone (Nabokov and Loendorf 2002). Artifacts and sites from the prehistoric and historic periods have been documented in diverse settings, including along rivers and lakeshores, on islands, in hydrothermal areas, and on mountain tops.

The European American presence in Yellowstone began in the early 1800s, with fur trappers and prospectors and by the mid-1800s, with military and scientific expe-

ditions. The park was established in 1872, adding to the continuously evolving record of the human imprint on the land. Historic period sites dating from the earliest days of the western expansion of the United States to the modern era include wagon roads, camps, military facilities, trails, and all manner of infrastructure related to the creation and continuous use of the park. Detailed information on the archeology of Yellowstone is available in various books and journals (Reynolds and Johnson 2003, Johnson 2010, Livers 2012, MacDonald and Hale 2012, MacDonald 2018).

Hundreds of archeological studies in YNP have provided insight on this vast history. These studies are primarily undertaken in order to meet legal mandates to preserve park resources ahead of infrastructure projects that support the needs of four million visitors each year. Others are tied to assessing potential or actual effects of natural processes on archeological sites, such as wildfire or erosion. For example, due to long-term upwelling in the Yellowstone magma reservoir, Yellowstone Lake is experiencing changes in wave action that can erode shorelines where sites are located. In order to assess that impact, the park undertook a four-year total survey of the shoreline, documenting numerous sites, some of which are being actively impacted by erosion.

Still other work is conducted for research purposes by university partners, most recently by the University of Montana and the University of Wyoming. For example, an ongoing study of sites related to the Nez Perce Flight of 1877 in Yellowstone discovered numerous sites connected to that event and yielded fascinating insights on some aspects of the war (Horton and Eakin, this issue). Research on prehistoric bear hunting (Ciani 2014), obsidian use (Park 2010, Doss and Bleichroth 2012), game drives and sheep traps (Eakin 2009), wickiups (Eakin 2009, White and White 2012), tipi rings (Livers 2012), 19th century wagon roads, mining, and tourist developments (Corbin and Russell 2010, Flather 2003) all incorporate archeological information and have greatly enriched our understanding of how people have used YNP.

As native peoples used this land for nearly 11,000 years, the vast majority of archeological sites documented are from the prehistoric period. These Native American sites include short-term or seasonal camps, trails, tipi rings, obsidian and chert quarries, vision quest sites, wickiups, game drives, and other places where people worshipped, hunted, gathered plants, made tools,

fished, traveled, or otherwise conducted a myriad of day-to-day tasks.

Archeology is not the sole source of information on human use of the park. Native American traditional knowledge and historical documents are rich sources of information. The best narratives of the past are based on many types of information, each leveraging the strengths of the others. However, the further back we look, the less there is to go on. For the majority of the prehistoric and historic periods, archeology is a primary source of information on the park's complex human presence.

Climate Impacts Life

While the climate has always been changing, how climate change affects people and their ways of life is less well understood. Researchers in paleoclimatology, paleontology, geomorphology, demography, and archeology have collaborated to develop a broad outline of ways in which people have interacted with changing climates. The findings indicate complex interactions between climate and lifeways, operating at different spatial and temporal scales.

Around 13,000 years ago, glaciers up to one mile thick began to melt off of mountains in the GYE. Within 1,500 years, people began to enter YNP, evidenced by distinctive large spear points made of obsidian from YNP's Obsidian Cliff found in the environs of YNP. Excavations at sites in the GYE show hunters in this period had a diverse subsistence base, with a focus on bison. Between 8,000 and 5,000 years ago, the climate became drier and hotter. Analysis of ancient pollen recovered from lake beds in the southern part of Yellowstone indicate peak dryness, much dryer than today, occurred around 7,000 years ago (Whitlock 1993). Stone tools from this period are much more abundant than those from the preceding period, however, archeological features dating from this period, such as hearths, are rarer and more ephemeral, suggesting long-term use of the area decreased. Animal bones recovered from this period point to a relative decrease in bison hunting. The drier, hotter climate may have led to poorer forage, resulting in smaller bison herds.

Beginning about 5,000 years ago, the climate cooled and became wetter. Changes in the human use of the area are correlated with this climatic shift. For example, increases in the number of artifacts and features indicate substantially increased use of Yellowstone between 3,000 and 1,500 years ago, and continue to increase all the way up to the 19th century. Thus, the long-term per-

spective that only archeological evidence can provide, points to a strong relationship between climate change and human ways of life. Evidence also points to how major changes in future climate patterns could impact modern people.

Climate Change Impacts on Archeological Resources

Modern scientific archeology investigates not just artifacts, but the environmental context in which they are found. Climate change can impact the environment in which these resources exist, and through which we understand and manage these resources in complex and often poorly understood ways. It is as much a fallacy to assume we can preserve these resources but not the environments where they exist, as it is to assume we can manage wildlife, but not wildlife habitat. Two major sources of climate change driven threats—wildland fire and the melting of ancient ice—are explored below.

Wildland Fire

The area impacted by wildfire is predicted to increase in the GYE with global warming. Empirical statistical models and process-based simulations agree almost universally. The relationship most subject to change is

between drought and fire, and this effect is being recorded at multiple scales.

Over 80% of YNP is now forested (Despain 1990). Fire evolved as a critical part of the forest ecology of YNP and continues to be so today. The normal fire season begins after deadfall dries out after the spring melt and summer rains decrease. By July, humidity drops and increasing “dry” lightning strikes create fire starts that can grow rapidly in the dry air. High temperature wind-driven fires burn both the forest understory and crown vegetation during this time (NPS 2015). As temperatures decrease and precipitation increases in September, the wildfire season ends (Marcus et al. 2012). The longer, warmer summers predicted by some models would alter the normal fire regime by creating bigger, hotter fires. Wildland fires are characterized as surface fires that burn surface vegetation, ground fires that burn buried fuels like forest duff, and crown fires that burn up into the forest canopy (Fuller 1991). All three create risk to archeological resources in distinct ways (figure 1).

Wildland fires can impact archeological resources both directly and indirectly. Through post-fire observation and field experiments, archeologists learned how fire impacts diverse types of artifacts (Winthrop 2015). At more than 572°F, obsidian artifacts will bubble, crack,



Figure 1. Surfaces denuded by wildland fire can rapidly erode, threatening archeological resources. Photo - ©D. MacDonald

or even melt. A more subtle impact is heat alteration of the artifact surface such that it cannot be dated using the obsidian hydration method. Above 662°F, chert artifacts can fracture, develop fine cracks, shatter, and change in color. Sandstone, bone, or shell artifacts can undergo a range of effects from breaking apart to complete destruction (Winthrop 2015). In Yellowstone, the massive 1988 fires burned over much of the Obsidian Cliff National Historic Landmark with intensely hot crown fires. Post-fire observations by archeologists detected probable fresh fracturing, oxidation, and disintegration of materials at nearly all of the 59 archeological features associated with the cliff (Davis et al. 1995).

The most susceptible artifacts are those on or near the surface (figure 2 and 3). While most fires have minimal impacts below 5.9 in., organic remains such as pollen can be affected. More destructive impacts are the tipping of crown fire burned trees, completely disturbing soil over a large area, or when burning roots carry fire below the surface. When rains or winds follow, sheet or gully erosion can move or bury artifacts, altering their original context; and hearths or midden layers can be destroyed. An indirect effect is the exposure of sites previously concealed by vegetation, creating risk for illegal collecting of artifacts (figure 4).

A little known class of features present in the GYE are Native American wooden structures. Wikiups, or conical timber lodges, and their remnants have been recorded in dozens of locations in the GYE. These small, tipi-like log structures are of varying ages, with some probably being prehistoric. Some may be simple expedient shelters, while others may be associated with ceremonial activities (White and White 2012). Game drives, or sheep traps consisting of rock and brush arranged in fence-like lines up to 200 yards long, were designed to control the movement of sheep or other ungulates across the landscape to areas where they could be easily hunted (Eakin 2009, Lee and Puseman 2017). These rare feature types, documented in the Absaroka Mountains in the eastern part of the park, are highly vulnerable to destruction by wildland fire (figure 5).

Finally, fire fighting itself can impact archeological resources. The heroic efforts of wildland firefighters are often followed up by a little known but critical effort to assess and repair both direct effects of the fire and impacts from the firefighting response. Nat-

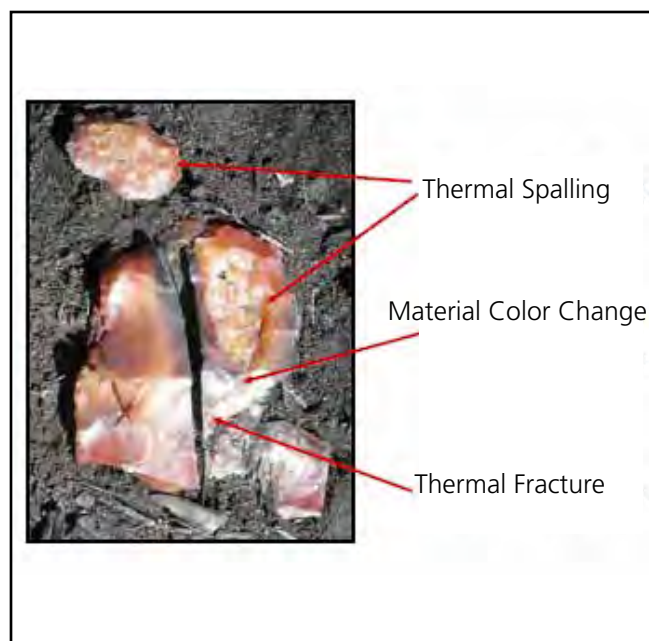


Figure 2. Fire damage to stone artifacts (adapted from Knapp 2006). Photo - ©A. Knapp



Figure 3. Left, unburned obsidian artifact, right, burned. NPS Photo - A. Steffen.

ural and cultural resource specialists survey burned areas to document the severity and extent of any damage from the fire or firefighting efforts on park resources. In YNP, burned areas are typically left to restore on their

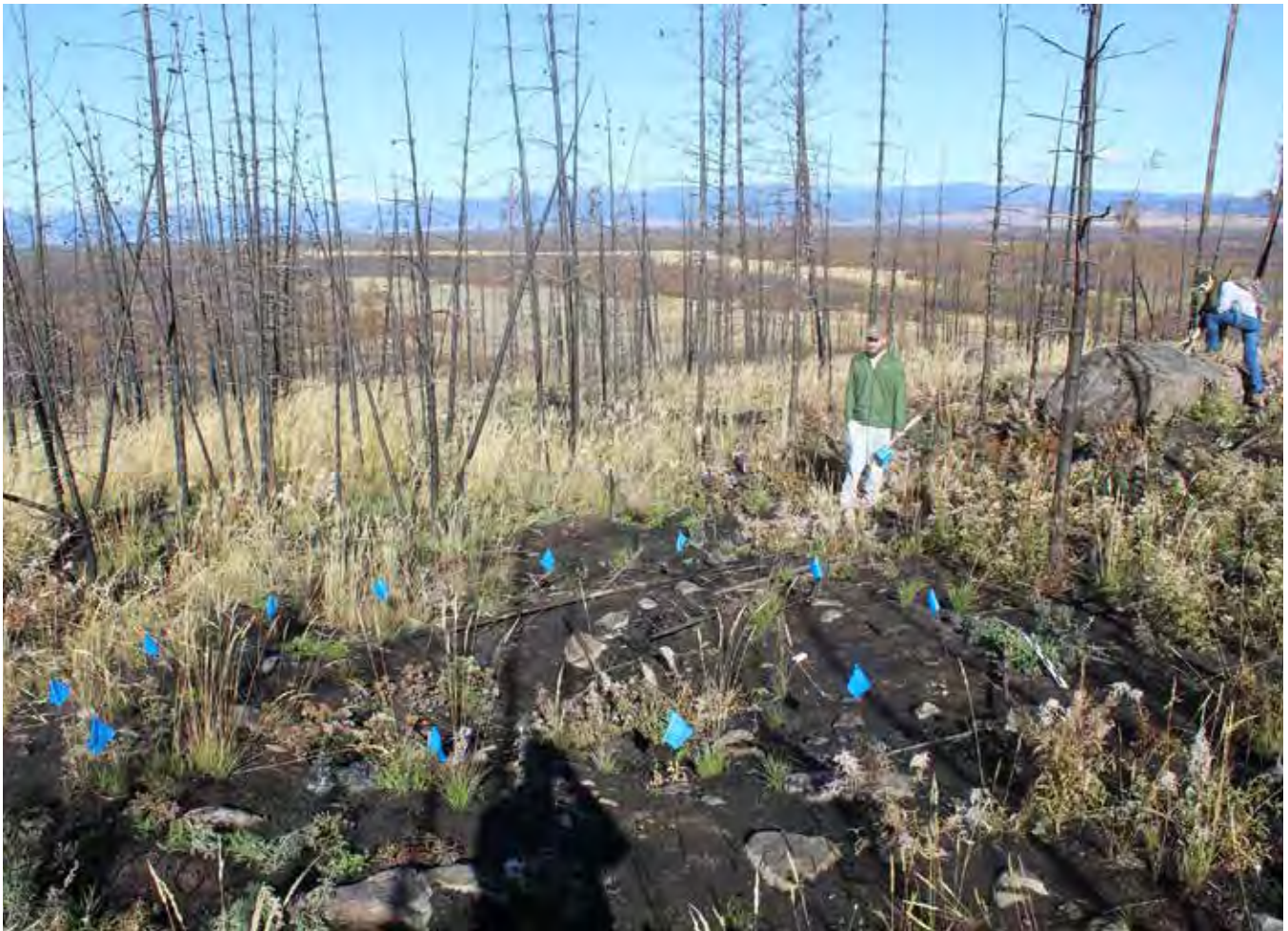


Figure 4. Prehistoric obsidian quarry exposed by wildland fire. Photo - ©D. MacDonald



Figure 5. Centuries-old sheep skulls near a prehistoric sheep trap were destroyed by a recent fire (from Eakin 2009). Photo - ©D. Eakin.

own, but tracks from firefighting vehicles or fire lines dug into the ground are typically repaired. Damage to archeological resources is documented and at-risk sites are recommended for follow-up investigations, including surface collection of artifacts or targeted excavations. Federal wildland fire policy is to deploy specially trained resource advisors alongside fire fighting crews with the goal of minimizing impacts to sensitive areas from fire lines and fire fighting vehicles, and to assess the condition of resources after the fire is over. Often that can involve documenting impacts and recommending ways to mitigate damages, such as recovering at-risk artifacts for long-term curation or restoring soil cover in affected areas.

When assessing any new site impacts, it is important to note that many sites may have already experienced impacts from human or natural causes. To better understand old versus new impacts, YNP archeologists monitor the condition of sites on a recurring basis, providing baseline data useful in identifying new impacts.

Modeling Potential Wildland Fire Effects in a Changing Climate

Global climate models provide anticipated trajectories in temperature and precipitation change. At the park level, this information can be used to model how those changes will be manifested, for example as near-, medium-, or long-term changes to ecosystem processes and land cover. Models of potential impact can then be used for scenario planning to understand whether under a given scenario resources would become vulnerable to harm (NPS 2016). In this case, vulnerability expresses the sensitivity plus the exposure to new effects. The ability to adapt to the impact would mitigate the resource vulnerability. Because cultural resources, as static “time capsules,” cannot adapt to changing environmental conditions, managers are responsible for finding ways to increase their resilience to impacts.

Wildland Fire Models

Using a suite of fire behavior analysis systems that incorporate fire behavior models and geographic information, resource managers can model the spread of wildfires and burn probabilities across a given landscape under a specified set of terrain, fuels, and weather conditions.

In recent years, YNP began modeling archeological resource vulnerability under a potential climate change model (Cannon 2015). Locational modeling of how and where destructive fires could occur in YNP was used in tandem with modeling of where prehistoric archeological sites are most likely to be found. These models specified 1) changes in fire season temperatures and precipitation to understand change in the likelihood of destructive crown fires under historic and altered climate change scenario and 2) the likelihood of any location to be suitable for archeological sites in terms of proximity to perennial water and the slope of the landform.

One climate change model compared fire risk under historic weather conditions (using park fire season data for 1941–2015) to fire risk under projected weather conditions to measure change in the risk of wildland fire. Fire risk is a function of weather conditions (temperature, precipitation), topography (slope, aspect), and land cover (fuel loads), all of which can vary substantially across Yellowstone. The model considered elevation, slope, aspect, a wildland fire fuel model, canopy cover, canopy height, crown base height, and crown bulk density (Scott and Burgan 2005). Historical and projected weather data for the study area were obtained from Cli-

mateAnalyzer.org (Tercek 2015). Thus, the risk factor was modeled pixel by pixel across the park, creating a parkwide map of fire risk, as low, medium, high risk. The historic model and the projected model (figure 6) were compared, showing where risk can change (Cannon 2015).

Archeological Site Location Probability Modeling

Archeologists are eager to understand past climate change as one factor that can explain the human past. Understanding future climate change is also of interest as a new risk to specific archeological resources. We need to know where those resources lie with respect to the fire risk map. The author created a site location favorability map that models the likelihood for prehistoric sites to occupy specific landform type. For example, the model indicates the most suitable site locations are within 400 yards of perennial water and where the slope is less than 10%. With this information in-hand, the altered fire risk for each class of site suitability (low, medium, high) was modeled. The results indicate that in areas under the climate change model conditions, fire risk in low suitability areas will remain unchanged, moderate risk areas will slightly decrease, and areas of high fire risk will increase by approximately 45%. This increase should be a red flag for managers concerned about at-risk resources should the model conditions become reality.

Ice Patch Archeology

In certain high altitude settings all over the world, conditions have promoted the formation and preservation of small but persistent patches of ice, some several thousand years old. As these ice patches are too small to flow downhill like glaciers, they can cryogenically preserve elements from their immediate locale for hundreds or thousands of years. Ice patches can preserve organic material such as pollen, seeds, plants, trees, bone, hair, entire animals, insects, dung, etc., and can also encapsulate human-made items. These materials are typically only preserved in dry caves, arid sites, bogs, and perennially frozen environments. Without preserved organic artifacts, archeologists in Yellowstone must infer lifeways using an extremely limited part of the total suite of objects past peoples created and used—typically only stone artifacts and charred organic remains.

At ice patches in the GYE, archeologists have recovered projectile points and shafts, basketry, wooden

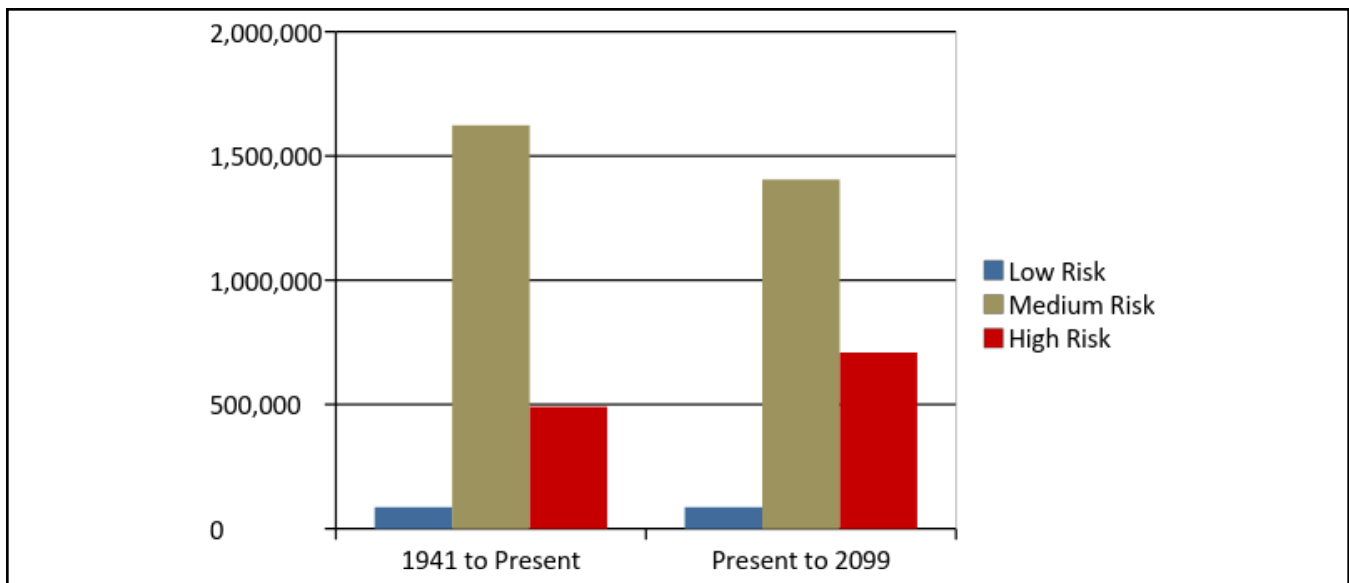


Figure 6. Risk category change under historic and projected climate scenarios (acres).

tools, butchered animal remains, and other artifacts from 200-10,000-years-old (Lee et al. 2014, Reckin 2014). Native American traditional knowledge suggests high altitude ice patches were important places for hunting, gathering, and ritual practices since ancient times. A key part of the story of human ice patch use is their role as favored hunting areas. Ice patches attract herbivores, such as sheep, that move upland in search of summer pastures, running water, and relief from biting insects. Ancient hunters understood this pattern, stalking and killing prey resting on the ice patches. Aerial images show active game trails near melting ice patches in Yellowstone (Lee 2014). Weapons and tools of wood, fiber, or stone would be lost or discarded in the act of hunting and processing game, eventually being encased in growing ice patches (figure 7). With the warming climate, these cryogenically preserved artifacts are slowly emerging.

A Greater Yellowstone Coordinating Committee-supported study has identified over 450 prospective ancient ice fields in the GYE that could contain archeological and paleobiological resources (Lee et al. 2014). While ice fields are inherently dynamic – being influenced by topography, accumulation rates, ice dynamics, and melt and evaporation rates – diverse and mutually reinforcing datasets show that across the Rockies and beyond, both ice patches and glaciers are in recent years retreating at an alarming rate. An analysis of stereophotography of glaciers in the Absaroka and Beartooth ranges in Montana has shown melt back rates of 1-8 ft. per year between 1952 and 2003 (Seifert et al. 2009).

Most ice patches in YNP are found on peaks in the Absaroka Range in the east and southeast parts of the park, above 8,000 ft. in elevation. They range in size from one half to hundreds of acres, found singly or in groups. Ice patches that are most likely to contain cultural material are near mountain passes, are not on steep slopes that would limit how animals could use them, and have minimal exposure to melt-inducing sunshine. Most ice patches contain preserved biological material accumulated over decades or centuries. A few in the GYE contain the remains of mature Engelmann and whitebark pine stands that grew during a brief warm period about 8,800 years ago when tree lines were significantly higher than today, then died and were encased in ice when the climate cooled. Spear points and arrowheads, bows, dart and arrow shafts, and remains of prey species such as bighorn sheep have been recovered in the Absaroka Range. Some of these artifacts have radiocarbon dates that range from 210-9,200-years-old (Lee et al. 2014, Lee and Puseman 2017).

Retrieving organic artifacts from these critically endangered ice patches is bedeviled by their remote locations. In most cases, accessing the areas requires days of hiking in and out of remote areas that are difficult to camp in and lack water or shelter from high winds. Missions must be timed to occur after newer snow cover has melted off, as exposed organic artifacts can crumble to pieces soon after exposure. The extreme perishability of many recently exposed artifacts is particularly troubling. Exposure also increases the risk of illegal collecting. In 2017, an individual was convicted of felony illegal



Figure 7. This artifact may represent one of the first ice patch artifacts recovered in the Greater Yellowstone Area. The artifact is composed primarily of plaited or twisted (not braided) leather partially covered with a coiled, blackish wrapping of organic material that may be bark from a chokecherry tree (*Prunus virginiana*). The artifact was collected on “melting snow” in the vicinity of a glacier that has been analyzed with repeat aerial photography. It appears the permanent snow and ice features in the area where this was found have undergone a significant decrease in snow and ice since the 1950s. The artifact was radiocarbon-dated to $1,495 \pm 20$, which makes it about 1,370-years-old (AD 558-578). Photo - ©C. Lee

collection of several artifacts from ice patches on public land, destroying much of their scientific value and their ability to be enjoyed by the public. Ideally one would continually monitor the ice patches for newly emerging materials, but doing so would be nearly impossible given the location of most ice patches. At best, archeologists get to the areas they can given the challenges and hope for a timely arrival.

Conclusions

If current climate change projections are correct, the observations and projections presented suggest an increased level of concern for irreplaceable resources. The climate threat forces a sobering reality, but also affords us new and powerful ways to conceive of park resources. Rather than considering our preservation mandate of park resources as minimizing threats to individual artifacts or sites, we now can think more broadly to how we can preserve the significant landscapes that contain these resources.

Future work should, of course, include strengthening the science needed to better understand future events and ways to respond to them. At present we do not have the tools needed to choose the most appropriate management action when new impacts are likely. What do we need to know in order to choose the right manage-

ment strategy? Are triage methods appropriate, such as choosing among survey, salvage, hardening, or is doing nothing at all the correct course of action? Work on these tasks is now within our grasp if we choose.

All resource management decisions are made within a complex matrix of federal law and regulations, funding realities, agency policies, and the multitude of potential impacts resulting from agency action or inaction. The mandate of preservation of the nation’s treasures means we owe it to this and future generations to devise ways to do the best we can to preserve the resources we are charged with protecting.

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DEBUNKING THE MYTH: *Seasonal Use of Yellowstone*

Thomas James



Historically there have been narratives that Yellowstone was either sparsely occupied by Native American groups or never inhabited by them at all. These accounts are at odds with both the wealth of prehistoric archeological sites in the park, and ethnographic accounts and oral traditions of the park's 26 associated tribes. A more recent narrative is one of Native Americans coming into the park seasonally, either as nomadic groups following game or as semi-sedentary peoples who moved between fixed settlements that were occupied seasonally. Research efforts have informed us that prior to the creation of the park, people moved seasonally from one established location to another to access different resources as they became available. We have three major avenues of research on the question of seasonal use of the park: history, ethnography, and archeology.

The historic account, written by the early European American park staff and perpetuated until somewhat recently, says the park was barely occupied in prehistory by small bands of Sheepeaters and other Native American populations shied away from it. This account indicates Native Americans had no interest in the park or its resources after the park was founded and the Indian Wars came to an end. Early ethnographic accounts likewise didn't touch much on Yellowstone; however, some information about our affiliated tribes was collected. More recent ethnographic accounts contain more nuance, and start to paint a picture of year-round use by some groups such as the Sheepeater Shoshone and occasional visits by other groups like the Blackfeet (Nabokov and Loendorf 2002).

Archeology is our most useful tool in trying to decipher past lifeways; however, there are challenges in interpreting seasonal use of the park from archeologi-

cal data. Seasonality in archeology is often interpreted through faunal and botanical artifacts, as these items are often available only during part of the year and their presence reflects the time of year they were used by site occupants. Unfortunately, the highly acidic soils of Yellowstone's volcanic environment are often uncondusive to the preservation of these organic materials. Although these types of fragile specimens are underrepresented in the park's archeological record, they are present in some cases and help us determine the seasons when people might have used those sites.

Fish bones are one type of faunal remains in the archeological record which help us infer seasonality. Though direct evidence of prehistoric fishing on Yellowstone Lake is lacking in the form of boats, bones, and piscine protein residues on tools (Johnson 2002, MacDonald 2013), we extrapolate that native peoples engaged in fishing using ethnographic information (Nabokov and Loendorf 2002), as well as the occasional stone net sinker recovered along the lakeshore (Johnson 2002). Ethnographic reports indicate Shoshone peoples, including the mountain-dwelling Tukudika, or Sheep Eaters, were voracious consumers of fish. Fishing weirs constructed from brush are highly perishable. Although we have no evidence of them in the park, based on historic and ethnographic accounts they were a well-known phenomenon among all Shoshone people (Nabokov and Loendorf 2002). Their presence cannot be discounted or confirmed at Yellowstone Lake, however, based on our current data. The best time for using weirs for catching native cutthroat trout, as well as other native fish such as grayling or whitefish, is during the spawning runs which take place in spring.

We also have direct evidence of fishing along the Gardiner River and the Yellowstone River near the Black

Canyon (Johnson 2002, Vivian et al. 2008). In addition to a fishing weight, large amounts of fish bone have been located in buried intact archeological deposits on a fluvial terrace overlooking the Yellowstone River. The nature of the site would lend itself well to the installation of fish weirs during the spawning season. This site's location on a fluvial terrace resulted in silt-laden soils that are more conducive to the preservation of organic materials than volcanic soils, which helped preserve large amounts of piscine and mammalian bone along with botanical remains (Vivian et al. 2008). Botanical artifacts identified included the remains of phacelia, cattail, sagebrush, juniper, pine and Douglas-fir. From a dietary standpoint, young phacelia shoots in the spring can be eaten as greens, cattail fruits can be collected and eaten in fall, and the tubers can also be eaten at any point in the year. Sagebrush seeds can be harvested from July until September, and juniper berries could be collected in the late summer and fall and then dried for use later in the winter. Based on this evidence, Black Canyon was likely occupied in the winter, spring, and early summer months (Puseman and Cummings 2005). Today, Black Canyon is known as one of the first places in the park where snow-melt allows for good hiking, but is very hot during the summer. This site could reflect where early inhabitants of Yellowstone lived during the colder months, before moving back to higher elevation camps in the summer.

Not far downstream from Black Canyon, a site along the Yellowstone River was occupied from roughly 3,050 BC to AD 1,550 (Livers 2012). Located on a glacio-fluvial landscape, this site has also produced botanical remains including juniper, willow, and sagebrush. The lack of evidence of plant processing suggests these plants may have been used as a fuel source. Animal bones from this site were primarily from large ungulates, such as bison and elk. The low overall density of artifacts suggests the site was occupied only for short durations, most likely as a late-fall and winter seasonal encampment (Livers 2012).

Camas roasting pits are a common type of archeological feature in the southern Greater Yellowstone Ecosystem and across the Columbia Plateau. Similar earth ovens were identified near Fishing Bridge. These large pits are filled with stone, and used to roast large amounts of camas or other tubers for eating or grinding into flour. Camas ovens were dug either by families or large communal groups, and often families would return to favored gathering spots year after year (Nabokov and Lo-

endorf 2002). Camas digging began in late summer or fall, so the presence of these features leads us to deduce that Fishing Bridge was occupied during autumn.

There is a wide diversity of archeological sites in Yellowstone, ranging from small lithic scatters found all over the park to large multi-occupation sites around Yellowstone Lake. Looking at the sites from a landscape perspective, the predominant pattern is one of people using higher elevation areas during the summer months when a multitude of resources are available and moving down into lower elevations to overwinter. This settlement pattern is referred to as a semi-sedentary lifestyle, where groups move from one established settlement to the next based on seasonal availability of food and other resources throughout the year.

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Thomas James see page 24.

Archeological Significance of Yellowstone Lake

Douglas H. MacDonald

Yellowstone Lake is considered by many to be the heart of Yellowstone National Park (YNP; figure 1). As North America's largest, high-elevation natural lake at nearly 8,000 ft. (2,400 m) above sea level, this 20 mile long by 15 mile (32 x 24 km) wide freshwater body of water has played an important role in the lifeways of Great Plains, Great Basin, and Rocky Mountain Native Americans for 11,000 years. As many as ten different tribes likely lived near enough to the lake to exploit its vast resources. The following article is an adapted excerpt from my book, *Before Yellowstone: Native American Archaeology in the National Park*, published by University of Washington Press in February of 2018.

I led my University of Montana (UM) archeology crews on five years of archeological research trips (2010-2014) along Yellowstone Lake's remote southern and eastern shores. We also conducted archeological excavations at

the lake's popular north shore between 2015 and 2017. From our two base camps (Grant Village and Fishing Bridge), our four-person team traveled along the western shore of the lake to the Bridge Bay Marina. Once at the marina, we loaded our equipment and supplies into a motorboat, which dropped us off at the boundary of the no-motor zone on the lake. From there, we transferred our supplies to two canoes and paddled to our backcountry camps. Once at our camp, we set up our tents, loaded the canoes with archeology gear, and paddled to many archeological sites to conduct excavations.

Just as we did, Native American hunter-gatherers traveled up the valleys of the major rivers and creeks to get to the lake. Many of the camps we lived in for our archeology work had been used by Native Americans before the park was created. Native Americans, however, walked to the lake and walked around the lake once they got there. Based on our research, it is unlikely that native



Figure 1. Map of Yellowstone Lake.

communities used boats on the lake; however, the lure of the abundant wild resources lured these hunter-gatherer peoples to its shore.

Because of its high altitude, the lake area averages about 70°F (21°C) in the summer; yet the valleys outside the park can be as much as 20°F (6°C) warmer. Streams that flowed readily in the spring and early summer at the lower elevation settings dry up, as do many of the wild resources. As part of their mobile seasonal settlement pattern, Native Americans from the lower elevations traveled upward, starting in the early spring, venturing to higher elevations during the warmer months not only to escape the heat, but also to follow the animals and ripening plants on which they subsisted.

The flow of the seasons is important in understanding prehistoric human use of Yellowstone Lake. May through October at the lake have average temperatures around or above 50°F (10°C). From November through April, the lake area receives snowfall averaging 20 in. (50 cm) or more per month, with an accumulation of 3 ft. (90 cm) or more. Yellowstone Lake freezes up to 25 in. (63 cm) thick between about early December and early to mid-May. In winter through early spring, Native Americans likely traversed the frozen lake surface to access the islands more easily than they could at other times of year. In the warm months, a variety of game animals migrate upward in elevation to places including Yellowstone Lake, then move down from the lake area to lower elevations in winter. As many as 60 different mammal species live in the vicinity of Yellowstone Lake, including bison, elk, moose, bighorn sheep, deer, antelope, grizzly and black bears, mountain lion, coyote, cougar, bobcat, and wolf. Our archeological research shows that Native Americans hunted all of these large animals while they camped at the lake, with rabbit, deer, bison, elk, and bear being particularly popular prey species.

Another seasonally migratory food source in Yellowstone Lake is Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*), one of only two surviving original native cutthroat trout species left in North America. This trout species was probably relatively abundant at the lake prehistorically, especially in spring when the trout runs up the lake's creeks to spawn. However, as I describe below, fish were not actively used as a food item by tribes that visited the lake.

The shores of Yellowstone Lake contain several vegetative zones, including a subalpine spruce and fir zone, pine woodlands, riverine and marshland habitat, and sagebrush grasslands, all a result of several transitions

occurring in the park after deglaciation. Interspersed among the extensive pine forests, there are abundant open meadows and riparian areas that contain an extremely diverse array of plants—as many as 400 different species. The ripening of these plants for food, such as camas bulbs and bitterroot, likely drew people to the lake in spring as well. During one of our archeological field schools at Yellowstone Lake in 2010, two of my students identified 52 different plant species used by early Native Americans in a 20-acre (8-hectare) meadow (Osprey Beach) on the northwest shore of the lake near Lake Lodge (figure 2). Of these 52 plant species, 15 were recognized as food sources, 17 as medicinal, and 8 as spiritually important.

To get to the lake and its variety of wild resources, Native Americans followed the valleys of major creeks and rivers that cut through the mountain passes. The Yellowstone River is the major lake tributary and has two confluences on the lake: one flowing in on the southeast corner and one flowing out about 18 miles (30 km) to the northeast at Fishing Bridge. Among the 40 or so other smaller streams that flow into the lake with headwaters in the Absaroka Range, Clear Creek arrives on the northeastern shore of the lake. Each of these three major waterways—the southern and northern conferences of the Yellowstone River and Clear Creek—were active travel routes in prehistory, along other major lake feeder streams. For example, the Madison River to the west of the lake and the Lewis River to the south were also major regional travel routes used by Native Americans to gain access to the resources of the Yellowstone Plateau.

Archeological Sites at Yellowstone Lake

The first survey for archeological sites in YNP was conducted by Montana State University (MSU), Missoula (now the University of Montana) in the late 1950s and early 1960s. Led by Jacob Hoffman, the first professional archeologist to identify the high density of prehistoric archeological sites at Yellowstone Lake, the original survey identified over 200 archeological sites within YNP. In the early 1960s, Dee Taylor of MSU-Missoula performed additional archeological excavations in the Fishing Bridge area on the north shore of the lake near the Yellowstone River. The National Park Service's Midwestern Archaeological Research Center and the University of Montana also conducted additional work there in the 1990s and 2000s, respectively. In the early 1990s, the National Park Service (NPS), together with a private archeological consulting firm, Lifeways of



Figure 2. Osprey Beach excavations.

Canada, led excavations at the Osprey Beach site and its 9,500-year-old Cody Culture occupations. Between 2009 and 2016, YNP again provided funding for my UM team to complete surveys and tests of archeological sites on the northwest, eastern, and southern shores of Yellowstone Lake. These various studies have identified at least 300 archeological sites along the shores of the lake.

Excavations by the UM team at dozens of sites from 2009 to 2017 confirm active use of the lake since the Clovis period. The UM team found a Clovis projectile point on the south shore of Yellowstone Lake, indicating its use by Native Americans approximately 11,000 years ago. After the first ephemeral visits to Yellowstone Lake by Clovis people, Late Paleoindian Period Cody Culture people increased their use of the lake beginning about 9,500 years ago. The Fishing Bridge site contained an Early Archaic hearth dating nearly 6,000-years-old, which remains the oldest radiocarbon-dated fire pit of any site at the lake. Early Archaic Native Americans used large side-notched projectile points that are often referred to as Mummy Cave points, since several were found at the Mummy Cave site (Wyoming) near the eastern park boundary on the east entrance road. Early Archaic hunter-gatherers sought the cool temperatures and reliable water supply of Yellowstone Lake during the Altithermal, a hot and dry period that prevailed

7,000 years ago. The Altithermal was so hot and dry at lower elevations that the modern form of bison (*Bison bison*) evolved at the expense of the large herds of the ancient, large-bodied bison (*Bison antiquus*).

Middle Archaic Native American camps were quite common at Yellowstone Lake as well. In the early 1990s, the NPS excavated several fire pits at two sites in the West Thumb near Arnica Creek, used by Native Americans dating to approximately 4,000 years ago. Here, as well as in Middle Archaic features at the Fishing Bridge Point site, archeologists found several split-base McKean and Oxbow points that are diagnostic of the Middle Archaic period.

The Late Archaic period witnessed a significant increase in Native American use of the lake area between 3,000 and 1,500 years ago, with numerous archeological sites around the lakeshore having fire features and projectile points dating to this time period. A hearth was excavated by my students in 2014 at a site on the Flat Mountain Arm of Yellowstone Lake (figure 3), with a radiocarbon date of the Late Archaic period, approximately 2,000 years ago, and associated with Pelican Lake-type projectile points. Late Archaic Native Americans hunted large herds of bison like those visible today in the park.

Native Americans continued active use of Yellowstone Lake in the most recent Late Prehistoric period (1,500–200 years ago). We excavated the remains of several campfires used by Native Americans near the Fishing Bridge campground and store in 2011, evidence that Native Americans probably utilized Yellowstone Lake around the time of Euro-American contact. For at least 10 millennia, Native Americans used a spear thrower, or atlatl, to hunt. About 1,500 years ago, the bow and arrow was introduced, changing the face of hunting in the Great Plains and Rocky Mountains. Requiring very small arrow points, these points are present at numerous sites around the lake, including a site in the lake's southeast arm (figure 4). Also at that site, in 2014 UM archeologists found the intact remains of a Late Prehistoric stone circle, or tipi lodge base, beneath a foot of dirt.

In addition to arrow points, sherds of small amounts of Late Prehistoric pottery used by Native Americans were found at the First Blood site in the West Thumb area. NPS archeologist Kenneth Cannon excavated that site in 1992, but most of the pottery was recovered in the late 1950s by Jacob Hoffman. The pottery was produced from local clay tempered with crushed rock, and was used to both cook and store food. This type of pottery is called Intermountain Ware, often associated with archeological sites used by the Shoshone Indians within the past 1,000 years in YNP.

Which Native American Tribes Used Yellowstone Lake?

Was Yellowstone Lake within the territory of one tribe or many? Some archeologists suggest that Yellowstone Lake was at the center of a large territory used by a single group of Native Americans, perhaps the Shoshone or another tribe. Other archeologists suggest that multiple tribes from different regions used the lake.

Peter Nabakov and Lawrence Loendorf conducted extensive research on Native Americans in YNP, much of which can be found in their 2004 book, *Restoring a Presence: American Indians and Yellowstone National Park*. Their research indicates that diverse groups, including the Shoshone, Bannock, Crow, Blackfeet, Salish, Kiowa, and Nez Perce, utilized the region in late prehistoric times. In particular, the Blackfeet and Crow were thought to have used the northern tier of the lake, while Nabakov and Loendorf suggested that the Eastern (or Wind River) Shoshone mostly used the lake's southern tier. The Bannock and Nez Perce mostly used the northern tier of the lake as well, with the Nez Perce apparently



Figure 3. Excavations by University of Montana at Flat Mountain Arm. Photo- ©D. MacDonald.

using the Pelican Creek Valley as a main warm-season bison hunting area. With this approach, it is not reasonable to think that the Shoshone were the exclusive users of present-day YNP, even in later prehistory.

In support of the multi-tribe model of lake use, data collected by my UM archeology teams and others at dozens of lake area sites suggest that a variety of Native American tribes used Yellowstone Lake before European American contact. Based on lithic raw material (stone tool) source locations, it appears that each tribe likely utilized different travel routes to get to Yellowstone Lake, following similar routes that people use today to travel to the park. Except for sites on the southeast shore of the lake, Obsidian Cliff obsidian is common at most lake area sites. Therefore, nearly all the Native American people who utilized the lake (with the possible exception of tribes on the southeastern shore) apparently also traveled to Obsidian Cliff, some 25 miles (40 km) to the northwest of Fishing Bridge, to procure stone for tool manufacture.

Based on stone tool material distributions and ethnographic data, Crow, Blackfeet, Salish, Nez Perce, and, to a lesser extent, Shoshone likely were active on the northern shore of Yellowstone Lake in the recent past. Because of extremely high densities of Obsidian Cliff obsidian and Crescent Hill chert at archeological sites near Fishing Bridge and Steamboat Spring, Native Americans living on the northwestern shore of the lake oriented their travel patterns toward Obsidian Cliff and the Yellowstone River, north of the lake. The low numbers of other types of obsidians from the south indicate infrequent travel and trade with people living south of Yellowstone Lake toward Jackson, Wyoming, and the Snake River Valley. On the eastern lake shore, Native Americans produced tools from Obsidian Cliff obsidian, Absaroka Mountain cherts, and local Park Point obsidian (with a source on the east shore of the lake).

On the southeast lake shore, the southern Yellowstone River and Snake River headwaters were likely origin routes for Shoshone and, perhaps, Crow, Northern Cheyenne, Kiowa, and Arapaho tribes in historic times. These Native American tribes on the southeastern lakeshore may not have traveled often to Obsidian Cliff because it was more than 75 miles (120 km) away, with Jackson, Wyoming, obsidian sources only 30 miles (48 km) away. The low densities of obsidian suggest that these southeastern shore Native Americans likely did not travel to Obsidian Cliff very often because of the long distance to walk around the lake to get to the cliff.

Therefore, the southwestern lakeshore appears to have been somewhat of a multi-use area for Native American tribes from the south, west, and north in late prehistoric times. The West Thumb appears to have seen active use by a variety of tribes, likely including tribes from the south (e.g., Shoshone), the west (e.g., Shoshone and Nez Perce), and the north (e.g., Crow, Blackfeet). Obsidian Cliff obsidian is among the more common obsidians at sites in the West Thumb area; but significant quantities of Absaroka cherts and Jackson-area obsidians also are present at West Thumb sites, suggesting multiple points of origin for Native Americans who camped there in the past.

These generalizations of lake use apply only to the recent past. As we go farther back in time, linking sites to tribes becomes very difficult, if not impossible, largely because of the similar types of material culture of Native American peoples across the region.



Figure 4. Comparison of Atlatl dart point (left) and Bow and Arrow point (right) from Yellowstone Lake. Photo- ©D. MacDonald.

The Subsistence Systems of Native Americans at Yellowstone Lake

Another major question for park archeologists is: How can we better understand the hunting, fishing, and gathering systems and the seasonality of Yellowstone Lake use by prehistoric Native Americans? In the 1980s, NPS archeologists were the first to speculate as to the function of the lake in the prehistoric settlement and subsistence systems in the pre-contact period. Mainly trying to figure out which seasons Native Americans used the lake area, those archeologists proposed that the lake was used during the winter to hunt animals at volcanic hot spots or, alternatively, during the spring to fish for cutthroat trout as they ran up the lake's tributaries to spawn. However, their limited data resulted in inconclusive results, finding no faunal remains to indicate winter hunting or fish remains to indicate spring fishing. Regardless, the archeologists indicated that locations of hunting sites near thermal features and near stream confluences confirmed their interpretations. In addition, they cited the presence of "notched flakes" as indication that Native Americans produced wooden sticks to be used for fishing. No detailed descriptions or illustrations of the notched flakes were provided; as well, no blood residue analyses were performed to confirm or refute the wood-working and fishing hypotheses. Nu-

merous stone tools have been examined for protein residues, with not a single one at Yellowstone Lake yielding evidence for wood or fish.

Nabakov and Loendorf's (2002, 2004) work suggested that the various Native American tribes that used the lake incorporated a wide variety of subsistence strategies in their survival repertoire. While various tribes hunted and gathered many mammals and plants, fishing appears to have been uncommon for tribes at the lake, despite the abundance of fish. Among the tribes, the Shoshone and Bannock were perhaps the only tribes likely to have used the lake for fishing, if at all. Nabakov and Loendorf reported that "[the Northern Shoshone] fished in Yellowstone Lake . . .", although details and specific ethnographic accounts of fishing at the lake were not provided. Great Basin cultural anthropologist Julian Steward's 1941 ethnographic report indicated that the Shoshone and Bannock fished extensively in the spring, mostly using brush dams and weirs (Steward 1941). Shoshone and Bannock legends describe how coyote spilled mother earth's basket of fish (interpreted as Yellowstone Lake), forming the various inland northwest river systems, thus establishing that the Shoshone were well aware of fish in Yellowstone Lake (Nabakov and Loendorf 2002).

Therefore, since the Shoshone fished and were aware the lake contains fish, it is reasonable to assume that the Shoshone likely fished at Yellowstone Lake. This activity probably occurred in spring, sometime between May through July, depending on the timing of the lake thaw and spring fish runs. Nabakov and Loendorf's informants, including Dick Washakie (son of the Shoshone Chief Washakie), as well as early ethnographer Ake Hultkrantz, confirmed that both the Northern and Lemhi Shoshone fished a lot and that there were no magical restrictions or other social limitations on who could fish, as there were with hunting activities. Nabakov and Loendorf, however, did not provide specific ethnographic accounts of the Shoshone fishing at Yellowstone Lake, only saying that the Shoshone were known to have fished. The ethnographic data indicated it is unlikely that the Blackfeet and Crow fished at the lake, both of whom focused on hunted and gathered resources, such as bison and camas, respectively, in their diets (Nabakov and Loendorf 2002).

If there is some question as to the extent of Native American fishing at Yellowstone Lake, ecological data fully support the viability of hunting and gathering at the lake in recent history. Ethnographic accounts of recent

use of the Yellowstone region include the collection of a wide variety of plants, including roots, seeds, and nuts. Mammal hunting was also vital to lake area subsistence. Bears are still active at the lake, although Nabakov and Loendorf (2002) did not provide data to address Native American bear hunting in the Yellowstone uplands. Bear hunting is common to a host of northern-latitude hunter-gatherer groups across the globe; therefore, it is certainly reasonable to speculate that Native Americans in prehistory were attracted to Yellowstone Lake and its surrounding environs to hunt bear. The lake does not thaw completely until late May or early June, so bear hunters likely were at the lake at a time when ice was still thick enough to walk on to reach the islands (all of which have prehistoric archeological sites) between January and early May.

In support of this supposition, YNP's bear management officer Kerry Gunther told me that he has observed bears on three islands and recorded a bear hibernation den on one of them. The hunting of hibernating bears on the islands certainly would have encouraged native hunters to walk across early spring ice, especially if the hunter had pre-scouted the presence of a den. This supposition could explain the presence of archeological sites on the lake's islands and would not require construction of boats to make the trip.

Archeological Evidence for Hunting, Gathering, and Fishing at Yellowstone Lake

In the 1990s and 2010s, Paul Sanders from the University of Wyoming explored the seasonal use of the park by Native Americans within the nearby Hayden Valley, just north of the lake along the Upper Yellowstone River Valley. Following the work of YNP archeologist Ann Johnson at the Osprey Beach site at Yellowstone Lake, Sanders suggested only warm-season use by Native Americans of the higher elevation portions of the Yellowstone Plateau, including Yellowstone Lake, with movement downslope into lower elevation river valleys in winter. Sanders (2013) also doubted the earlier speculation for fishing, suggesting that "although preservation of fish bones is a problem, fishing-related artifacts (e.g., net weights or sinkers) have not been clearly identified at any site in the lake area or Upper Yellowstone River."

More recently, archeologists Ann Johnson and Brian Reeves have speculated that the lake was exclusively used during warm months because of the lack of available resources at the lake in winter. However, they failed

to provide information to support their ideas, admitting in their site report on the Osprey Beach site (Johnson and Reeves 2004) that “We have not found any seasonal indicators for sites around the lake.”

Because of the intense winters and deep snow, most interpretations of YNP seasonality posit a late spring to early summer start of the tribal-use cycle. However, I think individuals traveled to the lake earlier in the seasonal cycle, possibly in March or April, trips perhaps oriented around finding possible bear dens on the islands of Yellowstone Lake or in the hills above the lake. At the same time, these travelers surely scouted snow conditions to estimate the timing of plant availability and even perhaps the timing of cutthroat trout runs.

Excavation of numerous archeological sites at the lake also provides excellent data by which to interpret how Yellowstone Lake was used in the past. Analysis of animal and plant remains, as well as protein-residue analysis of stone tools, provides insight into the nature of hunting, gathering, and fishing at Yellowstone Lake. Subsistence information has been recovered at twenty-two sites at Yellowstone Lake, including sites in all areas of the lake and dating to a variety of time periods.

Based on animal bones and protein residue on stone tools excavated at archeological sites, elk, bison, deer, bear, sheep, beaver, rabbit, cat, and squirrel were hunted by Native Americans at the lake in the past. Animal, or faunal, remains are rare at Yellowstone Lake sites because the highly acidic soils deteriorate bone quickly. In fact, only four archeological sites have yielded identifiable bone fragments at lake area archeological sites. One, located on the northeastern lakeshore, the Late Prehistoric Windy Bison site yielded the remains of bison, elk, and sheep during excavations by Kenneth Cannon (MacDonald and Hale 2013) in the early 1990s. Two, unidentifiable bone fragments (possibly bison) were found at the Donner site in a Middle Archaic occupation on the southeast arm of the lake. Three, in 2016, my crew recovered a large bison leg bone dated to about 800 years ago, in association with obsidian flakes eroding from the edge of Dot Island in the middle of Yellowstone Lake (figure 5). Finally, in 2014, my crew recovered an elk toe bone from near a Late Archaic hearth dated to 2,000 years ago, located on the Flat Mountain Arm of the lake, a few miles east of the West Thumb (MacDonald and Hale 2013).

In addition to animal remains, 13 lake area sites yielded lithic artifacts with positive blood protein residue. Deer

protein was identified on tools at six lake area sites, with bear identified at five sites. Rabbit was identified at four sites, with three each of bovine (bison), cat (bobcat, lynx, or cougar), and bighorn sheep. Dog (coyote, fox, or wolf) was identified at two sites, with rat (squirrel) and guinea pig (probably skunk or beaver) identified at single sites each. These protein identifications suggest a diverse hunting strategy at the lake, with the lithics dating from the Paleo-Indian to Late Prehistoric periods (9,500–300 years ago). The presence of bear protein on lithics from five lake area sites supports the hypothesis of active bear hunting at Yellowstone Lake in prehistory. That evidence also supports the idea of early spring trips to the lake by Native American hunters looking for bears waking up from hibernation.

Ethnobotanical plant remains and plant pollen have been identified at seven Yellowstone Lake sites, all excavated by my team between 2009 and 2016. These plant species include buckwheat, goosefoot, sagebrush, Jacob’s ladder, sedge, grass, sunflower, lily, and bitterroot. These species have edible and/or medicinal qualities and support the warm-season model of lake use because of their ripeness between May and September. Features in which these plants were found date variably to the Early Archaic, Middle Archaic, Late Archaic, and Late Prehistoric. This suggests long and consistent use of plants by lake area hunter-gatherers, at a minimum, during the most recent 8,000 years of prehistory.

Most significant in the subsistence data is the lack of any positive identification of fish remains or proteins on any of the tested materials at the dozens of sites studied at the lake. While UM’s protein residue analysis includes problematic lab results, many other studies, including ours analyzed at other labs, have also failed to identify fish protein on stone tools and fire cracked rock. Presumably, this means Native Americans did not fish at the lake very much, perhaps because of the abundance and ubiquitous availability of many other types of animals and plants for food.

Did Native Americans Use Boats at Yellowstone Lake?

Another fishing-related research question that needs answering is: Were canoes or other types of boats used by Native Americans at Yellowstone Lake? In their 2004 report on Osprey Beach, Johnson and Reeves (2004) explained how the lake’s islands contained archeological sites, pushing forward the notion that Native Americans



Figure 5: Matt Nelson on Dot Island with bone visible. Photo- ©D. MacDonald.

used canoes to access the islands. Johnson et al. (2004) stated that “although direct evidence is lacking, we suggest seasonally resident Cody bands at Yellowstone Lake . . . probably fished, fowled, and perhaps used skin-covered boats on Yellowstone Lake.” Their speculation of boat use is further confirmed in illustrations produced for the Late Paleo-Indian Osprey Beach site by Johnson for public presentations on that important site (Johnson and Reeves 2013). But, she largely disregarded access to the islands when the lake was frozen because she believed that the frigid winter conditions were too harsh for Native Americans (Johnson et al. 2004).

Boats certainly would have facilitated travel around the lake’s shores and to the lake’s islands, as well as facilitated the transport of lithic raw material and other goods to the various lake areas. However, ethnographic and ethnohistoric literature is lacking any accounts of Native American boat use at Yellowstone Lake. Philetus Walter Norris’s 1880 superintendent report indicated the casual observation of a dugout canoe downriver on the Yellowstone River (well downstream of the lake) and another on Beaverdam Creek near the southeast cor-

ner of the lake. However, those canoes may have been used by historic period trappers and do not necessarily support the hypothesis of Native American boat use at the lake. Nevertheless, among the tribes who used the lake, the Shoshone were known to have used skin boats (but not canoes) in their collection of riparian resources in lower elevation lakes of the Great Basin (south of Yellowstone), as recorded by the anthropologist Julian Steward (1941). There are no ethnographic accounts available that suggest any of the tribes using Yellowstone Lake had canoes.

If boats, especially canoes, were built and used at Yellowstone Lake, we should expect to see evidence of their manufacture in the archeological record. But in all of the excavations by the UM teams around the shores of the lake, only one possible wood-working tool was recovered. This tool showed a heavy worked edge, likely on hard materials such as wood. On the southwestern shore of the lake, Ann Johnson and her colleagues noted the presence of two adzes at the Osprey Beach site, although it is unclear whether wear indicated woodworking for those tools. I am unaware of any other lake area

sites yielding adzes or heavy-duty wood-working tools. If boats were utilized, it does not appear that they were of the dugout canoe variety; but possibly they could have been of the skin-boat (*umiak*) variety, known to have been used by the Shoshone in the Great Basin. Since the Shoshone frequented Yellowstone Lake, it is conceivable that they used skin boats there as well. However, no boats or boat parts have ever been identified to-date at any lake area site. Certainly, such finds would be remarkable at the lake, given the acidic nature of soils due to volcanism.

Stone artifact data can also be used to evaluate boat use. Presumably if boats were used to transport people around the lakeshore, it is reasonable that they also would have transported stone by boat to save energy and maximize stone material availability in tool manufacture. So, my prediction is that amounts of rock at sites should be more-or-less similar around the different areas of the lake shore if boats were used for travel, assuming Native Americans would have carried lots of stone with them. In contrast, if foot travel was emphasized, I predict that we should see significant reductions in the amount of stone in different areas of the lake. Under the walking option, Native Americans also would have reduced their stone tool kits to minimum levels to save energy as they walked around the lake.

Stone tool data do not seem to support a hypothesis that boats were used by Native Americans at the lake. The best example of this is to compare stone tools at sites on two areas of the lake that aren't far apart: the northwest shore (near Fishing Bridge) and southwest shore (along the West Thumb). These areas are about 10 miles (15 km) apart by boat or about 30 miles (45 km) by foot along the undulating shoreline. If boats were used anywhere, this would presumably be the place, as it would have saved a great deal of time and effort. Therefore, we should see similar amounts of stone artifacts in the two areas, with the distance fall-off curve flat. In contrast, if humans walked between the two areas, we would expect there to be a significant fall-off in the amount of stone at sites in the two areas. The major presumption here is that the north shore sites were closest to the main source of material in the area, Obsidian Cliff. Presuming Native Americans traveling from Obsidian Cliff to the lake stopped first at Yellowstone Lake's north shore, we should expect to see fairly large amounts of Obsidian Cliff obsidian at sites on the north shore. And if canoes were used, we should see similar quantities of stone at

sites on the southwestern shore. But if people walked between the two areas, we should expect to see a large drop off in the amount of stone between Fishing Bridge and the West Thumb. Logically, people would have carried less stone with them if they walked than if they took a boat.

From 2009 to 2012 on the northwest lakeshore, the UM team excavated 70, 1-meter-square excavation units at 7 sites, yielding 13,995 stone tools and flakes for a mean of 200 artifacts per excavation unit (MacDonald et al. 2012). On the southwest shore along the West Thumb and vicinity, archeologists excavated 94 1-meter-square excavation units at 8 sites, revealing only 2,178 tools and flakes, a mean of 23 artifacts per excavation unit. Both of these areas yielded Obsidian Cliff obsidian and/or cherts from northern lithic sources. Therefore, while people moved regularly between the northwest and southwest shores, the conservation of material (as shown in the reduced numbers of artifacts) supports the hypothesis that they traveled on foot, rather than by boat, to get from Fishing Bridge to the West Thumb.

The overall character of all sites along the north shore of Yellowstone Lake is of lithic (or flaked stone) abundance; whereas on the southwest shore, it is one of lithic scarcity. The amount of stone recovered during excavations at sites on the south shore is about forty-two lithics per excavation square (5,557 lithics; 131 1-meter-square test units; 11 sites) compared to 164 lithics per excavation square at sites on the north shore (18,809 lithics; 115 1-meter-square test units; 13 sites). The sheer volume of lithics from test units on the north shore—18,809 lithics—compared to the south shore—5,557 lithics—is even more striking, considering that 16 additional excavation squares were conducted on the south shore compared to the north.

These stone artifact data suggest a significant fall-off in lithic use in locations farther from their geological sources, suggesting Native Americans walked around the lakeshore and did not actively travel along the lake shore using boats. I propose that this pattern of stone tool use supports my supposition that boats were not used by hunter-gatherers at the lake. If they were, such significant fall-offs in the amounts and weights of lithic material use would not be evident, since Native Americans would presumably have filled their boats with stone material as they canoed around the lake. Also, it is clear from the stone material source data discussed earlier, different groups from different regions likely camped

on the different shores of the lake as well, supporting the idea that the lake was accessed on foot, not by boat.

Conclusion

Based on our UM archeological research at Yellowstone Lake between 2009 and 2017, we conclude that many different tribes of Native Americans actively used Yellowstone Lake in their daily lives over the last 11,000 years. In recent years, prior to the formation of the park, the Shoshone, Crow, Blackfeet, Nez Perce, among others, were likely the most active at Yellowstone Lake. Subsistence was focused on the collecting of dozens of distinct edible plants and the hunting of a variety of animals, including elk, bison, rabbits, deer, and bear. Fishing does not appear to have been an active part of the Native American diet, at least according to the rich archeological record at Yellowstone Lake. The reasons for the lack of fishing remain uncertain. As I discuss further in *Before Yellowstone* (MacDonald 2018), it is possible that native Yellowstone cutthroat trout did not arrive to Yellowstone Lake until the last few thousands years, well after Native Americans started to actively use the lake (since 11,000 years ago); thus, perhaps by the time Native Americans witnessed fish at the lake, they already had a well-established subsistence round that focused on the collection of plants and the hunting of animals.

Future research at Yellowstone Lake should determine when Yellowstone cutthroat trout arrived and further evaluate their role in the diet of Native Americans over the last 11,000 years. Current archeological research provides outstanding support for the fact that many tribes of Native Americans visited Yellowstone Lake since the retreat of glaciers in the Late Pleistocene. This history is rich in the remains of their daily lives, as evidenced by the thousands of artifacts at more than 300 archeological sites around every shore of the lake.

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Photo- ©M. MacDonald

DEBUNKING THE MYTH:

Fear of Yellowstone

Thomas James

One of the persistent myths about Native American attitudes regarding Yellowstone is that they were afraid of this place and avoided it. The stories passed to us by early Anglo explorers and park administrators report that the geysers, fumaroles, and other thermal features frightened the native peoples. It is clear this myth is false based on the more than 1,900 archeological sites so far identified within park boundaries and the numerous accounts from many different tribes of how they interacted with and revered this place. This misconception was perpetuated by early park administrators to further the objectives of promoting the park as a tourist destination, off-limits to its original inhabitants. The myth that the Native Americans of the area were superstitious and scared of being near the “evil spirits” of the geysers was a convenient one. As Euro-Americans began removing native peoples from this landscape, this falsehood was an often repeated rationalization. This idea is reinforced by one of the earliest written accounts of the region from William Clark of the Lewis and Clark Expedition:

At the head of this river the natives [sic] give an account that there is frequently heard [sic] a loud noise, like Thunder, which makes the earth Tremble, they State that they seldom go there because their children Cannot sleep—and Conceive it possessed of spirits, who were averse that men Should be near them (Haines 1974, Whittlesey 2002).

The myth of native fear of this landscape is one of the earliest European American historical accounts we have of Yellowstone, given by a man who never set foot in the park itself. Building off of this account from Clark, the myth has persisted through time and continues to be occasionally referenced with seriousness.

During an 1883 trip into the park, Hamilcar Hollister reports he was told by Native Americans that whites should not be allowed in the park, lest they fall in league with the devils that inhabit the thermal areas and end up destroying all native peoples (Hollister 1912, Whittlesey 2002). It remains unclear whether Hollister’s account was truly a belief of regional native peoples or a “tall tale” conjured by his guide (or himself), which he

passed on in his memoirs years after visiting. Perhaps the most prolific work done on Native Americans in the Greater Yellowstone Ecosystem was done by Åke Hultkrantz. He also perpetuated the myth that Native Americans were afraid of the thermal features in the park (Nabokov and Loendorf 2002).

What we do know is that soon after the foundation of the park Native American faces became sparse. Over the course of a decade all of the natural features in the park were given Anglicized names and native nomenclature was cast aside. However, the native place names were not totally forgotten. Many tribes have stories, several of which give names for specific features.

The Kiowa, who later moved to the southern plains, place their origin in Yellowstone. Their legend states that when the earth was created, there was no homeland for the Kiowa. Doh Ki, the Kiowa creator deity, offered the Kiowa a place to live if they were willing to make an arduous journey to a barren wasteland filled with steaming sulfurous vents and hot water bursting from the ground. After the Kiowa completed their journey, Doh Ki gathered them around a boiling pool of water which crashed and thundered. Called Tung Sa’u Dah, which means “the place of hot water,” he offered them this place as a homeland if any were willing to jump into the pool. One brave Kiowa jumped in, and when he emerged the Kiowa’s new homeland had been transformed into the most lush and abundant place on earth (Nabokov and Loendorf 2002, Whittlesey 2002). The spring which the Kiowa called Tô-sál-dâu is now known as Dragon’s Mouth Spring, located near Mud Volcano.

The Shoshone tell a story about the creation of the park’s landscape. Coyote, in the guise of a hungry traveler, asked Mother Earth in the form of an old woman to boil some fish for him to eat. The woman agreed, on the condition he not touch her basket of fish. As soon as she turned her back he knocked over her basket, the spilled contents turning into Yellowstone Lake. Water flowing from the newly created lake formed the Yellowstone and Snake rivers. Coyote attempted to stop the flow of the water with rocks, which became the Upper and Lower

Falls of the Yellowstone River and Shoshone Falls on the Snake River (Clark 1966, Nabokov and Loendorf 2002; Whittlesey 2002).

The Crow describe “Old Woman’s Grandchild,” who battled many animals and turned them into mountains and hills once defeated. After he killed a bison and a mountain lion, he created two of the park geysers, by placing these animals into the ground near one another where they still breath out hot air (Nabokov and Loendorf 2002; Whittlesey 2002). The Crow also report that steam vents around Yellowstone Lake were formed when a Crow man heated rocks and threw them into the mouth of a massive water beast, killing it and saving the lives of Thunderbird’s offspring (Nabokov and Loendorf 2002, Whittlesey 2002). A Crow man named Hunts-to-Die, born well before the establishment of the park, relayed stories of how the tribal members believed benevolent and helpful spirits were associated with the geysers (Whittlesey 2002). Hunts-to-Die’s oral history is among the earliest to contradict the stories that Native American’s feared the geysers.

As mentioned before, over 1,900 archeological sites are known in the park. The shocking part of this is that only 3% of the park has yet been surveyed by professional archeologists. If archeological site density remains constant over the entire park, we can extrapolate there could be tens of thousands of sites in the park. Regardless of how many sites are actually in the park, the 3% surveyed shows a site density that completely puts to rest any idea that people were afraid of this place.

As you travel through the park in awe and wonder of the landscape around you, remind yourself that people have used this landscape for over 11,500 years and likely felt the same overwhelming feelings of awe. They hunted here, gathered here, and lived their lives here. They probably all experienced fear at some point—of cold, of animals, of scarcity in winter—but the landscape itself did not frighten them. Yellowstone was a familiar and inspiring place to live and explore.

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Thomas James see page 24.



A Volunteer's Impressions

John J. Reynolds



Superintendent Suzanne Lewis and Cultural Resources Chief Ann Johnson presented John with The George and Helen Hartzog Enduring Service Award for his over 8,000 hours of volunteer work with the Yellowstone Archeology Program in 2012.

My introduction to the field of archeology was fortuitous for me and came late in my life. The field of archeology was essentially unknown to me when I applied to become a volunteer for the National Park Service (NPS). I had applied to increase my knowledge of NPS operations in order to become an advocate for the park system in my retirement.

The NPS developed a Volunteers-in-Parks (VIP) program to supplement the pursuit of its mission. Each park has its own program, and I applied to Yellowstone National Park (YNP) largely because of its natural beauty and abundant wildlife. In my application, I noted that I had few marketable skills, could work 3 months or so, and promised to work hard and follow instructions.

Through great good fortune, the efforts of the VIP Coordinator at Yellowstone, and the willingness of Park Archeologist Dr. Ann Johnson to take a chance on an unknown quantity, I was allowed to volunteer for her program. My plan was to work for the summer (1999) and move on to my next experience. I had no idea what I was getting into, but will be eternally grateful to Ann

and all the other wonderful folks who showed more patience than judgment by allowing me to work for 16 summers.

Early in my first summer, a gentleman stopped in the lab looking for Ann. As I accompanied him over to her office, he said to me, “Don’t catch it.” I clearly did not understand. He smiled and said, “Yellowstone Fever, don’t catch it.” He was a physician in his seventies, had worked in the park the summer before he started college, and had returned nearly every year since then. While I did not realize it, I already had caught Yellowstone Fever.

The Basic Work

My first year, and many of the years that followed, I worked with a crew of professional archeologists from Canada. They were substantively expert, all with graduate training, and were experienced at the sometimes very physically demanding field work. They prepared detailed scientific reports for each project, which are not available to the general public in order to protect the location of the sites and prevent looting. The team,

however, did publish several articles in *Yellowstone Science* which provided useful insights while protecting the locations.

With the team, our field time was devoted to surveys or excavations. Surveys consisted of forming a line and walking across a specific area simply looking at the surface of the ground for items of interest. In YNP most of the ground is acidic, so nearly all our finds were stone. I was totally lost as to what was important, but our team was very forgiving and brought me along slowly.

I thought any rock with a point on it was collectible. Soon I learned that only obsidian or chert was of interest. Of those materials, most of what was found were “flakes,” chips removed from a larger piece in the process of toolmaking. We found thousands of flakes and only a small number of tools, such as projectile points, knives, awls, and scrapers.

The first summer we began by surveying along the road west of the Madison Campground. We worked both sides of the highway from Seven Mile Bridge to West Yellowstone, much of it along the Madison River. This area was chosen at that time because we had Federal Highway money to support the work. Because of the proximity to the river, it was also likely habitat for early peoples.

When surface surveys identified significant concentrations and resources were available, sites could be selected for excavation. My part of excavating was not one requiring special skills. The choice of sites and the delineating of individual units within the sites was done meticulously. As soil was removed from each unit, it was placed in a bucket and then dumped into a screen suspended by a tripod. The screen was shaken vigorously to force the soil through, leaving items too large to pass through the screen. That was my job; and on windy days, such as at one site near Yellowstone Lake, I ate a great deal of dirt at my station. The residue was examined to see if any of it merited collection. The collected items were almost exclusively flakes; only in rare instances did a tool escape the critical review of the excavator.

All the items collected were brought to the lab to record where they were collected. Precise physical descriptions were added, and then the artifacts were labeled. All this was entered into a central database. The final step was transferring the prepared artifacts and the complete documentation to the museum for storage and subsequent research. Much of this work was done in the winter when field work was not possible. As the years passed, and with less funding for field work, more time

was spent in the lab. One summer I developed the information and created forms required to document some 1,800 artifacts, and then entered the information into our database.

When I began volunteering, Ann’s office and the lab were located in Mammoth. The long-planned Heritage and Research Center (HRC) in Gardiner was completed in 2004. At that time, all archeology activities shifted to our new quarters in that building. It was a significant upgrade with enough space to meet all our needs. The first summer after the move, I spent most of my time helping with the final stages of the move, unpacking boxes of finished reports, setting up a large library of archeology texts, and establishing files for over 1,200 site reports.

Unusual Duties

Ann, with one notable exception, was a one-person department. The exception was Elaine Hale, who worked full time on archeology-related duties associated with the Federal Highway projects in YNP. Elaine was invaluable in that role and an integral part of the overall success of the archeology program.

Because Ann’s many and varied responsibilities often included activities outside YNP, at times she called on me to substitute for her. This fell under “other duties as assigned.” I did not feel that I was competent to speak for Ann or, at times, for YNP; but she was always more than willing to pass some things to me. A few of these “opportunities” were particularly memorable to me.

One year in mid-September, Ann was out of the park, so I was sent down to Yellowstone Lake where the board of the Yellowstone Park Foundation (now known as Yellowstone Forever) was having its annual meeting. Some of the meetings were for the entire board, but a few presentations on specific topics were made available for anyone who was interested. My assignment was to give a 20-minute overview of archeology in the park and then take anyone interested on a walk along the lakeshore to demonstrate how a field survey worked. Needless to say, I approached this with great trepidation, but I drew a group of about 8-10 very pleasant folks who were extremely polite and asked good questions. By the time I offered the walk on the beach, the weather had turned a little raw—late in the day, getting chilly, drizzling, and the wind picking up. Except for one couple worried about travelling in possible snow, the remainder of the group was up for the walk and participated gamely. One of the ladies even spotted a scraper on the beach which I dutifully collected, recording its location with my GPS

device. I turned it over to Ann later, who added it to the collection, and sent our newest volunteer a nice letter congratulating her on her good work.

In another instance, I wasn't sure how my comments were taken. This involved a congressman who was in the park with his family but wanted to be briefed in depth on some of the work. He chaired a House Subcommittee that dealt with the NPS budget; therefore, we wanted to make a good impression. He was to visit the library, the curator's office for a look at the museum, and the archeology lab, all on a tight schedule. In addition, I was to provide a 30-minute overview of our work at the end of his visit. By the time the congressman reached the lab, he was running way behind schedule. I asked how much time he had; the answer was about 10 minutes. I did my part quickly, covering the size of the park, the number of sites, and the complexity of the research. Then I put a 9,500-year-old Cody knife in his hand, telling him its significance. All in less than 10 minutes. Then I asked if I could make an additional point. He said, of course. I noted he had just spoken to the library staff, who were employed by the then-named Yellowstone Association; to a part-time seasonal in the museum; and to me, a volunteer, on his tour of the HRC. I went on to say that none of us were NPS staff and that for the "Crown Jewel of the National Park System," that was embarrassing. He hung his head, said he knew, apologized, and added that he was trying to add funds. I am not sure the visit



John screening for artifacts near Norris Junction.

accomplished much, but I felt better for having said my piece.

My last anecdote about speaking for Ann was less dramatic but a bunch of fun. I spoke to a good portion of the students at the elementary school in Mammoth. The school, provided for the children of NPS employees, has since been closed due to the shrinking enrollment; all the youngsters are now bussed to Gardiner, Montana. It was great fun talking to this group; however, I learned to stay on message when talking to children of that age. September in YNP is the time when elk are in the rut and the bulls make a tremendous racket with continuous bugling. Some of that happened while I was speaking, but kids were ignoring it because they were used to it. When I complained about the competition I was getting from the elk, all the students leapt from their seats and ran to the window. Their teacher herded them back to their chairs so I could continue, and gave me a look indicating her displeasure. Each child wrote me a touching note, thanking me for my presentation and offering some pithy comments. I kept every note, but made a copy of the package and filed it in the lab with all the other scientific records.

I Encountered Superb People

Over the years I worked with many exceptional people. Every one of them worked very hard, made me feel welcome, and were always supportive, especially when I lagged behind their normal hiking speed. Also in the field were a number of other people who also volunteered, mostly for a few days but a couple for a few summers. The ones who returned for more than one year were the best.

Also during my time, Stanford University initiated a program to expose a select number of its students to YNP and the research work undertaken by the park. Over the years I worked with several of these young people who were always bright, energetic, and creative. I have stayed in touch with two or three of them and count my time with this group as one of the highlights of my time in YNP.

Ann Johnson was unfailingly upbeat, supportive, and incredibly dedicated to her chosen profession and the program she directed. She had many notable qualities. One I particularly prized was that she was direct. Early in my first summer, I hinted I would be happy to have an opportunity to return for another summer. She was non-committal so I repeated my thought. At that point, she said, "Well, John, we are happy you are here now, but if

you screw up we will send you home.” I did not broach the subject again until the last week of my tour. A week before I left, I told Ann that I would like to volunteer again and asked if I should contact the VIP Coordinator. She simply said, “No, you should call me.” The fact that I did call her each year for roughly a decade was testimony to my admiration for her professionalism, technical expertise, and skill at working with a disparate group of contractors, volunteers, and NPS personnel. Over time I was a witness to the tremendous growth of the program she created, as noted in a *Yellowstone Science* article published at the time of her retirement. I highly recommend reading it (*Yellowstone Science* 11:4. 2003).

During the last few years of Ann’s tenure, I was most fortunate to work with one of the more talented individuals I encountered in my federal service. One summer we were joined by a young lady from Canada, Robin Szamuhel (now Park), who quickly became invaluable in the field and in the lab. In no time, she mastered every aspect of our work in the field and the lab. Becoming my partner in revisiting sites for many days, she could out hike me and had sharper eyes. After one summer as a volunteer, Robin announced her intention to go to graduate school and seek a Master’s degree in archeology. She did exactly that, obtaining her MS in archeology from the University of Saskatchewan (Canada) while continuing to work summers in Yellowstone. After completing her degree, she came back to the park and worked as a contractor as Ann neared retirement.

YNP was indeed fortunate that Robin was willing to take over the work of the department in Gardiner upon Ann’s retirement and to remain until Ann’s replacement was named nearly two years later. During the interim, Robin and I worked on the backlog that had accumulated during the years when Ann was so short-handed. It was to Robin’s credit much progress was made. When the new archeologist, Dr. Staffan Peterson, was appointed, he quickly became a key asset in completing the elimination of the backlog. Staffan brought a wealth of archeological knowledge and skills and an exceptional understanding of the application of IT tools to archeology. By developing new techniques, he made the large and growing body of data more accessible and, therefore, more useful to everyone doing research in the field.

Volunteerism’s Rewards


By definition, volunteers do not earn a salary; however, money could never have adequately compensated me

for the experiences I had in YNP. I was able to participate in important work that expanded the understanding of archeology in the park and added to the general study of archeology in the Mountain West. Neither could money ever match what I gained from working with such outstanding people. They became and remain my Yellowstone family.

I had the opportunity to travel to parts of the park very few visitors ever see and to stay in backcountry cabins which had neither power nor water. We hiked for miles to reach some of them and canoed a few miles to another one. I spent nights looking at a sky that could only be seen in these remote areas. We saw wildlife in their natural state, varied our travel on foot a few times to accommodate a bear or two, and were able to see wolves that had been returned to where they had lived for millennia before being eradicated in the early 20th century.

A few weeks after arriving in YNP for my first summer, 1999, the crew and I were joined by Ann for a day of surveying. We hiked along a difficult trail for the better part of a mile next to a river, then climbed up to a ridge and through about 100 yards of regrowth from the fires of 1988. This led into an open meadow maybe a mile long and half a mile wide. Snow-covered mountains were to the west in the distance; to the east, hundreds of yards away, was a herd of scores of bison. I was stunned. When I recovered the ability to speak, I turned to Ann and said, “There are several billion people in the world; how many of them will see this today?” She shrugged and said, “Probably just us.”

I had lots of days like that. At home I have many photos and souvenirs to document the glorious days and nights I spent in paradise. They all pale when compared to the vivid images I will carry forever in my mind.



John Reynolds (pictured on page 65) volunteered with the Archeology program in YNP from 1999 to 2013 and 2015. He has a BS from the University of Kentucky and an MS from the University of Maryland. He retired from the Central Intelligence Agency and continued to consult for the agency several years after he began volunteering. In addition to many years of archeology activities, he did extensive backcountry work along the Yellowstone River and Hellroaring Creek and on the Southeast Arm of Yellowstone Lake. In his 16 summers and 2 winter periods, he volunteered more than 9,000 hours. He lives in Northern Virginia near his two daughters and son-in-law.

SHORTS

Communicating with International and North American Visitors about Bison Safety

Zachary D. Miller, Wayne Freimund, & Tami Blackford

Wildlife viewing is one of the primary motivations for visiting national parks (Manfredo 2008), and visitors come from all over the world to experience the abundant wildlife viewing opportunities of Yellowstone National Park (YNP). However, free-roaming wildlife coupled with record levels of visitation means that human-wildlife conflicts are bound to happen. For instance, in the summer of 2014, five visitors were gored by bison. To address human-wildlife issues, park managers often rely on communication (i.e., interpretation and education) with visitors. Recent human-wildlife incidents illustrate that it is more important than ever that communication sources are effective in reaching park visitors and encouraging them to adopt appropriate behaviors around wildlife.

Yet visitation in YNP is not just growing, it is also changing. In particular, international visitation is making up a larger proportion of YNP visitors. Very little research has considered international visitor experiences in YNP. The research that does exist explores some of the differences among North American (from the U.S. and Canada) and international visitors regarding communication preferences and perceptions about safety while viewing bison (Miller, Freimund, and Blackford 2018).

Researchers from the University of Montana contacted over 1,000 visitors in the Old Faithful and Hayden Valley areas of YNP during the summer of 2015 (Miller, Freimund, and Blackford 2018). Of the visitors who spoke English well enough to engage (94.3%), 890 agreed to participate (response rate = 85%). North American visitors were about 85% of the sample. International visitors represented every continent except Antarctica. The most frequent non-North American countries of residence were Germany (2.9%), China (1.9%), The Netherlands (1.9%), and The United Kingdom (1.9%).

When viewed collectively, North American and international visitors were using information sources (i.e., signs, map/brochure, newspaper) in almost the exact

same ways. North American and international visitors used about the same number of information sources (2.3 and 2.4 on average, respectively). Additionally, both groups used information sources at about the same rates. Lastly, there was no practical difference between North American and international visitors in how helpful they found the information sources.

This research also explored perceptions about safety while viewing bison. Visitors viewed three images and selected one of the images to answer the question, “Which of the following images best shows the distance where you would begin to feel unsafe viewing bison from?” (figure 1). There were significant differences between North American and international visitors. In general, international visitors chose the images that represented closer distances between visitors and bison. For instance, 14% more international visitors chose the image representing 5 yards between the bison and visitor as the distance they would begin to feel unsafe while viewing bison.

Results from this research indicate that although North American and international visitors were using information sources in the same ways, there were significant differences between the groups regarding perceptions about safety while viewing bison. International visitors tended to begin to feel unsafe at closer distances to bison than did North American visitors. If these beliefs lead to visitors actually getting closer to bison in YNP, it presents a safety issue for managers, visitors, and wildlife. Thus, park managers may need to specifically improve communications with international visitors about bison-visitor interactions.

However, there was a substantial proportion (18.9%) of North American visitors who also indicated they did not begin to feel unsafe viewing bison until they were at a distance of 5 yards from the bison, far closer than the recommended 25-yard distance. Although international visitors may be of particular concern due to unique language barriers and cultural differences, from a practical

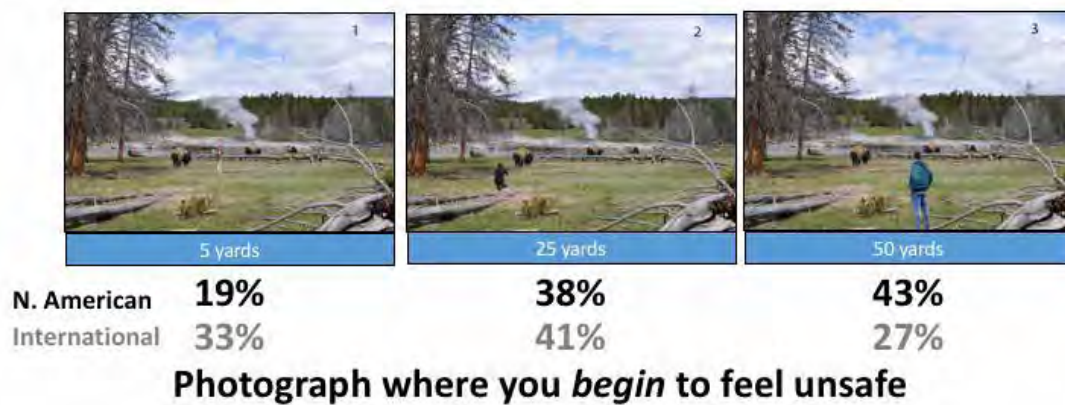


Figure 1. Percentage of visitors surveyed who begin to feel unsafe while viewing wildlife from three different distance choices (5, 25 and 50 yards).

point of view, communications about viewing bison in YNP need to be improved for all visitors.

One approach to improving communications would be to promote information sources visitors rated as more helpful. Some of the most used information sources in YNP were rated as less helpful than other information sources. Park managers may want to direct visitors to the information sources that were rated the most helpful, which include educational groups, personal communication with rangers/employees, and interpretive programs. Additionally, because the most helpful information sources were all face-to-face forms of communication (not digital or print), providing more opportunities for these types of contact may also prove useful.

Another approach would be to include additional information in communication resources. For instance, international visitors may have less of an embedded idea about what wilderness/wildness is or may have different perspectives about national parks from previous visits to parks in other countries. This presents an excellent opportunity for YNP managers to tell the unique story of national parks, and how and why the national parks differ from other protected areas people may have visited. Including this type of information may encourage visitors to behave in more appropriate ways around wildlife.

Lastly, it is important to recognize that the “why” messages (i.e., bison are dangerous, respect bison’s space) are just as (or more) important than the “what” messages (stay 25 yards away from bison) in motivating visitors to adopt appropriate behaviors. People need reasons to care. Social theories, such as the theory of planned behavior (Ajzen 1991) may help inform this process. Incorporating content about attitudes, subjective norms, and perceived behavioral sources would potentially

make information sources more effective in persuading visitors to adopt appropriate behaviors around bison and other wildlife. By motivating visitors with messages that are important and relevant, it becomes more likely that they will adopt appropriate behaviors (Petty and Cacioppo 1986).

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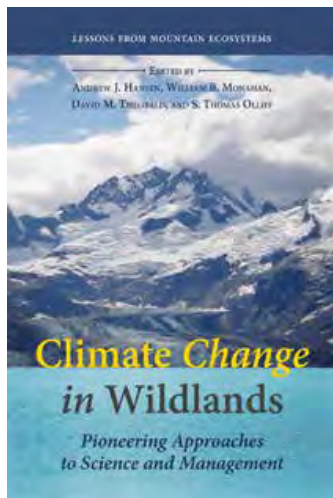


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Climate Change in Wildlands: Pioneering Approaches to Science and Management

Edited by Andrew James Hansen, William Monahan, David M. Theobald, & S. Thomas Olliff
Island Press, 408 pages

Book Review, Christie L. Hendrix



Understanding how our planet's climate is changing in response to human-caused and natural influences has been a primary focus of scientists, land managers, and governments and leaders across the world. As concern increases about the need for an appropriate response to a changing climate, the desire for thorough, accurate, and comprehensible information is increasing. An additional concern for land managers is the changing patterns in land use across federal lands, and how to respond to these changes coupled with climate change. Undeveloped federal and public lands contain critical resources for plants and animals, protect watersheds from impairment, and offer restorative recreational opportunities for the public. Guidance on how to adapt to simultaneous climate and land use changes is needed to preserve these areas. The book, *Climate Change in Wildlands: Pioneering Approaches to Science and Management*, offers an understandable and comprehensive overview of these issues, providing insights for land managers grappling with methods to manage these unique issues.

Edited and authored by experts in biology, landscape ecology, silviculture, fisheries, remote sensing, climate modeling, land management, statistics, and many other fields, the depth and breadth of the content contained

is excellent. The material in this book was a product of the NASA-funded Landscape Climate Change Vulnerability Project (LCCVP). The LCCVP was designed to use a wide variety of ground-based data collection techniques and remote sensing technologies, as well as several modeling programs to forecast the vulnerability of ecosystems and species. The data collected, analyzed, and modeled was from ecosystems on federal lands. And while the intended audience for this book is public lands managers, the approachable format of the material will also interest environmental organizations, local governments, college students, and the public, as they seek to learn how to protect the public lands they own for future generations.

The authors point out that many landscapes that are preserved, and on which we rely, are often found in desert and mountain ecosystems where the effects of climate change are more pronounced. Also, they discuss the issue of access—as more people use public lands, there are subsequent negative effects on ecosystems, such as the growth of human population and land development, invasive species introduction, and adverse effects on water and air quality. As land managers struggle to balance public access and land conservation, a primary goal of this book is to link science and management, and help land managers make informed, science-based decisions as they deal with these issues.

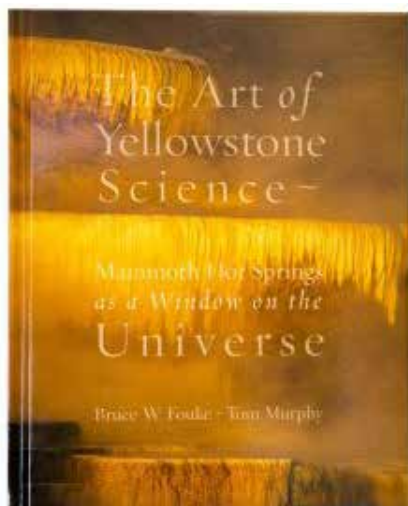
The authors carefully articulate why the study of climate change is important, providing real-world examples of how it affects ecosystems. The book includes an overview of past and present expected effects of climate change and land use on ecosystems, with a detailed review of two regions of the country, the Northern Rockies and the Appalachian Mountains. Several chapters focus in detail on the effects of climate change on trees, plants, and fish species. Finally, the book offers suggestions for identifying, prioritizing, and applying climate adaptation options, including case studies, and contains a review of past management lessons learned. While the authors underscore how little is known about climate change and land use and how it is an incredibly complex topic, the book provides a greater understanding of climate change in wildlands. This book is accessible to readers from all backgrounds, and includes tools that may help land managers with future decision-making as they strive to protect public lands.

The book is available in hardcover, paperback, and e-book format from Island Press (<https://islandpress.org/book/climate-change-in-wildlands>).

The Art of Yellowstone Science: Mammoth Hot Springs as a Window on the Universe

By Bruce W. Fouke and Tom Murphy, Crystal Creek Press, 300 pages

Book Review, Christie L. Hendrix



Some of the most fascinating things in our universe are more complex and beautiful than what initially meets the eye. *The Art of Yellowstone Science* pairs together renowned geobiologist Bruce Fouke and celebrated Rocky Mountain photographer Tom Murphy to provide a stunning written and visual account of Yellowstone National Park's Mammoth Hot Springs. This book is about the intersection of science and art, and how they both arise from a desire to observe and learn. The authors argue that the two disciplines are not mutually exclusive and work in harmony as we study the natural world.

The authors present Mammoth Hot Springs as a case study where science and art are interconnected, and where gaining insights about other geothermal systems is possible. They state, "Mammoth is a place to see powerful and important connections between deep time and human experience, among geology, microbiology, physics, and chemistry, as well as between the sciences and the arts." The authors acknowledge that recent scientific advancements, as well as innovations in photography and photo processing, have increased our understanding of the Mammoth Hot Springs area and made this book possible.

While Yellowstone has many geothermal systems, Mammoth Hot Springs is distinct from the others. It

falls outside of the Yellowstone Caldera and is found on a limestone rock deposit. As the limestone is superheated by 100°C water, it permeates the subsurface and deposits as travertine in a layer cake-like quality on the landscape. This expansive limestone system is uncommon, found only in a few locations around the globe. Mammoth Hot Springs is the second largest active deposit in the world (the largest located in Turkey). With deposition rates as high as 5 millimeters per day, the area allows scientists to complete full studies within short periods of time. Mammoth is also rare in that the system has been preserved in its natural state, with little human influence, making it more valuable for scientific study and more enjoyable for visitors seeking untrammelled beauty.

The authors remind us that "scientists and artists love surprises." Our tendency to visually observe unique forms in nature and become inquisitive is what draws people to Mammoth Hot Springs. The intricate patterns of the terraces and surrounding vegetation, the steam rising, the colors present in the terracettes lead the human mind to wonder, "How did this occur?" The book explains in detail how we have learned, through science and the visual arts, the inner workings of the Mammoth Hot Springs system.

Throughout the pages of this book, the authors provide thoughtful narratives juxtaposed with stunning photographic examples of the systems and concepts described. The book covers not only the current research efforts in Mammoth, but its geologic history, recent advancements in microbial taxonomy, and Mammoth's historical use by explorers and visitors. The images include traditional stills of nature, as well as aerial photography, and infrared and microscopy imagery. Fouke deftly explains challenging scientific processes in a relatable manner. Murphy also doesn't disappoint—his photos range from beautiful landscapes to fine-scale, detailed macros, making the reader's brain yearn to learn about the Mammoth Hot Springs system and to visit it in person. There are even a few photos of charismatic megafauna taking respite in the thermal areas.

This book is a culmination of years of observation, on the part of both a research scientist and an artist. It is not just a thesis on scientific inquiry with photo accompaniment; it is truly a marriage of essay and art that works as one to provide a valuable "window on the universe" of Mammoth Hot Springs. The book is available in both hard cover and digital format from Crystal Creek Press (<http://www.artofyellowstonescience.com/>).

Recovery of Soda Butte Creek, Post-Reclamation

Andrew Ray, Tom Henderson, Pete Penoyer, Autumn Coleman, & Kristin Legg

Nearly 25 years ago, researchers described a layer of unusual bright orange-red sediments on the floodplains of the lower reaches of Soda Butte Creek, just upstream of the confluence with the Lamar River inside Yellowstone National Park (YNP; Meyer 1993, Marcus et al. 2001). These conspicuously colored sediments were traced nearly 15 miles (23 km) upstream and outside YNP to the abandoned McLaren Mill and Tailings Impoundment located near Cooke City, Montana. The McLaren Mill processed material from the McLaren Gold Mine in the New World District. Abandoned in the 1950s, the mill was gone but the failing tailings impoundment plugged Soda Butte Creek. Sediments immediately downstream of the McLaren Mill and Tailings site (McLaren site hereafter) were not only rust colored (figure 1), they were enriched with heavy metals, including iron, copper, lead, arsenic, and zinc (Marcus et al. 2001). Iron levels from tailings sediments were 2-10 times higher, and copper levels were 1-2 orders of magnitude (10-100 times) higher than the background stream sediment levels (Meyer 1993, Marcus et al. 2001). Additionally, concentrations of iron in water sampled from Soda Butte Creek

below the McLaren site were 25 times higher than waters upstream of the tailings site (Boughton 2001). Iron-rich orange waters seeping from the base of the tailings impoundment were shown to be toxic to fish and zooplankton, causing 100% mortality within 24 hours of exposure (Nimmo et al. 1998). Stream insect community diversity was also dramatically reduced downstream of the former mine and tailings site, relative to upstream, unimpaired reaches of Soda Butte Creek (Marcus et al. 2001).

Tailings on the McLaren site bordering Soda Butte Creek near the town of Cooke City were identified as a significant anthropogenic source disproportionately contributing to Soda Butte Creek's impairment (Nimmo et al. 1998, Boughton 2001, Marcus et al. 2001, MTDEQ 2002). The segment of Soda Butte Creek below the McLaren site and downstream to the Montana-Wyoming border was first listed in 1996 as an impaired water body, under Section 303(d) of the Clean Water Act (MTDEQ 1996). Today, it represents the only Clean Water Act-impaired water body entering YNP (O'Ney et al. 2016). Montana Department of Environmental Quality's (MTDEQ) list of impaired waters identifies four metals (copper, iron, lead, and manganese) as the causes of water quality impairment in Soda Butte Creek (MTDEQ 2017).

In 2014, the MTDEQ Abandoned Mine Lands Program completed the McLaren Tailings Reclamation Project, culminating five years of reclamation work. This reclamation effort required excavating approximately one half million tons (equal to one billion pounds) of contaminated tailings, pumping and treating of over 100 million gallons (0.4 million m³) of contaminated water, and reconstructing approximately 1,800 ft. (550 m) of Soda Butte Creek and Miller Creek stream channels. Importantly, this work removed the potentially unstable tailings impoundment, moderated the metal loading, improved downstream water quality, and enhanced the ecological condition of Soda Butte Creek (Henderson et al. 2018). In 2015, National Park Service (NPS) and MTDEQ scientists initiated studies in Soda Butte Creek to document water quality immediately downstream of the reclaimed tailings



Figure 1. Oxidized iron sediments in Soda Butte Creek downstream of the McLaren mine and tailings impoundment in 2009, prior to reclamation. NPS Photo - A. Ray.

site (station SBC2; USFS 1999) to mirror the previous water quality studies begun a decade (2000-2010) prior to reclamation (USFS 2012).

Water quality results from monitoring station SBC-2, immediately downstream of the McLaren site and just east of Cooke City, show that exceedances (i.e., exceeding the MTDEQ water quality standard) for iron (figure 2a) and copper occurred annually from 2000 to 2010. During this period, iron exceeded the MTDEQ standard of 1.0 mg/L in 20 of the 31 samples (65%) collected. Iron concentrations were shown to be strongly related with river flows ($r = -0.768$, $p < 0.001$, $N = 30$); high iron levels and associated exceedances generally occurred during low flow conditions (figure 2a). Low flow water quality exceedances suggest that contaminated waters from the McLaren site disproportionately contributed to metal loading during base or low flows. In contrast, snowmelt runoff or tributaries' inputs during high flows acted to dilute mine-related metal loading. From the 11 water samples collected between June 2015 and June 2016 and following the completion of reclamation activities, no exceedances of iron were documented immediately downstream from the McLaren

site (figure 2b). While all of the 11 post-reclamation water samples showed low levels of total iron (average = 0.08 mg/L, range = 0.02 to 0.18 mg/L), iron levels are now lowest during low flows and increase modestly with increased flow levels. This latter finding supports the claim that the primary anthropogenic source of iron pollution to Soda Butte Creek (i.e., contaminated inflows from the McLaren tailings impoundment; Boughton 2001) have been successfully addressed.

Prior to reclamation activities, copper exceeded the MTDEQ hardness-based water quality standard less frequently than iron; however, copper exceedances occurred in 8 of the 31 samples (26%) and typically during high flows. In contrast, only one copper exceedance was documented in 2015 and 2016 following reclamation. Elevated copper levels have long been detected in Miller Creek (Furniss et al. 1999, Hren et al. 2001), a tributary that discharges into Soda Butte Creek in the middle of the McLaren site from the north and above the SBC-2 sampling site. It is shown that during high flow, approximately one half to two thirds of the copper load measured at SBC-2 can be attributed to Miller Creek.

Prior to reclamation, manganese concentrations exceeded the U.S. Environmental Protection Agency's National Secondary Maximum Contaminant Level (SMCL) in 14 of the 31 samples (45%) collected from 2000 through 2010. None of the 11 post-reclamation samples contained manganese above the SMCL. There were no documented lead exceedances below the McLaren site before or following reclamation activities.

The bright orange stream sediments that conspicuously marked the contamination in Soda Butte Creek prior to reclamation are gone (figure 3). These changes are a striking visual indicator of the improvements in ecological condition credited to the reclamation of the McLaren site. Improvements in water quality have been carefully documented (Henderson et al. 2018) and facilitated the return of beneficial uses, such as fishing. The collaboration between the MTDEQ and NPS was critical to the planning and execution of the McLaren Tailings Reclamation Project. This collaboration also made possible the post-reclamation characterization of water quality in upper Soda Butte Creek watershed. Project data quantifies water quality improvements and supports a formal assessment of post-reclamation water quality of this 303(d)-listed stream. Importantly, the data collected in Soda Butte Creek supports the preliminary decision by MTDEQ to recommend that Soda Butte Creek, from the McLaren site to the YNP boundary, be delisted for all metals, the

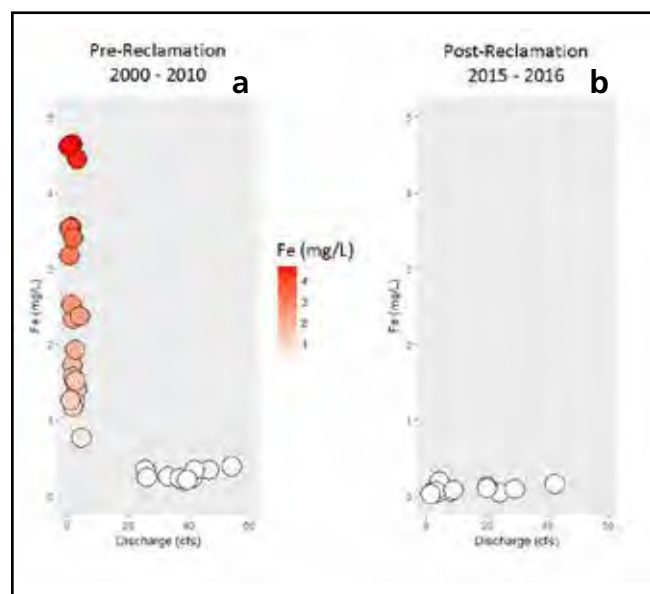


Figure 2. Pre-reclamation (a) and post-reclamation (b) iron concentrations from quarterly (2000-2010) and monthly (2015 and 2016) samples collected during ice-free periods in Soda Butte Creek SBC-2 monitoring site. Samples that meet the MTDEQ iron standard are shown in white; those that exceed the standard are shown in shades of red. The window of reclamation extended from summer of 2010 to fall of 2014. Excluded from this figure (for presentation reasons) was a low flow water sample collected pre-reclamation on 9 April 2009 that had an iron concentration of 27.4 mg/L, 5 times higher than the next highest pre-reclamation water sample.

first such recommendation in Montana. The reclamation and subsequent delisting represent major milestones to Yellowstone National Park. In addition, the water quality improvements and the removal of contaminated source materials will support Yellowstone native cutthroat trout (*Oncorhynchus clarkii bouvieri*) conservation efforts (MTFWP 2015), and safeguard downstream aquatic and riparian habitats from the legacy of mining in this region.

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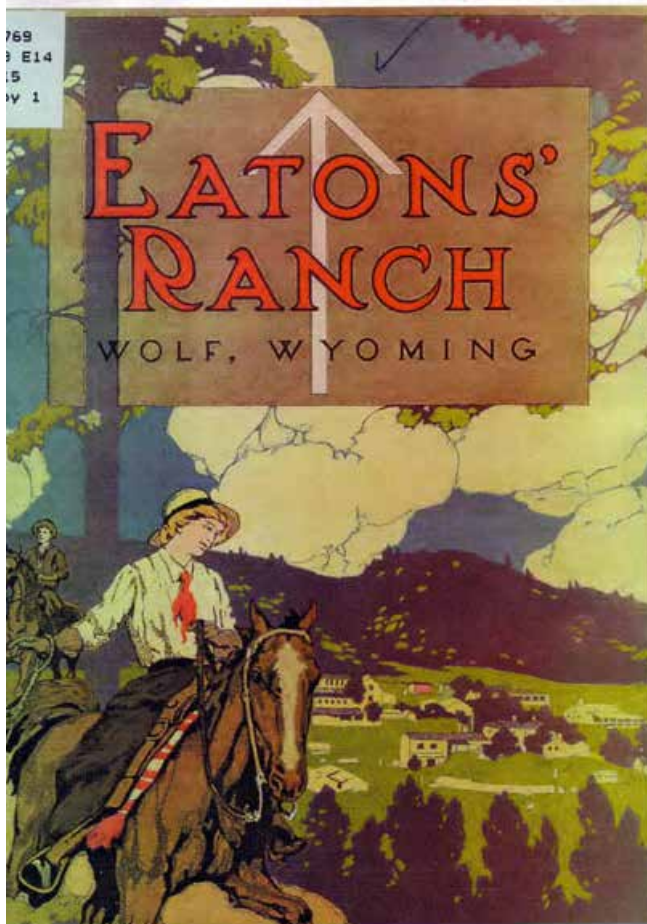


Figure 3. Comparison of Soda Butte Creek downstream of the McLaren Site in 2008 pre-reclamation (left) and 2013 post-reclamation (right). NPS Photo - A. Ray.

A LOOK BACK

Howard Eaton's Yellowstone Tour

Judith Meyer



Howard Eaton was one of Yellowstone National Park's (YNP) most famous and beloved concessioners who introduced hundreds of tourists to the wonders of Yellowstone between 1883 and 1921, and whose saddle-horse tours contributed to Yellowstone's popularity during the park's formative years. In 1923, one year after Eaton's death, the National Park Service (NPS) named a newly-completed, 157-mile bridle and hiking trail for him. The Howard Eaton Trail dedication ceremony was attended by movers and shakers from throughout the ranks of national, regional, and local government, attesting to Eaton's wide notoriety and respect.

Eaton's clients were wealthy, educated Easterners who traveled by railroad to Gardiner, MT, and then spent the

next two weeks on horseback with Eaton as their guide. They slept in tents and ate their meals outside—a Yellowstone experience very different from the more typical one of traveling by stagecoach, sleeping in hotels, and eating in dining rooms. Howard Eaton's colorful marketing brochures promised his guests they would be “roughing it with comfort” while enjoying “a harmony of wilderness and civilization” on the trail. Even a quick glance at Eaton's brochures reveals his keen understanding of what Easterners wanted of a Western experience; appealing to their sense of adventure and desire to spend time outdoors reliving the rugged frontier, but with all the convenience and safety of civilization.

If Eaton and his tours were so popular, what was it like to travel with Eaton? Where does Eaton's trail-ride-tourism fit in to the broader context of a “Yellowstone experience” and a unique “sense of place” for Yellowstone as a national park? These are questions for historical and humanist geographers. Geographers study not only the environmental and cultural characteristics of locations on Earth's surface but the personal, human response to those places as well. This “sense of place” describes how people experience a place as a combination of their own real experiences in combination with their expectations of what that place means (Tuan 1975).

Yellowstone has three qualities that make it an especially good study site for understanding sense of place. First, it has a rich history of meanings as a result of its almost 150 years as a national park (Meyer 1996). Second, much of Yellowstone's historical record has been preserved not only on the landscape, but in the museum and archives at the Heritage Research Center (HRC). Hence, evidence of people's experiences in the park have been preserved, catalogued, and made available for study. Third, studying people's sense of place for Yellowstone has value. Yellowstone's managers have the unenviable task of trying to make Yellowstone serve the needs of many different publics. Understanding how and why people feel the way they do about the park can help inform management decisions.

A Photo-Essay: Experiencing Eaton's Yellowstone

Eaton's brochures are a telling source of information about his tours, but only from a business or marketing perspective, providing logistical information about his tours and showing his keen understanding of his market. However, details of a day-to-day Eaton tour through Yellowstone remain a bit of a mystery. Because Eaton's customers were members of the upper class, it is surprising that so few left written record of their travels. One of only a few existent narratives is "When I Went West" by Robert McGonnigle, included in Whittlesey and Watry's *Ho! For Wonderland* (2009). Given this paucity of written narratives, the HRC's photographic record becomes all the more important. What follows is a photo-essay constructed from seven photographs of Eaton and his clients. The photograph captions come from the original photographs assembled into a photo album under the call number YELL 130117 in the HRC museum. All photographs are provided courtesy of the NPS in YNP and were made available with the patient and professional help of Curator Colleen Curry.

Eaton's annual tours to Yellowstone were not small, intimate affairs. Instead, Eaton brought three or four dozen tourists at a time. And, his pack train included at least two horses per client: a trail herd and a camp herd. Eaton must have had to choose his overnight camp sites with attention to plentiful water and grass for his many horses, as well as pleasant surroundings for his guests.

Because Eaton provided tents, bedding, food, and other supplies, he could insist each clients bring only one suitcase, relying on them to make practical and resourceful choices when packing clothes and toiletries:

Plain serviceable clothing and easy shoes or riding boots are recommended for wear on the trip. Though the Park days are usually warm, the nights and early mornings are cool, and medium weight underclothing, sweaters and light overcoats will be found very comfortable. As good bathing is found at many camps, bathing suits should also be taken. Raincoats or slickers should be provided in case of rain. Fishing tackle and a camera which may be conveniently carried form a desirable part of any outfit. The amount of baggage for the trip is necessarily limited to one bag or suitcase [sic] for each traveler (Eaton's Ranch 1912).

Although Eaton's earliest guided tours of Yellowstone allowed only men to participate, after the turn of the 20th century, Eaton made a point of welcoming women. As recorded in photographs and Eaton's brochures, at least half of Eaton's clients were women. When Eaton began building his guiding business, the women's suffrage movement was in its heyday; Eaton positioned himself to benefit from it. His brochures insisted "all ride astride" rather than side-saddle. Eaton reached out to women just as the side-saddle vs. riding-astride debate divided attitudes among women belonging to Eastern equestrian clubs (Miller 1901). Generally, women who wanted to ride astride supported women's suffrage and were the type who might prefer Eaton's tours over those provided by the railroad companies. The camp store at the Eaton Brothers' Ranch (Wolf, WY) carried any number of typical supplies, but not the special split-skirts needed for riding-astride; so Eaton recommended that "Ladies are advised to procure their habit for riding astride" before arriving at the ranch (Eaton's Ranch 1912).



This photograph of a Howard Eaton tour at Isa Lake, was most likely taken between 1912 and 1914 and shows at least 44 individuals, tourists and Eaton employees.

Eaton may have publically promoted his reputation as a conservationist, especially when it came to wildlife protection; however, his clients engaged in all the same environmentally insensitive tourist activities as other tourists, most of which are not allowed today. As these and other photographs attest, Eaton's travelers fed bears, sat on delicate thermal features, posed next to erupting geysers, washed their laundry in the hot springs, and tramped across a plank bridge to stand on the Fishing Cone formation. For his small business to succeed in competition with the mass tourism of the railroads, Eaton's tourists had to see all the usual sights and engage in all the usual activities, as well as enjoy life in camp and on the trail.

As one might imagine for such an active, physically-demanding means of travel, meals were important. Eaton's portable kitchen traveled in what must have been a specially-outfitted, heavy wagon with extra-large wheels. In this view, at least two stovetops and ovens with tall smokestacks are visible. The cabinet looks specially de-

signed and built to carry pots, pans, dishes, and other utensils required to feed such a large group.

In terms of the meals themselves, there seems to have been a large staff involved in helping set up, prepare, and serve the meals. One of Eaton's employees, a young woman named Dorothy Duncan recalled:

Breakfast was at 6:00 a.m. and we hit the trail by 8:30. Breakfast included hot mush, pancakes, eggs, and a "pail" of bacon that Uncle Howard personally served to the guests. The kitchen and dining room were large tents. . . . Long tables covered with oilcloth tablecloths sat on folding sawhorses. The aromas that came from the tents were enticing, and the meals were delicious.... The noon meal consisted of sandwiches... delicious canned fruit, and coffee. Loaves and loaves of bread had to be sliced. Uncle Howard gave me my first lesson in making sandwiches. I was putting butter on one side of the bread only when I felt his hand on my shoulder. "Young lady," he told me, "my dudes get butter on both sides of the bread" (Duncan in Ringley 2010).



Eaton guest with black bear in Upper Geyser Basin, as an Eaton wrangler stands by. This particular guest, possibly Mr. Scaife, appears in other photographs dated 1914. The guest is wearing a neckerchief and leather "gaiter-like" coverings over his lower pant legs. The wrangler wears chaps and also sports a neckerchief.



Eaton's guests washing clothes in Biscuit Basin.



Eaton tour at Fishing Cone, no date. Eaton's guests toured the same points-of-interest visited by most tourists using the Grand Loop Road. Howard Eaton is the tall man standing sixth from the left, keeping a watchful eye on his clients.

The tops of three oven stove-pipes poke through the canvas tent in several photos, and one photo reveals a large pile of wood stacked between the stoves. Because laws against felling trees for camp cooking were not passed until later, it is assumed Eaton gathered wood in the park for use in cooking meals. Although this photograph shows only men in the “big top” or mess tent, Eaton did hire young women to work for him on his trail rides, at least in the later years. Women helped to put-up and take-down the tents, lay out the mattresses, sheets, and blankets in the women’s tents, and prepare and serve meals.

Clients slept in pyramidal tents Eaton designed for their easy set-up and take-down. At every night’s camp, there was a row of white tents for single women, another row of darker tents for single men, and yet another row for married couples. As explained in the promotional material, “Pyramidal tepee tents of heavy waterproofed canvas with floors of the same material, are provided for every two persons. The bedding, receiving competent care every day, is warm, clean, and comfortable.” If guests needed more room to dress and undress, larger tents served as dressing rooms, and still other tents were provided for “sanitary arrangements” (Eatons’ Ranch 1922).

Beyond the dry logistics and the flowery prose and promises of advertisements, what was the real “experience of place”? Did any of these “city folk” regret spending weeks on a horse, even if they were avid members of riding clubs back home? One answer may lie both in the photographic and written record. In one HRC photo, there is a stagecoach parked in the middle of camp. It is

not a kitchen or supply wagon, but a sight-seeing coach, something out-of-place in a camp for saddle-horse tourists. Doris Whithorn, tireless historian of Park County, MT, wrote about Eaton’s tours and noted, “Officially called the ‘Fatigue Coach,’ this vehicle was dubbed the ‘Sore-ass Wagon’ by those who herded the guests. Any dude who became weary of the horseback trip on the trail could dismount and wait by the road” for the Fatigue Wagon (Whithorn 1969).

Understanding Howard Eaton’s role in shaping public expectations of not only a national park experience but a Yellowstone experience can help managers grasp



At least four men in aprons, one wearing a tie and smoking a cigar, stand in the main kitchen tent with five other men.



One of Eaton’s wranglers, probably Mr. Wooley, is photographed with the cook and a young man next to a wagon carrying food preparation supplies and furniture.



Tent Camp on Yellowstone River. Leslie Quinn, an expert on the Howard Eaton Trail, pointed out that Eaton's Canyon Camp was most likely located at the north end of Hayden Valley where the Yellowstone River begins to narrow on its way to the Upper Falls. A camp here meant flat ground, plenty of water and grass for the horses, easy access to the Upper and Lower Falls, and easy access to the main road for supplies.

the complex ways people respond to the Yellowstone landscape. Common sense would suggest traveling on horseback, sleeping on mattresses on the ground, and using tent latrines instead of bathrooms would be a less attractive way to tour Yellowstone than a stagecoach-hotel-dining room option, especially for those able to afford both. Yet Eaton's clients endured whatever privations life required, and praised Eaton and the experience he provided because they felt justly rewarded. "Experiencing the Yellowstone" was worth the effort. Understanding the many different ways people appreciate their time in the park should be good news for the NPS. Certainly more and more voices call for better or more tourist services every year, but it is important to understand the motivation calling for more amenities. If Howard Eaton's approach to providing a satisfying Yellowstone experience is any indication, what people want is an appropriate and meaningful experience, more than a comfortable one.

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Historic Relief Model Helped the Public Understand the Human Relationship to Yellowstone Geology

Melanie Schleeter McCalmont

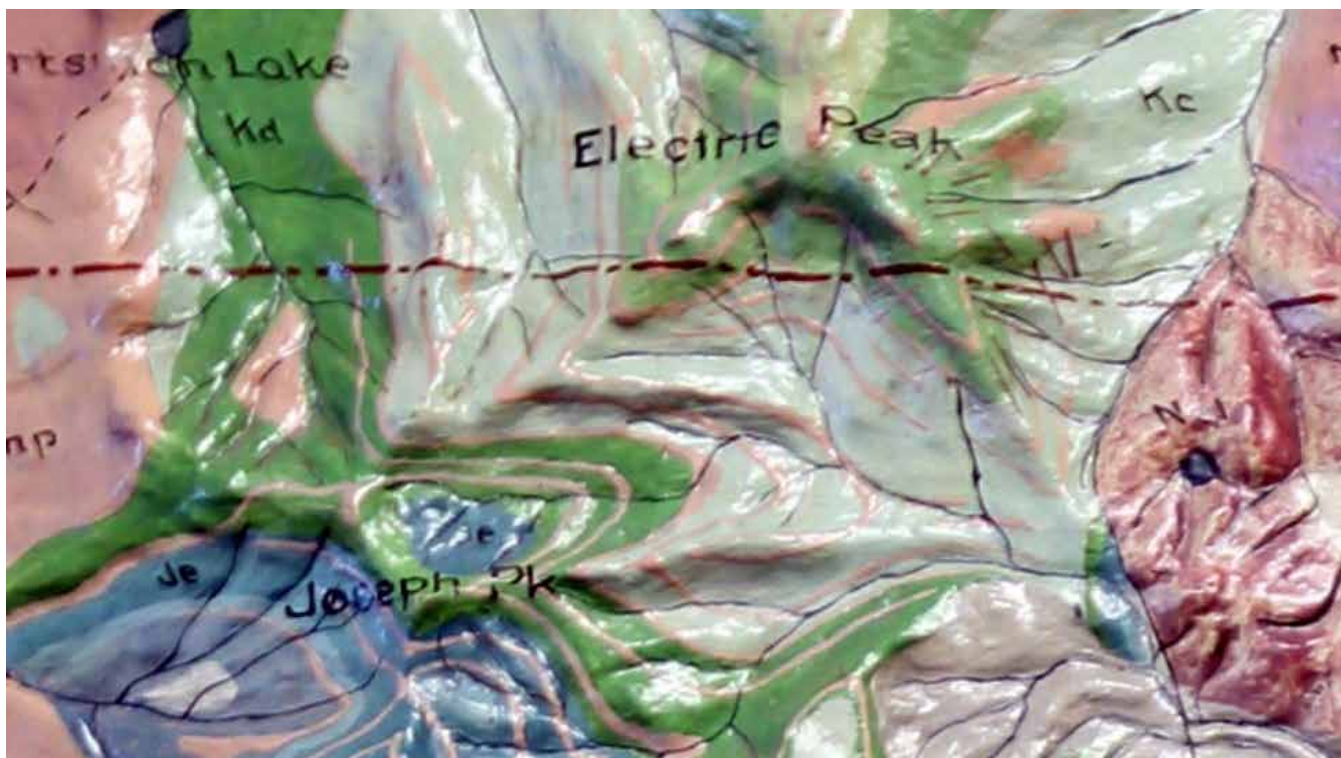


Figure 1. A detail of the Electric Peak area on the Yellowstone National Park and Absaroka Range (1897) relief model by Edwin Howell. This historically significant model was installed at the old Information Center and the Norris Museum before being displayed at the Yellowstone Justice Center. The base geology is from Arnold Hague's important natural science surveys of Yellowstone. Photo - ©M. McCalmont.

In the Yellowstone Justice Center in Mammoth, Wyoming, is a historic 1897 geologic relief model of Yellowstone National Park and the Absaroka Range by Edwin E. Howell. At 7 ft. square, it's a stunning scientific sculpture of a beloved geologic region in the U.S. (figure 1). It was donated to the park in 1921 and was installed in the old Information Center in Mammoth. A second relief model crafted by the Western Museum Laboratory in the 1930s is a cast copy of the Howell model and is installed at the Mammoth Community Center.

This article tells the relief model's cultural anthropology—how it arrived, why it was built, and its historic role in the scientific study of Yellowstone National Park (YNP). While the actual data on the maps have been superseded by modern satellite and ground imagery, these

historic maps and their educational interactions with park visitors persist to this day.

What's a Relief Model?

A relief model is a three-dimensional terrain map. From the 1870s to 1950s, relief models were a popular interpretive object for museums, schools, and offices to display a landscape and its science.

Standing in front of it at the old Information Center in 1921, tourists of any educational level had an immediate grasp of the entire park. They could understand the relationship of geologic to cultural features—geysers, mountains, and fossil forests crossed by a network of rails, trails, and hotels—and so could better understand their human relationship to the science under their feet.

Howell was a master at combining art and science in relief models for the public understanding.

Description of the Relief Model

The YNP relief model is about 7 ft. square and represents about 6,800 square miles, or about 4.3 million acres (figure 2). The 1897 model is colored geologically, based on the Arnold Hague U.S. Geological Survey (USGS) survey of the 1880-1890s (Hague 1899). Around the edge is a flat apron with the label “5000 Ft. Above Sea Level.” This apron was a standard method for relief models to show the base elevation and allow a more realistic vertical scale.

On either side of the title block are two geologic legends: on the left are geologic color patches of the major sedimentary formations and on the right, color patches for the major igneous flows. Within each legend, the formation patches are arranged from most recent to oldest formations reading left to right. On the model’s

map surface, the legend colors are labeled with the text key (e.g., Cm for Carboniferous Madison formation). A small symbol “FAULTS -----” in the right igneous legend indicates the many fault lines on the map.

Although not in the legend, the park’s cultural geography of the time is shown as a reference. Solid red lines indicate improved stage and carriage roads of the time, and red dashed horse and foot trails branch off from the main roads to popular sights. Park hotels are small black squares with labels. The Continental Divide is shown as a long-dash red line running from the Madison Plateau southeast to Twin Ocean Pass. The boundary line shown on the relief model is the pre-1929 boundary.

At first glance, some railroad track symbols appear to be on the YNP relief model, for example, along the north shore of Yellowstone Lake (figure 3). But railroads were not in the park in 1897 when the original map was created. The ‘track’ symbols are actually later road corrections made on the map. You can see corrections between



Figure 2. Yellowstone National Park and Absaroka Range (1897) by Edwin E. Howell. The model’s geologic map comes from the work of Arnold Hague. The park boundary is the original “square” boundary lines; and the map displays place names, roads, and even natural features that no longer exist. Photo - ©M. McCalmont.

Bunsen Peak and Mt. Everts, the old road line (red) has been crossed out and moved from the north to the south side of the valley. The road between Junction Butte and Crescent Hill, now the Northeast Entrance Road, has been redrawn. Roads have been altered on the Solfatara Plateau, near Kepler Cascade, and along the northwest shore of Yellowstone Lake. Not just roads, but physical features were corrected. What was previously labeled as the Stinkingwater River has been crossed out (figure 4) and changed to Shoshone River by park artisans due to the Wyoming legislature's name change (State of Wyoming 1901).

Edwin Howell was skilled at using color themes to help the viewer intuitively grasp the geologic story. Starting with a deep red color, the map lightens this red shade of each younger igneous flow until it becomes white at the most recent eruptions. Deep and light orange likewise display the age of these unusual intrusive formations in the Absarokas. For sedimentary rock, Howell uses

greens and blues, again making them lighter in color as they get younger. For a tourist public, Howell's deliberate and consistent color themes helped them visualize their own human lifespan in relation to geologic time. The stacked colors were a layer cake of volcanic lava, ocean-bottom sediment, violent fissures, and trickling erosion that created Yellowstone's features. Yellowstone was not just their vacation spot; they were participating in earth's history.

Like many of Edwin Howell models, the geologic coloring continues below the "surface" of the land. When you visit the relief model at the Yellowstone Justice Center, look at the edges. The geologic strata continues along the sides so the viewer could imagine how the surface geologic features warped or faulted below the surface and possibly emerged at another point at the surface.

Today, with the YNP relief model over 120-years-old, it has sustained some damage. The model was first installed in the park's new Mammoth Information Center



Figure 3. This replica Yellowstone National Park topographic relief model with visitor help features is located in the Mammoth Community Center. The relief of this model is Howell's but only shows park boundaries, roads, place names, and visitor guides. There is no legend or title, but it was likely crafted by Civilian Conservation Corps workers. Photo - ©M. McCalmont.



Figure 4. When changes were necessary, the solution was not always done as elegantly as the model maker himself would have preferred. Photo - ©M. McCalmont.

in 1921, then moved to the Norris Museum, and likely moved many more times before its present location. A long horizontal gouge runs across the model just below the park border, exposing the core plaster. Because this model type had its frame recessed from the terrain, many of the higher mountain tops are sheared off the lower half of the model. The corners are cracked, a few carved initials can be discovered, and a puncture is on Coulter Creek. Even so, the relief model is in good enough shape that visitors and researchers could use it today as a comparison against newer maps.

Finally, some mistakes and corrections can be found on the YNP relief model. “The Thunderer” is labeled “The Thundere” missing the last ‘r’ named after the famous John Philips Sousa march that was popular during the pre-park surveys.

The Scientific Origins of This Relief Model

The model at Yellowstone today was crafted by Edwin E. Howell (1845-1911, figure 5), a premier relief model maker in the U.S. with a knack for making beautiful scientific maps. Howell crafted models for scientific luminaries of the time, such as geologists Grove Karl Gilbert, John Wesley Powell, and Clarence King, and had personally worked in the Wheeler and Powell surveys



Figure 5. Edwin E. Howell, 1845-1911.

of the West. He was a friend and colleague of Arnold Hague, F.V. Hayden, and Charles Wolcott, all with a keen interest in Yellowstone (Biel 2004, McCalmont 2015, Russell 1934).

Howell was asked by USGS Director John Wesley Powell to draw up a relief model of YNP for the August 1891 International Congress of Geologists (IGC). Members of the IGC traveled to Yellowstone with Powell as a post-congress field trip (Howell 1891). Powell used it as an illustration on USGS work in the field. The model was a simple light brown topographic version with the major water and cultural features labeled. This early version resides in the Library of Congress Map Division.

From the 1891 IGC publicity, Edwin E. Howell received a new order from U.S. Government Board of Control to construct an updated relief model of the YNP for exhibition at the upcoming 1898 Trans-Mississippi and International Exposition in Omaha, Nebraska. The board wanted to illustrate the boundaries of the new 1891 national forest reserves and to feature the ongoing USGS survey data of the Yellowstone area by Arnold Hague (Science 1897). This model is the version the park has today.

On August 28, 1897, Howell walked over from his shop on 17th and F Street in Washington, D.C., to the U.S. Geological Survey offices to discuss the new Yellowstone model (Howell 1897). He met with Arnold Hague, the Geologist-in-charge of the ongoing USGS Survey of the YNP and vicinity. Hague's published work on Yellowstone would become USGS Monograph 32 and USGS Geologic Atlas GF-30 (Hague 1896). After a review of the Hague's data thus far, Hague promised Howell some improved draft geologic map sheets by October for the updated model.

Howell redesigned the Yellowstone relief model in two larger halves (the faint joint can be seen today if one looks from left to right from the words "Above" to "Sea"). To build up a relief model, Howell would enlarge USGS topographic sheets and dissect its contours for pasting onto special cardboard. The cardboard contours were stacked, glued, and nailed together with control markings every 500 ft. A layer of special clay was applied and carved into the correct terrain by his longtime geographic modeler, Miss Dawson. A mould was crafted; then the positive plaster model was cast, sanded, and sealed. The geologic markings from Hague's data were precisely applied to the surface with artists' paint, using all available photographs, field notes, stereographic sections, and historic maps. The title block lettering was

applied by the woman artist who lettered all the signage at the National Museum. For the model's final critique on April 9, 1897, Arnold Hague and his field assistants from the 1883 Yellowstone survey, Joseph Iddings and Walter Weed, spent the day at Howell's model shop to validate the geologic model and terrain. Updates were made to the geology. For Howell, this in-person critique was a required quality control step. Geologic relief models were scientific illustrations.

In May, the nearly-complete model's last visitor was USGS Director Charles Walcott, a longtime friend of Howell, who approved the model and then stayed for lunch to discuss the problem of how much scientific work was still undone at Yellowstone (Howell 1897, Smith 2006). Wolcott later ordered a copy of this YNP relief model for its Geology Room at the U.S. National Museum (now the Smithsonian Museum), where it was displayed for decades next to fossils, rocks, and specimens from the park (US National Museum, 1918).

On May 13, 1897, the YNP geologic relief model was shipped to the Omaha Trans-Mississippi and International Exposition by train and installed in the government building. At the exposition, the director of the South Kensington Museum, now the Science Museum of London, was so impressed by the Yellowstone model that he purchased the display model on the spot and had it shipped to London when the fair closed.

In January 1899, Arnold Hague wrote to Edwin Howell that he had been invited to give a March 8 capstone speech on his Yellowstone geologic research at the 89th meeting of the Geological Society of Washington. Hague's USGS Monograph 32 and Geologic Atlas GF-30 would be published, or nearly published, by then; and the geologic community was anxious to hear Hague's report (Hague 1896, Iddings 1919). Hague ordered a copy of the model to illustrate this speech. Howell crafted it in February, making a few corrections; and on March 8, they carefully packed it and shipped it the few miles to the Cosmos Club in Washington, D.C. Edwin Howell and Miss Dawson, the modelmakers, attended Hague's talk that evening (GSW 1899). On March 11, 1899, Howell carried it to the USGS Hooe Building and had Yellowstone National Park and the Absaroka Range map installed in Dr. Hague's office.

The journal *Science* acclaimed Hague's March 8th Yellowstone talk, setting a photograph of the model as its main illustration. They noted, "Mr. Hague stated that he hoped the map would be sent to the Paris Exposition next year," and Howell did send it as an example

of American scientific strength. In July 1901, Howell fulfilled an order from the University of Wyoming for a copy of the 1897 YNP model, along with a model of Mt. Vesuvius. After Howell's death in 1911, former Howell employees, the Robertson brothers of Washington D.C., continued to sell copies of the Yellowstone relief model to universities and museums worldwide until the 1930s.

How Did This Model Come to the Park?

During the summer of 1921, the YNP and Absaroka Range geologic relief model was installed in the new Information Office for Yellowstone (USNPS 1921). It was a gift to the park by longtime national park champions, Mr. and Mrs. Alvah Davison of New York City.

The Davisons were wealthy publishers of commercial books and part of the "Brooklyn Eagle," a travel group sponsored by the Brooklyn Daily Eagle newspaper. The Eagle group, like many of its kind nationwide, had keen interests in all the new national parks. Intrepid stewards, they had attended the dedication of Hawaiian National Park, Grand Canyon National Park, and Mount McKinley National Park as guests of National Park Service (NPS) Director Stephen Mather, longtime friends of the Davisons. But more than just tourists, the Davisons felt strongly that parks, from their inception, needed stewardship and scientific study (Brooklyn Daily Eagle 1922). The Davisons, having seen the effectiveness of Howell relief models at natural science museums in New York, contacted the modeling company and placed an order.

Horace M. Albright, superintendent of YNP, on receipt of the model, wrote Mr. Davison:

I am happy to advise you that the new relief map of Yellowstone National Park made by Robertson Brothers, Washington, D.C., has been received and placed in our big new information office. The map is entirely satisfactory in every respect and is a source of unending pleasure to the tourists who crowd about it during every hour of the day. I wish that you and Mrs. Davison might have an opportunity to see how much pleasure it is giving the Park visitors.

The Davison's gift allowed visitors to better appreciate why viewpoints and trails had been built in those places. They could recognize volcanic cones, breccia with basketball-sized boulders embedded in other rock, entombed fossil fish and trees, and active fault zones. As for hydrogeology, visitors could trace the sources of three of the largest rivers in America within a radius of

10 miles and, of most interest, could visualize the pattern of geysers and mineral springs within the park.

Is This the Only Relief Model at Yellowstone?

Today, YNP also has an interesting copy of the Howell model that is installed in the Mammoth Community Center in the park. The model has no title block, but its features and cultural sites date it the late 1930s and is a cast of the Howell relief model. The model size and topography are nearly exact, but it was painted and labeled without the geologic map coloring of the original. A large red arrow at the Lower Geyser visitor center as a "you are here" locator suggests it was installed at Lower Geyser as an area map.

Whereas the Howell model is an example of the cultural impact of Yellowstone science, this Yellowstone model is an example of federal works programs and their cultural impact on national parks (Fechner 1935, Lewis 1993, Smith 2014). Ned J. Burns wrote in the Field Manual for Museums in 1934 that:

Under the Emergency Conservation Work program supervisors and technicians were employed to guide the work of Civilian Conservation Corp, enrollees assigned to the laboratories to manufacture relief maps and other interpretative devices needed in the park museums. Civil Works Administration employees were made available as curators and research workers (Burns 1941).

Under the direction of Ansell Hall, chief naturalist of the NPS, and the landscape artist Ferdinand Burgdorff in Berkeley, California, over 100 men and women at the Western Museum Laboratory (WML) learned museum artisan skills and produced educational maps, posters, dioramas, and displays for many national parks (Bend Bulletin 1933, Berkeley Daily Gazette 1934). Despite federal defunding and post-war changes, the WML remained a source for museum exhibits for western national parks until the 1960s.

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Melanie McCalmont (pictured below) is a national expert on historic relief models. She is the author of *A Wilderness of Rock: The Impact of Relief Models on Data Science* (2015) which explores the history of geovisualization. Melanie received her MS in Geography and MS in Life Science Communication from the University of Wisconsin-Madison. She has worked for the USGS and the State of Wisconsin geography, statistical, and legal technology programs. Melanie is a nationwide consultant and speaker on relief models. A biography of Edwin E. Howell, modeler of the Yellowstone National Park map, is forthcoming.



Botanical Adventures in Yellowstone, 1899

Hollis Marriott

On June 24, 1899, a sentry on routine patrol discovered a party of six camped on the Madison River just inside Yellowstone National Park (YNP). Inspection revealed multiple infractions. In her diary, Mrs. Aven Nelson, a member of the party being inspected, recalled the event:

He was appalled to see so many papers on the ground and demanded that they be picked up at once . . . There ensued much talk about rules and regulations, in the course of which he discovered that we carried two rifles. After sealing both, he insisted that the signature of Captain Brown would be prerequisite (excerpts from Mrs. Nelson's diary are from Williams, 1984, who "abbreviated and paraphrased" them).

The soldier was shown a letter from the Acting Superintendent of the park, but was not persuaded. The campers picked up the felt papers they had carefully arranged in the sun, and drove 46 miles to Mammoth (two days travel) where they obtained a permit (Army Era records, YNP Archives). Professor Nelson, his family, and two student assistants were in the park ostensibly to document the flora (plant species). But Nelson had grander plans. By the time they left in early September, they had collected, pressed, and dried 30,000 specimens. The project would launch the Rocky Mountain Herbarium at the University of Wyoming—Nelson's greatest legacy.

An Accidental Botanist

In July of 1887, 28-year-old Aven Nelson came to Laramie, Wyoming Territory, to be Professor of English at the new University of Wyoming. But the Board of Trustees had mistakenly hired two English professors, so Nelson agreed to teach botany and biology instead. Apparently the six lectures on plants he attended at the Missouri Normal School, and his biology teaching assistantship at Drury College, qualified him for the job (Williams 1984).

It was a fortunate change in profession. Wyoming's flora was still poorly known, with abundant opportunities for discovery and academic advancement. Nelson's career would be long and productive. He remained active

in botany at the University of Wyoming almost until his death in 1952, at age 93.

A Botanical Expedition of Vast Importance

In the fall of 1898, extraordinary news spread across campus. The excitement was still fresh in Leslie Goodding's mind 59 years later:

A botanical expedition of vast importance was planned for the following summer. Some three or four months were to be spent in Yellowstone Park collecting plants . . . Many students, juniors and seniors, were anxious to accompany Dr. Nelson on that expedition, and were willing to work for nothing just to see the Park . . . this was in the days when autos were much like hen's teeth and trips through the Park by stage were expensive (Goodding 1958).

Nelson hired 19-year-old Goodding as a field assistant and chore boy, at \$10 per month and all expenses paid. The other assistant was Elias Nelson, Nelson's first graduate student and no relation (Williams 1984).

Nelson wrote to the park requesting permission to collect plants "to represent the vegetation of the Park in full . . . dried specimens of the smaller plants and such twigs of the larger as may conveniently be preserved on the usual herbarium sheets, 12 x 16 inches." An affirmative reply came within the month (Army Era records, YNP Archives).

He also contacted botanist P.A. Rydberg, who was preparing a *Catalogue of the Flora of Montana and the Yellowstone National Park* (Rydberg 1900). Rydberg replied, explaining what Nelson most likely already knew (Rydberg 1898-1899):

The flora of the park is, however well worked up as several collectors have been in there, viz., the Hayden Survey, C.C. Parry, Letteman, Burglehous, &c. The one that has done the most, however, is Frank Tweedy of U.S. Geological Survey. He spent two whole summers in the park.

Rydberg recommended Nelson focus on unexplored areas: "I would advise you to select the mountains east and south east of Yellowstone Lake. None of the collectors that I know of has collected in that region. Tweedy only touched it at the south end of the Lake."

To Yellowstone—for Adventure & Science

On June 13, 1899, botany students Leslie Goodding and Elias Nelson arrived by boxcar in Monida, Montana, then the western gateway to YNP. They unloaded a wagon, three horses, provisions and gear, including six plant presses and several thousand "driers and white sheets" (Goodding 1944). Two days later, their mentor, Professor Aven Nelson, his wife Allie (Celia Alice), and their two daughters arrived by passenger train. It was the start of a 14-week botanical adventure in Yellowstone.

They left Monida on June 19, traveling east up the valley of the Red Rock River where they did their first collecting. "As we approached the Continental Divide and the Idaho line, we were impeded by mud, and the wagon had to be unloaded to get it free," noted Mrs. Nelson. The next day they crossed the Continental Divide into Idaho, camped near Henry's Lake, collected the following morning, and moved on, entering the park on June 23 (descriptions of field work in the park are from Williams 1984, unless noted otherwise).

For the expedition, Nelson purchased a 12 x 14 ft. canvas tent with a stout ridge pole and a reinforced hole for the stove chimney. "For twelve consecutive weeks, no one slept under a roof other than the tent, and the two boys usually under the vaulted star-studded skies" (Nelson ca. 1937).

They could legally camp wherever they wished, as long as they were at least 100 ft. from roads. Park regulations required they leave their campsite "clean, with trash either buried or removed so as not to offend other visitors." Hanging clothing, hammocks, and other articles within 100 ft. of a road was banned, as was bathing without suitable clothes (Culpin 2003).

Most days they broke camp early and traveled park roads, stopping at promising sites. The men went out to collect, each with a vasculum over his shoulder—an oblong metal container (today we use plastic bags). Many plants were collected in their entirety, but for larger species they took parts—a section of stem with leaves, another with flowers, fruit if available.

In late afternoon, they would look for a suitable campsite with water, firewood, a flat spot for the tent, and grass for the horses. Plant processing began as soon as

the tent was pitched and materials unloaded, often continuing into evening.

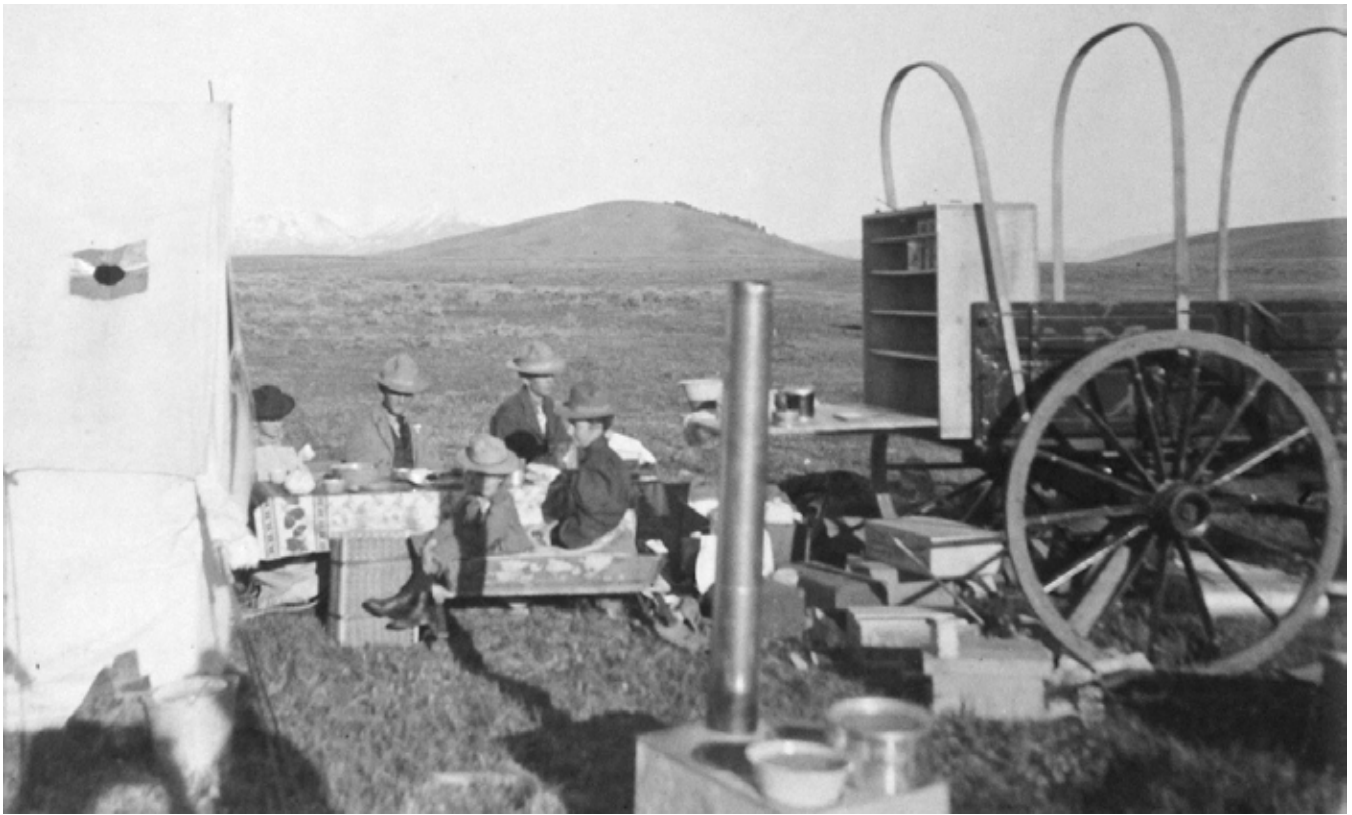
Plants were pressed and dried, using felt blotters to absorb moisture. Each specimen was carefully arranged between sheets of white paper and added to a growing stack alternating with blotters. Then the stack was tightly bound between wooden covers. The next day, presses were taken apart, damp blotters replaced, and presses reassembled. This continued daily until the specimens were dry.

Nelson had brought several thousand reusable blotters, but maintaining an adequate supply of dry ones was difficult. Ideally damp blotters were spread out to dry in the sun. But when it rained for days at a time, they kept a fire going all day in the tent, with plant presses and blotters carefully arranged around the stove.

They mainly collected near roads, even though earlier collectors had done the same (Goodding 1944). Occasionally two men made long excursions on foot while the third stayed with Mrs. Nelson and the girls. Notably, they did not collect in the unexplored country recom-



"The men fished but caught nothing," Mrs. Nelson wrote, until "Elias developed the technique of throwing his plant-digging chisel through a big fish as it moved upstream." On July 2, he caught 23 fish. Photo - ©Montana Historical Society.



The wagon had a mess box in the back, with a door that could be lowered to form a table. They also carried a large table with detachable legs, and a sheet iron stove. When the weather was fine, they dined outside. Photo - ©Montana Historical Society.

mended by Rydberg. Why did Professor Nelson ignore obvious opportunities for discovery? Lack of roads probably was a factor. But there was another consideration: By the time they reached the southern part of the park, they were short one man.

On July 26, Elias and Leslie were collecting near the popular Artist Paint Pots, where visitors were routinely warned to stay on established paths (Guptill 1892-1893). Elias wandered off anyway, sinking one leg in hot mud to the knee. He jumped to higher ground and pulled off his shoe and sock, along with a large patch of skin. A huge blister ran up his leg.

“With the help of several nearby tourists, I sprinkled the wound with soda, bandaged it, and covered the bandage with flour,” wrote Mrs. Nelson in her diary. “Elias was in great pain, but never uttered one groan.” At the Upper Geyser Basin, a visiting physician examined the burn and recommended Elias go to the hospital at Fountain or return home. So Professor Nelson drove him to Madison, where Elias took the stage to Monida, understandably disappointed his great adventure was over.

In early August, impassable muddy roads forced a two-day layover at Yellowstone Lake. When the weather improved, they drove south to the Teton Range, where

Nelson and Goodding collected alpine plants for the first time on the trip. Then it rained for a week. Snow fell on August 19. By the end of August, the Nelsons were ready to go home. They reached Monida on September 3, making scattered collections en route, and two days later were back in Laramie.

The Adventure Ends, But the Science Continues

In 14 weeks they collected roughly 30,000 specimens (Williams 1984)—an astounding number given the conditions, yet only about 500 species were represented (Rocky Mountain Herbarium 2015; precise number is unknown due to subsequent changes in classification and nomenclature). Most of the specimens were duplicates—multiple collections of a given species from a given site. Clearly, documenting the flora of YNP was not Nelson’s primary objective. He was intent on expanding the botany program at the University of Wyoming, specifically the herbarium (the same conclusion was reached in Williams 2003).

With just 1,500 specimens, the herbarium offered little prior to the Yellowstone project. That changed dramatically—1,400 specimens were added directly and



Left to right: daughters Helen and Neva, Leslie Goodding, and Mrs. Nelson, wearing the popular felt campaign hats (today's Mounty or Smokey the Bear hats). In photos, Mrs. Nelson and Neva are always in dresses; Helen, the younger daughter, sometimes wears knickers. The men wear ties. Photo - ©Montana Historical Society.

thousands more through exchange. Nelson knew institutions and collectors would want specimens from Yellowstone, the famous natural wonderland, and he collected accordingly—often 20-30 duplicates per species per site (Nelson ca. 1937). A full set of duplicates went to the U.S. Herbarium at the Smithsonian (the park had no herbarium at that time). Smaller sets were distributed across the U.S., in Europe, and as far away as India, in exchange for equal numbers of specimens for Nelson's herbarium. Sets also were sold to raise money for field work (Williams 1984), a practice no longer permitted by the National Park Service or the University of Wyoming.

Shortly after returning from Yellowstone, Nelson convinced the Board of Trustees to designate a separate institution for the plant collection—the Rocky Mountain Herbarium. They intended it to be “an accessible and serviceable collection” of the region's plants, but it has far exceeded their expectations. At 1.3 million specimens, it is now the tenth largest herbarium in the U.S.

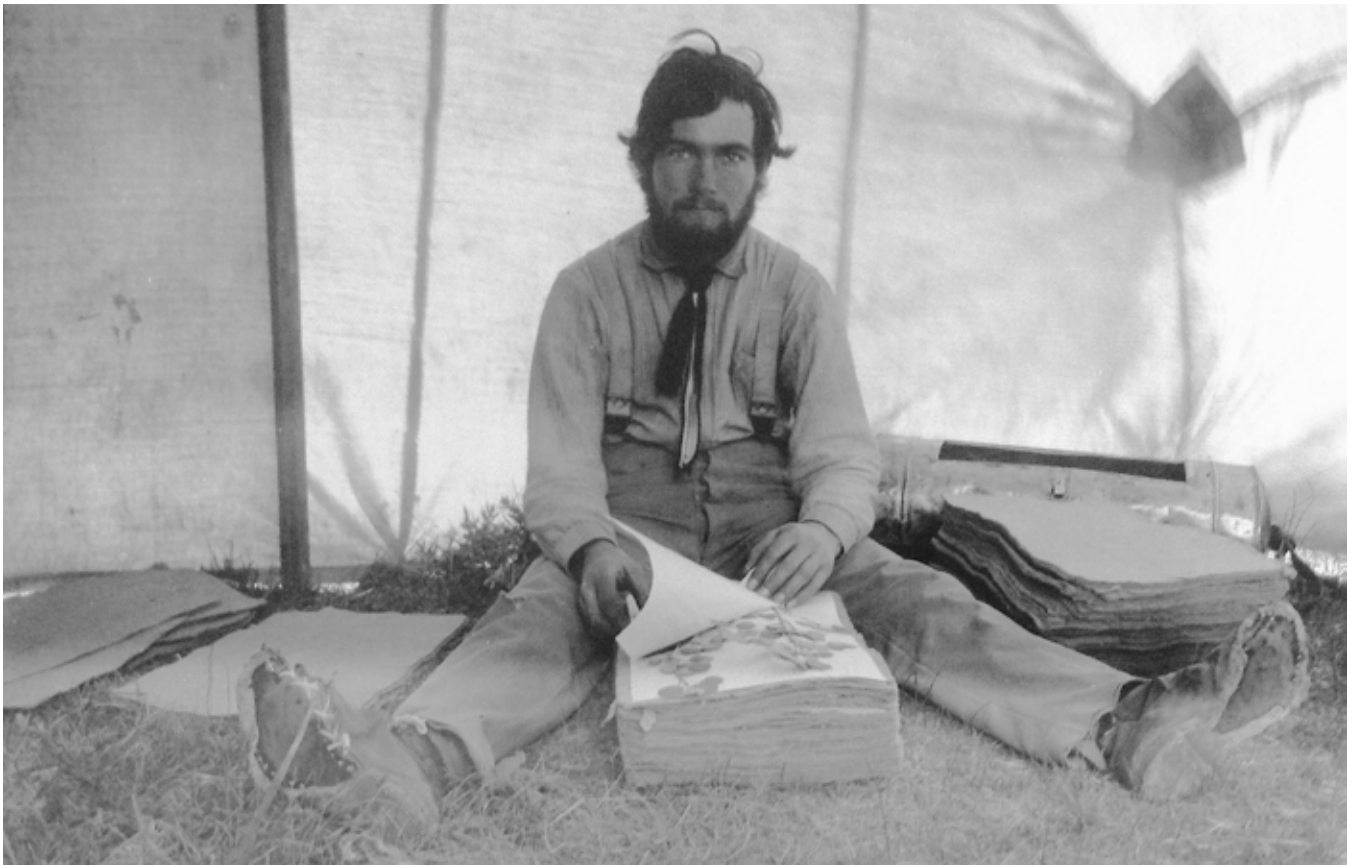
We call Aven Nelson the Father of Wyoming Botany, a delightful irony given that he became a botanist by bureaucratic error. In his long career, he collected many thousands of specimens (not counting duplicates), described numerous new species, published more than

100 academic articles, and mentored students who became prominent botanists themselves. But his greatest legacy is the Rocky Mountain Herbarium, a world-class institution built on a foundation of Yellowstone plants.

The park now has its own herbarium, considered an untapped gem. Established in 2005 in the park's Heritage and Research Center, the Yellowstone Herbarium contains over 17,000 specimens of vascular and non-vascular plants, fungi, and lichens. The aquatic plants collection is particularly extensive. The herbarium is available to visitors and scientists alike, for research or tour. Herbaria were originally invented to help people identify plants suitable for gardening and propagation. Today's herbaria, however, document current species distributions, as well as aid with plant identification. The Rocky Mountain Herbarium and Yellowstone Herbarium are prime examples of the United States' prominent herbaria.

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Leslie Goodding sits between stacks of blotters, checking specimens. The photo was taken near the end of the expedition, by which time he had worn the soles off his boots. Photo - ©Montana Historical Society.

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Hollis Marriott has worked as a field botanist in Wyoming and South Dakota for more than 40 years, for federal and state agencies, and private organizations. Her specialty is plant and natural area conservation on public lands. She also is a Research Associate with the Rocky Mountain Herbarium at the University of Wyoming, where the spirit of Aven Nelson provides a steady source of inspiration.

A DAY IN THE FIELD

Collaboration is Key to Upper Gibbon Fishery Restoration

Erik Oberg



Collaborating biologists prepare for the application of rotenone at Grebe Lake in September 2017. More than 75,000 pounds of chemical, boats, equipment, and supplies were transported to this backcountry site by helicopter to complete the project. NPS Photo - T. Koel

In September 2017, a collection of 35 biologists and ecologists, interns, and park volunteers from several parks, agencies, and non-governmental organizations (NGOs) gathered at a series of lakes in the upper Gibbon watershed of Yellowstone National Park (YNP). The task at hand was to implement an ambitious project. The project area included 16 km (10 mi) of the Upper Gibbon River and Grebe, Ice, and Wolf lakes, totaling over 92 ha (228 surface acres). The challenge involved moving 75,000 pounds of supplies and equipment into the backcountry. The goal of this fisheries project was to protect and restore native westslope cutthroat trout and fluvial (river dwelling) grayling to the upper Gibbon watershed. The process included treating these waters with the piscicide (fish poison) rotenone to kill every adfluvial (lake

dwelling) arctic grayling and non-native rainbow trout, deactivate the chemical, and then introduce native fish to the watershed. No small task.

The project site has an interesting history. As was common practice in the early days of park management, lakes, even fishless ones such as Grebe, Ice, and Wolf, were often stocked with non-native fish to provide recreational angling. Little was known about the long-term consequences of stocking. The first stocking of Grebe Lake occurred in 1921 with “one million fry from the State Fish Hatchery in Anaconda, Montana. Anaconda got its eggs from Georgetown Lake, and the Georgetown Lake population originated from spawning runs out of the Madison River near Ennis, Montana, about the turn of the century” (Varley and Schullery 1983). In 1932, a small hatchery



NPS fisheries biologists Philip Doepke and Todd Koel apply rotenone powder to Wolf Lake. Immediately afterwards the lake was detoxified using potassium permanganate. A total of 30,000 westslope cutthroat trout and 15,000 Arctic grayling were then reintroduced to Wolf and Grebe lakes in mid-October 2017 to reestablish the fishery and to provide a food source for common loons and other fish predators. NPS Photo - E. Oberg

and employee quarters were built near Grebe Lake to facilitate trapping and egg hatching efforts (Agency Report 1937). Today, old road grades, eroded dam structures, and foundations testify to these early efforts.

From the 1880s to 1930s, fishless lakes were stocked with non-native rainbow trout, grayling, and other species from outside the park. The descendants of these fish are now being removed in the upper Gibbon for the introduction of native westslope cutthroat and river-adapted grayling. It may seem counterintuitive to stock historically fishless lakes, even with native species; but these higher elevation waters are hoped to provide refuge for these species as water temperatures rise and other threats, such as water borne diseases, encroach on the park. Park managers are uncertain about how fish populations will adapt or adjust to climate change pressures. This project may provide the park with an important management tool for ensuring the long-term survival of fish that are native to the park, even if not native to this particular portion of the watershed.

Parks around the country face similar climate change questions. Will Joshua trees, giant sequoias, and redwoods still grow within the boundaries of the parks? Will they survive at all? Park managers in Yellowstone decided to experiment with a project like this and give native fish

a potential toehold at higher elevations rather than risk a catastrophic fish die-off, like the one that occurred outside the park in the Yellowstone River in 2016, which may have been related to warmer waters and low flows. It may be better to make this investment now than try to explain why we didn't do anything after it was too late.

The upper Gibbon River and aforementioned lakes have a long history of supporting fish populations. They are isolated from other watersheds, at higher elevations than many current fish populations, and are relatively easy to access. Park managers decided it was worth the effort to relocate these two native species to this area to buffer the effects of potential future climate warming.

A project this size dwarfed even the substantial staffing levels of the YNP fisheries program. They were going to need some help. Enter the collaborators. One of these collaborators came from a park over a thousand miles away and was an old friend. I've known Danny Boiano, Aquatic Biologist at Sequoia-Kings Canyon National Parks, for over fifteen years. We worked together at Sequoia, and I was immediately impressed with his knowledge and dedication. Danny has been working since 2002 to save the endangered mountain yellow-legged frog (*Rana muscosa*) from extinction. If you hike in the Sierras 30 years from now and are serenaded to sleep by a chorus



Backcountry fish restoration projects in Yellowstone are large, cooperative efforts. Here, staff from Yellowstone, North Cascades, and Sequoia-Kings Canyon national parks; Turner Enterprises; Student Conservation Association interns; private contractors; and long-term volunteers gather at the Grebe Lake fish camp for a pre-project safety meeting. NPS Photo - T. Koel.

of these frogs, it will be because of Danny Boiano. He recently wrote an environmental impact statement (EIS) to remove non-native trout from alpine lakes that are the last remaining habitat for these vanishing amphibians. Danny has been removing trout with nets for many years and making some progress. Piscicide treatments are the only way to effectively remove all trout over an area big enough to give frogs a fighting chance at survival. Danny came to Yellowstone for two weeks to work on this project, to see how managers plan and execute a large treatment project involving lakes and tributaries, and to learn the detoxification process.

The method for removing one or more aquatic species and introducing others is now fairly standardized: 1) isolate the project area, 2) completely remove target species, and 3) introduce native species. The process sounds simple; but the sheer size, timeline, and complexity of the project watershed made collaboration critical to success.

My role in this massive undertaking was small. Danny and I were assigned to follow a Grebe Lake tributary to its source, map it, and conduct a dye trace to chart its flow rate. This involved crawling over jack-strawed lodgepole pine trunks for several hours. We brought the data to project leader Jeff Arnold, who then calculated how much rotenone would be used for the drip station, set up to apply

a steady stream of chemical to remove fish from one end of the stream to the other. For help with the miles of tiny tributaries, with flows too slow to treat with drip stations, Yellowstone benefited from an experienced practitioner. Ashley Rawhouser, Aquatic Ecologist at North Cascades National Park, has been working on smaller fisheries projects like this for 12 years. He led another team treating tributaries with backpack sprayers and checking the sentinel stations where fish are set in portable cages to ensure the treatment is working. This work was comparable to the mapping and dye tracing, but with 30 pounds of piscicide on your back. I was glad to be wielding a camera.

The really heavy work was treating the lakes. This was accomplished by a combination of backpack spraying along the shore and a boat-based crew applying powdered rotenone into the water. Only trained staff with pressurized respirators could do this work. My job was to document Yellowstone's first-time use of boats to apply piscicide at this scale—and to stay upwind. During the Wolf Lake treatment, we saw a late-season common loon. The activity caused it to depart, but it served as a reminder of an important project element. We were removing the fish food source it and other species such as ospreys depend on. To mitigate this concern the piscicide would be applied, detoxified with potassium permanga-

nate, and then native fish introduced, all before the snow flies. These 45,000 native fish will provide breeding stock to continue to repopulate the area, as well as provide food for species such as the common loon come springtime.

The piscicide works quickly, and soon the surface is dotted with dead fish. They blow ashore and can quickly attract scavengers. In order to remove the dead fish, my fellow collaborators and I made hundreds of “scooping” trips. Imagine wading along the lake shore with a large fish net, scooping dead fish into buckets. We removed approximately 10,000 rainbow and grayling. These buckets of fish were loaded into boats, counted, cut to prevent floating, and returned to deep sections of the lake for nutrient cycling. Student Conservation Association interns, staff from Turner Enterprises, Inc., and returning volunteer Christine Mire all contributed to the effort. Volunteers signing up to scoop dead fish is a testament to the deep connection many people have to this place!

Perhaps the best part of the experience, at the end of a sun-up to sundown work day, was connecting with the other team members back at base camp. Swapping stories from the day’s adventures and sharing experiences from outside the park made for easy conversation around

the campfire. I don’t often have the chance to work with so many co-workers, volunteers, and, of course, my old friend Danny.

Our understanding of ecology has evolved a great deal from the early days of building roads and hatcheries to stocking non-native species. We won’t know if this project will provide a climate-change resilient habitat for many years to come. But for today, the Gibbon River project demonstrates the deep well of support YNP enjoys for its conservation efforts, the large scale of the challenges we face, and how much we can accomplish through collaborative efforts.

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Erik Oberg is a Biologist at the Yellowstone Center for Resources. He is an avid angler who one day hopes to catch his first fluvial grayling in the Gibbon River.

NEWS & NOTES

Bigelow Presented with Career Achievement Award by Montana Chapter of the American Fisheries Society

Pat Bigelow, Yellowstone National Park Fisheries Biologist, was honored by the Montana Chapter of the American Fisheries Society in 2018 for her career achievements in fisheries science.

The text excerpts below were written by her nominators, a group of peers, collaborators, and mentees.

“We are delighted to nominate Pat Bigelow for the Career Achievement Award. Pat grew up in Vermont on a dairy farm where her parents Don and Margaret instilled the work ethic that Pat has carried through her career and life...Pat has been an excellent supervisor, biologist, mentor, friend, pie baker...Pat’s understanding of the Yellowstone Lake ecosystem, and constant collaboration with researchers and other park staff is a driving force behind higher catch rates each year. Her happy demeanor is a major factor in fostering relationships with the many divisions in the Park.”

Gunther Given Director’s Award for Natural Resource Management

In October, Kerry Gunther was awarded the 2017 Regional Director’s Award for Natural Resource Management in the Intermountain Region.

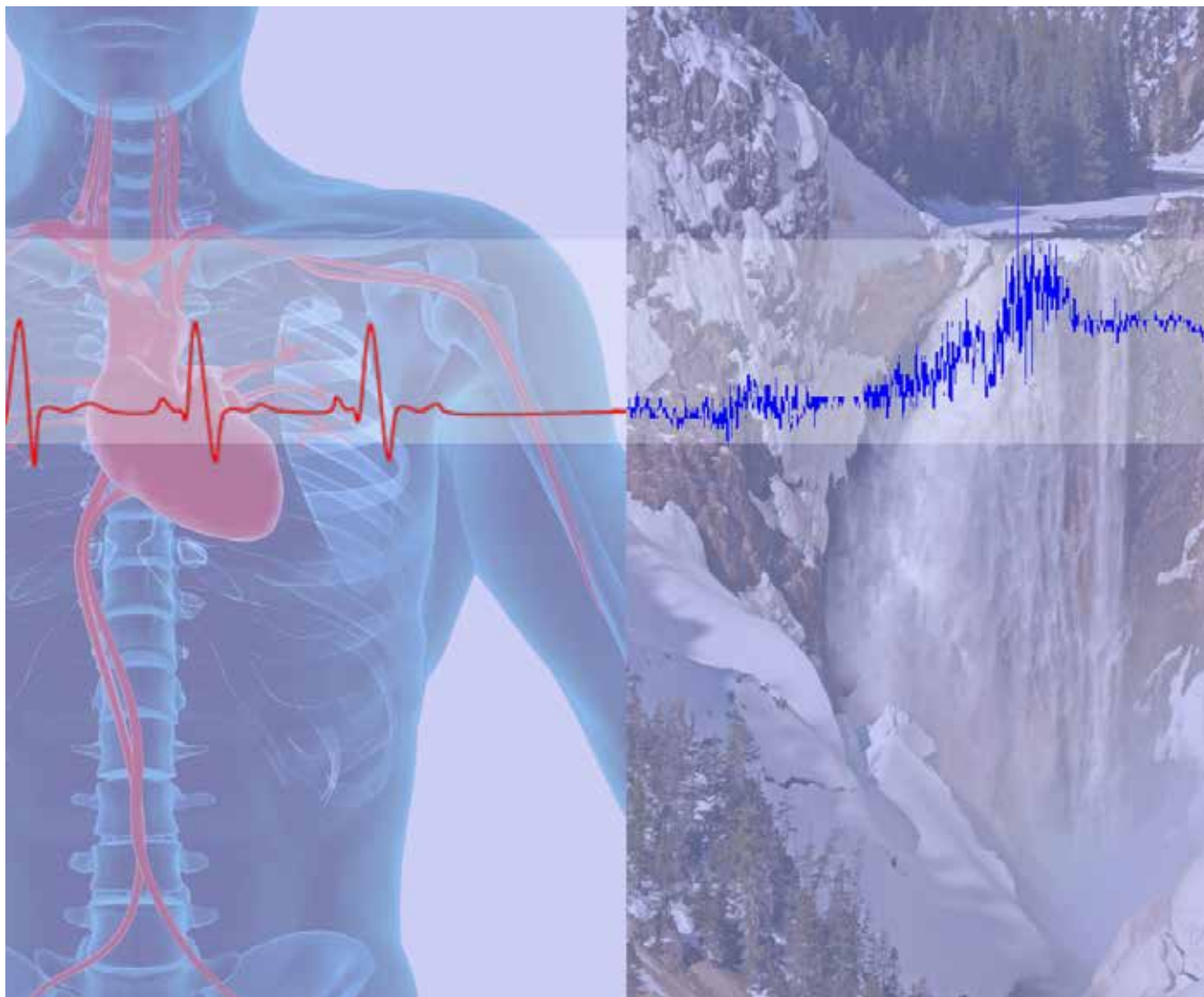
This award acknowledged the significant contributions Kerry made towards conservation and recovery of grizzly bears in the Greater Yellowstone Ecosystem. His efforts to reduce human-bear conflicts and human-causes of bear mortality, have increased human safety in bear country.

Kerry Gunther is the Bear Management Biologist for Yellowstone National Park and a member of the Inter-agency Grizzly Bear Study Team for the Greater Yellowstone Ecosystem. He has worked in grizzly bear and black bear research, monitoring, and conflict management in Yellowstone National Park for 33 years. His interests include the conservation of bears and finding practical solutions for reducing bear-human conflicts.

SNEAK PEEK

Coming Up in *Yellowstone Science* *The Vital Signs Issue*

*Andrew Ray, Adam Sepulveda, David Thoma, Mike Tercek,
Robert Al-Chokhachy, & Robert Diehl*



In medicine, vital signs, such as blood pressure and pulse rate, are simple routine measurements used to assess human health. When tracked over time, vital sign measurements contribute to diagnoses and support decisions concerning the response of patients to medical treatments. Slight abnormalities in vital sign measurements (e.g., elevated body temperature) are usually

not critical but may warrant a more careful diagnosis, whereas extremely abnormal vital signs may indicate a life-threatening condition requiring an immediate medical response.

Vital sign monitoring has strong parallels in ecology for understanding the health and function of plant and animal populations, ecosystems, parks, and even

the Earth itself. Ecological vital signs include both physical and biological indicators that are sensitive to environmental change. Monitoring of vital signs can also reveal when ecosystems reach critical thresholds or tipping point. The most valuable vital sign indicators can be used to support decisions that promote human and ecological health and characterize the success of past management actions. To highlight the importance of indicators, consider how miners historically used caged birds to detect dangerous levels of carbon monoxide. A sick or dead bird served as a warning sign, prompting evacuation and cementing the phrase “canary in the coal mine” into our everyday language. Today, ecological vital sign surveillance programs employ reliable and standardized measurements to assess whether a physical or biological indicator is functioning within a natural or historical range of variation and whether it is nearing an ecological tipping points (Tierney et al. 2009).

Physical indicators include streamflow volumes, snowpack depths, and air temperatures. Tracking these indicators reveals important information about the health of parks, but the combined monitoring of physical and biological vital signs offers more clear evidence of ecosystem change. For example, increases in Yellowstone’s air temperature changed more precipitation to rain than snow and, ultimately, contributed to snowpack declines (Tercek and Rodman 2016). Reductions in snowpack lead to reduced soil moisture and, in turn, can alter the distribution of plant and animal species and rearrange the mix of species present. Since Yellowstone’s ecology is tightly linked to snow, increases in air temperature and reductions in snowpack may have cascading effects on ecological health.

As with humans, we argue that ignoring vital signs has real consequences for the health of our parks and surrounding natural areas. Further, tracking just one or two vital signs is as insufficient to characterize human health as it is the health of a complex ecosystem or park. Lastly, extremely abnormal vital signs are just as serious for ecosystems as they are for humans and may require a response matching in intensity. For example, following declines in Yellowstone cutthroat trout, a systematic removal of non-native lake trout was initiated to aid in the restoration of cutthroat trout in Yellowstone Lake and head off larger problems and more costly interventions (Arnold et al. 2017, Bigelow et al. 2017).

Yellowstone, like many of our nation’s parks, encompasses some of the most pristine and intact ecosystems—vital sign monitoring is a critical part of managing these ecosystems “for the enjoyment of future generations.” Beginning in 2000, the National Park Service’s Vital Signs Monitoring Program formalized the use of ecological vital signs to track the health of national parks (Fancy et al. 2009, Rodhouse et al. 2016). The Greater Yellowstone Network and its partners formally began collecting data on several vital signs in Yellowstone National Park and across neighboring public lands (Jean et al. 2005). Whitebark pine, river water quality, and wetland and amphibian vital sign monitoring programs were launched and began generating regional information on vital signs that were believed to be experiencing stress at regional and global scales. The next issue of *Yellowstone Science* will discuss how monitoring ecological vital signs is being used to understand and assess the health of Yellowstone National Park and the surrounding area. Through a series of Feature and Short articles, we will summarize how vital sign trends are likely to shape the future of the Greater Yellowstone Ecosystem.

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Andrew Ray see page 75.

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