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DEDICATION

To the memory of Nathaniel Mathew Scherr, M.A.

Good friend and colleague (1982-2013)

We miss you, Nate
PREFACE

Douglas H. MacDonald and Elaine S. Hale, editors

The prehistory of Yellowstone National Park is rich, dating back more than 10,000 years. To date, Osprey Beach is the oldest archaeological site in the park. This site, located on Yellowstone Lake’s West Thumb, contains a record of prehistoric occupation that is unparalleled in southern Yellowstone. Many other archaeological sites exist around Yellowstone Lake—285 identified so far—that provide evidence of ancient prehistoric use of Yellowstone Lake and southern Yellowstone over the last several thousand years.

Each of the 14 chapters in this book contains important information about archaeological sites in this area. The contributors are experts in their fields, ranging from archaeologists to ethnobotanists to geomorphologists, and everything in between. Many of the papers were originally prepared for a symposium at the 2011 Rocky Mountain Anthropology Conference held in Missoula, Montana. This current volume—entitled Yellowstone Archaeology, Volume 2: Southern Yellowstone—covers the southern portion of the park and predominantly Yellowstone Lake. Without a doubt, this project could legitimately be entitled the Prehistory of Yellowstone Lake, Wyoming.

The predecessor—Yellowstone Archaeology, Volume 1: Northern Yellowstone—was published in 2011 and focused on archaeological research around Gardiner, Montana. The University of Montana, among others (University of Wyoming, Lifeways of Canada, Midwest Archaeological Research Center), have been working in the southern park area for many years now, providing a rich body of knowledge for this book.

We hope you enjoy this collection of 14 papers on the historic and prehistoric archaeology of the southern portion of Yellowstone National Park and Yellowstone Lake. We certainly enjoyed working on these projects and hope the research proves useful.

We would like to acknowledge the participation and financial support of the Yellowstone Park Foundation. Based in Bozeman, Montana, the YPF is the official fundraising partner of Yellowstone National Park. It works in close cooperation with the National Park Service to fund projects and programs that protect, preserve, and enhance the natural and cultural resources and the visitor experience of Yellowstone. We are certainly grateful to the YPF for funding the publication of this volume. We encourage all of our readers to donate to the YPF at www.ypf.org.

We also acknowledge the support of the National Park Service, including Tobin Roop, Staffan Peterson, Pei-Lin Yu, Robin Park, Christie Hendrix, Ann Johnson (now retired), among many others who facilitated the success of these various projects in Yellowstone. Thanks to the Rocky Mountain Anthropology Conference for facilitating the success of the 10th annual meeting in Missoula in 2011. Thanks to the Department of Anthropology at the University of Montana and the publications committee for agreeing to publish this, as well as its sister volume on northern Yellowstone. Thanks also to the dozens of UM archaeology students who participated in excavations and laboratory work on these projects, especially Stocky White for helping with proof-reading and reference checking. We blame him for any remaining mistakes. Finally, thanks to all of the authors who provided their research.

Please note that all photographs and figures are courtesy of Yellowstone National Park and are credited to the authors of the chapters, unless otherwise stated. Radiocarbon dates are presented in uncalibrated radiocarbon years B.P. (BP), unless otherwise stated. These chapters were peer-reviewed. Site locations have been left intentionally vague for their protection.
CHAPTER 1
PREHISTORIC CULTURE HISTORY AND PRIOR ARCHAEOLOGICAL RESEARCH IN SOUTHERN YELLOWSTONE

By Elaine Skinner Hale and Michael C. Livers

Abstract
Prehistoric hunter-gatherer occupation of the Greater Yellowstone Area (GYA) in the Northern Rockies Intermountain Region extends as far back as 11,500 uncalibrated radiocarbon years B.P. (BP) with the recovery of Paleoindian artifacts from Gardiner, Montana and Jackson Lake, Wyoming during the seminal years of archaeological inquiry. Christened during the late 1940s, formal archaeological survey did not come to force in Yellowstone National Park until the late 1980s after the 1988 fire. Since this time, archaeologists and cultural resource staff have documented well over 2,000 cultural resources including both prehistoric and historic sites. Even though documentation of cultural resources remains largely based in areas of historic development, YNP staff and archaeology consultants have developed and continue to add to the cultural record associated with Native American use of the Yellowstone Region, documenting continued use of the park over the last 10,000 years. The culture history of Southern Yellowstone is the culmination of more than 50 years of archaeological research around Yellowstone Lake, composed of data from a dozen or more projects involving dozens of people in pursuit of knowledge about those who lived off the land now cherished and protected by millions.

Introduction
It was obvious to the early trappers, prospectors, and explorers who ventured into the area that native people were familiar with and engaged in using the many resources in the land which later was designated Yellowstone National Park. Their accounts document peaceful and not so peaceful encounters with various groups of Indians (Haines 1965). The 1871 Hayden Expedition sent to create the first geological survey of the park had one of the supply pack strings "liberated"—an unauthorized procurement—by Native Americans near Henry’s Lake just east of the park. The Hayden Survey made numerous references to native peoples camping near or inside the park and traveling along the parks’ ancient trails (Baldwin 1976). What was poorly understood for the first century of the park’s formal existence is that people had traveled through the park and made good use of the flora and fauna on the landscape for many thousands of years. Between 1887 and 1897, Supt. P. W. Norris, the U.S. Geological Survey, and the Bureau of American Ethnology removed hundreds of Native American artifacts from the park, including spear, atlatl, and arrow points, stone knives, scrapers, soapstone vessel fragments, stone celts and axes, pottery sherds, shaft straighteners, stone drills, much flake stone debris, a steatite tube or pipe, and a pecked round stone,—which were sent to the Museum of Natural History, Smithsonian Institution, where they reside today (Sanders 2006). Although provenience of the early collected artifacts lacks locational details for the most part, there is some reference to artifacts retrieved from Yellowstone Lake and the south half of the park. A general view of the Museum of Natural History artifacts indicates they were left by people from the Paleoindian cultures nearly 10,000 years before present, through the Early, Middle, and Late Archaic cultures, on through the Late Prehistoric cultures 1,000 years before present. Most likely a few collected objects date to the Protohistoric period after contact with Euro Americans although no trade goods such as glass beads or metal points are present in that collection.

No evidence of long-term habitation or even over-winter camps have been identified in southern Yellowstone National Park (YNP), although it is clearly evident that early bands of hunter-gatherers—nomadic people who hunt game and collect plant food—were using the park’s southern landscapes in the warmer seasons for at least 10,000 years. Recent research by MacDonald et al. (2012) indicates that seasonal use of the lake area likely was initiated in early Spring, with ice still on the lake. An approximately 10,000 year old Folsom projectile point sourced to Obsidian Cliff was found just south of Yellowstone in the Bridger-Teton National Forest suggesting north to south movement of early peoples (Janetski 2002). The dense number of
prehistoric archeological sites located on the southern shores of Yellowstone Lake containing Paleoindian Cody points dating some 9,000 BP attest to the fact that people were engaged in seasonal rounds of hunter-gather and domestic activities in the park’s southern half for thousands of years. High quality dark green chert found in a Cody complex site on the south of Yellowstone Lake matches the dark green chert projectile point embedded in a bison skull recovered from the Cody "type-site", the Horner site, just east of the park (Frison, personnel communications with author, 2003), suggesting movement of people from east of the park to the south of the park or visa-versa. Ancient trails from the north along the Yellowstone River, from the west along the Madison River, from the south along the Snake, Bechler, Yellowstone, Falls, and Lewis rivers, and from the east following Crow Creek, Middle Creek, the Shoshone River, and the Jones Pass trail are a few examples of the ancient corridors of passage used by early visitors to southern Yellowstone.

For a variety of reasons mostly centered on the difficulty of access to the remote regions of the south half of the park, much less is known about the prehistoric use of the vast landforms that comprise southern Yellowstone. The park has now completed archeological survey of some of the developed areas such as Old Faithful, Lake, and Fishing Bridge and some of the road systems such as the Grand Loop Road, the East Entrance Road, and a small part of the South Entrance Road. As we finish initial survey and National Register testing of archeological sites along the shores of Yellowstone Lake we are aware of the vast amount of area in the south of the park for which no archeological survey has been conducted. There is very little survey of Shoshone Lake, Lewis Lake, Heart Lake and the many smaller bodies of water in the south of the park. The park's system of backcountry trails connecting the Bechler/Falls River area to Shoshone Lake; the Snake River trails; the Thorofare trail system; the Yellowstone River trail system; the Mist Creek Pass trail connecting the north of Yellowstone Lake to the Lamar River trail system in the north end of the park; and the Mary Mountain Wagon Road connecting the Firehole River to the Yellowstone River have had no systematic archeological survey. Vast areas of high plateaus in the south half of the park such as the Madison Plateau, the Pitchstone Plateau, the Central Plateau, the Red Mountains, Big Game Ridge, Chicken Ridge, the Two Ocean Plateau, and The Trident have had no archeological survey but we know from scattered visitor and backcountry rangers reports that there is evidence of pre-contact period human use in all of these areas.

Nevertheless, headway is being made in our recovery of archeological data valuable in understanding the prehistoric and early historic use of the south half of Yellowstone National Park. This chapter will provide some background in archeological research conducted in the southern portion of the park, and provide a basic prehistoric culture history for Southern Yellowstone developed from what is currently known from the archeological data.

Prior Archeological Research

Much of Yellowstone’s archaeology is reactive in nature and is usually conducted in heavily developed areas that are in continuous use by park visitors. With the increased number of federal projects occurring in Yellowstone since the inception of the National Historic Preservation Act of 1966 and President Nixon’s 1970 Executive Order # 11593 strengthening the Act, whether highway projects, utility upgrades, or visitor services buildings, the amount of archeological work performed in the park has grown exponentially. Yellowstone currently has over 2,000 cultural properties on file with the Montana and Wyoming State Historic Preservation Offices for both historic and prehistoric archeological sites. These 2,000 plus sites exist within an inventoried area no greater than 4%, a mere 140 of the entire 3,472 square miles (8,987 km²) making up YNP. Putting the inventoried area into perspective, this 4% amounts to roughly 88,883 acres, of which the last four years of the University of Montana’s and Yellowstone National Park’s (YNP) Montana Yellowstone Archeological Project (MYAP) surveys have amounted to almost 4,000 acres of inventoried area. It has taken over 40 years to approach 4% archeological inventory of the park. With funds in generally short supply and the NPS mission to keep wild places wild (meaning little project driven funds for archeology), it is difficult to predict future progress towards a more complete archeological record, especially in the less developed southern portions of the park.
The chronological listing of archeological work in the park begins with the previously discussed collections by P. W. Norris and a discussion of Obsidian Cliff by William H. Holmes in 1879. After a 62-year gap in the parks archeological record, the inadvertent discovery of a native burial at Fishing Bridge brought members of the Missouri River Basin survey crew to Yellowstone to investigate the burial site (Shippee and Hughes, 1947). A decade later a park ranger, Wayne Replogle, walked some of the park’s ancient trails and mapped the locations of approximately 80 prehistoric sites generally described as “chip-strewn areas.” Renowned wildlife conservationist George Schaller was studying pelican behavior on the Mollie Islands on the Southeast Arm of Yellowstone Lake in 1962 when he noticed many prehistoric artifacts on the south shore of the lake. He mapped and collected 187 artifacts and turned them over to the park where they were curated into the museum in 1967 and sat in storage until 2006 when the artifacts were re-examined (Szamuhel 2007.)

Replogle’s maps inspired Dr. Carling Malouf, head of the Montana State University (now the University of Montana) Anthropology Department to initiate the first “systematic” archeological survey of Yellowstone National Park in 1958. The two month field survey covered drainages along the Yellowstone River (both inside the park and north of the park), the Madison River, the Gallatin River (partially outside YNP), and Yellowstone Lake. Dee C. Taylor, co-director of the Yellowstone Survey, continued the University’s work in Yellowstone an additional season in 1959 with Mission 66 program money (Hoffman 1961.) The crew located and recorded 195 sites within the park, 78 of which were sites Replogle had previously mapped and many were recorded without revisiting the site. Their survey work in the parks southern half included Yellowstone Lake and its tributaries with a majority of the recorded sites located on the north end of the lake and on the shores of West Thumb, presumably for the Mission 66 development of Grant Village. Their survey work along Thorofare Creek, the Snake River drainage including Shoshone, Lewis and Heart lakes, and the Bechler River resulted in only two sites documented along the Snake River. The Madison and Firehole River survey produced 41 documented sites sparsely scattered along the river banks. Although their survey work was cursory, the crew did identify and excavate the first site in the park from which pottery was recovered, 48YE449, located along a creek draining into Yellowstone Lake (Hoffman 1961.) This is one of two pottery bearing sites known to date in YNP.

The park’s Cultural Sites Inventory (CSI) indicates that during the 1960’s, 1970s, and the 1980s archeological survey in the south end of the park was very spotty, with limited survey being conducted for small-scale projects such as minor trail reroutes, utilities or structural work within developed areas, backcountry cabin documentation, and mostly road inventories in support of the parks fledgling park-wide road reconstruction program (MWAC 2008). Initially the work was performed by J. J. Hoffman, whose work with the 1958-59 Montana State University survey gave him a good background for the small project inventories. Gary Wright, who was actively engaged in archeological survey work for Grand Teton National Park and the John D. Rockefeller, Jr. Memorial Parkway from 1972 until 1990, provided published research and hypotheses of migration routes between the Jackson Hole area and the south portion of Yellowstone National Park (Bender and Wright 1988.) In the late 1970s, Wright began conducting small archeological survey projects in YNP. Wright (1979) compiled the early archeological report for the assessment of the Greater Yellowstone Cooperative Regional Transportation Study, including archeology from Grand Teton and the Rockefeller Parkway. Wright conducted utility inventories throughout the developed areas of the park and block inventories at Grant Village and West Thumb in the south end of the park (CSI 2008.)

By the 1980s most of the archeological survey work was still small project work and was being conducted by the staff of the Midwest Archeological Center (MWAC), a NPS facility in Lincoln Nebraska. In the late 1980s, Doug Scott and Melissa Conner, both with MWAC, conducted archeological survey in the southern part of the park in the Fishing Bridge-Lake area and for the Craig Pass segment of road between Old Faithful and West Thumb. By the late 1980s, Ann Johnson from the NPS Regional Office was actively engaged in additional small project archeological surveys. The aftermath of the fires of 1988 required archeological assessment efforts from both the Regional Office and MWAC. Post-fire assessments of
sites along the backcountry trails and associated campgrounds continued in 1989 and 1990.

With the 1989 formalization of the road reconstruction program in Yellowstone National Park, the archeologists with MWAC became more actively engaged. Ken Cannon conducted archeological inventory, National Register testing, and excavated a few sites to recover archeological data along 27 miles of the East Entrance road, including work within the Fishing Bridge sites 48YE304 and 48YE1. At the same time MWAC provided archeological support for proposals to expand staff housing inside the park, working mainly in developed areas such as Old Faithful, Grant Village, Fishing Bridge, and Lake in the southern portion of the park. By 1992, road inventory expanded to the Arnica Creek to Little Thumb Creek segment of road around the West Thumb of Yellowstone Lake. MWAC staff was also conducting various utility corridor archeological surveys in the Fishing Bridge-Lake-Bridge Bay areas and expanding the road inventory to Madison to Old Faithful area on the south end of the Grand Loop Road.

By the mid-1990s, archeological work associated with the parks road program concentrated on road segments in the north of the park. In 1996, the NPS Submerged Resources Center conducted the first underwater archeological survey of Yellowstone Lake, identifying submerged prehistoric sites off shore of the Lake Developed area and the remains of the legendary 1880 lake tour boat the Zillah (Bradford, et al. 2003). Johnson, now the park archeologist, conducted several small inventories in 1996 for the Trail Creek and Pelican Creek placements of wolf pens for the wolf re-introduction program. Also in 1996, the Office of the Wyoming State Archaeologist (OWSA) began inventory and testing work for the park’s road program working on the Bridge Bay to Lake section of the Grand Loop Road. In 1997, the OWSA crew conducted archeological test excavations adjacent to Pelican Creek in support of bridge replacement. YNP staff continued to conduct archeological inventory for small trail re-routes and utilities work.

Cannon (1999) reported inventory conducted with Kenneth Pierce in 1997 around the Trail Creek Cabin area which included the Donner site. The Museum of the Rockies salvaged a hearth at the Donner site and conducted inventory around the bay of the South Arm of Yellowstone Lake in 2000 (Shortt 2001.) Starting in 2000, a crew of volunteers from Wichita State University, under the direction of Johnson, began to survey the lakeshore along the West Thumb area and identified the multi-component Osprey Beach Cody Complex site.

In 2002, the OWSA conducted archeological survey on 1.6 KM of the South Entrance Road and the Museum of the Rockies archeological crew documented four prehistoric sites in the Pelican Valley and three prehistoric sites on the east side of Heart Lake. Johnson conducted several small inventories for hazard fuels reduction around several backcountry cabins and the South Entrance Ranger Station. In 2003, Johnson and a crew of volunteers ventured to the south area of Yellowstone Lake along Trail Creek and identified the area as rich in prehistoric archeological sites and in need of intensive inventory. A well known Livingston photographer, Tom Murphy, oversaw the collection of archeological artifacts at the Donner site in 2000 and again in 2006. The artifacts were eroding out of the shores of the south end of the lake due to uplift in the northern part of the lakes’ thermal domes pushing excess water to the south end of the lake. Johnson was able to acquire funding from the Yellowstone Park Foundation (YPF) to carry out mitigative investigations at the Osprey Beach site in 2002 and at site 48YE252 in 2008, both sites actively eroding out into the lake. YNF also funded Yellowstone Lake shoreline inventory between Solution Creek to the Southeast Arm in 2006 that recorded 156 sites (Vivian et al. 2007.)

In 2007, a 490-acre block archeological inventory of the Old Faithful developed area was conducted by the OWSA (Sanders et al. 2008.) A 130 acre block inventory surrounding the Lake developed area was conducted by the OWSA, filling in the areas not survey in the small projects of the last 20 years (Sanders et al. 2009.) The University of Montana archeological crew filled in the gaps in archeological survey in the northwest shoreline of Yellowstone Lake (MacDonald and Livers 2011) and also filled in the gaps of the Bridge Bay-Lake-Fishing Bridge block survey for the parks comprehensive planning program. This survey work included survey of the Fishing Bridge recreational vehicle park and survey for Fishing Bridge developed area utility upgrades (Livers et al. 2010; Livers and MacDonald 2011) During the summer of 2010 the University of Montana closed the approximately 24 mile wide gap of un-surveyed shoreline.
along the eastern shore of Yellowstone Lake from the northern bank of the Yellowstone River Delta to the parking lot located off the East Entrance Road below the Lake Butte lookout as the roads heads east out of the park (Livers and Hare 2011). The University of Montana archeological crew has been working to complete survey and National Register testing on the remaining sites on the south portion of Yellowstone Lake shores. Work on this project continued in field season 2012 and it is hoped that the 2013 field work will complete the recording and National Register testing of the lake shore sites. Efforts to document the Nez Perce Trail through YNP were conducted in 2007, 2008, and 2009 by the OWSA, some of which was in the south end of the park (Eakin 2009; 2010; 2011). Much of the southern park remains without archeological survey but the work to date gives a great amount of information with which to develop a culture history of the southern portion of Yellowstone National Park.

Prehistoric Culture History of Southern Yellowstone

In order to provide a context for the description of archaeological findings, we provide a brief summary of the prehistory of the area. Few of the prehistoric archeological sites investigated in the 1950s through the 1990s have been radiocarbon dated (Cannon et al. 1996). Without corroborating absolute dates, archaeologists must rely on point technology phases as well as important stratified sites in the area like Mummy Cave (40km east of Yellowstone Lake) and Medicine Lodge Creek (80km northwest of Yellowstone Lake) (Cannon et al. 1996). Following Frison (1991) and Hale (2003), we organize the following culture history into six chronological periods (uncalibrated radiocarbon years BP), including: Paleoinian (11,000 to 8,000 BP); Early Plains Archaic (8,000 to 5,000 BP); Middle Plains Archaic (5,000 to 3,000 BP); Late Plains Archaic (3,000 to 1,500 BP); Late Prehistoric (1,500 to 300 BP); Contact and Historic Period (300 years ago to 150 BP). Without these classifications, it would be very difficult for archaeologists to establish a context of significance for Early to Late Archaic use of upland areas in the Greater Yellowstone Area (GYA) (Cannon et al. 1996) as little evidence has been documented.

The Upper Yellowstone River Valley, created by the Yellowstone River as it flows into to the park from Wyoming to the south, through the park and exits the park to the north flowing through Paradise Valley, was in constant use over thousands of years by hunter-gatherer populations from all over the northern Rockies and northern Plains. The Yellowstone River—both its southern and northern branches provide a natural corridor or conduit for the migration of animals and people following resources along the valley (Davis et al. 1995; Hale 2003). Native Americans traveling from the Snake River Plain to the southern Yellowstone River arrived at Yellowstone Lake’s southern shore, while those traveling southward along the upper Yellowstone River from Montana arrived at its northern shore (Park 2010.) The continued use of similar landforms, or the same landforms, by prehistoric groups, especially in the intermountain regions around YNP is well documented in archaeological research. High altitude upland valleys and foothills in the Greater Yellowstone region show a continued occupation by hunter-gatherer populations throughout the last 10,000 BP (Baumler et al. 1996; Bender and Wright 1988; Frison 1976; Kornfeld et al. 2001; Meltzer 1999; Reeves 1973; Shortt 1999a, 1999b; Smith and McNees 1999). Sites like Osprey Beach (Shortt and Davis 2002; Johnson et al, 2004), Fishing Bridge (Reeve 1989), and the Donner Site (Vivian et al. 2007a) detail the continued use of the upland areas of the park since at least 9,000 BP. Through absolute and relative dating techniques, these intermountain areas have proven to be habitable living locations for these groups for thousands of years. Knowledge of continued land use is important in order to understand settlement patterns of prehistoric populations in intermountain regions over time; however, understanding the use of the upland regions of the park by the same cultural groups living on the Plains comes with its challenges.
A majority of the archaeological sites in the park consist of ephemeral or short-term camps used for lithic reduction activities or hunting. The remains of these open-air campsites consist mainly of lithic debitage scattered over a utilized area with possible features such as hearths or boiling pits. Archaeology surveys along the
first 10 miles of the Yellowstone River north of Fishing Bridge resulted in almost 100 of these ephemeral lithic scatter sites (Reeves 2006; Sanders et al. 1996; Shortt 1999c). More than 280 lithic scatters or “chipping stations” have been documented around Yellowstone Lake with the highest concentration occurring between the Fishing Bridge peninsula heading south along the western shore to the Bridge Bay area (Cannon 1990). Additional lithic scatters have been identified sporadically along the East Entrance Road and on the east shore of the Lake (Cannon 1990). Survey along the southern shoreline of Yellowstone Lake has resulted in another 80 or more lithic scatters (Vivian et al. 2007a), adding even more evidence to support the extended use of Yellowstone Park during prehistory. On-going National Register inventory and testing of archeological sites along all of the shoreline of Yellowstone Lake by the University of Montana has provided a great deal of additional information about hunter-gatherer use of the resources and landscape of southern Yellowstone. (Livers and MacDonald 2010; Livers and MacDonald 2011; MacDonald and Livers 2011; Livers and Hare 2012; MacDonald et al. 2012; this volume).

Paleoindian (12,000 to 8,000 BP)

The early prehistory of Yellowstone National Park is a period of human colonization of a previously uninhabited landscape due to glaciations. The earliest known occupation in the Yellowstone region is the Clovis culture, radiocarbon dated from 11,500 to 10,900 BP. Clovis hunters utilized projectile points that are long, finely crafted lanceolates with retouched edges and a flat, or slightly concave or convex proximal end that is sometimes rounded. Fluting at the proximal ends is another characteristic of the Clovis Complex projectile points. Percussion flaking initiated at one margin and terminating at the opposite margin is characteristic of Clovis and can be seen in both their biface preforms as well as their projectile points.

The Clovis people would have been the first groups to traverse Yellowstone country, hunting all available game. Few Clovis points have been recovered within park boundaries. The 2007 MYAP team recovered a Clovis point fragment from the ground surface approximately one mile north of Airport Rings (48YE357) along the Yellowstone River (Maas and MacDonald 2009). However, the point was likely secondarily deposited at the site, either from upland slopes or by later site occupants via recycling. The second-most proximate Clovis point recovered was from the construction of the Gardiner Post Office (Janetski 2002). Approximately 100 miles north of the project area, the Anzick Clovis Cache yielded a wealth of data regarding Clovis burial and cache behavior in the northern Plains (Lahren 2006).

As with Clovis, the Folsom complex is rare in YNP and this portion of the Yellowstone River basin. The Folsom cultural complex dates to approximately 10,800 to 10,300 BP, and the culture is characterized by a subsistence pattern oriented toward bison hunting (MacDonald 1999, 2009; Hill 2007). A Folsom point found in the Bridger-Teton National Forest south of Yellowstone was sourced to Obsidian Cliff, indicating that Folsom individuals clearly entered the park to collect stone as early as 10,900 BP (Cannon et al. 1997; Frison 1991). An unfluted Folsom or Plainview point, geochemically similar to stone from Obsidian Cliff, was recovered during archaeological excavation on the shores of Yellowstone Lake (Hughes 2003a, b). Also, as presented by Hale at the 62 Plains Anthropological Conference, Billings, Montana in 2004, two fluted point bases—possibly Clovis or Folsom—have been sourced to Obsidian Cliff, implying use of the Greater Yellowstone Ecosystem during the Early Paleoindian period.

When looking at the range of Paleoindian artifacts recovered from the West Thumb area of Yellowstone Lake it is not surprising that 80% of the sourced obsidian artifacts came from Obsidian Cliff. A Pleistocene paleontology and prehistoric archeology site in the Centennial Valley of Northwest Montana, the Merrell Locality near Lima Reservoir investigated by Montana State University and the Bureau of Land Management in 1983, recovered obsidian flakes sourced to both Bear Gulch and Obsidian Cliff possibly in association with Pleistocene fauna (Hill and Davis 2005). This information provides additional evidence of the invested use of Yellowstone Park and its resources by Paleoindian groups throughout the Paleoindian period; occupational use that most people tend to dismiss due to the small number of Paleoindian artifacts. Not only were these Paleoindian groups investing time in obtaining obsidian from the park, it is evident from the point found in the Boundary Lands (Maas and MacDonald 2009) that groups were
using the raw material chert source from the Crescent Hill formation as early as the Paleindian Period.

The Goshen/Plainview complex has been documented at the Mill Iron site on the Northern Plains in Montana (Frison 1996) and dates around 10,500 to 11,000 BP. It was rumored that a Goshen point base was recovered along the south shore of the West Thumb of Yellowstone Lake but no record of that find currently exists. The initial inventory of sites on the Southeast Arm of Yellowstone Lake (Vivian et al. 2007) recovered a complete and a basal portion Goshen points on the surface of the shore. However, recent work in the findspot by UM did not confirm the presence of a Goshen site, unfortunately (MacDonald, pers.comm. 2012).

Folsom culture persisted in the Greater Yellowstone Area and the Great Plains until approximately 10,200 BP. At that time, archaeological data indicate that individuals ceased to use Folsom points, in favor of Agate Basin and Hell Gap stemmed lanceolate points and, subsequently, a variety of other unfluted point types. Although the location where the artifact was found is unknown, the oldest recognized projectile point collected from the interior of YNP by Supt. Norris in the late 1880s was described as Agate Basin like (Sanders 2006). It has been dated in other areas outside of the park at 10,500-10,000 BP (Taylor et al. 1964; Cannon and Hughes 1993). Taylor identified two Agate Basin points found in the Mammoth Museum prior to the Montana State University 1958-59 survey (Taylor et al. 1964). One Agate Basin point was collected from Alum Creek, a drainage of the Yellowstone River in the Hayden Valley and the other from Fishing Bridge at the outlet of Yellowstone Lake. Taylor (1964) recovered two additional Agate Basin like projectile points from pedestrian inventory from the shores of Yellowstone Lake between Fishing Bridge and Pumice Point. Later, in the 1990s Cannon collected an Agate Basin style point in the Fishing Bridge area (Cannon et al. 1994) that sourced to Obsidian Cliff. Agate Basin projectile points are elongated lanceolates with narrow, tapered bases and straight-convex blades.

Hell Gap points are similar, and are described as distinctively shouldered with a broad point which tapers to a straight or slightly concave base with medial flaking pattern that result in a lenticular cross section (Hofman and Graham 1998.) The 1958-59 survey recovered four Hell Gap points from the surface; three from sites along the shores of Yellowstone Lake and one on the banks of the Yellowstone River near Cascade Creek. Records of two additional Hell Gap points previously collected and curated in the Mammoth Museum indicate one point was found at the mouth of Bridge Creek on Yellowstone Lake (Taylor et al. 1964.)

Cody sites generally are associated with bison hunting, although blood residue analysis of Osprey Beach, the park’s most significant Cody site, did not indicate bison hunting and clearly represented a longer term camp where curation of tools and other domestic activities were taking place, rather than the very ephemeral hunting locals. Diagnostic projectile points associated with the Cody Complex are stemmed lanceolate projectile points, including Alberta, Eden, and Scottsbluff varieties. Each of these point styles is a cultural descendent of Agate Basin/Hell Gap style points, as represented by the fine bifacial flaking and use of high quality lithic materials in their manufacture (Kornfeld et al. 2009: 88, 493). Another diagnostic tool of Cody Complex sites is a beveled cutting tool called a Cody Knife, one of the most interesting knife forms in the prehistory of the Plains. The Cody knife is essentially a Scottsbluff/Alberta projectile point re-sharpened to an asymmetrical blade, useful in bison processing and other cutting activities (Frison and Todd 1987; Agenbroad 1978).

The 1958-59 inventory work recovered a Cody knife from the south shore of the West Thumb portion of the lake. 1989 excavations on the Fishing Bridge peninsula (Reeve 1989) recovered a Cody Complex lanceolate (Scottsbluff) projectile point. In support of the reconstruction of the East Entrance road, the Midwest Archeological Center recovered three Cody Complex tools from the Fishing Bridge area in 1992, including a Cody knife and portions of two stemmed projectile points. Blood residue analysis on one of the points indicated to Cannon et al. (1994) the tool was in contact with rabbit.

The 2000 Wichita State University surface reconnaissance of beachfront on the south shore of West Thumb produced two Cody knives, and diagnostic portions of Eden and Scottsbluff projectile points. Analysis indicated that some of the obsidian tools came from the park’s Obsidian Cliff and from Bear Gulch, Idaho. Shortt and Davis (2002) analysis of the artifacts
indicate that tools such as hide abraders, perforators, gravers, and choppers suggest domestic activity and tools such as shaft abraders indicate preparation of hunting tools. The blood residue analysis of the tools indicates contact with rabbit, dog (wolf, coyote, or fox), deer and sheep. Charcoal from the site provided a 9,360 BP date for the camp (Johnson et al. 2004). Other articles in this volume will provide more information on the Cody Complex in the southern portion of the park.

The Terminal Paleoindian Period, commonly termed regionally as the Foothill-Mountain Late Paleoindian Tradition (Frison 1991) produced diagnostic projectile points in the Pryor Stemmed, Lovell Constricted, and Foothill-Mountain Traditions. These types of projectile points have been recovered on the south end of the Yellowstone River and the north and south shores of Yellowstone Lake. Taylor et al. (1964) recovered a Lovell Constricted point from the lake shore Cannon et al. (1997) excavated a site along the northeast shore of Yellowstone Lake, the Steamboat Point site, and recovered a Lovell Constricted point. Cannon (1997) also recovered a Mountain-Foothill lanceolate from the Fishing Bridge area on the north of the lake. Sanders (2001) recovered a “fishtail” point similar to those oldest occupations of Mummy Cave at a site on the southern banks of the Yellowstone River before the outlet at the north end of Yellowstone Lake.

The record of Paleoindian occupation in the southern portion of the park remains limited, but the existing data points to a diverse subsistence pattern between approximately 11,000 and 8,000 BP.

The Plains Archaic or Holocene Period (8,000 to 1,500 BP)

By the end of the Paleoindian period—approximately 8,000 years ago—Plains Native Americans embraced a diverse subsistence pattern and used the atlatl in hunting. A variety of notched projectile points dominate lithic artifact assemblages from all three sub-divisions of the Archaic, including:

1) Early Archaic—8,000 to 5,000 BP
2) Middle Archaic—5,000 to 3,000 BP
3) Late Archaic—3,000 to 1,500 BP

The Archaic period is characterized by a decline in bison use during the Early Archaic, an increase by the end of the Middle portion, and a dramatic increase during the Late Archaic portion. This change over time largely is due to dramatic environmental shifts over the course of the Archaic period. A period of increased aridity and warm weather around 8,000 BP, indicated by warm weather adapted plants, marked the beginning of a period known regionally as the Altithermal. Pollen sites in the southern half of the park suggest maximum dryness after 7,000 BP with Yellowstone’s modern climate developing around 1,500 BP (Whitlock 1993). Projectile point technology changed over time, with the use of large side-notched points in the Early Archaic, bifurcated points during the Middle Archaic, and smaller side- and corner-notched points in the Late Archaic.

Early Plains Archaic (Early Holocene) (8,000 to 5,000 BP)

At the same time as the warm, dry conditions of the Altithermal developed, the Paleoindian stemmed and lanceolate projectile points decreased in frequency and the use of large side notched points increased. These are named Pahaska and Blackwater Side Notched and were identified in Mummy Cave, Hawken Side-Notched points found in Wyoming sites, and Elko-Bitterroot Side-Notched points found to the west. Early Plains Archaic side-notched projectile points are distinctive but Early Plains Archaic corner-notched points possess similarities to Middle Archaic corner-notched points. Projectile points from the Early Plains Archaic are diversified, with attributes not clearly defined, leading to misidentification of these early points as Late Archaic points (Buchner 1980; Frison, Schwab et al. 1996; Gryba 1980; Larson 1997; Reeves 1973; Roll and Hackenberger 1998).

One of the hallmark characteristics of the Early Archaic period is a lack of well-excavated archaeological sites and an apparent decline in human population. Early Archaic sites are as rare as Paleoindian sites and are also less visible, possibly due to a decreased reliance on bison hunting. This decreased role of bison hunting was largely due to the decreasing herd populations as a result of the emerging Altithermal climatic period (Antevs 1953; Wolfe et al. 2006). The Altithermal period is characterized by comparatively hot and dry climate, resulting in decreased forage for bison. Bison teeth that date to the Early Archaic period are badly worn, suggesting more dry grass and grit in their forage.

Surface water was likely reduced during this time and...
springs and summers were likely much warmer than during the previous Late Paleoindian period. Regionally, people seem to increase their dependence on plant foods and small game such as marmots, grouse, and rabbit; they used more local stone sources for tool manufacture and there is a noticeable decline in the quality of lithic technology, as documented in Mummy Cave (Frison and Mainfort 1996; Larson 1997).

Early Plains Archaic (or Early Holocene) sites have been recorded on the north shore of Yellowstone Lake, along the West Thumb area, on the shoreline of the Southeast Arm of Yellowstone Lake and along the Yellowstone River. Cannon et al. (1996) recorded a site with an Early Archaic component near West Thumb, recovering Pahaska Side Notched points from buried levels dating around 6,780 years before present. Analysis of the obsidian indicated Obsidian Cliff as the source and blood residue analysis suggesting contact with sheep (Cannon and Hale, this volume).

Excavations at the multiple component Donner site, discussed in another chapter of this volume, recovered two Early Archaic Bitterroot Side-notched points. The Breeze Point Site (48YE1645), another lithic scatter recorded by Vivian et al. (2007a) along the southern shore of Yellowstone Lake, also contained an Early Archaic element. Two Salmon River Side-Notched points typologically dated at many sites in Idaho to 7,750-4,500 BP were recorded at the site. This site contained heat-treated chert flakes, suggesting possible tool manufacturing at the site. A biface tip was sourced to the Packsaddle Creek obsidian source, 100km to the southwest of Yellowstone Lake in Eastern Idaho, providing information pertaining to prehistoric mobility patterns during the Early Archaic Period.

One final Early Archaic site important to discuss is the Fishing Bridge Point Site (48YE381) located southwest of the Fishing Bridge area (MacDonald, this volume). This site was the first and only excavated site in Yellowstone Park to provide an Early Archaic occupation date based on a radiocarbon sample date from a buried hearth feature. Site 48YE381 was formally excavated during the summers of 2009 and 2010, providing excellent depositional stratigraphy from which to examine distinct episodes of prehistoric occupation along Yellowstone Lake from the Early Archaic through Late Prehistoric Period.

Middle Plains Archaic (Middle Holocene) (5,000 to 3,000 BP)

The Middle Plains Archaic period is best characterized as a time of transition, by more varieties of projectile points on the Northwestern Plains, including several with bifurcated bases such as Oxbow, McKean, and Mallory points, and other slightly later varieties without bifurcated bases such as Duncan and Hanna. It appears the large, side-notched projectile points from the Early Plains Archaic period disappeared or were replaced by smaller, distinctive Oxbow points. Mainly a Northern Plains manifestation, Oxbow points are found in Southern Montana and Northern Wyoming and, although short-lived, may form a temporal bridge between the Early and Middle Archaic periods (Frison, Toom, et al. 1996). The McKean Complex is usually identified by the presence of several types of projectile points such as the indented base McKean lanceolates; side-notched Hanna points with straight-to-concave lateral margins; Duncan points with convex margins, expanded stems and notched bases, and Mallory points with a deep, narrow side notches about 1/3 of the distance from the base to the tip (Kornfield 1998).

Variations in a number of other categories such as technology, social and economic organization, as well as settlement strategies during this period should be expected due to the nature of short term and long-term changes (Hofman 1997). These seasonal and yearly changes likely affected where different cultural groups lived, the boundary of the territories they exploited, the duration of their occupations, as well as the extent of their social networks. Rock filled fire (roasting) pits, sandstone grinding tools, beveled edge side-notched knives, and concentrations of stone circles are cultural hallmarks of the Middle Archaic (Holocene) (Frison 1991).

Five thousand years ago, because the intensity of summer solar radiation was decreasing, the climate returned to conditions similar to those of the present marking the end of a 3,000 to 4,000 year hot, dry spell, although Yellowstone was still subject to occasional drought cycles (Whitlock and Bartlein 1991). Shrubs, herbs, and grasses also increase their proportions and distributions. This climate change coincides with the re-emergence of substantial bison herds and Native Americans began to transition back to bison hunting –
although not just bison hunting. Faunal remains found in archeological context on the shores of Yellowstone Lake are identifiable mainly though analysis of blood residues remaining on stone tools. Although providing only a broad range of possible association, blood residue yielded positive results for deer (deer, elk, moose, and pronghorn), rabbit (rabbit, hare, and pika), dog (coyote, wolf, fox and dog), bear (black and grizzly), sheep (goats and sheep), cat (bobcat, lynx, and mountain lion) and bovine (bison) (Cannon 1996; Shortt and Davis 2002).

Although it is not known how many, Superintendent Norris collected McKean complex projectile points from the park in the late 1880s and added several Duncan and Hanna points to the museum collection (Sanders 2006). Taylor et al. (1964) recovered Duncan and Hanna type points from both the Yellowstone River and Yellowstone Lake and a Mallory point from the Alum Creek area of the Yellowstone River.

Also in southern Yellowstone, obsidian Oxbow points have been recovered eroding out of the banks of the Yellowstone River (Marceau and Reeve 1984) and from excavations on the north end of Yellowstone Lake where a basalt Oxbow point tested positive for deer anti-sera (Cannon et al. 1994). Middle Archaic radiocarbon dates have been recovered from the Arnica Creek Site along the West Thumb (Cannon et al. 1996) and the Chittenden Bridge site (48YE516) on the Yellowstone River approximately 12 miles northwest of Fishing Bridge (Cannon et al. 1994). The 1962 collection of artifacts from the Schaller site on the Southeast Arm of Yellowstone Lake recovered a chert Oxbow point, three obsidian McKean lanceolate points, and one obsidian and one chert Hanna stemmed points.

The Arnica Creek, or First Blood site, yielded Oxbow or Elko Eared points as well as McKean points and radiocarbon dates around 4,500 BP. One Middle Archaic obsidian point was sourced to Bear Gulch, Idaho. Nearby, the Teton View site provided a radiocarbon date calibrated to 4,157 BP. Other Middle Archaic sites around Yellowstone Lake include the Donner Site and the Linden Site. Prior to Vivian et al.’s (2007a) collection of eight McKean phase projectile points, similar artifacts were recovered by park archaeologists between 2000 and 2006. McKean points were sourced to Teton Pass, Cougar Creek, Park Point, Packsaddle Creek and Bear Gulch in Idaho. The Linden Site (48YE1703), located on the west side of the south arm, was recorded as a domestic activity site due to the presence domestic artifacts like knives, unifaces, and scrapers (Vivian et al. 2007a). Three McKean points sourced to Teton Pass were collected from the site.

Recent archeological study of the complex and diversified use of the Yellowstone Lake landscapes and resources, as described in this volume, have increased our understanding of Middle Archaic hunter-gatherer use of southern Yellowstone.

Late Plains Archaic (Late Holocene) (3,000 to 1,500 BP)

Native Americans across Montana, southern Alberta/Saskatchewan, the Dakotas, and Wyoming once again focused upon bison as the focal point of their subsistence patterns. This period marks the emergence of the classic Plains Bison Hunting Culture, including the use of buffalo jumps and corrals that dominate the archaeology of the region. The Late Archaic period also witnessed the first use of pottery, the widespread use of tepees, trade of obsidian and Knife River flint across the U.S., and perhaps the last use of the atlatl as the weapon of choice for natives utilizing YNP and the Northern Plains.

Bison was a commodity across the Plains and Native Americans actively traded bison meat, hides, and tools with neighboring groups which were unable to regularly hunt bison. In addition to bison products, Plains Native Americans traded a variety of other goods during the Late Archaic period. In particular, Knife River flint from North Dakota and obsidian from Yellowstone National Park’s Obsidian Cliff have been traced to Middle Woodland-period archaeological sites—especially those of the Hopewell culture—in Ohio, Pennsylvania, and Michigan, among other states, during the Late Plains Archaic (Davis et al. 1995; DeBoer 2004.)

One Hopewell site in Ohio yielded over 10,000 pieces of Obsidian Cliff obsidian and an Illinois site of the same time period yielded one Obsidian Cliff obsidian core weighing over 10 kg (over 22.05 lbs.) While most of these goods are thought to have been transported indirectly via down-the-line trade from the Plains and Rocky Mountains to the Midwest and eastern United States, DeBoer (2004) proposes that some individuals within the Scioto River Hopewell culture of Ohio actively
travelled to Montana and Wyoming to obtain rare goods for use in ceremonies. Such goods include obsidian, Knife River flint, bison, as well as big horn sheep horns, among other unique Plains and Rocky Mountain items. Close to a hundred archaeological sites within the Mississippi, Ohio, and Missouri River Valleys, among others, contains obsidian from Wyoming—specifically Obsidian Cliff, Bear Gulch, and Teton Pass, all in close proximity in Idaho, and Wyoming (DeBoer 2004; Davis et al. 1995). Recent archeological investigations along the northwest shore of Yellowstone Lake yielded a large biface whose measurements only fit within Hopewell point typologies (MacDonald and Livers 2010.)

Late Plains Archaic Native Americans used three varieties of side- and corner-notched points: Pelican Lake points which date to around 3,000 to 1,500 BP (Davis 1998), Yonkee points whose use has been dated to 3,000 to 2,500 BP (Roll, 1998, and Besant points dating from 2,000 to 1,300 BP (Forbis 1998.) Pelican Lake projectile points are deeply corner-notched (creating sharp barbs on the corners) with straight blades and straight bases. The blade is triangular-shaped and the finely-made notches are u-shaped. Pelican Lake projectile points were well manufactured especially compared to their later Besant counterparts. Blades on some Pelican Lake points may be serrated, but most are not. There is noticeable variation in sizes for Pelican Lake points which range from 20-50 mm long, 15-35 mm wide, and 3-8 mm thick (Dyke and Morlan 2001.) Although the Pelican Lake style is more prevalent than Yonkee and Besant in the Yellowstone archaeological record, all three styles have been recovered from sites along the Upper and Lower Yellowstone River, at sites all around Yellowstone Lake, as well as along many other tributaries and drainages in the area.

As defined by Zeier (1983), Besant projectile points have triangular to lanceolate blades with straight-to-convex blade shapes. Their maximum width is at the shoulders, with simply-produced, u-shaped side-notches. The point base is concave to straight, but is occasionally convex. As defined from an assemblage of some 280 Besant projectile points from the Antonson site near Bozeman (Zeier 1983), typical Besant points measure 20-75 mm long (mean 25-40 mm), 9-26 mm wide (mean 16-20 mm), and 2.6-9.0 mm thick (mean 4.3-6.0 mm). The Besant point has been characterized by Zeier (1983:2) as the “last atlatl dart point.” After use of the Besant point, at approximately 1,500 BP, Native Americans quickly adopted bow-and-arrow technology, resulting in the demise of these Pelican Lake and Besant points.

Pelican Lake points have been recovered on the ground surface and from excavations in many areas, constituting a majority of Yellowstone’s Late Archaic sites as well as artifacts (Johnson 2002, Hale 2003). The Schaller site on the southeast shore of Yellowstone Lake yielded one complete Yonkee point and one Pelican Lake point. According to Cannon et al. (1994), a peak in prehistoric usage occurred around the end of the Late Archaic Period. Similar data are presented in the current volume in chapters by Sanders and MacDonald. Shortt & Davis (2002) touches on the fact that blood residue results for Late Archaic artifacts vary across the park, while Cannon et al. (1996) found variation in the record of Late Archaic subsistence patterns, ranging from big game hunting to prickly pear cactus roasting. Late Archaic projectile points from the First Blood site (48YE449/457) tested positive for sheep and canid blood residue while a Late Archaic point from 48YE652 tested positive to rabbit antiserum (Cannon et al. 1996). Both sites are located on the West Thumb of Yellowstone Lake.

Sanders (2001a; this volume) notes the increased use of the Hayden Valley during the Late Archaic and into the Late Prehistoric Periods. Cannon et al. (1994) summarize the evidence for the increased use of Yellowstone by Late Archaic groups. Late Archaic and Late Prehistoric projectile points account for over 50% of the Fishing Bridge artifact assemblage recovered between 1990 and 1994. At least three Late Archaic artifacts tested positive for blood residue. The points include a terminal Late Archaic point similar to the Avonlea style, testing positive for to deer anti-sera, an un-typed Late Archaic corner-notched point which tested positive for bear anti-sera, and a retouched flake from shallow deposits which tested positive for canid anti-sera, representing any member of the family, including coyote, fox, wolf, or dog (Cannon et al. 1994: 135).

More information concerning the Late Archaic (or Late Holocene) culture period can be found in the articles featured in this volume. Although the extent of the use of the parks’ southern landscapes during the Late Archaic has not been investigated to the depth needed, we do
have a beginning for the development of history of this culture period.

**Late Prehistoric (1,500 to 300 BP)**

In addition to heightened organizational complexity, the Late Prehistoric period witnessed another first—the introduction of the bow and arrow—which facilitated the increased hunting of bison. This innovative technology allowed for the use of smaller projectile points that were more easily produced in bulk and did not necessarily require the best lithic raw material. This was particularly useful for bison hunters forcing hundreds of animals over bison jumps and for hunters who travelled frequently away from sources of high quality lithic material in pursuit of bison herds. The small stature of the arrow points allowed for use of more local lithic materials of variable quality. The bow and arrow also allowed for improved hunting of other fauna because it allowed for clandestine firing behind protective cover. The Archaic-period atlatl required firing from a standing position, effectively forcing the hunter to reveal him or herself during the attack; the bow and arrow allowed for more discrete assault techniques (MacDonald 2012).

Many of the hallmarks of the Late Holocene, such as side-notched arrow points, pottery, and wider use of plants and animal resources are found in the southern portion of the park. However, many other hallmarks of the period, such as bison drives and jumps, sheep and pronghorn traps, aggregations of domestic stone circles, winter habitation sites, horticulture evidence by bison scapula hoes, rock art, medicine wheels, and variations in pottery styles (Frison et al. 1996) have yet to be found in YNP (Hale 2003).

The use of slab-lined food preparation pits for processing both plants and animal food increased during the Late Prehistoric (Conner 1989), with evidence of plants, seeds, and bone grease processing taking place in the slab lined pits. Deer, bison, and dog protein residues, as well as plant pollens identified on ground stone artifacts recovered from a Yellowstone Lake site in association with a radiocarbon date of 1,250 years before present, may indicate the production of pemmican, a dried mixture of plant and animal products (Cannon, et al. 1997) Stone lined roasting pits and ground stone tools became more prevalent in archeological sites along the Yellowstone River and on Yellowstone Lake during this time period, as the further discussed in this volume.

It is generally accepted that the first appearances of Avonlea projectile points mark the boundary between the Late Archaic and the Late Prehistoric periods. The earliest dates for the transition from atlatl to bow and arrow are around 1,800 BP lasting until around 800 BP in southwestern Montana (within the Greater Yellowstone Area) (Foor 1988). The Avonlea people were semi-nomadic hunters and gatherers and although largely dependent on bison, the highly organized Avonlea peoples employed a variety of adaptive strategies using various foods to sustain themselves in the harsh Northern Plains environment (Davis and Fisher 1988; Dyck and Morlan 2001; Frison, Schwab, et al. 1996.) The Avonlea archeological entity is considered to be widespread and relatively long-lived (Davis and Fisher 1988.)

The most clearly diagnostic attribute of all varieties of Late Prehistoric arrow points is their significantly smaller size compared than their Late Archaic counterparts. Late Prehistoric arrow points are, on average, half the size and sometimes a quarter of the size of an Archaic atlatl point. Some Late Prehistoric points are the size of a fingernail as evident from the photo. With the exception of the Avonlea style of arrow point, Late Prehistoric arrow points generally are not as finely manufactured as their atlatl counterparts and were frequently produced using low to medium grade material.

Between approximately 1,200 and 300 BP, the predominant style of point is called the Late Prehistoric Side-notched point, or LPSN. While Kehoe (1960) describes a large variety of these arrow points, the overall form of the arrow points is similar, with diversity coming in notching, blade and base shape. The typical LPSN point has shallow side notches and a straight base. Arrow point blades are typically straight to slightly convex with a triangular shape. Just before the contact period, approximately 500 BP, and some Late Prehistoric hunters added a third notch to the bases of their projectile points; these arrow points are sometimes referred to as Late Prehistoric tri-notch (LPTN) points.

Rose Springs arrow points are commonly associated with Late Prehistoric archeological sites in the Great Basin (Aikens and Madsen 1986). Rose Springs point types are also found in the Eastern Plateau culture region where excavations at an Idaho bison jump and another
bison kill site recovered Rose Springs arrow points sourced to Obsidian Cliff (Roll and Hackenberger 1998). A multiple component site on the south shore of Yellowstone Lake produced a Rose Springs-like point (Shortt & Davis 2002) and serrated obsidian Rose Springs points were recovered from excavations on the north shores of Yellowstone Lake (Cannon, et al. 1997). Small Rose Springs-like points were recovered from excavations in the West Thumb area in association with Intermountain pottery and radiocarbon dates between 1,350-1,500 BP (Cannon 1996.)

The Old Women’s Phase is understood to begin about 1,000 years ago and extended past the end of the Late Prehistoric and the people associated with the small side-notched arrow points are generally recognized as specialized bison hunters. These points are present in the Yellowstone River Corridor and on the shores of Yellowstone Lake in the same archeological context as Avonlea and Rose Springs arrow points. Taylor et al. (1964), Samuelson (1983) and Cannon (1990; 1996) collected the small corner-notched points from various location on the shores of Yellowstone Lake. Yellowstone River sites have also yielded small side-notched points from the surface (Shortt 1998, 1999a, 199b; Shortt and Davis 2002) and subsurface excavations (Sanders 2000) and in association with radiocarbon dates (Marceau and Reeve 1984; Sanders 2001a)

While pottery has been recovered from at least a dozen sites in the valleys along the Upper Yellowstone River (Arthur 1966), pottery inside the boundaries and at higher elevations within the park remains extremely rare. The only officially recorded Intermountain pottery occurring in the southern portion of the park is from the First Blood Site, surveyed in the late 1950s during Hoffman’s initial survey of Yellowstone archaeological potential. Hoffman (1961) recovered 33 sherds, including six rim and three flanged base fragments. The sherd thickness was similar to the other Intermountain Ware recorded north of the park in the Upper Yellowstone River Valley. Other pottery sherds have been recovered at a site in the northern portion of the park along the Yellowstone River.

Rock filled roasting pits, a grinding stone (mano) and grass and sunflower seeds recovered from a radiocarbon dated (1070 years ago) Late Prehistoric sites along the Yellowstone River corridor in Hayden Valley indicate use of plant resources and associated diagnostic projectile points indicate hunting of animals (Sanders 2000, 2001a). Projectile point sourcing from one site has also provided data on raw material acquisition from the Bear Gulch and Packsaddle Creek obsidian sources in Idaho, as well as the local Obsidian Cliff source.

The Historic Period (300 to 150 BP)

The end of the prehistoric cultural history in southern Yellowstone is marked by contact with Euro Americans, trade goods, horses, guns, and a multitude of written records. The first Euro Americans to enter southern Yellowstone were undoubtedly early fur traders although exactly who is debatable. We do know that John Colter passed through Yellowstone in 1807, after being engaged in the Lewis and Clark expedition from 1804-06. Colter was in the employ of a trapper/trader named Manual Lisa under instructions to contact surrounding bands of Indians about Lisa’s new trading post. Colter passed through the park many times during his employ with Lisa and on one occasion was captured by Indians (Colter thought they were Blackfeet, Chittenden thought they were Gros Ventres, and another fur trade historian, James, thought they were Flatheads and Crows) north of the park, who chased him relentlessly, Colter finally escaping under a log jam in a river (Chittenden 1986).

The first printed account of the “Yellowstone Wonderland” was from a member of Jedediah Smith’s California party published in the Philadelphia Gazette in 1827, titled “From the West”. It says, “that of the Yellow Stone has a large fresh water lake near its head on the very top of the mountain, which is about one hundred by forty miles in diameter an as clear as a crystal.” In 1829 a 19 year old trapper named Meek got lost from the party with which he was traveling and wandered through the hot springs country just east of the Yellowstone River before being found. In the spring of 1834, W. A. Ferris, a member of the American Fur Company traveled to Yellowstone’s Upper Geyser Basin and published an account of his visit in the Western Literary Messenger in Buffalo, New York (Chittenden 1986).

Osborne Russell, in his autobiographical Journal of a Trapper (1834-1843) describes numerous travels through Yellowstone where he encountered friendly Shoshone and Flathead Indians, not so friendly Blackfeet who attacked Russell’s party east of Pelican Creek in 1838 and
again when they were camped on Yellowstone Lake in 1840. In fact Russell records eight battles with the Blackfeet both in and out of the park (Haines 1965). In association with Yellowstone Park, Russell notes the presence of Flathead, Crow, Bannock, Shoshone, Grosventre, Sheepeaters, Snake (both referring to Shoshone and Sioux) and Pagan (cf. Piegan), Blood and Blackfeet Indians having a presence in the park during his 1834 through 1843 years as a trapper (Haines 1965). Little evidence of these more recent, contact period habitations have been documented in the south of the park although recent effort to locate remnants of the 1877 Nez Perce flight through the park have heightened our awareness of the possibility of contact period archeological sites, as will be discussed in this volume.

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National Park Service, Branch of Cultural Resources,
Yellowstone National Park, Mammoth.


CHAPTER 2
PREHISTORIC LAND-USE PATTERNS WITHIN THE YELLOWSTONE LAKE BASIN AND HAYDEN VALLEY REGION, YELLOWSTONE NATIONAL PARK: A REASSESSMENT

By Paul H. Sanders

Abstract
This article is a re-analysis and reassessment of the prehistoric occupation of Yellowstone Lake area that was originally presented about 10 years ago (Sanders 2002). Archaeological studies of the area are starting to provide a view on the prehistoric life ways of these peoples. This paper summarizes the nature of this prehistoric use, including lithic raw material utilization, stone tool characterization, and food procurement practices in light of new archaeological investigation of the area. Changes in landform evolution during the late Pleistocene and early Holocene and their potential impact on prehistoric groups occupying the area are also discussed. Finally, the question of change versus stability in this prehistoric occupation of the area is addressed.

Introduction
This paper summarizes the archaeological record of the Yellowstone Lake area. Previous researchers have described the prehistoric occupation of Yellowstone National Park as poorly known (National Park Service 1993; Cannon, Crothers, and Pierce 1994; Cannon, Pierce, Stormberg, and MacMillan 1997). This is partially true as there are very few of the stratified, key “type” sites which are necessary for archaeologists intent on building cultural chronologies, or investigate changes in prehistoric life ways through time. The current paper takes into consideration research in the southern portion of Yellowstone prior to 2011; thus, it does not take into full consideration the ongoing studies by the University of Montana at Yellowstone Lake, as presented in this volume and elsewhere.

There are several reasons for the comparatively poor state of archaeological knowledge at Yellowstone. Foremost is the volcanic nature of much of Yellowstone that has resulted in shallow and acidic soils. Both of these conditions adversely affect the preservation of prehistoric occupations. The acidic soils dissolve organic remains, which are most critical if one wants to know what animals prehistoric peoples were eating. This is particularly frustrating, since Yellowstone is the place people from across the world now come to view the wildlife, and the archaeological record is so poor in this respect.

The shallow soils that cover most of the Yellowstone Plateau are easily mixed by rodent burrowing, freeze-thaw cycles, and tree tip-ups, which disrupt the clarity of a buried prehistoric occupation. The volcanic rocks of Yellowstone and other geologic formations also lack caves or rock shelters that could have provided the more ideal locations for the preservation of prehistoric artifacts and organic remains. More recently, the 125 or more years of artifact collecting by tourists and others has depleted the number of diagnostic artifacts that were once present. Wayne Replogle, a Park naturalist who traced the Bannock Indian Trail through northern Yellowstone, noted in his 1956 publication on the trail (1956:71) that he found comparatively few projectile points, but stated that old timers said that they used to be quite common, and that they were also a common souvenir in the early days of the Park. This points to the diminishment of the archaeological resources by the 1950s. So consider the state of affairs 50 years later, when annual Park visitation is in the millions. Despite the efforts of the National Park Service to discourage such activities, unauthorized artifact collection continues.

Another factor is the virtual lack of large scale archaeological excavations within Yellowstone which provide the most detailed information on prehistoric life ways. Most of the archaeological work in Yellowstone has been cultural resource inventories and small scale test excavations. The inventories provide data on surface artifact assemblages and an assessment as to the site’s potential for buried artifactual remains. The test excavations are generally designed for evaluative purposes and typically do not expose enough of a buried cultural level to provide much more than an inkling as to its actual contents. Although some larger scale
excavations have occurred in recent years: Osprey Beach on the West Thumb of Yellowstone Lake (Johnson et al. 2004), Malin Creek site on the Yellowstone River above Gardiner (Vivian et al. 2008), and the Nymph Lake site (Sanders et al. 2011) north of Norris Junction, these are widely distributed across the Park and shed only limited light on the prehistory of the area. As a result of these factors, of the 1500 or so archaeological sites that have been recorded thus far, most provide only a minimal glimpse of the prehistoric occupation of Yellowstone.

As a consequence, researchers have had to borrow cultural chronologies from regions that neighbor Yellowstone. The chronologies developed on the Northwestern Plains by William Mulloy (1958) and later George Frison (1978, 1991) are most often cited. Dr. B. O. K Reeves has also developed a chronology for Yellowstone, but the chronology was never finished (see e.g., Shortt 2001). Briefly the chronological periods utilized in this paper follow Frison (1991) and are listed in uncalibrated radiocarbon years before present (BP): Paleolindian period (ca. 11,500-8000 BP), Early Archaic period (ca. 8000-5000 BP), Middle Archaic period (ca. 5000-3000 BP), Late Archaic period (ca.3000-1500 BP), Late Prehistoric period (ca.1500-500 BP). Much of this chronology is developed around changes through time in the styles of projectile points, as well as past climatic conditions.

It should be noted that, in some ways, the borrowing of chronologies is somewhat appropriate, since it is likely that most if not all of the prehistoric inhabitants probably occupied Yellowstone only on a seasonal basis, moving to the lower elevations outside Yellowstone in the winter. As a result, some of the archaeological remains in the valleys of southwestern Montana, northeastern Idaho, and northwestern Wyoming were likely created by the same peoples that spent the summer months in Yellowstone. Therefore, the styles and ages of the artifacts occurring in these neighboring areas should have associations with those found in Yellowstone.

Obsidian Utilization

The ability to source obsidian through x-ray fluorescence and similar techniques, and its prevalence within the Greater Yellowstone Ecosystem, is perhaps, the one saving grace of Yellowstone archaeology. Obsidian Cliff, located about 20 miles to the northwest of Yellowstone Lake, was a major source of obsidian for prehistoric peoples throughout prehistory. Its occurrence within Hopewell sites in Ohio about 2000 years ago (Griffin et al. 1969; Hatch et al. 1990; Hughes 2006) is one of the more dramatic instances of artifact dispersal within North American prehistory. Recently MacDonald and Livers (2011:146) found a large side-notched artifact at site 48YE1556 that they believe has similarities to Middle Woodland, Hopewell Snyder projectile points. The artifact was identified to Obsidian Cliff and would suggest that Hopewell groups may have visited Yellowstone. Additional analysis and comparison are needed to establish the similarity of this artifact to Snyder points rather than simply a large hafted biface, which are also found in Yellowstone and the Northwestern Plains.

Table 1 lists the results of the obsidian source analyses for the Yellowstone Lake area, while Figure 1 illustrates the locations of the various sources. All of the obsidian source analyses reported in this paper (and this volume, for that matter) were conducted by Dr. Richard Hughes of Geochemical Research Laboratory. Two things are evident in Table 1. First, as to be expected, Obsidian Cliff is the dominant source. The popularity of the Obsidian Cliff source for tools is evident in the huge amounts of debris generated at the source area through its quarrying (Davis et al. 1995). The Hayden Valley/Yellowstone River area, just to the north of Yellowstone Lake, ranges from about 13-24 miles from Obsidian Cliff and, as expected, has the highest percentage (86.4%). However, the North Shore of Yellowstone Lake and West Thumb are both about 25-30 miles from Obsidian Cliff, but West Thumb has only 47.0 percent Obsidian Cliff obsidian compared to the nearly 80 percent for the North Shore sites. The South Shore has even less Obsidian Cliff obsidian—falling to only 18.2 percent, although the sample size is small. Here, the closer Park Point obsidian is more prevalent accounting for 36.4 percent, which would be expected. However, Park Point accounts for only 3.0 percent of the West Thumb obsidian, suggesting it was a minor source overall. Park Point obsidian is occasionally found in other areas of Yellowstone, but here again it suggests limited usage.

Overall the pattern of Obsidian Cliff obsidian suggests that the movement of peoples was through the Hayden...
Valley, and then on toward Yellowstone Lake. Given the lower percentage of Obsidian Cliff obsidian at the West Thumb and South Shore sites suggests that the movement of peoples from the Obsidian Cliff source area was more indirect.

Additional indications of this movement are suggested by the Bear Gulch obsidian percentages, which are the next most common source. Although present in all of the Yellowstone Lake areas, it is most prevalent in the southern areas. The West Thumb sites contained 21.2 percent Bear Gulch obsidian, with other Idaho obsidians adding another 4.5 percent. South Shore contained nearly 10 percent. The Bear Gulch source area is in the Centennial Mountains along the Idaho-Montana border. From the West Thumb area, the Bear Gulch and Teton Pass (in Jackson Hole) sources are both about 60-65 miles away (Figure 1), yet Bear Gulch obsidian is much more common (Table 1).

Figure 1. Map of obsidian source locations identified from archaeological sites in the Yellowstone Lake area.
This pattern is duplicated in the Jackson Hole area, where Bear Gulch is also more prevalent than Obsidian Cliff obsidian (Reeve 1989; Schoen et al. 1995; Schoen 1997). It would seem to suggest that there was some sort of boundary or restriction that prevented people from easily accessing the Jackson Hole sources directly through southern Yellowstone. Based on the obsidian sourcing, the pattern of movement appears to have been from Jackson Hole northwestward into northeastern Idaho, and then back east toward Yellowstone, probably following along the Madison River. The other possibility is through Pacific Creek to the upper Yellowstone River and then along the Yellowstone Lake shoreline (Wright 1975; Crockett 1999). Either route is indirect and would result in the gradual falloff/discard of lithic materials that occurs as distance from the source increases. Park’s (2010) analysis of obsidian source frequencies in two northern and southern study areas of Yellowstone also found a similar pattern as described here. Recent studies by MacDonald et al. (2012; 2013) also confirm differential use of northern and southern-oriented obsidians based on both chronology and location of use.

Table 1. Summary of Obsidian Source Analyses in the Yellowstone Lake Area.5

<table>
<thead>
<tr>
<th>General Area of Source</th>
<th>Source</th>
<th>Hayden Valley/ Yellowstone River1</th>
<th>North Shore Yellowstone Lake2</th>
<th>West Thumb3</th>
<th>South Shore4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellowstone</td>
<td>Park Point</td>
<td>1 (0.9%)</td>
<td>4 (1.0%)</td>
<td>2 (3.0%)</td>
<td>4 (36.4%)</td>
</tr>
<tr>
<td></td>
<td>Obsidian Cliff</td>
<td>95 (86.4%)</td>
<td>318 (79.7%)</td>
<td>31 (47.0%)</td>
<td>2 (18.2%)</td>
</tr>
<tr>
<td></td>
<td>Cougar Creek</td>
<td>--</td>
<td>2 (0.5%)</td>
<td>3 (4.5%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unk (Warm Spring)</td>
<td>--</td>
<td>--</td>
<td>2 (3.0%)</td>
<td>1 (9.1%)</td>
</tr>
<tr>
<td>Teton Area</td>
<td>Lava Creek Tuff</td>
<td>--</td>
<td>1 (0.3%)</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>Conant Creek</td>
<td>--</td>
<td>--</td>
<td>2 (3.0%)</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>Crescent H</td>
<td>--</td>
<td>1 (0.3%)</td>
<td>--</td>
<td>2 (18.2%)</td>
</tr>
<tr>
<td></td>
<td>Teton Pass</td>
<td>1 (0.9%)</td>
<td>4 (1.0%)</td>
<td>5 (7.6%)</td>
<td>1 (9.1%)</td>
</tr>
<tr>
<td>NE Idaho</td>
<td>Reas Pass</td>
<td>--</td>
<td>--</td>
<td>1 (1.5%)</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>Huckleberry Ridge</td>
<td>--</td>
<td>--</td>
<td>1 (1.5%)</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>Bear Gulch</td>
<td>7 (6.4%)</td>
<td>17 (4.3%)</td>
<td>14 (21.2%)</td>
<td>1 (9.1%)</td>
</tr>
<tr>
<td></td>
<td>Packsaddle</td>
<td>1 (0.9%)</td>
<td>2 (0.5%)</td>
<td>1 (1.5%)</td>
<td>--</td>
</tr>
<tr>
<td>SW Montana</td>
<td>Cashman Quarry dacite</td>
<td>--</td>
<td>16 (4.0%)</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Unknown</td>
<td>Unknown Dacite</td>
<td>--</td>
<td>7 (1.8%)</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>Unknown Tuff</td>
<td>--</td>
<td>4 (1.0%)</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>Unknown</td>
<td>5 (4.5%)</td>
<td>23 (5.8%)</td>
<td>4 (6.1%)</td>
<td>--</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>110</td>
<td>399</td>
<td>66</td>
<td>11</td>
</tr>
</tbody>
</table>

1 - Sanders (1999:Appendix 2); Sanders (2000:Appendix 1); Sanders (2001:Appendix 2); Shortt (1999a:Appendix 2)
2 - Cannon, Pierce, Stormberg, and MacMillan (1997:Table 60), Livers and MacDonald (2011:Table 50)
3-Johnson et al. (2004:Figure 17, Table 18);
4-Vivian et al. (2007:Appendix A)
5- does not include UM data from South Shore (see Chapter 15, this volume and MacDonald et al. 2012)
with significant shifts in use in both time and space around Yellowstone Lake.

Another possibility is that the limited amount of Teton Pass or other Jackson Hole obsidians reflects a low prehistoric presence within this particular area. Except for Jackson Lake and a few other areas (Wright 1975; Connor 1998), previous inventories (e.g., Wright 1975; Waitkus et al. 1998; Sanders and Holtman 2001; Sanders et al. 2001) have documented unusually low prehistoric site densities over much of the open, lower elevations of Jackson Hole. Wright (1975: 44, 88) suggests that these areas of low site density may represent areas of low ecological productivity in regards to hunting and gathering potential and also suggests that the game numbers in Jackson Hole were unpredictable and unreliable. If this is the case, then the lower productivity of areas and carrying capacity within Jackson Hole could have resulted in fewer numbers of people, resulting in proportionally fewer peoples traveling out of Jackson Hole, and consequently, less instances for the deposition of Jackson Hole lithic materials into Yellowstone. Conversely, there would be less motivation or attraction to travel into Jackson Hole, with fewer peoples depositing exotic lithic materials from outside areas (e.g., Yellowstone).

Subsistence Practices

Inferences on the foods eaten by prehistoric peoples are primarily based on the recovery of faunal and floral remains from archaeological sites. As noted previously, faunal remains are particularly scarce within Yellowstone. Within the Yellowstone Lake area, faunal remains have been recovered from only two sites, 48YE697 (Windy Bison site) (Cannon et al. 1997) and 48YE545 (Sanders 2001). At the latter site, only a few calcined, unidentified medium-size mammals were found in a hearth feature. The faunal remains at the Windy Bison site consist of the remains of bison, elk, and sheep. In support of the rare occurrence of bone in sites at Yellowstone, no identifiable faunal remains were found by the University of Montana in any of their 31 prehistoric features excavated between 2009-2012 around the various shores of Yellowstone Lake (MacDonald, this volume).

Additional information has been gained from the analysis of blood or protein residue on stone tools which has identified a wider variety of animals that were likely hunted by prehistoric peoples. The data presented in Tables 2-4 show that the range of animals procured. Deer are most common, followed by rabbit. Bison, bear, felids and canids are also well represented. Curiously, no fish were identified, which would have been a rich resource, as evidenced in historic times (Table 2). Although preservation of fish bones is a problem, fishing related artifacts (e.g., net weights or sinker) are also rare (Sanders 2006; Nabokov and Loendorf 2004:139). No fishing artifacts have ever been identified during excavations at any site around Yellowstone Lake, with dozens of investigated sites and hundreds of lithics (MacDonald et al. 2012). Nabokov and Loendorf (2002:139) indicate that fishing was second only to bison (or perhaps mountain sheep in the high country) to the Shoshone; however, they only provide anecdotal information about fishing in Yellowstone, with no actual eyewitness or ethnographically-recorded accounts of individuals fishing at the lake (MacDonald et al. 2012). However, Nabakov and Loendorf suggest that the use of quickly built fish weirs and baskets on small streams was a more likely technique utilized by the Shoshone, which would have a low archaeological visibility.

As noted above, bison was a primary food resource for the Native Americans as evident by the number of bison kills that have been found throughout the Plains (see e.g., Davis and Wilson 1978; Frison 1991). No communal bison kills sites have been found within Yellowstone, although faunal remains are more common in the Lamar Valley and in sites along the Black Canyon of the Yellowstone, above Gardiner (Sanders et al. 1997; Sanders 2005) where the soils are deeper and apparently less acidic. The closest kill sites are north of Mammoth in Paradise Valley (Arthur 1966). The lack of communal kill sites is curious given the prevalence of bison within the Park today, but as noted earlier the acidic soils may be at least partially responsible. The excavations at the Windy Bison site indicated that only a single male bison was killed and butchered, along with remains of an elk and sheep. Cannon et al. (1997:170) suggest that game animals were probably taken by small groups of hunters.
Table 2. Summary of Prehistoric Subsistence Data in the Yellowstone Lake Area by Site and Area.

<table>
<thead>
<tr>
<th>Area</th>
<th>Site</th>
<th>Faunal</th>
<th>Protein Residue*</th>
<th>Chronological Period</th>
<th>Count</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northeast Lake</td>
<td>YE696</td>
<td>deer</td>
<td></td>
<td>Late Prehistoric</td>
<td>1</td>
<td>Cannon et al. 1997</td>
</tr>
<tr>
<td>Northeast Lake</td>
<td>YE697</td>
<td>bison</td>
<td></td>
<td>Late Prehistoric</td>
<td>1</td>
<td>Cannon et al. 1997</td>
</tr>
<tr>
<td>Northeast Lake</td>
<td>YE697</td>
<td>elk</td>
<td></td>
<td>Late Prehistoric</td>
<td>1</td>
<td>Cannon et al. 1997</td>
</tr>
<tr>
<td>Northeast Lake</td>
<td>YE697</td>
<td>sheep</td>
<td></td>
<td>Late Prehistoric</td>
<td>1</td>
<td>Cannon et al. 1997</td>
</tr>
<tr>
<td>Northeast Lake</td>
<td>YE701</td>
<td>--</td>
<td>cat</td>
<td>Unknown</td>
<td>1</td>
<td>Cannon et al. 1997</td>
</tr>
<tr>
<td>Northeast Lake</td>
<td>YE701</td>
<td>--</td>
<td>rabbit</td>
<td>Unknown</td>
<td>1</td>
<td>Cannon et al. 1997</td>
</tr>
<tr>
<td>Northeast Lake</td>
<td>YE701</td>
<td>--</td>
<td>rabbit</td>
<td>Unknown</td>
<td>1</td>
<td>Cannon et al. 1997</td>
</tr>
<tr>
<td>Northeast Lake</td>
<td>YE701</td>
<td>--</td>
<td>dog</td>
<td>Unknown</td>
<td>1</td>
<td>Cannon et al. 1997</td>
</tr>
<tr>
<td>Northeast Lake</td>
<td>YE701</td>
<td>--</td>
<td>sheep</td>
<td>Paleoindian</td>
<td>1</td>
<td>Cannon et al. 1997</td>
</tr>
<tr>
<td>Northwest Lake</td>
<td>YE1</td>
<td>--</td>
<td>cat</td>
<td>Unknown</td>
<td>1</td>
<td>Cannon et al. 1994</td>
</tr>
<tr>
<td>Northwest Lake</td>
<td>YE1</td>
<td>--</td>
<td>deer</td>
<td>Late Archaic</td>
<td>1</td>
<td>Cannon et al. 1994</td>
</tr>
<tr>
<td>Northwest Lake</td>
<td>YE1</td>
<td>--</td>
<td>dog</td>
<td>Unknown</td>
<td>1</td>
<td>Cannon et al. 1994</td>
</tr>
<tr>
<td>Northwest Lake</td>
<td>YE1</td>
<td>--</td>
<td>deer</td>
<td>Middle Archaic</td>
<td>1</td>
<td>Cannon et al. 1994</td>
</tr>
<tr>
<td>Northwest Lake</td>
<td>YE1</td>
<td>--</td>
<td>bear</td>
<td>Late Archaic</td>
<td>1</td>
<td>Cannon et al. 1994</td>
</tr>
<tr>
<td>Northwest Lake</td>
<td>YE1</td>
<td>--</td>
<td>deer</td>
<td>Unknown</td>
<td>4</td>
<td>MacDonald et al. 2011</td>
</tr>
<tr>
<td>Northwest Lake</td>
<td>YE381</td>
<td>--</td>
<td>dog</td>
<td>Unknown Archaic</td>
<td>1</td>
<td>MacDonald et al. 2011</td>
</tr>
<tr>
<td>Northeast Lake</td>
<td>YE381</td>
<td>--</td>
<td>deer</td>
<td>Unknown Archaic</td>
<td>1</td>
<td>MacDonald et al. 2011</td>
</tr>
<tr>
<td>Northwest Lake</td>
<td>YE381</td>
<td>--</td>
<td>deer</td>
<td>Early Archaic</td>
<td>1</td>
<td>MacDonald et al. 2011</td>
</tr>
<tr>
<td>Northwest Lake</td>
<td>YE381</td>
<td>--</td>
<td>bovine</td>
<td>Early Archaic</td>
<td>1</td>
<td>MacDonald et al. 2011</td>
</tr>
<tr>
<td>Northwest Lake</td>
<td>YE381</td>
<td>--</td>
<td>deer</td>
<td>Unknown Archaic</td>
<td>1</td>
<td>MacDonald et al. 2011</td>
</tr>
<tr>
<td>Northwest Lake</td>
<td>YE381</td>
<td>--</td>
<td>deer</td>
<td>Late Prehistoric</td>
<td>1</td>
<td>MacDonald et al. 2011</td>
</tr>
<tr>
<td>Northeast Lake</td>
<td>YE381</td>
<td>--</td>
<td>bovine</td>
<td>Late Archaic</td>
<td>1</td>
<td>MacDonald et al. 2011</td>
</tr>
<tr>
<td>Northwest Lake</td>
<td>YE381</td>
<td>--</td>
<td>bear</td>
<td>Early Archaic</td>
<td>1</td>
<td>MacDonald et al. 2011</td>
</tr>
<tr>
<td>Northwest Lake</td>
<td>YE459</td>
<td>--</td>
<td>guinea pig</td>
<td>Early Archaic</td>
<td>1</td>
<td>Livers and MacDonald 2011</td>
</tr>
<tr>
<td>Northwest Lake</td>
<td>YE459</td>
<td>--</td>
<td>rabbit</td>
<td>Early Archaic</td>
<td>1</td>
<td>Livers and MacDonald 2011</td>
</tr>
<tr>
<td>Northwest Lake</td>
<td>YE459</td>
<td>--</td>
<td>guinea pig</td>
<td>Early Archaic</td>
<td>1</td>
<td>Livers and MacDonald 2011</td>
</tr>
<tr>
<td>Northwest Lake</td>
<td>YE1553</td>
<td>--</td>
<td>deer</td>
<td>Late Prehistoric</td>
<td>1</td>
<td>MacDonald et al. 2011</td>
</tr>
<tr>
<td>Northwest Lake</td>
<td>YE1553</td>
<td>--</td>
<td>deer</td>
<td>Late Prehistoric</td>
<td>1</td>
<td>MacDonald et al. 2011</td>
</tr>
<tr>
<td>Northwest Lake</td>
<td>YE1553</td>
<td>--</td>
<td>bovine</td>
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*Salmonid antisera was used on all studies (pers. comm., editor MacDonald and authors, 2013.)
Besides faunal remains, inferences of hunting can be made by the presence of projectile points. Test excavations of 20 sites in the Hayden Valley/Yellowstone River area recovered 40 projectile points, which averages two points per site (Sanders 2000, 2001). Similar work in the Lamar Valley of northeastern Yellowstone found only
six projectile points in eight prehistoric sites (Sanders et al. 1997), while excavations at sites along the Mammoth to Norris highway in northwestern Yellowstone found seven points from nine prehistoric sites (Sanders 1998); both areas exhibiting less than one point per site. This suggests that hunting activities played a larger role within the Hayden Valley/Yellowstone River area than these other two investigated areas of Yellowstone, despite the fact that the Lamar Valley, in particular, also traditionally holds large numbers of potential game animals (National Park Service 1997). Nonetheless, the number of points per site appears to quite low considering the abundance of large mammals presently in the Park.

Much of the prehistoric diet was comprised of plants, usually the seeds, roots or tubers. Archaeologically, sites associated with the procurement and processing of plant resources are often identified by the presence of groundstone implements used to grind seeds and other plant remains. However, groundstone implements are uncommon. Within the Yellowstone Lake area, the most prominent site with groundstone is 48YE701 (Cannon et al. 1997), located on the north shore near Steamboat Point and also near the Windy Bison site. Limited groundstone suggests that processing of plant resources was similarly limited or utilized a different technology that is not presently showing up archaeologically. Blood residue analysis of the groundstone from 48YE701 suggests that these types of implements could also be used to process animal remains (Cannon et al. 1997:179).

The other line of archaeological evidence for prehistoric use of plants is from fire hearths. These are usually about a meter in diameter and 20-30 cm deep and often filled with burned rocks. Recent studies by the University of Montana at Yellowstone Lake have identified 31 prehistoric features, all but one of which date to the last 3,400 years (see MacDonald, this volume). Macrofloral analysis of the hearth fill can often reveal charred plant remains, most often Chenopodium-amaranth seeds. However, such features are also uncommon within Yellowstone, although a number have been found around Yellowstone Lake (Cannon et al. 1996), especially in the vicinity of Fishing Bridge (Livers and MacDonald 2011; MacDonald and Livers 2011). Overall they have generally yielded few charred plant remains (although see chapters by Gish and MacDonald, this volume). The limited number of such features is unusual since their other function is to provide heat; essential for survival within Yellowstone’s cool climate.

The limited number of identified hearths may also be due to their low archaeological visibility within Yellowstone. As noted above, burned rocks are commonly associated with hearth features however, the local volcanic rocks do not change colors or fracture differently when heated in fires. In essence, culturally heated volcanic rocks do not look any different than the natural ones, which deprives archaeologists from detecting the presence of fire hearths at an archaeological site. In contrast to other parts of Wyoming, where quartzite rocks were heated, these rocks turn bright red and seem to occur on at least half of every prehistoric site.

Concerning differences in the subsistence patterns through time, the chronological periods and Yellowstone Lake area subsistence data are presented in Tables 3 and 4. Overall there appears to be few clear patterns, other than the Middle Archaic period contains the fewest species, while the Paleoindian period has the most. This may be more a function of sampling and the fact that numerous tools were submitted for blood residue analysis from the late Paleoindian, Osprey Beach site in the West Thumb area of the lake. The northwestern area of the lake contains the most subsistence data, which again corresponds to the amount of archaeological work and tools submitted from sites in the Fishing Bridge area. In the latter area, deer is the most common species, with representatives spread out fairly evenly between the various time periods (except for the Paleoindian period). These data match that collected by the University of Montana in recent studies at the lake (MacDonald et al. 2012; MacDonald, this volume).

Geomorphological Factors

A factor concerning the locations and patterns of archaeological sites is changes in the landform through time (see Hendrix and Hoffman chapters, this volume). Within the Yellowstone Lake area, Kenneth Pierce and others (e.g., Hamilton and Bailey 1990; Pierce et al. 2001) have documented changes in the level of Yellowstone Lake during the past 10-12,000 years (see McIntyre and Sheriff, this volume, for a summary of this research). Obviously, this would have limited some of the areas
available for occupation, especially during the
Paleoindian period. Recent work within the Hayden
Valley/Yellowstone River area (Sanders 1999, 2000,
2001) provides some additional details on the landform
changes downstream from Yellowstone Lake.

In the late Pleistocene, after deglaciation, Alum
Creek created a large outwash plain that was at least 5 -
10 m higher than the present level of the Yellowstone
River. Alum Creek, and the Yellowstone River started
downcutting through the outwash plain sometime later.
The starting date for this downcutting is not currently
known, but was probably initiated by about 12,000 BP,
since a buried Paleoindian age occupation was found in
sediments overlying the outwash plains gravels at sites
situated near the mouth of Alum Creek (Sanders 2000).
Lower bracketing radiocarbon dates have been obtained
from organic layers overlying fine alluvial sands indicate
that the Yellowstone River was approximately 1 m higher
than present 8500 years ago, in the Otter Creek area, a
few miles north of the Hayden Valley but had only cut
down to within 2 m of the present river level in the
Buffalo Ford area by 6500 years ago
(Sanders 2001:159). Some of the reason
for this may be due to the differential
raising and lower of the Yellowstone
caldera along a fault line that passes
through Le Hardy Rapids, just upstream
from the Buffalo Ford area as
documented by Pierce et al. (2001).

The higher elevation of the
Yellowstone River during the Paleoindian
and Early Archaic periods indicates that
such occupations should consequently
be found on the higher terraces.
Likewise, the lower terraces along the
Yellowstone River would have only been
available for occupation after the Early
Archaic period. This appears to be the
case in the Otter Creek/Chittenden
Bridge area (just to the north of the Hayden Valley),
where the first occupations on landforms just above the
river at 48YE446 (Sanders 1999) and 48YE516 (Reeve
1984) are associated with the Middle Archaic period (i.e.,
5000-3000 BP). The availability of the Yellowstone Lake
shore for prehistoric occupation is much more complex
(Pierce et al. 2001; McIntyre and Sheriff, this volume).

Prehistoric Land Use Patterns

The investigation into the prehistoric land use of the
Yellowstone Lake area is based on the spatial distribution
of those prehistoric sites containing chronologically
diagnostic artifacts and/or radiocarbon dates
(Photograph 1). These data are presented in Table 5 and
then summarized by area and chronological period in
Table 6. Chi-square tests comparing the site/component
frequencies in each of the four areas for each
chronological period indicate that none of the
distributions are significant at the 0.01 level. Data
presented in this section do not take into consideration
University of Montana studies on the eastern and
southern shores of the lake (as presented in this volume).
In general, though, their preliminary results show
chronological (MacDonald 2013; MacDonald, this
volume; McIntyre and Sheriff, this volume) and
geographic (MacDonald et al. 2012; McIntyre 2012)
trends similar to those presented below.

Photograph 1. Paleoindian artifacts from the
Hayden Valley/Yellowstone River area.
From left to right: Fish-tailed point fragment
from 48YE243, Scottsbluff point from
48YE448, and a spurred end scraper also
from 48YE448.
### Table 5. List of Prehistoric Sites and Their General Location and Chronological Periods.

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**List of Prehistoric Sites and Their General Location and Chronological Periods.**

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Table 5 (Continued from previous page).
List of Prehistoric Sites and Their General Location and Chronological Periods.

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<th>Area</th>
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<th>Middle Archaic</th>
<th>Late Archaic</th>
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<th>LPSN</th>
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<td>X</td>
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<td>20</td>
<td>36</td>
<td>45</td>
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The actual locations of Paleoindian sites are presented in Figure 2. Photograph 1 shows a few Paleoindian points from the region. The figure shows that there are four sites in the Hayden Valley/Yellowstone River area, 10 sites in the North Shore area (especially around the Fishing Bridge/Yellowstone Lake outlet), nine sites in the West Thumb area and five sites along the South Shore of the lake. While there is no statistically significant difference between the various areas, there are some clusters in the distribution of Paleoindian sites around the lake. Foremost is a cluster of sites in the Fishing Bridge/outlet of the Yellowstone River area of the lake, where seven of the 10 North Shore sites occur. There is also a series of fairly evenly spaced Paleoindian sites along the southern shore of the West Thumb area. Elsewhere along the South Shore of the lake and in the Hayden Valley, the Paleoindian sites are more scattered.

One of the interesting aspects of the Paleoindian occupations is the discovery of Cody Complex style artifacts from this portion of Yellowstone (Johnson et al. 2004), along with other stemmed or “fish-tailed” points (Sanders 2000) (Figure 3). Cody knives and Scottsbluff points have been considered more “plains” adaptations, for example the Horner buffalo kill site near Cody, which incidentally contained the base of an obsidian Scottsbluff point thought to be from Yellowstone (Frison 1991:66; Frison and Todd 1987:275). The distinctive Cody Complex artifacts appear to illustrate the movement of peoples from plains or basins into mountainous area, while the fish-tailed points appear to be a part of a mountain-foothills adapted complex that developed at around the same time.

For the Early Archaic period (Figure 3), there is an overall slight decrease in the number of sites/components (n=20) compared to the Paleoindian period (n=28). The distribution of the Early Archaic period sites shows a continuation of the use of the Fishing Bridge and West Thumb areas (Figure 4). Within the West Thumb area, some of the focus has shifted to Arnica Creek (north shore of West Thumb), which may have been due to a subsidence in lake levels. There appears to be less utilization of the Hayden Valley/Yellowstone River area during this period, while there is a small cluster of sites in the southwestern corner of the Southeast Arm of the South Shore of the lake.

The Middle Archaic period site distribution shows a considerable increase in the number of sites/components from the Early Archaic period. Again there is a cluster of sites in the Fishing Bridge area. However there are increased occupations within the west half of the West Thumb and the Hayden Valley/Yellowstone River areas. Additional sites/components are clustered along the southern shore of the Southeast Arm of Yellowstone Lake (Figure 3). One of the latter occupations is located on the Molly Islands indicating the first use of watercraft occurred during this period.

The Late Archaic period exhibits another increase in the overall number of sites/components. Some of this increase is in the Fishing Bridge area, but there is also an

![Figure 2. Paleoindian Site Distributions.](image-url)
increased use of the Hayden Valley/Yellowstone River area (Figure 3 and Table 6). The number of sites/components decreased slightly in the West Thumb areas, compared to the Middle Archaic period, however there is much more widespread use of nearly the entire South Shore of the lake.

Overall there is another increase in the number of Late Prehistoric period sites/components (n=51). Here we see an increase in the use of the Hayden Valley/Yellowstone River, Fishing Bridge/North Shore, and West Thumb areas, but a major decrease in the use of the South Shores of Yellowstone Lake (Figure 3 and Table 6). One of the sites at Arnica Creek (48YE449) contained pottery, the only instance within Yellowstone (Taylor et al. 1964; Cannon et al. 1996). Figure 6 also shows the distribution of two styles of Late Prehistoric period projectile points: side-notched and corner-notched/stemmed points. The latter may be associated with the early portion of the Late Prehistoric period (i.e., Reeves’ Tower Junction subphase; Shortt 2001). These sites appear to be more prevalent within the southern portion of the Hayden Valley area and along the southern shorelines of Yellowstone Lake, including West Thumb. Corner-notched/stemmed points are common in southwestern Wyoming and have similarities to the Rose Springs/Eastgate expanding stemmed point of the Great Basin (Thompson and Pastor 1995).

These types of points were also found in Mummy Cave east of Yellowstone where particularly exquisite forms were associated with a burial that dated to 720 AD (Husted and Edgar 2002). The side-notched points are more limited in distribution, although they co-occur with corner-notched/stemmed points at sites in the Fishing Bridge to Le Hardy Rapids area along the Yellowstone River, indicating multiple occupations during the Late Prehistoric period at these particular sites.

Finally, the overall pattern in the use of the Yellowstone Lake area is depicted through the distribution of sites containing multiple components (Figure 4). This figure shows that the multi-component sites are concentrated in a small area of the South Shore of Yellowstone Lake, the west half of West Thumb, the North Shore (especially around Fishing Bridge), and spread out along the Yellowstone River. Within the latter area, most of the sites border the Hayden Valley, with only one multi-component site situated within it. This would suggest that the use of the Hayden Valley may have been as an extractive locale, where resources may have been procured and subsequently brought to campsites located at the valley margins.

### Table 6. Number of Sites/Components by Area and Period.

<table>
<thead>
<tr>
<th>Chronological Period</th>
<th>Hayden Valley/ Yellowstone River</th>
<th>North Shore Yell Lake/ Pelican Crk</th>
<th>West Thumb</th>
<th>South Shore Yellowstone Lake</th>
<th>Total</th>
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<tr>
<td>Paleoindian (ca. 11,500-8000 BP)</td>
<td>4 (14.3%)</td>
<td>10 (35.7%)</td>
<td>9 (32.1%)</td>
<td>5 (17.9%)</td>
<td>28</td>
</tr>
<tr>
<td>Early Archaic (ca. 8000-5000 BP)</td>
<td>2 (10.0%)</td>
<td>8 (40.0%)</td>
<td>6 (30.0%)</td>
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<tr>
<td>Middle Archaic (ca. 5000-3000 BP)</td>
<td>9 (25.0%)</td>
<td>11 (30.6%)</td>
<td>9 (25.0%)</td>
<td>7 (19.4%)</td>
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<tr>
<td>Late Archaic (ca. 3000-1500 BP)</td>
<td>12 (26.7%)</td>
<td>15 (33.3%)</td>
<td>8 (17.8%)</td>
<td>10 (22.2%)</td>
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<tr>
<td>LPCN/Stemmed (ca. 1500-1000 BP)</td>
<td>8 (34.8%)</td>
<td>10 (43.5%)</td>
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<tr>
<td>LPSN (ca. 1000-500 BP)</td>
<td>9 (32.1%)</td>
<td>10 (35.7%)</td>
<td>4 (14.3%)</td>
<td>5 (9.8%)</td>
<td>28</td>
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<tr>
<td>Late Preh. Total (ca. 1500-500 BP)</td>
<td>17 (33.3%)</td>
<td>20 (39.2%)</td>
<td>9 (17.6%)</td>
<td>5 (9.8%)</td>
<td>51</td>
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<tr>
<td>Total by Area</td>
<td>44 (24.4%)</td>
<td>64 (35.6%)</td>
<td>41 (22.8%)</td>
<td>31 (17.2%)</td>
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<td>Number of Multiple Component Sites</td>
<td>11 (23.9%)</td>
<td>16 (34.8%)</td>
<td>11 (23.9%)</td>
<td>8 (17.4%)</td>
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</table>
Figure 3. Early Archaic (upper left), Middle Archaic (upper right), Late Archaic (lower left), and Late Prehistoric (lower right) Site Distributions.
Figure 4. Multiple Component Site Distributions.

The last question concerns evidence for stability versus change in the prehistoric use of the Yellowstone Lake area. Generally, there are few differences between the sites in this area as they mostly consist of scatters of flakes and chipped stone tools, most of which were made from obsidian, primarily from the Obsidian Cliff source. These sites also contain relatively few fire hearths, groundstone implements, or floral or faunal remains. Although there appears to be some differences in the distribution of sites through time, the reasons for this remains elusive. However, 16 of the 28 Paleoindian sites/components (57.1%; Table 5) were reoccupied by later groups suggesting that the characteristics that made these particular locales attractive for extractive activities and/or habitation during the Paleoindian period continued to be attractive in the later periods as well. At this time, it would appear that the limited variability in the archaeological remains suggests prehistoric use of the Yellowstone Lake area has been one of consistency (i.e., stability). However, we have not looked closely enough at site type or other aspects of the lithic assemblages to see if the occupied sites are camp sites, limited activity locales, or other site types that would provide some additional insight on the nature of the prehistoric occupations of the lake area over the past 10,000 years. Current and future research at the lake by the University of Montana among others will attempt to address these questions, as presented in preliminary form in many of the chapters of the current volume and elsewhere.

References Cited


Shore. University of Montana, Department of Anthropology, Missoula, Mt.


CHAPTER 3
PARK POINT OBSIDIAN: GEOLOGIC
DESCRIPTION AND PREHISTORIC
HUMAN USE OF A PRIMARY
OBSIDIAN SOURCE AT
YELLOWSTONE LAKE

By Jordan C. McIntyre, Michael C. Livers, Douglas H. MacDonald, Richard E. Hughes, and Kristin Hare

Abstract
The Park Point obsidian source is located along the eastern shore of Yellowstone Lake, Wyoming. Spanning approximately 600m of shoreline, the source is comprised of small obsidian pebbles and cobbles eroding from the associated Lava Creek Tuff. This study utilizes EDXRF analysis to determine the composition of Park Point obsidian in order to characterize it for future archaeological studies. We also assess the regional distribution of Park Point obsidian, as well as include a detailed study of use of the stone along the Clear Creek Valley on the northeastern shore of Yellowstone Lake. In so doing, we conclude that Park Point is a unique and distinct obsidian source that was casually-collected by local hunter-gatherers in need of a quick replacement of diminished toolkits at Yellowstone Lake, Wyoming. Due to the stone’s comparatively poor quality, low abundance, and small size, it did not rank highly compared to other regional toolstones, such as Obsidian Cliff obsidian. Nevertheless, Park Point obsidian is important to consider when understanding prehistoric hunter-gatherer use of the southern portion of Yellowstone National Park and Yellowstone Lake.

Introduction
Over the past 2.1 million years, active volcanism in the form of pyroclastic eruptions as well as both rhyolitic and basaltic magma flows have played pivotal roles in shaping the Greater Yellowstone Area (Christiansen 2001). The most recent volcanic cycle began more than 640 kya, with the pyroclastic eruption of the Lava Creek Tuff and was later frequented with massive eruptions of both rhyolitic and basaltic magma flows. Subsequently, these geologic events have provided prehistoric hunter-gatherers occupying the Intermountain Region of Yellowstone National Park with a diverse suite of volcogenic lithic raw materials. These sources range from amorphous obsidians to silicic rich materials that have undergone eons of diagenesis to concentrate in the form of quartzites, cherts, chalcedonies and other quartz-rich materials. Figure 1 in the previous chapter shows the locations of volcanic sources of materials discussed in this volume.

Park Point obsidian is one such volcanic raw material source found within the confines of the Park’s boundaries that was used for stone tool production. Figure 1 shows its location at Yellowstone Lake, Wyoming. Although just recently confirmed as a distinct obsidian source, it has been identified in numerous Yellowstone archaeological sites during the entire prehistory of the park. While most Yellowstone obsidian sources were quarried from extensive outcrops, such as the famous Obsidian Cliff, Park Point was casually-collected in the form of small nodules eroding from vetrophyric ash-flow deposits of the Lava Creek Tuff formation along the eastern shoreline of Yellowstone Lake.

This chapter presents the results of research by Yellowstone National Park (YNP) and the University of Montana (UM) involving several aspects related to the cultural and petrologic identification of this unique raw material source type, identified herein as Park Point obsidian. We describe the petrologic chemical attributes of this material, as well as its geological origins along the eastern shore of Yellowstone Lake. We then briefly describe the cultural and geographic distribution of Park Point obsidian at Yellowstone National Park archaeological sites. Finally, we present a case study into the prehistoric use of Park Point obsidian involving lithics recovered from dozens of archaeological sites along the eastern shore of Yellowstone Lake by the University of Montana (UM). Additionally, through the use of gravity and lithic decay models, we hope to gain a better understanding of the significance and role Park Point obsidian in hunter-gatherer lifeways in the Greater Yellowstone region.
Figure 1. Park Point Location on Yellowstone Lake, Wyoming, in Relation to Other Site Areas and Landmarks discussed in Text.
Park Point Source History

The use of energy-dispersive x-ray fluorescence (EDXRF) technology to source artifacts from archaeological sites at Yellowstone National Park has been occurring since the early 1990s. In the early 1990s studies, Park Point was unknown as a source; however, the high amount of “unknown” source identifications with similar chemical composition from sites around the eastern shore of Yellowstone Lake led former Park Archaeologist Ann Johnson to survey the lake area for a source. In so doing, she was the first to encounter Park Point obsidian along the eastern shore of Yellowstone Lake. At the location shown on Figure 1, Johnson collected a small handful of red and black obsidian pebbles and cobbles and submitted them to one of us (REH) to source (Park 2010). These “Park Point” samples provided the first preliminary EDXRF results for the newly discovered Park Point obsidian. Artifacts with unknown sources from sites along the northern and northeastern shores of the lake (previously dubbed “Unknown A” by Hughes) were preliminarily linked to the Park Point source by these initial samples. Additionally, Johnson et al.’s (2004; this volume) work at the Osprey Beach site on the West Thumb successfully showed the antiquity of use of Park Point obsidian by hunter-gatherers at the lake. They sourced a Late Paleoindian Scottsbluff projectile point from the site to the Park Point source.

Fingerprinting the Park Point Source

Following the lead of Ann Johnson, UM sought the source of Park Point obsidian on the eastern shore of Yellowstone Lake, with the goal being the collection of additional samples to substantiate the preliminary Park Point identifications discussed above. Thus, in 2010, UM collected three samples and in 2011, UM collected an additional 25 Park Point obsidian and welded-tuff samples from the eastern shore source location. Table 1 provides the EDXRF data for these samples, while Figure 2 compares Park Point with other regional obsidians. Figure 3 shows UM’s collection locales at Park Point.

Figure 2. Y vs. Zr Composition for Geologic Obsidian Samples from Park Point, Yellowstone National Park, Compared to Other Regional Obsidians. Dashed Lines represent range of variation measured for source samples. PPM=parts per million. From Hughes (2011b).

Park Point is situated on a 600m long beach just north of Park Point on the eastern shore of Yellowstone Lake hugging the fringes of an exposure of the Lava Creek Tuff formation. Diagnostically, Park Point ranges from coarse to smooth textures with an open matrix of spherulites composed of one or more anhydrous minerals that range in diameter of 0.2mm to 1mm in diameter. Park Point obsidian ranges from small to large fist sized cobbles (Photograph 1) and ranges from black to red or a combination of both color varieties, but is most commonly black. In general, Park Point obsidian is of a poor-to-moderate quality due to the spherulites which cause internal fractures during tool manufacture. The obsidian pebbles are abundant on the shore of Park Point, however their small size typically precludes their use in production of large tools. Photograph 2 shows the general setting of the Park Point location.
Table 1. Quantitative Composition Estimates for Obsidian Samples from Park Point and Flat Mountain Arm, Yellowstone Lake, Wyoming (Hughes 2011a and 2011b).

<table>
<thead>
<tr>
<th>Sample</th>
<th>Rb</th>
<th>Sr</th>
<th>Y</th>
<th>Zr</th>
<th>Nb</th>
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<td>71</td>
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<td>1.36</td>
<td>57 Unknown-Flat Mtn</td>
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</table>

Values in parts per million (ppm) except total iron (in weight %) and Fe/Mn intensity ratios; plus-minus not included but available upon request to the tertiary author.

Photograph 1.
Park Point Obsidian Pebbles.
the elemental composition of the Flat Mountain Arm obsidian with Park Point.

Results of this analysis indicate that the Park Point samples have distinct elemental characteristics compared with other regional source locations like Obsidian Cliff or Bear Gulch (Figure 2). As shown in Table 1, results of Hughes’ XRF study indicated that 21 of the 23 obsidian samples from Park Point match the “unknown A” samples Hughes identified at sites on the east and northern shores of Yellowstone Lake. They also match the chemical composition of the samples originally analyzed by Hughes for Ann Johnson in her original studies. These data substantiate the Park Point obsidian as a unique and distinctive source within Yellowstone.

In addition, two of the Park Point samples match signatures for Lava Creek Tuff. This identification is important because it substantiates the association of Park Point obsidian with this geologic formation; it is also significant because we now know that the Lava Creek Tuff likely has multiple outcrops with similar elemental composition within the region of the Yellowstone caldera. Prior to this study, the only known source of knappable obsidian from the Lava Creek Tuff was from a source to the southwest of Yellowstone Lake toward Jackson, Wyoming.

Finally, two of the three welded tuff samples returned basalt signature chemical composition, while one of them returned a non-obsidian signature (e.g., probably a rhyolite). Importantly, the two Flat Mountain Arm samples revealed unknown signatures, dissimilar to Park Point or to any other known obsidian source. As such, the obsidian gravels on the south shore at Flat Mountain Arm are distinct from the obsidian gravels at Park Point. Because of its unique elemental composition, the Flat Mountain source will need to be surveyed in more detail in the future to evaluate its potential as another possible prehistoric location for obsidians at Yellowstone Lake. Based on these sourcing data, thus, Park Point obsidian appears to be a unique point source with its only source location the eastern shore of Yellowstone Lake, Wyoming.

Photograph 2. Park Point Obsidian Source Location. View North.

The natural obsidian pebbles and hand-sized cobbles occur within an area where the Lava Creek Tuff was directly exposed to lake water. After considerable research on the petrologic and formational characteristics of tuff, it became clear that the Park Point obsidian was eroding out of the basal margins of the Lava Creek Tuff exposure, just north of the Park Point geographic location. Figure 3 shows the distribution of surface-exposed Park Point pebbles along the eastern shore of Yellowstone Lake.

Twenty-six of the 28 Park Point obsidian samples collected during 2010-2011 were analyzed by one of us (REH) using EDXRF analysis (Table 1). Twenty-three samples were small obsidian pebbles collected along the Park Point beaches, while three samples were welded tuff collected from the same area (locations shown in Figure 3). The objective of the analysis was to define the composition of the Park Point obsidian and to compare the trace elements with obsidian samples bearing the same physical attributes taken from lithic assemblages. Finally, UM also submitted two natural obsidian pebble samples collected from the Flat Mountain Arm area of Yellowstone Lake. Natural obsidian pebbles are fairly common along beaches in the southern area of the lake; thus, our goal with the latter samples was to compare
Figure 2. Map of Park Point Obsidian Source showing the Locations of UM’s Samples.
**Geological Formation of Park Point Obsidian**

Based on these results, it was important to conduct a geological analysis of the Park Point obsidian and its association with the Lava Creek Tuff. We hoped to evaluate the hypothesis that the Park Point obsidian formed within the Lava Creek Tuff and is eroding in nodules onto the eastern shore beaches. Christiansen (2001:26) notes that the basal margins of the Lava Creek Tuff is completely vitrified with dark volcanic glass. The vitrification of this glassy material forms when superheated volcanic ash nearer to the ground surface of an ignimbritic debris flow is immediately quenched by cooler ground surfaces (see Hughes and Smith 1993). The immediate cooling of superheated vitrophyric material condenses into a molecularly unstable amorphous glass, disallowing any defined crystalline structure to materialize (Christiansen 2001, Dalakishvili 2005; Gifkins 2005).

It is very likely that the obsidian near the vicinity of Park Point was formed as a result of this type of formational process. There are two hard lines of evidence substantiating this. First is the fact that the Lava Creek Tuff comprises about a third of the lithological facies on the entire east shore of Yellowstone Lake (Photograph 3). The obsidian samples that were collected from our most recent analysis were collected in an area where the Lava Creek Tuff is directly exposed to lake waters. Beyond the boundaries of the exposed tuff, the obsidian cobble concentration becomes noticeably less pronounced and eventually dissipates. This suggests that over geologic time during both glacial and paraglacial periods, erosional forces have reworked this formation to expose the vitrophyric boundaries of the tuff sheet allowing lenses of obsidian to dislodge.

In fact, as shown in the table above, two of the hand-collected obsidian samples collected by UM from the beaches at the Park Point source revealed chemical compositions identified by Hughes as Lava Creek Tuff. As such, prior studies that have identified Lava Creek Tuff only in sources south of Yellowstone Lake toward Jackson, Wyoming, are incorrect; in fact, some samples from the Park Point source on Yellowstone Lake are chemically-indistinguishable from the Lava Creek Tuff found in other areas of the park.

The second line of evidence confirming that the Park Point obsidian is associated with the Lava Creek Tuff is the physical characteristics of the obsidian. As mentioned earlier the obsidian attains unique inclusions called spherulites. Spherulites are concentrically ordered crystalline structures made up of one or more anhydrous minerals. These structures begin to nucleate in an open matrix at temperatures above 400 C° and will grow exponentially depending upon the supplied temperature of an under cooling facies (Watkins et al. 2009). They are a common phenomenon with vitrophyric ash-flows, obsidian domes and volcanic vents (Smith and Braile 1984; Gifkins 2005).

**Photograph 3. Lava Creek Tuff Exposures at Park Point.**

Like all crystalline structures, spherulites require significant amounts of heat over extended durations of time in order for them to nucleate and grow (Watkins et al., 2009). This requires that there be an additional facies of rock that serves as an undercooling mass that slowly releases residual heat Christiansen 2001; Castro et al. 2008). Welded tuff is a prime example of an undercooling facies. While the lower and upper portions of a tuff sheet readily lose heat to the air and ground surfaces, the middle portion retains so much heat that the grains of ash and litho-clasts compact together and form a dense welded zone. The residual heat given off
from welded tuffs may take up to days, years or even decades to cool depending upon the temperatures and depositional thickness at which it was emplaced.

The larger the depositional unit the more time is needed for residual heat to dissipate. This ultimately fosters longer periods of spherulitic growth. In a study by Jim Watkins et al. (2009), they modeled the growth rates of spherulites by utilizing a diffusion controlled growth model. The results from their study demonstrated that a spherulite measuring 2.6 mm in diameter could take up to 300 days to grow if the temperature being supplied maintained 800 C°. However, it would take nearly ten years if the temperature were at 600 C° and over 300 years at 400 C°. They pointed out that spherulite growth rates were severely stunted once temperatures fell below 400 C°, suggesting a lower limit of crystalline growth rates.

The spherulites that make up the Park Point obsidian are on average two fifths the size of the example previously described, measuring 1 mm in diameter. Considering if the Lava Creek Tuff acted as the undercooling mass, the diffusion control model would predict that a 1mm spherulite would require 120 days to nucleate if temperatures sustained 800 C°. Lower temperatures at 600 C° and 400 C° would require up to four and 120 years for the nucleation of spherulites. This is not an exact means to determine the residual heat given off from the emplacement of the Lava Creek Tuff, but serves as a generalization of what conditions may have been like. Further studies from geophysicists would have to be carried out to determine the specific nature and extent of the environment at the time of the Lava Creek Tuff emplacement. However, the diffusion control model does inform us that a sustained period of high temperatures were required for the nucleation of spherulites in the Park Point obsidian.

Considering that spherulites require sustained high temperatures from an undercooling mass and are largely associated with vetrophyric ash tuffs, it is highly probable that the cobble samples collected by UM at Park Point originated from the Lava Creek Tuff exposure. The fact that the concentration of obsidian dissipates beyond the boundaries of the exposed Lava Creek Tuff, suggests that the tuff is directly associated with the obsidian found in the vicinity. Furthermore, the spherulites found within the obsidian clearly indicate that the tuff acted as the secondary undercooling-mass that would have furnished the necessary heat to foster their growth.

UM’s research at the source location confirmed the prior research conducted by retired park archaeologist Dr. Ann Johnson. Park Point is the source for the obsidian previously identified as Park Point obsidian. Further, UM’s studies suggest that Park Point likely formed because of the emplacement of rhyolitic tuff during the Lava Creek Tuff eruption more than 640,000 BP. This would have occurred through the immediate quenching of ash nearer the air and ground surfaces of a superheated rhyolitic ash-flow, transforming vitrophyric ash into glass. After the emplacement of the Lava Creek Tuff, the residual heat from the cooling facies would have supplied the necessary heat and duration to allow spherulites to form and nucleate in the lenses of obsidian. Over time, processes of erosion primarily through periods of glaciations and fluctuating lake levels would have exposed the basal margins of the tuff allowing obsidian cobbles to become dislodged from their parent material.

Today, the Park Point obsidian source is revealed on the beaches of the Park Point area of Yellowstone Lake. As discussed in more detail below, Native Americans knew of the source and utilized it, albeit in a much more casual manner compared to the collection patterns for other obsidians in the park, such as Obsidian Cliff. Below, we present a regional overview of the use of Park Point obsidian, as well as a case study of the use of Park Point obsidian along the eastern shore of Yellowstone Lake, an area encompassing 20 miles of shoreline that includes the point of origin for the material.

Lithic Sourcing Studies in Yellowstone

The chemical sourcing of obsidian and dacite artifacts recovered from years of archaeological work in YNP is quite new in relative comparison to the 50 plus years of XRF spectrometry capabilities in the United States stemming from the University of California, Berkeley (Hughes 2013). Continuing the work he conducted at UC Berkeley, Hughes continues EDXRF research on geologic samples and artifacts within and adjacent to YNP. Some of the first Yellowstone artifacts submitted for EDXRF analysis came from a survey project to ascertain the chemical makeup and distribution of Obsidian Cliff obsidian, the nationally-famous obsidian source.
occurring within the Park (see Figure 1 in the previous chapter). Occurring in 1989, Hughes, along with many regional archaeologists and NPS cultural resource staff, reported on the use and distribution of Obsidian Cliff obsidian and in doing so chemically sourced approximately 80 obsidian artifacts. These 80 artifacts from within the park boundaries were compared to another 80 artifacts from at least a dozen prehistoric archaeology sites across Montana (Davis et al. 1995).

Subsequent to the initial rounds of obsidian sourcing from Yellowstone (e.g. Cannon and Hughes 1993, 1997), almost every major archaeological report stemming from work in YNP over the past 20 years documents the recovery of obsidian artifacts and in succession. Table 2 shows a list of XRF sourcing studies conducted within Yellowstone National Park. Results of many of these studies are compiled in Sanders’ chapter in this volume.

Several major obsidian acquisition locations exist within the boundaries of YNP, as shown in Figure 1 in the previous chapter. Park (2010) provides an in depth review of lithic sources in the region including one major source and five secondary obsidian sources occurring within the boundaries of the park. Obsidian Cliff is the major source of obsidian found in almost all lithic assemblages recorded in the Greater Yellowstone Area. Within YNP, there are also five secondary sources, including Park Point, Cougar Creek, Parker Peak, Cascade Creek, and Warm Creek. Major primary sources occurring outside of YNP boundaries include Bear Gulch in Idaho and Cashman Quarry Dacite in southwest Montana, as well as several sources to the west and south, including Malad Creek, Teton Pass, Crescent Hill, Conant Creek Tuff, Packsaddle Creek, Reas Peak, American Falls/Mud Lake, and Timber Butte.

As reflected in Table 2 below, approximately 2,000 artifacts have been analyzed by Hughes over the past 15 years. Park Point makes up a small minority of these artifacts, with only approximately 100 (5%) of the 2,000 sourced artifacts deriving from this source (Table 3). As shown in Table 3, most of its use was restricted to Yellowstone Lake, with only eight sites beyond the lake yielding Park Point obsidian artifacts. Based on these

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<td>2005</td>
</tr>
<tr>
<td>Vivian et al.</td>
<td>35</td>
<td>South Shore Yellowstone Lake</td>
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<tr>
<td>Reeves et al.</td>
<td>77</td>
<td>Black Canyon of Yell. River</td>
<td>2006</td>
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<tr>
<td>Reeves et al.</td>
<td>50</td>
<td>Fishing Bridge – Hayden Valley</td>
<td>2006</td>
</tr>
<tr>
<td>MacDonald</td>
<td>21</td>
<td>Gardiner Basin</td>
<td>2007</td>
</tr>
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<td>Maas and MacDonald</td>
<td>51</td>
<td>Gardiner Basin</td>
<td>2008</td>
</tr>
<tr>
<td>MacDonald and Livers</td>
<td>234</td>
<td>Lake Developed Area</td>
<td>2009-10</td>
</tr>
<tr>
<td>Livers et al.</td>
<td>136</td>
<td>East Shore Yellowstone Lake</td>
<td>2011-12</td>
</tr>
<tr>
<td>MacDonald</td>
<td>119</td>
<td>South Shore Yellowstone Lake</td>
<td>2012</td>
</tr>
<tr>
<td>Other reports</td>
<td>~100</td>
<td>Park wide</td>
<td>-</td>
</tr>
</tbody>
</table>

| Total XRF-Sourced Lithics in YNP | ~2000 |
data, Park Point was not specifically targeted as a source, but nonetheless would have been important to hunter-gatherers at the lake, an area with short supplies of lithic raw material (Bohn 2007). In contrast, Obsidian Cliff obsidian was used thousands of miles from its source (Griffin et al. 1969; Hughes 2006); it dominates most lithic material studies in the northern portion of the GYE. Thus, the two materials present contrasting use and trade patterns related to the distinctive qualities of the each stone. Obsidian Cliff is a very high quality material, abundant on the landscape, occurs as large cobbles, and is easily accessible. In contrast, Park Point is a comparatively poor quality material, is not abundant, occurs in small pebble morphology, and is located on a fairly remote portion of Yellowstone Lake.

Use of Park Point Obsidian on the East Shore

In 2009-2010, the University of Montana conducted a comprehensive survey and evaluation of archaeological sites on the east shore of Yellowstone Lake, Wyoming (Livers and MacDonald 2011). During this survey, UM documented the Park Point obsidian source described above. Given the proximity of the source to the eastern shore archaeological sites, UM collected lithic data by which to compare and contrast the use of the local Park Point obsidian with other obsidians by lake-area hunter-gatherers in prehistory. The next section provides an overview of the lithic sourcing results from eastern shore sites studied by UM with the ultimate goal to determine how important a toolstone Park Point obsidian was for hunter-gatherers at the lake.

MYAP submitted 25 east-shore lithic artifacts for

<table>
<thead>
<tr>
<th>Site No.</th>
<th>Location</th>
<th>Artifact</th>
<th>Distance from Park Point</th>
</tr>
</thead>
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<tr>
<td>2000YP40</td>
<td>Hellroaring Creek</td>
<td>Unknown</td>
<td>~20 Miles N</td>
</tr>
<tr>
<td>48PA2874</td>
<td>Greybull Drainage</td>
<td>Untyped Archaic PP</td>
<td>50 Miles SW</td>
</tr>
<tr>
<td>48YE0169</td>
<td>Lake Bypass</td>
<td>Unknown</td>
<td>~10 Miles NW</td>
</tr>
<tr>
<td>48YE0242</td>
<td>SE Arm</td>
<td>2 flakes</td>
<td>9 Miles S</td>
</tr>
<tr>
<td>48YE0243</td>
<td>Hayden Valley</td>
<td>1 flame</td>
<td>21 Miles NW</td>
</tr>
<tr>
<td>48YE0381</td>
<td>Lake Lodge Area</td>
<td>2 flakes</td>
<td>10 Miles NW</td>
</tr>
<tr>
<td>48YE0410</td>
<td>South Shore</td>
<td>Scottsbluff PP</td>
<td>10 Miles W</td>
</tr>
<tr>
<td>48YE0446</td>
<td>Otter Creek</td>
<td>Unknown</td>
<td>30 Miles N</td>
</tr>
<tr>
<td>48YE0549</td>
<td>Fishing Bridge</td>
<td>MA PP</td>
<td>10 Miles NW</td>
</tr>
<tr>
<td>48YE0623</td>
<td>Hayden Valley</td>
<td>Unknown</td>
<td>28 Miles N</td>
</tr>
<tr>
<td>48YE0678</td>
<td>Clear Creek</td>
<td>Multiple</td>
<td>2.6 Miles N</td>
</tr>
<tr>
<td>48YE0701</td>
<td>Steamboat Point</td>
<td>Multiple</td>
<td>6.8 Miles N</td>
</tr>
<tr>
<td>48YE1016</td>
<td>Hellroaring Creek</td>
<td>1 flame</td>
<td>~20 Miles N</td>
</tr>
<tr>
<td>48YE1320</td>
<td>Firehole Drive</td>
<td>Biface</td>
<td>30 Miles NW</td>
</tr>
<tr>
<td>48YE1326</td>
<td>South Arm</td>
<td>Unknown</td>
<td>~11 Miles S/SW</td>
</tr>
<tr>
<td>48YE1333</td>
<td>South Arm</td>
<td>Unknown</td>
<td>~11 Miles S/SW</td>
</tr>
<tr>
<td>48YE1337</td>
<td>South Arm</td>
<td>Mid. Archaic PP</td>
<td>~11 Miles S/SW</td>
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<td>48YE1385</td>
<td>Flat Mountain Arm</td>
<td>Unknown</td>
<td>~12 Miles SW</td>
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<tr>
<td>48YE1501</td>
<td>SE Arm</td>
<td>Pelican Lake PP</td>
<td>~10 Miles S</td>
</tr>
<tr>
<td>48YE2080</td>
<td>Clear Creek</td>
<td>Multiple</td>
<td>2.6 Miles N</td>
</tr>
<tr>
<td>48YE2082</td>
<td>Clear Creek</td>
<td>Multiple</td>
<td>2.6 Miles N</td>
</tr>
<tr>
<td>48YE2083</td>
<td>Clear Creek</td>
<td>Multiple</td>
<td>2.6 Miles N</td>
</tr>
<tr>
<td>Heart Lake</td>
<td>South of lake</td>
<td>unknown</td>
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<td>$8YE2107</td>
<td>East Shore</td>
<td>Biface</td>
<td>8.2 Miles SE</td>
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<tr>
<td>48YE2025</td>
<td>Cub Creek</td>
<td>1 flame</td>
<td>3 Miles N</td>
</tr>
<tr>
<td>N/A</td>
<td>Big Game Ridge</td>
<td>1 flame</td>
<td>30 Miles S</td>
</tr>
<tr>
<td>48YE2111</td>
<td>Lake Lodge Area</td>
<td>1 flame</td>
<td>~10 Miles NW</td>
</tr>
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</table>
sourcing analysis in 2010 and 111 lithic artifacts from eastern shore archaeological sites from 2011 (Table 4). Lithic sourcing was successful in matching eastern shore artifacts to six known source locations with two unknowns consisting of an unknown dacite source/s and an unknown volcanic glass source. The six known obsidian sources include Obsidian Cliff, Bear Gulch, Teton Pass, Conant Creek Tuff, Lava Creek Tuff, and Park Point. Obsidian Cliff makes up 49.3% (n=67) of the submitted artifacts, while the Park Point type accounts for 41.2% (n=56) of the artifacts. It is important to note that the Lava Creek Tuff source likely originates from the same location as the Park Point obsidian source in light of the 2011 XRF sourcing of obsidian samples from Park Point.

For lithic artifacts at sites found north of the Yellowstone River Delta, southern-oriented sources from the Jackson area and vicinity are extremely rare. A single obsidian flake from Clear Creek site 48YE2082 resulted in a positive match to Teton Pass. With 121 of the 125 (97%) artifacts sourced north of the Yellowstone River Delta (all sites north of 48YE1500) matching northern and eastern source locations, the XRF data indicates mobility patterns with the Yellowstone River creating a barrier between the southern and eastern shore of the lake at the delta. The low numbers of northern and eastern obsidian sources turning up from the Southeast Arm sites, especially the local Park Point obsidian source, provide additional support to this theory. Overall trends would suggest a southern and western approach to the south shore and a northern and eastern approach to the east shore with an apparent division of the areas by the Yellowstone River or another unknown barrier.

MacDonald et al. (2012) discuss these lithic raw material use trends on the respective shores of the lake in more detail.

The lithic sourcing results suggest that eastern shore Native Americans rarely ventured to the southern shore of the lake, but fairly frequently moved northward across the lake to Obsidian Cliff. They collected and used approximately an equal amount of the local Park Point obsidian and the more exotic Obsidian Cliff obsidian. However, the low densities of Park Point obsidian at sites on the northwest shore and south shore of the lake implies that the material was not curated by people moving from one area to the other. While it is especially clear that eastern shore Native Americans traveled to

<table>
<thead>
<tr>
<th>Site</th>
<th>Ob. Cliff</th>
<th>Park Point</th>
<th>Bear Gulch</th>
<th>Teton Pass</th>
<th>Conant Creek</th>
<th>Lava Creek</th>
<th>Unc. Dacite</th>
<th>Unknown</th>
<th>TOTAL</th>
<th>%</th>
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<tr>
<td>48YE2075</td>
<td>3</td>
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<td>0</td>
<td>0</td>
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<td>3.7</td>
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<td>48YE678</td>
<td>7</td>
<td>13</td>
<td>0</td>
<td>0</td>
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<td>14.7</td>
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<td>20</td>
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<td>0</td>
<td>0</td>
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<td>7</td>
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<td>0</td>
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<td>0</td>
<td>0</td>
<td>1</td>
<td>0.7</td>
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<tr>
<td>Total</td>
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<td>56</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>136</td>
<td>100</td>
</tr>
<tr>
<td>%</td>
<td>49.3</td>
<td>41.2</td>
<td>0.7</td>
<td>1.5</td>
<td>0.7</td>
<td>1.5</td>
<td>2.2</td>
<td>2.9</td>
<td>100</td>
<td>- 52-</td>
</tr>
</tbody>
</table>
Obsidian Cliff, they would have walked right through the northwest shore area (see Figure 1). For reasons explored more below, Park Point obsidian was not carried extensively by Native Americans on those trips.

Mobility and trade patterns can be inferred from data collected from archaeological sites along the eastern shore of Yellowstone Lake. One difference between lithic use patterns on the east shore and the northwest shore is the heightened reliance on Obsidian Cliff obsidian. Obsidian Cliff obsidian accounts for less than half of all obsidian on the east shore (46% of lithics), likely due to the close proximity of the Park Point obsidian source; however, sites on the northwest shore near Lake Lodge have 70 percent Obsidian Cliff obsidian.

Even less Obsidian Cliff obsidian (6.3% of lithics) was used by Native Americans along the southeastern shore (MacDonald et al. 2012: 266-271). Results of these areal comparisons of lithic raw material use around the lake perimeter are discussed in MacDonald et al. 2012, as well as in MacDonald’s chapter on features in the current volume.

**Figure 4. Lithic Raw Material Use Comparisons between Obsidian Cliff and Park Point for Tools (top) and All Lithic Artifacts (bottom) from Six Clear Creek Sites. Values in Percent of Lithic Assemblages from Sites.**

**Clear Creek Study**

In order to better understand use of Park Point obsidian on the east shore, UM compared lithic data at sites excavated within the Clear Creek Valley on the northeast shore of the lake (Figure 4). UM conducted test excavations at six sites in the Clear Creek Valley in 2010-2011 (Photograph 4). In the graphs at right, the archaeological sites along the x-axis are organized by increasing distance from the lake shore; as such, 48YE678 is located at the mouth of Clear Creek on the lake, while the other sites are located at an increasing distance from the lake shore. Thus, 48YE2085 is the most distant from the lake, ca. one mile inland.

Two major identifiable trends occur in the frequency of lithic raw material from the lithic artifact collections of six sites in the Clear Creek Valley. Regression analysis indicates a significant correlation between material type and distance from the lake.
(R²=0.7569; p<.05). Non-Park Point obsidian (i.e. Obsidian Cliff and other sources) increases in use with increasing distance from the lake. The opposite trend is observed for Park Point obsidian, which experiences a decrease in use with distance from the lake and primary source area. Regression analysis also indicates that Park Point tool use declines with distance from the source (R²=0.7429; p<.05). It appears that hunter-gatherers curated the high quality obsidians (comprised mostly of Obsidian Cliff obsidian) and discarded the lower-quality Park Point obsidians as they moved away from the lake up the Clear Creek Valley to the east (see Figure 1).

Beyond the effort to produce lithic tools and time constraints, Andrefsky (1994) notes the availability and quality of lithic raw material as two key factors to understanding the use and acquisition of various source materials in prehistory. “Archaeological evidence suggests that prehistoric populations have discarded formal tools made of high-quality lithic raw materials when fresh raw materials were close at hand” (Andrefsky 1994: 23). In the case of the six Clear Creek sites, inventory and testing results produced at least five dozen, high quality diagnostic projectile points. However, Park Point obsidian accounts for only 16% (n=28) of all recovered stone tools at the Clear Creek sites (N=176), confirming that it was not used frequently in formal tool manufacture. Instead, it was apparently used to meet the needs of daily toolstone use, including production of expedient tools to meet the needs of daily tasks.

Like most sites near local raw material sources (Andrefsky 1994, 1994b, 1998; Beck 2008; MacDonald et al. 2006), the artifact assemblage from each of the Clear Creek sites is biased toward production of lithics with locally available raw materials. Park Point obsidian debitage dominates the site assemblages and leads one to believe Park Point was a local source commonly worked, yet apparently not in the production of curated types of tools (e.g., projectile points and scrapers). Most formal or curated tools derive from sources such as Obsidian Cliff, located some 30 miles northwest of the Clear Creek Valley. While Park Point was located less than five miles to the south, Native Americans clearly were biased against the material for use in the manufacture of projectile points and other items to be curated beyond sites. Instead, Park Point was used to produce daily-task tools discarded before traveling.

These expectations are predicted by Andrefsky’s (1994) lithic raw material use model. Low-quality lithic materials of local origin will be used for expedient, informal tool manufacture, with higher-quality (perhaps exotic) materials used in formal/curated tool manufacture.

These data support a distance-decay model of lithic use in the Clear Creek Valley, with modifications of use due to lithic material quality and availability. As shown in Figure 4 above, both the quantities of Park Point tools as a whole, as well as Park Point tools in particular, drop-off significantly as one moves further from the source. Nevertheless, one lithic trend runs counter to the distance-decay model. Mean flake weight for Park Point typed artifacts increases with distance from the lake (R²=0.8107; p<.05). While most use of Park Point lithic tools and debitage shows a decrease, hunter-gatherers at the lake moved up the Clear Creek Valley to the east and curated some larger flakes and tools of the material with them, likely to minimize risk of toolstone failure. Due to the uncertainty of finding replacement stone in the Absarokas to the east, hunter-gatherers hedged their bets by carrying a few larger flakes of Park Point obsidian with them, despite its low quality.

Discussion

Gravity models are often utilized for predictive behavior modeling; in this case, the gravity model presented by Wilson (2007) is utilized to understand the value, or attractiveness, of Park Point obsidian versus Obsidian Cliff obsidian (Table 5). While Wilson notes there are four aspects associated with the exploitation of a raw material or raw material location (acquisition, transportation, use, and abandonment), the following model is designed to rank the attractiveness of a lithic source based mainly on the factors involved with acquiring and transporting said source material (Wilson 2007: 388-389). The model takes into account the quality and availability of the material, the location and difficulty of reaching the source, as well as the size of individual cobbles/stones and the outcrop/source location. For a thorough explanation of the lithic raw material gravity model, see Wilson (2007) or Adams (2011).
Park Point’s attractiveness is low when compared to Obsidian Cliff obsidian. The quality of Park Point is fairly low, but it is a workable tool stone suggesting the variable quality is somewhere between very poor and good, garnering an overall quality score of about 2 on the scale of 0 to 16. The extent of the source is only high due to the length of the shoreline exposure containing obsidian nodules. Occurring along an approximately 600m section of shoreline, the Park Point source scores a 4 on the extent scale. The size of a majority of the obsidian nodules averages around 5cm while some of the largest pieces measure around 10 cm. This size difference is obvious in Photograph 4 which compares Park Point and Obsidian Cliff obsidians. The smaller nodules are most common in the gravel shoreline deposits and have a scarcity ranking of 3, while the larger cobbles are much harder to find earning a scarcity ranking of 4. Extraction cost of obtaining Park Point is low, given the surface collection of loose gravels (extraction ranking of 1). Caloric costs associated with acquiring Park Point would be low as the source is easily reached by walking along the shoreline during periods of low water levels or even by watercraft. Even with a low-end caloric cost of 50 Cal/km, the Park Point source earns an attractiveness rating of 36.67. Utilizing similar rankings from Wilson’s (2007) data on raw material attractiveness, the attractiveness of the Park Point source is realistically closer to 26.19 or possibly even lower depending on the distance of travel to the source location.

Photograph 5. Comparison of Size and Morphology of Park Point and Obsidian Cliff Obsidians.

Compared to Obsidian Cliff (Table 5), these data indicate that Park Point obsidian likely was not sought out, except in situations of serious toolstone shortages. The ephemeral nature of toolstone availability at Yellowstone Lake promoted the use of Park Point obsidian, as one of only two potential sources of stone available for hunter-gatherers at the lake. The other source of material at the lake is scattered pebbles and cobbles of chert, orthoquartzite, and quartz within beach gravels. These were used quite frequently on the southern shore of the lake, but occur infrequently on the east shore, making Park Point obsidian even more important for hunter-gatherers facing toolstone shortages in this area. Thus, while not regionally important, such as Obsidian Cliff, Park Point was important locally, providing an adequate and predictable emergency supply of material which could be used by
Table 5. Gravity Model Comparison of Factors from Elston (1992) between Obsidian Cliff Obsidian and Park Point Obsidian.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Obsidian Cliff</th>
<th>Park Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality</td>
<td>High; isotropic; homogenous</td>
<td>Low; heterogeneous; inclusions</td>
</tr>
<tr>
<td>Abundance</td>
<td>High, large cobbles</td>
<td>Low; small pebbles</td>
</tr>
<tr>
<td>Distribution</td>
<td>Consolidated; accessible</td>
<td>Consolidated; remote location</td>
</tr>
<tr>
<td>Mode of Occurrence</td>
<td>Dense, abundant outcrop</td>
<td>Scattered along Park Point beach</td>
</tr>
<tr>
<td>Procurement Methods</td>
<td>Encounter, quarry, retrieval</td>
<td>Surface collection; no quarrying</td>
</tr>
<tr>
<td>Overall Value</td>
<td>Very High; regional use</td>
<td>Low; local use</td>
</tr>
</tbody>
</table>

hunter-gatherers at the lake desperate for replacement material for worn tool kits.

Conclusion

The University of Montana study of the Park Point obsidian source area accomplished several important research goals, as summarized in this chapter. With the help of Richard Hughes and Ann Johnson, UM identified the point of origin for Park Point obsidian and also determined its composition so that future research can accurately link prehistoric artifacts to this important toolstone source. During this study, UM also described the geological contexts of Park Point obsidian within the Lava Creek Tuff; indeed, one significant result of the composition study was the discovery that a minor amount of the obsidian from the Park Point source shares the chemical signature of the Lava Creek Tuff, previously thought to only be present south of the lake toward Jackson, Wyoming. UM’s research also evaluated the distribution of Park Point obsidian within the Greater Yellowstone Area, concluding that it decreases in use with distance from its Yellowstone Lake source. This conclusion is similar to the detailed study of archaeological materials from the eastern shore of Yellowstone Lake discussed herein, which indicate that hunter-gatherers used Park Point close to the source a lot, but decreased its use as they moved away from Yellowstone Lake up the Clear Creek Valley to the east. The comparatively low quality, availability, and morphology of the Park Point obsidian (compared to other regional sources) made it a fairly insignificant source in the GYA as a whole.

Nevertheless, for hunter-gatherers along the eastern shore of Yellowstone Lake, the Park Point obsidian source was an ideal solution to temporary deficiencies in toolstone. Despite its inferior qualities, the stone was likely casually collected by hunter-gatherers moving through the area, providing a much-needed supply of toolstone in a Yellowstone Lake environment that is generally devoid of high-quality replacement material. Instead of traveling all the way to Obsidian Cliff or some other more-distance source, hunter-gatherers were able to temporarily meet their toolstone needs by collecting Park Point obsidian along the eastern shore of Yellowstone Lake. However, it is fairly clear that it was not the type of stone that was carried for much distance beyond the source. Indeed, once hunter-gatherers moved away from the lake, it is fairly apparent that they put their stock in other, higher quality stones (e.g., Obsidian Cliff), while discarding the lower-quality Park Point obsidian.

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CHAPTER 4

PRECONTACT OCCUPATIONS AT OSPREY BEACH, YELLOWSTONE LAKE

By Ann M. Johnson, Brian O.K. Reeves, and Mack W. Shortt

Introduction

The Osprey Beach Site (48YE409/410) is located on the southwest shore of Yellowstone Lake in south-central Yellowstone National Park. The Osprey Beach Excavation Locality is primarily known for its major Cody Complex archaeological component but has a variety of Middle Period components at or adjacent to the locality. The Paleoindian materials are extensive and their description is much too lengthy for this venue. Therefore, this report emphasizes the Middle Period components from inventory and data recovery efforts (Johnson et al. 2004). However, a summary of the Paleoindian materials is included because of their significance.

Yellowstone National Park is the heart of the Greater Yellowstone Ecosystem. Yellowstone Lake is a vast body of water measuring nearly 28 km (north/south) by 20 km (east/west) at an elevation of 2,358 m. The Osprey Beach site is at the western extreme of Yellowstone Lake. The area along the south shore of West Thumb is a largely level, forested plain that rises in elevation only 20 m over distances of 250 to 700 m in southerly to south-southeasterly directions from the lakeshore. The preponderance of lodge pole pine is typical of the mostly burned forest community on the landform adjacent to Osprey Beach (Photograph 1).

Photograph 1. The Osprey Beach Excavation Locality; Note the Beach, Riser, and Crew Working on Top of Landform; View East-Northeast.

Sites 48YE409 and 48YE410 (sites combined in this report) were recorded by J.J. Hoffman (University of Montana) in 1958 (Taylor et al. 1964). Hoffman collected 12 Early Period lanceolate points and a Cody knife. Unfortunately, these artifacts were not available for inclusion in this study. The site received no professional attention again until 2000. Wichita State University (WSU) and the Museum of the Rockies (MOR) crews carried out inventory, testing, and excavations in 2000, 2001, 2002, and 2003. Testing results are not separated from excavation here.

Landforms and Stratigraphy

As part of the project, the local terrace system was mapped and this proved to be valuable in understanding which terraces may have contained the diagnostic artifacts found on the beach. Placing ages on various terraces was possible because Dr. Ken Pierce (Pierce et al. 2002) had spent years studying the geomorphology around Yellowstone Lake (Figure 1). The Osprey Beach excavation locality is primarily associated with the beach of the S4 paleo-shoreline (7 m). Segments of the later paleo-shorelines (S3 and S2) front the S4 shoreline to the west, beginning approximately 75 m to the west. Paleo-shoreline S5 (8 m) lies to the south of the excavation locality curving to the northeast and fronting the beach 100 m further east of the excavation locality towards Solution Creek. Paleo-shorelines S5.5 and S6 lie above and to the south of the S5 paleo-shoreline. The S4 paleo-
shoreline to the west of the immediate Osprey Beach Excavation Locality is fronted by erosional remnants of the S3 and S2 paleo-shores dating to ca. 7.5 and 7.2 rcybp. They lie to the north and below the S4 platform. Ken Pierce identified a section of an inset paleo-shoreline from which some of the McKean Complex points (Middle Archaic) found on the beach might have eroded.

John Albanese and Ken Pierce described the stratigraphy of the Osprey Beach Excavation Locality (S4 shoreline/terrace) (Figure 2). Sedimentary Units 1 and 2 both consisted of sand deposits. Sedimentary Unit 1 was described as a massive grey-brown deposit composed primarily of medium-sized, well sorted sand grains. Pebbles were uncommon (less than one percent of the matrix). Albanese interpreted Sedimentary Unit 1 as colluvial sediment derived from lacustrine sediment.

Sedimentary Unit 2 was an aggregation of laminated sand lenses that varied in color from greyish-brown to brownish-grey. It was composed of medium-sized sand grains. Coarse sand grains were more frequent in Sedimentary Unit 2 than in Sedimentary Unit 1. While most of the sediment consisted of fine-grained igneous rock grains, sand grains of obsidian were also present. This was similarly noted in Sedimentary Unit 1. Unlike Sedimentary Unit 1, however, a portion of the sand grains was coated with silt and clay film. While the well-

![Figure 1. Northern Yellowstone Lake Paleo-shoreline Chronology (after Pierce et al. 2002).](image-url)
sorted, laminated structure of Sedimentary Unit 2 indicated an aeolian origin, Albanese tentatively classified the unit as slope wash sediment noting that the composition of Sedimentary Unit 2 indicated that it was derived from lacustrine deposits.

Albanese’s Sedimentary Unit 3 lies below. The uppermost portion of his Sedimentary Unit 3 was characterized by a massive sand layer with small pebbles intermixed. Inferior to the sandy level was a series of thin sand lenses, some of which contained rounded pebbles that ranged in size from 0.6 to 3 cm in maximum dimension. Unlike the lenses identified in superior sedimentary units, the Sedimentary Unit 3 lenses contained relatively greater quantities of rounded pebbles (up to 20 percent). In composition, the basal sediment strongly resembled the sands exposed on the
modern beach below the Osprey Beach Locality. Sedimentary Unit 3 was interpreted as a former shoreline of Yellowstone Lake and suggests that the Cody Complex people were living on the beach. Such details enrich our interpretation of the lives of these people. Further, about 50 cm of soil had developed in the past 8,000-8,500 years at this location.

The Artifact Collection
Testing and excavation were carried out in 1x1 m units, which were most often combined into blocks. The West Excavation Block, Center Excavation Block, East Excavation Block, and South Excavation Block totaled 18 1-x-1 m units (Figure 3; Photograph 2). The 13 m Test Trench at the Osprey Beach Locality included 15 complete and 11 partial 1-x-1 m excavations. While debitage was common, lithic tools were recovered only from the East Excavation Block and the Test Trench. No human or animal bones were identified.

Lithic material types include various colors and grades of translucent to semi-translucent chert, various colors and grades of opaque chert, translucent obsidian, opaque obsidian, opalized wood, light brown to grey quartzite, siltstone, and rhyodacite/basalt. Chert colors include light grey, medium to dark brown, tan, and red-brown. While some obsidian and cherts were identified as coming from distant sources, much of the lithic materials may have been derived from beach gravels, which are rich in a wide variety of silicate stones or from a wide variety of obsidian/ignimbrite sources in the Greater Yellowstone Area. Cherts and chalcedonies from the Crescent Hill source (Adams 2011) in northern Yellowstone were not recognized.

Excavated materials were combined with tools collected from the beach that the crews traversed twice a day to get to the site with their locations marked by GPS. This resulted in an intensive beach inventory where both Paleoindian and Middle Period diagnostic materials were collected.

Components
The 2002 Test Excavation Trench at the Osprey Beach Excavation Locality contained the best preserved stratigraphy. Here, the distributional data of temporally diagnostic artifacts suggested that two components were present: an upper component assignable to the Pelican Lake Horizon (Keaster Phase, Lamar Valley Subphase) and a lower component assignable to the Cody Complex (Horner Phase, Osprey Beach Subphase).

Projectile points found on the beach associate with four to five archaeological complexes of Early–Middle Period age found in Yellowstone National Park (Table 1). The Osprey Beach Subphase and other Early Period complexes (ca. 9,400 to 9,000 rcybp) associate with the extant and eroded S4 paleo-beach. The Corwin Springs Subphase (ca. 5,200 rcybp) was originally associated with the now eroded S3 and S2 paleo-shorelines. The Hayden Valley Subphase (ca. 4,500 rcybp) also originally associated with the now-eroded, near-lake level paleo-shoreline. Finally, the Lamar Valley Subphase (ca. 2,500 to 1,600 rcybp) associated with both a now eroded, near-lake level paleo-shoreline as well as the upper-middle part of the sedimentary cap developed on the S4 beach platform (Figure 3).

Photograph 2. 2002 Center and East Excavation Blocks; View Grid East: Visti Kjar, Kevin Thorson, and John Reynolds (foreground to background).
Where possible, the non-projectile point tools from the beach were separated into Paleoindian and Middle Period time periods based upon lithic technology. Rational for this sorting is described in detail in Johnson et al. (2004). The reader is referred to Johnson et al. (2004) for description and illustrations of the incomplete bifaces/points, points we were unable to assign to a cultural tradition, and other non-diagnostic tools from the beach.
**Table 1. Osprey Beach Precontact Archaeological Sequence (Updated from Reeves 2000, 2003)**

<table>
<thead>
<tr>
<th>Early Precontact (Paleo-Indian) Period (ca. 11,500 to 7,750 years B.P.)</th>
<th>Middle Precontact Period (ca. 7,750 to 1,300 years B.P.)</th>
<th>Late Precontact Period (ca. 1,600 to 200 years B.P.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Thumb Subphase (Foothills-Mountain Complex) (9,000 to 7,750 years B.P.)</td>
<td>Antonsen Subphase (Besant Phase) (1,800 to 1,300 years B.P.)</td>
<td>First Blood Subphase (Ahvish Phase) (800 to 200 years B.P.)</td>
</tr>
<tr>
<td>Osprey Beach Subphase (Code Complex) (9,500 to 8,500 years B.P.)</td>
<td>Lamar Valley Subphase, Keaster Phase (Pelican Lake Horizon) (3,000 to 1,600 years B.P.)</td>
<td>Tower Junction Subphase (Unita Phase) (1,600 to 800 years B.P.)</td>
</tr>
<tr>
<td>Windust/Cascade Complex (10,000 to 9,000 years B.P.)</td>
<td>Hayden Valley Complex (McKean Complex) (4,500 to 3,000 years B.P.)</td>
<td>Black Canyon Subphase (Avonlea Horizon) (1,600 to 1,200 years B.P.)</td>
</tr>
<tr>
<td>Agate Basin/Hell Gap Complexes (10,000 to 9,500 years B.P.)</td>
<td>Corwin Springs Complex (Mummy Cave Complex) (7,750 to 4,500 years B.P.)</td>
<td>Cody Complex and Other Paleoindian Materials</td>
</tr>
<tr>
<td>Clovis Complex (11,500 to 10,000 years B.P.)</td>
<td></td>
<td>One hundred forty three lithic and 15 ground stone tools assignable to the Cody Complex, based on type and stratigraphic location, were recovered from the 2000 to 2003 investigations. Tool types recovered during the 2000, 2001, and 2002 excavations and from the beach (2003) are shown in Table 2. Six temporally diagnostic artifacts (two incomplete Eden points, one Scottsbluff point, a lanceolate point, and two Cody knives) were recovered from the 2002 excavations at depths ranging from 50 to 60 cm b.s. to nearly 90 cm b.s. Other Cody Complex specimens came from the beach or testing with many manufactured from obsidian. Cody knives (Figure 4:1-3) were manufactured from Obsidian Cliff Plateau obsidian. Additionally, lanceolate points from the beach include a Metzal point, a Deception Creek point, and 16 non-typeable lanceolate points/point fragments.</td>
</tr>
</tbody>
</table>

**Figure 4. Cody Artifacts (1-4) Cody Knives; (5) Obsidian Hafted Knife.**
Table 2. Paleoindian Tools from Osprey Beach Locality (Excavated and Beach Materials).

<table>
<thead>
<tr>
<th>Artifact Type</th>
<th>Number</th>
<th>Percent of Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cody Knives</td>
<td>15</td>
<td>10.8</td>
</tr>
<tr>
<td>Scottsbluff Point</td>
<td>7</td>
<td>4.8</td>
</tr>
<tr>
<td>Eden Point</td>
<td>6</td>
<td>4.2</td>
</tr>
<tr>
<td>Lanceolate Point/Point (frag.)</td>
<td>13</td>
<td>9.1</td>
</tr>
<tr>
<td>Deception Creek Point</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td>Metzia Point</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td>Point Tip</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td>Core/Core Frag</td>
<td>4</td>
<td>2.8</td>
</tr>
<tr>
<td>Gravers and Burin</td>
<td>34</td>
<td>24.0</td>
</tr>
<tr>
<td>Wedge</td>
<td>2</td>
<td>1.4</td>
</tr>
<tr>
<td>Retouched/Utilized Flake</td>
<td>12</td>
<td>8.4</td>
</tr>
<tr>
<td>Side Scraper</td>
<td>4</td>
<td>2.8</td>
</tr>
<tr>
<td>End Scraper</td>
<td>3</td>
<td>2.1</td>
</tr>
<tr>
<td>Biface</td>
<td>17</td>
<td>11.8</td>
</tr>
<tr>
<td>Knife</td>
<td>3</td>
<td>2.0</td>
</tr>
<tr>
<td>Sandstone Abrader</td>
<td>12</td>
<td>8.4</td>
</tr>
<tr>
<td>Edge-ground Cobble/Anvil</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td>Hide Abrader</td>
<td>2</td>
<td>1.4</td>
</tr>
<tr>
<td>Adze</td>
<td>2</td>
<td>1.4</td>
</tr>
<tr>
<td>Drill</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td>Hammerstone</td>
<td>2</td>
<td>1.4</td>
</tr>
<tr>
<td>Manuport</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>143</strong></td>
<td></td>
</tr>
</tbody>
</table>

The abraders are generally irregular in outline and fit into the hand easily. Three specimens have U-shaped straight grooves and are classified as shaft abraders. Each also has v-shaped grooves present. The other specimens have a variety of v-shaped grooves for sharpening pointed ends of fine tools, such as needles and awls. The hide abrader was manufactured from a pumice cobble. One adze came from the 2002 excavations and one from the beach. Dr. Ken Pierce collected a charcoal sample during the 2000 investigations. The charcoal (60 cm b.s.) subsequently provided a conventional radiocarbon age of 9,360±60 14C yr B.P. (Beta-148567) (calibrated to 8,760 to 8,460 BC [10,710 to 10,410 years B.P.] at a 95 percent probability).

A radiocarbon age of 9,360±60 14C yr B.P. “fits” with the temporally diagnostic artifacts (e.g., Cody knives and Eden/Scottsbluff projectile points) found at Osprey Beach.

Middle Period Components

- All Corwin Springs, Hayden Valley, and most of the Lamar Valley points came from disturbed context on the beach. The Corwin Springs Subphase is considered to represent a now destroyed occupation that once was associated with the S-2 and S-3 beaches, which date to ca. 7,200 14C yr B.P.

  Bitterroot Side-Notched points (n=5) are side notched, triangular in outline, straight or convex base, with a semi-regular to random flaking pattern (Table 3). The five obsidian points (n=5) were manufactured from Obsidian Cliff Plateau (n=2), Bear Gulch (n=1), black opaque obsidian (n=1), and Teton Pass Obsidian (n=1) (Figure 5:1-4).

  Two Salmon River Side-Notched points came from the beach. Both are manufactured from obsidian. One semi-complete Salmon River Side-Notched projectile point (Figure 5:6) has a slightly concave base with convex basal ears, open notches, small barbed shoulders, and straight lateral edges forming a triangular-shaped blade. The second point has been resharpened and has less prominent shoulders and basal edges with a straight base.

  Seven McKean Complex points were collected from the beach (Figure 6). Five were obsidian and two were
brown quartzite. Three obsidian specimens came from Obsidian Cliff Plateau and one from Bear Gulch.

The Lamar Valley Subphase component identified during the 2002 MOR excavation program was manifested by minimal debitage, one fragmentary Pelican Lake Corner-Notched projectile point (Figure 7:5), one Middle Precontact Period point fragment (Figure 7:1), three biface fragments, three hammerstones, and a rubbing stone of porphyritic (andesite?) stone. One surface of the latter was smooth and more polished than other surfaces. This condition was interpreted as the resulting from the preparation of hides or other tasks where rubbing or light abrasion was desired.

Five points/fragments were collected from the beach (Figure 7). One was manufactured from a very dark red, semivitreous chert and the others from various kinds of obsidian (Teton Pass=1 (Figure 7:10), Obsidian Cliff Plateau=1).

Tips of five bifaces at various stages of manufacture were found on the beach. Two were obsidian, one was a red-brown volcanic tuff, and two were red semi-translucent. One retouched and one utilized flake came from the 2002 MOR excavations.

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Figure 5. (1-4) Bitterroot Side-Notched Points; (5-6) Salmon River Side-Notched Points.

Figure 6. (1-4) Stemmed Indented Base Dart Point; (5,7) Stemmed Dart Point; (6) Notched Flake Point.

Figure 7. Lamar Valley Subphase Artifacts: (1) Point Tip; (2-3) Biface Tips; (4) Utilized Flake; (5,7) Pelican Lake Corner-Notched Points; (6) Biface (Point?) Tip; (8,9) Pelican Lake Corner-Notched Point Body Fragments.
The retouched flake is a bifacially retouched fragment. The lithic material of this tertiary flake is a mottled, light purple and white chert with very fine, dark purple and white inclusions throughout. The utilized flake is a complete, semi-translucent, light grey chert, tertiary flake.

The Osprey Beach Locality only rarely resulted in the recovery of cobbles, large pebbles, or features. However, the one exception was a concentration of volcanic FCR and unmodified cobbles exposed during the excavation of Units 18, 28, and 29 in the Test Excavation Trench. In form, the feature (Figure 8) was a generally circular, one m diameter arrangement of FCR and cobbles with the heaviest concentration forming its southern and southeastern margins. Individual pieces of FCR, one unmodified cobble, and two burnt sticks formed the dispersed northern extreme of the feature. All of the FCR exhibited water fractures or heat spalls (e.g., Brink and Dawe 2003; Rennie 2001). With regard to depth, basal measurements below ground surface ranged from 34 to 52 cm b.s., However, the majority fell within the 40 to 50 cm b.s. level. There was no color differentiation between the fill in the hearth and the surrounding matrix.

Interpretations and Comparisons

The Cody Complex—Early Period Occupation(s)

The inclusion of lanceolate points with Cody Complex Scottsbluff and Eden points shows these point types to be contemporaneous at this site. We defer discussion of whether these points represent different peoples camping together, such as Mountain/Plains and Cody Complex, and what this means for Mountain-Plains typology. The variety of tools (Table 2) documents a wide range of activities that these early people carried out at the site. Clearly, they were at the site for some time as well as frequently revisiting this locale.

Ground stone includes a pumice abrader, metate, and sandstone abraders. The sandstone abraders (n=12) are manufactured from loosely cemented sandstone considered to be local in origin as obsidian sand is included in the matrix. An exposed sandstone outcrop west of the excavation area was similar but not identical to the abraders’ material. A focused search could perhaps identify the sandstone source.

The Cody Complex is the most common of the occupations at the Osprey Beach locality and was radiocarbon dated at 9,400 B.P., which fits well with Cody Complex components elsewhere. The Cody Complex collection at Osprey Beach is robust. The site is unusual due to the extensive use of a wide variety of regional obsidians as well as a number of sandstone shaft and tip abraders. Lanceolate points and other points of Late Paleoindian age from excavation and the beach demonstrate their contemporaneity with the Cody Complex. Clearly, a variety of people visited this locality on Yellowstone lake about 9,000 years ago.

Osprey Beach and Malin Creek (24YE353) (Vivian et al. 2008) contain excavated Cody Complex components within the park, which permit a fuller examination of life at those times than do the isolated and surface materials at individual locations.

The Middle Period Complexes

Middle Period Complexes include Mummy Cave sites, such as the Corwin Springs Site on the Yellowstone River just north of the park (Davis et al.
The Mummy Cave Complex, characterized by side-notched atlatl points, takes its name from Mummy Cave on the North Fork of the Shoshoni River in the Absaroka’s east of the park. A well-stratified set of occupations characterized by these points were excavated here in the early-mid 1960s (Husted and Edgar 2002). The characteristic points had earlier been found in excavations in late 1950s to early 60s in the Birch Creek Valley of Lemhi Range in eastern Idaho some 170 km west of the park (Swanson 1972; Swanson et al. 1964; Swanson and Sneed 1966). Swanson et al. (1964) proposed they be named Bitterroot and Salmon River Side-Notched. The points were diagnostic of Swanson’s Bitterroot Phase. They are a common point type in the Central and Northern Rockies and the adjacent Northwestern Plains (Reeves 1972, 1973, 2003).

The Corwin Springs Subphase takes its name from the Corwin Springs Site (24PA195) (Davis et al. 2012) located on the Yellowstone River a short distance north of Yellowstone National Park. Archaeological testing there in 1979 and 1980 uncovered a well-defined set of Mummy Cave occupations (Davis et al 2012, Reeves 1972, 1973). Typically, these large corner-notched points are rare and most often found as isolated artifacts. The only known feature dating to this period comes from site 48YE381. This small amorphous cluster of fire-cracked rock was identified during testing and produced an AMS uncalibrated radiocarbon age of 5,910±50 B.P. (Beta-265310) (MacDonald, this volume).

The Corwin Springs Subphase points (=5) from Osprey Beach were recovered from disturbed contexts. However, judging from their lack of abrasion, they had not been on the beach that long, so their origin was nearby. This is the largest collection from a single site in the park.

The Corwin Springs Subphase is not well represented on Yellowstone Lake reflecting the fact that, during most of the temporal range of this subphase, the lake level was below that of today’s (Fig. 2). Cannon et al. (1994: Table 46) summarized projectile point types at Fishing Bridge. Large side-notched points (Mummy Cave Complex) constitute 7.81 percent (n=5) of the assemblage, in contrast to Middle Period lanceolate and stemmed forms (Hayden Valley Subphase) that constitute 14.06 percent (n=9). Bitterroot points are most often identified as single points in disturbed contexts.

Corwin Springs sites, while as frequent as the preceding Late Paleoindian West Thumb Subphase (21 sites as recorded by 1999), are considerably less common than the subsequent Hayden Valley Subphase (44 sites) (Reeves 2000). In contrast, Mummy Cave is more frequent on the Beartooth Plateau than McKeen (Husted 1992), which it should be as it spans some 4,000 radiocarbon years compared to McKeen that only spans some 1,500 to 2,000 years. In our opinion, these differences in frequencies reflect in large part, past geological processes at Yellowstone Lake and elsewhere in Yellowstone National Park that have inundated or buried mid-Holocene sites. It is highly likely that Corwin Springs component frequencies in Yellowstone were similar to those for the Beartooth Plateau. This is the case in the Northern Rockies (Reeves 2003) where the increase in sites and intensity of site occupation appears also to reflect an increase in ungulate and human carrying capacities as a result of expanded grasslands, more open forests, and rising timberlines during the mid-Holocene. We prefer this explanation rather than the older hypothesis, which suggests use of the mountains as Altithermal refugia. The Altithermal refugia concept has most recently been promoted by MacDonald (2012; this volume).

Salmon River type points are infrequently identified, which may be partially explained by mis-identification as Late Archaic or Pelican Lake. An obsidian side-notched atlatl point (Cannon et al. 1997:Figure 13b), similar to Salmon River types associated with the Mummy Cave Complex from site 48YE701, reacted positive to sheep antiserum.

The Hayden Valley Subphase is represented by seven dart points (Fig. 4) from the beach. These were originally associated with a destroyed Mid-Holocene shoreline, which lay at or slightly above today’s lake level. Four of the obsidian specimens have been sourced: three to Obsidian Cliff Plateau and one to Bear Gulch. Cannon and
Hughes sourced a McKeans Complex “Eared Point” from site 48YE410 to the Obsidian Cliff Plateau (Cannon et al. 1996:Table 10).

Hayden Valley is the local representative of the McKeans Complex, which is an intrusive cultural complex into the Northern Plains/Rocky Mountains. The McKeans Complex most probably originated in the Northeastern Great Basin and Southern Columbia Plateau (Reeves 2003; Rennie 1994). McKeans Lanceolate, Duncan Stemmed, Hanna Stemmed, and Hanna Corner-Notched points characterize Hayden Valley components. Hayden Valley Subphase occupations are common in Yellowstone National Park. Forty-four sites/components were identified by 1999 (Reeves 2000).

McKeans Complex points are the second most common types (following Pelican Lake forms) in the park. The north shore of Yellowstone Lake was a significant settlement area for Hayden Valley populations. The 1990s Midwest Archeological Center (Cannon et al. 1994) carried out extensive excavations at Fishing Bridge (48YE1). McKeans Complex and other point types typed as Middle Archaic by Cannon et al. (1994:Table 46) account for 25.56 percent (17 specimens) of the total projectile point assemblage. This represents a significant increase in occupational intensity over points typed as Early Archaic in age (7.81 percent, n=5 specimens) by Cannon at Fishing Bridge.

At West Thumb, Hayden Valley occupations are present at site 48YE449 (First Blood), which can be seen across the bay from Osprey Beach. An ear of a stemmed indented base (?) point (Cannon et al. 1996:Figure 26a) was recovered from a small (45 by 35 by 20 cm deep) basin-shaped, rock-filled hearth (Feature 92-2) radiocarbon dated at 4570±100 (Beta-56708) and 4,580±90 (Beta-55365) (Cannon et al. 1996:48).

Stemmed, indented base points (Cannon et al. 1996:Figure 26c, j) were also found at equivalent levels in other test locations in site 48YE449.

Macrofloral remains were recovered from a matrix analysis from Feature 92-2 at site 48YE449. Analysis produced limited results as only 14 macrofossils were recovered. Carbonized seeds of Carex were among those identified. Aaberg (1996) suggested that Carex (sedge) may have been used to line the roasting pit.

Excavation at Malin Creek on the Yellowstone River identified five shallow circular hearths on a living surface with five radiocarbon dates averaging 4,500 B.P. (Vivian et al. 2008). Only wood charcoal from local species was identified from the hearths at Malin Creek (Vivian et al. 2008).

Hayden Valley Subphase components are very common in Yellowstone National Park where land surfaces of the appropriate age are present. In a 2000 Reeves study, diagnostic points were recovered from 44 sites. The frequency of sites of this age, in comparison to the earlier Corwin Springs, suggests a substantive increase in Native resource harvesting and occupancy occurred during this subphase in Yellowstone National Park. The number of obsidian points suggests that quarrying and workshop activities associated with the Obsidian Cliff Plateau primary and secondary obsidian sources also increased markedly. The presence of roasting pits and fire-cracked rock suggests that new food cooking techniques involving roasting and stone boiling also appeared. These trends intensified in the following Lamar Valley Subphase.

The Lamar Valley Subphase component in the 2002 Osprey Beach excavations is represented by eight tools, debitage from contexts above 50 cm b.s. in the Test Excavation Trench, and the FCR/cobble feature. Included in the excavation tool assemblage is a Pelican Lake Corner-Notched projectile point (Fig. 5:5), a point tip (Fig. 5.1), three small biface fragments, two hammerstones, and a rubbing stone. The Lamar Valley Subphase component, while likely present in the West, Center, East, and South Excavation Blocks, was only identified as a separate stratigraphic entity in the Test Excavation Trench.

Four Pelican Lake Corner-Notched points (Fig. 5:7-10) were collected from the beach. Three of the obsidian specimens have been sourced: one specimen to Bear Gulch, another to Obsidian Cliff Plateau, and a third to Teton Pass. Cannon and Hughes sourced a “Late Archaic Corner-Notched Point” from site 48YE410 to Bear Gulch (Cannon et al. 1996:Table D1).

Pelican Lake is the most common Precontact culture in Yellowstone based upon the number of sites with components, radiocarbon dates, and projectile points. Reeve (1989:12) indicates these points are the most common type recovered from sites along the lake, which is supported by later work (MacDonald and Livers 2011).
It was most probably during the Lamar Valley Subphase that obsidian was transported to the Hopewell culture in Ohio by Antonsen Subphase/Besant Phase-related peoples, although many questions remain about who was involved in this Hopewell obsidian movement and how it was accomplished (see MacDonald and Livers 2011:146-149; DeBoer 2004).

Typical Besant points such as those found at the Antonsen site out of Bozeman, MT (Davis and Zeier 1978) are very uncommon in Yellowstone suggesting a very restricted presence of Besant phase-related occupation in contrast to the Lamar Valley, Black Canyon, and Tower Junction subphases. The pattern is similar to that identified in the Northern Rockies (Reeves 2003) and is thought to reflect a regional seasonal settlement pattern in Besant, who focused their summer activities on bison hunting out on the plains, while wintering in the foothills and fronts of the mountain valleys rather than summering in the high country.

Many Lamar Valley Subphase occupations have been recorded in Yellowstone National Park. Relative to the preceding Hayden Valley Complex and succeeding Late Precontact Period (Table 1), the number of Pelican Lake projectile points indicates increased human occupancy in the Greater Yellowstone Ecosystem during that time (Reeves 2000). Lamar Valley is a local subphase of the Keaster Phase of the Pelican Lake Horizon, first identified at the Mortlach site in southern Saskatchewan (Wettlaufer 1955). It developed out of the McKean Complex in the Northwestern Plains and Rocky Mountains (Reeves 2003). Pelican Lake Horizon components and occupations have a wide distribution across southern Alberta, Saskatchewan, and Manitoba, southward to Montana and Wyoming, and as far east as the Missouri River in the Dakotas.

Reeves (1983) proposed several phases then referred to as subphases for the area, including Spring Creek in the Bighorn-Shoshone Basin in north-central Wyoming and Keaster in adjacent Montana. Corner-notched atlatl points characterize the Lamar Valley Subphase projectile point assemblage. Surface and excavated specimens from Yellowstone encompass a variety of styles/types ranging from typical Pelican Lake Corner-Notched forms typical of the regional Pelican Lake phases-Keaster and Blue Slate Canyon of the Upper Yellowstone, Missouri plains and mountains, to corner-notched forms typical of the Spring Creek Phase of the Bighorn Basin (Reeves 1983). Yellowstone Pelican Lake points are more closely related to corner-notched forms of the Pine Springs Phase of southwestern Wyoming (Sharrock 1966). Other barbed-corner-notched stemmed forms more typical of the Snake River Corner-Notched that characterizes assemblages in the Snake River drainage to the west also occur. Using the assumption that peoples in more contact with one another are likely to have more similar tool forms, we should look for local Pelican lake relationships to the south and west.

The earliest Pelican Lake dates with associated corner-notched points are from site 48YE170 in the Lamar Valley. Testing produced an AMS date on bone collagen of 2720±70 (Beta-99932) from TU3 and a charcoal date of 2640±70 (Beta-98151) from a two m diameter by 20 cm thick fire-cracked rock feature (Sanders et al. 1997:165).

Pelican-Lake radiocarbon dates also come from site 24YE366, a terrace campsite on the Yellowstone River. A date of 1,420±90 (Beta-42151) was obtained on charcoal from a “bone bed” at 60 to 70 cm b.s. (Cannon 1997). A hearth feature salvaged from this site in 1998 by MOR produced a date of 1,580±80 (Beta-34977) but used charcoal combined from several layers. This component appears to contain both atlatl and arrow points and may be mixed or transitional. The current volume includes data regarding many more Late Archaic site occupations excavated since the late 1990s.

Lamar Valley is well represented by occupations along the north shore of Yellowstone Lake. The majority of fire cracked rock features (roasting pits and hearths) around Yellowstone Lake appear to associate with Pelican Lake components.

Clues as to vegetation at the time of Pelican Lake components and to plant foods can be obtained from macrofloral analyses of these features. The contents of a slumped, 1 m diameter, fire-cracked rock feature (92-4) at site 48YE449 (First Blood) dated to 1,720±90 (Beta-56707) and 1,780±90 (Beta-55376) was analyzed by Aaberg (1996:49). Macrofossils were very common (ca. 25,000 specimens). Present were carbonized seeds of Carex (sedge), goosefoot (Chenopodium sp.), needles from Engelmann spruce, and a wild violet seed. Pinus contorta (lodgepole pine) needles were also identified. Aaberg (1996:210) suggests, based on ethnoarchaeologic...
analog and the occurrence of similar materials in pits at other sites, that sedge was probably used to line the pits to protect the material being baked from dehydrating and charring.

From immunological analysis we can infer what animals were people of the Lamar Valley Subphase harvesting at Yellowstone Lake. Very few bones are recovered in archaeological contexts due to the acidic forest soils. Positive reactions on chipped stone tools from around the lake were obtained for the cervid family, species-specific to elk, deer, rabbit, bear, carnivore, dog, and cat. These results largely duplicate those from the Cody Complex tools at Osprey Beach and show continuation of the faunal populations.

More interesting are results on two ground stone slab fragments from site 48YE701, which reacted positively, one to deer anti-sera and another to both bovid antiserum as well as dog. These results suggested to Cannon (Cannon et al. 1997:126 fol., 137) that ground stone tools were used for processing foods other than plant foods. He suggested they might have been used as surfaces for pemmican preparation, splitting long bones for marrow extraction, and hide preparation. The ground stone slab fragment, which reacted positively to bison antiserum, came from a test excavation level that also produced a large corner-notched point (not illustrated in Cannon et al 1997). Charcoal from this level yielded a date of 1,250±70 (Beta-83300) that was considered by Cannon (1997:135, 174) to be a minimal date because of the presence of the corner-notched atlatl point.

To date, no evidence of fishing activities for Pelican Lake in the form of fish bones or net sinkers has been found associated with the occupations at Yellowstone Lake. Nor have any tools reacted positively to fish antiserum. This negative evidence suggests that if fishing occurred, still or slack water weighted net fishing was not practiced. For if it were, then net sinkers would have been found in the excavations at sites such as Fishing Bridge as well as along the Upper Yellowstone River. Net sinkers (usually single specimens) have been collected from several sites in the Black Canyon (Dorwin and Payette 1993; Vivian et al. 2008) and at Corwin Springs (Davis et al. 2012). The net weights are surface or eroded specimens but come from sites with Lamar Valley components (Reeves 2000).

In contrast to Yellowstone, net sinkers are found in sites of equivalent age/projectile point type to Lamar Valley associated with fish lakes and rivers in the Northern Rockies: St. Mary, Waterton, and Crownsnest on the eastern Rocky Mountain slopes and the Kootenai River, and western slopes of the Rocky Mountains including Flathead Lake, Flathead River, and Clark’s Fork (summarized in Reeves 2003). Cutthroat in Yellowstone Lake could have been collected by hand or fish traps in small streams during spawning.

Some Northern Rockies lake and riverside sites with net sinkers also have chipped oval-rectangular disks associated with them, as do some bison processing sites (Reeves 2003). These disks are common in some areas of the Columbia Plateau. Disks from the Spokane River have reacted positively to fish antiserum (Draper and Andrefsky 1991). These Northern Rocky Mountain and Columbia Plateau disks are similar to three chipped sandstone disks recovered by Cannon et al. (1994:117, Fig. 55) from the lakeshore and excavation at Fishing Bridge. Testing along the Pelican Creek side of the Fishing Bridge site recovered a chipped disk at 146 cm, from which a charcoal sample yielded a date of 3430±30 (Beta-68626; ibid:96). These disks merit immunological analysis.

Conclusion

High water on Yellowstone Lake in the past 15 years has accelerated erosion of lakeside terraces with loss of cultural materials contained therein. Archeological inventory of the Lake beach line identified new and redocumented previously recorded sites. Components in the West Thumb area included Cody Complex and other Late Paleoindian materials, as well as a variety of Middle Period materials: Mummy Cave, McKeen Complex, and Pelican Lake. The Middle Period components were assigned to Mummy Cave, Hayden Valley, and Lamar Valley subphases, respectively. Significantly, no Late Prehistoric points were identified by the 40 mile shoreline inventory between West Thumb and the Yellowstone River delta (Vivian et al. 2007). One Avonlea point was later recovered as part of a site monitoring project by the senior author and several Late Prehistoric points were found at Arnica Creek, north of Osprey Beach (Cannon and Hale, this volume). These results suggest possibly reduced use of the area by post-Pelican
Lake groups. We are aware more recent work by the University of Montana that classified a number of projectile points as Late Prehistoric (see MacDonald, this volume; cf. Cannon and Hale, this volume). In addition to form and technology to type projectile points, the University of Montana used a formula including neck width and thickness for assignment (MacDonald personal communication to Ann Johnson, 2012); as such, the conclusions of these different studies are not directly comparable (cf. Sanders, this volume).

Geomorphological investigations identified a number of terraces ranging in age from 10,000 years (S4) to present (S1). Analysis of the paleo-shoreline history and the tools collected from the beach suggest that most associate with the Cody Complex-Early Period (Table 1) and eroded from the S4 shoreline (Figure 1). Later occupations on the beach are associated with eroded, radiocarbon-dated, transgressive paleo-shorelines that once fronted the Osprey Beach S4 paleo-beach. These later occupations include an early ca. 7,200 year old Corwin Valley Subphase (Mummy Cave Complex) occupation characterized by Bitterroot and Salmon River Side-Notched points (Figures 1 and 5) that would have associated with the S3 and S2 transgressive shorelines; a Hayden Valley Subphase (McKean Complex) occupation (Figure 6) associated with a ca. 4,500 rcyrp shoreline; and a Lamar Valley Subphase occupation (Fig. 9), which is associated with a paleo-shoreline approximately the same elevation as today’s beach.

Significant insights into settlement patterning and cultural associations were obtained by understanding the local geomorphology. The rise and fall of shorelines around Yellowstone Lake is well documented and archeologists have suggests the benefits of understanding their various ages (Reeve 1989; Cannon et al. 1995). However, this study (Johnson et al. 2004) provides the tangible results of such knowledge.

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Visti Kjar catalogued the debitage and described many of the artifacts. Kevin Thorson prepared the maps, figures and site photographs. Amanda Dow photographed the artifacts and contributed other graphics. We thank Priscilla Madsen, Amanda Dow, and Nancy Saxberg for providing the artifact line drawings and Janet Blakely for assisting with the illustrations.

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CHAPTER 5
EARLY AND MIDDLE HOLOCENE HUNTER-GATHERERS AT THE FISHING BRIDGE POINT SITE, NORTHERN YELLOWSTONE LAKE

By Douglas H. MacDonald

Introduction
Archaeological data from sites in the northwestern Plains and Rocky Mountains of Wyoming and Montana, U.S.A., suggest that some portions of the region were attractive to Early and Middle Holocene hunter-gatherers. Several archaeological sites in the region indicate active use of high-elevation watersheds and lakes between 8,000 and 5,000 uncalibrated radiocarbon years ago (BP). During this period—usually referred to as the Early Plains Archaic or Early Archaic (Frison 1991) and documented by Antevs (1953) as the Altithermal climatic period—temperatures increased and precipitation decreased across the Great Plains and Rocky Mountains (Oetelaar 2004; Yansa 2007). The impact on people is a bit more controversial (Artz 1996; McBrinn 2010; Reeves 1973; Sheehan 1994), but it is generally accepted that the climate changes led to reduced bison herds, increased human subsistence diversity, and displacement of human populations from more-arid settings to cooler, wetter settings (Benedict and Olson 1978; Mulloy 1958; Reider and Karlstrom 1987; Sheehan 1994).

Another key change in the Early Archaic is a dearth of sites in the hot and dry lowlands of the Great Plains (Mulloy 1958; Meltzer 1999). However, analysis of Early Archaic site data indicate that there are some regions—among them the Yellowstone River Ecosystem (YRE) of northwestern Wyoming and southern Montana—in which sites are comparatively well-documented (Kornfeld et al. 2010). As reviewed below, sites in the YRE are concentrated in uplands and at stable sources of water (e.g., rivers, streams, springs, and lakes), suggesting that human settlement during the period was tethered to stable water supplies (Yansa 2007; Reider and Karlstrom 1987; Sheehan 1994).

This paper provides data on another high-elevation Early Plains Archaic site—Fishing Bridge Point (48YE381)—along the shores of Yellowstone Lake (MacDonald et al. 2012). The site has yielded the only Early Archaic hearth feature in Yellowstone National Park. Lithic data indicate a tethered settlement pattern with reduced regional mobility and use of local resources. As discussed by Gish (this volume), palaeoenvironmental data indicate the presence of a high-elevation shrub-grassland around the lake at the time of occupation. Results of this study suggest that the high-elevation Yellowstone Lake area attracted grassland-adapted ungulates, as well as their human hunters during a period in which game, water, and a variety of other resources may have been more sparse in the hot and dry lowlands.

Early Plains Archaic Background
Below, we evaluate the two major hypotheses regarding Early Archaic hunter-gatherer adaptation to the Altithermal: first, that hunter-gatherers diversified their resource base; and, second, that they constricted their settlement patterns to comparatively cool and well-watered habitats. This constriction of settlement patterns largely resulted in hunter-gatherer mobility patterns that were tethered to reliable water sources. We describe the general conditions of the Altithermal and subsequently the archaeological data for the region. These ecological and archaeological data provide a context for the subsequent discussion of Fishing Bridge Point, Wyoming.

The Altithermal or hypsithermal period is characterized by comparatively hot and dry climate (Antevs 1953; Dean et al. 1996; Wolfe et al. 2006). Dean et al. (1996) provide an excellent summary of the effects of the Altithermal on the Midwestern U.S.A. based on analysis of fossil pollen, aeolian proxy variables in lake cores, and dune migration. Their research, confirmed by similar research in Saskatchewan by Wolfe et al. (2006), in Wyoming by Eckerle (1989), and in North Dakota by Yansa (2007), clearly shows that northern North America experienced hotter and drier conditions resulting in heightened dune movements during the middle Holocene (aka, the Early Plains Archaic) between approximately 8,000 and 4,000 BP.
The effect of the Altithermal was dramatic for bison, with the hotter and drier conditions resulting in decreased forage and habitat for bison in the Great Plains (Sheehan 1994). Bison teeth that date to the Early Archaic period are badly worn, suggesting more dry grass and grit in their forage (Meltzer 1999). In fact, it is generally accepted that the Altithermal is responsible for the demise of *Bison antiquus* and the emergence of modern *Bison bison* by 5,000 BP (McDonald 1981). Surface water was likely reduced during this time and springs and summers were likely much warmer than during the previous Late Paleoindian period (Meltzer and Collins 1987).

Within higher-elevation portions of the northern Rocky Mountains of North America, paleoenvironmental data collected by Whitlock (Whitlock 1993; Whitlock et al. 2001) among others suggest the presence of steppe vegetation after 7,600 BP. Whitlock and her colleagues also note that forest fire frequency increased during the mid-Holocene (Huerta et al. 2009), likely due to the increased summer insolation of the Altithermal (Millsbaugh et al. 2000). Based on these various data, the Altithermal is best characterized as a period of hotter and drier conditions, leading to dynamic effects on people, animals, and habitats.

Based on the lack of an Early Archaic occupation at the famous Pictograph Cave site near Billings, Montana, William Mulloy (1958) was the first to suggest that humans abandoned the hot and dry open Plains in favor of uplands and water sources such as river valleys. However, Reeves (1973) among others have disputed the Plains abandonment theory, instead suggesting that the hot and dry conditions of the Altithermal resulted in less sediment accumulation in river valleys and a more unstable geoarchaeological environment (Eckerle 1989; Running 1995). The end result was reduced site preservation during this time period and fewer archaeological sites.

Regardless of the causes, no one disputes that there is a decline or at the very least a leveling off in archaeological site counts in the Plains and Rocky Mountains between 8,000 and 5,000 BP (Artz 1996; Benedict and Olson 1978; Frison 1991; Kornfeld et al. 2010; Sheehan 1994). Figure 1 shows data collected for sites in western North Dakota (Artz 1996:388) compared to data collected by Sanders (2001:219; Chapter 2, this volume) in the Yellowstone Lake area of northwestern Wyoming. Similar to these two studies, most surveys indicate reduced site counts or, at the very least, no increase in site counts between the Late Paleoindian and Early Plains Archaic periods, while noting a substantial increase in sites in the subsequent Middle Plains Archaic, after 5,000 BP.

![Figure 1. Site Counts during the Paleoindian Period (Paleo), the Early Plains Archaic (EPA), and the Middle Plains Archaic (MPA) in Western North Dakota, Southern Montana, and Northern Wyoming.](image)

While the causes are still controversial (Artz 1996), Sheehan’s (1991, 1994, 2002) research suggests that Early Plains Archaic Native Americans abandoned some portions of the Great Plains that lacked reliable water sources. In the southern Great Plains, Meltzer (1999) has recorded archaeological sites with excavated wells, suggesting an extreme water shortage, while Yansa’s (2007) study of North Dakota lakes indicates that severe droughts of the Altithermal resulted in some human movement away from the hot and dry northern Plains. In further exploration of this, we provide details below which indicate a movement from the hot and dry lowlands to higher-elevation settings along well-watered settings in the northwestern Plains and Rocky Mountains.
The Yellowstone River Ecosystem

In Montana and Wyoming, several key Early Archaic sites have yielded data that support the hypotheses of diversified subsistence and a tethered settlement pattern. Figure 2 shows a map of Early Archaic sites in the study region, including the Yellowstone River watershed, the core focus area for this paper. One of the most obvious regional trends shown on the map is the dearth of sites in the eastern portion of Montana during the period. Most Early Archaic sites are clustered along the Rocky Mountains and into the YRE. We focus the discussion below toward sites in the YRE to provide a context for the introduction of results of excavations of the Fishing Bridge Point Site at Yellowstone Lake. The YRE covers millions of square kilometers in Montana and Wyoming. As reflected in Figure 2 above, it is centered on the 680-mile-long Yellowstone River, which emerges from Yellowstone Lake in far northwestern Wyoming. Yellowstone Lake is the largest high-elevation lake in the continental United States.

The Yellowstone River remains its largest free-flowing (undammed) river. From its outlet at Fishing Bridge in Yellowstone National Park, the Yellowstone River flows northward and eastward through south-central and eastern Montana to its confluence with the Missouri River near the Montana-North Dakota border. The YRE covers much of southern and eastern portions of Montana and northern Wyoming, including its major tributaries, the Powder, Bighorn, and Tongue Rivers, among other major streams. Elevations in the region range from lows of ca. 2,000 ft. above mean sea level (amsl) near its terminus in western North Dakota to highs of greater than 13,000 ft. amsl in the Absaroka Mountains above Yellowstone Lake, Wyoming.

Early Archaic Sites and the Effect of the Alithermal

Early Archaic sites are rare in the lower (northeastern) reaches of the Yellowstone River basin, where elevations are reduced and hot and dry conditions of the Alithermal were likely exacerbated. As reflected in Figure 2 below, at an elevation of 5,100 ft. above mean sea level (amsl), the Myers-Hindman Site in Livingston, Montana, is the last Early Archaic site along the Yellowstone River. No sites exist north of Myers-Hindman, as elevations decrease to near 3,000 ft. amsl at Pictograph Cave in Billings to 1,950 ft. amsl near the Yellowstone’s confluence with the Missouri River near the Montana-North Dakota state line. Even today, there are significant climate differences between cities along the Yellowstone River. While they are only separated by 115 miles of river, Livingston receives 2.5 inches more rain annually and is four degrees cooler in July than Billings. In turn, Yellowstone Lake, at the headwaters of the Yellowstone River, receives nearly seven inches more annual precipitation than Billings and is 14 degrees (Fahrenheit) cooler.

Interestingly, no Early Archaic sites have been identified in this entire stretch of the Yellowstone River north of the Myers-Hindman site in Livingston. As discussed below, it appears that Native Americans avoided low-elevation settings, giving preference to areas near permanent water and at higher elevations. In fact, Mulloy’s (1958) study of Pictograph Cave in Billings notes the significant absence of an Early Archaic occupation between the Paleoindian and Middle Archaic occupations. The following discussion provides an overview of important Early Archaic sites in the region and identifies a general trend toward higher-elevation, well-watered settings.

As introduced above, the Myers-Hindman Site (24PAS04) in Livingston, Montana, is arguably the most important Early Archaic site in Montana (Lahren 1976, 2006). At an elevation of ca. 5,100 ft. amsl, the site was excavated in the 1970s by Larry Lahren and colleagues along an upland feeder stream of the Yellowstone River.

Of most interest are the contrasting data provided by faunal remains (Figure 3) which show a 13 percent decrease in bison use between the Late Paleoindian site occupation of 8,900 BP and the Early Archaic occupation of approximately 5,300 BP (Lyman 2004). Lahren (2006:112-114) records a corresponding 15 percent increase in Bighorn sheep procurement between the Late Paleoindian and Early Archaic occupations of the site. These data exemplify the changes of the Early Archaic period in which Native Americans increased their reliance on game other than bison. Other faunal remains in the Early Archaic levels at Myers-Hindman include pronghorn antelope, deer, elk, bird, and canid.
Figure 2. Map of Early Plains Archaic and Lithic Procurement Sites Discussed in Text in Relation to the Yellowstone River Ecosystem.
Another important Early Archaic occupation in Montana is the Buckeye Site in Carbon County, south-central Montana (Peterson 1999; Peterson et al. 2004). At an elevation of 4,680 ft. amsl, the site is located in Kings Canyon near a permanent spring which feeds the Shoshone River and, ultimately, the Bighorn and Yellowstone Rivers. Radiocarbon dates on sediments from the well-stratified site indicate three occupations around 6,300 BP. Excavations yielded nearly 2,000 lithic artifacts, including one Early Archaic side-notched projectile point with protein-residue of pronghorn. Mussel shell was also abundant at the site, suggesting its collection was an important part of the Early Archaic subsistence realm in south-central Montana.

Ethnobotanical remains from Early Archaic features and soil samples at the Buckeye Site indicate use of prickly pear cactus and biscuitroot for food and sagebrush and pine for firewood. The pine likely derived from the nearby Pryor Mountains, suggesting that Early Archaic people travelled into the mountains for food and supplies. Overall, data from the Buckeye Site indicate a wide diet breadth for Early Archaic hunter-gatherers, confirming data collected from other sites in the region.

Another Early Archaic site worthy of mention is Pretty Creek (24CB4), also in Carbon County in the south-central portion of Montana. At an elevation of approximately 4,200 ft. amsl, the site is located adjacent to a tributary stream of the Bighorn River within the foothills of the Pryor Mountains (Loendorf et al. 1981). A radiocarbon date of approximately 7,750 BP (UGa-957) (reported by Loendorf et al. 1981:189, as 7,685±580) places its occupation in the early portion of the Early Archaic (Frison 2001: 133-135).

Among the most important Early Archaic sites is Mummy Cave, which yielded five substantial Early Archaic site occupations between approximately 7,700 and 5,600 years ago (Wedel et al. 1968; Husted and Edgar 2002: 26). Mummy Cave is located at an elevation of 6,215 ft. amsl adjacent to the Shoshone River. Each of the occupations is characterized by large side-notched projectile points, with the three main occupations at 7700, 7200, and 5700 BP. In each of the occupations, the faunal assemblage is dominated by Bighorn sheep, along with lesser amounts of deer, elk, marmot, and bird remains.

The Helen Lookingbill site is located at an elevation of greater than 10,000 ft. amsl within the Absaroka Mountains of northwestern Wyoming. Excavated by the University of Wyoming, the Lookingbill site is a testament to the heights that Early Archaic Native Americans went to survive in the hot and dry Alithermal climate. At an elevation of more than 10,000 ft. amsl, Kornfeld et al. (2001) recovered seven male deer within a bone bed dating to approximately 6,800 BP. In addition, several Bighorn sheep are represented at the site with a notable lack of bison. Local cherts were procured at the site, suggesting a tethered settlement pattern around known resources in this rugged setting.

In addition to Lookingbill, two other northern Wyoming sites—Laddie Creek (Reider and Karlstrom 1987) and Medicine Lodge Creek (Frison and Walker 2007: 69-72)—support the hypothesis that human groups sought permanent water and cooler climates during the Early Archaic. Both sites yielded Early Archaic artifacts within well-watered steam valleys at elevations above 4,700 ft. amsl.

The prevalence of these high-elevation and well-watered sites stands in contrast to the lack of sites at lower elevations. In addition, none of these regional Early Archaic sites contained significant bison remains (Hill 2007; MacDonald 2012). Few substantial bison kill sites are recorded for the Early Archaic period anywhere in the northern Plains, even though several are present.
during earlier and later periods (Frison 1991; Kornfeld et al. 2010; MacDonald 2012). In our review of the archaeological literature, we observed only six sites in the entire northern Plains with bison remains during the Early Archaic, including Myers-Hindman (discussed above), Hawken (Frison et al. 1976), Beaver Creek Shelter (Alex 1991), Rustad Quarry (Running 1995), Licking (Fosha 2000), and Head-Smashed-In (Reeves 1983). Of these, only one—Hawken in the Black Hills, Wyoming (Frison et al. 1976)—can be considered a bison kill site on par with those identified during the Late Paleoindian period. As discussed above, Myers-Hindman shows a decline in bison remains between the Late Paleoindian and Early Archaic site occupations (see Figure 3). The other sites yielded small numbers of bison alongside the remains of other flora and fauna, suggesting a diverse diet breadth, rather than one focused on bison. An increased number of Early Archaic occupations within uplands would support the hypothesis that hunter-gatherers of this time period at least partially abandoned the hot, open Plains for the cooler, upland mountains and foothills. Proximity to water would also confirm the hypothesis that such access resulted in a tethered settlement pattern. In the above review, several sites fit this bill, including Myers-Hindman in uplands above the Yellowstone River, the Pretty Creek and Buckeye Sites along south-central Montana creeks, Mummy Cave on the Shoshone River, Lookingbill in the Absaroka Mountains, as well as Laddie Creek and Medicine Lodge Creek in the Big Horn Mountains.

The lack of Early Archaic sites of any kind in the eastern portion of Montana on the lower Yellowstone River suggests that Early Archaic Native Americans steered clear of the very hot and dry portions of the northern Plains. None of the Early Archaic sites in the region are at elevations of less than 4,200 ft. amsl and all are near water. As reflected in Figure 2, several other Early Archaic sites have been studied beyond the limits of the YRE, with most of these also at higher elevations near permanent water sources as well. Below, we provide data from another high-elevation site—Fishing Bridge Point on Yellowstone Lake in Wyoming—which supports the information presented above that Early Archaic hunter-gatherers regarded mountains, foothills, and well-watered areas as excellent places to live during the Altithermal.

Fishing Bridge Point Site (48YE381)

Archaeological excavations by the University of Montana and Yellowstone National Park at the Fishing Bridge Point site (48YE381) provide supportive evidence for the use of the high-elevation portion of the YRE by Early Archaic Native Americans (MacDonald et al. 2011, 2012). Archaeological and environmental data suggest that Yellowstone Lake was an oasis of sorts during the Early Archaic (per Yansa 2007), providing an ungulate-friendly grassland and comparatively cool and moist setting next to America’s largest high-elevation lake. At an elevation of 7,785 ft. amsl, the Fishing Bridge Point Site (48YE381) contained a small Early Archaic component above stratified Middle Archaic, Late Archaic and Late Prehistoric occupations. Located along the northwest shore of Yellowstone Lake, the site is near the outlet/headwaters of the Yellowstone River near Fishing Bridge in Yellowstone National Park. Fishing Bridge Point is located on Pierce’s (Pierce et al. 2007) S2 lake shoreline landform which he interpreted as dating to the early Holocene.

In July 2009, the University of Montana excavated a total of 18 1x1-meter test units at Fishing Bridge Point, yielding 4,811 lithic artifacts, as well as six prehistoric fire-features (MacDonald and Livers 2011). The six prehistoric features at Fishing Bridge Point range in age from Early Archaic (n=1), Middle Archaic (n=3), Late Archaic (n=1), to Late Prehistoric (n=1). Figure 4 shows a schematic profile with the features at their relative depths at the site. Of interest to us here is the Early Archaic site occupation, since it documents the only Early Archaic hearth feature of its kind in Yellowstone National Park and provides data on lake use during the period in discussion. As shown in Figure 5, Feature 12 was a small rock cluster 75-80 cm below surface within Test Unit 18, approximately 25 meters from the edge of Yellowstone Lake. The Early Archaic Feature 12 was located at the interface of the Ab2 buried soil and the BC/C horizon sub-soil. As such, it was likely built on the incipient beach of the lake shore during the time of use.

The feature lacks well-defined boundaries and is largely comprised of a loosely-associated grouping of burned and fire-cracked rock (MacDonald and Livers 2011). Small charcoal fragments in the matrix of the feature were collected for AMS radiocarbon dating. Beta
(265310) returned a conventional radiocarbon age of 5910±50 BP with a 2-sigma calibration of Cal BC 4910 to 4690 (Cal BP 6860-6640).

Feature 12, thus, dates to the Early Plains Archaic period and is the only radiocarbon-dated feature in all of Yellowstone National Park to yield a date of this time period. While Early Archaic projectile points have been recovered in the park, no features had ever been excavated prior to Feature 12 at Fishing Bridge Point. As discussed below, studies by Cannon and Hale (this volume) at Arnica Creek yielded a date of ca. 4500 uncal BP (5200 cal BP) on a hearth, suggesting a late-Early Archaic to early-Middle Archaic age; however, it was associated with a Middle Archaic projectile point. Given the effects of the hot-dry Alithermal climatic period on hunter-gatherer populations in the northern Plains, it was long thought that Yellowstone Lake and vicinity would have provided an excellent habitat for human use during the Early Archaic (Johnson 2001; Sanders 2001).

As such, Feature 12 confirms the presence of Early Archaic hunter-gatherer populations at high elevations of Yellowstone National Park. The site is approximately 35 km west of the Mummy Cave site and 100 km northwest of Lookingbill, two other Early Archaic sites discussed above. Below, we discuss the results of lithic analysis data which provide insight regarding how Early Archaic Native Americans lived at Yellowstone Lake approximately 7,000 BP.

**Lithic Analysis, Fishing Bridge Point Site**

Comparison of lithic raw material data from Fishing Bridge Point with earlier Late Paleoindian occupations and later Middle and Late Archaic occupations at Yellowstone Lake suggest dynamic shifts in settlement patterns during the early and middle Holocene in the region. Below, we compare Fishing Bridge Point Early
Archaic lithic data with those from the Late Paleoindian occupations at Osprey Beach (Johnson et al. 2004; MacDonald et al. 2011; Shortt 2001, 2003), as well as with the other Archaic features at Fishing Bridge Point. The Osprey Beach site contained a substantial Late Paleoindian (ca. 9,000 BP) occupation on the southern shore of Yellowstone Lake, approximately 20 km south of Fishing Bridge Point (Johnson et al. 2004). As reflected in Figure 6, Late Paleoindian occupations at Osprey Beach contained significant amounts of chert (46%) from at least six sources and non-Obsidian Cliff-volcanics (24%) from another 10 sources to the south and west of the lake. In stark contrast, Early Archaic Fishing Bridge Point occupations yielded nearly exclusively obsidian (90%), with 95% of that sourced to Obsidian Cliff. Only one other non-obsidian source (southwest Montana dacite) was identified in the Early Archaic assemblage at Fishing Bridge point, while chert and other non-sourced materials represent less than 10 percent of the entire Early Archaic assemblage (Figure 6).

Figure 6. Comparison of Late Paleoindian Osprey Beach Lithic Material Use with Early Archaic Fishing Bridge Point. Both Sites are within 12 miles of each other on Yellowstone Lake, Wyoming.

In total, at least 17 sources are represented in the Late Paleoindian Osprey Beach lithic assemblage, while only 6-8 sources account for the lithic assemblage at the Early Archaic Fishing Bridge Point Site (Figure 6). Total lithic assemblages from the two sites are not significantly different, with 127 lithics used in the Osprey Beach study (Johnson et al. 2004; this volume) and 90 used in the Fishing Bridge Point sourcing study (MacDonald and Livers 2011; MacDonald et al. 2011). The incredible diversity of lithic raw materials speaks to wide-ranging travel and trade patterns during the Late Paleoindian period in the northern Rocky Mountain region; this is in stark contrast to the constricted mobility of Early Archaic peoples living in virtually the same location.

Late Paleoindian hunter-gatherers at Yellowstone Lake incorporated a diverse suite of lithic raw materials into their repertoire, reflecting a settlement pattern encompassing much of the southern portion of the YRE. In contrast, Early Archaic occupations at Fishing Bridge Point indicate predominant use of a single source of obsidian (Obsidian Cliff) and comparatively few other materials, supporting the hypothesis of a tethered settlement pattern during the Altithermal.

In order to compare the chronological shifts in material use over time between Early, Middle and Late Archaic occupations, we compare the lithic artifact assemblages between the six dated features at Fishing Bridge Point (Table 1; Figure 7). Artifacts from immediate feature contexts—5 cm on the vertical and 50 cm on the horizontal—were utilized in these comparisons, with each feature typically having between 50-300 artifacts, thus making data samples sufficient for comparative statistics.

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As shown in Table 1 and Figure 7, there are definite trends in lithic raw material use over time between the various features. Of particular interest, the Middle Archaic features contain significantly less (83%) obsidian than the Early Archaic feature (90%). There is remarkable consistency in obsidian and chert usage between the three Middle Archaic features and the Late Archaic feature, especially in the comparative use of obsidian and chert. Chi-square tests show no significant differences in amounts of obsidian and chert from the four Middle/Late Archaic features (e.g., x^2=1.321; df=1; p=.250 between Middle Archaic Features 5 and 6; x^2=.536; df=1; p=.464 between Middle Archaic Feature 6 and Late Archaic Feature 4). The trend of increased obsidian use during the Early Archaic corresponds to decreased use of Crescent Hill chert (from sources approximately 45 km north) and slight increases in dacite from southwest Montana (more than 150 km northwest). Thus, during the Middle Archaic, Native Americans used less obsidian and dacite, but more Crescent Hill and other materials compared to their Early Archaic counterparts. Grouped Middle/Late Archaic lithic material data also show significant differences to the Late Prehistoric Feature 10 at Fishing Bridge Point (x^2=7.632; df=1; p=.006).

In summary, the Late Prehistoric and Early Archaic occupations were similar to each other in having increased obsidian and decreased chert use (x^2=.075; df=1; p=.784), while the Middle and Late Archaic occupations also were uniform, having less obsidian and more chert use compared to the other site occupations, as described above.

In addition to the general lithic raw material trends discussed above, 141 obsidian and dacite artifacts were submitted for x-ray fluorescence analysis to identify sources of volcanic materials used by prehistoric site occupants (Hughes 2010). Of those 141 volcanic artifacts, 101 were from the dated features at Fishing Bridge Point and three other sites within 0.5 mile of that site. These data are summarized in Table 2 and Figure 8. Obsidian Cliff is the predominant source during all site occupations, but is even more dominant during the Early Archaic (95%) compared to the subsequent Middle Archaic (86.4%) and Late Archaic (84.0%) periods. Use of dacite from southwest Montana is fairly minimal during all occupations, while use of Bear Gulch obsidian (50 km west) was strongest in the Middle Archaic, accounting for eight percent of the artifacts. The Middle Archaic also witnessed the widest variety of obsidian use, with another eight percent of the Middle Archaic artifacts deriving from the Crescent H and Teton Pass obsidian sources near Jackson, Wyoming (ca. 90 km south). During the Early Archaic occupations, only two sources of volcanic materials are represented in the sampled feature contents, compared to four volcanic sources during the Middle Archaic. These trends in directionality of obsidian sources are significantly different between the Early and Middle Archaic (x^2=12.766; df=1; p=.000).

Overall, based on artifacts sourced from well-dated feature contexts, the Middle Archaic period witnessed the most diverse use of obsidian and dacite sources at

<table>
<thead>
<tr>
<th>Site</th>
<th>C14 Date</th>
<th>Obsidian (%)</th>
<th>C.Hill (%)</th>
<th>Dacite (%)</th>
<th>Other (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late Prehistoric Feature 10</td>
<td>760±40</td>
<td>95.1</td>
<td>1.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>Late Archaic Feature 4</td>
<td>1730±40</td>
<td>82.9</td>
<td>5.7</td>
<td>0.0</td>
<td>8.6</td>
</tr>
<tr>
<td>Middle Archaic Feature 5</td>
<td>2920±40</td>
<td>82.9</td>
<td>4.9</td>
<td>0.0</td>
<td>12.2</td>
</tr>
<tr>
<td>Middle Archaic Feature 6</td>
<td>3090±40</td>
<td>82.9</td>
<td>6.3</td>
<td>0.0</td>
<td>10.8</td>
</tr>
<tr>
<td>Middle Archaic Feature 7.1</td>
<td>2840±40</td>
<td>83.8</td>
<td>5.4</td>
<td>0.0</td>
<td>8.1</td>
</tr>
<tr>
<td>Early Archaic Feature 12</td>
<td>5870±50</td>
<td>90.0</td>
<td>3.8</td>
<td>1.3</td>
<td>5.1</td>
</tr>
</tbody>
</table>

1 Conventional years B.P. All dates were assayed by Beta using AMS method on pine charcoal (MacDonald et al. 2012).
2 Includes untyped chert, orthoquartzite, petrified wood, quartz and quartzite.
narrow suite of lithic materials, with an almost exclusive reliance on Obsidian Cliff obsidian (95%) and dacite (5%). Lithic material distribution—via hunter-gatherer mobility and trade—can be inferred from these data. At Yellowstone Lake, travel/trade appears to be constricted during the Early Archaic, as reflected by the reduced diversity of lithic raw material selection and the heightened reliance on Obsidian Cliff obsidian. This suggests a tethered settlement pattern with fairly regular movement in localized areas and perhaps less travel/trade to areas outside of that localized territory.

**Figure 7. Comparison of Lithic Raw Material Use from Archaic Features at Fishing Bridge Point, Wyoming.**

When long-distance travel or trade occurs during the Early Archaic, it appears to be oriented to the west toward southwest Montana. During the subsequent Middle and Late Archaic, a heightened use of Crescent Hill chert and other materials suggests a relaxation of the constricted settlement pattern that characterized the Early Archaic. While Early Archaic Native Americans traveled fairly locally with rare travels to southwest Montana, Middle Archaic Native Americans appear to have widened their settlement and trade networks to incorporate the Gardiner Valley to the north and the Snake River Valley to the south, as reflected by trace amounts of obsidian from around Jackson, Wyoming.

While little diversity in lithics indicates more local travel perhaps tethered within the Upper Yellowstone River watershed during the Early Archaic, diversity in resource procurement is noted in the presence of deer, bovine,
and bear protein on artifacts from the Early Archaic occupations (Table 3; MacDonald and Livers 2011). As discussed by Gish (this volume), the presence of edible grasses in the Early Archaic Feature 12 also suggests use of plant resources at Yellowstone Lake during the Early Archaic. These data support those found at other regional sites (discussed above) which indicate a move away from bison specialization to a generalized foraging pattern (MacDonald 2012: 61).

### Table 2. Summary XRF Results, Five Evaluated Yellowstone Lake Sites (includes only dated feature artifacts).

<table>
<thead>
<tr>
<th>Period</th>
<th>Obsidian Cliff</th>
<th>Dacite</th>
<th>Bear Gulch</th>
<th>Teton Pass</th>
<th>Crescent H</th>
<th>Total XRF Lithics</th>
</tr>
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<tbody>
<tr>
<td>Late Prehistoric</td>
<td>34</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>35</td>
</tr>
<tr>
<td>Late Archaic</td>
<td>19</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td>Middle Archaic</td>
<td>21</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>Early Archaic</td>
<td>19</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>93</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>101</td>
</tr>
</tbody>
</table>

### Figure 8. Comparisons of XRF Data (volcanic materials) for Early Archaic, Middle Archaic, and Late Archaic Features, Fishing Bridge Point Site, Yellowstone Lake, Wyoming.

**Summary and Conclusions: Early Plains Archaic in the Greater Yellowstone Ecosystem**

While the effects of the Altithermal on humans in the Great Plains and Rocky Mountains are still debated, archaeological data from the Fishing Bridge Point site at Yellowstone Lake supports the contention that Early Archaic Native Americans were significantly affected by the changing climate between 8,000 and 5,000 BP. In contrast to the preceding Paleoindian Period, in which bison hunting was fairly popular, Early Archaic Native Americans hunted a diverse suite of fauna, as represented by deer, bison, Bighorn sheep, pronghorn, elk and other game at Early Archaic sites in the Yellowstone River Ecosystem, including Myers-Hindman, Pretty Creek, Mummy Cave, Helen Lookingbill, Medicine Lodge Creek, Laddie Creek, and now, Fishing Bridge Point at Yellowstone Lake, Wyoming.

The tethered settlement patterns and overall low site counts in the northern Plains and Rocky Mountains indicate that the Early Archaic was a time of change for Native Americans in Montana and vicinity. Between 8,000 and 5,000 BP, archaeological sites in the region are concentrated near water and at high elevations likely due to the increased temperatures and decreased precipitation of the Altithermal.
Lithic data indicate a significant constriction of lithic raw material sources during the Early Archaic period compared to the earlier Late Paleoindian period and subsequent Middle and Late Archaic periods. Ninety-five percent of the xrf-sourced artifacts from the Early Archaic occupations derived from one source, Obsidian Cliff. This is a dramatic switch from the Late Paleoindian occupation at Osprey Beach (only 20 km south of Fishing Bridge Point), which is represented by 11 different obsidians and six different cherts from across the southern YRE. Subsequent Middle Archaic occupations at Fishing Bridge Point also yielded greater lithic material diversity than the preceding Early Archaic occupation. These data suggest that hunter-gatherers at Yellowstone Lake switched from a wide-ranging settlement pattern in the Late Paleoindian period to a constricted, tethered mobility pattern in the Early Archaic. With the diminution of the hot and dry Altithermal, settlement patterns once again opened up to a wider landscape than was previously used during the Early Archaic. As discussed elsewhere in more detail (MacDonald et al. 2012), chi-square tests show significant differences in use of Obsidian Cliff and other obsidians between the Early Archaic Fishing Bridge Point and the Late Paleoindian Osprey Beach sites, despite their being only 12 miles apart ($\chi^2=102.055; \text{df}=1; p=.000$).

Finally, as discussed by Gish (Chapter 14, this volume), paleoenvironmental data collected at Fishing Bridge Point indicate the presence of a shrub-grassland at Yellowstone Lake (elevation: 7,750 ft. amsl) approximately 6,000 BP. Our pollen data confirm soils data from the nearby Dead Indian Pass in the Absaroka Mountains, which also indicate substantial shrub-grasslands in the pass at the same time (elevation: 7,900 ft. amsl) (Reider et al. 1988). As at the high-elevation Yellowstone Lake, the grasslands at Dead Indian Pass likely drew grass-hungry ungulates which also attracted their human predators during the Early Archaic period. Gish (this volume) also presents pollen data indicate increasing pine and decreasing grass pollen over the Holocene, suggesting the infiltration of lodgepole pine forest after the end of the Altithermal.

Archaeological data from the Fishing Bridge Point site support previously-collected data from other regional sites that the Altithermal was a significant climatic event for early and middle Holocene hunter-gatherers.
Specifically, hunter-gatherers living in the northern Plains and Rocky Mountains during the Altithermal—8,000 to 5,000 BP—moved into areas with reliable and permanent water sources, including river watersheds and lakes, especially those at higher (cooler) elevations. The Altithermal climate reduced bison herds in the Plains and Rockies during the Early Archaic, apparently encouraging a generalized foraging pattern for human hunter-gatherers.

The Early Archaic period is among the most interesting, but least well known, of any of the prehistoric periods in the northern Plains and Rockies. While excavations at Fishing Bridge Point are an important step forward, more work needs to be done at Early Archaic sites so that we can better understand the dramatic changes that occurred during this time.

Acknowledgements

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CHAPTER 6
FROM ARNICA CREEK TO STEAMBOAT POINT: PREHISTORIC USE ON THE WEST AND NORTHEAST SHORES OF YELLOWSTONE LAKE

By Kenneth P. Cannon and Elaine S. Hale

Limited excavations were conducted at four sites which produced a much richer story of periodic occupation from possibly as early as the Early Archaic through Late Prehistoric times. Across the lake are the steaming geothermal features of Steamboat Point. There within the grassy bluffs overlooking Yellowstone Lake are a series of sites that produced a rich material culture of lithic and ground stone tools, as well as evidence of bison hunting. The sites, 48YE696, 48YE697 and 48YE701, provide evidence of seasonal occupation that dates back roughly 8,000 uncalibrated radiocarbon years ago (BP) based on the recovery of a Lovell Constricted projectile point. Obsidian, sourced predominantly to Obsidian Cliff, is the dominant lithic raw material of an assemblage that includes thousands of pieces of debitage, expedient tools, formal tools, bifaces and cores, indicating tool production was occurring at these sites. Ground stone artifacts were also recovered from the excavations, two of which tested positive for deer, another one for bovine/bison antler, indicating domestic activities such as pemmican production or splitting of long bones for marrow extraction were taking place at the camp. Other tools tested positive for sheep blood, rabbit blood, cat blood on two artifacts, and canid blood, indicating a wide range of species were being utilized. The diverse tool assemblage at the Steamboat Point site suggests a longer term, multi-task, presumably warm seasons only, occupation (Cannon et al., 1997).

This chapter will present the unique qualities of each of the prehistoric occupation areas. Although different, they illustrate a uniformity of life ways of the hunter-gatherers through millennia of use of the landscape around Yellowstone Lake and a quality of life camped in a beautiful place with ample resources from which to secure sustenance. The work for this project was funded by the Federal Highway Administration, the National Park Service, and the U.S. Geological Survey. Many thanks to all who participated and made this project possible particularly Kenneth Pierce, George Crothers, Vince MacMillan, Linda Hulvershorn, Dawn Bringelson, the various field crew members, Cal Calabrese, Doug Scott, John Andresen, Ken Gobber, Ann Johnson, Adrienne Anderson, John Loundsbury, Dan Reinhardt, Wayne

Hamilton, and Grant Meyer.

**The West Shore of Yellowstone Lake: The Arnica Creek Complex**

The initial documentation of the area identified several surface scatters of artifacts on several terraces of the Yellowstone Lake shoreline near the mouth of Arnica Creek on the West Thumb (Figure 2). The 1958-59 Montana State University (MSU) crew recorded each surface scatter as an individual site but later surface and subsurface investigations by the MWAC crew found no separation between the site 48YE449, the First Blood site where the first pottery sherds in the park were documented, and the nearby site 48YE457, The Brothers site, another surface and subsurface lithic scatter adjacent to 48YE449 but on a higher terrace of the shore. Appropriately the sites were combined and are further investigated and documented as 48YE449/457. The other sites located at the mouth of Arnica Creek are site 48YE395, named (somewhat dubiously) the Fish Trap site, and 48YE454, the Teton View site. All of the sites lie within the lacustrine terraces at the mouth of Arnica Creek which flows into a lagoon protected from prevailing winds by naturally formed offshore storm bar deposits—a spit on which site 48YE395 is located. The elevation of the area is around 7700 ft. (2367 m) AMSL with the main evidence of cultural activity in areas of open meadows adjacent to the lakeshore and creek and on the spit. Cultural materials were not found in the area of the lodgepole pine overstory and it is possible that the forest may be encroaching on the meadow area which may have been more open in the past (Jakubus and Romme 1993).

Vegetation in the meadow areas is fairly sparse, consisting of numerous low-growing species which favor very well-drained sandy soils. A cursory vegetative

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**Figure 1. Location of Arnica Creek and Steamboat Point within Yellowstone National Park.**
inventory found lupine, buckwheat, stipa, phacelia, wild rose, plox, *Potentilla* sp. Jacob’s ladder, silver sage, yarrow, and penstemon, among others. There was less vegetation on the spit due to the seasonal reoccupation of the landform by the lake.

The modern climate regime for Yellowstone Lake is considered severe. Mean annual temperature at the Yellowstone Lake Station (elevation 7741 ft. [2359 m] AMSL) is 32.3°F with the mean monthly temperature ranging from 10.7°F in January and 55.2°F in July. Precipitation, falling mainly as snow, exceeds 30 inches (76.2 cm) per year (Dirks and Martner 1982) and the lake is usually icebound from December until late May.

Yellowstone Lake represents the remnants of a massive caldera which collapsed approximately 600,000 years ago. The northern and western portions of the caldera were subsequently filled by successive rhyolite flows between 160,000 and 70,000 years ago. At present, geysers, thermally influenced areas, and hot springs surround the lake and attest to the continuing volcanic and geothermal activity in the area (Christensen and Blank, 1975). The West Thumb portion of the lake, where Arnica Creek is located, is also the result of volcanic activity, probably having been formed between 200,000 and 150,000 years ago after the collapse of another caldera (Christensen and Blank 1972).

The 1992 MWAC research interests were oriented towards gaining a better understanding of the occupation in light of current knowledge concerning lake-level change. In subsequent years it has been recognized that many sites located on the Yellowstone Lake shores are indeed being lost to erosion. The work conducted at Arnica Creek by MWAC incorporated the geologic expertise of Dr. Kenneth Pierce whose study and current understanding of lake level changes suggests at least three and possibly six major cycles of caldera uplift and subsidence which influenced changes in the levels of Yellowstone Lake over the past 10,000 years (Pierce et al. 2007), possibly influencing human settlement (see McIntyre and Sheriff, this volume)
48YE449/457—The First Blood Site

In 1970 J. J. Hoffman returned to the site he initially documented and extended its boundaries farther west to the mouth of Arnica Creek and with the 1992 addition of site 48YE457, three subareas of the site were identified and investigated separately by the MWAC crew. Subarea East is the original site as defined by the 1958-59 MSU archaeologists and contained the ceramics. Subarea West is the meadow adjacent to the mouth of Arnica Creek, and Subarea 457 is the addition of the adjacent site. The extension of this site complex entails about 45,000 square meters.

Prior to excavation of the expanded First Blood site, a surface collection of artifacts resulted in the recovery of a chert projectile point, four retouched obsidian flakes, four obsidian biface fragments, one rhyolite biface fragment, one quartzite biface and a mottled reddish grey chert biface (possibly a preform). Twenty five shovel tests were conducted to assess the continuity of buried cultural material. Seventy-two percent were positive for buried cultural material and two obsidian projectile point fragments were recovered.

Excavations in the Subarea East recovered five more ceramic sherds, one of which is a rim sherd with a rounded tip (Figure 3). These may have been from the same pot reconstructed from the 33 sherds recovered by the MSU crew in 1958-59. The pot is stylistically similar to Intermountain Ware and the nature of the inclusions in the paste suggests a local origin for the clay (Figure 4). Three projectile points were also recovered in this subarea (Figure 5), one an obsidian corner-notched likely Late Holocene point, another a red obsidian serrated point tip suggesting a possible Late Prehistoric age and the third, a triangular obsidian point with wide corner-notches and a straight base, also suggesting a Late Holocene age. Subarea East also produced radiocarbon samples from the A Horizon or “the old occupation level” as described by Taylor et al. (1964) with the mean of the two dates at 1320 cal years BP (Figure 6). This date is consistent with ages obtained elsewhere for similar projectile point styles.

Subarea West, the portion of the site added on by Hoffman in the 1970s is located on the first terrace above the mouth of Arnica Creek. This area produced a much larger and more diverse array of cultural remains, implying more intensive utilization of the area. The artifact density was five times more than that of Subarea East. No ceramics were recovered from this unit. The projectile point fragments (Figure 5) include an indented base obsidian point with some affinity to McKean types (Figure 5c-d), but smaller; a point fragment with a straight serrated blade of banded tan chert, similar to Avonlea-type point (Figure 5h); one obsidian corner-notched straight-based point recovered in association with a 1500-year-old radiocarbon date (Figure 5g); and an obsidian point base fragment too incomplete for positive identification (Figure 5i), but an eared tang and the depth at which it was recovered suggests an Oxbow (Middle Holocene) association. Two radiocarbon dates were obtained from wood charcoal from within a feature deposit (F92-2) dated to 4575±67 (5297 cal) years BP (Figure 7), suggesting a middle Holocene age. Macrofossil remains from the feature include Carex sp., Salvia sp., and Silene vulgaris. The dominant taxa was initially identified as Hydrophyllum capitatum (waterleaf) but later suggested they were actually clubmosses or horsetail. Pollen samples from this feature were identified as Artemisia with low levels of Pinus and

Figure 3. Ceramic Sherds, First Blood Site
Gramineae pollen types.

Radiocarbon samples of wood charcoal from a fired rock feature (F92-4) eroding out of a sloping cutbank provided dates statistically the same at 1626 cal years BP. Analysis of the macrofossils from this feature include Carex sp., Chenopodium sp., cf. Hydrophyllum capitatum, Picea engelmannii, Pinus albicaulis, Pinus contorta, Pinus sp., Potamugeton sp., Spergula arvensis, and Viola sp. A single pollen sample from the feature produced frequencies of Pinus and Artemisia similar to modern samples. The elevated frequency of Gramineae pollen suggests possible economic utilization of grasses.

The features excavated in Subarea West produced dates from the Mid-Holocene through the Late Holocene and evidence of plant processing, which in 1992 and to date, is very limited in the park.
Investigations in Subarea 457 indicate continuous deposits along the eastern bank of Arnica Creek identifying it as a subarea of the First Blood site. Buried cultural deposits indicate a chronology contemporary with deposits near the mouth, as represented by several mid Holocene McKean-like projectile point bases (Figure 5). A large number of flakes recovered from this area provide an artifact density which is three times that of Subarea West. Obsidian dominates all of the artifact counts by about 80% throughout the site. Two general time periods are represented by both the diagnostic projectile points or point fragments and the radiocarbon dates: the Middle Holocene (Archaic) and the Late Holocene (Archaic). Possibly the earliest point represented in the assemblage is a side-notched point with a convex base (Figure 5a) which fits within the range of the Blackwater Side-notched points from Mummy Cave Layer 16 which dates to about 7630 years BP (Husted and Edgar 2002).

Curiously, few formal or expedient tools were recovered from this site. The assemblage consists only of biface fragments and utilized flakes. Only one scraper was recovered from excavations by MSU. Debitage from the site is consistent across the three subareas and fits the expectations of an assemblage associated with maintenance activities such as tool resharpening. No evidence of early-stage reduction is suggested by the assemblage, which is dominated (99.23 percent) by interior flakes.
48YE454—The Teton View Site

This site lies across the mouth of Arnica Creek from the First Blood site within similar aged deposits of eolian sands. The site was originally recorded in 1959 and the first National Register testing was conducted in 1992 for contemporaneity of deposits with the First Blood site as well as to understand the duration and nature of the prehistoric occupation.

A more substantial mantle of eolian sands is present on site 48YE454 than on the east side of Arnica Creek, and safety concerns (collapsing unit walls) did not allow excavations to continue until sterile levels. Therefore, the recovered assemblage should be considered representative only of the latest occupations; older, deeper deposits may also be present (Figure 8).

Diagnostic projectile points (n=8) were recovered from the surface and subsurface excavations (Figure 9). They include a quartzite Avonlea-like point (Figure 9a); a Late Prehistoric obsidian side-notched point; a broad corner-notched Late Holocene (Archaic) point with expanding base and serrated blade (Figure 9c); the base of an obsidian point too small for identification; two obsidian point tips (not diagnostic); the base of a split-stemmed obsidian point (Figure 9d); and the tip of a red chert projectile point (Figure 8).

Test Unit 8 produced a large number of chert flakes in Level 12 suggesting a lithic workshop area. Two radiocarbon ages provide a weighted average age of 3822 cal years BP (Figure 10). Nearly 900 artifacts were recovered from the surface and subsurface deposits at site 48YE454 with debitage being the largest class of artifacts at 878 items. In contrast with the First Blood site, obsidian is not the dominant material type recovered. Chert is the largest class but that predominance may not represent the site as a whole, possibly just the lithic workshop area (Figure 10). The debitage size and virtually no cortical flakes suggest late stage biface reduction and tool rejuvenation. The tool...
assemblage from the site is very limited, represented by only three expedient tools.

The age of occupation of site 48YE454 comes from two sources: radiocarbon dates and the cross-dating of projectile point styles from which two periods of occupation can be surmised. However, the sample may be biased since the potential of wall collapse prevented excavation below 1.5 meters. Middle Holocene (Archaic) occupation of this site is suggested by the three radiocarbon dates obtained from charcoal in stratigraphic association with cultural material. The split-stemmed base recovered from the site suggests occupation around 3980 years BP (Figure 9d). Other projectile points recovered from this site suggest Late Holocene occupation and several Avonlea-like points suggest Late Prehistoric occupation of the site (Figure 9a-b).

48YE395—The Fish Trap Site
Originally recorded by MSU in 1958 as a lithic scatter on the west end of a sand spit 75 yards south and 50 yards west of the mouth of Arnica Creek, the site (spit) receives the brunt of onshore winds and wave energy action. Vegetation is sparse with a few lodgepole pines,
and low-growing species such as penstemon, buckwheat, *Potentilla* sp., yarrow, silver sage, among others.

It is unknown whether fish were trapped behind the spit which never completely closes, or if prehistoric hunters used the spit to trap fish. Work by Kenneth Pierce, and more recently by YNP geologists, confirms that the spit is of natural origin. But from the prehistoric stone artifacts found on the spit, it is certain that prehistoric people used the spit.

A pedestrian inventory of the site in 1992 produced five obsidian bifaces, two expedient tools (one obsidian, one quartzite), and three projectile points from the surface. The projectile points include a side-notched brownish chert dart point that is similar to the Blackwater Side-notched point from Layer 16 (mid-Holocene) at Mummy Cave (Husted and Edgar 2002; Plate 13 and Table 3); a basal portion of an eared white chalcedony point that appears to have been notched at the base and is within the range of either McKean or Elko types; and an Oxbow-like point manufactured from tan translucent chalcedony. A black basalt lanceolate biface, with water erosion and an edge-worn obsidian flake which possibly functioned as a scraper were also recovered from the spit. Subsequent re-examination of the spit in 2002 with a student crew from Wichita State University and the University of Arkansas recovered seven chert and quartzite scrapers (Don Blakeslee unpublished field notes, 2002). The latest inventory took place after the extreme high water years of 1996 and

**Figure 10. Profile of Test Unit 8 (A) and 10 (B), Teton View Site (48YE454).**
1997 which may have washed away sands and small gravels exposing the scrapers.

The possibility exists that the artifacts may represent re-deposited materials eroding from the sites on the terraces. However, the number of Middle Holocene (Archaic) projectile points and the limited subsurface assemblage suggest evidence of in situ deposits. This site likely represents a work area used by the same groups occupying the near-by terraces. It is logical that hide scraping, processing of game, and other similar activities which would be made easier with ready access to water could have occurred on the spit which is easily accessible most of the summer months.

Although the site does not have sufficient cultural material, and the fact that the site is cyclically deflated by rising lake levels, it is not considered eligible for the National Register. Nevertheless, it is an area closely associated with the First Blood and Teton View sites that are eligible for National Register listing and this area should be considered as part of the Arnica Creek Archaeological Complex.

Northeast Shore of Yellowstone Lake

Beginning in 1989 the MWAC began recording and assessing 17 sites along the north shore of Yellowstone Lake as part of road reconstruction of the East Entrance Road which included testing at sites 48YE1 and 48YE304 near the outlet of the lake (Cannon et al., 1994). The culmination of this work occurred in 1993 and 1994 with the data recovery excavations being conducted at three sites in the vicinity of Steamboat Point (48YE696, 697, and 701; Cannon et al. 1997). Of particular importance are the results of two sites, 48YE697 and 48YE701, which are discussed below. Figure 11 shows the general location of the sites.

48YE697—The Windy Bison Site

The Windy Bison site (48YE697) was initially recorded in 1989 during the East Entrance Road survey (Cannon 1990). Near the edge of the cutbank in an area that appears to represent a blowout, many flakes were observed on the surface. However, the aspect of the site that was most intriguing was the exposure of bone in the cutbank. Testing in 1990 was conducted in several areas across the site, but the small bone bed was the most significant aspect of the site.

In 1993 and 1994 data recovery excavations were conducted by MWAC which included excavation of the bone bed, as well as the investigation of other portions of the site. However, the bone bed was the main focus of the investigations. Excavations entailed 23.2 m³, plus the excavation of two backhoe trenches for the investigation of the site’s geomorphic history.

The Windy Bison site is within eolian sands along the north shore of Yellowstone Lake at the eastern boundary of Sedge Bay (Figure 12). The area has been referred to in the past as Earthquake Camp, named by Dr. F.V. Hayden after an earthquake was felt by the expedition while camping here on the night of 19 August 1871 (Haines 1977). A photo of the campsite was taken by William H. Jackson (Figure 11).
The site is situated in an open meadow with isolated sagebrush. Overstory species include subalpine and Engelmann spruce. Changes in the vegetation since the Hayden expedition indicate an encroachment of overstory species on the meadow, a pattern observed in other portions of the Central Plateau (Jakubos and Romme 1993). They attribute the tree invasion of dry meadows to regional climatic shifts towards warmer and wetter growing seasons since the end of the Little Ice Age (ca. 1870). The modern on-site community is described by Despain (1990) as the Subalpine fir/western meadow rue habitat type.

The geomorphic context of the site consists of Holocene-aged lacustrine deposits of eolian coarse to medium sands (Figure 13). The sands tend to be poorly sorted and have probably undergone mixing by tree throws and rodent burrowing, as suggested by the general lack of internal stratification. However, at the western edge of the site two paleosols were described and dated in 1990. At about 1.9 m below surface a distinct organic layer is present. This clay loam deposit, Stratum VI, is about 10 cm thick and dark grayish brown in color. A bulk soil sample produced an age of 4260 ± 60 BP (Beta-38813). A second paleosol is present from about 1.6 to 1.75 m below surface (Stratum IV). This dark grayish brown clay loam produced a bulk soil age of 1620 ± 50 BP (Beta-38812). Between these two paleosols is a brown sandy clay loam disconformity (Stratum V) that may represent a period of erosion or limited deposition.

Climatic change is usually the mechanism driving landform stability and the development of soils; however, at this site lake level change may be a more...
important factor driving this system. When the lake is high, constant wave-lapping and periodic storm surges act to maintain an unstable cutbank that cannot support vegetation. As wave action continues to undercut the bankwinds pick up the sediments and redeposit them on the beach surface. This type of lake regime provides a ready source of depositional material that produces rapid buildup. At the opposite extreme, when the lake is at a low stand, wave action is reduced and the bank remains stable. During this time, deposition is limited and soils have an opportunity to form (Kenneth L. Pierce, personal communication 1990).

The role of hydrothermal activity in the geomorphic history of the site has not been fully assessed. Deposits of altered and angular rock, tentatively identified as hydrothermal ejecta, have been mapped and described across the site. A subaqueous vent is present at the western portion of the site and visible during late summer when lake levels are low. Hydrothermal input (e.g., increasing temperature with depth) has also been detected by soil temperature probes placed on the site for obsidian hydration dating (Cannon et al. 1997). Ground heating may have been an attraction for game in the past, as it is today around Steamboat Springs and Beach Springs, and other thermal areas (Meagher 1973).
As previously mentioned, initial investigations at the site in 1989 and 1990 (surface collection and four test units) provided evidence of buried deposits (Figure 14). While the lithic assemblage was limited to the recovery of 17 bison elements, the associated debitage and fired rock provided impetus for returning to the site to conduct data recovery investigations.

Figure 15. Unifacial Flake Tools from Bone Bed, Windy Bison Site, 48YE697.
The bone bed was the main focus of the 1993-1994 investigations (Figure 14). This block excavation was terminated at a depth of approximately 110 cmbd and produced two stratigraphically consistent radiocarbon ages. The upper age, 360 ± 60 BP (Beta-78906, CAMS-17810), was provided by a charcoal wood fragment from a burn zone exposed in the west wall of N936/E1059 at 22 cmbs. The lower age, 800 ± 60 BP (Beta-38723), was provided by a collagen age from an unburned bison rib.

The lithic assemblage from the site consists of 376 pieces of predominantly tertiary flakes (98.4%), two expedient tools, and two formal tools. Among the debitage, obsidian is dominant (73.14%), followed by chert (24.54%), and then other material types (4.52%). Among the tools, half are obsidian and half are chert. The debitage assemblage indicates resharping and late-stage bifaces reduction were the main activities.

The tool assemblage from the Windy Bison site is rather limited consisting of two formal tools and expedient flake tools. The formal tools consist of a chert graver and a chert scraper (Figure 15). The employable units identified on the formal and expedient tools indicate they were used for a number of tasks that range from the heavy working of bone or wood, heavy cutting of semi-rigid or rigid materials, and cutting of yielding to semi-rigid materials.

Sixty-one faunal elements were recovered during the 1993-94 excavations. The majority (n=59) were recovered in the bison bone block (Figure 16; Figure 17). Four mammalian species are represented, but only the bison can unequivocally be associated with the human occupation of the site.

In addition to bison, the olecranon portion of the left ulna from an elk (Cervus elephus) was recovered from N930/E1058 at a depth of 49 cmbs. This element was recovered in the higher portion of the unit that produced the bison bone. In 1990, two elk elements (an unsided metatarsal and the portion of a right ilium) were also recovered from the cutbank below the bone bed, suggesting that a larger deposit of bone (possibly multi-period occupations) may have been present at one time, but has since eroded into the lake.
Fifty-eight bison (Bison bison) elements were recovered from excavations at this site, with all but a right tibia (N959/E1025 at 144 cmbd) being recovered from the bone bed. The bone bed extended between depths of 50-70 cmbd within portions of excavation levels 4-7. The elements consist of almost the complete skeleton of a young bull bison in association with obsidian flaking debris. The most notable elements missing are the mandibles, which may have eroded into the lake. Although the bison appears to have been minimally butchered based on the general articulation of the elements, score marks, possibly the result of butchering, are present on the anterior portion of the humerus diaphysis, the hyoid, and the distal-lateral surface of the tibial crest of the left tibia.

Between the 1990, 1993, and 1994 excavations, a total of 49 pieces of debitage were recovered from the six test units within the bone bed. Two peaks in lithic density occur within these test units (Figure 18), one near the surface (n=32 flakes) and one in association with the bone bed (n=17 flakes). The profile of lithic debitage density by level illustrates two density peaks, confirming the likely cultural association between the lithics and the bone in excavation levels 4-6. Flakes on the surface may have derived from the buried bone bed via bioturbation. Alternatively, the surface flakes could mark a more recent site occupation.

Gender of the bull bison was determined by comparing the size of the metapodials with those of known modern bison and characteristics of the skull. Based upon incomplete fusion of the humerus the age of the bison was judged to be approximately four years old at the time of death.

The weathering patterns and the general lack of carnivore gnawing suggest a complicated pattern of deposition. In general, the bone preservation is good,
although a number of long bones exhibit advanced stages of dry bone cracking that may be attributed to compression or surface exposure. However, if the carcass was exposed on the surface for a long period of time, greater evidence of scavenging would be expected—extensive evidence of gnawing and dispersal of elements. Examination of the elements revealed evidence of only one bone, the right tibia (FS20841), with carnivore gnawing marks. Dry bone cracking may also not be a good indicator of surface exposure, but instead may be the result of geothermal heating of the ground.

In order to assess the possible season of death, as well as how long the carcass was on the surface, a soil sample from within the skull and body cavity of the bison was submitted to Dr. Scott Elias (Royal Holloway, University of London) for extraction of insect remains. Unfortunately, no insect carcasses were recovered that were contemporary with the bison skeleton. The lack of data may suggest that either the animal was killed during a season of cool weather when beetles are not active, or the sediments did not allow for preservation. While preservation was probably a factor, the late-season of death cannot be ruled out.

Examination of the weathering stages on several elements using the taxonomy described by Todd et al. (1987), reveals that non-compact elements, or long bones, have greater evidence of weathering damage than compact elements. This pattern would be expected since long bones have greater surface area and are more susceptible to weathering than smaller, compact bones.

The cf. fifth cervical vertebra of a bighorn sheep (*Ovis canadensis*) was recovered from the same unit (54 cmbd) as produced the bison and elk, possibly providing more credence to the hypothesis that this bone bed was more extensive at one time.

The right portion of the skull, including palate, maxilla, zygomatic arch, and M^2, from a meadow vole (*Microtus montanus*) were recovered from unit N939/E1058 between 30 and 40 cmbd and most likely represent a natural deposit of this common meadow species.

Although the Windy Bison site does not have an extensive record of cultural materials, the recovery of bison from the site was important and represented one of the few recovered in YNP to date in a cultural context. Although somewhat equivocal, the score marks and associated debitage indicate a cultural origin for the bison remains.

![Debitage (% by level/bone bed)](image-url)

**Figure 18. Distribution of Flaking Debris by Excavation Level within Bison Bone Bed, Windy Bison Site.**
48YE701—Steamboat Point Site

Initially recorded in 1989 during the first phase of the East Entrance Road survey, the site occupies several landforms between the shore of Yellowstone Lake and the Pleistocene terraces (Cannon 1990). An active geothermal vent that lies on the southern periphery of the site producing steam which attracts both tourists and bison today as it appears to have in the past considering the near-by bison kill site. This site is the first opportunity for a close view of Yellowstone Lake from the current East Entrance Road alignment and remains today an uncommonly beautiful vista. This site lies within at least three terraces on the north east shores of the lake encompassing about 9000 square meters. Previous, 1930s construction of the road and the parking area have likely destroyed a large portion of the site although early investigations indicate that a substantial portion of the site is still intact. The MWAC crew of archaeologist conducted data recovery at the site in 1993 and 1994 prior to the mid-1990s road widening.

The southern portion of the site lies in an open meadow with various grasses of the Poaceae family and other herbaceous species. The rest of the site is generally in a mixed-conifer overstory community. Despain (1990) classifies the community as subalpine fir/western meadow rue habitat type. Vegetation recorded on the site includes subalpine fir, Douglas fir, lodgepole pine, silver sage, elderberry, red raspberry, white stem, gooseberry, huckleberry, sticky geranium, balsam root, woodland strawberry, mountain dandelion, wheatgrass, woodland star, bed straw, yellow columbine, cow parsnip, yarrow, western groundsel, wax currant, heartleaf arnica, and wild rose. Sediments are generally of sandy loams of eolian origin that have been mixed by tree throws and rodent burrowing. Larger clasts of cobbles and boulders are present in subsurface deposits.

During the initial 1989 survey of the site surface collections included 83 pieces of debitage, 14 expedient obsidian flaked stone tools, 1 obsidian scraper, one obsidian base point fragment, 1 large obsidian eared projectile point/knife, 3 obsidian bifaces, 2 obsidian cores and 1 chert (cryptocrystalline silicate, CCS) core.

In 1990, various subareas of the site were excavated for National Register assessment of the site. These test excavations produced 368 pieces of debitage, the basal portion of a quartzite Lovell Constricted projectile point generally considered to be 8,000 years old, two ground stone slabs (Figure 19), and numerous formal and expedient tools. The eastern portion of the site which lies within the oldest terrace sequence of the lake produced the most interesting ground stone and projectile point artifacts. It was determined that excavation and recovery of significant archaeological data from the site areas to the north of the road alignment where road widening would further impact the site should be conducted.

A series of units were excavated in 1993 and 1994 along with additional surface collections and shovel tests at the site. The flaked stone tools recovered from the site included 1,498 pieces ofdebitage, 70 expedient tools, 14 formal flaked tools, 7 bifaces and 13 cores. Almost 95% of the recovered debitage was between 3.34 mm to 1.27 cm indicating that both tool resharpening and biface reduction activities were taking place.

A total of 11 projectile points and knives were recovered, three of which were from the surface and include an obsidian, basal stem fragment, a large obsidian eared projectile point and a large chert corner-notched projectile point (Figure 20). A large obsidian corner-notched point which tested positive for sheep blood residue was recovered from a shovel test. From the excavation units one projectile point basal fragment of a quartzite Lovell Constricted-Stem with edge grinding evident was recovered; an obsidian base fragment and two large obsidian corner-notched projectile points were recovered although none tested positive for blood residue. One chert straight-based stemmed and hafted knife tested positive for rabbit blood residue while another chert knife with a concave base was negative for blood residue. A chert projectile point base tested positive for cat blood residue.

Other formal tools included an obsidian scraper, a chert end scraper and a chert graver. Of the 70 expedient tools nearly 93% were obsidian and the rest chert. The expedient tools displayed a variety of edge angles. Low edge angles are suitable for slicing meat and cutting hide. The medium edge angles are suitable for skinning, hide scraping, sinew or plant fiber shredding or cutting of bone, wood or horn. Expedient tools with high edge angles are suitable for heavy working of bone or wood or heavy plant fiber shredding.
The recovery of micro-tools, smaller flakes with signs of retouch and use, from the site is an uncommon occurrence in YNP. They consist of complete tertiary flakes between 0.5 and 1.5 cm in maximum dimension. All ten of the micro-tools from the site are of obsidian and all come from subsurface proveniences between 20 to 50 and 60 to 70 cm below datum. They are found in a variety of shapes from convex to concave, straight, and sigmoid all with steep edge angles. Due to their small size it is likely they were hafted in some manner and possibly involved in detailed scraping or shredding.

Such micro-tools have been documented in other sites such as the hafted bipolar flakes at the Hoko River site (Flenniken 1981), the Bootlegger Trail site, although somewhat larger (Roll and Deaver 1980) and were discussed by Irwin-Williams and Irwin (1966) and Black (1991).

Few bifaces were recovered at the site (n=7), all of which are obsidian and none are complete. Edge wear analysis identified low, medium and high edge angles with a variety of suggested uses and several retouched unifacial edges.

Figure 19. Groundstone Slabs from Steamboat Point Site, 48YE697.
A total of thirteen cores, seven chert, five obsidian, and one basalt were recovered from the site representing an unusually high number of this tool type for sites in Yellowstone. Most of the cores were exhausted and some of the chert cores displayed scalar scars.

Ground stone tools are not commonly recovered in buried archaeological context in the park although three ground stone tools were recovered at Steamboat Point (Figure 21). All three ground stones were recovered from buried context within three horizontal meters of each other and vertically within 25 cm, possibly suggesting a localized activity. Two ground stones were submitted for pollen and blood residue analysis. One tested positive for deer and the other tested positive for both bovine (bison) and dog (coyote, grey wolf or red fox). This result suggests the ground stone tools were used for processing resources other than plant foods. The presence of deer and bison proteins may indicate that the tools were used as a surface for the preparation of pemmican or the splitting of long bones for marrow extraction. The canid protein also suggests food preparation and that ground stone tool also showed evidence of grinding and pounding.

The pollen wash from the surface of the ground stone was disappointing for it did not yield sufficient pollen for analysis. The phytolith record for the ground stone was also limited. The grass phytoliths recovered were dominated by festucoid grasses and may reflect a preference for grinding certain grasses or grass seeds. Festucoid grasses (Stipa, Poa) are the most common grasses in the park and indicate cool, moist habitats. Of interest is the large quantity of volcanic ash in relation to the total quantity of grass phytoliths. Approximately four times as many volcanic ash fragments were recovered from the wash as grass phytoliths.

The presence of ground stone, also referred to as milling tools, metate, and grinding slabs, in archaeological sites in Yellowstone National Park and other montane environments of the central and

Figure 20. Stone Tools from Steamboat Point Site, 48YE697.

Figure 21. Profile of Steamboat Point Site Showing Groundstone.
Northern Rocky Mountains and adjacent basins has been interpreted as evidence for the processing of plant resources (Frison 1991; Benedict 1981), although Mulloy (1954) suggested their use for grinding up small animal bones into a paste. Groundstone artifacts have been seen as a hallmark of the archaic lifestyle or subsistence pattern (Mulloy 1954; Husted 1969; Frison and Grey 1980). Ground stone artifacts recovered from the Medicine Lodge Creek and Bighorn Canyon sites has been argued as evidence for extending this pattern back to the terminal Paleoindian times, with increasing use and quality of tools culminating with the Middle Plains Archaic McKeen complex (Frison 1991).

For the Grand Teton-Yellowstone area, the presence of these artifacts at sites of various altitudes has been argued as evidence for the procurement of seasonally ripening plant resources. This model assumes the relationship between ground stone artifacts and plant processing, despite the paucity of direct evidence (Wright et al., 1980; Wright 1984; Bender and Wright 1988). More direct evidence from pollen washes of ground stone and macrofossil evidence from features as well as organic residue and macrofloral analysis of both ground stone and fire cracked rock features are now possible and would more clearly demonstrate the range of uses of these artifacts in the diverse economies of hunter-gatherer groups.

Regionally and locally archaeological excavations have recovered fired rock features without ground stone, and ground stone artifacts have been recovered in context other than association with fire cracked rock, suggesting closer scrutiny and additional interpretations of the functions of ground stone tools is needed. This hypothesis is based not only on the positive reaction to animal blood antiserum on two ground stone artifacts from the Steamboat Point site (also see Yohe et al., 1991), but also from ethnographic accounts of various tribes combining ground meat with roots, seeds, plants, and berries for enhancing food storage (Walker 1975; Walker 1987; Adams 1988).

Geochemical analysis of selected obsidian artifacts from the Steamboat Point site revealed the majority of obsidian artifacts were made from Obsidian Cliff volcanic glass. Three artifacts were sourced to the Bear Gulch source suggesting movement of people from the west where the Bear Gulch obsidian was obtained eastward to the east shores of Yellowstone Lake where the artifacts were discarded. Another artifact from the Steamboat Point site was sourced to Cougar Creek, again suggesting eastward movement of people. Another obsidian artifact was sourced to Teton Pass, which is south of Yellowstone Lake and may suggest movement of people from south to north. Eight obsidian artifacts were sourced to areas unknown in 1996, but were later confirmed to be from the Park Point obsidian source on the eastern shore of Yellowstone Lake (see McIntyre et al. this volume), approximately 10 miles south of the site.

A single radiocarbon age was obtained from the Steamboat Point site. The age was obtained from a charcoal sample in association with ground stone (FS6983), but may represent a mixture of charcoal from different sources and should be considered a minimum age for the deposit. Bioturbation, in the form of tree throws and rodent burrowing, was commonly identified during excavation and may have mixed younger and older charcoals. Taylor (1987) found that a one-percent addition of modern charcoal to a sample with an age of 5000 BP will result in an apparent age of 4950 BP; a five percent addition would cause a 350 year decrease in age. The effect will increase proportionately with age. The age obtained, 1250 ± 70 BP (Beta-83300), should be considered minimal. Unfortunately, characteristics of the groundstone do not provide any clues to its age and cannot be used as a cross-check of the radiocarbon age.

Projectile points provide the best evidence for understanding the occupational history of the Steamboat Point site and indicate seasonal use from the late Paleoindian era as evidenced by the recovery of the buried Lovell Constricted point (around 8,000 years before present.) Additional projectile points suggest use of the site during the Late Archaic and Late Prehistoric culture periods (3,000 to 1,000 years before present).

The Steamboat Point site (48YE701) provides a unique glimpse of cultural use of the lake shore and evidence of diverse activities and procurement strategies. Although very different than the archaeological record left in the Arnica Creek complex, both sites enhance our understanding of the lifeways of early park visitors.
Conclusion

Between 1989 and 1994 the Midwest Archaeological Center was involved in a series of investigations along the West Thumb and Northeast Shore portions of Yellowstone Lake that provided some of the first detailed and extensive excavations. These excavations provided evidence of seasonal use of the lakeshore for approximately 10,000 years.

Limited testing for National Register assessment at four previously recorded sites at the mouth of Arnica Creek provided evidence of intermittent occupation over the last 4500 years, possibly as early as 7600 years ago. Investigations at 48YE449 indicated continuous surface and subsurface deposits between this site and an upstream site (48YE457) that has led us to incorporate the cultural deposits within a single site complex 48YE449/457.

A buried soil dating to about 1450 B.P. was uncovered with associated artifacts. This soil had been briefly described based on investigations at the site in 1959 (Taylor et al., 1964), but was undated. Ceramics, tentatively identified as Intermountain Ware, were recovered from the surface of the site. Probably the most exciting evidence recovered was the remains of three fired rock hearths dating from 4570 to 1700 B.P. Macrobotanical remains include Carex, Salvia, Silene vulgaris, Chenopodium, Picea engelmannii, Pinus albicaulis, Pinus contorta, Potamagen, Spargula arvensis, and Viola.

Excavations at 48YE454 produced a lithic assemblage similar to that of 48YE449/457, dating to the last 4000 years, however, no evidence of plant processing was uncovered. Site 48YE395, located on a partly reactivated storm bar, may have originally been constructed during the mid-Holocene. Our current understanding of lake level change suggests at least three major cycles, possibly as many as six, of caldera uplift and subsidence influencing changes in lake levels over the past 10,000 years (Pierce et al. 2007). Currently, the lake is at a culmination as evidenced by backflooding of Arnica Creek and other tributaries in the area.

Geochemical analysis of obsidian artifacts resulted in identification of at least seven geochemically distinct obsidian sources in the assemblages (Table 1). Not surprisingly, almost 80 percent of the aggregate was from Obsidian Cliff, with sources from Jackson Hole and Idaho represented in smaller proportions. At Steamboat, Park Point obsidian represents a significant amount (16%) of the obsidian assemblage. Additional analyses conducted include blood residue analysis of lithic tools which produced evidence of canid, bear, sheep, rabbit, and bovine antisera on various projectile points spanning the Holocene (Table 2).

While the excavations in the Steamboat Springs area were more limited in their results, they did provide important evidence of seasonal occupation of this portion of the lake that likely extends back to the late Paleoindian. These discrete artifact deposits indicate that bifacial thinning and resharpening were the major lithic activities. The number of flaked tools and artifact classes recovered from the Steamboat Point site would suggest that a greater diversity of activities were being accomplished in comparison to the other two sites.

Evidence for evaluating prehistoric subsistence patterns at the Steamboat Point sites was in general limited, owing most likely to factors of preservation. The only faunal remains recovered from an unambiguous cultural context was the 800-year old bison from 48YE697. The evidence from this site suggests a single, male bison was taken and minimally butchered adjacent to the bluff overlooking the lake. The bluff may have aided in the trapping of the bison by the hunters and may have been opportunistic. Other subsistence evidence comes from blood residue analysis on many flaked and non-flaked artifacts. These results produced evidence of six genera: bison, deer, sheep, canid, cat, and rabbit. These protein-residue data are summarized in Table 2.

The lakeshore sites offered an opportunity to investigate subsistence patterns utilizing traditional methods (lithic analysis) and emerging, non-traditional techniques, such as blood residue analysis, that indicate that other avenues of investigation are relevant for addressing these issues. The truly important aspect of these studies was to demonstrate that lithic scatters in the Rocky Mountains, historically viewed as having limited research potential, had more to offer, and management of these resources needed to allow for a more critical investigation using a range of methods and techniques.
### Table 1. Summary of XRF Analysis Results for Arnica Creek and Steamboat Point Areas.

#### Arnica Creek Sites, XRF Results

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#### Steamboat Point Sites, XRF Results

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### Table 2. Summary of Protein Residue Analysis Results for Arnica Creek and Steamboat Point Areas.

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#### Protein Residue Results, Summary, Both Areas

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CHAPTER 7
RESULTS OF EXCAVATION OF THE DONNER SITE (48YE252), SOUTHEASTERN YELLOWSTONE LAKE

By Robin J.M. Park

The Donner site (48YE252) is a multi-component campsite located on the Southeast Arm of Yellowstone Lake (Figure 1). Fluctuating lake levels (caused by the “breathing” of the volcanic caldera and spring melt runoff) trigger rapid erosion of the shore banks of Yellowstone Lake, revealing pre-contact cultural materials which end up on the beach surface. This constant erosion threatened the survival of the Donner and other sites, as well as invited illegal collecting of identifiable tools from the beaches.

Several visits to the Donner site recorded many formed tools exposed on the beach surface and a hearth feature eroding from the shore bank. The sheer volume of materials observed and the research potential of these materials, as well as the success of the excavation at another lakeshore site (Osprey Beach), indicated that the Donner site was potentially a significant occupation and in need of salvage excavation. A full data recovery project was performed in July 2008, to attempt to mitigate natural impacts to the site. The results of that excavation are summarized here, and include the recovery of a large hearth feature, over 3000 lithics (including knives, scrapers and drills/other perforating tools), and 28 projectile points, several of which were collected from a submerged sandbank offshore from the site area.

Background
Many resources essential to a hunter-gatherer lifeway were readily available near Yellowstone Lake, including fish, animals, edible plants and stone tool making materials. This area was likely very attractive to pre-contact peoples, a key stop-over place on seasonal migrations across the Yellowstone Plateau. There is ethnographic, historical and archaeological evidence for use of a natural travel route following the Yellowstone River from its source to Yellowstone Lake, what is now called the “Thorofare”, after historic accounts of its popularity as a route north from the Jackson Hole area (see Jones 1875 for an example). Indeed, the archaeological evidence for pre-contact use of the lakeshore is significant, particularly during the Paleoindian period. To date, 285 pre-contact sites have been recorded along the 110 miles of lakeshore surrounding Yellowstone Lake (MacDonald, this volume; Vivian et al. 2007). This area is also one of the most threatened by natural and human impacts to these sites, particularly erosion and illegal collecting. Sitting directly on top of an active volcanic caldera, Yellowstone Lake is subject to regularly fluctuating water levels not only from high water years, but from the “breathing” of the caldera beneath it. The wave action on sandy benches comprising the lakeshore means a very rapid erosion of these benches and beaches. This rapid erosion rate has been revealing components of pre-contact sites for decades, with artifacts and features literally eroding out of the banks of the lakeshore and onto the beaches surrounding the Lake. This situation presents an interesting challenge to the park archaeology program, namely how to manage sites which are being severely impacted by natural forces, and how to best salvage as much information from these threatened sites as possible before they are lost forever.

As evidence for the high potential of lakeshore sites to yield significant information, much of the material collected from the beaches during surface survey is diagnostic and includes different types of formal tools. The variety of dates and tools types represented in beach collections alone shows the potential for gaining valuable insight into life on the Lake for pre-contact people.

Yellowstone Lakeshore Sites
The Yellowstone Lake area has long been recognized as having great potential for archaeological resources. Select portions of the southern lakeshore were initially inventoried by Cannon in 1999 (see Cannon 1999). However, the southern lakeshore was not thoroughly inventoried for cultural resources until the Lakeshore survey project performed by Lifeways of Canada Ltd. in 2004 (see Vivian et al. 2007). Currently, a major project performed by the University of Montana is in its fourth
year of systematic inventory and testing of the entire circumference of the lake (MacDonald et al. 2012; MacDonald, this volume). This project was initiated largely in response to the continuing, rapid destruction of sites as evidenced by the Donner and other key sites along the lakeshore.

Not only are sites along the lake subject to massive soil matrix disturbance, they are also among the most significant sites in the park, particularly for their representation of Paleoindian cultures. One of the most significant and oldest recorded sites excavated in the park is the Osprey Beach site, located on the western lakeshore. Osprey Beach is a multi-component, Cody Complex campsite representing repeated seasonal use by several families through time (see Johnson et al. 2004). It remains one of the most significant sites ever recorded in the park. This site was excavated in the mid-nineties following several surface/beach collections which yielded a high volume of diagnostic artifacts which had eroded from the bank. The Osprey Beach site has served as an example of what we might be losing to erosion if sites along the lake are not monitored and salvaged if necessary. The results of the Osprey Beach excavation were part of the impetus to monitor the Donner site and
others which had already yielded a significant volume and variety of diagnostic tools and other lithics through beach collections. A few other sites close to the Donner site on the Southeast Arm were also of interest and are briefly described below to provide a better picture of the potential density of sites in this area and the similar impacts these sites are facing.

Schaller Site and Grace Point Site Collections
The Schaller site (48YE1495) was originally discovered by Dr. George Schaller, a prominent biologist and conservationist, while performing research in Yellowstone in 1962 (Photograph 1). He was studying the pelican population roosting on the Molly Islands, tiny islets visible from the southern end of the Southeast Arm of Yellowstone Lake. He observed many lithics exposed on the beach near where he was camped, made maps of the find spots and site location, took photos and collected some of the more identifiable formed tools to prevent their looting. It was not until 2006 that this collection (totaling 187 artifacts) was analyzed and considered in conjunction with additional surface collections made by volunteers and staff (see Szamuhel 2007). The site was named after Schaller by park archaeologist Ann Johnson, and the site was considered in connection with other nearby sites with similar surface assemblages, such as the Donner and Grace Point sites. The Grace Point site was recorded, surface collected and mapped by volunteers Joel and Patty Scrafford in 2001. These sites all appeared to be campsites occupied during several different time periods, including the Paleoindian and Archaic (based on diagnostic tools). In addition, they were all affected by water and wind erosion, disturbing the soil matrix and exposing artifacts on the beach. These sites clustered around the south end of the Southeast arm were re-visited several times between 2000 and the Lifeways survey in 2004. In each instance, more and more lithics and fire cracked rock were observed eroding from the bank onto the beach, and the sheer volume of artifacts visible on the surface was indicative that this part of the Lake had potentially seen a lot of use in the past. As a testament to the severe erosion and loss of shoreline in this area, the University of Montana visited the Schaller Site in 2012, finding little left of the site, with most of it submerged (Photograph 1).

Discovery and Management Actions
The Donner site was first recorded as two sites, 48YE252 and 48YE253, by Ken Cannon in 1997, as part of a pedestrian survey of select sections of the southern lakeshore (Cannon 1999). Cannon recorded a large dense lithic scatter occurring on a beach along the shoreline southwest of the Molly Islands. This lithic scatter consisted of a variety of artifacts including formal tools, ground stone and debitage, with a variety of material types represented. Although Cannon observed the lithic scatter over much of the beach surface, he did not find any evidence of material eroding from the lakeshore bank. Thus, he suggested that cultural material was likely “being redeposited along this beach by long shore drift that flows from east to west” (Wyoming Cultural Properties Form, on file at Yellowstone’s Heritage and Research Center archaeology lab). Cannon collected five projectile point fragments, all made of volcanic glass.

In the years following its discovery, the site was repeatedly visited by Park Archaeologist Ann Johnson to monitor and document the rate of erosion and impacts to the site, as well as to salvage eroding features and
collect surface artifacts from the beach. Observations and collections made by volunteer Tom Murphy, an avocational archaeologist and professional photographer, led to further the sense of urgency to mitigate the destruction of the site. Murphy re-visited the site in 2000, mapping and collecting artifacts exposed on the beach (Photograph 2). This collection was for the purpose of limiting the visibility of the site to visitors in an attempt to control illegal collection. This collection also served to further the need for testing of the site, as in addition to collecting a large number of artifacts, Murphy also recorded a hearth feature eroding from the bank, surrounded by fire cracked rock littering the beach. The artifacts collected by Murphy included 29 formal tools, mostly projectile points representing Middle and Late Archaic as well as the Late Prehistoric time periods.

The Donner site was revisited in 2000, through a partnership between Yellowstone and the Museum of the Rockies (MOR) at Montana State University (see Shortt 2001). The MOR crew re-assessed and re-recorded sites 48YE252 and 48YE253 as one large site (48YE252), which remained unnamed. The crew quickly re-located the extensive lithic scatter recorded by Cannon in 1999 and Murphy earlier in 2000. They also re-located the hearth feature and fire cracked rock scatter observed by Murphy, and a salvage excavation of this feature was performed.

Twenty-six projectile points/fragments were collected, ranging in age from the Early Archaic to Late Prehistoric (Shortt 2001: 41). Thirty-two additional tools were recovered, including side and end scrapers, a drill, engraving tools and a hafted chopper (Shortt 2001). The hafted chopper/pulper was considered unique by the Principal Investigator for this project (Mack Shortt), as he was “unaware of similar specimens from other sites around the lake” (Shortt 2001: x). The hafted chopper was described as a “complete Stage II biface made of relatively coarse grey quartzite”, generally oval in shape, with a “heavily ground edge” forming a “slight constriction” indicating hafting at the tapered end (Shortt 2001:59). The recovery of this type of artifact from the site indicates “either animal or plant products were processed by relatively heavy chopping or pulping activities” (Shortt 2001: x). Based on lithics observed at the site during this project (n=200), obsidian was the most popular tool stone (at ~30-35%), with petrified wood, chert and quartzite equally representing ~20% each (Shortt 2001:10-11).

Obsidian sourcing results from these artifacts (n=23) represented six different obsidian sources (Shortt 2001:25). Obsidian Cliff was the dominant source (at 14 out of 28 artifacts), with the remainder equally spread among five other sources (Park Point, Bear Gulch, Cougar Creek, Teton Pass, Packsaddle Creek) scattered throughout the Greater Yellowstone Ecosystem (Shortt 2001:25). A newly recognized tuff source called Park Point was represented in this sample. The Park Point source is now understood to be a fairly popular local tool stone source for people camping along the Lakeshore, and recent field efforts were made in 2011 by a University of Montana crew in an attempt to further refine our knowledge of this source locality.

These admittedly limited results gave rise to a hypothesis of increased exploitation of southern-oriented and local sources by people on the south lakeshore, a concept later argued by Park (2010, 2011) and refined by MacDonald et al. (2011).

The excavation of the hearth feature yielded an uncalibrated radiocarbon age of 1970 ± 60 BP (calibration: 2050-1810 BP), coinciding with the Pelican Lake phase in Yellowstone (Shortt 2001:23). No faunal remains or lithic debitage were recovered from the hearth fill. Pollen and macrofloral analysis was performed on hearth fill material yielded no insight into possible plant processing activities at the site. In fact,

Photograph 2. Tools Recovered from Beach Surface during 2000 Reconnaissance.
there was no indication of any plant processing occurring at the site based on hearth fill remains (Shortt 2001:78). It was estimated based on the shape and composition of the hearth as excavated, that over one half of the hearth had already eroded onto the beach below (Shortt 2001:22).

The 2008 Data Recovery Project

The remoteness of the southern lakeshore (accessible only by foot, horseback or non-motorized watercraft) contributed to a slow accumulation of evidence needed to make an argument for data recovery. Finding funding for data recovery was also a challenge. Park archaeologist Ann Johnson contacted the Yellowstone Park Foundation (YPF), which had previously funded the Osprey Beach site excavations. Members of the YPF, Joan and Bob Donner, were advocates for the preservation of archaeological sites in Yellowstone and personally donated the money to fund the data recovery through a YPF grant. In honor of their generous donation and ongoing support of the archaeology program, the site was named after them.

A crew of three persons from Lifeways of Canada excavated over a period of 18 days in the remote backcountry, led by Brian Vivian as Principal Investigator. 2008 had seen significant snowfall, cold spring weather and a late melting of the snowpack, which resulted in higher-than average lake levels in July. Indeed, upon arriving at the site, it was observed that most of the beach which had in previous years been exposed was now under water. Nearly all the beach below the eroding first terrace/shore bank was inundated, and active erosion of the bank was observed in several places. This inundation resulted in a rather creative “beach” survey method employed by the crew. Since previous visits to the site had yielded much material on the beach surface which was now under water, the crew decided to “survey” the beach and a sandbar running

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Figure 2. Map of Data Recovery Excavations at the Donner Site on Southeast Arm, Yellowstone Lake. UTM Coordinates Intentionally Omitted.
parallel to the shore by wading through the knee deep water along these landforms and gazing down through the water. Careful foot placement kept sediment disturbance to a minimum and allowed for a surprisingly clear view of any artifacts settled on these surfaces underwater. Indeed, the three feet of water produced a sort of magnifying and brightening effect, highlighting artifacts made of colorful chert and reflective obsidian materials. This creative survey technique allowed for more thorough recording of the site surface which would be exposed in lower water level years.

Thirty-seven 1x1 meter units totaling approximately 34.3 square meters were excavated over an eighteen day period (Figure 2).

Results and Discussion: 2008 Data Recovery Project

A total of 3,329 lithic artifacts were recovered during the 2008 data recovery project (Vivian 2009:49). Fourteen of these were formal tools recovered from surface contexts and under water along the inundated beach and sandbar. A wide variety of raw material was represented, including chert, chalcedonies, quartzite, obsidian, dacite, and petrified wood. Well over half of the assemblage was composed of chalcedony (35%) and chert (30%), with obsidian (18%) and petrified wood (11%) the next most common (Vivian 2009:49).

It is interesting to note that obsidian, which was the overwhelmingly dominant raw material choice for people at the Osprey Beach site (at 53% of the total assemblage; see Johnson et al. 2004) and was the most common material type observed during the 2000 field work at the Donner site (see above), was a distant third in popularity behind chert and chalcedony. This difference may represent temporal shifts in obsidian use/raw material preference, given that the Osprey Beach site was a Cody Complex occupation and the Donner site represents Middle/Late Archaic use (Vivian 2009:49). This contrast might also be explained in other ways, perhaps indicating access to certain tool stone sources was unavailable during occupations at the Donner site, or other reasons that are beyond the scope of the evidence. Recent research comparing use of lithics in the Southeast Arm (e.g., Donner) and the West Thumb Area (e.g., Osprey Beach), indicates that the preference for chert at Donner is likely due to its local availability in beach gravels, as well as a lack of access to obsidians, such as would have been available to people at Osprey Beach (MacDonald et al. 2012).

Ten obsidian tools were submitted for source affinity testing, with the results indicating a variety of sources being exploited by occupants of the Donner site (Table 1 and Figure 3). Compare these results to the cumulative results of surface collection and excavation from 2000-
2008 (Figure 4), and we see a similar focus on exploitation of “southern-oriented” sources such as Teton Pass and Warm Creek (a newly designated source with localities in the southwest corner of the park—see Szamuhel 2008, Park 2010). This pattern also mirrors the results from the obsidian recovered during the 2000 hearth salvage excavation. Consistent with previous analyses of Lakeshore area obsidian selection patterns (Park 2011, MacDonald 2012), Obsidian Cliff obsidian dominates in both obsidian sample sets, but as a whole represents less than 10 percent of the total lithic assemblage. Interestingly, Park Point obsidian (see Chapter 3) represents approximately 10 percent of the obsidian from Donner, but overall accounts for less than 1 percent of the entire lithic assemblage. These data may support the hypothesis presented in Chapter 3 that hunter-gatherers on the south shore near the Yellowstone River inlet (e.g., at Donner) rarely ventured along the eastern lake shore.

Table 1. Obsidian Sourcing Results, Donner Site 2008 Data Recovery

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Given the relatively high number of Paleoindian artifacts collected from the beach at surrounding sites along the southern Lakeshore, it was thought that there might be a significant Paleoindian component. However, it appears that the Donner site is a multi-component site, with a significant Middle-Late Archaic component based on diagnostic tools recovered in situ (Figure 5). Charcoal collected from the single excavated hearth feature (Feature 1) produced an uncalibrated radiocarbon age of 1270 ±40 BP (calibrated to 1290-1080 BP; see Vivian 2009:76), much younger than expected based on projectile points collected during the excavation. However, this date is consistent with the date yielded from the hearth salvaged nearby in 2000. Interestingly, the radiocarbon dates produced from the hearths excavated in 2000 and 2008 both indicated Late Prehistoric occupation, while the diagnostic artifacts from surface collections in 2000 and from all contexts in 2008 indicated a Middle-Late Archaic occupation. A combination of this information suggests that the Donner site was regularly occupied from ~ 4,000-1,200 BP. The relatively wide scatter of cultural materials both horizontally and vertically across the site indicate it was reoccupied frequently through time (Vivian 2009:17). Lithics were recovered from every level of excavation up to 100 cm below surface (Vivian 2009:17). Based on the sediments observed during excavation and the distribution of diagnostic artifacts, it appeared that bioturbation combined with loose sediments have likely contributed to vertical movement of artifacts through time after deposition (Vivian 2009:21). Vivian (2009:21) determined that it was ultimately not possible to stratigraphically discern distinct cultural/temporal occupations, resulting in the conclusion that this represents “a mixed assemblage or single palimpsest of the assorted occupations at this location.”

Protein residue analysis was performed on a number of projectile points and other formal tools. Only one positive result was returned, found on the blade of a McKean lanceolate point found in Level Five of Test Unit

Figure 5. Middle Archaic Projectile Points, Donner Site.
9. The result was positive for bovine protein, which would indicate the hunting and/or butchering of bison (see Vivian 2009 and Chapter 2, this volume).

Two hearth features were recorded, but only one was excavated as the second appeared to be of more recent origin (potentially historic) was well buried and located inland from the shore bank and thus not threatened by erosion.

The hearth feature that was excavated (Feature 1) was rock lined and basin shaped, typical of Middle/Late Archaic hearth features (Photographs 3-4). However, as noted above, the radiocarbon date returned from analysis of charcoal from this hearth feature was younger, dating to the Late Prehistoric period. This feature was initially discovered eroding from the shore bank on to the beach. The feature was the subject of a more intensive, 3x2 m block excavation, uncovering a large, basin shaped, rock-lined hearth buried 20-40 cm below the surface. This hearth was constructed of 282 fist-sized cobbles, and the excavated feature measured ~115 x 90 cm. An additional 55 fire cracked rock pieces were recovered from the beach immediately below the eroding feature, representing the missing portion of the hearth which had already eroded from the terrace edge (Vivian 2009:55). No formal tools were found in direct association with the feature, but six flakes were recovered from the hearth fill and 13 others were recovered from the fill directly above the hearth. In the units immediately adjacent to the feature a few formal and expedient tools were recovered, including two Duncan points, one Hanna.

Photograph 4. Planview of Middle/Late Archaic Feature 1, Donner Site.
point, one Late Prehistoric point, one non-diagnostic point, one biface and one utilized flake (Vivian 2009:55).

A third hearth feature or dump site for fire broken rock was believed to have been located, based on the concentration and patterning of the rock and charcoal stains (see Vivian 2009:61). However, this concentration was located in a unit immediately adjacent to the eroding terrace edge, and the rock patterning suggests much of this feature had already eroded and been washed away (Vivian 2009:61). Not enough of the feature was left to definitively identify it as a hearth.

The excavated hearth feature fill yielded material for radiocarbon dating (see above) and macrofloral analysis. Macrofloral analysis produced little definitive insight into plant processing/cooking activities which may have been occurring at the site. The fill sample was also analyzed for organic residue using the Fourier Transform Infrared Spectroscopy (FTIR) technique. These analyses did give an interesting result in the presence of unburned prickly pear cactus seeds/fruit (see Vivian 2009). This plant grows in hot, dry desert environs such as those found to the north (Gardiner Basin), south (Snake River), and west (Madison River valley). It is conceivable that hunter-gatherers carried this plant with them to the lake from one of these locations; however, ethnobotanists consider only charred remains to be prehistoric unless special preservation conditions exist (Hickey and Cummings 2009:1). Thus, the unburned prickly pear cactus seeds are hypothesized to be of modern deposition, representing modern vegetation growing nearby (Hickey and Cummings 2009:7) and perhaps mixed in to the hearth fill through bioturbation. This is a reasonable hypothesis, however prickly pear is not known to be present in the modern environment around the south end of Yellowstone Lake, and was not likely to have been present in the wetter, colder, more heavily wooded environment hypothesized for the Middle and Late Archaic periods. The presence of these seeds in the hearth fill likely indicates a prehistoric human origin from the north, south, or west.

The FTIR analysis and pollen analysis also revealed a match with yucca basal leaves (Hickey and Cummings 2009:8), which is another documented food source found in dry, desert environments such as those discussed above. However, the match with yucca leaves might also indicate cooking other members of the lily (liliaceae) family in this hearth (Hickey and Cummings 2009:8), such as the mariposa/segolily, which is found in abundance in meadows around the south and eastern Lakeshore. Indeed, “[b]oth wild onion (Allium) and segolily (Calochortus) fall within the approximate size range of Liliaceae pollen recovered” from the Donner Site hearth feature (Hickey and Cummings 2009:5). Wild onion is a common edible plant found in meadows throughout the park.

Summary and Conclusion

Overall, the Donner site yielded insight into several key research questions pursued by Yellowstone National Park’s archaeology program. The Lakeshore area has long been understood to be a key region within the park for archaeological sites, particularly from the Paleoindian period. The Donner site has added to our understanding of Lake area use during later time periods, showing that the popularity of Yellowstone Lake for camping continued up to modern times. The 2008 data recovery project was a necessary salvage operation in the face of certain destruction at the hands of erosion. Given the sheer volume of sites identified around the Lakeshore, and the significance of the sites already investigated, this race against time will continue as we make every effort to save as much information on these sites as possible. The example of the Donner site gives an indication of what is at stake when sites are subject to severe natural threats such as erosion, and what might be gained through targeted, time-sensitive management of these resources. The rescue excavation of the Donner site shows that efficient, thoughtful resource management can turn a potentially disastrous situation into a story with a happy ending.

References Cited


CHAPTER 8
ARCHAEOLOGICAL INVESTIGATIONS ALONG THE NEZ PERCE TRAIL, YELLOWSTONE NATIONAL PARK

By Daniel H. Eakin

Abstract
In 2008 Yellowstone National Park (YNP), in partnership with the Office of the Wyoming State Archaeologist, initiated the Nez Perce National Historic Trail (NPNHT) project to identify prehistoric and historic archaeological sites within the YNP portion of the NPNHT corridor. A major focus of the project was use of archival and other resources in an attempt to identify Nez Perce, U.S. Military, and civilian localities associated with the Nez Perce War of 1877. This paper reports on the Radersburg party wagon abandonment locality, the Helena party camp, and a possible Nez Perce camp near Parker Mountain. Results of these investigations are discussed in light of both the well documented and poorly understood sections of the NPNHT.

Introduction
This report briefly summarizes archaeological investigations at several localities along the Nez Perce National Historic Trail (NPNHT) within Yellowstone National Park (YNP). The investigations were conducted by the Office of the Wyoming State Archaeologist as part of a multi-year study conceived to identify archaeological resources along the NPNHT corridor (Johnson 2006). The NPNHT was added to the National Historic Trail system in 1986 and is administered by the U.S.D.A. Forest Service. A comprehensive summary of the NPNHT can be found in the Nez Perce (Nee-Me-Poo) Trail a Study Report (USDA Forest Service 1982).

Given the relatively late (1877) occurrence of the Nez Perce War, metal objects of many kinds had been incorporated into Nez Perce material culture, and an assortment of similar or identical items would have been used by the U.S. Army and civilian participants as well. Therefore, a Section 110 reconnaissance using metal detectors as a search tool was proposed as a field strategy. As an added benefit, areas of YNP investigated during the NPNHT project also figured prominently into use patterns of prehistoric and historic Native Americans, Euroamerican fur trappers and exploration parties, the post 1885 YNP military administration, and early tourist groups (Eakin 2009, 2010, 2012; Eakin et al. 2012).

Historic Background
The NPNHT extends for roughly 1,170 miles from Wallowa Lake, Oregon to the Bear’s Paw Mountains Battlefield, Montana (Figure 1). The trail crosses parts of Oregon, Idaho, Montana, and Wyoming, and represents the route followed by the non-treaty Nez Perce (numbering some 700-800 men, women, and children, with approximately 2000 horses) during their June 17th - October 5th, 1877 attempt to escape from the U.S. Army, and ultimately seek refuge with the Lakota chief Sitting Bull in Canada. From the war’s inception, the Nez Perce were pursued by forces under the Command of General O.O. Howard (Dept of the Columbia), but were ultimately defeated by forces under Colonel Nelson A. Miles (Department of Dakota) approximately 40 mi south of the international boundary. After the battle, about 300 followers managed to cross into Canada, while Joseph and the remaining survivors were sent to Indian Territory (Greene 2000, 2010). The NPNHT includes a number of battle and skirmish sites including Whitebird Canyon, Clearwater, Big Hole, Camas Meadows, Canyon Creek, Cow Island, and the Bear’s Paw Mountains.

Approximately 84 miles of the NPNHT is located within YNP. This does not include routes used by scouting and raiding parties. The section of NPNHT between the west boundary of YNP and Indian Pond, a few miles east of Fishing Bridge, has been described in eyewitness accounts and is the best documented section of the trail within the park. The section of trail east of Indian Pond remains poorly understood, with ambiguity surrounding the few known eyewitness accounts. In the context of the 1877 war, the NPNHT was used only once, and travel was in a west to east direction. Howard’s pursuing army followed essentially the same route, before turning north at the Yellowstone River. Remains of Nez Perce and U.S. Army camps, as well as other site types, may be expected to be found along sections of the trail route.
The following summarizes recent investigations at three sites within the NPNHT corridor. Site 48YE2020 is the location of the abandonment of the Radersburg party wagons on Nez Perce Creek. Site 48YE1783 is the location of the attack on the Helena Party. Site 48YE506 is located in the Parker Peak-Hoodoo Basin area, and may represent the only example of a Nez Perce campsite found thus far. Several works provide a detailed history of the Nez Perce War in its entirety (Brown 1967; Greene 2000; McWhorter 1992), and Aubrey Haines’ (1997) *Yellowstone Story* includes a chapter devoted to the events which were played out within YNP. The space available in the present volume does not permit an in-depth background discussion for each site, and consequently the reader is referred to the above volumes for details of this unique and important chapter in American history.

### 48YE2020 Radersburg Party Wagon Abandonment Site

Site 48YE2020 is situated at an elevation of 2194 m (7200 ft.) within the lower Nez Perce Creek Valley, a short distance east of the Grand Loop Road. This site is the location where, on the morning of August 24, 1877, the Nez Perce forced the Radersburg tourist party to abandon two wagons and the majority of their equipage. Several information sources have been tapped in order to relate the site and its location to the event. The first is identification and temporal classification of selected artifacts collected from the site in 2010. The second is a review of eyewitness accounts referring to the location and items confiscated or left behind by the Nez Perce.
Background
At first light on the 24th of August, 1877 Nez Perce scouts under Looking Glass approached the Radersburg party’s camp along Tangled Creek in the Lower Geyser Basin. The group consisted of nine people: George and Emma Cowan, Emma’s brother and sister, Frank and Ida Carpenter, and acquaintances Charles Mann, Andrew Arnold, William Dingee, Albert Oldham, and Henry Meyers. After the initial encounter, Indian numbers quickly swelled, and the tourists, aware of the precarious nature of their situation, promptly packed wagons, saddled riding horses, and headed north toward the Madison River. When they departed camp, they did so under an escort of a number of warriors who accompanied them to a point near the north end of Fountain Flats. Along the way, one of the party described the Nez Perce procession at three miles long, and driving a thousand to fifteen hundred horses up the trail following the East Fork of the Firehole (now Nez Perce Creek). Near the mouth of Nez Perce Creek, the tourists and their escort were ordered to halt and turn up Nez Perce Creek in the direction of the main procession. After proceeding up-valley to a point where heavy timber prevented further wagon travel, the Nez Perce ordered the wagons abandoned. Horses from the teams were saddled and a few articles of clothing were taken by the hostages. The wagons were then looted and partially destroyed by the Nez Perce. Later that day, at a location several miles up valley, George Cowan and Albert Oldham were shot; Cowan’s wife Emma, and Frank and Ida Carpenter were taken hostage, and the remainder of the party escaped (Greene 2000).

Archaeological Investigations
A total of 35 artifacts were collected from the site (Figures 2 and 3; Table1). A number of these may be significant in regard to the site’s identification and historic context.

Personal Items
Artifact 193442 is a steel pen nib or tip. The item is identical in shape and design to a No. 14 Esterbrook Steel Pen as shown in the Montgomery Ward & CO’s Catalog No. 57 for 1895 (Emmet 1969:114).

Shotshells
Artifacts 193432 and 193448 are both paper-hulled (deteriorated), folded head, 12 gauge shotshell bases headstamped U.M.C. CO. N° 12. Both possess primers that are .179” in exterior outside diameter and have a small metal bar or wedge crossing the interior flash hole which could represent an early primer type from the experimental phase of primer and case development of the early and mid-1870s. Union Metallic Cartridge Company (U.M.C.) began production of paper-hulled shotshells in 1873 (Gunther et al. 2000:544), indicating these could date from the early to late-1870s.

Artifact 193435 is a Parker Brothers, flat-head, solid head brass shotshell headstamped PARKER BRO’S 12 A WEST MERIDEN CT. Parker Brothers was a well-known manufacturer of shotguns and accessories from 1868 through 1895. During this time, Parker Brothers marketed unloaded UMC-made brass shotgun shells that carried the exclusive Parker Brothers headstamp. Several design changes occurred throughout the production period and certain of these can be employed to estimate approximate time of manufacture. In 1872 U.M.C. ceased use of a Millbank reinforcing band (indicated by the presence of solder around the inside edge of the head) in their shotshells when they retooled from folded to solid-head manufacture. According to Gunther et al. (2000:544), U.M.C. ceased production of the Millbank reinforcing band in 1873, and any Parker shotshell lacking solder around the inside edge of the head is probably an 1874 or later solid-head shell. No solder is visible on specimen YELL193435. Additionally, according to Muderlak (2008:153) cartridges fabricated with the tube affixed to a stamped or machine turned base having a perfectly flat head were manufactured prior to 1877. If these details are accurate, then the shotshell recovered from 48YE2020 was manufactured sometime between 1874 and 1877.

Horse Trappings
Specimen 193436 is an iron snap hook. A nearly identical item was found in a Native American association at the site of the 1874 Battle of Palo Duro Canyon (Cruse 2008:213-214) and is identified as a halter chain snap hook produced for the civilian market. Three roller buckles (193438, 193444 and 193446) were found. Roller buckles were and are commonly used in horse and
mule trappings, team breechings, as well as many other uses employing leather straps. Artifact 193443 is a harness terret. Terrets were used with tandem teams to prevent tangling and guided the reins of the lead pair to where they joined with the rear pair. Terrets were common in 19th and early 20th century horse trappings and would have remained on the trappings when only a two-horse team was in use.

Canisters

Ten cans and can fragments were found. Artifact 193430 is rectangular and possesses crimped edges, suggesting it may have been a can base. Two crushed external friction fit canisters (193437, 193449) represent items that became popular as dry goods containers in the 1860s and remain popular today (Rock 1989). Three external friction lids (193431, 193434 and 193459) range from 2 9/16", 3 1/8", and 4" in diameter. The smallest lid is intact, with the two others only exhibiting minor damage.

These lids most likely fit cylindrical canisters that were often used for storage and quick access of many substances, from dry goods to hardware (Rock 1989:48). Artifact 193440 is a hole in top, solder side seam meat can base having what appears to be a double patch. Hole in top meat cans with a solder side seam were in production from about 1875-1930 (Rock 1989:136-139). One crushed hole in top/solder side seam can (193441) and two hole in top can ends (193451 and 193452) were found. Solder side seam cans generally date between 1830 and 1890 when the crimped seam cans became popular (Rock 1989:65). Considering the high consistency of the artifacts at the site, the two hole in top cans are most likely solder side cans (Rock 1989:66).

Bottle Glass

Artifact 193433 consists of two unidentifiable pieces of aqua glass, an upper bottle neck and finish, and an aqua-glass cognac bottle stopper. The bottle fragment possesses an applied finish, popular in the U.S. from the
1830s through the 1880s (Society for Historical Archaeology 2011). The stopper is the club sauce type, used on a variety of late 19th century containers, including liquor bottles. Much of the lead seal remains on the stopper, including a complete brand name and makers mark: **OTARD DUPUY & C° COGNAC**. Otard Dupuy cognac is a premium French cognac in production since the 1700s (Jones and Sullivan 1989:152).

**Fasteners and Hardware**

Nine fasteners were recovered from the site. Eight are machine cut nails (193447, 193454, 193455, 193456, 193458, 193460) ranging from brad size (3/8" long) to 8d (2.5" long). Three are straight and appear unused, while the remaining are bent to some degree. One flat-headed 1.5" (No. 9) slotted wood screw (193457) was also recovered.

**Miscellaneous**

Artifact 193439 is a 15/16" (OD) copper ring made from 1/16" copper tubing. Artifact 193445 is a lozenge-shaped, three-holed raised brass escutcheon or plate possessing beveled edges. The beveled edges raise the interior of the plate away from the surface to which it is attached. Both end perforations (3/32" diameter) show evidence of flattening on the raised face indicating their function as fastener holes. The item is bent at each of the fastener holes indicating it was forced or pried from the surface to which it was attached. One hole exhibits a torn edge indicating excessive force. The center perforation (3/16" diameter), though deformed, does not exhibit flattening that would be associated with a fastener hole. The piece could be a handle plate or decorative item, perhaps off of a trunk, ornamental wooden box, satchel, or buggy. Artifact 193450 consists of 15 pieces of 3/4" non-magnetic metal strapping. Laid end to end the pieces are 32" in length.

Three iron rivets are present in two end pieces. Artifact 193453 consists of 30 fragments of a porcelain dinner plate. The plate has a yellow floral pattern with gold edge trim. No makers mark is present on the plate. The plate was recovered alongside what appeared to be a tin or steel dinner plate that oxidized to a totally unidentifiable and non-preservation condition soon after exposure.

**Accounts of Wagon Abandonment Location**

Several eyewitness accounts provide general information pertaining to the location of the abandoned wagons. Emma Cowan states that they traveled a mile or more from the camp on Tangled Creek before being stopped by a line of mounted warriors. She
Table 1. Artifacts found at 48YE2020.

<table>
<thead>
<tr>
<th>Catalog Number</th>
<th>Description</th>
<th>Count</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>193442</td>
<td>Pen Nib</td>
<td>1</td>
<td>Late 19th Century (Emmet 1969:114)</td>
</tr>
<tr>
<td>193432, 193448</td>
<td>UMC Shotshell base</td>
<td>2</td>
<td>Early-Mid 1870s (Gunther et al. 2000:544)</td>
</tr>
<tr>
<td>193436</td>
<td>Snap Hook</td>
<td>1</td>
<td>Mid-1870s (Cruse 2008:213-214)</td>
</tr>
<tr>
<td>193438, 193446</td>
<td>Roller Buckle</td>
<td>2</td>
<td>Unknown</td>
</tr>
<tr>
<td>193444</td>
<td>Bar Roller Buckle</td>
<td>1</td>
<td>Unknown</td>
</tr>
<tr>
<td>193443</td>
<td>Harness Terret</td>
<td>1</td>
<td>Unknown</td>
</tr>
<tr>
<td>193431, 193434, 193459, 193437, 193449,</td>
<td>External Friction Canisters and Lids</td>
<td>5</td>
<td>Common after 1860 for various dry goods (Rock 1989:40)</td>
</tr>
<tr>
<td>193451, 193452,</td>
<td>Hole-in-cap Food Can End</td>
<td>2</td>
<td>Pre-1920 (Rock 1989:50)</td>
</tr>
<tr>
<td>193441</td>
<td>Solder Side Seam Food Can</td>
<td>1</td>
<td>1870s-circa 1900 (Rock 1989:42, 63-64)</td>
</tr>
<tr>
<td>193440</td>
<td>Meat Can Base</td>
<td>1</td>
<td>1875-1930 (Rock 1989:136-139)</td>
</tr>
<tr>
<td>193433</td>
<td>Otard Dupuy Cognac Bottle Finish and Stopper</td>
<td>1</td>
<td>1830-1885 (Society for Historical Archaeology 2011)</td>
</tr>
<tr>
<td>193453</td>
<td>Porcelain Dinner Plate Fragment</td>
<td>1</td>
<td>Unknown</td>
</tr>
<tr>
<td>193447, 193454, 193445, 193456, 193458, 193460</td>
<td>Machine Cut Nail (various sizes)</td>
<td>11</td>
<td>Pre-1890 (Fontana and Greenleaf 1962)</td>
</tr>
<tr>
<td>193439</td>
<td>Copper Ring</td>
<td>1</td>
<td>Unknown</td>
</tr>
<tr>
<td>193445</td>
<td>Brass escutcheon</td>
<td>1</td>
<td>Unknown</td>
</tr>
<tr>
<td>193450</td>
<td>Metal Strapping</td>
<td>1</td>
<td>Unknown</td>
</tr>
</tbody>
</table>

makes no reference to crossing Nez Perce Creek, which was probably north of where they were ordered to turn east and proceed up valley toward Mary Mountain. Her account implies they remained on the creek’s south side and followed the existing trail.

“Passing and leaving our morning camp to the right, we traversed the trail towards Mary’s lake for two miles. We could go no further with the wagons on account of fallen timber” (Guie and McWhorter 1935:168).

Henry Buck, a teamster supporting Howard’s Army and one of Spurgin’s Skilletts passed the abandoned wagons on August 31st, one week after the incident. Buck recalled..."Reluctantly, we repaired to our wagons again and moved on over a stretch of land full of boiling pools. A short distance above say one mile we came to one of the spring wagons that belonged to the Radersburg party. The wagon stood about fifty feet to the right [south] of the trail. I stopped my team and went over to it. In the wagon, I found a box containing many pretty specimens. I took a number of them, fixed them up as best I could and brought them home with me......" (Buck 1922:41).

Buck’s reference to a stretch of land full of boiling pools indicates that he was on the south side of Nez...
Perce Creek, in the vicinity of Morning Mist Springs. If true, he over-estimates the distance from the springs to where he encountered the wagons by a half-mile. It should be noted that in 1901 George and Emma Cowan returned to Yellowstone Park and, with Chittenden and several other veterans, retraced their route, as well as that of Howard and the Nez Perce, to identify various 1877 landmarks. Therefore Chittenden’s version, which clearly describes the abandonment location, is based on his direct interaction with eyewitnesses.

“Forced to accompany the army of Chief Joseph, the hapless party felt their hopes of escape were slender and that they would all be massacred at the first favorable opportunity. They were wretchedly armed and could offer no effective resistance. They moved on up the valley of Nez Perce Creek, and when about a mile and a half above the present bridge were stopped by the timber. Charley ordered the wagons abandoned, and the passengers to mount the horses. The provisions were all confiscated and the spokes cut out of the wheels of the spring wagon” (Chittenden 1915:132-133).

**Accounts of Property Lost by Radersburg Party**

Emma Cowan’s vivid account describes the looting of the wagon....

“Here we unhitched, mounted the horses, taking from the wagon the few things in the way of wraps that we could carry conveniently, and moved on. It gave us no pleasure to see our wagons overhauled, ransacked and destroyed. Spokes were cut from the buggy wheels and used as whip handles. We did not appreciate the fact that the Indians seemed to enjoy the confiscated property. One young chap dashed past us with several yards of pink mosquito bar tied to his horse’s tail. A fine strip of swansdown, a trophy from Henry’s lake, which an ugly old Indian had wrapped around his head turban fashion, did not please me either” (Guie and McWhorter 1935: 168).

On August 26th, Stanton Fisher, Chief of Scouts under General Howard, included the following entry in his journal.

“Baptiste let the man Harmon have his mare to go back to the command, as we are out of rations. Charles Mann goes on with us. I furnished him a horse to ride and we rode on a lope most of the way up to the Lower Geyser Basin, where the wagon and buggy belonging to the Radersburg party had been left......The Indians had cut up the harness, cut the spokes out of the buggy, and scattered things around promiscuously” (Fisher 1896:272).

About 60 hours after being shot and left for dead at the eastern base of Mary Mountain, George Cowan made his way back to the wagons....

“As I approached the wagons, I saw some papers [fluttering?] upon the trees, and on going closer to them I saw that they were Mann’s sketches made on the trip. I discovered portions of Frank’s journal, and on [crawling?] around I managed to pick it all up......I also found Frank’s pocket book, and many other articles scattered about in confusion.

The Indians had attempted to destroy everything, and had even cut the spokes from the buggy wheels for stalks for their whips......The buggy was laying upon the ground, all the spokes having been taken from two of the wheels, and I could search it without rising. I found some rags, and a portion of a man’s underclothing, which were very acceptable, but could find nothing to eat” (Guie and McWhorter 1935 211-212).

A. J. Arnold, after having found Howard’s army at Henry’s Lake, passed the site about a week later with Howard’s forces....

“The next day we passed the wagon and buggy that our party had abandoned, and found that they were almost totally destroyed. We gathered up what we could, and carried the pieces with us” (Guie and McWhorter 1935:224).

The account of A. J. Arnold is unclear regarding what kinds of items they removed. At any rate, like Henry Buck, Arnold salvaged items that he or perhaps those with him, thought were of some value.

**Depredation Claim filed by George Cowan**

Table 2 lists George Cowan’s failed depredation claim against the Nez Perce and the United States Government for losses incurred on August 24th, 1877.

**Discussion**

Most eyewitness statements describing the wagon abandonment provide little information useful in determining the exact site location, with Emma Cowan’s estimate of two miles from the turn-around point, and
Henry Buck’s of one mile above the hot pools. However, both Emma Cowan and Chittenden mention that the wagons were abandoned on account of timber, and Buck states that the wagons were about 50 ft. to the right (south) of the trail. Site 48YE2020 is situated at the edge of the timber, and several artifacts were recovered about 50 ft. south of the trail. Perhaps the best estimate is that of Chittenden (an engineer) at one and one-half miles above the “present” bridge. An examination of Hague (1904) Sheet IV (surveyed in 1884) shows that if Chittenden’s distance estimate is measured in road miles, it places the incident exactly where site 48YE2020 is located.

Specific information describing lost property is scanty at best within the popular literature, and leaves much to the imagination considering the paucity of artifacts found at the site. George Cowan’s reference to sketches and a journal indicate the party was in possession of writing implements, perhaps pens with extra nibs. Stanton Fisher’s observation that the harnesses had been cut up indicates the items were made useless and may have been unfit for salvage. The three roller buckles, harness terret, and snap hook could represent the harness remains seen by Fisher.

Although George Cowan’s depredation claim is general in its description, given the prices of the time one might conclude from the values listed that he and his wife were relatively well-to-do, and had an assortment of expensive items along on their camping trip. This would not be surprising, as George Cowan was a progressive and politically active citizen of the state of Montana. He was born in Ohio in 1842, but reared in Wisconsin, and briefly studied law before enlisting in the Wisconsin Infantry at the outbreak of the Civil War. He and his unit saw heavy fighting during the war, and he was discharged as a sergeant in 1864. In 1865 he arrived at Last Chance Gulch, where he mined briefly before moving to Helena in 1867. For the next few years he served as assistant collector of internal revenue, Captain in the state militia, and later as assistant adjutant-general under General Thomas F. Meagher. Cowan was admitted to the Montana Bar in 1872, and later served three terms as deputy territorial district attorney for Jefferson County, Montana (Anonymous 1903). According to testimony provided at the claim inquiry, Cowan was still a practicing lawyer in 1892.

Several artifacts may relate to specific items and property types listed in Cowan’s depredation claim. The listing of “1 set of harness” (line 4) is consistent with the harness mentioned by Fisher, and could be represented by the harness related items found. Line 12 lists “provisions” worth $100.00, and would probably include items such as food, cooking gear, table ware, and related items and equipment that many people would be disposed to include on an extended camping trip. Artifacts consistent with this category would include food cans, friction lid cans, and possibly the unidentified porcelain and metal plates. The value attached to this category indicates that the total list and diversity of items was extensive.
Line 13 specifies a breech loading shotgun valued at $100.00. Cowan’s sworn testimony taken during the inquiry reads “One breech loading shotgun, with its equipments” which implies additional components, such as shotshells and perhaps other accoutrements such as reloading equipment. Breech loading shotguns were a relatively recent innovation in 1877, with a few relatively inexpensive single-barreled models available in the ten-to twenty-dollar price range (see Muderlak 2008). Double barreled breech loading shotguns were becoming very popular, however, and as with many firearms of the 1870s, ranged widely in cost and quality. Of the two most successful brands (the Model 1873 Remington Whitmore and the various Parker Brothers models), the Parker Brothers shotgun was viewed by many as superior in quality and, due to its cost, was popular among people of means. In 1874 the Remington Whitmore was priced from $45 to $100 (West 1970:8-5) while Parker Brothers guns that same year ranged from $45 to $250. By 1876 the Parker Brothers shotgun was being advertised as the best breech loading shotgun in the world (Muderlak 2008). The grade 3 (D grade) “hundred-dollar gun” was one of the highest sellers in the Parker Brothers line, and came with a wooden case containing fitted receptacles for fifty shotshells, along with cleaning and reloading accoutrements (see Muderlak 2008:47). The price listed in Cowan’s claim suggests that the lost breech loading shotgun was probably a premium quality double-barreled model.

One of the three shotshells found at the site is a Parker Brothers 12 (A) gauge (193435). A Parker Brothers headstamped shotshell provides indirect evidence that the breech loading shotgun listed could well have been a Parker. This possibility exists because until the mid-1890s (when inexpensive, factory loaded ammunition became available) it was common for Parker Brothers shotgun buyers to also order unloaded brass shotshells, and these would have had the Parker Brothers headstamp. The identical type of shell was also manufactured by and available from U.M.C., but would have possessed a U.M.C. headstamp. The two early U.M.C. paper-hulled shotshell bases found at the site do not conflict with this possibility, as the ‘A’ designation on the Parker Brothers brass shell indicates the gun’s chambering would accept both brass and paper shotshells (Gunther et al. 2000).

Line 13 includes a kit of carpenter tools valued at $55.00. Although no tools were found at the site, an assortment of square cut nails and the wood screw could have been included in a tool kit for repair or maintenance of wagons or other equipment. Such a tool kit, if not confiscated or destroyed by the Nez Perce, may have been salvaged by a subsequent passer-by.

48YE1783 Helena Party Site

The Helena Party site is located on Otter Creek, a short distance west from its confluence with the Yellowstone River. The artifacts collected during the 2008 field study are consistent with and can be related to historic events identifying it as the actual campsite of the Helena Party tourists. Most of what has been found then represents the tourist’s personal property abandoned after the attack. Several other items (specifically cartridge cases) were likely discarded by Nez Perce raiders, and probably represent their firing positions during the raid. The historic events surrounding the Helena Party tourists in Yellowstone Park have been described and summarized in several well-known works. Due to the nature of the findings, the following review is provided, and taken mainly from Greene (2000:188-190).

On August 25th, 1877 a party of ten men from Helena, Montana, after sight-seeing in the park for nearly two weeks, were traveling up the Yellowstone Valley, between the falls and Mud Geyser. The party included, Richard Dietrich, Leander Duncan, August Foller, Charles Kenk, Frederick Pfister, Joseph Roberts, John Stewart, Benjamin Stone, Andrew Weikert, and Leslie Wilkie. From a high point en route, the party observed the Nez Perce moving down Hayden Valley, with some having already crossed the Yellowstone River. Realizing their predicament, the party elected to retreat and conceal themselves in a secluded location on Otter Creek until the Indians moved on. Early the next day, Weikert and Wilkie left camp to reconnoiter and at around noon, as the remaining party were about to prepare lunch, Nez Perce warriors rushed the camp and opened fire from close range. The attack was a complete surprise and the tourists scattered in an attempt to hide in the surrounding timber. Although the tourist party did carry a number of weapons, none returned fire.

Most of the party escaped outright, but some did not. Dietrich, unable to jump Otter Creek, opted to hide in it
for several hours. Stone, after rolling down a steep embankment, also hid in the creek. John Stewart was wounded in the leg and hip at the initial attack, but a warrior spared his life in exchange for a watch and $263. Charles Kenk on the other hand, was chased down and killed.

The survivors reported that after the attack, the raiders remained in camp eating the party’s food and high-grading their goods. When Weikert and Wilkie returned later that day, they found camp abandoned and the party’s fourteen horses, saddles, and most of their property gone. Unwanted materials had been piled up and burned. The raiders also destroyed two double barrelled shotguns by beating them against trees.

Virtually no reliable information exists on the size or composition of the Nez Perce raiding party that attacked the Helena Party camp. It is known that several raiding parties were operating concurrently as the Nez Perce traveled through YNP, and these were responsible for attacks near Mammoth, the burning of Barronett’s bridge, and the probable disappearance of several individuals. Yellow Wolf states that in addition to the raiding party he led, two others were also active. “One [party] was headed by Kosoooyeen, the other by Lakochets Kunnin. I do not know which of these made attack on some hunters or visitors, but I have heard they killed one man” (McWhorter 1940:177).

**Artifact Description**

Archaeological investigations at the Helena Party camp produced a wide assortment of artifacts (Figures 4 through 7, Table 3). One unique aspect of the artifact collection is that many items are directly or indirectly mentioned by eyewitnesses in several historic narratives. A few artifacts - specifically parts of two muzzle loading shotguns destroyed by the Nez Perce - were used to positively identify the site during field investigations. Although most of the assemblage can be attributed to the Helena tourists, three cartridge cases and a possible bullet are likely attributable to the Nez Perce.

**Firearms and Related Artifacts**

Of the firearms related artifacts recovered from the site, three are cartridge cases, five are parts from guns destroyed by the Nez Perce, and another may be a melted bullet or fishing weight.

One Benet primed .45-70 Government cartridge case (131580) was recovered near the edge of the meadow, approximately 45m south of the camp area. The specimen has no headstamp and was made at the Frankford Arsenal between January 1874 and March 1875 (Lewis 1972). Of the two .50 caliber cartridge cases recovered, one (#131586) is a Berdan primed case 1.6 inches in length. The overall length suggests it may be a .50 U.S. Carbine cartridge (Barnes 2009). The case was found about 15 m south of the camp area. The second (131587) is a 1.04 inch long, Berdan-primed case found about 20 m up-slope from the camp. The closest cartridge size to this specimen is the .50 caliber Center Fire Pistol (Barnes 2009), designed for the Model 1871 Remington Army (West 1970). The primer indentation is offset to one side, indicating the case was fired through a side-hammer firearm (Scott et al.1989:177). Both .50 caliber cases could have been fired through the same or different weapons.

A breechblock with attached double-triggers (131580) for a double-barreled percussion lock was found about 20 m up-slope from the camp area. The breechblock is of the hooked-breech design, popular with muzzle loading arms since the latter half of the 18th century (McCrory 1966). Although the breechblock and attached triggers appear undamaged, the machine screw connecting the two is bent, apparently from force delivered from the weapon’s underside.

A compete percussion lock set (131585), most likely from a double barreled shotgun, was found approximately 30 cm from the breechblock and trigger assembly. The locks appear undamaged, but the machine screw joining them is bent, resulting in misalignment. Lock workings are frozen by oxidation and both lock plates are oxidized to a degree that factory markings are indiscernible. Both hammers have open nose cavities for percussion cap extraction. The left hammer rests in the fire position while the right is at half-cock.

A badly deformed trigger guard (131583) was found in the main artifact concentration. The trigger guard is the more ornate spurred and curled type common to rifles rather than the plain type, common to shotguns. No engraving or other markings are visible and it is heavily oxidized. Artifact 131582 is a tap-in type brass
<table>
<thead>
<tr>
<th>Catalog Number</th>
<th>Artifact</th>
<th>Description</th>
<th>Age Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>131586</td>
<td>Cartridge Case</td>
<td>.50-70 Government, Berdan primed, 1.6&quot; long, possibly .50 U.S. Carbine</td>
<td>Late 19th century (Barnes 2009)</td>
</tr>
<tr>
<td>131587</td>
<td>Cartridge Case</td>
<td>.50 Caliber Remington Army, 1.04&quot; long</td>
<td>Late 19th century (Suydam 1979)</td>
</tr>
<tr>
<td>131581</td>
<td>Cartridge Case</td>
<td>.45-70 Government, Benet primed</td>
<td>January 1874-March 1875 (Lewis 1972)</td>
</tr>
<tr>
<td>131580</td>
<td>Breechblock/Trigger assembly</td>
<td>Percussion shotgun breechblock and tang with attached trigger assembly, damaged, oxidized</td>
<td>Late 19th Century</td>
</tr>
<tr>
<td>131585</td>
<td>Gun Lock Set</td>
<td>Percussion shotgun lock set, damaged, oxidized</td>
<td>Late 19th Century</td>
</tr>
<tr>
<td>131583</td>
<td>Trigger Guard</td>
<td>Spurred and curled, 11.5&quot; long, damaged, oxidized</td>
<td>Late 19th Century</td>
</tr>
<tr>
<td>131582</td>
<td>Barrel-key plate</td>
<td>Tack type, 1&quot; long, .5&quot; wide, slot 7/16&quot;x1/8&quot;, brass</td>
<td>Late 19th Century</td>
</tr>
<tr>
<td>131584</td>
<td>Amorphous lead glob</td>
<td>possible melted bullet or fishing weight, 12.6 gm</td>
<td>Unknown</td>
</tr>
<tr>
<td>131594</td>
<td>Ramrod ferrule</td>
<td>1.25&quot; x .5&quot; (OD), oxidized</td>
<td>Late 19th century</td>
</tr>
<tr>
<td>131595</td>
<td>Three-prong fork</td>
<td>Riveted handle (wood missing), oxidized</td>
<td>Late 19th century</td>
</tr>
<tr>
<td>131596</td>
<td>Table knife</td>
<td>Riveted handle (wood missing), oxidized</td>
<td>Late 19th century</td>
</tr>
<tr>
<td>131593</td>
<td>Plate or saucer fragment</td>
<td>White glazed stoneware, polychrome green</td>
<td>Unknown</td>
</tr>
<tr>
<td>131579</td>
<td>California Spur</td>
<td>1 5/8&quot; rowel, remains of leather present, oxidized</td>
<td>Unknown</td>
</tr>
<tr>
<td>131591</td>
<td>Clothing Buckle</td>
<td>Nickel plated, three-prong, leather still attached</td>
<td>Late 19th century</td>
</tr>
<tr>
<td>131588</td>
<td>Button</td>
<td>Steel, rivet type, 7/8&quot; diameter, 36 line button, anchor on face, oxidized</td>
<td>Unknown</td>
</tr>
<tr>
<td>131590</td>
<td>Button</td>
<td>Steel, rivet type, 7/8&quot; diameter, 36 line button, anchor on face, oxidized</td>
<td>Unknown</td>
</tr>
<tr>
<td>131599</td>
<td>Picket Pin with tether ring</td>
<td>17.5&quot; long, <em>figure 8</em>tether ring, oxidized</td>
<td>Similar to late 19th century military type (Cruse 2008)</td>
</tr>
<tr>
<td>131597</td>
<td>Steel Ring</td>
<td>2 7/8&quot; (OD), 2 1/8&quot; (ID), saddle or harness ring, oxidized</td>
<td>Unknown</td>
</tr>
<tr>
<td>131589</td>
<td>Steel Cinch (D) Ring</td>
<td>4 1/4&quot; long, 2 1/4&quot; wide, oxidized</td>
<td>Unknown</td>
</tr>
<tr>
<td>131601</td>
<td>Horse Shoe</td>
<td>Complete, bent, 2 clinched nails, oxidized</td>
<td>Unknown</td>
</tr>
<tr>
<td>131602</td>
<td>Horse Shoe fragment</td>
<td>4 3/4&quot; long, two clinched nails, oxidized</td>
<td>Unknown</td>
</tr>
<tr>
<td>131612</td>
<td>#2 Hole-in-top Food Can</td>
<td>Solder side seam, crushed, oxidized</td>
<td>Pre-1888 (Rock 1989)</td>
</tr>
<tr>
<td>131604</td>
<td>Hole-in-cap lid</td>
<td>Double vent holes, oxidized</td>
<td>Pre-1888 (Rock 1989)</td>
</tr>
<tr>
<td>131613</td>
<td>Five can fragments</td>
<td>#2 size, solder side seam, knife opened, crushed, oxidized</td>
<td>Pre-1888 (Rock 1989)</td>
</tr>
<tr>
<td>131603</td>
<td>Can body</td>
<td>4&quot; high, locked side seam, crushed, oxidized</td>
<td>1869-1890s (Rock 1989)</td>
</tr>
<tr>
<td>131606</td>
<td>#2 ½ food can</td>
<td>Lap side seam, twisted wire attached to two holes poked in rim, crushed, oxidized</td>
<td>1840s- early 20th century (Rock1989)</td>
</tr>
<tr>
<td>131598</td>
<td>Oval Canister</td>
<td>Hinged, 2 5/8&quot; long, 1 9/16 wide, 7/8&quot; tall, lap-seam, soldered base with wire hinge, oxidized and crushed</td>
<td>Unknown</td>
</tr>
<tr>
<td>131616</td>
<td>Steel Strap</td>
<td>4.25&quot; long, 2&quot; wide, oxidized</td>
<td>Unknown</td>
</tr>
<tr>
<td>131615</td>
<td>Steel Strap</td>
<td>30&quot; long, 2&quot; wide, slightly bent with a 3/4 twist, one end has a 1/4&quot; riveted lug, oxidized</td>
<td>Unknown</td>
</tr>
<tr>
<td>131610</td>
<td>External friction fit Canister</td>
<td>2 13/16&quot; high, 2 1/8&quot; diameter, ridge 1/4&quot; below lip, two probable bullet holes slightly larger than 1/4&quot; diameter, crushed, oxidized</td>
<td>Common after 1860 (Rock 1989)</td>
</tr>
</tbody>
</table>

--continued on next page--
loading barrel-key plate from the fore-end of a muzzle loading firearm. The part anchors the barrel to the stock via a flattened key that passes through an eye mounted to the underside of the barrel. Artifact 131594 is a ramrod ferrule. The item would have been attached to the center rib of one of the double-barrel shotguns. One amorphous lead glob (131584) was found approximately 10 m northeast of the main artifact concentration. No lands or grooves are observable on the specimen. The specimen could be a melted bullet or fishing weight.

**Food Cans**

Five food cans or food can pieces were found. Two (131612 and 131604) are of the solder side-seam type. One locked side seam can (131603) may have contained gun powder, lard, or dry goods. A lap seam can (131606) as well as five food can fragments (131613) were also found. All can types are consistent with an 1877 context.

**Mess Gear**

Three artifacts can be attributed to mess gear. These include a three-prong fork (131595), a table knife (131596), and one piece of a white glazed polychrome-green stoneware plate or saucer (131593).

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**Personal Items**

Four personal items include a California style spur (131579), a nickel-plated, three-prong clothing buckle (131591), and two steel buttons (131588 and 131590). All of the personal items were recovered in or near the main artifact concentration.

**Miscellaneous Metal**

Miscellaneous metal (n=36, no photo) includes unidentifiable pieces of strapping, sheet metal, and crushed canisters. A crushed, hinged, oval canister (131598) was found within the main artifact as well as two friction-fit canisters (131609 and 131610). Another crushed canister (131610) possesses two holes approximately .24" in diameter that could be the result of buckshot. A partially crushed, internal friction lid (131614) with a small ring handle was found about 10 m east of the main artifact concentration. Two oval handles (131592 and 131611) with associated sheet metal were found within the main artifact concentration. These are probably from a bucket or wash-basin type container. Twelve badly oxidized metal fragments (131605, 131607 and 131608), some of which are from a curled or rolled rim bucket or wash basin, were also found in the main artifact area.
Equestrian Gear

Horse-related artifacts (n=5, no photo) include a picket pin (131599), a circular steel ring (131597), a cinch or D-ring (131589) (both commonly used on saddles and harasses), and one fragmentary (131602) and one complete (131601) horse shoe.

Blaze Tree

A cross-shaped blaze cut into an undressed fire scar was found on the south side of a living lodge pole pine (no photo). The blaze (44 cm high and at least 15 cm across) appears to have been cut with a hatchet or a shovel. The ends of the horizontal portion of the blaze are engulfed by new growth. Considering the shape of the blaze and the events that occurred at the site, it could be related to the temporary burial of Charles Kenk.

Discussion

Figure 8 shows the main artifact concentration area situated within a shallow topographic depression surrounded on three sides by hill slopes. The area is most likely the site of the actual Helena Party camp where equipment and provisions were initially unloaded and stockpiled, and where most of the tourists were gathered when attacked. The area of the entire event is undoubtedly much larger and would include horse picket areas, the approach route and firing positions of the Nez Perce, flight routes and concealment locations of the white's, the location of Kenk's murder, interment and exhumation. Artifacts concentrated in and around this area allow a brief examination of the immediate area with regard to eyewitness accounts and the event that occurred there. Some years after the attack, Hiram Chittenden visited the site and observed:

“...The camp site on Otter Creek was well chosen for defense, but its natural advantages were absolutely ignored by the party. It was a triangular knoll between the forks of the stream, and some twenty feet above them. It commanded every approach, and with the slightest vigilance and intelligent preparation, could have been made impregnable to the.....Indians who attacked it. But while the camp was properly pitched in a little depression back of the crest, the men themselves all
staid back where the view around them was entirely cut off. They kept no guard, and were, therefore, in a worse position than if actually out in the open plain below” (Chittenden 1903:165).

Given the circumstances faced by the tourists, the camp was indeed in a very good spot, as it was well hidden in the timber and a good distance up valley from the Yellowstone River travel corridor. The ridge crest overlooking Otter Creek lies about 30 m north, while the ridge overlooking the Main Otter Creek Valley lies at about twice that distance to the east. A meadow that would have provided grass for the horses is located about 30 m south of the camp area. A small spring-fed stream flows through the meadow and would have provided water for both men and stock. A second meadow lies a short distance upstream from the first and would have been another location where horses could graze.

Eyewitnesses state that the Nez Perce were able to infiltrate to close quarters prior to opening fire. John Stewart’s account states that the shooting woke him from a nap, and when he sat up he found his companions had fled and Nez Perce raiders were within 15 or 20 feet of his location. Stewart describes running into the brush, crossing a “small creek” and coming “to a small open park.” At this point he saw Kenk 75 to 100 ft. ahead of him. Stewart was shot the first time just after seeing Kenk, and Kenk was shot at about this same time. Stewart managed to run another 50 ft. before being shot a second time. Several Indians then ran past him and killed Kenk. After successfully bartering for his life, Stewart was left in view of the camp for several hours while it was pillaged (Courier Reporter 1877a).

When compared to Stewart’s account, the location of the artifact concentration appears consistent with the present topography, drainage, and vegetation patterns. The terrain he describes passing through during his unsuccessful flight begins in the “little park” near camp, then crosses through “brush”, then crosses the “creek” where he “again came into a small open park”, where he was shot. Kenk was evidently ahead of Stewart when both were shot, perhaps in the same open park. We might postulate then that the Stewart/Kenk flight path was generally in a southwest direction, away from the camp area (Figure 8).

The escape routes of the other tourists most likely followed a northeast direction from camp.
Ben Stone claims that Duncan lit out first, with Dietrich and us following (Courier Reporter 1877b). Stone’s account indicates most of the men initially ran in the same direction, although Duncan may have made it to the woods and hid (Weikert 1900:163). Stone remembered turning three somersaults down a steep hill, and after a near miss by a bullet, rolling into and hiding in the creek channel (Courier Reporter 1877b). Stone’s flight path, as well as several of his companions, was probably north or east from camp, the most direct route being slightly northeast (about 25 m) to the ridge and down the steep slope to the creek bottom.

Figure 7. Personal items recovered from Helena Party Camp.

Eyewitness accounts provide little direct information regarding the Nez Perce approach route, firing positions, or how many shots were fired during the attack. Hiram Chittenden (1903:165), though not a participant in the event, writes “....The Indians approached under cover of the hill, climbed its sides and burst over its crest directly into camp before anyone suspected their presence.” His statement indicates the Nez Perce advanced from the east, with the nearby hill acting as a visual shield. An advance from that direction would have limited the tourist’s flight path options as they would have probably been reluctant to flee toward the attackers or cross open terrain. Stewart’s statement that “the Indians [were] within 15 or 20 feet”, when he awoke suggests that the raiders inadvertently placed themselves between his napping spot and the camp area, thus forcing himself and Kenk to flee westward, while Stone and the others had an unobstructed flight route over the ridge to the northeast.

It is assumed that the three recovered cartridge cases were fired by the Nez Perce raiders during the attack. It is also assumed that the cases were immediately discarded so they could reload their weapons. If these assumptions are correct, the cartridge case locations represent firing positions of at least two, and possibly three individuals. Given the short distances involved, one might wonder how the Nez Perce could have missed the several potential targets at such close range. One question comes to mind with this scenario, that is, did the Nez Perce deliberately miss, and was the attack designed more to run the tourists off so their goods could be confiscated? The subsequent shooting of Stewart and killing of Kenk does not support this contention.

48YE506 Parker Mountain Site

The Parker Mountain site is located near the eastern boundary of YNP along the northern flank of Parker Peak in a high mountain valley forming the headwaters of the Lamar River. The site covers an area approximately 480 m by 280 m in size. The upper end of the site is situated at an elevation of 9720 ft. and overlooks Hoodoo Basin to the east. The valley containing the site has been cut by a small, unnamed stream fed by snowfields lining the north and east faces of Parker Peak. A series of melt-water-fed bogs, small ponds, wet meadows and erosional cuts extend down valley along the base of the peak’s north face. A small, melt- water pond (known locally as Bannock Lake) has formed at the base of the peak, immediately west of the ridge crest overlooking Hoodoo Basin. Mixed conifer tree islands, separated by grassy meadows, characterize the valley in the site vicinity.
Figure 8. Map showing August 25-26, 1877 Helena Party camp area, possible Nez Perce approach routes and firing positions, tourist escape routes, and possible shooting locations of Stewart and Kenk.
P. W. Norris provides an account of an 1880 visit to the Parker Mountain site in his Annual Report to Congress:

“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 to mark this habitation of the red man. These poles are near the summit of an open, grassy pass between Hoodoo and Miller Creeks, close by a dwarf-timber-fringed pond at the base of an old snowfield on the side of Parker’s Peak, and within sight and easy striking distance of rough, elevated passes to Crandall’s Creek [a branch of Clark’s Fork], and other passes to the Stinking Water. Hidden upon the flanks by snowy mountains, and in the pass by a screen of dwarf pines and balsams, and with a precipitous descent over the snow-fields to Hoodoo Creek, 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. This position, therefore, formed one of the most secure lairs and admirable lookouts for hostile Indians that I have ever met with, and also bears ample evidence of its frequent summer occupancy. Fragments of china-ware, blankets, bed clothing, and costly male and female wearing apparel here found, were mute but mournful witnesses of border raids and massacres” (Norris 1881:7).

Initial documentation of the Parker Mountain site occurred in 1961 when Aubrey Haines (1963) and several companions investigated a small area north of the snowmelt pond. Cultural materials mentioned in his report consisted of numerous worked chips, two thumb scrapers, a porcelain button, percussion cap, and numerous pieces of badly weathered wood which showed crude chop marks. Many of the pieces of wood were observed in what Haines refers to as shallowly eroded spots. In his abbreviated conclusions, Haines suggests the camp may have been a lair for raiding Indians, particularly during the Bannock War of 1878. The site was revisited by Stuart Connor (1977) and several companions in 1977. Their investigations focused on two small stands of timber on either side of the pond where they found evidence of bark stripping on several dead trees, along with several lodge pole sized stumps that had been cut with a hatchet or axe.

The 2008 investigations at the site included metal detecting and survey, along with recording of the weathered wood believed to be remains of the same poles mentioned by Norris and later discussed by Haines. Two main artifact concentration areas were identified (Figure 9): Area A at the east end of the site near the melt water pond; and Area B which is located approximately 300m down valley along a spring fed tributary. In addition, culturally-modified trees were found in 10 stands of trees. A number of prehistoric artifacts were also documented, including Archaic and Paleoindian projectile points. As this paper focuses on historic occupation, prehistoric materials are not discussed.

Area A

Pole Remains

Seventeen clusters and single occurrences of weathered and deteriorated wood fragments were observed in the meadow area north of the pond (Figure 9). In all, 72 pieces of wood were recorded, and ranged from 23 to 154 cm long. No evidence of past or present tree growth was observed in the area and the wood pieces are located well away from existing trees that could be a source for the remains due to blow down. Although Haines (1963) observed crude chop marks on many of the poles at that time, no definite chop marks were observed on any of the pole remains in 2008. It remains probable, however, that they are remains of the same poles observed by Norris in 1880.

Figure 9. Remains of desiccated poles observed in meadow at the Parker Mountain site.
Culturally Modified Trees

Culturally modified trees include two types: 1) those believed related to cambium stripping, and 2) axe-cut stumps.

Four trees were identified as possessing cutmark patterns indicative of cambium harvesting (Figure 10). These possessed large, oval-shaped scars outlined by tool marks. Scar edges were defined by a series of closely-spaced incisions made by a relatively small cutting tool, such as a hatchet or a curved-blade knife. Some scars show cuts indicating the tool orientation was upward at the high-points of the scars and horizontal or downward along the sides and base of the scar. The tool marks began about six inches above the base of the tree and extended to a height of four to six feet.

The harvest and consumption of cambium and secondary phloem tissues was a relatively common practice among native people of the Columbia Plateau (Hunn et al. 1989:531) and other areas in the Rocky Mountains (White 1954, Martorano 1981). According to Swetnam (1984) historic and ethnographic accounts indicate cambium harvest and consumption was a normal part of the annual cycle of some native people, especially during the spring months. The Kootenai harvested Ponderosa cambium annually in the spring when the sap was reported to be good (White 1954). Malouf (1989:299) reports the Flathead and Pend d’Orelle harvested cambium from evergreens during the spring when sap was running. The Umatilla (Stern 1989:396) used Ponderosa cambium as a starvation food, and people of the Colville tribes are also reported to have harvested cambium from a number of trees (Kennedy and Bouchard 1989:243). Lewis and Clark (Thwaites 1904: July 19, 1805) report bark peeling and consumption of sap and the soft part of the wood among the Northern Shoshone. Peeled trees in the Bitterroot Valley and surrounding mountains are attributed to Salish, Kootenai, Nez Perce, and Shoshone (Walker 1989).

A total of 64 axe-cut stumps were found in the 10 tree islands (Figure 11). The stumps range from 8 to 15 cm in diameter and about 15 cm to as much as 1 m in height. The stumps have been cut with an axe or similar implement as indicated by the surfaces on the stumps. Many are still rooted in the ground while others have

Figure 10. Tool marks on suspected cambium harvest tree (left) close-up of tool marks (left) , Area A Parker Mountain site.

Figure 11. Example of axe cut stump at the Parker Mountain site.
rotted at ground level and fallen, but are otherwise intact. Although some potential for dendrochronological dating exists, association of the stumps with a specific historic event is not possible at present. It is possible that the stumps represent harvest points of the now weathered poles scattered north of the pond.

![Figure 12. Artifacts found in Area B at the Parker Mountain site.](image)

**Area B**

A total of 19 historic artifacts and possible remains of a pole structure were documented in an area approximately 10x40m in size (Figure 12, Table 4). Most artifacts were found on a 2-3m high terrace along the south bank of a spring-fed tributary of the main drainage in the valley. Artifacts include a tinkler and a tinkler preform, iron projectile point, six pieces of hardware from a pre-1874 pattern McClellan saddle, four unused horse shoe nails and a horse shoe nail fragment, a possible canteen spout, a possible drinking cup handle, two hole-in-top can ends, a wire handle, and a bail ear.

Tinklers (131676 and 131688) (also known as bangles, danglers, v-cones, and tinkling cones) were cone-shaped pieces of rolled metal attached to clothing edges as decorations and sound producers (Cleland 1971:27-28; Crabtree 1968:38-42). Both specimens retain surface tinning (see below). Steel projectile point 131687 has distinct shoulders and a relatively narrow tang. The asymmetry of the artifact suggests it is Indian made. Metal points were a popular 19th century trade item although many were Indian made, using axes, chisels, files, and even shears to cut strap iron or any other suitable material (Hanson 1972).

Artifacts 131680 (front) and 131681 (rear) are steel “barrel head” ring staples from a pre-Model 1874 McClellan saddle. The staples fastened tie-down rings to the saddle side bar. Both are deformed, indicating they were pried from a saddle tree. While this type of staple was used on all enlisted pattern 1859, Civil War, and early Indian War pattern saddles, design changes for the Model 1874 saddle included narrower ring staples made of brass (Dorsey and McPheeters 1999:38). An iron foot staple (131691) was also found. Foot staples were attached to the saddle sidebars by two brass screws and used as tie-downs for saddlebags and other accouterments (Hutchins 1970). Design modifications for the Model 1874 saddle included a change to brass footstaples (Dorsey and McPheeters 1999:85). Other parts include a brass pommel shield and two brass cantle guard plates (131690) found stacked atop one another. The pommel shield has a “1” (indicating an eleven-inch seat) punched into the bottom center. As this item lacks the standard embossing it may be of a non-regulation type, possibly manufactured during the Civil War or early Indian War period (Dorsey and McPheeters 1999:51). Cantle guard plates trimmed tie-down holes located on both the cantle and pommel. These items remained unchanged on 19th century saddles. All of the saddle hardware is consistent with a pre-Model 1874 type. Dorsey and McPheeters (1999:83) note that due to Indian War era budget constraints, most
McClellan saddles in use through the late 1870s were largely variations of the 1869 and 1872 patterns, and the 1874 upgrades were not in production until after 1876. Several other artifacts could also be army related. Artifact 131667 may be fragments of a canteen spout. Spouts for the U.S. model 1872 canteen were made of both pewter and tin (McChristian 1995:90). This particular specimen is oversize for period canteens curated at the University of Wyoming Repository in Laramie. Such items were often bought privately, however, and may not be of that exact pattern. Artifact 131693 appears to be a rolled wire reinforced handle to a standard army drinking cup (McChristian 1995: 99-100). The object is composed of six oxidized fragments,

Table 4. Area B artifacts from the Parker Mountain site.

<table>
<thead>
<tr>
<th>Catalog Number</th>
<th>Artifact</th>
<th>Description</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>131676</td>
<td>Tinkler Preform</td>
<td>2.07 cm wide, 2.53 cm long, triangular, may have been scored with knife and bent</td>
<td>Late 19th Century</td>
</tr>
<tr>
<td>131688</td>
<td>Tinkler</td>
<td>3.07 cm long by .84 cm wide, oxidized</td>
<td>Late 19th Century</td>
</tr>
<tr>
<td>131677</td>
<td>Possible canteen spout</td>
<td>Two fragments representing about 50% of circumference</td>
<td>Unknown</td>
</tr>
<tr>
<td>131678, 131679</td>
<td>Four Horseshoe nails</td>
<td>2.25&quot; long, oxidized, unused</td>
<td>Unknown</td>
</tr>
<tr>
<td>131680</td>
<td>Iron Ring Staple</td>
<td>3/8&quot; wide by 1.25&quot; long, complete though deformed, appears to have been extracted, clinched tips, oxidized</td>
<td>Pre-Model 1874 McClellan Saddle (Dorsey and McPheeters 1999)</td>
</tr>
<tr>
<td>131681</td>
<td>Iron Ring Staple</td>
<td>½&quot; wide by 1 5/8&quot; long, complete though deformed, appears to have been extracted, clinched tips, oxidized</td>
<td>Pre-Model 1874 McClellan Saddle (Dorsey and McPheeters 1999)</td>
</tr>
<tr>
<td>131682</td>
<td>Horseshoe nail tip</td>
<td>Long, oxidized</td>
<td>Unknown</td>
</tr>
<tr>
<td>131683, 131684</td>
<td>Hole-in-top can lid (2)</td>
<td>“R&amp;R” embossed on cap, oxidized though some tinning visible</td>
<td>Pre-1888 (Rock 1989)</td>
</tr>
<tr>
<td>131685</td>
<td>Friction-lid can fragments</td>
<td>Six fragments, double side-seam, oxidized and crushed</td>
<td>Post 1860 (Rock 1989)</td>
</tr>
<tr>
<td>131686</td>
<td>Hole-in-top can lid</td>
<td>12 fragments, oxidized, edges appear cut</td>
<td>Pre-1888 (Rock 1989)</td>
</tr>
<tr>
<td>131687</td>
<td>Steel projectile point</td>
<td>5.3 cm long, 1.5 cm wide, oxidized, Indian</td>
<td>Late 19th century</td>
</tr>
<tr>
<td>131689</td>
<td>Bail ear</td>
<td>Oxidized</td>
<td>Unknown, probably late 19th century</td>
</tr>
<tr>
<td>131690</td>
<td>1 brass pommel shield and 2 cantle guard plates from a McClellan saddle</td>
<td>Shield has “1” punched into center bottom</td>
<td>Pre-Model 1874 McClellan Saddle (Dorsey and McPheeters 1999)</td>
</tr>
<tr>
<td>131691</td>
<td>Iron Foot Staple</td>
<td>Complete, 1 7/8” long</td>
<td>Pre-Model 1874 McClellan Saddle (Dorsey and McPheeters 1999)</td>
</tr>
<tr>
<td>131692</td>
<td>Wire can handle</td>
<td>Long, 1.25&quot;wide</td>
<td>Unknown</td>
</tr>
<tr>
<td>131693</td>
<td>Possible military cup handle</td>
<td>Six fragments, oxidized</td>
<td>Probably post-civil war</td>
</tr>
<tr>
<td>131694</td>
<td>Wire</td>
<td>Four pieces, oxidized</td>
<td>Unknown</td>
</tr>
</tbody>
</table>
the largest of which possesses edges curled over wire as were the original cup handles.

Artifacts 131678 and 131679 are pairs of unused horse shoe nails found in two separate spots. The Model 1859 and later saddle bags were designed to carry extra horse shoes and nails for use in the field (Dorsey and McPheeters 1999:195-197). A fragmentary horse shoe nail (131682) was also found in the area and appears to have been lost from a shod horse as the end is clinched.

Three hole-in-top food can lids were found, two (131683 and 131684) of which possessed caps with “R&R” (unidentified) embossed on the soldered cap. Unoxidized portions of these two pieces retain tinning, and are similar in appearance to the unoxidized tinned portions of the tinkler preform and tinkler. A third lid (131686) is in an advanced state of oxidation. Other artifacts include six fragments of a double side-seam friction-lid can (131685) a steel handle or bail ear (131689), a wire handle or small bail (131692) and five fragments of oxidized metal (131694).

Remains of a possible structure were found approximately 12m west of the Area B artifact concentration. The feature is represented by at least three poles that protrude from beneath a large rotted tree that has fallen to the ground (Figure 13). The exposed pole ends are axe-cut and remaining portions extend beneath the forest floor duff; two are on the west side of the fallen tree and one is on the east side. Their configuration suggests several poles may have been attached to one another to form a structure, and these were either already collapsed or, if standing, crushed when the tree fell. Additional poles may be present below the duff layer.

Discussion

The presence of the projectile point, tinkler and tinkler perform indicates that the Area B assemblage resulted from a late 19th century Native American occupation. What remains of the tinning on the tinkler and tinkler preform is similar in appearance to that remaining on two of the can lids, indicating the cans may have been the raw material for tinkler manufacture. The assortment of McClellan saddle hardware suggests that an entire saddle was probably not abandoned at the site. Instead, these pieces were probably brought to the site after being salvaged from a saddle or removed from a saddle at the site and then the saddle was removed from the area. The saddle parts, horse shoe nails, and two other artifacts of possible military origin, as well as those representing food and dry-goods containers, could have been acquired concurrently. Army horses, military equipment, and provisions were commonly acquired by American Indians during the Indian War Period (Cruse 2000).

When P. W. Norris rode along the north face of Parker Peak in 1880 he observed a standing lodge and more than 40 others that had fallen, which he assumed had been used the previous year. He also observed fragments of china, blankets, and costly male and female clothing, which he attributed to raids by Indian groups
that he did not name. Unfortunately no additional
description of the appearance or distribution of the lodge
remains was given, nor was their potential origin
discussed in light of the Nez Perce (1877) and Bannock
(1878) insurrections which had occurred, at most, a few
years before. The association of the perishable material
along with the standing and collapsed lodges does
however convey a feeling of recency to the materials he
saw. Various interpretations have attributed the remains
described by Norris to the Sheepeater Shoshone, Nez
Perce, and Bannock. The following discussion attempts
to juxtapose these and provide an interpretation based
on available information pertaining to the subject.

The montane setting, presence of whitebark pine and
other high elevation resources notwithstanding, the
remains found at the Parker Peak site share little
similarity with historic Shoshonean (Sheepeater)
assemblages (see Eakin 2005). Although many of the
structural remains scattered around the Central Rocky
mountains have been attributed to these groups
(Dominick 1964; Frison 1991), clothing and other
material observed at the site in 1880 were probably not a
result of Sheepeater activity, as they are not known to
have been raiding in the region at that time. In addition,
by the late 1870s, the number of Sheepeaters remaining
in the park was probably low since many of them had
moved south to the Wind River Reservation after
Washakie extended an invitation for them to do so in
1871 (Haines 1997:29).

Haines (1963) has suggested that the poles he
observed resulted from a Bannock camp during the 1878
war, but cites no reasons for his opinion. Walpole
(1998:18) cites evidence placing the Bannocks near Index
Peak several days before the Bennett Butte fight on
Clark’s Fork. If true, and if the group had taken the
Parker Mountain route on their eastward trek, it would
have necessitated a circuitous track down a tributary of
Crandall Creek to Clark’s Fork, and then an upstream turn
for some distance. From a logistical standpoint, this
information indicates the Bannock did not visit Parker
Peak in 1878. Other evidence to the contrary can be
found in the military report filed after the Bennet Butte
fight of September 4th, 1878 which lists a total of about
80 Bannocks in 20 lodges (Walpole 1998). The 40 lodge
estimate of Norris at Parker Peak would indicate an
excessive number of lodges for the number of Bannocks
involved in the final engagement of the war. John
Shively, after his 13 day abduction by the Nez Perce,
reported the main body numbered between 600 and 800
in about 125 “lodges” (Bozeman Times 1877). This
estimate would indicate that at 5.6 persons per lodge,
the 40+ lodges seen by Norris could have sheltered a
minimum of 224 people. Based on this information, it is
argued that the remains in the camp were created by a
larger group, the Nez Perce, who would have moved
through the area one year prior to the Bannock.

Although none of the artifacts found during the 2008
investigations at the Parker Mountain site can be
associated with any particular Native American group, it
is entirely possible that these items resulted from a Nez
Perce occupation. The McClellan saddle parts could have
originated as stolen property from the army, as there
were many such instances during the war (see Greene
2000). The association of these items with cans and
other goods would also be consistent with property the
Nez Perce obtained through raiding both military and
civilian sources. Within this, the most provocative
association may be expressed in the original Norris
description, specifically the “Fragments of china-ware,
blankets, bed clothing, and costly male and female
wearing apparel” he saw strewn about on his ride
through the area. All of the items could have been
procured through raiding activities by the Nez Perce on a
number of occasions. The Nez Perce warrior Yellow
Wolf, in reference to the looting of McCartney’s Hotel in
Mammoth, states that the Nez Perce were literally taking
“everything we could, especially in clothes” (McWhorter
1992:439). Some items, however, such as the costly
male and female wearing apparel, might have been
relatively rare in the region at the time. One potential
source of such items is listed as “A quantity of clothing,
belonging to claimant and his wife,” of the value of
250.00 on line 15 of the depredation claim (Table 2) filed
by George Cowan for property losses incurred on August
24th, 1877.

Although it is unfortunate that Norris does not
describe the standing and collapsed lodges in greater
detail, it is probably safe to assume that what he saw at
nearly 10,000 ft. in a rugged and mountainous landscape
were probably not remains of classic Plains Indian
teepees, but rather shelters of a much more basic form.
Emma Cowan’s account of her overnight stay as a Nez
Perce hostage provides the only known description of a Nez Perce camp as they traveled through YNP...

“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, thus affording some protection from the cold night air” (Guie and McWhorter 1935:296).

Her description suggests a more practical and expedient form of shelter had been adopted under the circumstances. The shelters were probably a simple pole framework, covered with canvas or pine boughs, a logical choice for a highly mobile group with no intention to remain at any one location for an extended time.

**Conclusions**

Systematic metal detecting and archival research has added to our knowledge of the NPNHT in YNP. One highlight of the project is the identification of the locality where the Radersburg party was forced to abandon their wagons and property after being taken captive by the Nez Perce. The party’s abduction has been described numerous times in the popular literature of 1877 and continues to be a topic in modern historic overviews. Artifacts recovered from the site, as well as eyewitness accounts of the event and claims for lost property filed by the survivors, provide supportive evidence for site identification. Spatial isolation of the locality aids in the verification of the route of the Nez Perce, the U. S. military, and the involvement of civilian participants in the 1877 war. Similarly, the investigation of the Helena party site provides insights into the organization of the camp prior to the attack, and with the use of archival information and local topography, permits speculation on tourist flight routes and the wounding and murder of two party members. Both sites lend a temporal context regarding the types of goods taken by visitors to YNP during the early days of tourism.

The Parker Mountain site may be particularly significant as it possesses several types of physical evidence (pole “lodges,” pole and cambium harvesting, as well as a late 19th century artifact assemblage) indicating that it could well be a Nez Perce camp. Some potential exists for dendrochronological dating of the axe cut stumps found thus far. If the stumps were to date to 1877, the other data gathered from the site would combine to provide strong evidence for a Nez Perce occupation. This would lend a higher level of credence to both the NPNHT route and the belief by some that the Nez Perce divided into splinter groups after departing the Pelican Valley. The items Norris mentions, though basic in their description, offer some indication that they were acquired through raiding activities, but later abandoned. It is both possible and plausible that some articles he describes represented property stolen from both the Radersburg and Helena tourist parties, not to mention other non-military sources. If so, the pattern would unite the Nez Perce with a common theme faced by Native American groups involved in late 19th century warfare with the U.S. Government; a severe lack of material goods with no source of resupply.

**Acknowledgements**

The efforts of a number of former and current YNP employees were integral to the successful completion of several seasons of fieldwork for this project. Ann Johnson, Rosemary Succic, Tobin Roop and Elaine Hale (YCR) were instrumental in initiating the project, scheduling, and financial support over several seasons of investigation. Wally Wines and his expert packers, Dave Elwood, Travis McNamara, Ben Cunningham, and Julie Oliveri repeatedly proved their skills with regard to insertion and extraction of food, gear, and gadgetry from the back country. Rangers Mike Ross, Bob Kistart, John Loudsberry and the late Jerry Mernin provided support, knowledge, and enthusiasm regarding various aspects of the NPNHT. Both Doug Scott (MWAC) and Dale Wedel (OWSA) provided valuable advice and reference material which aided in the identification of a number of artifacts. Perhaps the greatest level of recognition should be given to the crewmembers who willingly endured several long stretches in the back country and many miles on the trail. My wife, Julie Eakin, assumed the responsibility of assembling food and gear, and assured our general welfare in the back country. Other crew members include Andrew Woodhouse, Will Hollingberry, and Tim Pinkham (Nez Perce Tribe). Volunteers include Raymond Kunselman and William Eckerle. Without the efforts and positive attitudes of these individuals the overall success of the project could not be guaranteed.
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CHAPTER 9
MORPHOLOGY AND SEDIMENTOLOGY OF GILBERT STYLE DELTAS ALONG THE EASTERN AND SOUTHERN MARGINS OF YELLOWSTONE LAKE, YELLOWSTONE NATIONAL PARK, WYOMING

By Michael H. Hofmann and Marc S. Hendrix

Abstract
Geomorphologic and sedimentologic analysis of two triangular-shaped, flat-topped landforms located immediately north of Alluvium Creek and immediately west of Trail Creek along the southeastern and southern shorelines of Yellowstone Lake suggests that these features are inactive Gilbert-style deltas, deposited when the level of Yellowstone Lake was significantly higher level than present. The landforms represent the delta morphologies at their abandonment stage and include a gently-sloping topset surface, ranging on average between 1.5° and 3.5°, and steeply dipping delta slopes ranging between 14° and 25° and facing Yellowstone Lake.

Detailed sedimentologic measurements of stratigraphic sections reveals that the deltas are composed of four dominant facies: 1) a topset distributary facies, composed of poorly-sorted, locally imbricated gravel incised into older sedimentary deposits and inferred to reflect fluvial in-channel deposition; 2) topset overbank facies, consisting of finer-grained and well-stratified packages of upward-finishing sand with local open framework gravel, interpreted to represent sediments deposited on the delta floodplain, laterally offset from the topset distributary facies; 3) foreset facies, consisting of granule- to pebble-bearing, frequently graded, sandy units that dip 12° to 26° basinward, are interstratified with cm thick layers of mud, and are interpreted to reflect sediment deposition on the delta front by sediment gravity flows, mainly turbidity currents; and 4) bottom set facies, exposed only near the base of the Alluvium Delta at the morphologic break in slope and consisting of gently inclined layers of poorly-sorted pebbly sand interpreted to represent the distal deposits of high- and low-density turbidity currents.

Recovery of woody debris from topset overbank facies near the apex of the Alluvium Creek Delta, ~1.5 m below the abandoned delta top surface, yielded a date of 10,390±150 cal yr BP (9,220±50 BP C14 yr BP). We interpret this date to reflect active deposition of the Alluvium Creek Delta when the lake surface elevation was 1.5 m below the morphologic break in slope of the Alluvium Creek Delta, at a level ~ 21 m higher than the present day lake level of 2358 m. Similar morphologic profiles and internal stratal architectures of the two Gilbert-style deltas suggest that they developed contemporaneously and in response to lake level fluctuations. Good preservation of the delta front morphology and deep incision by modern Alluvium and Trail Creeks together suggest that the surface elevation of Yellowstone Lake fell rapidly following delta abandonment and without significantly reworking of delta front deposits.

Recognizing these geomorphic features as Gilbert-style deltas implies that the high terraces they form are constructional surfaces resulting from frequent environmental changes not conducive to human settlement. Much of the time, the topset surfaces were submerged or at least swampy, and rapid changes in channel location and local topset morphology would have prevented repeated occupation of single campsites across generations. Because of these factors, we infer that archaeological artifacts related to Paleoindian time (~11,500 – 8,000 cal yr BP) will not be widely preserved on these surfaces. In contrast, the drop in relative lake level in the early Holocene, coupled with attractiveness of the abandoned delta top surfaces for seasonal or shorter periods of human occupation, suggest that artifacts of Early Archaic period (~8,000 – 5,000 cal yr BP) and younger periods should be preserved.

Introduction
At 10,000 cal yr BP the inner Yellowstone area was just emerging from underneath a thick cover of ice that occupied the area during the latest Pleistocene glacial
maximum (e.g. Licciardi and Pierce 2008). The melting of the ice cap and smaller valley glaciers associated with this latest Pleistocene and early Holocene warming trend resulted in high sediment yield flood events in many of the local rivers and creeks. The Gilbert style deltas that we identified in the southeastern part of the Yellowstone Lake area are the direct reflection of these high sediment yield events and coincide with the first recorded seasonal habitation of the central Yellowstone area, north of the lake during the Paleoindian period (~ 11,500 – 8,000 yr BP; Sanders 2002).

Gilbert-style deltas are a unique delta style composed of steeply dipping, relatively straight delta foresets, flat lying, nearly horizontal delta topsets, and tangentially-dipping delta bottom-sets (Figure 1). These deltas are commonly coarser grained (gravel bearing) than other delta styles and were first described by Gilbert (1885) in Pleistocene Lake Bonneville deposits, Utah. The characteristic geometries of Gilbert-style deltas are directly related to the catchment morphologies and load and flow intensity of fluvial currents and the sediment dispersal in the receiving basin. They form most commonly in basins with high gradients and high sediment yield.

Many of the parameters necessary for the formation of Gilbert-style deltas are found in lake environments (e.g. Bates 1953; Stanley and Surdam 1977) and in particularly glacial lake environments characterized by steep gradient margins following glacial retreat (e.g. Gilbert 1885, 1890; Gustavson et al. 1975). In addition to lacustrine settings, Gilbert-style deltas have been reported from a wide range of coastal marine environments, commonly related to basins with high sediment yield (e.g. Prior et al. 1987; Colella 1984, 1988; Postma 1984; Postma and Roep 1985; Postma et al. 1988; Colella et al. 1987; Nemec and Steel 1988; Nemec 1990; Falk and Dorsey 1998; Mutti et al. 2003).

In this paper we present the detailed sedimentologic and geomorphologic characteristics of previously unrecognized Gilbert-style deltas located along the southern and eastern margins of Yellowstone Lake, Wyoming (Figure 2), and we discuss the dominant depositional processes and associated evolution of these deltas. The interpretation of these landforms as Gilbert-style deltas has implications for the reconstruction of the early post-glacial history of the Yellowstone Lake Basin and the settlement of humans in this area. Results presented in this paper stem from work directed towards documenting the geomorphologic and geologic framework of archaeological sites located along the eastern and southern shores of Yellowstone Lake, Yellowstone National Park, Wyoming as part of the University of Montana-Yellowstone Archeological Project (Hofmann and Hendrix 2012).

Figure 1. Schematic model of common Gilbert-Style delta morphologies.
Location and Geological Setting

Yellowstone Lake occupies the southern portion of a caldera that formed from collapse of the Yellowstone Volcano following eruption of the Lava Creek Tuff approximately 640,000 years ago (Christiansen 2001). Around Yellowstone Lake, well-preserved geomorphologic features, including paleoshorelines, drowned river valleys, and multiple river terraces have been used as the basis for interpreting a Late Pleistocene and Holocene history of millennial-scale vertical ground motions associated with continued activity of the Yellowstone Volcano (Locke and Meyer 1994; Morgan et al. 2007; Pierce et al. 2007). Vertical ground movements have been interpreted to reflect migration of magma and gas within the magma chamber (Wicks et al. 2006) and/or hydrothermal fluid sealing and inflation followed by seal cracking, pressure release, and deflation (Pierce et al. 2002, 2007). Up to 20 m of Holocene and earlier vertical ground motions have been inferred from geomorphic studies near the Yellowstone Lake outlet (Pierce et al. 2007) and from shoreline surveying work around the lake margin (Locke and Meyer 1994).

The millennial-scale fluctuations of Lake Yellowstone’s surface elevation inferred to represent continued activity of the Yellowstone Volcano are supported by historic observations of both positive and negative meter-scale ground motion of the caldera floor. Reoccupation of leveling line sites between 1923 and

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Figure 2. Location map of study area (A) and detailed location maps of measured sections for the Alluvium Creek Delta (B) and the Trail Creek Delta (C); darker gray areas on maps B and C outline approximate area of Pleistocene Gilbert-style deltas as mapped from satellite images. AC = Alluvium Creek section; CC1 = Columbine Creek section 1; CC2 = Columbine Creek section 2; TC = Trail Creek section
1975-77 (Pelton and Smith 1979, 1982) suggests that >7 m of uplift occurred between 1923 and 1975 in the region between the Mallard Lake and Sour Creek resurgent domes in Yellowstone, with as much as 5 m of uplift affecting the outlet region at the northern end of Yellowstone Lake near Fishing Bridge. The magnitude of vertical motion inferred from leveling line surveys generally decreases to the south away from the caldera center and was inferred to be ~0 m at the southern margin of the caldera and parts of Yellowstone Lake further south, including the present study area in the Southeast Arm of the lake.

The study area for this paper is located along the southeastern and eastern margins of Yellowstone Lake, Wyoming (Figure 2A). There, at the mouth of two medium sized catchment areas, we surveyed two large, previously unrecognized Gilbert-style deltas that we named the Alluvium Creek Gilbert Delta and Trail Creek Gilbert Delta after named modern streams adjacent to these deltas. These Gilbert-style deltas were deposited during a lake level highstand in the wake of the late Pleistocene - early Holocene deglaciation of the area (Hendrix and Hofmann, this volume) and are now exposed along the margins of present day Yellowstone Lake as the result of a gradual lake level drop throughout the Holocene.

In the Alluvium Creek area we measured several stratigraphic sections along the modern, incised channel walls of Columbine and Alluvium Creeks (Figure 2B). The first two sections, Columbine Creek 1 (CC1) and Columbine Creek 2 (CC2) are located near the eastern narrow apex of the delta feature about 1.5 km east of the mouth of Columbine Creek and ~100 m above the point at which Alluvium Creek makes an orthogonal turn to the left (southwest). Both the CC1 and CC2 measured sections consist mainly of proximal delta deposits.

The third stratigraphic section (section AC) in the Alluvium Creek area was measured in the modern valley and is located ~ 250 m northeast of the present day mouth of Alluvium Creek near the break in slope between the approximately flat lying delta top and steeply dipping delta front. This stratigraphic section consists of very well-preserved distal delta top and proximal delta front deposits.

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**Figure 3:** Elevation profile of the Alluvium Creek Gilbert-Style Delta surface. Vertical scale (gray scale) and horizontal scale (Easting and Northing) in meters.
In the Trail Creek area we measured one stratigraphic section (section TC) located in a morphologic position similar to that of section AC in the Alluvium Creek area to allow for best comparison of these two landforms. The Trail Creek section is located in the modern valley of an unnamed creek that is dissecting the Trail Creek Gilbert-style delta and located about 1 km west of Trail Creek (Figure 2C). The section exposed by the unnamed creek consists mainly of well-preserved delta front facies.

Morphologic Characteristics

Landforms in the study area include a series of prominent, flat topped benches with steeply basinward dipping margins that rim the present day Yellowstone Lake basin. The two most prominent such features are located near the mouth of present day Alluvium Creek and Columbine Creek along the southeastern margin of Yellowstone Lake and just to the west of present day Trail Creek along the southern margin of Yellowstone Lake (Figure 2). To determine the detailed morphology of these landforms, we collected a total of ~9200 spatial data points using a Trimble GeoXH hand-held GPS unit and post-processed these data using five UNAVCO base stations and one CORS base station in the Yellowstone area. After post-processing, 85% of the data set yielded a vertical accuracy of 50 cm or less.

Morphologic characteristics of the Alluvium Creek Gilbert-style delta

This delta shaped landform along the southeastern margin of Lake Yellowstone was previously mapped by Richmond and Pierce (1972) mainly as middle Pinedale age coarse-grained lacustrine deposits. The landform is characterized by a wide, low gradient bench starting at an elevation of ~2379 m (~7806 ft.) or ~ 21 m (68 ft.) above the present day lake level of 2358 m (7736 ft.) and extending eastward away from the lake for 1.6 km to exposed bedrock (Figures 2, 3). The average slope on top of this surface is <3.5°. To the west, this wide bench is bounded by a steeply dipping slope (max. slope angle ~14°) that continues down to the present day Yellowstone Lake shoreline (Figure 3). A similar morphology extends for more than 3 km parallel to the shoreline. The low gradient bench narrows towards the east to an apex located a few hundred meters below Brimstone Basin at a point where Alluvium and Columbine Creeks diverge. The surface area of the nearly perfect triangle defined by the bench is ~ 3 km². In general, the shape and morphology of this landform resembles that of a modern Gilbert-style delta.

Morphologic Characteristics of the Trail Creek Gilbert-Style Delta

The Trail Creek landform also has morphologic characteristics of a Gilbert-style delta, but was mapped by Richmond and Pierce (1972) as middle and late Pinedale age sandy gravel kame and lake deposits. The main geomorphologic feature is a wide, low gradient bench starting at an elevation of ~2379 m (~7806 ft.) or ~ 21 m (68 ft.) above the present day lake level of 2358 m (7736 ft.). The average slope on top of the bench is <1.5°. To the north this wide bench is bounded by a steeply dipping slope (max. slope 25°) that drops down to the present day Yellowstone Lake shoreline (Figures 2,4). The break in slope between the flat topped bench and the steeply dipping slope parallels the modern day shoreline for more than 1.5 km and is interrupted only by some post formation, modern-day creek incisions. The low gradient bench extends southward away from the lake and coalesces to an apex about ~0.9 km to the south. In general the outline and morphology of this feature resembles that of a Gilbert-style delta (Figure 4).

Sedimentologic Characteristics

To constrain the genesis and architecture of the Alluvium Creek and Trail Creek deltas, we examined the distribution and relationships of sediment facies exposed along deeply incised modern streams.

A total of four stratigraphic sections were exposed by hand-digging and troweling a series of pits that were offset laterally. Upon digging and troweling, the stratigraphy of each pit was described and measured. Sedimentary units observed in each pit were described at centimeter to decimeter scale, meaning that individual beds of this thickness or other sedimentary features existing at this scale were resolved. Facies determination is based on the recorded grain size, grain sorting, grain texture (form, rounding), grain composition, presence of biogenic debris including charcoal and/or wood, and presence and nature of biogenic or sedimentary
structures. Dip direction and dip angle measurements of sedimentary structures were conducted using a standard compass.

Each of the deltas is topped by an almost perfectly flat surface marking the last position of the delta’s distributary system. In the Alluvium Creek area we were able to trench this top surface and associated deposits in two areas, one in a proximal location near the delta apex, the other in a distal location near the break in slope of the flat lying top surface and the steeply inclined delta front surface (Figure 2). In the Trail Creek area the sedimentology was recorded in a trenched section near the transition from delta top to delta front.

To best link our observations with regard to sedimentology with our environmental interpretations, we describe the following sediment facies: 1) a topset distributary facies only observed in the proximal delta top locations; 2) a topset overbank facies dominating the sediments in the distal delta top locations; 3) a foreset facies that includes all deposits associated with the steeply inclined delta front; and 4) a bottom-set facies that is characterized by more gently dipping beds near the paleodelta’s toe of slope in Alluvium Creek.

**Topset distributary facies**

The topset distributary facies was only recognized in delta top locations CC 1 and CC 2 in the Alluvium Creek area (Figure 2). There the distributary facies of the Pleistocene Alluvium Creek Gilbert-style delta is composed of a poorly sorted, massive to crudely-stratified, gravelly interval erosionally overlying older strata (Figure 5A). The gravel clasts are sub-angular to sub-rounded, grain supported, and poorly sorted. The median gravel size is in the cobble fraction, but clast sizes range from pebble- to boulder-sized. The largest boulder exposed in either section is 40 cm in diameter. Some clasts are weakly imbricated with intermediate to long axis planes dipping to the NE (~40°). Matrix is sparse but where present typically consists of medium sand. The erosional surface at the base has a characteristic undulating relief and is present in both sections.
Topset overbank facies

The *topset overbank facies* occurs in intervals that are typically bedding parallel to the morphologic delta top surfaces but are distinctly finer-grained and better stratified than the previously described *topset distributary facies*. The *topset overbank facies* is dominated by centimeter thick fine sand and very fine sand deposits and locally interstratified open framework pebble conglomerate (Figure 5B). Clasts in the conglomerate are commonly sub-angular to sub-rounded and medium to well sorted. The maximum pebble size is 3 cm. The alternating sandy intervals are well sorted. Grain size in these layers ranges from very fine sand to fine sand. Upward-coarsening and upward-fining sedimentary packages with decimeter scale thickness occur in this succession. Many of the framework gravel layers and some of the finer grained layers are iron stained. We interpret the latter as ferricretes forming in overbank deposits. Fine sandy sediments display faint unidirectional ripples, and some contain small burrows or woody debris. In section CC2 white colored, poorly consolidated airfall (ash) deposits are interbedded with

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**Figure 5. Gilbert-style delta lithofacies examples:** (A) topset distributary facies, (B) topset overbank facies; (C) finer grained, laminated, distal foreset facies; and (D) interbedded pebble conglomerates, sands, and mud of the proximal foreset facies.
the finer grained sandy deposits. In the AC section topset overbank deposits overlay the foreset facies along an angular unconformity that was cut when the distributary system beveled its own delta front deposits. In the CC sections the overbank facies is directly related to the topset distributary facies.

Foreset facies

The *foreset facies* is the most diverse facies in the study area. It is generally recognized by steep depositional dip angles ranging from ~12° in finer grained intervals and intervals near the toe of the foresets to ~26° for coarser grained, granule and pebble bearing units and sedimentary units near the upper delta slope (Figure 5C, 5D). In general the individual foresets beds are centimeter to decimeter scale and composed of a series of medium- to coarse-grained, grayish to brown, poorly sorted sand with abundant granules and pebbles. Clasts are commonly well rounded, but clast size is highly variable and ranges up to 8 cm. Apart from a few intervals dominated by open framework gravels with clast to clast contacts, most beds are matrix supported. Sand grains forming the surrounding matrix are sub-angular to sub-rounded and in general medium-sized. Upward-finining centimeter to decimeter scale thick layers of granule-bearing sand are locally common. Interstratified with these coarser sediments are centimeter thick layers of mud that separate individual upward-finining sand layers. Upward-finining layers with smaller overall grain sizes are well sorted and contain fewer outsized clasts (~1 cm diameter) than coarser-grained layers which are medium sorted and contain local cm-sized clasts. The finer sandy layers also are distinctly laminated.

Bottom set facies

The *bottom set facies* is only exposed near the base in the Alluvium Creek section. There it is dominated by massive, dark brown, medium grained, sub-angular to sub-round, poorly sorted pebbly sands. Pebble sizes range up to 3 cm in diameter.

Alternating with the massive sands are a few well layered fine to very fine sand intervals that lack pebbles. The average thickness of the sand layers is ~5 cm and layers are gently inclined (~8°). Sand grains in these latter units are angular to sub-angular and color ranges from light gray to yellowish-brown.

Discussion

Depositional Processes

The following section briefly describes the dominant depositional processes associated with the depositional facies described above. These processes range from fluvial in-channel processes to suspension settle out processes in the distal delta front and bottom sets (Figure 6).

Topset processes

Facies associated with the delta topsets are generally formed by fluvial depositional processes. The locally imbricated, well-rounded, partially open-framework gravel (boulders up to 40 cm in diameter) of the *topset distributary facies* overlying the unconformity suggests large discharge, high competence flows of water. Interstratified finer-grained (sandy) units within the conglomerate suggest fluctuating flow strength. We interpret the coarser-grained deposits to reflect deposition in or near the center of a stream and the finer-grained, better stratified units to reflect deposition outside the main flows or during a phase of lower discharge. These flow processes were probably not too dissimilar to those in the modern Columbine Creek channel during large runoff events. The erosional basal surface associated with these deposits is also indicative of large magnitude (episodic?) flow events in a weakly channelized (braided?) fluvial system.

In contrast, the horizontally stratified, graded beds of the *topset overbank facies*, which contain a high percentage of matrix, centimeter scale sandy rhythmites, ripples, and burrows, are interpreted to represent fluvial overbank deposition on the delta plain (fan surface) with occasional standing water (shallow lakes?). During large flooding events highly concentrated flows spilled over the channel margin into the delta plain. Rapid flow deceleration due to flow expansion caused the widespread deposition of these graded deposits, largely through suspension settle-out. The observed iron staining is interpreted to reflect weak soil development at times when the water table dropped below the land surface, allowing draining of the shallow subsurface and
precipitation of iron oxide cements and grain coatings (Figure 6).

**Foreset processes**

The dominant mechanism by which sediment is dispersed on steeply dipping delta fronts is by subaqueous high density gravity flows, resulting from either slope failure in the upper part of the steep foresets (Prior et al. 1987; Bornhold and Prior 1990; Nemec 1990; Mutti et al. 2003) or the sustained high density inflow of hyperpycnal flows (Gilbert 1973; Bornhold and Prior 1990; Mulder et al. 2003). In modern Gilbert-style deltas, foreset slope gradients can reach up to 35° in coarser gravelly foresets but more commonly they range between 20°-27° in finer grained, sand-dominated foresets (Nemec 1990). In the upper part of a steeply dipping delta front, these sediment-laden flows are commonly dominated by inertia associated with the slowing fluvial current. These inertial flows can also be triggered by subsequent gravitational avalanching of grain flows, flow transformation from frictionally-dominated debris flows, and turbidity currents resulting from wave erosion of the delta front during storms (Kuenen 1965; Mutti et al. 2003). In addition to the inertia-dominated flows avalanching down the steeply dipping delta front are hyperpycnal flows which reflect semi-continuous delivery of sand- and silt-dominated sediment to the lower delta front and beyond from the

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**Figure 6.** Schematic model of dominant depositional processes interpreted from the Alluvium Creek and Trail Creek Gilbert-Style delta deposits. Topsets are dominated by fluvial processes, foresets and bottom-sets are dominated by a variety of gravity-driven flows.
fluvial system. These hyperpycnal flows can be the dominant flow process in some Gilbert-style deltas, where they typically leave behind stratified silty and sandy deposits associated with the lower foresets and bottom-sets.

The high degree of stratigraphic heterogeneity (inverse and normal grading, local presence of massive beds, variable dip azimuth and magnitude, and spatial distribution of sedimentary structures) documented from the Alluvium Creek and Trail Creek deltas reflects the variation in flow dynamics and basin configuration during deposition. The occurrence of fine (mm-scale) lamination in the silt-bearing upward fining units permit the interpretation that these beds are equivalent to Tb deposits of Bouma’s classification of fine grained turbidites (Bouma 1962).

The poorer sorting and crude normal grading of the coarser, pebbly intervals, together with the presence of outsized pebble clasts locally floating in sandy matrix, are typical for laminar sediment gravity flows (Haughton et al. 2003). The flows never completely disaggregated when flowing down the steeply inclined surface, and sediments were deposited from poorly sorted, coarse grained debris flows. This alternating occurrence of debrites and turbidites within different stages of flow transformation from the avalanching stage to the fully turbulent turbidity currents is typical of Gilbert-style delta front environments where flows are flashy, flow processes neither steady nor uniform, and sediment delivery rates are occasionally very high.

The sediment gravity flow deposits described above are separated by muddy interbeds interpreted to represent either the fine grained tail of turbidity currents (Td deposits after Bouma 1962), or background sedimentation in the lake (Te deposits after Bouma 1962; Figures 5D, 6).

**Bottom-set processes**

Most of the deposits associated with the relatively low-gradient bottom-sets resulted from a series of high density and low density turbidity currents (Figure 6). We interpret massive sandy beds as Bouma Ta beds (Bouma 1962), deposited by a rapidly decelerating high density turbidity current. Deceleration occurred mainly as a result of decreasing gradient from the steeply dipping foresets to the gently dipping bottom-sets. The finer-grained well stratified intervals associated with the massive beds are the deposits of low-density turbidity currents. The alternating layers of massive beds and better stratified finer grained units can be best explained by changes in flow strength and sediment input as a result of discharge fluctuations in the catchment area. Expectations are that the massive sands are associated with time-equivalent debrite deposits in a proximal up-dip location, while the low-density turbidites are associated with time-equivalent massive beds immediately up-dip. Run out distances of these low density turbidites can extend for long distances on the lake floor (e.g., Hofmann and Hendrix, 2010), making it difficult to clearly demarcate the pinch out of delta bottom-set beds and the start of time-equivalent lake floor deposition.

**Delta Evolution**

**Alluvium Creek Gilbert-style delta evolution**

The Alluvium Creek Gilbert-style delta occupies an area ~3 km² along the southeastern shore of Yellowstone Lake, reflecting the relatively large catchment area to the east and southeast of the delta. The majority of the present day delta area is formed by a gently dipping delta top surface marking the abandonment stage of a fluvial and floodplain system at a time when the lake level of Yellowstone Lake was at a significantly higher level than at its present (~21 m above present day surface, see detailed discussion at Hendrix and Hofmann, this volume).

Below this top surface, stratal architectures preserved in the Alluvium Creek section (AC, Figure 7) and the two Columbine Creek sections (CC1 and CC2, Figure 8), reveal a complex evolutionary history for the Alluvium Creek Gilbert-style delta. Stacking of topset, foreset, and bottom-set facies suggests that the Alluvium Creek Gilbert-style delta is composed of multiple delta lobes rather than just a simple progradation of one individual continuous delta lobe.
Figure 7. Alluvium Creek (AC) detailed sedimentary log. Schematic maps on right depict delta evolution through time. For explanation see text. Black outline of hatched area marks the inferred position of the paleo-shoreline at the different time steps of delta evolution; dark shaded area is inferred extent of the Alluvium Creek Gilbert-style delta at the different time steps; light shaded area outlines present day Yellowstone Lake.
Figure 8. Columbine Creek stratigraphic logs CC1 and CC2. Both sections are located along Columbine Creek near the apex of the Alluvium Creek Gilbert-style delta (see Fig. 2 for location). Note the similar stratigraphy in both sections. Strata below the erosional unconformity are unrelated to the Gilbert-style delta development and are not discussed here. The arrow in section CC2 marks location of C14 sample 10-CO-11, dated at 10,390±150 cal yr BP (9,220±50 BP C14 yr BP).
The basal 1.5 m in the AC section are composed of gently dipping (<10°) strata of the bottom-set facies. These beds are overlain by progressively steeper dipping beds associated with deposition along the delta front. Dip angles change from 12° to 26° as grain size increases from coarse-grained sand to very coarse-grained sand. We interpret this 5 m thick package of sediments to reflect an overall progradation of the Alluvium Creek Gilbert-style delta basinward at a time when the feeder system was fixed in a relatively steady position and avulsion and migration were subordinate and did not significantly impact sedimentation at the delta front (Fig. 7, Time 1).

At ~ 5 m above the base of section we observe a distinct decrease in bed thickness and a change in sediment transport direction from a predominant westerly direction to a SSW direction. The most common facies across these changes is the foreset facies, but the detailed sedimentologic analysis of these layers suggests a change in dominant flow processes. Fining upward beds were deposited by turbidity currents, resulting in massive to faintly graded beds or well graded deposits respectively. These stand in contrast to the avalanching or debris flow processes that mainly controlled sediment transport in the lower part of the section. All these observations lead to the conclusion that the feeder system shifted to a more distal location relative to the AC location, resulting in more distal facies (finer grained, turbidity currents dominant) and lower gradient dip angles of the foresets. We suggest that the shift occurred in response to a minor increase in lake level and at the same time, the feeder system avulsed or migrated to the north resulting in the more southerly transport direction of the sediments (Figure 7, Time 2). Although the exact relationship between the AC location and the two CC locations is poorly constrained, we propose that an increase in lake level resulted in an increase in accommodation on the delta top and the subsequent increase in preservation potential of floodplain facies. Therefore we suggest that the lower interval in the CC sections (Figure 7), dominated by topset distributary facies, was deposited in conjunction with the prograding delta when accommodation was low, while the topset overbank facies in the upper part of the succession is related to the increase in accommodation in the basin.

Another shift in delta evolution is represented by the erosional unconformity clearly visible at ~ 7 m above the base of the AC section (Figure 7). Steeply dipping beds exposed in this part of the section are interpreted as delta front deposits, whereas the more gently-inclined deposits above the erosional unconformity are interpreted to belong to the topset overbank facies. These topsets were deposited after the break in slope associated with the transition from delta front to delta top had prograded basinward of the section location to a position at or near the present day break in slope (Figure 7, Time 3). The beds above the unconformity dip gently in a NNW direction. We interpret these beds as levee (overbank) deposition at a time when the feeder system had migrated (avulsed) to a location south of the measured section. The delta top/delta front transition was located basinward of the measured section at or near the present day break in slope.

After the deposition of the floodplain facies, the youngest stratigraphic unit in the measured sections, lake level dropped, initiating incision into the Alluvium Creek Gilbert-style delta. During lake level drop, some wave reworking of the last delta front deposits likely occurred, smoothing the delta front. The overall good preservation of the Gilbert-style delta, combined with a lack of failed incised valleys in the area suggests that lake level dropped quickly following the most basinward progradation of the Alluvium Creek Gilbert-style delta.

**Trail Creek Gilbert-style delta evolution**

The present-day morphology of the Trail Creek Gilbert-style delta with its steep delta front and gently dipping delta top reflects the last stage of a colorful delta evolution. The similarity in morphologic profile (maximum slope angle of ~25°) and depositional dip measured from the inclined strata (foreset dip angle of 22°) in outcrop suggests that this delta has not been significantly reworked since it was active.

As previously discussed, the steeply dipping inclined strata dominating the deposits in the Trail Creek section resulted primarily from subaqueous density currents. The absence of topset sediments is largely expected as the measured section is located on the lakeward side of the break in slope between the gently dipping morphologic bench interpreted as the final position of the delta top.
and the steeply dipping slope interpreted as the final position of the delta front.

Similar to the Alluvium Creek Gilbert-style delta, stratal geometries in the Trail Creek measured section suggest that this Gilbert-style delta is composed of three individual lobes. The first two delta lobes, making up most of the thickness in the Trail Creek section are the result of an overall continuous progradation of the delta system into paleo-Yellowstone Lake (Figure 9, Time 1). Lake level at the time of progradation was significantly higher (~21 m higher) than the present day lake level as evident by the position of the break in slope measured on the present morphology (for detailed lake level discussion see Hendrix and Hofmann, this volume). The delta front deposits in the Trail Creek section steepen and coarsen upward throughout most of the succession, suggesting a consistent basinward progradation of the delta. In the lower 2 m of the measured section, more gently dipping strata (dip angle of 15°) are associated with mostly finer grained (medium to coarse sand) sediments on the delta front. Between 2 m and 3 m above the base of section is a minor rotation of the dominant transport direction of delta front deposits from a WNW (~300°) direction to a NNW (~330°) direction. Associated with this change in transport direction is a minor increase in grain size and an increase in abundance of pebbles within the sandy matrix as well as an increase in foreset dip angle from ~15° to ~22°. All of these changes suggest that the delta prograded farther basinward, shifting the Trail Creek measured section to a more proximal position relative to the sediment influx point (Figure 9, Time 2). At the same time the feeder system also migrated from east to west moving to a position just to the SSE of the Trail Creek location.

Throughout most of the lower 5 m of delta deposits, the sedimentary characteristics ranging from outsized clasts floating in finer matrix to normally graded and laminated beds suggest a constant change between laminar and turbulent flow processes typical for Gilbert-style delta deposition.

Another change in delta evolution is interpreted at ~5 m above the base of the measured section. There we observed a decrease in grain size and dip angle of the beds, suggesting a shift from proximal delta front facies to distal delta front facies. Associated with this grain size shift is a shift in transport direction from a NNW (~330°) direction to a westerly (~280°) direction (Figure 9, Time 3). This change reflects either a shift in the position of the main feeder system away from the measured section to the east, or, alternatively a decrease in discharge in the catchment near the end of the existence of the Trail Creek Gilbert-style delta. In both cases, however, lake level must have risen slightly to allow for the deposition of a more distal facies on top of a proximal facies. A similar rise in lake level at this time was also interpreted from the Alluvium Creek section.

Timing of delta formation

The Alluvium Creek and Trail Creek Gilbert-style deltas are both constructional depositional features, actively building into the lake basin in response to the same lake level fluctuations. The elevation of the abandonment break in slope in both deltas is ~21 m above the modern lake level of Yellowstone Lake and marks a relative highstand during delta evolution. As shown by the facies relationships in both deltas, lake level wasn’t stable throughout the formation of the entire delta, but underwent minor fluctuations. Delta formation occurred during the latest Pleistocene and was likely related to the latest deglaciation in the area, after Yellowstone Lake became largely free of ice (e.g. Licciardi and Pierce, 2008). Apart from sedimentologic and morphologic characteristics that show no evidence of ice impacting delta formation, a late Pleistocene age for delta construction is confirmed by a radiocarbon sample recovered from section CC2 of 10,390±150 cal yr BP (9,220±50 BP C14 yr BP). The radiocarbon sample was collected ~1.5 m below the abandonment delta top surface (~6 m above the base) of section CC2, thus we infer that the surface elevation of Yellowstone Lake was ~1.5 m below the morphologic break in slope at the time of sample deposition. This linear relationship is deemed to be a valid assumption given the consistent grain size and composition of sediments exposed in the topsets of the Alluvium Creek section, as well as the consistent grain size and composition of the alluvial deposits in the Columbine sections. Together these observations suggest a consistent hydrologic regime throughout the time of delta deposition.
Figure 9. Trail Creek sediment log (TC) and schematic maps of delta evolution. See text for details. Black outline of hatched area marks the inferred position of the paleo-shoreline at the different time steps of delta evolution; dark shaded area is inferred extent of the Trail Creek Gilbert-style delta at the different time steps; light shaded area outlines present day Yellowstone Lake.
Although we weren’t able to recover any dateable material from the Trail Creek site, the striking similarities in morphology and sedimentary record described above permit the interpretation of a similar lake level history to that inferred from the Alluvium Creek site. It is important to note that this latest Pleistocene, post-glacial formation age is significantly younger than the previously suggested mid-Pinedale age for these landforms (Richmond and Pierce, 1972).

The good preservation of these landforms throughout the Holocene suggests that lake level dropped quickly after the deposition of these two deltas at the Pleistocene Holocene transition. If lake level would have remained at levels between the highstand and present day lake level, expectations are that more significant reworking by waves would have occurred in the Alluvium Creek delta and at least some wave reworking should have occurred on the Trail Creek delta. The overall absence of any sedimentary or morphologic evidence of significant wave reworking on the front of either delta suggests a rapid drop in lake level to near the present day level following formation of the deltas (see also Hendrix and Hofmann, this volume).

Implications for Prehistoric Land-use

Recognizing these landforms as Gilbert-style deltas that actively formed during the latest Pleistocene and earliest Holocene is of importance for studying prehistoric land-use patterns in the Yellowstone Lake area and might help to explain the virtual absence of signs of human occupation in the southeastern part of the lake during the Paleoindian period (~11,500 – 8,000 cal yr BP; Sanders 2002).

We suggest that the higher lake level associated with the formation of these deltas at ~10,000 cal yr BP inundated low lying, flat portions of the land (Figures 7,9) and pinned the shoreline against steep bedrock cliff faces along parts of the eastern shoreline. This circumstance made for challenging access into the southeastern portion of the lake for humans moving into the area from the north.

In addition, cooler and wetter conditions in the Yellowstone Park area during the latest Pleistocene and earliest Holocene (Huerta et al. 2009) resulted in presumably deeper and prolonged snow coverage in the area. Areas in the high country would have been hard to cross throughout much of the year and rivers feeding the large Gilbert-style deltas would have been difficult to ford during the peak of the snowmelt in early and mid-summer.

Sedimentary evidence from our field sites suggests that both streams had high flow competencies during their peak discharges. Using a well-established relationship between maximum grain size and flow velocity (Hjulstrom 1939), we estimate that the flow velocity for the paleo-Alluvium/Columbine Creek exceeded 200 cm/s during the formation of the Gilbert-style delta. This estimate is based on the maximum boulder size (40 cm diameter) observed in the topset deposits in the Alluvium Creek site (Figure 5A).

This coarse grained nature and extensive spatial distribution of these deposits across large portions of the delta plain (topsets) suggests that flows were very rapid and violent at times and delivery of sediment often occurred in form of high capacity flash floods associated with extensive overbank deposition across the entire, flooded delta top. Therefore it is unlikely that these sites were occupied for anything more than short, temporary occupation, assuming this part of the park was accessible during the Paleoindian period. Finally, the preservation potential of any archaeological artifacts from the Paleoindian period in these delta top locations is low, because of the likelihood of reworking and re-deposition during frequent and extensive high discharge flooding events.

During the early Holocene lake level in Yellowstone Lake started to drop and the delta tops of the Alluvium and Trail Creek deltas emerged as dry, flat surfaces amenable to occupation. Access to the southeastern arm of the lake became easier in response to the falling lake level. In addition, the continuous rise in temperatures, decrease in precipitation (snow pack) and a resulting decrease in fluvial discharge during this time (Huerta et al. 2009) favored human visitation and short-term (seasonal?) occupation. The remaining flat, high terraces of the Gilbert-style delta tops would have provided ideal resting places and vintage points for any human migrating into the area. Significantly, the first signs of occupation in the southeastern part of the lake area occurs during the Early Archaic-period (~8,000 – 5,000 cal yr BP; Sanders 2002), consistent with the lowering of lake
level and widespread exposure of these Gilbert-style delta topset surfaces.

Conclusion
Detailed morphologic and sedimentologic studies of two prominent landforms in the Alluvium Creek and Trail Creek areas suggest that both are well preserved remnants of Gilbert-style deltas. These deltas were constructed during the early post-glacial history of the area when Yellowstone Lake was at a higher level.

Our findings from this study are as follows:
• The elevation of the abandonment break in slope between the low gradient delta top and the steeply dipping delta front for both Gilbert-style deltas requires a lake surface elevation ~21 m higher than present.
• The presence of coarse grained and fine-grained topset facies, steeply dipping foreset strata and gently dipping bottom-set facies support the interpretation of these landforms as Gilbert-style deltas.
• Topset depositional processes were dominated by high discharge fluvial in-channel deposition and overbank floodplain processes.
• The high discharge rivers feeding the Gilbert-style deltas may have been difficult to cross for early humans and likely resulted in seasonal flooding of much of the delta top, rendering it not favorable for human occupation during the Paleoindian period (~11,500 –8,000 cal yr BP). Alternatively archaeological artifacts from the Paleoindian period may have been reworked and buried during subsequent flood events on the delta top.
• Delta front depositional processes vary between sediment gravity flows in proximal delta front deposits (large flow events) and high- and low-density turbidity currents in more distal delta front areas (small discharge events).
• The bottom-set facies was deposited by alternating high- and low-density turbidity currents.
• Stratigraphic architectures and facies stacking reveal that the Alluvium Creek and Trail Creek Gilbert-style deltas are composed of several delta lobes rather than one continuous delta progradation. The individual delta lobes reflect minor changes in lake level as well as changes in sediment discharge in the catchments.
• The formation of the deltas occurred at around 10 kya, based on radiocarbon dating (10,390±150 cal yr BP (9,220±50 BP C14 yr BP)) of proximal deltaic sediments near the delta apex.
• The first signs of human occupation in the southeastern part of the Yellowstone lake area occurred during the Archaic period (~8,000 – 5,000 cal yr BP) coincident with the lowering of lake level and the abandonment of the Gilbert-style deltas.

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CHAPTER 10
LAKE LEVEL HISTORY AS INFERRRED FROM SEDIMENTOLOGY AND GEOMORPHOLOGY ALONG THE EASTERN AND SOUTHERN MARGINS OF YELLOWSTONE LAKE, YELLOWSTONE NATIONAL PARK, WYOMING

By Marc S. Hendrix and Michael H. Hofmann

Abstract
Sedimentologic and geomorphic analysis of several landforms along the southeastern shore of Yellowstone Lake in Yellowstone National Park, Wyoming (Figure 1) provide the basis for construction of a lake level history from latest Pleistocene to present. Kilometer scale abandoned Gilbert-style deltas occur at Alluvium Creek and Trail Creek, and were formed when lake level was ~21 m above modern lake level. Radiocarbon dating of charcoal recovered from the Alluvium Creek delta indicates that it was actively constructing at 10,390 ± 150 cal yr BP (9,220±50 C14 yr BP), the maximum age of delta abandonment. At Clear Creek, hand-dug pits cut into erosional fluvial terraces 2-5 m above the modern creek revealed centimeter-scale layers of very fine sand/silt interlaminated with <0.5 cm thick layers of clay. These relations are interpreted to reflect episodic sediment delivery followed by suspension settleout under low energy conditions either in a floodplain or lacustrine setting. Floodplain deposition would require a ~2 m higher base level, whereas lacustrine deposition would require a ~5 m higher base level around 3,730 ± 40 C14 yr BP (4,100 ± 130 cal yr BP), the age of a charcoal sample recovered from the section. At lower Columbine Creek, a distributary channel with ~1 m of incision exposes fluvial channel and overbank deposits. Charcoal recovered from this section was dated at 2,660 ± 40 C14 yr BP (2,795 ± 55 cal yr BP), suggesting a ~1 m higher base level at this time, prior to incision. Total station surveying of constructional beach ridges north of lower Columbine Creek reveal well-preserved ridges at ~2368 m, 2363 m, 2362 m, 2361 m, and 2360 m, suggesting that lake level stabilized several times during the Holocene, before dropping to the present elevation of 2358 m. Collectively, these observations are interpreted to reflect overall fall of lake level from ~10.4 ka to today. From ~10.3 ka to ~2.7 ka, the average rate of fall was between 2.5 and 3.0 m/ka, followed by a slower fall rate of ~0.35 m/ka from ~2.7 ka to present. This lake level history is broadly consistent with independent paleoclimate studies from the Yellowstone area based on pollen and charcoal abundance analysis which suggest a warm and dry post-glacial early Holocene with high fire frequency, a

Figure 1. Overview map of Yellowstone National Park and adjacent areas. Location of the three study areas near Clear Creek, Alluvium Creek, and Trail Creek are marked by black dots (see also Figure 2). All study sites are located outside the Yellowstone Caldera (dotted line). Dark gray dots mark locations of small lakes used for climate studies by Gennett and Baker (1986), Millspaugh et al. (2000), and Huerta et al. (2009); CR = Crevice Lake; BP = Blacktail Pond; SC = Slough Creek Lake; CY = Cygnet Lake.
warm mid-Holocene, and a wetter cooler late Holocene beginning ~3-4 ka. Results from this study are also broadly consistent with the lake level history by Locke and Meyer (1994), but considerably different than more recent lake-level history published by Pierce et al. (2007). The results presented herein have important implications for the timing of human occupation of the Yellowstone Lake region.

A high lake level during the early Holocene combined with glacial fed high discharge events in streams and creeks inhibited human occupation of the southeastern Yellowstone lake region during the Paleoindian period (~11,500 – 8,000 cal yr BP), consistent with the complete lack of artifacts of this age from the study area. With retreating water levels throughout the Holocene, the abandonment of Gilbert-style deltas, and the emergence of delta top surfaces along the southeastern shoreline, the study area became more hospitable for humans, consistent with the recovery of artifacts from the Early Archaic period (~8,000 – 5,000 cal yr BP). By the Middle Archaic period, ease of access to the area and availability of flat lying rest-, and campsites close to the lake margin likely resulted in frequent occupation of the study area by humans. Although our lake level model from the southeastern part of Yellowstone Lake correlates well with the archaeological interpretation of human occupation of this region and might be a key factor controlling access to the area, future work should focus on expanding observations to other parts of Yellowstone Lake and resolving discrepancies among the published lake level models.

Introduction

Located in the south-central part of Yellowstone National Park, Yellowstone Lake is the largest high-altitude freshwater lake in North America (Figure 1). The lake has a surface area of 341 km² (Morgan et al. 2007) and a surface elevation of 2,357 m.

The northern parts of Yellowstone Lake occupy remnants of the Yellowstone caldera (Figure 1), formed 0.64 Ma ago following the catastrophic eruption of the Lava Creek Tuff (Christiansen 2001). The southern margin of the caldera intersects the Yellowstone Lake shoreline about 2 km southeast of Steamboat Point and extends to the southwest, crossing the southern part of Frank Island and continuing southwest up the length of the Flat Mountain Arm (Finn and Morgan 2002; Morgan et al. 2007). Earthquake epicenter locations (Smith 1991) indicate that the region north of the lake is seismically active, and recent bathymetric, seismic reflection, and ROV surveying of the Yellowstone Lake floor have documented extensive evidence of modern tectonic activity within the lake basin, including rhyolite lava flows, hydrothermal vents and hydrothermal explosion craters, and fault scarps (Morgan et al. 2007). The West Thumb and northern basins of the lake are characterized by extremely high heat flow ranging between 1,650 and 15,600 mW/m², consistent with their position inside the 0.64 Ma caldera (Morgan et al. 1977).

Several submerged postglacial lake shorelines that form underwater benches have been reported from the West Thumb, northern, and central basins of Yellowstone Lake (Morgan et al. 2007; Pierce et al. 2007). Pierce et al. (2002) reported a date of 3,835 C14 yr BP from pebbly submerged beach sand 5.5 m below the modern lake surface in Bridge Bay, suggesting either significant basinwide lake lowering or late Holocene downwarping of the northwestern lake margin. Up to nine emergent terraces formed over the past 9,500 radiocarbon years also have been reported from around the lake (Locke and Meyer 1994), suggesting significant non-seasonal changes in lake level during the entire Holocene. The lake level changes recorded by the collective set of terraces have been mostly interpreted to represent inflation and deflation of the Yellowstone Caldera, although hydrothermal processes, tectonic extension, and/or glacioisostasy also have been suggested as possible influences (Dzurisin et al. 1994; Locke and Meyer 1994; Pierce et al. 1997; 2002; 2007; Wicks et al. 1998).

Consistent with the interpretation of tectonically-driven lake level fluctuations are both positive and negative vertical ground motions documented from the floor of the Yellowstone Caldera over the past century. Reoccupation of line-leveling surveys within the caldera between 1923 and 1985 showed that it underwent up to 0.7 m of uplift during this period (Pelton and Smith 1982). This phase of uplift was followed by decimeter scale tectonic subsidence from 1985 to 1995 (Dzurisin et al. 1990; Pierce et al. 2002; 2007), before returning to active uplift thereafter as shown by laser interferometry (Wicks et al. 1998). Significantly, the axis of uplift
documented from line leveling surveys and interferometry trends northeast-southwest approximately between the Sour Creek and Mallard Lake resurgent domes. This axis crosses the Yellowstone River approximately at Le Hardy Rapids, which forms the drainage sill for Lake Yellowstone. As such, changes in the surface elevation of Le Hardy rapids directly affect the fill level of Lake Yellowstone.

In contrast to the northern part of Yellowstone Lake, the southern parts of the lake are situated outside of the caldera margin and appear to be significantly less tectonically active. A conspicuous lack of lake floor hydrothermal vents have been documented from the southern part of the lake, although two circular depressions interpreted as hydrothermal explosion craters (Morgan et al. 2007) suggest that the lake floor south of the caldera margin is not devoid of thermal activity, a conclusion supported by the presence of a significant onshore thermal area at Brimstone Basin, also located south of and outside the caldera margin. Tectonic activity south of the crater margin is also indicated by north-south trending normal faults cutting Holocene deposits in the upper Yellowstone River Valley (Richmond and Pierce 1972) and several north-south trending faults mapped south of both Arms (Christiansen 2001). Bathymetric images of the southern portion of the Southeast Arm show a field of depressions interpreted as potholes formed by stagnant glacial ice (Morgan et al. 2007), suggesting that glacioisostasy likely also influenced this part of the lake.

Based on results from 230 surveying transects around the margins of Yellowstone Lake, Locke and Meyer (1994) concluded that the major terraces observed in the Southeast Arm were less steeply tilted and characterized by less complex patterns of deformation compared to the same terraces inside the caldera. Based on these observations, Locke and Meyer (1994) concluded that terraces around the Southeast Arm were a reasonable proxy for outlet incision and could be used to estimate accumulated deformation around the lake by calculating the elevation difference between each terrace in the Southeast Arm relative to its location elsewhere around

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**Figure 2.** Detailed location maps of measured stratigraphic sections (black dots) and total station survey lines (dotted line) within the three study areas near Alluvium Creek (left), Trail Creek (middle), and Clear Creek (right; see Figure 1 for location of study areas); darker gray polygons on the Alluvium and Trail Creek maps represent Pleistocene Gilbert-style deltas as mapped from satellite images. AC = Alluvium Creek section; CC1 = Columbine Creek section 1; CC2 = Columbine Creek section 2; CC3 = Columbine Creek section 3; CC-TS = Columbine Creek Total Station Survey; TC = Trail Creek section; CL = Clear Creek section.
the lake.

In this paper we present a novel lake level history for Yellowstone Lake, based on a suite of new radiocarbon ages, coupled with sedimentologic and geomorphic analysis of late Pleistocene and Holocene landforms around the lake’s Southeast Arm. Following, we discuss the implications of our inferred lake level history in the context of prehistoric human occupation of the region. Results presented in this paper stem from work directed towards documenting the geomorphologic and geologic framework of archaeological sites along the eastern and southern shores of Yellowstone Lake in conjunction with the Montana-Yellowstone Archeological Project.

Methods

Results from this study include detailed sedimentologic description of six stratigraphic sections and surveying of the surface morphology of several prominent landforms along the southern and southeastern margins of Yellowstone Lake (Figure 2). The measured stratigraphic sections at upper Columbine Creek (CC1 and CC2) and along lower Columbine Creek (CC3) were well exposed along abandoned fluvial channel walls. In contrast, the three stratigraphic sections at Alluvium Creek (AC), Clear Creek (CL), and Trail Creek (TC) required hand-digging of pits to expose the strata before it could be measured and described. Sedimentary units observed in each exposure were described at centimeter- to decimeter scale, meaning that individual beds of this thickness or other sedimentary features existing at this scale were resolved. Observations made during section description included grain size, grain sorting, grain texture (form, rounding), grain composition, presence of biogenic debris including charcoal and/or wood, and presence and nature of biogenic or sedimentary structures. A standard compass was used to measure dip direction and dip angle measurements of sedimentary structures. Several of the measured sections contained samples of charcoal and other woody debris that was used for accelerator mass spectrometer (AMS) radiocarbon analyses. The elevation of each stratigraphic section was measured using differentially corrected GPS; stratigraphic thicknesses were measured directly with a tape.

Total station and differentially-corrected GPS surveys were also conducted to determine the position and elevation of paleo-shorelines and other geomorphologic information relevant to the reconstruction of Yellowstone Lake levels. A digital topographic survey across shoreline terraces north of Columbine Creek (CC-TS; Figure 2) was conducted using a Leica TC307 total station. Survey points were typically placed 4-5 m apart, and closing of the survey indicated that uncertainty in the X-Y and Z directions was <1 cm. Instrument accuracy is ~0.2mm/30m rod-TS distance.

Surface elevations of Pleistocene deltas in the vicinity of Alluvium Creek and Trail Creek were surveyed using a Trimble GeoXH hand-held GPS unit. After post-processing using five UNAVCO base stations and one CORS base station in the Yellowstone area, 85% of the ~9200 points comprising the data set yielded a vertical accuracy of 50 cm or less.

Results

Latest Pleistocene-Holocene Gilbert-style deltas

At both Alluvium Creek and Trail Creek, we observed kilometer scale triangular-shaped landforms with a planar top and a steep front facing Yellowstone Lake (Figure 2). Both features are characterized by a sharp break in slope between the upper and frontal surfaces and are interpreted as Gilbert-style paleo-deltas based on their geomorphology and sedimentology. Overall descriptions of the geomorphology and sedimentology of the two deltas are presented in Hofmann and Hendrix (this volume) and will not be repeated here. The following description summarizes the sedimentary context of radiocarbon samples collected from the deltas and dated.

We recovered sample 10-CO-10 and sample 10-CO-11, both fragments of charcoal, from section CC2, an abandoned channel wall along the northern bank of Columbine Creek, ~ 1.7 km upstream (east-southeast) of the present day stream mouth and near the apex of the Alluvium Creek Gilbert-style delta (Figure 2). The outcrop exposes a 7 m thick tripartite stratigraphy that we also observed in section CC1, located just 200 m downstream of section CC2.

Sample 10-CO-10 was recovered from laminated very fine sand and silt that form the basal 0.8 m of section CC2 and the basal 1.0 m of section CC1. These fine-grained deposits are tilted and are separated from younger strata by an erosional, undulating unconformity
with ~ 20 cm of relief (Figure 3). We infer that this basal unit was deposited in an environment with suppressed current activity as is common in floodplain and/or lacustrine settings. Based on the fact that sample 10-CO-10 was radiocarbon dead, we infer that such a subaqueous, relatively quiet water environment existed at these locations sometimes before 43,500 cal yr BP, the maximum dateable age using the radiocarbon technique. After deposition, these fine-grained deposits were tilted and dissected by clastic dikes. We interpret the tilting and dike intrusions to either reflect paleo-seismic activity or to be related to loading by glacial ice.

In both the CC1 and CC2 sections, sediments directly above the unconformity are parallel bedded, poorly sorted gravels dominated by sub-rounded cobble-sized clasts but also containing local boulder sized clasts up to ~40 cm. The gravel is clast supported with minor fine-grained matrix and is interpreted to represent topset delta distributary facies (Hofmann and Hendrix, this volume).

Overlying the gravel at both sections are alternating layers of very fine sand and sandy gravel. Most layers are ~1 dm thick. The fine-grained layers are composed of poorly-consolidated white-colored volcanic ash mixed with sand-sized clastic detritus. The coarser intervals consist of granule and pebble conglomerate (max. clast size ~3 cm) with a fine- to medium-sized sandy matrix. Clast-to-clast contacts are dominant and iron(?) staining is common (Figure 3). Hofmann and Hendrix (this volume) interpret this unit to represent delta topset distributary facies. Sample 10-CO-11 was recovered from this interval ~6 m above the base of section CC2 and yielded a date of 10,390 ± 150 cal yr BP (9,220±50 C14 yr BP).

Approximately 1 km down the Alluvium Creek drainage from sections CC1 and CC2 is a prominent modern cut bank along which section AC was measured and described by Hofmann and Hendrix (this volume).

Figure 3. Sedimentary log and photograph of section CC2; total thickness of section is 7 m.
Section AC consists primarily of sand and gravel interstratified at centimeter to decimeter scale and includes an erosional truncation separating more steeply-dipping beds in the lowermost 5 m of the section from sub-horizontal beds above. Hofmann and Hendrix (this volume) interpret this change in primary dip magnitude to represent the transition from foreset facies to topset overbank facies in the Alluvium Creek Gilbert-style delta.

The Alluvium Creek section is located about 20 m upstream from the prominent break in slope representing the transition from delta top to delta front at the time of abandonment. This break in slope is ~21 m above the present day lake level, suggesting that the Late Pleistocene post-glacial lake-level was stable at this elevation for some period of time before dropping to its present level.

Additional evidence for such a lake level stillstand comes from another Gilbert-style paleo-delta described near Trail Creek (Hofmann and Hendrix, this volume; Figure 2). Although we recovered no radiometrically-dateable material from the Trail Creek Gilbert-style delta, geomorphologic and sedimentologic similarities between the Trail Creek delta and the Alluvium Creek delta permit the interpretation that both were responding to the same forcing mechanism.

**Holocene alluvial deposits**

Radiometric dates, geomorphology, and sedimentary character of Holocene alluvial sediments from Columbine and Clear Creeks (Figure 2) provide additional information relevant to lake level fluctuations. Samples 10-CO-10 and 10-CC-100 were recovered from alluvial deposits along Clear Creek and Columbine Creek respectively.

At Clear Creek, we measured a stratigraphic section from two pits dug into an erosional terrace rising between 2 and 5 m above the modern creek bottom and ~300 m inland (upstream) of the present day river mouth (section CL; Figure 2). The basal 20 cm are composed of mud (silt and clay; Figure 4) with a few outsized pebble clasts (max. 18 cm diameter) floating in the fine grained matrix. The overlying 23 cm are dominated by gray-brown fine sand with sub-rounded granules and pebbles (max. diameter 2 cm) floating in this fine-sand matrix.

This interval contains abundant charcoal clasts, one of which (sample 10-CC-10) yielded an age of 3,730 ± 40 C14 yr BP (4,100 ± 130 cal yr BP).

Sediments further up in the section, above a covered 2 m thick interval, are also dominated by gray-brown fine sand and silt. The basal 25 cm above the covered interval consist of three thin layers of clay, each less than 0.5 cm thick, separated by layers of very fine sand/silt. The very fine sand and silt layers are between 3 and 10 cm thick. Above this basal interval is a 45 cm thick interval of massive well sorted, well rounded fine to very fine sand.

The limited exposure renders a detailed interpretation of these sediments difficult. The generally very fine grain size requires deposition in a low energy environment, and lamination observed in the muddy portions further suggest episodic sediment delivery followed by suspension settle out under low-energy conditions. Such hydrologic regimes can exist in a variety of depositional environments including lacustrine settings or floodplains of fluvial systems.

Based on observed sediment grain sizes, preservation of laminae, and location of the Clear Creek section immediately upstream of one of several small bedrock knickpoints, we infer that the sediment exposed in this section was deposited either in standing water on the Clear Creek floodplain or in a low-energy environment within Yellowstone Lake when lake level was at a level significantly higher than today.

The fact that the measured stratigraphy exists several meters above the present day modern creek bottom suggests that when the muddy sediments exposed in the Clear Creek section were deposited, base-level (lake surface elevation) must have been at least 2 m higher than present, the vertical elevation difference between the lake surface elevation and a bedrock knickpoint located ~40 m downstream of the CL section. This estimate assumes that the fine-grained sediment is related to floodplain deposition along Clear Creek. If the muddy sediments were deposited in a low-energy environment associated with Yellowstone Lake, the lake surface must have been high enough to inundated the Clear Creek study area, or a minimum of ~5 m above the modern lake surface of 2358 m.
Figure 4. Sedimentary log of section CL (left) and photograph of fine-grained laminated facies interpreted as lacustrine or fluvial overbank deposits. Total height of section ~ 3 m; scale bar in photograph in centimeters.

To summarize, we infer the muddy sediments exposed in the Clear Creek section to have been deposited in low energy subaqueous conditions that require a high enough base-level (lake surface elevation) to inundate the bedrock knickpoint. If the lake level were as high as the knickpoint (~2 m above modern lake level), the Clear Creek section would have been located on the floodplain and subject to periodic standing water and deposition of fine-grained sediment. Alternatively, the fine-grained sediment may reflect deposition directly in Yellowstone Lake, a scenario that would require the lake surface elevation to have been ~5 m above the modern level around 4,100 cal yr BP. After the sediment at Clear Creek had been deposited, the lake surface elevation dropped to its present level and incision of the Clear Creek drainage commenced, forming the erosional terraces of the Clear Creek site.

At Columbine Creek, we measured a 1.3 m thick section that was naturally exposed in the cutbank of a small distributary channel located ~50 m south and ~1 m above the modern stream (section CC3; Figure 2). Sediments in this section are dominantly coarse grained, although the basal 10 cm are composed of yellowish-brown mud (silt and clay). The overlying 70 cm are dominated by weakly stratified coarse-grained sand with abundant floating pebbles (max. 2 cm diameter). Individual beds are ~20 cm thick and fine upward. This coarse grained succession is topped by a 10 cm thick layer of fine sand with mud. We recovered a sample of charcoal from this unit (10-CO-100) that yielded an age of 2,660 ± 40 C14 yr BP (2,795 ± 55 cal yr BP). Above this fine grained unit is another ~20 cm thick bed of sand with abundant pebbles floating in the matrix. The uppermost 30 cm exposed in the cut bank is a pebbly gravel with pebble sizes up to 4 cm in diameter. This youngest unit appears to downcut into the underlying sediments.

The limited exposure makes a detailed interpretation of section CC3 difficult. The overall coarse grain size of the sediments and their similarity to modern Columbine Creek deposits, however, suggests a depositional environment very similar to that associated with the modern stream. The fact that these sediments are presently exposed in the cutbank of a distributary channel above the present day creek surface furthermore suggests that their deposition occurred at a time when Yellowstone Lake was ~1 m higher than present, based on the amount of incision of the Columbine Creek distributary channel.
Holocene (?) Shorelines

Additional information relevant to lake level history in the study area is derived from a total station survey conducted just north of Columbine Creek. The survey was undertaken to document the surface profile of a series of low relief shoreline-parallel ridges (CC-TS; Figure 2). The ridges are well expressed on aerial and satellite images and cut across a network of meadows and clearings. They are all located at elevations between the present day lake level and the break in slope on the Alluvium Creek and Trail Creek Gilbert-style deltas.

We recognized at least five prominent paleo-shoreline positions marked by constructional beach ridge deposits composed mainly of rounded gravel (Figure 5). These paleo-beach ridges rise 20 cm – 100 cm above the surrounding areas, suggesting only minor erosional degradation since their formation. We did not recover any dateable material from the paleo-beach ridges and therefore can only speculate about their age. The highest elevation beach ridge along the line of transect is at ~2368 m, ~ 10 m above the present day lake level and ~11 m below the Alluvium Creek and Trail Creek delta slope breaks. Other beach ridges were surveyed at elevations of 2363 m, 2362 m, 2361 m, and 2360 m, suggesting that lake levels were situated in a stable position at several times throughout the Holocene, before dropping to the present elevation of 2358 m (Figure 5).

The grain size and texture of the ancient beach ridges is very similar to that of modern beach deposits on the eastern shore of Yellowstone Lake. These similarities suggest that the depositional processes during formation of the beach ridges, and the wave climate in the basin in particular, were similar to those of today. These sedimentologic similarities also imply that the paleo-beach deposits were related to shoreline processes and

![Figure 5. Total Station transect across paleo-beach ridges (arrows and labels) north of Columbine Creek. The modern lake surface is 2,358 meters asl.](image-url)
wave energy associated with discrete lake level positions rather than being related to singular catastrophic events, such as a seismically-generated seiche.

Discussion

Pleistocene and Holocene lake level fluctuations interpreted from the southern part of Yellowstone Lake

Based on the limited age data from the measured sections and our sedimentologic, stratigraphic and geomorphologic observations, we infer the following model for lake level variation through time within the study area.

Our data suggest that relative to the modern lake surface of 2358 m, Yellowstone Lake was ~21 m above its modern level at the time of deposition of sample 10-CO-11 (10,390 ± 150 cal yr BP or 9,220 ± 50 C14 yr BP). This interpretation assumes a constant slope gradient from the location of radiocarbon sample 10-CC-11 in CC2 to the break in slope between delta topset and foreset, located just west of section AC. Sample 10-CO-11 was collected ~1.5 m below the modern ground surface, thus the surface elevation of Yellowstone Lake was ~1.5 m below the present day morphologic break in slope when
the dated charcoal was deposited. This linear relationship is deemed to be a valid assumption, because the grain size, sorting, and composition of sediments exposed in the tipsets of the Alluvium Creek section and in the upper part of the Columbine section from which the radiocarbon sample was collected suggest a constant hydrologic regime throughout the time of deposition.

Striking similarities in morphology and sedimentary record between the Alluvium Creek Gilbert-style delta and that described from Trail Creek (Hofmann and Hendrix, this volume) suggest that both were responding to the same lake level history, although we are not able to demonstrate this through the recovery of any dateable material from the TC site. Most notably, the break in slope between the top and front of both deltas is at the same elevation (2379 m), suggesting that both deltas were active when the lake level was steady and ~21 m above the present day lake surface.

Sample 10-CC-10, sampled ~ 2 m above the stream bed of the modern Clear Creek and ~ 5 m above the present day lake level, was taken from thinly layered deposits of either lacustrine or floodplain origin. The sample age of 4,150 ± 80 cal BP (3,730 ± 40 C14 yr BP) suggests that the surface level of Yellowstone Lake was at least 5 m above present day, assuming the deposit is lacustrine (Figure 6). Alternatively, if these fine-grained deposits are related to overbank floodplain deposition of Clear Creek, lake level may have been only 2 m to 3 m higher than present, assuming the gradient of Clear Creek has remained constant since the deposition of sample 10-CC-10 (Figure 6).

The youngest chronological date of 2,795 ± 55 cal yr BP (2,660 ± 40 C14 yr BP) from sample 10-CO-100 along lower Columbine Creek suggests that the surface elevation of Yellowstone Lake was ~ 1 m above the present day at that time. This inference assumes a constant gradient for Columbine Creek, which we deem as valid given the similar grain size, texture, and composition of these late Holocene deposits to the modern flood plain and fluvial deposits of lower Columbine Creek.

These three data points collectively suggest that lake level dropped continuously at a constant minimum rate of ~ 2.5 – 3.0 mm/yr throughout most of the latest Pleistocene and Holocene. The lower rate of 2.5 mm/yr assumes that the sediments in the Clear Creek section are of lacustrine origin and therefore lake level was ~ 5 m higher than today. The higher rate of 3.0 mm/yr applies if the sediments in the Clear Creek section are of fluvial/overbank origin and lake level was at a surface elevation ~ 2 m higher than present around 4,100 cal yr BP. Notably, these rates are similar to those calculated by Locke and Meyer (1994) for post glacial lake level decline (2.5 - 3 mm/yr). Our data suggest that the rate of decline slowed to 0.35 mm/yr after the deposition of sample 10-CO-100.

A continuous lake level lowering is also suggested by the well-developed and well-preserved shoreline terraces (beach berms) north of Columbine Creek (CC-TS; Figures 2, 5). The terraces show no signs of secondary reworking after their emplacement, as would be expected if lake levels fluctuated.

The lowermost shoreline terrace at 2360 m is at approximately the same elevation as the inferred lake level for the time of deposition of sample 10-CO-100 at lower Columbine Creek (2,795 ± 55 cal yr BP). Similarly, lake levels inferred from the deposits containing sample 10-CC-10 (4,150 ± 80 cal BP) coincide with well-developed shoreline terraces at elevations of ~2361 m or ~ 2363 m, depending on the environmental interpretation of fine-grained sediments in the CC section. Although our data set did not provide any direct temporal constraints of the shoreline feature at 2368 m, applying a linear interpolation between our data points, lake level lowering rates were between 3 mm/yr and 2.5 mm/yr, suggesting that this feature was deposited sometime between ~5.8 ka and ~6.4 ka.

In general, formation of these pronounced shoreline features requires a stable lake position for a sustained period of time. Therefore we suggest that lowering likely occurred in steps marked by times of gradual lake level drops followed by intervals of stillstand that enabled the formation of the beach ridge and shoreline features.

**Comparison with other Yellowstone Lake level records**

The lake level model presented in this study suggests a gradual lake level lowering throughout the Holocene, starting from a lake level high stand ~21 m above present lake surface during the Pleistocene to Holocene transition (Figure 6). Although our model suggests gradual lake level lowering rates that are similar to
downcutting rates (lowering rates) near the Yellowstone Lake outlet described by Locke and Meyer (1994), it is significantly different from the lake level models reported by Pierce et al. (2002, 2007). The models presented by Pierce et al. (2002, 2007) suggesting rapid fluctuations of lake level throughout the latest Pleistocene and Holocene (Figure 6) instead of a continuous gradual lowering as we propose from our data set. Their model also suggests that lowering of lake level started earlier in the Pleistocene and was significantly lower at the Pleistocene to Holocene transition than inferred from our data. Pierce et al. (2007) link these fluctuations to changes in tectonic uplift (inflation of the caldera) and subsidence (deflation of the caldera) during the Holocene and Pleistocene, similar to that inferred for vertical ground movements within the Yellowstone caldera during the last century (Pelton and Smith 1982; Dzurisin and Yamashita 1987; Dzurisin et al. 1990; Wicks et al. 1998).

Although our data is limited and does not provide a basis for further refinement of our lake elevation model relative to that of Pierce et al. (2002, 2007), one explanation for the differences between these models might be the different locations of the two study areas. While the model presented in this study is solely based on field data from the southern and southeastern part of the lake, the model presented by Pierce et al. (2002, 2007), is based mainly on data from the northern lake shoreline that is situated within the Yellowstone delta (Figure 1). The northern part of the lake is significantly influenced by active tectonism associated with the Yellowstone caldera, and vertical ground movements there likely are superposed on basinwide lake level fluctuations due to changes in the rate of outlet incision or basin hydrology. In contrast, the southern part of the lake, situated outside the Yellowstone data, likely is less influenced by intra-caldera tectonism and therefore is more likely to record lake level fluctuations due to changes in outlet incision rates or basin hydrology.

Future studies in geoarcheology should focus on constraining and explaining these different lake level models, because the data presented in this paper suggest a much younger formation for some of the terraces and landforms surrounding Yellowstone Lake than suggested by Pierce et al. (2007) and, therefore, a much later timing for inhabitation of the study site by humans.

Does climate play a role in changes of lake level? Comparison of lake level data to local climate records

Lake level and lake level changes have the potential to impact the timing of inhabitation by humans locally, but climate and climate changes might have a more regional impact on the history of inhabitation. Although many factors might influence the surface level of Yellowstone Lake, to evaluate the causal linkage between local climate and lake level, we compare our lake level model to previous paleo-climate studies from the Yellowstone area. Most of these climate studies come from analysis of pollen and charcoal records from small lakes within Yellowstone National Park (e.g. Gennett and Baker 1986; Millsapgh et al. 2000; Huerta et al. 2009; Figure 1).

During the latest Pleistocene, in the wake of deglaciation in the northern hemisphere, significant warming occurred throughout the northern Rocky Mountains after ~ 12,000 cal yr BP (Whitlock et al. 2008). This Holocene summer insolation maximum was marked by significantly higher than present summer temperatures and lasted from ~ 12,000 cal yr BP to ~ 6,000 cal yr BP (Bartlein et al. 1998), with a peak maximum at ~ 10,000 cal yr BP (Berger 1978). Several studies from sites in the northern and central Rocky Mountains suggest that Holocene warm conditions lasted even longer until ~ 4,000 cal yr BP (Baker 1983; Bright 1966; Burkart 1976; Mack et al. 1978; Mehringer et al. 1977; Gennett and Baker 1986).

In the Yellowstone area this early Holocene warming was accompanied by an increase in fire activity. After a period of wet and colder conditions during the late Pleistocene, fire activity increased significantly after 12,000 cal yr BP (e.g. Millsapgh et al. 2000; Huerta et al. 2009), likely in response to the increased summer temperatures and decrease in precipitation. Fire activity peaked during the earliest Holocene sometime between ~10,000 cal yr BP and ~7,500 cal yr BP, and then gradually decreased throughout most of the Holocene (Millsapgh et al. 2000; Huerta et al. 2009).

This latest Pleistocene and early Holocene climate history is relatively consistent with our proposed lake
level model. The recorded wet and cool conditions for the latest Pleistocene match the proposed lake level highstand at and before 10,390 ± 150 cal yr BP. This highstand is also associated with high discharge and sediment flux responsible for the formation of the Gilbert-style deltas in Alluvium Creek and Trail Creek. The exquisite preservation of the Gilbert-style delta morphologies in both locations suggest that the lake level fell quickly shortly after delta abandonment, thereby preventing significant reworking of these deposits. This proposed rapid early Holocene drop in lake level coincides with the reported maxima in Holocene insolation and fire activity for the area, suggesting that a decrease in discharge and an increase in evaporation could have played some role in the rapid lowering of Yellowstone Lake at this time. The apparent absence of shoreline terraces between the highstand delta slope break (2379 m) in the Alluvium Creek and Trail Creek study areas and the highest reported shoreline terrace in the Columbine Creek area (2368 m) is consistent with a rapid and continuous drop in lake level shortly after 10,390 ± 150 cal yr BP.

After the phase of rapid lake level lowering during the early Holocene, a phase of slower lake level lowering occurred sometime between ~3,000 and ~4,000 cal yr BP. We estimate that the lowering rate at this time changed from a possible maximum average of 3.0 m/ka to an average of 0.35 m/ka. This inferred decrease in the rate of lake lowering coincides with the onset of wetter and cooler conditions in the region (Huerta et al., 2009) and an abrupt drop in fire frequency to the lowest Holocene level (Millsbaugh et al. 2000; Huerta et al. 2009).

In general, the proposed lake level changes in Yellowstone Lake correlate well with the reported climate changes for the region. However, further studies are needed to develop a more complete understanding of the causal linkage between these data sets.

**Implications of lake level model for pre-historic human inhabitation of the study area**

Prior analysis of paleo-human artifacts from the Yellowstone region (Sanders 2002) has suggested that early occupation of the Yellowstone Lake shoreline during the Paleoindian period (~11,500 – 8,000 cal yr BP) occurred exclusively along its northern and western margins. As confirmed by McIntyre and Sheriff (this volume), Sanders (2002) also reported that the first documented occupation of the southeast arm did not occur until the Early Archaic period (~8,000 – 5,000 uncal yr BP). Significantly, X-ray fluorescence analysis of projectile points from the north shore and West Thumb regions of Lake Yellowstone suggest that paleo-humans regularly procured raw lithic material from Bear Gulch obsidian sources located in the Centennial Mountains to the west. Lithic material from Bear Gulch occurs much more commonly along the northern and western shorelines of Lake Yellowstone than material from obsidian sources in the Teton Pass region, although both sources are approximately equidistant from the West Thumb/north shore regions. According to Sanders (2002), these observations suggest that there was some sort of obstacle that prevented or deterred people from passing directly from the Jackson Hole region to Lake Yellowstone.

Our geomorphic analysis of Gilbert-style deltas along the southeastern shoreline of Lake Yellowstone is consistent with Sanders’ conclusion that a direct route from Jackson Hole to Lake Yellowstone may have been challenging to negotiate, or at least less favorable in terms of food procurement, than the longer route through the Centennial Mountains. Although the timing of complete deglaciation of the Yellowstone Plateau, including the Yellowstone Lake area, remains poorly constrained, cosmogenic dating of boulders in terminal and recessional moraines around the margins of the Yellowstone and Teton ice caps suggest that both may have reached their maximum as recently as ~14.6 ± 0.7 \(^{10}\)Be ka (Licciardi and Pierce, 2008). The partial covering of the Jenny Lake terminal moraine, which yielded a cosmogenic date of 14.6 ± 0.7 10Beka, by south-directed outwash from the deglaciating Yellowstone Plateau (Licciardia and Pierce 2008) indicates that at least part of the plateau underwent deglaciation after this time. Given the generally higher elevations of the Absaroka Range southeast of the study area, it is reasonable to conclude that this range would have been among the last parts of the greater Yellowstone area to deglaciate and that substantial volumes of glacial ice may have remained in upslope of the study area during the Paleoindian Period.
Our documentation of actively constructing Gilbert-style deltas at 10,390 ± 150 cal yr BP strongly suggests that significant volumes of ice remained in the Absaroka Range at this time and that melting of this ice provided the high competence flows capable of transporting boulders such as those documented in the CC1 and CC2 stratigraphic sections. Moreover, the likelihood that much or all of the delta topset distributary and floodplain systems were characterized by periodic (seasonal?) high discharge flooding would have deterred humans from establishing campsites along the delta tops and may have impeded regular movement of people through the region during the Paleoindian period. Such flooding also may have physically reworked paleo-human sites, further obscuring any Paleoindian archeological record in the study area.

The excellent preservation of the Trail Creek and Alluvium Creek Gilbert-style delta morphologies suggests that these features were abandoned relatively quickly during the early Holocene, consistent with the solar insolation peak around 10ka and the interpretation of maximum fire frequency between 10,000 and 7,500 years (Huerta et al. 2009). Following abandonment of the Alluvium Creek and Trail Creek deltas and emergence of their topsets, conditions became more favorable for human occupation during the Early Archaic period (e.g., MacDonald, this volume). Although an established route connecting the Tetons and Lake Yellowstone directly has yet to be documented, it is more likely that such a route may have been more actively traveled following delta abandonment as the topset surfaces emerged and vegetation began to grow on them. This interpretation is consistent with observation that the oldest documented artifacts from the southern arm of the Lake Yellowstone area are Early Archaic in age and that artifacts associated with the Middle (~5,000 – 3,000 cal yr BP) and Late Archaic (~3,000 – 1,500 cal yr BP) periods occur with increasing density. We interpret this increase in the density of Middle and Late Archaic artifacts to be related to the continued drop in lake level and the exposure of flat lying areas near the lake shore that were favorable for human occupation.

Among the more significant findings of middle and early Archaic artifacts are those from Molly Island, a small island in the southeast arm of Yellowstone Lake (Sanders 2002). This small island has a maximum surface elevation of 2363 m, or 5 m elevation above present day mean lake level. Our model suggests that lake-level had dropped to an elevation of max. ~ 5 m above present by ~ 4100 cal yr BP, based on the sedimentary findings in the Clear Creek locations (CC3). At this time during the Middle Archaic period, Molly Island would have started to emerge above the lake surface and would have been accessible to humans for the first time. The preservation of the Middle Archaic artifacts and re-occupation of the site during the Late Archaic period also suggests that lake level remained below the Molly Island maximum elevation from the Middle Archaic period onward, consistent with our interpretation of the lake level history.

Summary and Conclusion

Based on sedimentologic, geomorphologic, and geochronologic information from study sites along the southern and southeastern margin of Yellowstone Lake we conclude the following:

A radiocarbon date of 10,390 ± 150 cal yr BP from charcoal collected from within coarse gravels of the Alluvium Creek Gilbert-style delta in section CC2 indicates that the delta underwent construction at this time, around the Pleistocene-Holocene transition.

Assuming a constant slope gradient between the location of the sample yielding the radiocarbon date of 10,390 ± 150 cal yr BP and the break in slope on the Alluvium Creek delta, the lake level at that time existed ~20 m above that of the present day.

A radiocarbon date of 4,100 ± 130 cal yr BP from charcoal recovered from low energy deposits inferred to be floodplain or lacustrine and located ~ 5 m above the present day lake surface and ~2 m above present day Clear Creek suggests that lake level was elevated between 2 and 5 m at that time.

A radiocarbon date of 2,795 ± 55 cal yr BP from a sample of charcoal collected in a fluvial section measured in an abandoned channel wall with ~1 m of incision suggests that base (lake) level was about 1 m higher than present at that time.

Preliminary geologic/geomorphologic evidence, combined with the results of three radiocarbon ages, suggest that relative to the modern ground surface, the surface elevation of Yellowstone Lake was significantly higher along its southeastern shore than outlined by
Pierce et al. (2002, 2007), but consistent with a lake level model published by Locke and Meyer (1994). However, additional radiocarbon ages, along with geomorphologic and sedimentologic analyses from other locations around the lake, are needed to confirm these findings.

Changes in lake level interpreted in this paper are consistent with reported variations in Holocene climate. Post-glacial lake level was at a highstand but lowered rapidly during the early and mid-Holocene due to warm climatic conditions independently interpreted from pollen and charcoal records. The rate of lake level lowering slowed roughly by an order of magnitude beginning around 3-4ka and continuing to the present, consistent with a wetter climate during this timeframe.

The presence of actively constructing Gilbert-style deltas and the possible existence of a substantial volume of glacial ice in the Absaroka Mountains southeast of Lake Yellowstone during the Pleistocene-Holocene transition likely inhibited both the travel of people through the region and the establishment of temporary campsites there. High discharge seasonal flooding of the delta tops would have impeded travel and temporary occupation and may have reworked any artifacts of the Paleoindian period from this region. In contrast, rapid lowering of the surface of Lake Yellowstone and the abandonment of the Alluvium and Trail Creek deltas would have resulted in relatively flat ground suitable for camping. Thus, we anticipate that the archeological record from the Southeastern portion of Lake Yellowstone will contain few artifacts of Paleoindian age, but may represent a significant source of Early Archaic and younger artifacts.

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CHAPTER 11

YELLOWSTONE LAKE: DYNAMIC SHORELINES, GIS, AND PREDICTING ARCHAEOLOGICAL SITE LOCATIONS

By Jordan C. McIntyre and Steven D. Sheriff

Introduction: Lakeshores and Deformations

During the recent twelve millennia the Yellowstone Lake basin experienced episodic deformation from cross cutting faulting and the aperiodic inflation and deflation of the Yellowstone caldera superposed on long term isostatic rebound from glacial unloading. Intra-caldera deformation can be up to decimeters per decade. These tectonic forces affect the lake basin and displace lake water thereby changing the elevation of the shoreline at the time of deformation. During any particular stand of the lake, wave erosion forms a wave-cut platform and undercut shoreward cliffs. When the lake stand changes these steps and terraces are abandoned and a new set formed at the new elevation of the lake surface. Thus, a set of geomorphic features resembling the tread and riser system of a staircase records previous lake levels. Subsequent erosion, deposition, and burial by hydrothermal-explosion deposits helps obscure these shorelines. Regardless, a terrace cut at some specific time is available for human occupation after it is abandoned by generally decreasing lake levels.

The ancient shoreline terraces around Yellowstone Lake provide a superb history of postglacial surface deformation. Richmond (1973) first mapped these shorelines but earlier observers also noted them (see history in Locke and Meyer 1994). Early observation is not a big surprise as the ancient terraces are obvious to any casual observer near the current shores of Yellowstone Lake. Better detail came about when Pelton and Smith (1982) contributed precise geodetic measurements of deformation by resurveying USGS benchmarks along Yellowstone Park’s roads. At a more detailed scale, Meyer and Locke (1986) measured, mapped, and correlated shorelines around the northern part of Yellowstone Lake. More recent work continues to add detail to our knowledge of terrace ages, their formation, and subsequent deformation (e.g. Hofmann and Hendrix, this volume; 2011).

Meyer and Locke (1994) conducted a thorough survey between 1984 and 1988 that encompassed the entire perimeter of Yellowstone Lake. Using automatic levels, rods, and tapes with centimeter scale resolution of topography they surveyed 230 topographic profiles perpendicular to the shorelines and identified 11 recognizable terraces. Out of these 11 terraces, five were continuous around the lake basin and were used to identify deformation patterns. These were identified as the S3, S4, S5, S7, and S9 shorelines.

In the northern region of the lake the elevation of the S3 was approximately 5.7 m above the modern lake level as derived from a USGS digital elevation model (DEM) which puts the modern lake elevation at 2,356.74 meters above sea level. The S4, S5, S7 and S9 shorelines are approximately at 8.7 m, 12.2 m, 17 m and 23.7 m above lake elevation. In the central portions along the east shore near Clear Creek and Cumbline Meadows the paleo-shorelines above DEM elevation were; S3, 1.2 m; S4, 3.7m; S5, 5.7m; S7, 13.7m and S9 at 20.7m above the modern lake elevation. In the southern region near Beaver Dam Creek paleo-shoreline elevations were recorded at; S3, 2.2 m; S4, 3.7m; S5, 8.7m; S7, 15.7m and S9 at 23.7m above the modern lake elevation. The ages of these shorelines are interpreted by Locke and Meyer as; S3, 2ka; S4, 3ka; S5, 4.5 ka; S7, 9 ka and S9 at 11.5 ka.

Pierce et al. (2007) performed a similar study around the northern shores of the lake and identified six abandoned terraces. Both studies of Meyer and Locke (1994) and Pierce et al. (2007) used carbon-isotopic analysis to date shoreline features. However, Pierce et al. (2007) also incorporated archaeological evidence to better constrain the shoreline chronology. Their new dating and archeological studies showed that the lower shorelines are much older than previously thought in the northern region of Yellowstone Lake. Pierce et al.‘s 2007 shoreline sequence starts at the modern shoreline (S1) at 1.9 ±0.3 m above their datum and then extends from S2 through S6. S2, the lowest generally recognizable shoreline, was cut at 8 ka and is about 5 meters above datum. S6, cut at approximately 14.4 ka is about 20 meters above their datum. There are some submerged...
shorelines, but the lake has been at or near its present level for about 8 thousand years; successively higher shorelines are also older. Of note for our analysis, Locke and Meyer (1994) observed that most shorelines are subhorizontal and the highest, oldest postglacial shorelines are at similar elevations inside and outside of the caldera (± 8 meters at most).

In recent geomorphological studies of the eastern and southern shores, Hofmann and Hendrix (2012; this volume) found considerable evidence that substantiates Locke and Meyer’s (1994) shoreline chronology. During their field season surveys in 2010 and 2011, Hofmann and Hendrix (2012; this volume) conducted geomorphological field studies on several formational terraces along the eastern and southeastern shores of Yellowstone Lake. During these studies they obtained dates from three carbon samples. The lowest elevation sample, from three to four meters above datum in an abandoned stream channel of Columbine Creek, yielded an age of 2,795 ± 55 cal B.P. About seven meters above datum they recovered a second carbon sample (4,150 ± 80 cal B.P) above the nearby Clear Creek streambed. Finally, as discussed in this volume, Hofmann and Hendrix recovered a carbon sample (10,390 ± 150 cal B.P) 23m above datum in coarse gravels that form of the Alluvium Creek Gilbert-style delta. Though known to be sporadic, the average rise of these terraces is on the order of 2-3 mm/year.

Hofmann and Hendrix infer from the ages and stratigraphic positions of their carbon samples two periods of differing rates of relative terrace uplift. The first period indicates a rate of uplift of about 2.6m/kyr between 10,390 B.P. and 2,795 B.P. The last period from 2,795 B.P. to modern times shows a decrease in rate to about 1.3m/kyr. While carbon samples were few in number to achieve more accurate interpretations in their shoreline model, the rates of lake level decline are similar to Lock and Meyer’s (1994) interpretation. Hofmann and Hendrix also note that a Gilbert-style delta near Trail Creek in the Southeast Arm of Yellowstone Lake shares very similar geomorphologic characteristics to the Alluvium Creek Gilbert-style delta further north. Thus, they infer that the lake level histories between these two deltas situated in the central and southern regions of the eastern shore were the same and that the abandonment of terraces coincided at the same times and elevations.

This indicates that the shoreline models proposed by Locke and Meyer (1994) and Hofmann and Hendrix (2012) are appropriate for the central and southern regions of the Yellowstone Lake where caldera-related processes are not as high amplitude as at the northern end of the lake. Conversely, the model proposed by Pierce et al. (2007) best reflects the deformational process leading to uplift and tilting of shorelines in the northern regions of Yellowstone Lake. At the north end, subaerial shorelines incur greater deformation due to their close proximity to the Sour Creek resurgent dome which lies just to the northeast of Fishing Bridge. As a result, the northern shorelines exhibit higher amplitude changes in elevation due to cyclic caldera breathing (Christiansen et al. 2002; Pierce et al. 2007). As one proceeds south along the eastern shore the caldera breathing component of deformation is greatly attenuated. Along the central and southern lake shores isostatic and climatic forces dominate the relative uplift of terraces. Given that Locke and Meyer’s (1994) shoreline models are appropriate as indicated by Hofmann and Hendrix (2012) we use their terrace designations and ages to suggest likely areas for concentrated surface surveys along the eastern and southeastern shores of Yellowstone Lake (Figure 1). Our expectation is that there should be a good correlation between the age of human occupations and the age of ancient wave-cut terraces. Sites of seasonal habitation should be younger than the age of terrace formation. And we should find the oldest most deeply buried sites of occupation on the oldest, highest elevation terraces where water covered soon to be younger terraces. Of course, redistribution of individual artifacts due to erosion and recycling will move older items onto levels that were submerged while the original sites were occupied. We also note that camp sites must be accessible. At higher lake stands some travel paths between the lake shores and wintering grounds for sheep and elk herds are submerged and those sites of potential occupation would be difficult to access. Thus, to predict likely sites of occupation, we seek those that are accessible at the appropriate times, have sufficient level ground for camping, provide nearby access to streams or the lake, and offer adequate provision for security and food supply.
Methods
To predict likely sites of occupation we used the shoreline elevations and ages of Locke and Meyer (1994) as discussed above. To map those shoreline elevations and predict likely sites of human occupation we used 1/3 arc-second USGS digital elevation models (DEM) from the USGS Seamless Server. We do that in three simple steps. First, we assume we can map ancient shorelines around the lake using the previously established terrace designations and elevations. The errors in the shorelines
elevations (Locke and Meyer 1994) are generally small relative to the difference between designated shoreline terrace elevations. Second, we determine suitable camping locales by limiting areas on those terraces to slopes of less than 5%, a slope which yields suitable flat camping for groups. Though 5% would be steep for camping, given 1/3 arc-second DEM, areas of suitable lesser slope may well exist with 5% patches. Third, we consider access to suitable sites as restricted by lake levels at the probable time of occupation. We do this by simulating the backfilling of the lake to the low elevation contour rising to a particular terrace.

We used the Pierce et al. (2007) datum elevation for their work as 2356.48 m since no elevation was given for Lock and Meyer’s (1994) datum at Fishing Bridge. Datum elevations between the two studies must be very similar with an error of ±0.3 meters given fluctuations in seasonal lake levels and episodic uplift or contraction of caldera breathing. The USGS DEM has the open water of Yellowstone Lake at an elevation of about 2,356.74 meters. This equals Pierce’s datum level of 2,356.48 m plus 0.26 meters which is a reasonable range in variability in lake stand due to seasonal lake level fluctuations that have nominal amplitude of one meter depending on annual precipitation.

To accommodate accumulated uncertainties in DEM, tectonics, terrace estimates, and the like we use a generalized model of terraces and their ages and broke the group into three periods: Early, Middle and Late. We also allowed a one meter overlap at the transitions between periods to account for variability in shoreline elevations. The earliest period includes the highest lake shores between 2,369 m to 2,379 m (13 m to 23 m above datum; S7-S9) and reflects the paleoindian cultural period beginning around 12,000 BP and ending at 8,000 BP. The Middle period has lake shore elevations between 2,361 to 2,370 meters (5 to 14 m above datum; S4-S6) comprised of the Middle and Early Archaic periods from 8,000 to 3,000 BP. The Late Period, with lake shore elevations from 2,356.48 meters to 2,362 meters (0-6 m above datum; S1-S3), spans the last 3,000 years and includes the Late Archaic and Late Prehistoric cultural periods.

Having designated elevation bounds for the three age groups, we used ESRI® ArcMap to calculate and predict potential ancient campsites on lakeshore terraces along the eastern and southeastern shores of Yellowstone Lake. We limited areas of interest to those with sufficiently flat areas for group camping (<5% slope) and predict their ages based on shoreline elevation by binning them into elevations reflecting the Early, Middle and Late periods of lake level history (Figure 2). MYAP field crews investigated the east shores of Yellowstone Lake in the summers of 2010 and 2011; here, we compare those results with the predictions.

Results/Discussion

Following methods established elsewhere (McIntyre 2012), our GIS analysis revealed four main areas along the eastern shores with slopes of less than 5% that would seem ideal for hunter-gatherers to exploit (Figure 2). First, the Clear Creek Area, along the northeastern section of the study area, includes two stream drainages (Cub Creek and Clear Creek) flowing westward from the Absaroka Mountain Ranges. The Clear Creek area is comprised of erosional step terraces (Hofmann and Hendrix, this volume) that extend eastward a kilometer with the oldest subaerial shorelines further away from the lake and obviously at higher elevations. The second potential habitation area is approximately 2.5 km further south at Meadow Creek and was a small protected harbor until at least 3,000 BP after which lake levels dropped enough to expose its surfaces. The third habitable area is further south in the vicinity of Columbine Meadows and the Alluvium Creek Delta and extends approximately 3 km north from Alluvium Creek to 800 meters past the mouth of Columbine Creek. The final area that may reflect habitable living spaces is adjacent to the northern most edge of Yellowstone Lake’s delta foot near Beaver Dam Creek. However, this area is primarily made up of the delta’s flood plain on which bugs and floods likely decrement the attraction of this area for hunter-gatherers seeking temporary occupations.

The Clear Creek habitation area, subject to considerable archaeological survey in 2011 and 2012 (Livers et al. 2012; McIntyre et al. this volume), yielded a wealth of artifacts from several sites with dates as expected from our GIS analysis. For example, site 48YE678 yielded multiple hearth features at approximately 1,500 BP which lie on terraces S1-S3 within 5 meters of the current lake level (Figure 2).
addition, the carbon samples dated to 4,150 ± 80 cal BP recovered by Hofmann and Hendrix (2012; this volume) come from terraces about 7 meters above datum (site 48YE2080) just as expected in our Middle and Early Archaic zone (8,000 to 3,000 BP). The 2011 field work of the Montana Yellowstone Archaeological Project (MYAP) identified additional projectile points distinctive to the Middle Archaic Period (5,000 to 3,000 BP) on the same
terrace exposed at about 8,000 BP as predicted in our analysis. These points were found among the same terraces where Hofmann and Hendrix (2012; this volume) recovered their carbon samples and verify that lake levels were at the predicted elevations. The oldest artifacts recovered in 48YE2080 are Middle Archaic. Unfortunately, MYAP’s 2010 and 2011 field season failed to recover archaeological material or C\(^{14}\) samples older than Middle Archaic. Thus, we have neither positive nor negative confirmation of much older sites on the highest terraces in Clear Creek. Given the wealth of artifacts (nearly 6,000) from six Clear Creek sites (Livers et al. 2012) the higher terraces are ripe for exploration for Paleoindian era sites. Regardless, the archaeological discoveries and C\(^{14}\) dates confirm the GIS predictions for the Clear Creek habitation area.

In the Meadow Creek area our GIS analysis indicates the region was a small protected bay prior to 8,000 years ago. Based upon C\(^{14}\) dating analyses of samples recovered by Hofmann and Hendrix (2012) near Clear Creek, much of the bottom surfaces of this bay were exposed by 4.1 ka during the Middle Archaic Period (5,000-3,000 BP). By the transition into our Late Period (less than 3,000 years), lake levels had receded far enough to expose the entire bottom of this bay, thus creating new living surfaces for prehistoric occupations. Unfortunately, during 2010 MYAP field crews identified only one datable prehistoric site, culturally distinct to the Late Archaic Period (3,000 to 1,500 BP). That site, 48YE2092, was on a lower terrace within the expected elevation range for lake levels during this period in time (Figure 2). Revisiting the area in 2011, MYAP crews excavated 48YE2090 and discovered a probable Late Archaic or Late Prehistoric occupation at 2,360 meters (4 meters above datum) as predicted. During the 2010 investigations, field crews surveyed the higher elevated terraces for older sites but found insufficient surface scatter to warrant excavation. Thus, as with the Clear Creek area, we have no archaeological evidence from the higher terraces. Note that the Meadow Creek-Park Point area is somewhat isolated and may have experienced less use than the Clear Creek site. Travel up Meadow Creek does not lead to a pass; rather it leads to a tributary of Clear Creek. During higher lake stands, arriving at Meadow Creek and Pack point requires travel from Clear Creek two miles to the north. During those high stands, access is less easy from the south as the lake lapped against clffy terrain.

Our third habitable area, the Columbine Creek habitation area, is about seven kilometers south of Meadow Creek. It can be accessed either along the eastern shoreline during all but the highest lake stands or from a pass ten kilometers to the northeast. However, the MYAP 2010 and 2011 field season surveys did not identify any prehistoric sites even though terraces from all three of our age/elevation groups exist in the area. Hofmann and Hendrix’s (2012) geomorphologic field analyses confirms lake levels in this region at approximately 2,379 m at 10.4 ka and 2,359 m at 2.8 ka. Thus, though we have good available living surfaces in all age groups we have no archaeological confirmation of their use.

The last area from this study exhibiting slopes gentle enough to support comfortable living surfaces is at the mouth of Beaver Dam Creek where it meets the Yellowstone River delta (Figure 2). Again, our GIS analysis shows suitable living surfaces in all three age groups in terms of slope and access. However, this region would have been wet, marshy, and subject to seasonal flooding. Such conditions are not desirable for modern camping, nor would they be so in the past. This would have restricted occupations onto the higher more stable terraces that were away from the flood plain. In 2010, two culturally distinct sites were identified in this region and one of these is likely to reflect a secondary deposition. 48YE2106 rests on a low-lying erosional terrace within the predicted elevation bounds and is culturally associated with the Middle Archaic McKean Complex (5,000 to 3,000 BP). Another 2010 site, 48YE250, was identified on the edge of the delta foot and is culturally distinct to the Late Prehistoric Period. It too is within the expected elevation range. However, 48YE250 likely reflects the redistribution of archaeological material transported by natural erosional mechanisms in a fluvial environmental context (Livers and MacDonald 2011). Site 48YE1499, excavated in 2011, yielded a Pelican Lake projectile point and a radiocarbon date of 1,260-1,060 Cal BP at an elevation of 2,365 meters (8.6 m above datum). Thus, as expected, the site is younger than the exposure of the terrace.
Conclusions

We suggest that the shoreline designations of Locke and Meyer (1994) are more appropriate for the east and southeast shores of Yellowstone Lake, that portion outside the seismically active caldera, than those of Pierce et al. (2007) as also noted by Hofmann and Hendrix (2012; this volume). We separate these shorelines into three general groups: 1) the earliest period (13 m to 23 m above datum) reflects the Paleoindian cultural period from 12,000 B.P. to 8,000 BP, 2) the middle period (5 to 14 m above datum) comprised of the Middle and Early Archaic periods from 8,000 to 3,000 BP, and 3) the Late Period (0-6 m above datum) from Late Archaic to historic. After separating the shorelines into these age groups we calculated topographic slopes based on 1/3 arc-second DEMs and masked those results for areas with slope less than 5%. Thus, we find areas in designated age bands with surface slopes suitable for group camping and use that as a basis for predictive modeling of occupation sites. The Montana Yellowstone Archaeological Project’s 2010 and 2011 archaeological results from the east and southeast shores of Yellowstone Lake corroborate our predictions from GIS analysis of ancient shoreline levels.

Unfortunately, there is a very limited sample range of datable archaeological sites along the eastern and southeastern shores (Livers and MacDonald 2011; Livers et al. 2012) and there are no sites earlier than Middle Archaic. Regardless, the spatial distribution of the discovered sites is in agreement with our predicted ranges. Prehistoric sites dating to the Late Archaic and Late Prehistoric cultural periods are found on terraces associated with Late Period lake levels (2,356.48 m to 2,362 m) that have been gradually receding over the last 3,000 years. Occupations dating to the Middle Archaic cultural period are associated with lake levels (2,361 to 2,370 m) during the Middle Period of the lake shore model. MYAP did not discover any Early Archaic cultural period (8,000 to 5,000 B.P.) or Paleoindian era (12,000 to 8,000 B.P.) occupations even though there is previous evidence of those cultures in the Yellowstone Lake area. For example, there are more Paleoindian points are found around Yellowstone Lake than in any other area of the park (Johnson 2002). Included here is the nearby Late Paleoindian Osprey Beach locality (Shortt 2001) on the West Thumb portion of the southern shore of Yellowstone Lake. Further, Pitblado (2012) has 92 Paleoindian sites less than 300 kilometers to the southwest in Idaho and Utah, sites that include Clovis, Folsom, and Angostura artifacts. Similar, yet fewer, such sites are distributed around Yellowstone in the adjacent areas of Montana and Wyoming. As Livers et al. (2012) note, it is our earliest period with the highest terraces that should hold records Paleoindian and Early Archaic.

Two explanations come to mind. Perhaps there was less occupation in those times or there is insufficient surface scatter from more deeply buried sites to reliably discover them using pedestrian surface surveys.

Our predictive modeling identifies many suitable occupational living surfaces on successively higher and older lake shores. Yet, there appears to be fewer sites on the eastern and southeastern than on the northern or western shores (e.g. Livers et al. 2012). It is possible that hunter-gatherers avoided much of the east shore as the frequency of site counts dramatically diminishes south of Clear Creek (Livers and MacDonald 2011) where higher lake stands encroached on cliffy areas (see Figure 2 in Chapter 13, below). One can travel easily from Clear Creek to Meadow Creek at all lake levels. At higher stands, travel further south to Columbine Creek is impeded by cliffy shores at the foot of the Absaroka Range. Both Clear Creek and Columbine Creek lead east to passes out of the Yellowstone ecosystem but Sylvan Pass at the head of Clear Creek provides somewhat easier travel. This route leads to the Shoshone River and the big game wintering grounds around Cody, WY. There is much easier travel to Yellowstone Lake from the north and southwest so perhaps those shores were simply more popular and hunter-gatherers avoided the eastern areas because the invested energy costs outweighed the caloric energy to be gained from the resources. There is also a paucity of sites demonstrating prehistoric occupations at the south of our study area in the Beaver Dam Creek region, possibly due to its floodplain settings with its attendant wet, marshy, buggy conditions and frequent spring flooding. Even occupations that did exist would be subject to the erosive and depositional processes of the Yellowstone River; local ecological conditions must be part of the prediction.

Alternatively, perhaps Paleoindian and Early Archaic sites exist on the higher terraces and have yet to be discovered. It is easy to imagine effective burial of
archaeological evidence in the current ecological conditions of Yellowstone. Clear Creek, Meadow Creek, Columbine Creek, and the Yellowstone River deliver vast quantities of sediment to their fan and delta systems each year. Lodgepole forests grow fast and burn frequently; duff builds rapidly, and grasses are tall. Clearly Clear Creek has been well used for millennia; yielding nearly 6,000 artifacts from the Middle Archaic forward (Livers and MacDonald 2011). Due to that artifact frequency, its large area, and easy access from the north and from Sylvan Pass to the east the higher older terraces of Clear Creek seem to be the most likely on the eastern shore to hold evidence of earlier occupation. Geophysical exploration using total field magnetic observations has proven to be very successful on the northwestern shores of Yellowstone Lake (Sheriff and MacDonald 2011; Sheriff, this volume). In some of those investigated areas 40% of test units excavated hearth features. Given the success of the GIS predictions, combining geophysical exploration and further archaeological investigation may yield older sites on higher terraces and help establish archaeological resources in Yellowstone National Park as well as the document the change in use and technologies from Paleoindian through historic times.

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CHAPTER 12
TOTAL FIELD MAGNETIC EXPLORATION FOR PREHISTORIC ARCHAEOLOGICAL SITES ALONG YELLOWSTONE LAKE’S NORTHWEST SHORE

By Steven D. Sheriff

Abstract
The Montana- Yellowstone Archaeological Project is a joint archaeological project of the University of Montana’s Department of Anthropology and Yellowstone National Park’s Center for Resources. Our 2009 and 2010 field seasons contributed about 200 hectares of archaeological survey focused on the northwest shores of Yellowstone Lake (Figure 1). In hopes of optimally placing archaeological test units, we subjected a small fraction of those 200 hectares to total field magnetic (TMI) and/or Ground Penetrating Radar (GPR) investigation. The typical archaeological features and geophysical targets in Yellowstone National Park are temporary campsites, small ephemeral surface hearths, occasional larger roasting pits, stone rings, and indeterminate artifact scatters; there are no village sites. The materials used for the campsite features were existing glacial erratics, ice-rafted dropstones, and colluvial debris. This introduces a complication in that given TMI or GPR results alone, it is not yet possible to separate rocks used for many of the above cultural processes from those occurring naturally.

Our first geophysical objective was to complete a number of detailed TMI grids occasionally followed by GPR surveys in sub-areas with a high likelihood of cultural features. To choose these small areas for investigation with magnetometry we first completed close-interval pedestrian surveys to map visible artifact density on the surface over large areas. Following discovery of high counts of surface artifacts or other indications of potential sites, we employed detailed surface surveys and then sited test grids for magnetic exploration. Those magnetic grids range from 100 m² to 2,500 m² depending on access and our interest. Our next objective was to rapidly acquire, process, and interpret sufficient, meaningful magnetic data in the time available to guide placement of test units. In some cases, sufficiently clear and flat ground conditions allowed GPR investigation as well. The GPR results can be particularly valuable by allowing one to eliminate magnetic anomalies from fluvial features from further consideration.

After excavating test units at selected magnetic anomalies about 40% of those excavations yielded cultural material with most of the remaining sources being glacial erratics or occasional historic ferromagnetic materials. Thus, our hierarchical method of pedestrian survey and geophysical exploration followed by archaeological test units successfully contributed to delineating archaeological resources and ascertaining the cultural history of Yellowstone National Park.

Figure 1. Location of Study Area
Project Overview

The University of Montana’s (UM) 2009 and 2010 field seasons were focused on the lake developed area along the northwestern shores of Yellowstone Lake near Fishing Bridge and Lake Lodge (Figure 1). As discussed above, we conducted total field magnetic (TMI) and/or Ground Penetrating Radar (GPR) investigations at several sites in meadows and shorelines between Lake Lodge and Fishing Bridge. We do not show precise site locations to avoid artifact collection in this busy area of the park. We placed these geophysical grids in areas where standard pedestrian surveys found higher concentrations of artifact scatter suggesting a reasonable likelihood of subsurface archaeological features.

The typical archaeological features and geophysical targets in Yellowstone National Park are temporary campsites, small ephemeral surface hearths, occasional larger roasting pits, stone rings, and indeterminate artifact scatters; there are no village sites. The materials used for the campsite features were existing glacial erratics, ice-rafted dropstones, and colluvial debris. This introduces a complication in that given TMI or GPR results alone, it is not yet possible to separate rocks used for many of the above cultural processes from those occurring naturally.

The ultimate MYAP goal is to inventory all archaeological sites around the lake and evaluate their eligibility for listing on the United States National Register of Historic Places. During this survey and evaluation, MYAP (MacDonald and Livers 2011) collected nearly 11,000 prehistoric artifacts indicating ephemeral use of the northwest lakeshore since the Late Paleoindian period (~10,000 BP). We include here a summary of our techniques, representative maps of processed total magnetic intensity, and examples from excavation of typical archaeological and/or geophysical targets.

Prehistoric Setting, Geophysical Targets

Pleistocene volcanic eruptions, lava flows, and associated thermal uplift formed the Yellowstone Plateau physiographic province (Pierce et al. 2007). During glacial maxima an icecap covered almost the entire Yellowstone area. The most recent icecap was virtually gone by 12,000 BP (Hale 2003; Licciardi and Pierce 2008), more recent than the oldest archaeological sites in North America. The resulting glacial deposits are poorly to moderately sorted boulder-rich gravels and sand, including gneiss, rhyolite, welded-tuff, and basalt boulders up to a meter or more in diameter. These boulders are present along the current lakeshore and in the shallow subsurface. The magnetic susceptibility and remanent magnetization of these boulders varies dramatically. A series of lakeshore terraces, named S2-S6 by Pierce et al. (2007) related to glacial rebound and caldera deformation range in age from 14,000 BP to present. These terraces provide potential living surfaces when they emerge. Thus, we expect evidence of habitation and human use of terraces shortly after their emergence.

Sagebrush and short-grass prairie as well as stands of lodgepole pine and spruce dominate the study area (Figure 2). Both the boulders and sagebrush complicate geophysical investigation and interpretation. Naturally distributed boulders yield geophysical signals similar to many human arranged features. The sagebrush, bunchgrass, and surficial erratics often rule out using GPR as those antennas must contact the ground for good electromagnetic coupling and low-noise results. Further,
the sagebrush, bunchgrass, and surficial rocks make smooth walking difficult during the acquisition of magnetic observations. The latter complication is efficiently and effectively addressed with signal processing techniques (e.g. Sheriff et al. 2010).

The 2,380-meter elevation of the project area yields a deep snowpack and extremely low winter temperatures that drive animal migration to lower elevations generally beginning in October (e.g. Hale 2003). Deep snow and paucity of game renders the area uninhabitable during winter assuring that habitation of the upper portions of the Yellowstone Plateau, including Yellowstone Lake, by prehistoric peoples would have been seasonal. People followed migrating herds and sought seasonal flora. Thus, their temporary campsites are the typical archaeological features and geophysical targets in Yellowstone National Park, similar to the targets sought by Jones and Munson (2005). These are the features we seek with the geophysical exploration methods in this study. Camps were small and used for short-term occupations during summer months. Of the features of interest, only stone rings would have geometry and signal different than naturally occurring features.

**Methods**

**Total Field Magnetic Investigation**

About 180 km of shoreline surrounds 350 km² of Yellowstone Lake. Consequently, the archaeological survey of the areas included multiple field seasons and, lacking infinite funding, some expedience in site surveying, discovery, and limited excavation is necessary. In sitting small areas for investigation with magnetometry, we first completed close-interval (ca. 2-3 meter) pedestrian surveys to map visible artifact density on the surface over large areas. Following discovery of high counts of surface artifacts or other indications of potential sites, we employed detailed surface surveys and then sited test grids for magnetic exploration. Those magnetic grids range from 100 m² to 2,500 m² depending on access, our interest, and available time. Thus, we employed a hierarchical method hoping to exploit magnetometry to locate excavation test units likely to discover small subsurface features left from ephemeral occupation in the Yellowstone Lake area. Our principal objective was to rapidly acquire, process, and interpret sufficient, meaningful magnetic data in the time available to guide placement of archaeological test units.

Once we determined an area for which we desired magnetic data, we established grids using the archaeological datum with tape measures and corner stakes or by using a total station when available. Following establishment of a grid, we acquired total field magnetic intensity (TMI) observations at 10 Hz to assure sub-decimeter sampling along traverse lines (see Figure 2). We acquire these data while walking bidirectional transects spaced one meter apart using a Geometrics G858 Cesium vapor magnetometer holding the sensor roughly 30 cm off the ground. We guided those transects with observers at each end of the line. For longer transects we used rope on transect lines for additional guidance and included a reference mark at the grid center. The magnetometer software then linearly interpolates the observations along each line while assuming straight lines.

The Geometrics G858 is a total field cesium vapor magnetometer with nominal sensitivity of 0.05 nT at a 10 Hz sampling rate. While vertical gradient fluxgate (vector) magnetometer surveys are quite common in Western Europe (Aspinall et al. 2008) and to some extent in the United States (e.g. Jones and Munson 2005, De Vore 2008a, De Vore 2008b) collecting total field intensity (TMI) offers several advantages. First, collecting the vertical gradient of a magnetic anomaly is essentially applying a high pass filter, or edge detector, in the field to bias against signal from deeper sources. Modeling of appropriate causative sources shows that if such sources are buried a meter of more, their signal is severely attenuated on vertical gradient maps relative to TMI maps. Thus acquiring TMI data allows detection of deep and shallow targets which can later be isolated with common equivalent layer separation techniques (Sheriff 2010). Second, deciding on line separation to be used during magnetic surveys is a fundamental part of experimental design. One wants sufficient coverage to guarantee finding all features of interest within a specified depth and size limit. Yet, decreasing the spacing between acquisition lines adds substantially to the total time, thus cost, of a magnetic survey. Here, TMI investigations offer another advantage over acquisition of the vertical gradient. This improvement is evident upon consideration of the magnetic field over a simple
magnetic dipole. That field strength is proportional to $1/r^3$ where $r$ is the distance from the magnetometer to the magnetic dipole; the vertical gradient of the same dipole is proportional to $1/r^4$. Thus, because the vertical gradient falls off notably faster with distance than the total field, vertical gradient surveys necessarily require tighter line spacing to achieve the same detection ability as total field surveys. Finally, given the total field anomaly, calculating the vertical component and its vertical gradient, is a simple procedure (Pedersen et al. 1990). Thus, one can display the gradient of the vertical component along with other edge detection techniques to highlight shallow sources as part of the processing routine while still acquiring signal from deeper sources.

Traditionally, when designing a magnetic survey, we use standard sampling theory which requires at least two observations per the shortest wavelength of signal in any gridded or profiled data set (e.g. Blakely 1995). We then calculate the power spectrum of expected buried sources to determine the ratio of elevation above sources and spacing between lines of acquired data. Upon doing so, we find that an isolated dipole requires line or sample spacing equal to or less than the depth of the source below the sensor. Obviously, isolated theoretical dipoles are uncommon archaeological targets; hearths, boulders, or assemblages of fire cracked rock, are not point source dipoles. The sources we seek are better characterized by the equations for a magnetized half space with magnetic distribution proportional to $1/t^3$, where t is spatial frequency; colloquially, this fractal distribution is known as red noise. This more realistic model has less stringent sampling requirements than that of an isolated magnetic dipole. Assuming a $1/t^3$ distribution suggests maximum sample or line spacing equal to twice the depth of the layer.

We acquire TMI observations on lines spaced one meter apart after analyzing the power spectra for simulated sources which shows line spacing can be twice the separation of the source and sensor. This keeps aliasing of shorter wavelength components sufficiently small to still allow detection and accurate modeling by forward or inverse methods. Boulders and arranged cobbles are distributed sources with respect to theoretical dipole targets. Thus, though theoretical individual dipoles require half that line spacing our targets of interest are spatially broader than dipole sources and readily evident on data acquired at one meter line intervals. Our empirical comparison of occasional test grids from other projects collected at half meter intervals typically shows no additional anomalies of interest compared to data collected at one meter line intervals.

Sources of measurement noise during acquisition include slow to rapid changes in Earth’s magnetic field, positioning errors, and instrumental noise. Rough ground, substantial sagebrush, and bunchgrass in our field areas made steady, straight walking difficult. Such difficult acquisition causes regular spatial and rotational displacement of the magnetometer’s sensor as well as changes in pace which adds much noise to the acquired observations. Fortunately we can filter the vast majority of that noise with techniques typical for aeromagnetic and ground magnetic data acquired in the energy and minerals exploration industry.

We collected our TMI data during magnetically quiet periods as observed by NOAA (2010) and our on-site observations. We also used a GEM Systems recording Proton Precession base station magnetometer for diurnal corrections on many larger grids. For these grids, we perform the correction for diurnal variations of the geomagnetic field by simply subtracting the time-appropriate ambient field strength at a fixed location from the observation made at the corresponding time in the grid of data being collected. Grids collected and processed without simultaneous base station observations of the ambient field will contain geomagnetic variations convolved with the desired anomalies from targets of interest. The frequency spectrum of such geomagnetic variance can be broad. Low frequency components have periods similar to the acquisition time of several transects and longer. High frequency components have periods ranging from the time for acquiring a few observations to that for acquiring a few transects. In the filtering described below, we deal with the possibility of long period geomagnetic variation in combination with that for regional and deeper geologic sources. We treat the potential effects of high frequency variance with filtering techniques adapted from the energy and mining industry. This proved successful as is demonstrated by the final maps; whether diurnally corrected or not, the results are comparable. The ultimate anomalies of
interest have amplitudes of nanoteslas to 10's of nanoteslas which are much larger than the amplitude of short period magnetic field changes during our studies.

Our TMI observations, gridded by kriging with 0.4 meter spacing, include features at three dominant scales. First, there is experimental noise resulting from sensor position errors during acquisition and the effects of highly magnetic rhyolite and obsidian cobbles and historic debris on the surface. The corrugation (e.g. Sheriff et al. 2010) from acquisition can be significant and is typical in ground and airborne magnetic surveys where one acquires observations at relatively high spatial frequency along more widely spaced transects. Yet, this approach requires less surveying and grid setup and allows acquisition at walking speed as compared to surveying each acquisition point. Despite the usual efforts to keep the sensor a constant distance from the ground and walk at a consistent pace, sage, bunch grass, rough surfaces, rocks and wind combine to interfere with the operator. This impacts the distance and orientation of the sensor relative to the ground and causes variation in pace while acquiring TMI observations at 10 Hz which manifests as linear magnetic anomalies, known as corrugation, in the direction of acquisition. These anomalies are highly correlated with acquisition lines.

We use a common technique (Urquhart 1988) for decorrugaration filtering as elaborated on in Sheriff et al. (2010). Essentially, we filter the data and add short wavelength components from along acquisition lines to long wavelength components across the lines.

The second and third spatial scales of magnetic anomalies in ground based magnetic investigation are from deeper geologic sources and shallow potentially interesting sources at the archaeological and/or environmental scale. Anomalies at the latter scale also include near surface sources such as lateral or vertical changes in the soil or other local geology. We typically separate magnetic signal from these shallow and deep sources into equivalent layers using either differenting of upward continuations following (Jacobsen 1987) or matched bandpass filtering based on equivalent sources (Pedersen 1991). Upward continuation (Blakely 1995) is a process whereby the magnetic field is recalculated as if the observations were acquired at a higher level above the ground, thereby simulating a buried target. The application, subsequent choice of method and its success is largely empirical and determined by experimentation.

Employing matched bandpass filtering for anomaly separation has a long history (Nabighian et al. 2005) in the application of aeromagnetic data to tectonics, structure, and resource exploration, but not in archaeology. Yet, it works quite well in many archaeological situations as demonstrated by Sheriff (2010). The successive application of correcting for diurnal variation of the geomagnetic field, orthogonal wavelength filtering to remove corrugation, and then separating the TMI observations into equivalent magnetic layers yields magnetic maps ready for interpretation.

Edge detection follows filtering applied for decorrugaration and equivalent layer separation. Not only does edge detection highlight anomalies of interest, done properly it centers anomalies over their causative sources as does a reduction to pole transform (e.g. Blakely 1995). For edge detection and source location, we typically compare results from calculating the analytic signal (Roest et al., 1992) and horizontal gradient (Blakely and Simpson 1986) of either the equivalent layer or the pseudogravity transformation (Baranov 1957) of that layer. For small features, such as concentrations of fire-cracked rocks, the analytic signal provides a single anomaly over the source while the horizontal gradient tends to work better for delineating edges of larger features. Calculating the vertical gradient (Pedersen et al. 1990) of the total magnetic intensity can also highlight shallow sources (e.g. Aspinall et al. 2008) so we also occasionally employ that technique along with other image enhancement and edge detecting techniques.

Typically, during the processing and interpretation steps discussed above, one tests different methods and parameters during each step. Thus, one would evaluate different filter window sizes to select the optimal size for decorrugaration hoping to best decrement noise and retain anomalies of interest. Sometimes differenting upwards continuations isolates different interesting anomalies during equivalent layer separation than does matched filtering. Ultimately, comparing and considering the results of several edge detection techniques often leads to anomaly recognition missed by any individual technique. Consequently, in the following we present the final interpreted results from our magnetic exploration.
Grids within various archaeological sites around the northwest shore of Yellowstone Lake without all the intervening processing steps and decisions.

**Ground Penetrating Radar Investigation**

In some instances we were also able to collect ground penetrating radar (GPR) data within a magnetic grid. A very large percentage of the area around Yellowstone Lake is not amenable to successful GPR investigation because a requirement for reasonable GPR results is less than 2.5 centimeters of ground clearance and roughness; GPR antennas must sit on the ground. The tall grasses, sage brush, rabbit brush, other foliage, rocky terrain, and geomorphological rugosities greatly exceed the 2.5 cm specification throughout the area limiting GPR acquisition without significant clearing of the area. In a few cases we were able to acquire GPR observations within limited areas where topography and surface conditions allowed its use.

Ground Penetrating Radar (GPR) is an active source geophysical tool in which tuned antennas, typically 250 - 500 MHz for archaeological work, transmit radar waves into the subsurface and subsequently receive radar reflections from subsurface changes in electrical properties. Antenna choice is based on the likely targets, ground conditions, and depth of interest. For this study we collected the GPR data using a Mala Ramac 500 MHz antenna system. We chose this antenna because the expected targets from the magnetic investigations appeared to be within a meter of the surface and the 500 MHz wavelengths are on the order of one quarter of a meter. With a nominal transect spacing of 0.5 meters and radar velocities appropriate for the materials in the area, the 500 MHz signal spreads enough to allow overlap and very good line-to-line interpolation of results. We collected GPR profiles with a line spacing of 0.50 meters at 20 individual radar pulses (traces) per meter along lines.

In GPR profiles (depth sections) we plot reflections from subsurface sources as the time to travel down to, and back up from, reflectors thereby mapping the depth and shape of the reflectors. When collected in a tight grid, we also make time-slice maps showing the amplitude of reflected radar waves in map view.

GPR results require substantial processing to get the most information out of the data. Typically, one analyzes and interprets numerous individual profiles and iteratively processes those with different parameters to determine the most suitable filter parameters for a given situation. Assembling the group of profiles yields a 3D volume for analysis. Next, one produces and inspects a myriad of time slices to determine the best interpolation parameters, window lengths, and starting times to bring out reflection features of potential archaeological interest. In either case (profiles or time slices) we analyze the results looking for disruptions of natural stratigraphy and subsurface geology. We interpret truncated reflections, diffraction returns, and changes in amplitude while rarely seeing definite images. Typical shapes we might find in time slices would be that of stone rings, pit houses, compacted living surfaces, grave sites, and the like.

**Expectations and Examples**

Temporary campsites represented by small ephemeral hearths (Figure 3), rare larger basin-shaped features (Figure 4), stone rings (tipi rings), and indeterminate artifact scatters are the typical archaeological features and geophysical targets in our Yellowstone work as they were for Jones and Munro (2005). Given these targets, strong obvious magnetic signals with characteristic, non-natural geometry are rare. And, the building materials, which are the locally derived glacial erratics common on the surface and in the

![Figure 3. Representative hearth exposed in profile due to wave erosion at 48YE380, dated to 1600 BP (MacDonald, Chapter 13, this volume).](image)
anomalies exist. This demonstrates that the radial symmetry of such features is detectable at depth with minimal filtering and edge enhancement. Jones and Munro (2005) showed similar results.

While designing experiments, our expectation was for subtle anomalies that, in the case of hearths, look quite similar to signal from natural sources. Of course, in the case of stone rings there would be a benefit from their diagnostic radial symmetry. We designed experiments and acquired observations with these features in mind. Most of our magnetic grids were successful in locating productive test units. Other grids were successful in delineating historic disruption which rendered potential sites ineligible for inclusion in the National Register of Historic Places.

Representative Grids, Archaeological Results
Site 48YE381 (Fishing Bridge Point Site)
Located on an S2 terrace dating to approximately 8,000 B.P., site 48YE381 (Fishing Bridge Point; MacDonald, this volume) is along Yellowstone Lake’s northwest shore and holds cultural features from ca. 1,500 B.P. to 6,000 B.P. Low, hummocky wetlands mark the southern and western limits. On-site vegetation consists of lodgepole pine and open meadow consisting of sagebrush, marsh/alpine meadow flowers, various alpine grasses and shrubs along the terrace. A substantial amount of obsidian and lesser chert flaking debris is scattered throughout the pine stand and the sagebrush open area along the lakeshore. Artifact densities fall-off significantly on the far western and southern limits of the site near a wetlands and hummocks. The whole area of diffuse to more concentrated artifact scatter covers about 32,500 m². We sited two magnetic grids (2,500 m² and 300 m²) to cover the areas with the most artifact scatter. We were also able to collect Ground Penetrating Radar (GPR) data on a relatively open portion of the smaller (northern) grid which helped eliminate excavating some test units into fluvial structures.

Figure 5 shows the magnetic and radar anomalies we chose to investigate with 1x1 meter test units in the first of the two grids in 48YE381; other apparent anomalies had surface sources or lack the shape or size of interest. Although GPR time slices showed some interesting arcuate features where we also had magnetic anomalies, the GPR profiles confirmed those were from horizontal slices through the cross bedded fluvial sediments. Thus
we refrained from excavating at those anomalies. To interpret the magnetics, we used the analytic signal and horizontal gradient maxima of the TMI for edge and source detection. We combined those results along with recognition, in the field, of a decades old road in the northeast corner of the grid. The sum of these steps leads to the selection of the marked test units. The discoveries in those test units (Figure 5) include:

- #1, #2, and #3 yielded only boulders. Each individual anomaly has the character of a boulder yet their concentration and alignment was promising. We placed test units to the sides of the marked anomalies to avoid dropping in on top of features. Thus, these anomalies were not directly investigated;
- #4: hearth (1,720 ±40 BP) and evidence of obsidian tool manufacturing at 0.56 meters;
- #5: hearth (2,920 ±40 BP) at 0.8 meters;
- #6: hearth (3,090 ±40 BP) at 1.0 meters;

Figure 6, from elsewhere in site 48YE381, shows an excavated magnetic source along with an isolated set of anomalies and a subsurface model of the potential shape of the sources from the second magnetic grid in the site. A test unit on the central anomaly yielded a welded tuff boulder with its surface at 30 cm and its base at about 1.0 meter deep. The surface of the boulder was smoothed, as if used for a table or food processing area.

Figure 5. Upper image is filtered TMI showing a shallow equivalent layer separated from TMI by matched filtering. Numbers mark test units; three of these test units revealed hearths and three revealed boulders. The dashed lines mark a historic road. Horizontal dimensions are meters; contour interval is 2 nT. Lower image is a GPR profile showing inclined strata of fluvial origin; time is two-way travel time. The GPR profile crosses the upper image at the heavy black line with left on the profile to the north. Meter Scale.
(Macdonald and Livers 2011). Extensive flakes around the base of that boulder indicated its long-term use as a seat or “furniture rock” for production of arrowheads, scrapers, and spear points. Test unit 12, two meters north of this feature, yielded several burned and fire cracked rocks at a depth of 0.5 meters with a conventional radiocarbon age of 2840±40 BP. Figure 6 shows a calculated shape of the subsurface sources using MAG3D (2007) employing the techniques of Li and Oldenburg (1996). There are several radially distributed magnetic highs (Figure 6) surrounding the anomaly over the furniture rock which is the central magnetic source. Although not investigated with test units, the remaining modeled sources (Figure 6) radially around the central source may represent hearths associated with additional ephemeral camps around the central furniture rock. This is likely because Macdonald and Livers (2011) report Middle Archaic features with fire cracked rock in test units within two meters of the test unit intersecting the furniture rock.

Of ten total test units placed in site 48YE381 based on magnetic anomalies, four yielded ancient cultural results. For the remainder, boulders of welded tuff were the causative source (four test units) or, test units were placed adjacent to anomalies and missed the source. An additional benefit was that we avoided placing test units in parts of the grid which showed the impact of recent (historic) cultural disruption.

**Site 48YE1558 (Lake Lodge Meadows Site)**

Site 48YE1558, the Lake Lodge Meadows Site, located on an S4 terrace dating to approximately 10,700 BP is roughly 250 meters inland from the northwest shore of the lake and holds evidence of Paleoindian (c. 9,000 BP) occupation (MacDonald and Livers 2011). This is an area of a few lone pines, sagebrush, marsh/alpine meadow flowers, various alpine grasses and shrubs along the terrace. Low natural hummocky wetlands bound the site on its southwest and for most of its eastern limits. As delineated by surface artifact distributions, the site covers about 120,000 m². We sited three magnetic grids

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**Figure 6.** The left image (from Macdonald and Livers, 2011) shows Elaine Hale brushing off the welded tuff boulder in 48YE281 referred to as ‘furniture rock’; it is the subsurface source for the magnetic anomaly shown to the right. To the right, the upper image is filtered TMI with relative amplitudes shown in relief, and the lower image is a 3D rendering of source distribution from inversions of TMI. The central source in the lower image is from the “furniture rock”; the radially distributed surrounding sources are probable hearths. Horizontal dimensions are meters.
to investigate areas with the most artifact scatter in the southern part of the site just parallel to the old road (now a walking path).

In the southern (2,000 m$^2$) of those three grids we excavated five 1x1 meter test units during the 2009 field season. One of the test units recovered a Late Archaic fire feature (1,470±60 BP) at 0.8 meters. Given its thinness (<5 cm) and amorphous shape, the feature likely was a very short-term fire during a camping episode on the S4 terrace at the end of the Late Archaic period. Another test unit had a historic metal artifact as a source, while the three remaining test unit sources were large rhyolitic boulders.

In the second (1,000 m$^2$) of the magnetic grids, about 125 meters north of the first, we excavated three test units based on magnetic results. One contained two stratified prehistoric features, the other two failed to yield features, probably due to mislocations. The excavated features (Figure 7) were both small burn features at depths of 45 and 70 cm below datum with ages of approximately 2,130 and 2,310 BP, respectively.

The third and northern most magnetic grid (2,400 m$^2$) in 48YE1558 showed several high amplitude, short wavelength anomalies characteristic of near-surface metallic sources as well as numerous similar but smaller anomalies from similar sources or magnetic cobbles at or near the surface as labeled on Figure 8. We investigated only three of those anomalies with test units (19-21) placed at the marked anomalies g, k, and b, respectively (Figure 8); none yielded cultural features confirming this interpretation. The anomaly labeled ‘M’ has promising character but further observation showed significant recent surface disturbance which likely is the source of that anomaly and rendered it unlikely to contain prehistoric materials. We placed an additional test unit (TU22) in the grid on a spot without a magnetic anomaly but with a concentration of lithic scatter on the surface. MacDonald and Livers (2011) note that this excavation yielded a ‘possible feature’, a circular dark black soil stain with a few fire cracked rocks at a depth of about 60 cm. Magnetic anomalies from such sources would likely yield signals too small for detection within the background noise.

Within site 48YE1558, as in others, while the results

![Image](image.png)
from magnetic exploration are positive they definitely demonstrate the difficulty of having a mix of glacial erratics, drop stones, and fluvial material in the subsurface. These same materials are used for building ancient cultural features and containing ephemeral campfires. All magnetic anomalies have sources, but it remains difficult to separate natural and cultural sources in these conditions. As noted by MacDonald and Livers (2011), in this site the magnetometry work produced a feature-identification rate of 37.5% when only ancient cultural results are considered as positive. From an exploration and anomaly identification standpoint, isolating the signature of any subsurface source can be considered positive as well. Throughout 48YE1558, ten test units were placed outside of magnetic grids or within a grid but not on an anomaly. Only one of these, TU13, between the northern and central magnetic grids yielded a feature (MacDonald and Livers 2011). This success rate of 37.5% is consistent with our results in other sites around Yellowstone Lake.

**Site 48YE380 (Lake Pump Station Site)**

Site 48YE380, also known as the Lake Pump Station Site (Hoffman 1961), is approximately 150 m east of Lake Lodge on a small point along the lakeshore. It sits on an S1 terrace dating to about 7,000 BP (Pierce et al. 2007). Numerous studies have excavated hearths and other features, all of which span the Late Archaic period between 3,000 and 1,500 BP (Sanders, this volume; MacDonald, this volume). Many of the previously excavated features, as well as some recently exposed features, are along the lake edge and most of the site is within a small grove of lodgepole pines along the lake shore. Therefore, we only collected magnetic data on

![Figure 8. Analytic signal from the northern most magnetic grid in 48YE1558; darker shading denotes higher amplitude. Meter Scale.](image)
one small (250 m²) grid (Figure 9). The filtered anomalies from this grid are readily apparent and consistent in that they form a strong linear trend from southwest to northeast and clearly mark historic construction as the trend points directly at the historic location of the pump house. The anomaly marked by the ‘X’ is characteristic of a reversely magnetized metal post or pipe. Given this historic disruption we did not excavate within this magnetic grid.

Site 48YE1556

This site shares a characteristic with the previous (48YE380) in that not all of our magnetic investigations provided direct positive results with respect to archaeological excavation. Rather, some results were positive in the sense that they provided evidence of significant historical disruption. Such disruption can lead one to exclude a site from further consideration for listing on the United States National Register of Historic Places.

At Site 48YE1556 we collected about 1,250 m² of total field magnetics (Figure 10) on an S6 terrace (~14,000 BP) which only revealed the existence of historic disruption due to old sewer lines and probable septic drain fields. Thus these results are negative in the sense of locating prehistoric features but positive in that they characterize the subsurface and still guide excavation. We chose not to put test units in the historically disrupted areas marked by the rectangles in Figure 10. Rather, we placed five test units in the eastern (right) ten meters of the grid where there are no meaningful anomalies; those test units yielded no features.

On Figure 10 the marked rectangles around rectilinear anomalies highlight relatively deep-sources; the source beneath the dashed rectangle, with its lower gradient and amplitude anomaly, is probably deeper than that beneath the solid rectangle. The solid line marks a probable trench leading to those rectilinear sources. Debris piled during excavation of the trench probably caused the large magnetic highs symmetrically across the line towards the western (left) edge of the grid.

The relatively shallow and deep sources beneath the rectangles marked on Figure 10 provide a convenient example regarding the benefits of total field magnetics versus collecting the gradient of the vertical component as discussed earlier in this paper. Typically in magnetic exploration we seek buried sources and hope to delineate the edges of those sources and their depths. Calculating and comparing the analytic signal (Roest et al. 1992) and/or horizontal gradient (Blakely and Simpson 1986) of TMI or the pseudogravity transformation

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**Figure 9.** Total magnetic intensity from grid near the Lake Pump Station site; contour interval is 2.5 nT. Dashed Line and “X” likely indicate Modern/Historic Disturbances.
(Baranov 1957) of TMI typically provides good edge detection for source location. For shallow sources, in-the-field edge detection using the vertical gradient of TMI is also common and valuable (e.g. Aspinall et al. 2008). That is among the reasons that vertical gradient magnetometers are often used in archaeological surveys.

To demonstrate the loss of resolving power for deeper sources when measuring the vertical gradient rather than the total field anomaly, we calculated (Pedersen et al. 1990) the vertical component of magnetization for two upward continuations (Blakely 1995) of the TMI to 0.25 meters and 0.75 meters above the observation surface, respectively. This calculation simulates the common setup of a vertical gradient magnetometer (e.g. Aspinall et al. 2008). Differenting those vertical components yields the vertical gradient (Figure 11) expressed in nT/m. The vertical gradient (Figure 11) clearly helps delineate the trajectory of the trench going into the rectilinear area. The cost of that delineation is the degradation of resolution of the shallower rectilinear source shown by the solid rectangle on Figure 10 and the near total loss of signal from the deep source marked by the dashed rectangle on Figure 10. Normal sedimentation and turf buildup suggests that ancient cultural sources buried deeply in the older terraces would be missed with a vertical gradient magnetometer survey.

Summary

This study was one of exploration rather than an attempt to provide total field magnetic data for 100% of the area. Thus, we sought valuable results within timing and funding constraints that would improve the productivity of archaeological test units. The approach proved successful.

The targets in mind while designing our geophysical surveys along the northwest shore of Yellowstone Lake included temporary campsites, small ephemeral surface hearths, larger roasting pits, stone rings (tipi rings), and the like. We used a hierarchical approach, starting with close-interval (ca. 2-3 meter) pedestrian surveys followed by more detailed observation, and then siting limited grids for the acquisition of total field magnetic observations. In one case we also had sufficiently open ground to cover part of the magnetic grid with GPR observations.

The resultant seven magnetic grids in four sites were quite positive in locating anomalies for excavation and yielding cultural or natural sources. Note that while many test units recovered lithic fragments, sometimes in high
concentration, those would rarely create detectable anomalies. In 48YE380 the magnetic grid showed a historic trench (no longer apparent on the surface) trending to the sewer pump house; we avoided excavation in this grid. In 48YE381 in two magnetic grids, four of ten test units sited on magnetic anomalies revealed hearths, four yielded subsurface boulders (one of which showed cultural use), and two test units were placed adjacent to anomalies. In 48YE1556 the magnetic grid revealed the location of historic disruption from historic septic facilities; we avoided excavation in this area. However, we did site five test units in the grid north of the disruption. These lacked magnetic anomalies and revealed no cultural features. The northern grid in 48YE1558 lacked any archaeologically compelling anomalies; test units confirmed that interpretation. However the southern two grids in 48YE1558 revealed cultural features, mainly hearths, in four of ten test units sited on magnetic anomalies. Four of the remaining tested anomalies revealed naturally distributed subsurface rocks, while two were placed adjacent to anomalies and revealed no additional sources. Throughout the magnetic grids, we found no buried stone rings nor roasting pits, though some rock concentrations may result from their construction. Perhaps stone ring material is commonly recycled forward in time and upward in stratigraphy.

Our hierarchical method, comprised of pedestrian survey, then siting geophysical grids in areas of high surface scatter, followed by excavation of archaeological test units successfully contributed to delineating archaeological resources and ascertaining the cultural history of Yellowstone National Park (MacDonald and Livers 2011). After excavating test units at selected magnetic anomalies about 40% of those excavations yielded cultural material with most of the remaining sources being glacial erratics or occasional historic ferromagnetic materials. Other results rejected sites or excavation due to historic disruption. Of course, all magnetic anomalies have sources; the glacial erratics around Yellowstone Lake produce anomalies similar to those of the ephemeral hearths we seek. In the case of the feature we call “furniture rock” a buried glacial erratic with a magnetic anomaly characteristic of such a source proved to be a nice lakeside seat for flaking and other camp chores.

The general magnetic exploration and processing protocol we use is adapted from common techniques.
used during aeromagnetic exploration for energy and minerals (e.g. Reeves 2005). We acquire TMI data at 10 Hz while walking bidirectional transects separated by one meter. These data are then decorrugated and separated into shallow and deep equivalent magnetic layers (Sheriff 2010). Following separation, the analytic signal (total gradient), horizontal gradient, and vertical gradient all contribute good edge detection and further insight into the source characteristics. At times, those results are suitable for depth estimate or inversion for the shape of the subsurface source. We base final decisions on placing test units on the sum of the results and visualizations.

Acknowledgements

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References Cited


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CHAPTER 13
HUNTER-GATHERER USE OF AMERICA’S HIGHEST, LARGEST LAKE: COMPARATIVE ANALYSIS OF DATA FROM 27 PREHISTORIC ARCHAEOLOGICAL FEATURES AROUND YELLOWSTONE LAKE

Douglas H. MacDonald

Introduction
Archaeological features provide important information that capture specific moments in time in the past. At Yellowstone Lake, Wyoming, features largely reflect the short-term use of hearths and cooking features by mobile hunter-gatherers exploiting the lake’s abundant resources in a variety of subsistence activities (MacDonald et al. 2012). By analyzing artifacts associated with features, archaeologists can capture a picture of hunter-gatherer life at specific moments in time.

In this paper, we present data from 27 prehistoric features identified on the shores of Yellowstone Lake between 2009-2011 by the University of Montana (UM) and Yellowstone National Park (YNP). In the next chapter, Gish takes an in-depth look at the pollen and ethnobotanical remains at these sites. The features were identified during archaeological survey and National Register evaluations of 153 sites (Figure 1), including 18 on the northwest shore (MacDonald and Livers 2011; Livers and MacDonald 2011), 52 on the east shore (Livers and MacDonald 2012), and 83 to date on the south shore (MacDonald 2012) (Table 1). These studies were focused on the determination of eligibility of the sites for listing on the National Register of Historic Places (NRHP). UM continued this research on the south shore in 2012, identifying an additional four prehistoric features; however, analysis of data associated with these features is on-going and not included in this paper (although Gish covers them in the next chapter). Test excavations will be completed on the south shore in 2013.

Between 2009-2011, UM and YNP excavated 171 test units and identified 27 prehistoric features from 12 hunter-gatherer camps situated around the lake. UM collected a variety of artifacts from feature contexts, with results of those analyses presented here. The main type of artifact recovered at the sites are stone tools and the debitage from their manufacture. UM’s work at the lake between 2009-2011 has yielded 22,131 lithic artifacts, including 96 diagnostic projectile points dating to the Paleoindian (n=8), Early Archaic (n=5), Middle Archaic (n=17), Late Archaic (n=33), and Late Prehistoric periods (n=33). Obsidian dominates lithic assemblages on the northwest, northeast and southwest shores, while various Absaroka cherts dominate assemblages on the southeast shore (MacDonald et al. 2012).

As the main focus of this paper, UM describes and interprets archaeological data recovered in association with the 27 features to sketch diachronic—geographic and chronologic—trends regarding hunter-gatherer use of the lake in prehistory. This paper provides summary descriptions of the 27 features, radiocarbon dating results, lithic analysis results, x-ray fluorescence (XRF)-source data, as well as subsistence data, including ethnobotanical/pollen, organic-residue (FTIR), and protein-residue analyses results. Each prehistoric feature represents an event of hunter-gatherer use, with the associated artifacts providing data on specific activities conducted at that point in time. Based on data recovered in association with these features, it is clear that hunter-gatherers differentially utilized the various areas of the lake, with some chronological variation as well.

Data for the paper are summarized here from technical reports written by UM for YNP in four major areas of the lake with high densities of archaeological sites, including the northwest shore (Livers and MacDonald 2011; MacDonald and Livers 2011), the northeast shore (Livers and MacDonald 2012; Livers 2012; McIntyre and Sheriff, this volume; McIntyre et al., this volume), the southeast shore (Livers and MacDonald 2012), and the southwest shore (MacDonald 2012).
Table 1. Summary Results of UM Studies in the Various Lake Shores between 2009-2011.

<table>
<thead>
<tr>
<th>Project</th>
<th>Lake Area</th>
<th>Sites</th>
<th>Test Units</th>
<th>Features</th>
<th>Lithics</th>
<th>Lithic Density n/m²</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Lodge</td>
<td>Northwest</td>
<td>11</td>
<td>67</td>
<td>14</td>
<td>10,970</td>
<td>163.7</td>
<td>MacDonald and Livers 2011</td>
</tr>
<tr>
<td>Fishing Bridge</td>
<td>Northwest</td>
<td>7</td>
<td>14</td>
<td>4</td>
<td>4,295</td>
<td>306.8</td>
<td>Livers and MacDonald 2011</td>
</tr>
<tr>
<td>East Shore</td>
<td>Eastern</td>
<td>52</td>
<td>60</td>
<td>4</td>
<td>6,281</td>
<td>104.7</td>
<td>Livers and MacDonald 2012</td>
</tr>
<tr>
<td>South Shore’11*</td>
<td>Southern</td>
<td>83</td>
<td>30</td>
<td>5</td>
<td>585</td>
<td>19.5</td>
<td>MacDonald 2012</td>
</tr>
<tr>
<td>Total</td>
<td>Southern</td>
<td>153</td>
<td>171</td>
<td>27</td>
<td>22,131</td>
<td>129.4</td>
<td>--</td>
</tr>
</tbody>
</table>

*fieldwork will finish in 2013; UM also excavated 53 sites in 2012, yielding four additional features, not included in this analysis.
Background

As described by Livers and Hale (Chapter 1, this volume) and McIntyre and Sheriff (Chapter 12, this volume), Yellowstone Lake is North America’s largest, high-elevation, natural lake and was used extensively during prehistory by Native Americans from the north, south, east and west (MacDonald et al. 2012). The lake measures approximately 20 miles long (north-south) and 15 miles wide (east-west).

To date, 285 sites have been identified around the lake, with 175 dateable occupations (Figure 2; McIntyre 2012). These sites cluster strongly within four areas discussed in this paper, including: 1) northwest shore—18 features from five sites—near the outlet of the Yellowstone River; 2) northeast shore in the Clear Creek Valley, 3 features from two sites; 3) southeast shore near the inlet of the Yellowstone River, 1 feature; and 4) southwest shore, 5 features from four sites. As show in Figure 2, all areas of the lake shores were utilized in the past, with dense clusters of activity on the northwest, northeast, and southwest shores.

While access to the associated creek valleys was important for placement of camps during prehistory, McIntyre (2012) has shown that stream confluences with

![Figure 2. Distribution of Prehistoric Archaeological Sites at Yellowstone Lake (McIntyre 2012).](image-url)
the lake were of secondary importance to the meadows and riparian habitat that provided abundant resources for hunter-gatherer populations and their prey (Elliot and Hektner 2000). Areas of the lake that lack these open settings are deficient in prehistoric sites, especially the middle portions of both the eastern and western shores (Figure 2).

Several prior studies have been conducted around the lake, as summarized by Livers and Hale (this volume), but in-depth feature studies are rare. On the northwest shore, previous studies identified prehistoric features at 48YE380 near Lake Lodge (summarized in MacDonald and Livers 2011) and at 48YE1 at Fishing Bridge (Cannon et al. 1993), while on the northeast shore, Cannon et al. (1997) investigated the Windy Bison Kill (48YE697; Cannon and Hale, this volume). On the southeast shore, investigations at the Donner Site (48YE252) by Lifeways of Canada (Vivian 2009; Park, this volume) also identified features and associated lithics. Finally, on the southwest shore, Johnson et al. (2004; Johnson and Reeves, this volume) investigated the Osprey Beach Site (48YE409/410) and Cannon et al. (1996; Cannon and Hale, this volume) studied several sites on the northern portion of the West Thumb, including 48YE449 and 48YE652. Two additional sites around the lake have yielded features which were salvaged by Yellowstone, including 48YE246 on Solution Creek and 48YE449 on Arnica Creek, although resulting data have not been publically disseminated (Ann Johnson, personal communication, 2012).

These various studies have provided an outstanding baseline of information regarding use of Yellowstone Lake; however, few of them focused on feature descriptions and analysis of contents. In particular, none of the prior studies conducted XRF source analysis for lithics from features, instead focusing on XRF sourcing of tools and projectile points. Also, prior to the current study, no ethnobotanical data have been publically disseminated from features at Yellowstone Lake.

The current paper provides additional lithic and ethnobotanical data regarding prehistoric features which lend insight into Native American subsistence, land-use, and stone tool use. As we discuss below, Hughes (2010a, 2010b, 2011a, 2011b, 2012a, 2012b) XRF-sourced a total of 489 lithics collected by UM, including 270 from the 27 radiocarbon-dated features. In addition, each prehistoric feature was analyzed for ethnobotanical contents, with a select sample queried for pollen and organic residue (FTIR). The remainder of this paper summarizes the features by type/morphology, age, subsistence remains, and lithic analysis in order to characterize use of the lake in the past by Native American hunter-gatherers.

**Yellowstone Lake Feature Types and Chronology of Use**

The 27 features studied by UM and YNP for the current study can be grouped into two types, surface hearths (n=18) and basin-shaped features (n=9) (Table 2). These types reflect their morphology, location, and use-type. At Yellowstone Lake, UM excavated 18 surface hearths from sub-surface contexts at seven sites (Photograph 1). Surface hearths were excavated from sub-surface contexts, but were constructed and used in prehistory without subsurface excavation; thus, we call them surface hearths. These features have the following traits: 1) no sub-surface depth; 2) built on the ground surface during use; 3) low numbers (<20) of clustered rock and fire-cracked rock (FCR); 4) minimal burned earth and only slight sediment discoloration; 5) minimal charcoal (typically small enough fragments to require accelerator mass spectrometry—AMS—dating); 6) generally circular to semi-circular; and 7) 30-70 cm in diameter. We interpret these ephemeral features to be the remains of small, short-term cooking and heating hearths used only briefly by hunter-gatherers at the lake (ca. 1-2 days at most).

In addition to the 18 surface hearths, UM excavated nine basin-shaped features at six sites (Photograph 2). Basin-shaped features have the following characteristics: 1) 10-30 cm depth; 2) basin-shaped with wide, u-shaped, tapering-at-the-rim profiles; 3) 50-100 cm in diameter; 4) circular; 5) distinctive staining from burning/heating; 6) dense concentrations of charcoal, both under and between rocks; and 7) densely packed with cobbles and FCR. These features are interpreted to be either rock-heating pits from which rocks were removed and used in nearby (but unidentified) boiling pits or, alternatively, as longer-term (or higher-intensity) roasting pits or hearths. Given the lack of identified boiling pits associated with any of the features, we prefer the second interpretation, that the basin features are roasting pits or intensive cooking/heating hearths.
As shown in Table 2 and Figure 1, surface and basin features are ubiquitous across the various portions of the lake, with no discernible regional patterning. For example, in the northwest area, 18 features were identified, including 15 surface hearths and three basin features. In the northeast and southeast, all four features are basin-shaped, while there is a fairly even split in the southwest (two basin, three surface). Features seem to have been constructed and used to suit the need of the user, likely related to subsistence activities.

**Feature Age, Morphology, and Function.** Fortunately, each of the 27 features yielded sufficient quantities of charcoal for use in AMS dating. With the widespread abundance of pines at Yellowstone Lake, it is no surprise that pine charcoal was the ubiquitous type submitted for dating in each feature. Charcoal identifications were conducted by splitting samples from features, with one
portion submitted to the ethnobotanist (Gish 2010, 2011; Parker 2009) for identification and the other portion submitted for dating by Beta Analytic, Inc.

Figure 3 shows each of the 27 feature dates in chronological order from most recent (left) to oldest (right). Feature data are also summarized in Table 2. Basin-shaped hearths date exclusively to the Late Archaic to Late Prehistoric period transition, or between approximately 770-1910 uncalibrated radiocarbon years BP (BP). Surface hearths range in age from the recent Late Prehistoric period (ca. 200 BP) to the more ancient Early Archaic period (ca. 6,000 BP).

As shown in Figure 3, 26 of the 27 UM features post-date 3,400 years ago BP, including four Middle Archaic.

Table 2. Summary of Yellowstone Lake Features in this Study.

<table>
<thead>
<tr>
<th>Site</th>
<th>Feature #</th>
<th>Feature Type</th>
<th>Age</th>
<th>Uncal C14 age</th>
<th>Cal early</th>
<th>Cal late</th>
<th>Beta #</th>
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<td>1</td>
<td>basin</td>
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<td>1910±40</td>
<td>1940</td>
<td>1740</td>
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<td>286000</td>
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<td>48YE1558</td>
<td>5</td>
<td>surface</td>
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<td>1290</td>
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<td>2300</td>
<td>2000</td>
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<td>1140</td>
<td>265312</td>
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<td>4</td>
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<td>1720</td>
<td>1540</td>
<td>265305</td>
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<td>2950</td>
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<td>510</td>
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<td>2290±30</td>
<td>2350</td>
<td>2200</td>
<td>305260</td>
</tr>
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</table>
12 Late Archaic, and nine Late Prehistoric (Figure 4). The only earlier date is for the Early Archaic—ca. 6,000 BP—feature (Feature 12) at Fishing Bridge Point on the lake’s northwest shore (MacDonald et al. 2011). These feature dates generally resemble site ages for the lake as a whole, as compiled by McIntyre (2012; McIntyre and Sheriff, this volume). The feature ages also compare well with UM’s own projectile point data (n=96) which show remarkably similar age distributions to the features (Figure 4).

Clearly, the period from 3,400 to 300 BP was an intensive period for Yellowstone Lake prehistory. As shown in Figure 3, there is a nearly continuous succession of occupations around the lake during this time, with few if any breaks. While the Late Archaic period is dominant—12 features and 33 projectile points—compared to all other periods, substantial occupation continued into the Late Prehistoric period (n=9 features and 33 projectile points), while earlier occupations are scarce. Nevertheless, while few features predate 3,400 BP, diagnostic projectile points are recovered at sites from the Middle and Early Archaic, as well as the Paleoindian, periods around the lake. Certainly, occupations such as Osprey Beach, while lacking prehistoric features, shows active use of the lake by 9,000 BP and thereafter (Johnson et al., this volume). Based on the surveys conducted by Lifeways (2007) and UM discussed herein, we expect that other prehistoric features are present at sites that date to these earlier time periods, but simply remain unidentified due to the limited testing that many of these sites have experienced.

Subsistence and Feature Function

While the features generally contain ethnobotanical remains, charcoal, and lithic debris, none of the features at the lake yielded faunal remains, likely due to the highly-acidic soils which increase rates of decomposition. The lack of faunal remains precludes our ability to identify hunted resources that might have been used in the features. While not exclusively from feature contexts, various lithic artifacts have been subjected to protein-residue analyses from the lake area sites. As discussed elsewhere (MacDonald et al. 2012), deer (n=6 sites), bear (n=5), rabbit (n=4), cat (n=3), bovine/bison (n=3), sheep (n=3), dog (n=2), and rat/guinea/squirrel (n=2) have been identified on lithic artifacts from lake-area sites (by UM and others), certainly confirming the importance of hunting in the subsistence regimes of Native American hunter-gatherers at the lake. For example, a large cutting tool found in association with the Early Archaic hearth at 48YE381 yielded evidence of bovine protein, while a Late Prehistoric point found in the feature of the same age at 48YE1553 yielded evidence of deer protein (MacDonald and Livers 2011).

Thus, while it is clear that hunting was an important
aspect of hunter-gatherer subsistence at the lake, those data are not informative as to feature function. Fortunately, analysis of ethnobotanical contents provide significant data to facilitate interpretation of feature uses (Figure 5). The nine basin features contained significantly greater amounts of ethnobotanical remains, as identified by Gish from pollen and soil samples (2010, 2011; this volume), including goosefoot (cheno-am), sunflower, sagebrush, grasses, pine, ash, aspen/willow, and dwarf mistletoe. The surface features contained significantly less identifiable macrobotanical remains, including pine and aspen/willow charcoal, as well as wild buckwheat, with the latter the only identified plant remains likely used in subsistence in the surface features.

In addition to the ethnobotanical analysis of feature soil samples, organic-residue analysis (Fourier Transform Infrared Spectroscopy, or FTIR) was conducted on FCR from four of the basin features by PaleoResearch (Logan and Cummings 2011). These results indicate the possible processing of balsamroot, wild onion, prickly pear cactus, sunflower, pine (nuts?), and grasses within four of the basin features.

Based on the FTIR and ethnobotanical analyses, the surface and basin features served different purposes. Surface features generally contain small amounts of pine wood fuel for fires, with edible plant remains largely absent. In contrast, basin features contain both wood charcoal for fuel, as well as plant remains likely used in subsistence, including balsamroot, wild onion, sunflower, goosefoot, pine (nuts?), and grasses.

**Lithic Analysis of Feature Artifacts**

Lithic analysis of artifacts recovered from feature contexts is informative as to specific activities associated with features. We compare lithic types among the features to ascertain aspects of camp life and lithic manufacture. We focus upon lithic material use between the various features, lake areas, and over time to see how material use and settlement patterns vary by region and period of use.

As noted above, Hughes conducted EDXRF analysis of 489 lithic artifacts collected by UM at the lake, including 270 found in association with the 27 features (Figure 6). Feature lithics are mainly flaking debris from stone tool manufacture. Here, we provide those data, as well as other material indices, to account for lithic raw material use around the lake.

These data are informative as to prehistoric Native American settlement patterns at Yellowstone Lake over time and space. We discuss results of analysis in each of the four lake areas, beginning in the northwest and proceeding clockwise around the lake to the northeast, southeast, and southwest areas.

As shown in Figure 7 below (also see Table 1), the northwest lake shore was the major focus of UM activity due to its high density of archaeological sites and potential impacts from modern use. UM recovered 15,265 lithics from sites on the northwest shore, while 6,281 lithics were recovered on the east shore. The lithic data from these northern shores show intensive use compared to the south shore (n=585 lithics), the reasons for which are discussed extensively elsewhere (MacDonald et al. 2012). To summarize those findings, it is clear that access to lithic sources on the north shore facilitated active lithic production, while limited access to lithic resources promoted curation and stone conservation for hunter-gatherers on the south shore.
Proximity to Obsidian Cliff on the north shore drove this increased stone tool production and use, as did the proximity to two of the main travel routes used in prehistory, the Yellowstone River and Clear Creek.

Northwest Shore Features and Lithic Use

The northwest shore was the focus of intensive prehistoric use, resulting in abundant lithic data by which to characterize settlement patterns and stone tool use. Overall, the 18 northwest shore features and associated artifacts from the five sites show intensive use of obsidian compared to chert, a trend that is consistent over time (Figure 8). Among the obsidian and chert artifacts, Obsidian Cliff and Crescent Hill varieties dominate northwest shore assemblages, respectively. Both of these sources are located approximately 20 miles north of the northwest shore sites. As with the Gardiner Basin to the north (Adams et al. 2011; MacDonald and Maas 2011), Obsidian Cliff was preferred due to its high quality, abundance, and knappable morphology compared to Crescent Hill chert.

<table>
<thead>
<tr>
<th>Period</th>
<th>Obsidian</th>
<th>Chert</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late Prehistoric</td>
<td>12.8</td>
<td>87.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late Archaic</td>
<td>18.9</td>
<td>81.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle Archaic</td>
<td>16.7</td>
<td>83.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early Archaic</td>
<td>12.2</td>
<td>87.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 8. Lithic Raw Material Use, Prehistoric Features, Northwest Shore Sites excavated by UM, 2009-2010.

Generalized lithic raw material data indicate a heightened reliance on obsidian during use of all features on the northwest shore, with Late Prehistoric (87.2%) and Early Archaic (87.8%) Native Americans preferring it more so than their Middle and Late Archaic counterparts. Other materials—including Crescent Hill Chert, untyped chert, chalcedony, petrified wood, quartz, and quartzite—comprise between 12.2 and 18.9% of the dated feature artifacts from northwest shore features, with more use of those other materials during the Middle and Late Archaic Periods. In general, lithic raw material use patterns are very similar between all occupations, but especially so between the Middle and Late Archaic, a pattern also observed by Park (2010, 2011) for Yellowstone sites.

Just as obsidian use increased over time (with a peak in the Late Prehistoric Period), use of Obsidian Cliff as a primary source increased as well, as reflected below in Table 3 and Figure 9. These data are for 176 XRF-sourced lithics from the dated features at UM’s northwest shore. Obsidian Cliff use peaked during the Late Prehistoric Period, comprising approximately 96% of the sourced artifacts from features (Figure 9, top). Lithics from western sources, including Cashman Dacite and Bear Gulch Obsidian, decreased over time. These western sources comprise only 4.4% of the Late Prehistoric volcanic assemblage, compared to 7.8% during the Late Archaic. Eastern and southern sources occur only in the dated Middle Archaic features; otherwise, they are absent in features dated to the Early Archaic, Late Archaic, and Late Prehistoric Periods. As a result, western sources are overwhelmingly reflected in non-Obssidian Cliff volcanic counts from dated feature contexts at sites on the northwest shore of Yellowstone Lake.

Eastern Shore Lithic Raw Material Use

As with the northwest shore, the eastern shore of the lake—in particular, the northeast and southeast shores—also experienced active use in prehistory. UM excavated four prehistoric features at three sites on the east shore, as well as recovering 6,281 lithics from 52 sites. The four features date to the transitional Late Archaic-Late Prehistoric period, between 1220 and 1500 conventional radiocarbon years B.P. Table 4 provides the results of XRF analysis of lithics from the three sites with features on the east shore. Sites 48YE2075 are on the northeast shore, while 48YE1499 is on the southeast shore. The northeast and southeast shores are separated by nearly 20 miles of shoreline.

In terms of overall lithic material use on the eastern shore, chert comprises 40.3 percent (n=2,532) of eastern shore lithics, while Obsidian Cliff obsidian (33.2%; n=2,082) and Park Point obsidian (26.5%; n=1,667) are
also well-represented (Livers and MacDonald 2012). While these are hand-identifications, they were randomly XRF-checked, with a 99% accuracy rate in hand-distinguishing Obsidian Cliff obsidian from Park Point at sites on the eastern shore of Yellowstone Lake. We have found no other portions of the lake where hand-identification of obsidian is reliable, given the wide variety of obsidians available in the north, west, and southern parts of the lake. However, on the east shore, Obsidian Cliff and Park Point obsidians appear to have been almost exclusively the only two obsidian materials used during prehistory, especially in the Clear Creek drainage. Refer to Chapter 3 of this volume for more information on Park Point obsidian.

UM submitted a total of 136 lithics for XRF sourcing for eastern shore sites, including 32 from the three sites with features, as shown in Table 4. Of the 25 sourced lithics from the Late Archaic features on the northeast lake shore, 15 are from the local Park Point obsidian source (McIntyre et al., this volume), while ten are from Obsidian Cliff. No other sources of obsidian are represented in the Late Archaic northeast shore features, indicating a very restricted range of material use.

On the southeastern lake shore, the lone feature is a Late Prehistoric surface hearth from 48YE1499. Only seven volcanic lithics were recovered in association with the feature, but they show considerably more diversity than northeast lake shore results. Two Obsidian Cliff and two unknown dacite lithics indicate northern origins, as does the single Bear Gulch obsidian flake. One Teton Pass and one unknown source were also identified at 48YE1499. These lithics do not provide a fair representation of regional use due to the low overall amounts of obsidian in the southeastern shore assemblages. As we’ve shown elsewhere (MacDonald et al. 2012), Obsidian Cliff comprises only 6 percent of the

**Figure 9. Comparative Use of Obsidian Cliff and Volcanics from Other Regional Sources for XRF-Sourced Lithics, UM Radiocarbon Dated Northwest Shore Features.**

Table 3. Summary XRF Results, Northwest Shore Yellowstone Lake Sites (only artifacts associated with radiocarbon dated features).

<table>
<thead>
<tr>
<th>Age</th>
<th>Bear Gulch</th>
<th>Cashman</th>
<th>Crescent H</th>
<th>Unk. dacite</th>
<th>Obsidian Cliff</th>
<th>Teton Pass</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Archaic</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>20</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>Middle Archaic</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>32</td>
<td>1</td>
<td>35</td>
</tr>
<tr>
<td>Late Archaic</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>47</td>
<td>0</td>
<td>51</td>
</tr>
<tr>
<td>Late Prehistoric</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>65</td>
<td>0</td>
<td>68</td>
</tr>
<tr>
<td>Total</td>
<td>6</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>164</td>
<td>1</td>
<td>176</td>
</tr>
</tbody>
</table>
origin for materials used by Native Americans, since obsidian accounts for such a small overall percentage.

Southwest Shore Lithic Material Use

UM conducted an archaeological investigation of 83 sites along the south shore of Yellowstone Lake in 2010-2011, yielding 585 prehistoric artifacts, while excavating five prehistoric burn features at four sites. As discussed above, lithic densities on the south shore are very low, with only approximately 20 lithics per square meter recovered compared to 188 on the north shore. Southwest shore features range in age from 1330-2290 BP. Based on the five radiocarbon-dated features, as well diagnostic projectile points, the predominant period of use was the Late Archaic and Late Prehistoric periods. However, artifacts from the Late Paleoindian, Early Archaic, and Middle Archaic were also collected at south shore sites. Each of the 2011 south shore features is a small (40-75cm in diameter) heating and or cooking hearth that used pine and occasionally other woods as fuel for short-term camp fires. We characterize the two features from 48YE1660 as basin features and the remaining three features as surface hearths.

In contrast to the east shore, obsidian is the dominant material in the southwest shore features, accounting for 61.6 percent (n=53) versus 38.4 percent for chert (n=33) and other materials (Table 5). However, there is significant variability in lithic material use between the three Late Archaic features and the two Late Prehistoric features. The Late Prehistoric features from 48YE2190 and 48YE1384 yielded 12 obsidian/dacite artifacts and 19 chert/other artifacts versus only 13 chert and 41 obsidian for the three Late Archaic features from 48YE1383 and 48YE1660. These differences in lithic raw material use between the Late Archaic (>1500 BP) and Late Prehistoric features (<1500 BP) on the southwest shore are significant (x^2=11.62; df=1; p=.001). Southwest shore features also show very different trends in material use from the northwest shore features which showed an increasing preference for obsidian over time.

These differences between Late Archaic and Late Prehistoric features denote possible chronological

<table>
<thead>
<tr>
<th>Site/Feature</th>
<th>Age</th>
<th>obsidian/dacite</th>
<th>obs%</th>
<th>Chert/other</th>
<th>other %</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1383</td>
<td>2290</td>
<td>11</td>
<td>91.7</td>
<td>1</td>
<td>8.3</td>
<td>12</td>
</tr>
<tr>
<td>1660/F.1</td>
<td>1850</td>
<td>11</td>
<td>78.5</td>
<td>3</td>
<td>21.5</td>
<td>14</td>
</tr>
<tr>
<td>1660/F.3</td>
<td>1690</td>
<td>19</td>
<td>67.9</td>
<td>9</td>
<td>32.1</td>
<td>28</td>
</tr>
<tr>
<td>2190</td>
<td>1410</td>
<td>7</td>
<td>43.8</td>
<td>9</td>
<td>56.2</td>
<td>16</td>
</tr>
<tr>
<td>1384</td>
<td>1330</td>
<td>5</td>
<td>33.3</td>
<td>10</td>
<td>66.7</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>53</td>
<td>61.6</td>
<td>33</td>
<td>38.4</td>
<td>100.0</td>
<td>86</td>
</tr>
</tbody>
</table>

Table 4. Summary of XRF Analysis Results, Eastern Shore Features.

<table>
<thead>
<tr>
<th>Site</th>
<th>Ob. Cliff</th>
<th>Park Point/Lava Crk</th>
<th>Bear Gulch</th>
<th>Teton Pass</th>
<th>Lava Creek</th>
<th>Unk. Dacite</th>
<th>Unknown</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>48YE2075</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>15.6</td>
</tr>
<tr>
<td>48YE678</td>
<td>7</td>
<td>13</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>20</td>
<td>62.5</td>
</tr>
<tr>
<td>48YE1499</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>7</td>
<td>21.9</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>15</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>32</td>
<td>100.0</td>
</tr>
<tr>
<td>%</td>
<td>37.5</td>
<td>46.9</td>
<td>3.1</td>
<td>3.1</td>
<td>3.1</td>
<td>6.2</td>
<td>3.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5. Summary of Lithics from 2011 Features, Southwest Shore.
variation in material use between individuals on the southwest shore (Table 6). EDXRF results supply additional information by which to evaluate material use between volcanic sources over time. In total, UM sourced 62 lithics found in association with the five dated features from the southwest shore sites. These sourced materials from the five features include 56 flakes, three bifaces, two unifaces, and one core. Of the 62 sourced lithics from the features, 45 (73%) are from Obsidian Cliff, nine (15%) are from southern sources, five are from Park Point (east; 8%), while three (5%) are from western sources.

For the two sites that post-date 1500 BP (2190/1384), 18 lithics were sourced from the features, with 10 from Obsidian Cliff, five from southern sources, one from a western source, and two from the east. For the three Late Archaic features, 35 are from Obsidian Cliff, four are from southern sources, two are from the west, and two are from the east. While Obsidian Cliff is the dominant material for both periods, these differences in Late Archaic and Late Prehistoric use of Obsidian Cliff versus the other regional igneous materials are significant. In the Late Prehistoric, Obsidian Cliff is reduced and there is more use of southern sources compared to the Late Archaic ($\chi^2=3.69; df=1; p=.05$). Overall, considering use of all lithic materials at the sites, Obsidian Cliff represents 34.3 percent of the southwest shore lithic assemblages. Again, as with lithic materials as a whole (including cherts), southwest shore lithics show increasing use of cherts and southern sources over time, with less use of Obsidian Cliff. This is a reverse trend to that observed in the northwest shore features.

Northern versus Southern Lithic Use

Comparison of flake counts, weights, and types between sites on the north and south shore sites indicates substantial differences in the organization of lithic technology. Toolkits indicate high material curation with little evidence of material procurement at South Shore sites. The overall lithic artifact count (ca. 20/sq.m) on the south shore is significantly less than the north shore (ca. 188/sq.m.). Mean flake weights for the two areas are also significantly different, with south shore flakes weighing 0.86g on average compared to 1.89g for north shore flakes. These flake data support the hypothesis that south shore hunter-gatherers used fewer lithics and produced smaller flakes, likely to conserve material in the face of the toolstone-depleted environment. The morphology of the material on the south shore also likely contributed to the small size of lithic artifacts. Most available local materials are very small (less than palm-sized) chert cobbles in the glacial beach gravels.

Production of tools from these local chert materials on the south shore of Yellowstone Lake ultimately yields small flakes when compared to those produced during Obsidian Cliff obsidian tool production (as is predominant on the northwest shore).

Another difference between the northwest and southwest shores is the greater percentage of final-stage shaping/pressure flakes on the southwest shore (51.7%) compared to biface-reduction flakes (48.3%) compared to the northwest shore (44.9% vs. 55.1%). While this difference is not significant at the .05 level ($\chi^2=2.145$; $p=.16$).

### Table 6. Summary of XRF-Sourced Lithics from Southwest Shore Features, Yellowstone Lake.

<table>
<thead>
<tr>
<th>Site/Feature</th>
<th>Age</th>
<th>O.Cling</th>
<th>Southern Sources</th>
<th>Western Sources</th>
<th>Eastern Sources</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1383</td>
<td>2290</td>
<td>10</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>1660/1</td>
<td>1850</td>
<td>9</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>1660/3</td>
<td>1690</td>
<td>16</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>18</td>
</tr>
<tr>
<td>2190</td>
<td>1410</td>
<td>8</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>1384</td>
<td>1330</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Total (n)</td>
<td></td>
<td>45</td>
<td>14.5</td>
<td>4.8</td>
<td>8.1</td>
<td>62</td>
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<tr>
<td>Total %</td>
<td>72.6</td>
<td>14.5</td>
<td>4.8</td>
<td>8.1</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Southern sources include Crescent H, Teton Pass, Packsaddle Creek, etc.; Western sources include dacite and Bear Gulch obsidian; Eastern sources include Park Point and Lava Creek.
df=1; p=.143), the overall ratio of biface-reduction flakes to shaping flakes is 0.93 on the southwest shore (more shaping flakes) compared to 1.23 on the northwest shore (with more biface-reduction flakes). These data suggest that bifaces and projectile points were in a more finished state by the time they reached the southwest shore compared to the northwest shore.

Finally, it is also clear that significantly greater numbers of biface-reduction and shaping flakes were produced at northwest shore sites (n=3,781) versus southwest shore sites (n=118), despite experiencing similar volumes of excavation. These data support those discussed above that tool production was a focus on the northwest shore, but not on the southwest shore in which tools were curated and carried beyond sites.

**Conclusion**

Analysis of feature contents provides insights into the use of Yellowstone Lake in prehistory. The 27 features excavated by UM yielded numerous lithics and ethnobotanical remains from the Early Archaic through Late Prehistoric periods. Overall trends in features indicate a heightened use of the lake between approximately 3,400 and 300 BP. While sites are present around the entire lake, the northwest and northeast shores experienced especially intense use, likely due to the proximity of both shores to Obsidian Cliff and to active travel routes, including the Yellowstone River and Clear Creek. Both surface and basin features are present at sites on all lake shores, with use likely associated with subsistence procurement. The basin features, in particular, are linked to plant procurement and processing (and probably game as well), while the surface features are likely associated with heating and short-term cooking/food processing.

Sites on the northwest shore show significant amounts of stone tool manufacture, while sites on the south shore indicate curation and preservation of stone tool kits in the face of lithic raw material deficiency. The extremely different lithic material use patterns between South Shore—few flakes from the high curation of material—versus the North Shore—lots of flakes produced from tool manufacture—supports the hypothesis that boats were not used by hunter-gatherers for transportation around the lake shore (MacDonald et al. 2012). Instead, pedestrian hunter-gatherers transported stone to the various lake shores. On the south shore, those hunter-gatherers curated and preserved stone, while on the north shore, they conducted extensive lithic production.

In addition to geographic trends in material use, chronological variation in material use is observed by comparing feature contents on the north and south shores of Yellowstone Lake. On the north shore, overall use of Obsidian Cliff obsidian increased over time, peaking in the Late Prehistoric period in which it represents greater than 95 percent of obsidian from features. In contrast, on the south shore, feature data indicate increased use of chert and southern obsidians over time at the expense of Obsidian Cliff obsidian. Obsidian Cliff obsidian represented 80 percent (n=35/44) of Late Archaic volcanic material feature contents on the south shore, compared to only 56 percent (n=10/18) for the Late Prehistoric period. These trends may indicate increased territorialization during the Late Prehistoric period, with northern-oriented hunter-gatherers staking a preferred claim for Obsidian Cliff. In turn, southern-oriented hunter-gatherers gradually decreased use of that material in preference for southern cherts and obsidians.

Yellowstone Lake was clearly a destination resort during prehistory for Native American hunter-gatherers. They began to visit the lake more than 9,000 BP and escalated that use quite intensively between 3,400 and 300 BP. As shown here, there are significant differences in the use of the various lake shores based on geography. In addition, chronological variation is observed through careful analysis of artifacts recovered from feature contexts at Yellowstone Lake. Future research should aim to better understand Paleolithic, Early Archaic, and Middle Archaic lake-area use to compliment the abundant data available from the Late Archaic and Late Prehistoric periods.

**Acknowledgements**

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CHAPTER 14
ARCHAEOBOTANICAL RESULTS
FROM PREHISTORIC SITES AT
YELLOWSTONE LAKE, WYOMING

By Jannifer W. Gish

Introduction
Archaeobotanical results are presented for 14 sites along Yellowstone Lake. The interpretations are then compared to results from two sites in Gardiner Basin, Montana (Gish 2010, 2011a), and also to another Gardiner area site, 24PA1081, which is included here and was not discussed in the earlier studies.

The sites along Yellowstone Lake can be divided into five areas roughly from north to south. Figure 1 shows approximate locations of each site. The northwest shore region includes: 48YE380, 48YE381, 48YE1558, and 48YE549. The first three of these occur west of the lake outlet, while 48YE549 lies to the east behind Fishing Bridge. Two sites occur along the northeast shore near Clear Creek: 48YE2075 and 48YE678. Along the southwest shore, 48YE1642 is located east of Breeze Point, while 48YE1660, 48YE2190, 48YE1384, and 48YE1383 occur between the West Thumb and Flat Mountain Arm. Site 48YE1332 is situated on the west shore of the South Arm. The remaining two sites: 48YE1588 and 48YE1499 occur along the Southeast Arm.

Archaeobotanical Techniques
Twenty-two pollen samples were analyzed from three of the sites in the lake outlet region, with two from 48YE380, 17 from 48YE381, and three from 48YE549 (Table 1) (Gish 2010). Previously, four pollen samples were analyzed from 24YE355 and two from 24YE357 in the Gardiner Basin (Gish 2010, 2011a). The chemical processing of all of the pollen samples was conducted at Northern Arizona University, Flagstaff, and follows the technique described by Smith (1998). This and the sample analysis techniques are discussed in detail in the Gardiner Basin study (Gish 2011a:107-108).

Briefly, in the analysis procedure, 200-grain pollen counts and scanning were conducted for all the samples, with large-fraction scanning for one sample from 24YE357 and four from 48YE381. Pollen aggregates were recorded during the counts and scanning. Aggregates are clumps of the same pollen type that can indicate local plant presence and/or direct introduction of plant parts into a context through cultural activities. Both quantity and size of the aggregates were recorded, with “a” meaning one aggregate, “b” indicating two-five aggregates, “c” signifying six to 10 aggregates, and “d” 11-25 aggregates. Hence, a designation such as Ar-8b(50) means that two-five aggregates of sagebrush (Artemisia) pollen were recorded during the count with the largest containing eight grains, and larger aggregates of up to 50 grains were seen in scanning.

Inferences about the ecological and ethnobotanic meanings of the pollen samples are based on high percentages of taxa and occurrences of aggregates. Where plant use is inferred, the taxon is considered to be “culturally enhanced.” This means that plants subsumed by the taxon are probably present locally but the pollen representation is higher, or aggregates larger or more common, than would occur naturally. Cultural activities can result in an overlay of modifications on the inferred natural pollen rain.

Twenty flotation samples and seven specimen identification samples were analyzed from sites along Yellowstone Lake, along with two flotation and five specimen identification samples from 24PA1081 (Table 2) (Gish 2010, 2011a, 2011b). Nineteen of the flotation samples were processed in the archaeological laboratory at the University of Montana (UMT) using standard bucket methods. One sample, FS 72 from 48YE380, was water-floated by students of the 2010 UMT Archaeological Field School at Yellowstone National Park using the same portable flotation equipment under the direction of this author. The remaining two samples: FS 24 from 48YE1332 and FS 20 from 48YE1642 were water-floated by this author using the portable equipment.
Before microscopic examination, the light fractions of the flotation samples were screened through 4.0 mm, 2.0 mm, 1.0 mm, 0.5 mm, and 0.25 mm sieves with the remainder caught in the pan of the sieve set. Each subfraction was weighed, and then all but the 0.25 mm and pan subfractions were sorted at 10X-20X magnification. The 0.25 mm subfractions were scanned only for small seeds, while the pan subfractions were not examined. The heavy fractions also were scanned rather than sorted. One exception to this procedure was FS 20 from 48YE1642 where the light fraction was not screened.

Figure 1. Map of Study Areas showing Approximately Site Locations.
before weighing due to the friable appearance of the wood charcoal.

Identifications of the plant remains and other materials were made at 20X-63X magnification. Counts of burned wood were obtained from remains in the 4.0 mm subfractions, although fragments in the 2.0 subfractions were incorporated, when necessary. With the exception of two samples (FS 158 from 48YE549 and FS 164 from 48YE1558), these wood counts varied from 10-50 pieces each. Abundances of other burned and unburned plants materials were found, along with small quantities of bone and flakes. Only the burned plant remains are presented here. In some instances, these materials were too abundant to count fully, and estimates were used. Estimates were obtained by spreading the material in the light subfraction evenly across a grid tray. The quantity of each plant item per square was counted for at least 30 squares, then averaged, and multiplied by the total number of grids covered by the subfraction. Hence, a needle fragment designation of “77(167)” means that 77 fragments were directly counted, with an estimated additional 90 in the sample. This technique was applied only to items in the 1.0 mm and 0.5 mm subfractions.

The specimen identification samples consisted of single or multiple items, which were weighed before microscopic examination. In a few instances, the samples included numerous pieces of burned wood, and only the largest were analyzed, although the remaining materials were scanned (Table 2).

**Archaeobotanical Taxa**

Over 50 plant taxa were identified in the pollen and macrobotanical analyses (Table 3). Interpretive considerations for the pollen taxa are discussed in the Gardiner Basin study (Gish 2010, 2011a). Also, the complete data base for the flotation and specimen identification samples and discussions of the taxa are presented elsewhere (Gish 2010, 2011b), with the exception of the results from 48YE1332, 48YE1588, and 48YE1642, which were not included in the earlier studies.
<table>
<thead>
<tr>
<th>Site</th>
<th>TU</th>
<th>Feature</th>
<th>Level</th>
<th>FS</th>
<th>FI/ID</th>
<th>Date BP</th>
<th>Cultural Period</th>
<th>FI Vol in liters</th>
<th>Weight in grams</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>48YE380</td>
<td>2</td>
<td>hearth</td>
<td>2</td>
<td>62</td>
<td>Fi</td>
<td>1570 ± 40</td>
<td>Late Archaic</td>
<td>1.0</td>
<td>3.56</td>
<td>Light</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>hearth</td>
<td>3</td>
<td>72</td>
<td>Fi</td>
<td>1570 ± 40</td>
<td>Late Archaic</td>
<td>2.2</td>
<td>49.14</td>
<td>Light</td>
</tr>
</tbody>
</table>

| 48YE549   | 2  | hearth  | 3     | 59 | Fi    | 240 ± 40     | Late Prehistoric  | 1.0              | 20.06          | Light     |
|           | 1  | hearth  | 1     | 91 | Fi    | 940 ± 40     | Late Prehistoric  | 1.0              | 9.06           | Light     |
|           | 4  | Rock conc. | NA       | 158 | Fi    | 220 ± 40     | Late Prehistoric  | 0.25             | 3.25           | Light     |
|           | 8  | FCR Conc. | 2     | 122 | Fi    | 360 ± 40     | Late Prehistoric  | 1.0              | 7.59           | Light     |

| 48YE678   | 1  | hearth  | 2     | 17 | Fi    | 1460 ± 40    | Late Archaic      | 0.5              | 11.63          | Light     |
|           | 1  | hearth  | 1     | 29 | Fi    | 1420 ± 40    | Late Archaic      | 1.0              | 4.88           | Light     |

| 48YE1332  | 2  | NA      | 7     | 24 | Fi    | 2880 ± 30    | Mid-Late Archaic  | 0.1              | 21.50          | Light     |

| 48YE1383  | 2  | NA      | 12    | 19 | ID    | 2290 ± 30    | Late Archaic      | NA              | 0.94           | 1 burned wd |
|           | 2  | NA      | 6     | 19 | Fi    | 2290 ± 30    | Late Archaic      | 0.5             | 2.27           | Light     |

| 48YE1384  | 2  | NA      | 16    | 19 | Fi    | 1340 ± 30    | Late Prehistoric  | 1.0             | 11.56          | Light     |

| 48YE1499  | 1  | NA      | 15    | 19 | Fi    | 1220 ± 30    | Late Prehistoric  | 0.25            | 10.43          | Light     |

| 48YE1558  | 13 | 6       | 1     | 164 | Fi    | 2790 ± 40    | Mid-Late Archaic  | 1.0             | 0.97           | Light     |
|           | 9  | 7       | NA    | 181 | Fi    | 2130 ± 40    | Late Archaic      | 0.275           | 1.81           | Light     |
|           | 9  | 8       | Rock Conc. | 1    | 214 | Fi | 2310 ± 40 | Late Archaic | 1.0 | 4.02 | Light |

| 48YE1588  | 3  | NA      | 4     | 37 | ID    | 780 ± 30     | Late Prehistoric  | NA              | 0.52           | 5 burned wd |

| 48YE1642  | 3  | 1       | FCR conc. | 3    | 15 | ID | 1610 ± 30 | Late Archaic/LP | NA | 0.51 | 1 burned wd |
|           | 4  | 2       | FCR conc. | 3    | 19 | ID | 2890 ± 30 | Mid-Late Archaic | NA | 0.81 | 5 burned wd |
|           | 4  | 2       | FCR conc. | 3    | 20 | ID | 2890 ± 30 | Mid-Late Archaic | 0.2 | 1.28 | Light |

| 48YE1660  | 3  | 1       | NA      | 27   | NA | 1850 ± 30 | Late Archaic | NA | 0.36 | 6 pcs bu wd |
|           | 3  | 1       | NA      | 62   | NA | 1850 ± 30 | Late Archaic | 1.0 | 20.37 | Light |
|           | 6  | 3       | NA      | 37   | NA | 1690 ± 30 | Late Archaic | 3.68 | 20 bd wood | Heavy |
|           | 6  | 3       | NA      | 38   | NA | 1690 ± 30 | Late Archaic | 1.0 | 4.02 | Light |

| 48YE2075  | 1  | 1       | NA      | 2    | 7   | Fi | 1500 ± 40 | Late Archaic | 0.5 | 67.56 | Light |

| 48YE2190  | 1  | 1       | NA      | 9    | NA | 1380 ± 30 | Late Prehistoric | NA | 0.20 | 1 burned wd |
|           | 1  | 1       | NA      | 14   | NA | 1380 ± 30 | Late Prehistoric | 0.5 | 4.39 | Light |

| 24PA1081  | NA | 3       | NA      | 184  | ID   | NA | NA     | NA | 0.34 | 2 Bnd bone |
|           | NA | 3       | NA      | 235  | ID   | NA | NA     | NA | 0.24 | 3 burned wd |
|           | 10 | 3       | NA      | 131  | ID   | NA | NA     | NA | 0.52 | Light |

| 2 NA Exc. Level | 3  | 163 | ID | NA | Recent | NA | 0.06 | 1 seed frag |
| 2 NA Exc. Level | 4  | 172 | ID | NA | NA     | NA | 0.06 | 2 Bnd bone |
| 2 NA Exc. Level | 4  | 167 | FI | NA | 1340 ± 30 | 0.5 | 1.05 | Light |
| 2 NA Exc. Level | 5  | 176 | FI | 1340 ± 30 | Late Prehistoric | NA | 0.53 | 6 bu wood |

Key: bu = burned, FCR = Fire-cracked Rock, Fl = Flotation, FS = Field Specimen, ID = Specimen Identification, LP = Late Prehistoric, NA = Not Applicable, pcs = pieces, TU = Test Unit, Vol. = Volume, ST=stone; conc=concentration; wd=wood; bnd=burned; exc=excavation
### Table 3. Archaeobotanical Taxa and Abbreviations.

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abies</td>
<td>Fir</td>
</tr>
<tr>
<td>Alnus</td>
<td>Alder</td>
</tr>
<tr>
<td>Apiaceae</td>
<td>Parsley family</td>
</tr>
<tr>
<td>Arceuthobium cf. americanum</td>
<td>Dwarf-mistletoe</td>
</tr>
<tr>
<td>Artemisia</td>
<td>Sagebrush</td>
</tr>
<tr>
<td>Betula</td>
<td>Birch</td>
</tr>
<tr>
<td>Carex</td>
<td>Sedge</td>
</tr>
<tr>
<td>Cheno-Am</td>
<td>Chenopodiaceae (Goosefoot family) excluding Greasewood (Sarcobatus) but including Amaranth (Amaranth family)</td>
</tr>
<tr>
<td>Collomia</td>
<td>Collomia</td>
</tr>
<tr>
<td>Cyperaceae</td>
<td>Sedge family</td>
</tr>
<tr>
<td>Dicotyledoneae</td>
<td>Subclass of Flowering Plants</td>
</tr>
<tr>
<td>Draba-type</td>
<td>Draba-type group in the Brassicaceae (Mustard family) with tricolpate (three-furrowed) pollen forms</td>
</tr>
<tr>
<td>Ephedra nevadensis-type</td>
<td>Joint-fir pollen form with branched furrows</td>
</tr>
<tr>
<td>E. torreyana-type</td>
<td>Joint-fir pollen form without branched furrows</td>
</tr>
<tr>
<td>Eriogonum, Eriogonum-type</td>
<td>Wild-buckwheat and Wild-buckwheat-type group in the Polygonaceae (Buckwheat family)</td>
</tr>
<tr>
<td>Euphorbia-type</td>
<td>Spurge-type group in the Euphorbiaceae (Spurge family)</td>
</tr>
<tr>
<td>Gayophytum-type</td>
<td>Groundsmoke-type group in the Onagraceae</td>
</tr>
<tr>
<td>Gentiana</td>
<td>Gentian</td>
</tr>
<tr>
<td>Geranium</td>
<td>Geranium</td>
</tr>
<tr>
<td>Gilia</td>
<td>Gilia</td>
</tr>
<tr>
<td>High-spine Asteraceae</td>
<td>Group in the Asteraceae (Sunflower family) with High-spine pollen form eg. Helianthus (Sunflower)</td>
</tr>
<tr>
<td>Juniperus</td>
<td>Juniper</td>
</tr>
<tr>
<td>Juniperus cf. scopulorum</td>
<td>Juniper cf. Rocky-Mountain Juniper</td>
</tr>
<tr>
<td>Lamiaceae</td>
<td>Mint family</td>
</tr>
<tr>
<td>Lewisia</td>
<td>Bitterroot</td>
</tr>
<tr>
<td>Liguliflorae</td>
<td>Tribe in the Asteraceae with fenestrate (window-like openings) pollen forms, eg. Lactuca (Wild Lettuce)</td>
</tr>
<tr>
<td>Liliaceae</td>
<td>Lily family</td>
</tr>
<tr>
<td>Low-spine Asteraceae</td>
<td>Group in the Asteraceae (Sunflower family) with Low-spine pollen forms, eg. Ambrosia (Ragweed)</td>
</tr>
<tr>
<td>Oenothera-type</td>
<td>Evening-primrose-type group in the Onagraceae</td>
</tr>
<tr>
<td>Papilionoideae</td>
<td>Group in the Fabaceae (Pea family)</td>
</tr>
<tr>
<td>Phlox</td>
<td>Phlox</td>
</tr>
<tr>
<td>Physalis/Solanum</td>
<td>Groundcherry/Nightshade</td>
</tr>
<tr>
<td>Picea</td>
<td>Spruce</td>
</tr>
<tr>
<td>Pinaceae/Juniperus</td>
<td>Pine family/Juniper</td>
</tr>
<tr>
<td>Pinus, cf. Pinus</td>
<td>Pine</td>
</tr>
<tr>
<td>Pinus contorta</td>
<td>Lodgepole pine</td>
</tr>
<tr>
<td>P. flexilis</td>
<td>Limber pine</td>
</tr>
<tr>
<td>Pinus fragments/3</td>
<td>Pinaceae (Pine family) pollen fragments/3, predominantly pine but potentially including fir and spruce pollen</td>
</tr>
<tr>
<td>Plantago</td>
<td>Plantain</td>
</tr>
<tr>
<td>Platyopuntia</td>
<td>Prickly pear cactus</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Grass family</td>
</tr>
<tr>
<td>Polonemium</td>
<td>Jacobs ladder</td>
</tr>
<tr>
<td>Polygonum</td>
<td>Bistort, Smartweed, and others</td>
</tr>
<tr>
<td>Populus tremuloides</td>
<td>Aspen</td>
</tr>
<tr>
<td>Populus T/Salix</td>
<td>Aspen/Willow</td>
</tr>
<tr>
<td>Pseudotsuga</td>
<td>Douglas-fir</td>
</tr>
<tr>
<td>Quercus</td>
<td>Oak</td>
</tr>
<tr>
<td>Ranunculaceae</td>
<td>Buttercup family</td>
</tr>
<tr>
<td>Rosaceae</td>
<td>Rose family</td>
</tr>
<tr>
<td>Salix</td>
<td>Willow</td>
</tr>
<tr>
<td>Sarcobatus</td>
<td>Greasewood</td>
</tr>
<tr>
<td>Silene-type</td>
<td>Catchfly-type group in the Caryophyllaceae (Pink family)</td>
</tr>
</tbody>
</table>

Note: An "LFS" in the pollen tables indicates a taxon present in Large-fraction Scanning, and an "X" indicates a taxon present in Scanning.
Table 4. Pollen Results from 48YE380 and 48YE549.

<table>
<thead>
<tr>
<th>Site:</th>
<th>48YE380</th>
<th>48YE380</th>
<th>48YE549</th>
<th>48YE549</th>
<th>48YE549</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Unit:</td>
<td>1</td>
<td>2</td>
<td>NA</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Feature:</td>
<td>1</td>
<td>3</td>
<td>NA</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Field Specimen:</td>
<td>38</td>
<td>72</td>
<td>NA</td>
<td>157 PW</td>
<td>158</td>
</tr>
<tr>
<td>Pollen Sample:</td>
<td>1</td>
<td>NA</td>
<td>Modern</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Pollen Concentration:</td>
<td>123,893</td>
<td>185,840</td>
<td>185,840</td>
<td>NA</td>
<td>92,920</td>
</tr>
<tr>
<td>Pollen Sample:</td>
<td>1</td>
<td>NA</td>
<td>Modern</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Pollen Concentration:</td>
<td>123,893</td>
<td>185,840</td>
<td>185,840</td>
<td>NA</td>
<td>92,920</td>
</tr>
</tbody>
</table>

**ARBOREAL POLLEN:**

<table>
<thead>
<tr>
<th>Pollen</th>
<th>48YE380</th>
<th>48YE380</th>
<th>48YE549</th>
<th>48YE549</th>
<th>48YE549</th>
</tr>
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<tbody>
<tr>
<td>Pinus</td>
<td>49.0</td>
<td>45.5</td>
<td>78.0</td>
<td>52.5</td>
<td>25.0</td>
</tr>
<tr>
<td>Pinus fragments/3</td>
<td>4.5</td>
<td>4.5</td>
<td>4.5</td>
<td>12.0</td>
<td>17.5</td>
</tr>
<tr>
<td>Picea</td>
<td>5.5</td>
<td>4.5</td>
<td>3.0</td>
<td>1.5</td>
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</tr>
<tr>
<td>Pseudotsuga</td>
<td>0.5</td>
<td>0.5</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abies</td>
<td>0.5</td>
<td>4.5</td>
<td>5.5</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>Juniperus</td>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Populus tremuloides</td>
<td>0.5</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salix</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alnus</td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quercus</td>
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**NON-ARBOREAL POLLEN:**

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<th>48YE380</th>
<th>48YE549</th>
<th>48YE549</th>
<th>48YE549</th>
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<tbody>
<tr>
<td>Ephedra nevadensis-type</td>
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<td>X</td>
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</tr>
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<td>Cheno-Am</td>
<td>4.5</td>
<td></td>
<td></td>
<td>1.0</td>
<td>0.5</td>
</tr>
<tr>
<td>Sarcobatus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silene-type</td>
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<td></td>
<td>0.5</td>
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<td>X</td>
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<tr>
<td>Drobo-type</td>
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<td>Rosaceae</td>
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<td></td>
<td>X</td>
</tr>
<tr>
<td>Papilionoideae</td>
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<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Geranium</td>
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<tr>
<td>Gayophytum-type</td>
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<td></td>
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<td>X</td>
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<tr>
<td>Oenothera-type</td>
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<td>X</td>
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</tr>
<tr>
<td>Apiaceae</td>
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<td></td>
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<tr>
<td>Phlox</td>
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<td>Gilia</td>
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<tr>
<td>Polemonium</td>
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<td>0.5</td>
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<tr>
<td>Lamiaceae</td>
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<td></td>
<td></td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Physalis/Solanum</td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-spine Asteraceae</td>
<td>1.5</td>
<td>1.0</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>High-spine Asteraceae</td>
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<td>2.5</td>
<td>1.5</td>
<td>0.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Artemisia</td>
<td>14.0</td>
<td>28.0</td>
<td>2.5</td>
<td>25.5</td>
<td>44.5</td>
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<tr>
<td>Liguliflorae</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td>0.5</td>
</tr>
<tr>
<td>Unknowns</td>
<td>1.0</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Total Grains Counted:</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
</tbody>
</table>

**Pollen Aggregates:**

<table>
<thead>
<tr>
<th>Aggregate</th>
<th>48YE380</th>
<th>48YE380</th>
<th>48YE549</th>
<th>48YE549</th>
<th>48YE549</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pi-3b(6)</td>
<td>Pi-4b(11)</td>
<td>Pi-11b</td>
<td>(Pi-6b)</td>
<td>(Pi-40b)</td>
<td></td>
</tr>
<tr>
<td>Po-3b(5)</td>
<td>(Pic-3b)</td>
<td>(Hi-4a)</td>
<td>Po-2b</td>
<td>Po-4b</td>
<td></td>
</tr>
<tr>
<td>Ch-4a</td>
<td>Po-2a(12)</td>
<td>(Ar-5a)</td>
<td>Ar-2a</td>
<td>Ar-20b(25)</td>
<td></td>
</tr>
<tr>
<td>(Hi-12a)</td>
<td>(Pol-2a)</td>
<td>(Ar-8b(50)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ar-2a(18)</td>
<td></td>
<td></td>
<td>(Pi-6b)</td>
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</table>

**Oribatid Mites**

<table>
<thead>
<tr>
<th>Mites</th>
<th>48YE380</th>
<th>48YE380</th>
<th>48YE549</th>
<th>48YE549</th>
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</tr>
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<tbody>
<tr>
<td></td>
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</table>
**48YE380 (Lake Lodge Pump Station Site)**

At an elevation of 2,377 m (7,800 ft.), 48YE380 is situated on a terrace of Yellowstone Lake in soils overlying old, S2 shoreline, beach and dune sands. The modern vegetation is sagebrush (*Artemisia* spp.) with grasses, stands of conifers, and meadow openings. Numerous forbs occur not only in the meadows but also in association with the sagebrush community and conifer stands. Some of these are sulphur buckwheat (*Eriogonum umbellatum*) in the Polygonaceae, field chickweed (*Cerastium arvense*) in the Caryophyllaceae, wild strawberry (*Fragaria* sp.) in the Rosaceae, members of the pea family (*Fabaceae*), fireweed (*Epilobium angustifolium*) in the Onagraceae, cowparsnip (*Heracleum maximum*) in the Apiaceae, Jacobs ladder (*Polemonium* sp.) in the Polemoniaceae, and numerous members of the sunflower family (*Asteraceae*).

The two pollen samples, which were evaluated from Late Archaic hearths (Features 1 and 3), are both dominated by pine, with moderate values of sagebrush, followed by grass (Table 1 and Table 4) (Gish 2010). Other conifers are represented and numerous non-arboreal meadow elements occur.

The two flotation samples are both from Feature 3 (Table 2). Fifty-piece wood counts were obtained in both samples and are dominated by pine (*Pinus*) followed by sagebrush (Table 5). Also, in FS 62, lodgepole pine (*Pinus contorta*) female cone scale fragments and abundances of needle fragments were recorded. Additionally, needle fragments of limber pine (*Pinus flexilis*), spruce (*Picea* sp.), and fir (*Abies* sp.) were found, along with a sedge (*Carex* sp.) achene and achene fragment, and Cheno-Am seeds and seed fragments. The materials are similar in FS 72 (Fl), with representations of lodgepole pine, limber pine, spruce, and fir. Also, a bud and seed fragment were found, although they could not be identified specifically.

From an ecological perspective, the combined pollen and flotation results suggest pine, specifically lodgepole pine, was the dominant conifer at the site during the Late Archaic period. Limber pine, spruce, fir, and sagebrush also were present locally, along with grasses and numerous meadow constituents. Many of the forbs correlate with plants in the modern vegetation. The pines, sagebrush, and some forbs, like wild-buckwheat-type and groundsmoke-type (*Gayophyllum*-type), suggest dry conditions, while the spruce and fir representations, along with forbs like Jacobs ladder, indicate moist habitats (Table 6). The alder (*Alnus*) pollen presence (seen in scanning) in FS 38 also implies at least regional, if not local, riparian vegetation. Variable habitats apparently existed in the site environs in the past, although the predominant conditions were dry. Altogether, the setting appears similar to the modern situation.

Ethnobotanically, the pine and sagebrush wood occurrences reflect fuels used in Feature 3. Lodgepole pine cones and needles, and the needles of limber pine, fir, and spruce also were used for fuel, and emphasize the local availability of these resources.

Also, use of small seeds is indicated, with sedge, Cheno-Am, and an unknown plant documented in the hearth. Sedges and many members of the Chenopodiaceae family and amaranth genus (*Amaranthus*) yield edible seeds (Table 7). The unidentified bud found in the FS 72 (Fl) sample further suggests some use of edible greens. The FS 38 pollen count from Feature 1 also implies use of Cheno-Am plants along with members of the High-spine Asteraceae group and sagebrush, while the FS 72 (PS) record indicates use of sagebrush. Seeds or greens could have been utilized (Table 7). Although the wood and other fuels have an extended seasonal availability, the small seeds and greens imply summer gathering activities during the occupations associated with both hearths.

**48YE381 (Fishing Bridge Point Site)**

At an elevation of 2,373 m (7,785), this site is located close to 48YE380, discussed above. The modern vegetation includes sagebrush steppe, pine stands, and meadows. Portions of the meadow areas are seasonally marshy. Of the 17 pollen samples, one is a surface control sample, 10 were collected in a column, three are from Middle and Late Archaic period basin-shaped hearths, two were collected from Early Archaic and Late Prehistoric fire-cracked rock concentrations, and one is from an historic non-cultural context (Table 1; Figure 2).
Table 5. Flotation and Specimen Identification Results (Burned Materials) (continued on next page)

<table>
<thead>
<tr>
<th>Site</th>
<th>Ft</th>
<th>Site</th>
<th>Ft</th>
<th>Site</th>
<th>Ft</th>
<th>Site</th>
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<tr>
<td>48YE830</td>
<td>3</td>
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<td>1</td>
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<td>2</td>
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<td>48YE849</td>
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<td>2</td>
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<td>2</td>
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<td>3</td>
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<td>2</td>
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<td>48YE1332</td>
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<td>1</td>
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<td>48YE1383</td>
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<td>6</td>
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<td>3</td>
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<td>1</td>
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<td>2</td>
<td>1</td>
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<td>2</td>
<td>1</td>
<td>3</td>
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<td>48YE1384</td>
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<td>3</td>
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<td>48YE1499</td>
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<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

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Table 5. Flotation and Specimen Identification Results (Burned Materials) (continued from previous page)

<table>
<thead>
<tr>
<th>Site</th>
<th>F1</th>
<th>F2</th>
<th>Al</th>
<th>Ab</th>
<th>Pic</th>
<th>PiCo</th>
<th>Pl</th>
<th>PinJu</th>
<th>Di</th>
<th>So</th>
</tr>
</thead>
<tbody>
<tr>
<td>48E/668</td>
<td>164</td>
<td>20</td>
<td>15</td>
<td>19</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>48E/658</td>
<td>37</td>
<td>6</td>
<td>23</td>
<td>15</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
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<td>1</td>
<td>1</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Key: F1 = Feature, F2 = Field Specimens, NA = Not Applicable
Note: A designation in parentheses means that additional quantities were estimated and did not fit in the count.
<table>
<thead>
<tr>
<th>Taxon</th>
<th>Plant Correlation within Yellowstone Park</th>
<th>Reference</th>
<th>Habitat</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selaginella (Little clubmoss)</td>
<td><em>Selaginella densa</em> (Little clubmoss)</td>
<td>McDougall and Bagley 1956:19</td>
<td>dry slopes, among rocks</td>
<td>Nelson 1962:60</td>
</tr>
<tr>
<td><em>Abies</em> (Fir)</td>
<td><em>Abies lasiocarpa</em> (Subalpine fir)</td>
<td>McDougall and Bagley 1956:22</td>
<td>moist sections in higher elevations</td>
<td>Nelson 1962:65</td>
</tr>
<tr>
<td><em>Juniperus</em> (Juniper)</td>
<td><em>Juniperus communis var. saxatilis</em></td>
<td>McDougall and Bagley 1956:24</td>
<td>north-facing slopes, foothills, and under open forest</td>
<td>Nelson 1962:67</td>
</tr>
<tr>
<td></td>
<td><em>(Mountain common juniper)</em></td>
<td></td>
<td>dry foothill slopes, rocky slopes</td>
<td>Nelson 1962:68</td>
</tr>
<tr>
<td><em>Ephedra nevadensis</em> (Joint-fr)</td>
<td>None</td>
<td>None</td>
<td>sandy or rocky plains</td>
<td>Harrington 1967:358</td>
</tr>
<tr>
<td><em>Betula</em> (Birch)</td>
<td><em>Betula occidentalis</em></td>
<td>McDougall and Bagley 1956:64</td>
<td>stream-sides</td>
<td>Nelson 1962:102</td>
</tr>
<tr>
<td><em>Quercus</em> (Oak)</td>
<td>None</td>
<td>None</td>
<td>foothills</td>
<td>Nelson 1962:103-104</td>
</tr>
<tr>
<td><em>Lewisia</em> (Bitterroot)</td>
<td><em>Lewisia minima</em></td>
<td>McDougall and Bagley 1956:73</td>
<td>dry soil or gravel</td>
<td>McDougall and Bagley 1956:73</td>
</tr>
<tr>
<td><em>Silene</em> (Catchfly)</td>
<td><em>Silene acaulis</em> (Moss campion)</td>
<td>McDougall and Bagley 1956:75</td>
<td>meadows, among bushes and aspen trees</td>
<td>Nelson 1962:118</td>
</tr>
<tr>
<td>Taxon</td>
<td>Plant Correlation within Yellowstone Park</td>
<td>Reference</td>
<td>Habitat</td>
<td>Reference</td>
</tr>
<tr>
<td>-------</td>
<td>------------------------------------------</td>
<td>-----------</td>
<td>---------</td>
<td>-----------</td>
</tr>
<tr>
<td>Geranium (Geranium)</td>
<td>Geranium richardsonii, G. viscosissimum</td>
<td>McDougall and Bagley 1956:103</td>
<td>mountain valleys and streamside</td>
<td>McDougall and Bagley 1956:103</td>
</tr>
<tr>
<td>Euphorbia-type (Spurge)</td>
<td>Euphorbia serpyllifolia (Spurge)</td>
<td>McDougall and Bagley 1956:104</td>
<td>fields, rocky slopes</td>
<td>Nelson 1976:88</td>
</tr>
<tr>
<td>Apiaceae (Parsley family)</td>
<td>Apiaceae (Parsley family) (11 genera)</td>
<td>McDougall and Bagley 1956:112</td>
<td>meadows, dry plains, foothills, also in shade, in moist or wet soil, along streams, or in water</td>
<td>Nelson 1969:207-211, McDougall and Bagley 1956:112</td>
</tr>
<tr>
<td>Polemonium (Jacobs ladder)</td>
<td>Polemonium spp. (5 Jacobs ladder species)</td>
<td>McDougall and Bagley 1956:125</td>
<td>in lightly shaded areas, open woods, moist meadows, also in disturbed ground</td>
<td>Nelson 1969:232-233</td>
</tr>
<tr>
<td>Lamiaceae (Mint family)</td>
<td>Lamiaceae (6 Mint family genera)</td>
<td>McDougall and Bagley 1956:129</td>
<td>meadows, foothills, dry ground, also wet ground, moist soil, and in disturbed soil</td>
<td>Nelson 1969:240-242</td>
</tr>
<tr>
<td>Physalis/Solanum (Groundcherry/ Nightshade)</td>
<td>Physalis longifolia (Long-leaf groundcherry)</td>
<td>Vizgirdas 2007:277</td>
<td>dry plains, rocky ground, hills, also dry to moist soils of disturbed ground</td>
<td>Nelson 1969:243-244, Craighead et al. 1963:165</td>
</tr>
<tr>
<td>Solanum dulcamara (Climbing nightshade)</td>
<td>Vizgirdas 2007:277</td>
<td>moist, open ground, disturbed ground</td>
<td>Vizgirdas 2007:277</td>
<td></td>
</tr>
<tr>
<td>S. triflorum (Cut-leaf nightshade)</td>
<td>Vizgirdas 2007:277</td>
<td>moist, open ground, and disturbed ground</td>
<td>Vizgirdas 2007:277</td>
<td></td>
</tr>
<tr>
<td>Liliiflorae (Asteraceae group)</td>
<td>Lactuca pulchella (Larkspur-lettuce)</td>
<td>McDougall and Bagley 1956:161</td>
<td>medium-dry to moist soils in fields, prairies, valleys, and in mountains</td>
<td>Craighead et al. 1963:221</td>
</tr>
</tbody>
</table>

Table 6: Ecological Associations for Selected Taxa (continued from previous page)
The pollen column was collected by this author from Test Unit 18, from the bottom upwards and 5 cm deep into the west wall (Figure 2) (Gish 2010). With the exception of the upper Ao horizon and the lowest levels where there was a clear demarcation between the basal BC/C horizon and overlying soil, the samples were collected in arbitrary 10 cm levels.

The surface control sample yielded the highest pine value (69.0 percent) among the 17 samples, followed by sagebrush and grass (Table 8). Numerous forbs were record along with birch (Betula) pollen. The on-site presence of pine, then, is well documented in the pollen rain along with the sagebrush community and meadow elements. The pine, sagebrush, and some forbs reflect the predominantly dry conditions, while other forbs indicate localized moist settings (Table 6). The birch is a wet habitat indicator and reflects regional vegetation along Yellowstone Lake or its tributaries.

The pollen column encompasses pre-Altithermal to recent times (Figure 2). PC 1 and PC 2 were collected from the basal BC/C beach/dune sands (clayey sandy loams) of the S2 shoreline, which reflects declining lake levels as Yellowstone Lake retreated during the Altithermal Period. This shoreline is dated at about 8000 BP, and the drier Altithermal Period extended from about 7500-4000 BP (Pierce et al 2007). Although the climate ameliorated after 4000 BP and became more mesic, the lake continued to decline as part of a long-term post-glacial trend. The modern shoreline, S1, is about 5 m below the S2 shoreline (Pierce et al 2007:136). As the lake retreated, soils formed above the beach/dune sands. As can be seen in Figure 1, PC 3 was collected from the initial silty loam (Ab horizon) that formed above the BC/C deposit. PC 4 also relates to the Ab horizon, while PC 5, in silty sandy loam, is transitional between the Ab and Bw levels. PC 6 and PC 7 reflect the Bw soil, and PC 8, in silty loam, is transitional between the Bw and upper, organic rich and drier, Ao horizon. PC 9 and PC 10 are both from the Ao soil, with the PC 10 level ending just below the modern ground surface. None of these soils in the pollen column were dated directly, but their relative ages in relationship to the archaeologically derived cultural chronology are indicated in Figure 2.

The two deepest samples (PC 1 and PC 2) from the pollen column are dominated by non-arboreal categories (Table 8). Sagebrush and grass are the most abundantly represented taxa, with much lower proportions of High-spine Asteraceae, Cheno-Am, and others. Only low to moderately-low values of pine pollen were recorded. The representation of pine remains low in PC 3, which equates stratigraphically with the Early Archaic period, but begins to increase in importance in PC 4, which corresponds to the Middle Archaic. Pine continues to increase gradually up through PC 10. A shift to actual arboreal pollen dominance occurs in PC 8, which equates with the Late Prehistoric/Historic transition, although the

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**Figure 2. Pollen Column from 48YE381.**

<table>
<thead>
<tr>
<th>SOIL</th>
<th>cmbs</th>
<th>PC</th>
<th>SOIL</th>
<th>AGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ao</td>
<td>1-5</td>
<td>10</td>
<td>very dark grayish brown (10YR 3/2) silty loam, dry, very dense roots</td>
<td>Historic 500 BP-present</td>
</tr>
<tr>
<td>1-17</td>
<td>5-15</td>
<td>9</td>
<td>very dark grayish brown (10YR 3/2) silty loam, dry, dense roots</td>
<td>Feature 10 (790 +/-40 BP)</td>
</tr>
<tr>
<td></td>
<td>15-25</td>
<td>8</td>
<td>very dark grayish brown (10YR 3/2 silty loam, moist roots</td>
<td>Late Prehistoric 1500-500 BP</td>
</tr>
<tr>
<td>Bw</td>
<td>25-35</td>
<td>7</td>
<td>very dark brown (10YR 2/2) silty sandy loam, moist, roots</td>
<td>Late Archaic 3000-1500 BP</td>
</tr>
<tr>
<td>17-53</td>
<td>35-45</td>
<td>6</td>
<td>very dark brown (10YR 2/2) silty sandy loam, moist, roots</td>
<td>Middle Archaic 5000-3000 BP</td>
</tr>
<tr>
<td>Ab</td>
<td>45-55</td>
<td>5</td>
<td>very dark brown (10YR 2/2) silty sandy loam, moist, roots</td>
<td>FI 12 (5870 +/- 50 BP) (5870 cmbs map) Early Archaic 8000-5000 BP</td>
</tr>
<tr>
<td>53-75</td>
<td>55-65</td>
<td>4</td>
<td>very dark brown (10YR 2/2) silty loam, moist, roots</td>
<td>S2 terrace, beach/dune sands</td>
</tr>
<tr>
<td>65-75</td>
<td>75-80</td>
<td>3</td>
<td>very dark brown (10YR 2/2) silty loam, moist, roots</td>
<td></td>
</tr>
<tr>
<td>BC/C</td>
<td>75-90</td>
<td>2</td>
<td>dark yellowish brown (10YR 3/4) clayey sandy loam, moist, roots</td>
<td></td>
</tr>
<tr>
<td></td>
<td>80-90</td>
<td>1</td>
<td>dark yellowish brown (10YR 3/4) clayey sandy loam, moist, roots</td>
<td></td>
</tr>
</tbody>
</table>

Note: The pollen column was collected July 13, 2010 from the bottom upward and 5 cm deep into the west wall of Test Unit 18. Key: map = north wall profile.
Feature 4 pollen record, discussed later, suggests the change might have occurred somewhat earlier in the Late Archaic period. As pine increases in the pollen column, the proportions of non-arboreal pollen decline, with a continuous decrease in both grass and sagebrush although with some irregularities. These trends are illustrated in Figure 3, which compares the proportions of the major pollen taxa in the column samples and also contrasts the proportions of all arboreal taxa with all non-arboreal taxa.

These results indicate that sagebrush, grasses, and forbs were the initial colonizers at 48YE381 around 8000 BP as the water level of Yellowstone Lake receded and soils developed. The low percentages of pine in PC 1, PC 2, and PC 3 suggest only regional or extra-regional presence of conifers.

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Potential Use</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pinus</strong> (Pine), including <em>P. albicaulis</em></td>
<td>edible seeds and inner park, firewood, lodge poles</td>
<td>Vizgirdas 2007:35</td>
</tr>
<tr>
<td><em>P. albicaulis</em> (Whitebark pine), <em>P. contorta</em> (Lodgepole pine), <em>P. flexilis</em> (Limber pine)</td>
<td>firewood, lodge poles</td>
<td>Zalucha 1986:152-154</td>
</tr>
<tr>
<td><strong>Juniperus</strong> (Juniper), including <em>J. scopulorum</em></td>
<td>edible berries; also fiber and firewood</td>
<td>Harrington 1967:242</td>
</tr>
<tr>
<td><em>J. scopulorum</em> (Rocky Mountain juniper)</td>
<td></td>
<td>Kirk 1970:19</td>
</tr>
<tr>
<td><strong>Poaceae</strong> (Grass family)</td>
<td>edible grains, basketry, other non-food uses</td>
<td>Harrington 1967:304, 310, 320-322</td>
</tr>
<tr>
<td><strong>Liliaceae</strong> (Lily family), including <em>Camassia quamash</em> (Common camas)</td>
<td>edible bulbs</td>
<td>McDougall and Bagggley 1956:57-58</td>
</tr>
<tr>
<td><strong>Salix</strong> (Willow)</td>
<td>edible inner bark</td>
<td>Kirk 1970:106</td>
</tr>
<tr>
<td><strong>Eriogonum-type</strong> (Wild buckwheat)</td>
<td>edible stems</td>
<td>Kirk 1970:231</td>
</tr>
<tr>
<td><strong>Cheno-Am</strong> (Goosefoot family)</td>
<td>edible seeds and greens</td>
<td>Harrington 1967:55-62, 69-71, 63</td>
</tr>
<tr>
<td><strong>Sarcobatus</strong> (Greasewood)</td>
<td>edible young twigs</td>
<td>Kirk 1970:62</td>
</tr>
<tr>
<td><strong>Lewisia</strong> (Bitterroot)</td>
<td>edible roots</td>
<td>McDougall and Bagggley 1956:73, 1970:48-49</td>
</tr>
<tr>
<td><strong>Silene-type</strong> (Catchfly)</td>
<td>edible greens</td>
<td>Kirk 1970:44</td>
</tr>
<tr>
<td><strong>Brassicaceae</strong> (Mustard family)</td>
<td>edible seeds and greens</td>
<td>Kirk 1970:35-39</td>
</tr>
<tr>
<td><strong>Rosaceae</strong> (Rose family)</td>
<td>edible fruits, young shoots, roots, and leaves for tea</td>
<td>Harrington 1967:270-276, 89-99</td>
</tr>
<tr>
<td><strong>Platyopuntia</strong> (Prickly pear)</td>
<td>edible fruits and joints</td>
<td>Kirk 1970:50</td>
</tr>
<tr>
<td><strong>Oenothera-type</strong> (Evening-primrose)</td>
<td>edible roots</td>
<td>Kirk 1970:113</td>
</tr>
<tr>
<td><strong>Apiumaeae</strong> (Parsley family)</td>
<td>edible roots, stalks, seeds, and greens for tea</td>
<td>Harrington 1967:132-134, 171-173, 117-125</td>
</tr>
<tr>
<td><strong>Lamiaceae</strong> (Mint family)</td>
<td>edible seeds, greens, or tubers, and greens for tea</td>
<td>Kirk 1970:80-86</td>
</tr>
<tr>
<td><strong>Physalis/Solanum</strong> (Groundcherry/Nightshade)</td>
<td>edible fruits</td>
<td>Kirk 1970:74</td>
</tr>
<tr>
<td><strong>Low-spine Asteraceae</strong>, including <em>Ambrosia</em> (Ragweed), and <em>Iva species</em> (Povertyweed and sumpweed)</td>
<td>edible achenes</td>
<td>Harrington 1967:312-315, Vizgirdas 2007:71</td>
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<tr>
<td><strong>High-spine Asteraceae</strong>, including <em>Helianthus</em> (Sunflower)</td>
<td>edible achenes, leaves for tea</td>
<td>Kirk 1970:132-139</td>
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<tr>
<td><strong>Artemisia</strong> (Sagebrush)</td>
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<td>Kirk 1970:141</td>
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<tr>
<td><strong>Liguliflorae</strong>, including <em>Lactuca</em> (Wild lettuce)</td>
<td>edible greens</td>
<td>Kirk 1970:150</td>
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Table 8. Pollen Results from 48YE381 (continued on next page).

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<td>Ao</td>
<td>Ao</td>
<td>Ao</td>
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<td>185,840</td>
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<td>74,336</td>
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**ARBOREAL POLLEN:**

- *Pinus* 69.0 50.0 50.5 45.0 41.5
- *Pinus* fragments/3 1.5 10.0 5.0 5.5 5.0
- *Picea* 2.5 0.5 2.5 X X
- *Pseudotsuga* X X
- *Abies* 1.0 2.0 2.0 1.5 X
- *Betula* X

**NON-ARBOREAL POLLEN**

- *Ephedra nevadensis*-type X X 0.5
- *Poaceae* 8.5 13.5 23.0 19.0 27.5
- *Eriogonum*-type X 0.5 X X
- *Polygonum* X X
- *Cheno-Am* X 0.5 0.5 0.5 1.0
- *Sarcobatus* X X
- *Lewisia* X 0.5 X
- *Silene*-type 0.5 0.5 X 1.0 0.5
- *Ranunculaceae* X
- *Rosaceae* X
- *Geranium* X 0.5 X
- *Gayophytum*-type X X X 0.5 X
- *Oenothera*-type X X
- *Apiaceae* X 1.0 0.5
- *Gentiana* X
- *Phlox* X
- *Collomia* 0.5
- *Gilia* X X
- *Polemonium* 0.5 0.5 X
- *Plantago* X
- *Low-spine Asteraceae* 0.5 0.5 2.0
- *High-spine Asteraceae* 1.0 2.0 1.5 3.5 1.5
- *Artemisia* 15.0 18.5 13.0 21.0 20.0
- *Liguliflorae* X X X
- *Unknowns* 0.5 0.5 0.5 0.5 0.5

**Total Grains Counted:** 200 200 200 200 200

**Pollen Aggregates:**

- Pi-3b Pi-3b (Pi-3b) Pi-2b(4) Pi-4b
- Po-4b Po-3b(12) Po-18d Po-5c(12) Po-16a(30)
- (Si-16a) Hi-2a (Ar-4a) Ar-80b Lo-2a
- Ar-6b (Ar-3a) (Hi-18b)
- Ar-5a(11)
Table 8. Pollen Results from 48YE381 (continued from previous page; continued on next page).

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<td>Bw</td>
<td>Ab</td>
<td>Ab</td>
<td>BC/C</td>
<td>BC/C</td>
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**ARBOREAL POLLEN:**

- *Pinus*
  - 38.5 28.5 24.0 12.0 7.0 15.5
- *Pinus* fragments/3
  - 4.5 9.0 11.5 12.0 6.5 9.0
- *Picea*
  - 1.5 2.0 X 0.5 0.5
- *Pseudotsuga*
  - LFS 0.5 0.5
- *Abies*
  - 0.5 0.5 X 1.0 0.5
- *Juniperus*
  - 0.5
- *Populus tremuloides*
  - 0.5

**NON-ARBOREAL POLLEN:**

- *Ephedra torreyana-type* X
- *Poaceae*
  - 14.5 21.0 25.0 35.0 22.0 28.5
- *Cyperaceae*
  - 0.5
- *Lilaceae*
  - 0.5
- *Eriogonum-type*
  - X X 0.5 0.5
- *Cheno-Am*
  - 1.5 1.0 2.0 2.0 3.5 3.5
- *Sarcobatus*
  - X
- *Lewisia*
  - 0.5 X
- *Silene-type*
  - 1.0 1.0 X X 0.5 1.0
- *Ranunculaceae*
  - X
- *Draba-type*
  - 1.0
- *Rosaceae*
  - X X
- *Geranium*
  - 1.0 X 1.0 1.0
- *Gayophytum-type*
  - X X X
- *Oenothera-type*
  - 0.5
- *Apiaceae*
  - 0.5
- *Collomia*
  - X
- *Gilia*
  - 0.5
- *Polemonium*
  - X X
- *Plantago*
  - 0.5
- *Low-spine Asteraceae*
  - 0.5 0.5 0.5 0.5 0.5
- *High-spine Asteraceae*
  - 3.5 4.0 4.5 3.5 6.5 5.5
- *Artemisia*
  - 30.5 28.5 31.0 29.5 49.0 28.5
- *Liguliflorae*
  - 1.0 X 1.0
- *Unknowns*
  - 0.5 2.0 0.5 1.0 3.0 4.5

**Total Grains Counted:**

- 200 200 200 200 200 200

**Pollen Aggregates:**

- Pi-3b(4)
- Po-2a
- Pi-2a (Pi-2a)
- Po-3b
- Pi-2a
- Po-2b(16)
- Hi-7a
- Po-4a
- Po-2a(60)
- Po-9b
- (Hi-7b)
- (Ar-11b)
- Hi-2a
- Hi-2a
- Ch-3a
- Ar-2b(10)
- Ar-2a(9)
- (Ar-2a)

**Selaginella** X
Table 8. Pollen Results from 48YE381 (continued from previous page).

| Test Unit: | 17 | 18 | 18 | 4 | 5 | 6 |
| Feature:   | 11 | 10 | 12 | 4 | 5 | 6 |
| Soil:      | Ab (Ao) | Bw | Ab | Ab2 | Ab2 | Ab2 |
| Field Specimen: | 238 | 208 | 247 | 86 | 89 | 93 |
| Pollen Sample:   | 5 | 4 | 6 | 1 | 2 | 3 |
| Pollen Concentration: | 92,920 | 371,680 | 33,789 | 46,460 | 53,097 | 53,097 |

**ARBOREAL POLLEN:**

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**NON-ARBOREAL POLLEN:**

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<td>Pi-3a</td>
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</table>

Key: c = culturally enhanced, EA = Early Archaic, Fl. = Feature, H = Historic, H/LP = Historic/Late Prehistoric, LA = Late Archaic, LP = Late Prehistoric, MA = Middle Archaic, M/R = Modern/Recent, NC = Non-cultural, pw = pollen wash

Note: A "*" indicates less than 3.0 percent. Unknowns are excluded from the AP and NAP totals.
Figure 4. General Archaeological and Paleobotanical Chronology Pertaining to the Yellowstone Plateau.

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<td>Development of Mixed Spruce, Fir, and Pine Forests on Non-rhyolite Substrates, with Parkland but Less Aspen and Douglas-fir.</td>
<td>More Frequent Fires</td>
<td>Decreasing Organic Content in Lakes to &lt; 20% Due to Lower Water Temperatures and Less Biological Production</td>
<td>Pine Forest Dominance</td>
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<td>1000 _</td>
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<tr>
<td>8500 _</td>
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<tr>
<td>9000 _</td>
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<tr>
<td>9500 _</td>
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<tr>
<td>Paleolithic Period</td>
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<tr>
<td>10500 _</td>
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<tr>
<td>11000 _</td>
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<tr>
<td>11500 _</td>
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</tr>
<tr>
<td>12000 _</td>
<td></td>
<td></td>
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</tbody>
</table>

**Notes:**
- AP and NAP - Arbooreal and Non-Arbooreal Pollen
- GPA - Glacier Peak Ash, 12100-11450 BP
- LCO - Little Climatic Optimum, 1000-800 BP
- MA - Mazano Ash, 7000-6700 BP
By the Middle Archaic period, during the Altithermal, more local growths of pine became established and pine forest expanded at the expense of sagebrush steppe vegetation. Arboreal pollen dominance occurs by LatePrehistoric/Historic times (and probably by the Late Archaic period), and pine forest expansion continues up through modern times.

These 48YE381 pollen assemblages parallel patterns seen in early post-glacial lake and pond deposits in Grand Teton and Yellowstone parks, although the timing differs. Whitlock (1993) repeatedly found that initial colonizers in deglaciated regions were shrub and herbaceous meadow communities with sagebrush, grasses, sedges, and many kinds of wildflowers. These assemblages were established prior to 11,500 BP under cool/moist conditions (Whitlock 1993:187). In a different pollen core study of a pond near the Southeast Arm of Yellowstone Lake, Baker (1976:E22-E23) also found higher values of sagebrush, grass, and Cheno-Am pollen and lower values of pine in the deeper sediments, which date earlier than 11550 BP. The lower pine values are accompanied by low values of cool/moist indicators like spruce, and wet habitat indicators like birch and willow. Unlike Whitlock (1993), Baker (1976:E32) attributes the steppe elements, like sagebrush, to long-distance pollen influx rather than locally pioneering species. The current analysis of 48YE381 follows the interpretations by Whitlock (1993), as summarized in Figure 4.

In the early Holocene, Whitlock (1993:195) found that pine proportions began to increase sharply between 10500 and 9500 BP, with a concomitant decrease in non-arboreal pollen. Pine becomes dominant about 9500 BP and remains high after that time (Whitlock 1993:190). The warmer/drier conditions of the Altithermal especially favored the expansion of lodgepole pine forests (Whitlock 1993:195). Baker (1976:E22-E23) similarly found a marked increase in pine and decrease in non-arboreal pollen after 11,550 BP. Although there is a depositional hiatus is his pond study, Baker (1976:E22-E23) found high pine values about 5390 BP. Unlike these sequences, the establishment and expansion of pine in the vicinity of 48YE381 is far more gradual. Probably fluctuations in the water levels of Yellowstone Lake inhibited any rapid transition from colonizing shrub and meadow communities to conifer forest. This aspect of gradual environmental change would have affected the subsistence opportunities available during the Early, Middle, and Late Archaic, and Late Prehistoric activities at the site.

The pollen record from Feature 12, which dates to the Early Archaic period, is dominated by grass pollen followed by pine and sagebrush (Table 8, Figure 3). Overall, non-arboreal taxa exceed arboreal taxa. This parallels PC 3 from the pollen column. Feature 12 was located in Test Unit 18, and at a comparable depth to PC 3 (Figure 1). The grass values in both samples are sufficiently high to raise the possibility of cultural enhancement of the category through direct use (note aggregates in PC 3). This suggests a summer gathering activity.

Feature 10, which dates to the Late Prehistoric period, also was located in Test Unit 18 at a depth comparable to PC 8. Like PC 8, the pollen record, FS 208, is dominated by pine pollen. Sagebrush is secondary in importance followed by a low value of grass pollen. Aggregates of sagebrush pollen suggest this taxon could be enhanced in both samples (Table 8). A summer gathering activity of edible achenes or greens could be indicated.

It can be noted that throughout the pollen column there are suggestions of plant use as indicated by higher frequencies and/or occurrences of noteworthy aggregates. Hence, altogether, grass appears enhanced in PC 3, PC 7, and PC 9, while sagebrush appears enhanced in PC 4, PC 5, PC 6, PC 7, and PC 8. Further, the High-spine Asteraceae taxon might be enhanced in PC 5, PC 6, and PC 7 based on abundances of aggregates although the values are not outstanding. Like grass and sagebrush, use of plants in the High-spine Asteraceae group suggests summer activities. Two other categories, the lily family (Liliaceae) and bitterroot (Lewisia), also might reflect plant use (Table 7). Edible bulbs in the lily family can be gathered in the spring and summer, while the roots of bitterroot plants are more of a spring resource. An occurrence of bitterroot pollen in the surface sample testifies to the continued subsistence potential of the 48YE381 locality up through modern times. The inferences about prehistoric plant use are summarized in Table 9. Although it is likely that the pollen column in Test Unit 18 is not completely natural, the broad environmental trends indicated by the records remain clear.
<table>
<thead>
<tr>
<th>Pollen Conc.</th>
<th>Test Unit</th>
<th>Feature</th>
<th>Date BP</th>
<th>Age</th>
<th>FS</th>
<th>Paleo-Ecology Listed by Abundance (also Wet Habitat Plants)</th>
<th>Paleo-Ethnobotany Listed Taxonomically</th>
</tr>
</thead>
<tbody>
<tr>
<td>48YE380</td>
<td>1</td>
<td>B-shaped Hearth with FCR</td>
<td>1600 ± 40</td>
<td>LA</td>
<td>38</td>
<td>Pine, Sagebrush, Grass, Spruce</td>
<td>Cheno-Am, High-spine Asteraceae, Sagebrush</td>
</tr>
<tr>
<td>48YE381</td>
<td>1</td>
<td>Surface, Pine to Sagebrush, 0-1 cmbs</td>
<td>Modern Recent</td>
<td>NA</td>
<td>NA</td>
<td>Pine, Sagebrush, Grass, (Birch)</td>
<td>NA (Bitterroot)</td>
</tr>
<tr>
<td>371,660</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Pine, Sagebrush, Grass, (Birch)</td>
<td>NA (Bitterroot)</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>NA Pollen Column, 1-5 cmbs</td>
<td>Ao Horizon</td>
<td>H</td>
<td>NA</td>
<td>Pine, Sagebrush, Grass</td>
<td>None</td>
</tr>
<tr>
<td>135,840</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pine, Sagebrush, Grass</td>
<td>Bitterroot, Sagebrush</td>
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<tr>
<td>46,760</td>
<td>18</td>
<td>NA Pollen Column, 5-15 cmbs</td>
<td>Ao Horizon</td>
<td>LP/H</td>
<td>NA</td>
<td>Pine, Sagebrush, Grass</td>
<td>Grass, Bitterroot, High-spine Asteraceae, Sagebrush</td>
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<tr>
<td>39,789</td>
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<td>Pine, Sagebrush, Grass</td>
<td>Grass, Bitterroot, High-spine Asteraceae, Sagebrush</td>
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<td>74,836</td>
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<td>Bitterroot, High-spine Asteraceae, Sagebrush</td>
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<td>53,097</td>
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<td>Pine, Sagebrush, Grass</td>
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<td>123,893</td>
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<td>37,168</td>
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<td>1,184</td>
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<td>BC/C Hor.</td>
<td>S2</td>
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<td>Pine, Sagebrush, Grass</td>
<td>Bitterroot, High-spine Asteraceae, Sagebrush</td>
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<td></td>
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<td>Pine, Sagebrush, Grass</td>
<td>Bitterroot, High-spine Asteraceae, Sagebrush</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>NA Pollen Column, 80-90 cmbs</td>
<td>BC/C Hor.</td>
<td>S2</td>
<td>NA</td>
<td>Pine, Sagebrush, Grass</td>
<td>Bitterroot, High-spine Asteraceae, Sagebrush</td>
</tr>
</tbody>
</table>

Table 9: Ecological and Ethnobotanic Summary (continued on next page).
Table 9. Ecological and Ethnobotanic Summary (continued from previous page; continued on next page).

<table>
<thead>
<tr>
<th>Pollen Conc.</th>
<th>Test Unit</th>
<th>Feature</th>
<th>Date BP</th>
<th>Age</th>
<th>FS</th>
<th>Fl, ID, PC, PS, or PW</th>
<th>Paleo-Ecology (also Wet Habitat Plants)</th>
<th>Paleo-Ethnobotany Listed Taxonomically</th>
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<tbody>
<tr>
<td>48YE381</td>
<td>92,920</td>
<td>17 11</td>
<td>None, Ab (Ao)</td>
<td>H</td>
<td>238</td>
<td>5</td>
<td>PS</td>
<td>Pine, Sagebrush, Grass</td>
</tr>
<tr>
<td>371,660</td>
<td>18 10</td>
<td>FCR Concentration</td>
<td>760 ± 40</td>
<td>LP</td>
<td>208</td>
<td>4</td>
<td>PS</td>
<td>Pine, Sagebrush, Grass</td>
</tr>
<tr>
<td>33,789</td>
<td>18 12</td>
<td>FCR Concentration</td>
<td>5,670 ± 50</td>
<td>EA</td>
<td>247</td>
<td>6</td>
<td>PS</td>
<td>Grass, Pine, Sagebrush</td>
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<tr>
<td>48YE549</td>
<td>44 4</td>
<td>B-shaped Hearth with FCR</td>
<td>1,730 ± 40</td>
<td>LA</td>
<td>86</td>
<td>1</td>
<td>PS</td>
<td>Pine, Grass, Sagebrush, (Willow, Alder)</td>
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<tr>
<td>53,097</td>
<td>5 5</td>
<td>B-shaped Hearth with FCR</td>
<td>2,920 ± 40</td>
<td>MA</td>
<td>89</td>
<td>2</td>
<td>PS</td>
<td>Pine, Grass, Sagebrush</td>
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<tr>
<td>53,097</td>
<td>6 6</td>
<td>B-shaped Hearth with FCR</td>
<td>3,090 ± 40</td>
<td>MA</td>
<td>93</td>
<td>3</td>
<td>PS</td>
<td>Pine, Sagebrush, Grass</td>
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<td>48YE678</td>
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<td>NA NA</td>
<td>Surface, Pine/Fir Forest to Meadow Fringe, 0-1 cmbs</td>
<td>Modern/Recent</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Pine (Willow, Alder)</td>
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<td>NA 2</td>
<td>1</td>
<td>Small Hearth</td>
<td>240 ± 40</td>
<td>LP</td>
<td>59</td>
<td>NA</td>
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<td>Lodgepole pine, Pine</td>
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<tr>
<td>NA 4</td>
<td>3</td>
<td>FCR Concentration</td>
<td>220 ± 40</td>
<td>LP</td>
<td>157</td>
<td>NA</td>
<td>PW</td>
<td>Pine, Sagebrush, Grass, (Alder)</td>
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<tr>
<td>92,920</td>
<td>4 3</td>
<td>FCR Concentration</td>
<td>220 ± 40</td>
<td>LP</td>
<td>158</td>
<td>NA</td>
<td>PS</td>
<td>Sagebrush, Pine</td>
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<tr>
<td>NA 8</td>
<td>4</td>
<td>FCR Concentration</td>
<td>360 ± 40</td>
<td>LP</td>
<td>122</td>
<td>NA</td>
<td>Fl</td>
<td>Lodgepole pine, Pine, Fir</td>
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<tr>
<td>NA 2</td>
<td>NA</td>
<td>FCR Concentration</td>
<td>2880 ± 30</td>
<td>M/LA</td>
<td>24</td>
<td>NA</td>
<td>Fl</td>
<td>Lodgepole pine, Pine, Spruce, Fir</td>
</tr>
<tr>
<td>Pollen Conc.</td>
<td>Test Unit</td>
<td>Feature</td>
<td>Date BP</td>
<td>Age</td>
<td>FS</td>
<td>FL, ID, PC, PS, or PW</td>
<td>Paleo-Ecology Listed by Abundance (also Wet Habitat Plants)</td>
<td>Paleo-Ethnobotany Listed Taxonomically</td>
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<tr>
<td>48YE1383</td>
<td>2</td>
<td>1 Hearth</td>
<td>2290 ± 30</td>
<td>LA</td>
<td>12</td>
<td>NA</td>
<td>Pine</td>
<td>Pine</td>
</tr>
</tbody>
</table>


| 48YE1558    | 13        | 6 Small Heath  | 2790 ± 40 | M/LA| 154| NA                   | Pine                                                         | Pine                                   |

| 48YE1688    | 3         | NA Stone Circle | 780 ± 30  | LP  | 37 | NA                   | Pine                                                         | Pine                                   |

| 48YE1642    | 3         | 1 FCR Concentration | 1610 ± 30 | LA/LP| 15 | NA                   | Pine                                                         | Pine                                   |
|             | 4         | 2 FCR Concentration | 2890 ± 30 | M/LA| 19 | NA                   | Pine                                                         | Pine                                   |

| 48YE1680    | NA        | 1 Hearth        | 1690 ± 30 | LA  | 37 | NA                   | Pine                                                         | Pine                                   |
|             | 3         | 1 Hearth        | 1650 ± 30 | LA  | 68 | NA                   | Lodgepole pine, Pine, Dwarf-mistletoe, Fir                   | Pine, Lodgepole pine, Fir, Dicotyledoneae Unknown |

Table 9. Ecological and Ethnobotanic Summary (continued from previous page; continued on next page).
<table>
<thead>
<tr>
<th>Pollen Conc.</th>
<th>Test Unit</th>
<th>Feature</th>
<th>Date BP</th>
<th>Age</th>
<th>FS</th>
<th>Paleo-Ecology Listed by Abundance (also Wet Habitat Plants)</th>
<th>Paleo-Ethnobotany Listed Taxonomically</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>48YE2076 Elevation 2,362 m (7,750 ft); Modern Vegetation: conifers, sagebrush, grass.</td>
<td>NA 1</td>
<td>1 Basin-shaped Hearth</td>
<td>1500 ± 40</td>
<td>LA</td>
<td>7</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NA 1</td>
<td>1 Hearth</td>
<td>1380 ± 30</td>
<td>LP</td>
<td>14</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>24PA1081 Elevation 1,829 m (6,000 ft); Modern Vegetation: grass, sagebrush, also conifers, juniper, and deciduous trees nearby.</td>
<td>NA</td>
<td>NA</td>
<td>3 Hearth</td>
<td>NA</td>
<td>184</td>
<td>NA</td>
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<td>NA</td>
<td>2</td>
<td>NA Excavation Level 3</td>
<td>Recent</td>
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<td>163</td>
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<td>NA</td>
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<td>NA Excavation Level 4</td>
<td>NA</td>
<td>172</td>
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<td></td>
<td>NA</td>
<td>2</td>
<td>NA Excavation Level 5</td>
<td>1340 ± 30</td>
<td>LP</td>
<td>167</td>
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<tr>
<td></td>
<td>24YE355 Elevation 1,577 m (5,175 ft); Modern Vegetation: sagebrush, grass.</td>
<td>74,336</td>
<td>4</td>
<td>37 B-shaped Hearth with FCR</td>
<td>1600 ± 70</td>
<td>LA</td>
<td>413</td>
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<td></td>
<td>4,589</td>
<td>6</td>
<td>4 B-shaped Hearth with FCR</td>
<td>4/37 overlap</td>
<td>LA</td>
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<td></td>
<td>24,779</td>
<td>5</td>
<td>6 B-shaped Hearth with FCR</td>
<td>2530 ± 40</td>
<td>LA</td>
<td>424</td>
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<td>14,296</td>
<td>7</td>
<td>3 B-shaped Hearth with FCR</td>
<td>1670 ± 50</td>
<td>LA</td>
<td>427</td>
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<td>24YE357 Elevation 1,594 m (5,230 ft); Modern Vegetation: sagebrush, grass.</td>
<td>10,819</td>
<td>18</td>
<td>8.1 Heath in Ft. 8 Stone Circle</td>
<td>270 ± 50</td>
<td>LP</td>
<td>124</td>
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<td>4,322</td>
<td>23</td>
<td>4.2 Heath in Ft. 4 Stone Circle</td>
<td>4,520 ± 40</td>
<td>MA</td>
<td>106</td>
</tr>
</tbody>
</table>

Key: B-shaped = Basin-shaped, Conc. = Concentration, Dicot. Unk. = Dicotyledoneae Unknown(s), EA = Early Archaic, FCR = Fire-cracked Rock, Fl = Flotation, FS = Field Specimen, H = Historic, ID = Specimen Identification, LA = Late Archaic, LP = Late Prehistoric, LPH = Late Prehistoric/Historic, MA = Middle Archaic, M/LA = Middle/Late Archaic, NA = Not Applicable, PC = Pollen Column, PS = Pollen Sample, PW = Pollen Wash.
Feature 4 from Test Unit 4 dates to the Late Archaic Period. The pollen record is dominated by pine, followed by grass and sagebrush (Table 8, Figure 3). Arboreal taxa exceed non-arboreal taxa. This suggests a shift towards more forested conditions earlier than is indicated in the pollen column where PC 6, which equates with the Late Archaic period, still exhibits non-arboreal pollen dominance. There are no strong indications of plant use in the Feature 4 record, whereas some enhancement of the High-spine Asteraceae and sagebrush categories is suggested in PC 6. Hence, the arboreal pollen proportion could be slightly suppressed relative to the higher non-arboreal taxa. If so, the Feature 4 record would indicate arboreal pollen dominance at 48YE381 by about 1730 BP.

In Test Unit 5, the pollen record from Feature 5, which dates to the Middle Archaic period, is moderately dominated by pine followed by grass and sagebrush. The total proportion of non-arboreal pollen in the count, however, exceeds that of arboreal pollen. There is no outstanding evidence for plant use in the pollen record. From an environmental perspective, the results are comparable to PC 4 and PC 5 from the pollen column.

The pollen record from Feature 6 in Test Unit 6, which also dates to the Middle Archaic period, is dominated by pine followed by sagebrush and grass. Overall, non-arboreal taxa exceed arboreal taxa. The Cheno-Am and sagebrush taxa appear slightly enhanced here, and could reflect plant use. In general, however, the results are comparable to PC 4 and PC 5 from the pollen column.

The remaining sample in the pollen study at 48YE381 is from Feature 11, which proved to be a non-cultural Historic period context. Pine pollen strongly dominates the record, with a moderate value of sagebrush and low value of grass pollen. Arboreal taxa exceed non-arboreal categories and the results are similar to the surface control sample.

No flotation or specimen identification samples were analyzed by this author from 48YE381. Elsewhere, wood charcoal from Features 4, 5, 6, 10, 11, and 12 was identified by Katie Parker as pine, probably lodgepole pine (MacDonald and Livers 2011:204). Also, pine needle and twig fragments and a pine bud were found in Feature 5. With the exception of Feature 12, these findings are fairly consistent with the pollen records from the pollen column and features, which suggest some local presence of pine by the Middle Archaic period. The pine wood charcoal in Feature 12, however, raises the possibility of local pine presence by the Early Archaic period. Perhaps a few scarce trees occurred closer to the site at an earlier time than is indicated in the pollen results, and were exploited as a preferred fuel source. Ethnobotanically, the use of pine for fuel adds another item to the variety of plants utilized at 48YE381.

48YE1558

Site 48YE1558 is located at an elevation of 2,362 m (7,750 ft) near 48YE381. This site is located in an open meadow near Lake Lodge. The modern vegetation across the site includes sagebrush steppe, conifer stands, and meadow openings. Of the three flotation samples analyzed from this site, one was collected from a small hearth, Feature 6, which dates to the Middle/Late Archaic transition, and two were collected from Late Archaic rock concentrations, Features 7 and 8 (Table 2).

Only pine wood was identified in Feature 6 (Gish 2010). Feature 7 yielded lodgepole pine needle fragments, pine wood, and needle fragments of spruce, fir, and limber pine. Feature 8 produced similar, plus lodgepole pine female cone scale fragments (Table 5).

These results suggest at least local pine presence during the Middle/Late Archaic, and a more varied conifer forest of lodgepole pine, limber pine, spruce, and fir by the Late Archaic period. This could indicate a shift in vegetation conditions over time, but the paucity of burned finds in Feature 6 could account for the contrast. Also, although only coniferous forest vegetation is documented in the past at 48YE1558, the full vegetation picture might have been different. No pollen samples were analyzed here, and these usually provide a broader basis for reconstructing past vegetation. It remains unclear, then, whether the local setting was substantially different prehistorically from the modern condition of sagebrush steppe, conifer stands, and meadow openings. Ethnobotanically, the burned materials all indicate fuel use of conifer resources.

48YE549

Site 48YE549 is situated at an elevation of 2,379 m (7,775 ft) at the edge of conifer forest bordering a small open meadow on terraces adjacent to the Yellowstone River, north of Fishing Bridge. The conifer forest is
dominated by lodgepole pine in the dry, sandy soils in the immediate site vicinity with some limber pine and occasional fir trees. Downhill from the site towards the lake, soils are more moist and fir is more abundant along with Engelmann spruce (*Picea engelmannii*) at the expense of pines. The meadow opening is fairly dry with a variety of grasses, little clubmoss (*Selaginella sp.*), and numerous wildflower species. Among the latter are sulphur buckwheat, wild strawberry, lupine (*Lupinus sp.*), phlox (*Phlox sp.*), pussytoes (*Antennaria sp.*), and yarrow (*Achillea sp.*). Occasional sedges occur and moisture conditions appear to vary across the meadow. Sagebrush is conspicuously absent in the site vicinity, although it is present regionally.

Three pollen and four flotation samples were analyzed from 48YE549 (Gish 2010). The pollen samples were collected by this author and members of the 2010 UMT Archaeological Field School. They consisted of a surface control sample and two samples from Feature 3, a concentration of fire-cracked rocks. Of the Feature 3 samples, FS 157 PW was a pollen wash of fire-cracked rocks and FS 158 was a soil sample collected beneath the rocks. The flotation samples were collected from: Features 1 and 2, both small hearths, Feature 3, and Feature 4, which is another fire-cracked rock concentration (Table 2). All four features date to the Late Prehistoric period.

The surface control sample was collected from the pine dominated forest and meadow fringe. It did not include the fir and spruce dominated forest closer to the lake or the main part of the meadow. The pollen record is dominated by pine pollen with low values of fir, spruce, sagebrush, and grass (Table 4, Figure 3). The pine forest, then, is well reflected in the pollen rain. Both willow and alder were recorded, indicating some influx of pollen from riparian vegetation along the nearby lake.

Of the two subsurface samples, pine dominates FS 157 PW, followed by sagebrush, and a low value of grass. Alder pollen also was recorded. In contrast, the FS 158 record is dominated by sagebrush (note aggregates), followed by pine (Table 4, Figure 3). In FS 158, the overall proportion of non-arboreal pollen exceeds that of arboreal pollen, while in FS 157 PW arboreal taxa still predominate (Figure 2). These differences are noteworthy considering that both samples are presumed to reflect the same contemporaneous activity. Sagebrush aggregates, however, are outstanding in FS 158, and cultural enhancement of the taxon through plant use could explain the high value. From this perspective, it is also possible that the sagebrush value in FS 157 PW, although lower, might also be enhanced by plant use. If so, a summer gathering activity is implied. In any case, the sagebrush values in both samples are far higher than in the surface sample. Even though the values appear enhanced culturally, they still suggest that sagebrush shrubs grew closer to the site, or locally, in the past in contrast to their modern absence. Given the recent date for Feature 3 of 220 ± 40 BP, this indicates a major shift in vegetation conditions over a short time span. An explanation for this is unclear at this time. The pines, sagebrush, and some of the forbs, like wild-buckwheat-type and groundsmoke-type suggest dry soils at the site, while Jacobs ladder is more suggestive of moist soils. Moisture conditions probably varied slightly across the site in the past. The alder pollen in FS 157 PW reflects the presence of riparian growths along the lake.

The flotation sample, FS 158 (Fl) analyzed from Feature 3 does not shed any additional light on the possible local presence and use of sagebrush. The sample was small (0.25 liters), and only an eight-piece wood count was possible, and all fragments were identified as pine (Table 5). Lodgepole pine female cone scale fragments and needle fragments, and a limber pine female cone scale fragment and needle fragments also were identified, but no sagebrush remains. The burned materials do verify the importance of pine forest in the past, as well as indicating the use of conifer resources for fuel.

The other flotation samples from 48YE549 also yielded evidence of pine use but no sagebrush. The Feature 1 sample produced pine wood and lodgepole pine female cone scale and needle fragments. In Feature 2, burned materials consist of lodgepole pine female cone scale and needle fragments, pine wood, and limber pine female cone scale and needle fragments. The Feature 4 remains include lodgepole pine female cone scale and needle fragments, and fir needle fragments. All of the finds reflect the use of fuels and emphasize the local predominance of pine forest, with some fir, during the Late Prehistoric period.
48YE2075
Site 48YE2075 is located on the northeast shore of Yellowstone Lake near the confluence of Cub Creek at an elevation of 2,362 m (7,750 ft). The vegetation in the vicinity includes lodgepole pine, sagebrush, and grasses. A single flotation sample was analyzed from a Late Archaic Period basin-shaped hearth, Feature 1.

A 50-piece burned wood count was obtained from this hearth. Forty-eight pieces were identified as pine, while two were identified to the rose family. Lodgepole pine needle fragments also were found.

The flotation results indicate the presence of lodgepole pine in the past, like today, as well as members of the rose family. The source for the rose family wood is unclear, as numerous shrub members of this family occur in the park along with many herbaceous species. A likely possibility, however, is western mountain ash (Sorbus scopulina). McDougall and Bagley (1956:98) specifically note the presence of this shrub or small tree along Cub Creek; although it is uncommon within the overall park area. Many members of the rose family produce edible fruits, roots, and young shoots (Table 7), but the use in Feature 1 appears to be limited to fuel. No other exploitation of the potentially varied vegetation along Cub Creek is indicated.

48YE678
This site is situated on the northeast shore of Yellowstone Lake at an elevation of 2,382 m (7,750 ft), near the confluence of Clear Creek with the lake. The modern vegetation includes lodgepole pine forest near an open meadow. Two flotation samples were analyzed from basin hearths, Features 1 and 2 (Table 2) (Gish 2010). Both features date to the Late Archaic period.

A 50-piece count of burned wood was obtained from Feature 1. Two pieces were identified as sagebrush, while the others are pine. Other burned materials in Feature 1 are needle fragments of lodgepole pine, fir, and limber pine. Feature 2 yielded pine wood, lodgepole pine female cone scale and needle fragments, spruce needle fragments, and fir needle fragments (Table 5).

The results indicate a mixed conifer forest and sagebrush steppe community at 48YE678 during the Late Archaic period. This possibly reflects a change in vegetation conditions between the Late Archaic and modern times, but the information on the modern flora is too limited to be certain. All of the burned materials in Features 1 and 2 imply fuel use in the hearths.

48YE1642
Site 48YE1642 is located at an elevation of about 2,365 m (7,760 ft) in a grassy opening along the lake shore within the southwest portion of Yellowstone Lake. The vegetation includes forbs, adjacent pines, and possibly other conifers in the vicinity. No sagebrush was observed. A specimen identification sample was analyzed from Feature 1, a concentration of charcoal and fire-cracked rock that dates to the Late Archaic/Late Prehistoric transition, and both a flotation sample and specimen identification sample were studied from Feature 2, another charcoal and fire-cracked rock concentration that dates to the Middle/Late Archaic transition (Table 2).

In Feature 1, the specimen identification sample, FS 15, was determined to be pine. The specimen identification sample, FS 19, from Feature 2 consisted of five pieces of pine wood, while the flotation sample, FS 20, yielded pine and sagebrush wood, a lodgepole pine female cone scale fragment and needle fragments, and fir needle fragments. All of the remains suggest fuels used in the features.

Ecologically, the pine in both features, and sagebrush in Feature 2, suggest dry conditions, while the fir in Feature 2 also implies more varied surroundings with locally moist habitats. The results from Feature 1 are too limited, however, to infer changes in vegetation between the earlier and later activities at the site. Further, it is difficult to assess differences between the prehistoric settings and modern vegetation, although the sagebrush presence in Feature 2 contrasts with the modern absence of this shrub. Like many of the sites along Yellowstone Lake, 48YE642 had a conspicuous abundance of dead trees from recent forest fires, and the full effects of the fires on contemporary vegetation at the site location are unknown.

48YE1660
Site 48YE1660 is located at an elevation of about 2,377 m (7,800 ft) on the southwest shore of Yellowstone Lake. The modern vegetation includes conifer forest and a meadow opening. Specimen identification samples and
flotation samples were analyzed from two Late Archaic period hearths, Features 1 and 2 (Table 2) (Gish 2011b).

In Feature 1, the specimen identification sample, FS 27, consisted of several pieces of burned wood (Table 5). The six largest were determined to be pine (Gish 2011b). The flotation sample, FS 62, yielded lodgepole pine female cone scale and needle fragments, pine wood, one fir needle fragment, a dwarf-mistletoe (*Arceuthobium cf. americanum*) stem fragment, and an unidentified Dicotyledoneae seed fragment.

The specimen identification sample, FS 37, from Feature 3 included numerous pieces of wood. The 20 largest were determined to be pine. In the flotation sample, FS 38, lodgepole pine remains are common with female cone and cone scale fragments, needle fragments, and one seed fragment. Other materials in FS 38 are pine wood, limber pine needle fragments, one grass grain, and an unidentified Dicotyledoneae seed, seed fragment, and bud fragment.

From an ecological perspective, a conifer forest, dominated by lodgepole pine, characterized the site in the past. Conditions apparently were dry, although the single fir needle also indicates more moist habitats nearby. The herbaceous remains imply a meadow community, although ground cover plants in the forest could be represented. The setting during the Late Archaic was probably comparable to the modern situation.

Ethnobotanically, the conifer remains in both hearths reflect fuels. Dwarf-mistletoe is parasitic on pine so the stem fragment in Feature 1 was probably introduced into the hearth through pine use. Small seed processing for food is indicated in Feature 1 even though the evidence is limited to a single unidentified Dicotyledoneae seed fragment. In Feature 3, small seed processing is documented by the grass grain, and Dicotyledoneae seed and seed fragment. Additionally, the pine seed fragment in Feature 3 could reflect use of edible pine seeds (Table 7). The Dicotyledoneae bud fragment further implies use of greens. The 48YE1660 location might have been particularly favorable for gathering activities during the Late Archaic period.

48YE2190

This site is situated at an elevation of about 2,377 m (7,800 ft), and the modern vegetation includes conifers and a meadow. The site is located on the southwest shore of Yellowstone Lake. A specimen identification sample, FS 9, and a flotation sample, FS 14, were analyzed from a Late Prehistoric hearth, Feature 1 (Table 2) (Gish 2011b).

FS 9 was identified as pine wood (Table 5). The flotation sample yielded pine wood, a lodgepole pine female cone scale fragment and needle fragments, and unidentified Dicotyledoneae wood. Lodgepole pine apparently was present at the site in the past and was exploited for fuel. Although meadow vegetation is not evident, conditions might have been comparable to the modern setting.

48YE1384

This site is located at an elevation of about 2,377 m (7,800 ft), and the modern vegetation includes conifer forest and an open meadow. This site is located on the southwest shore of Yellowstone Lake. A single flotation sample, FS 16, was analyzed from a Late Prehistoric hearth, Feature 1 (Table 2) (Gish 2011b).

The flotation sample yielded lodgepole pine female cone scale and needle fragments, pine wood, and needle fragments of limber pine, spruce, and fir (Table 5). Also, a wild-buckwheat seed was found. This last suggests food use and a summer gathering activity, while the other materials reflect fuels in the hearth. Ecologically, a mixed conifer forest apparently existed locally at the time the site was occupied, while the wild-buckwheat occurrence probably relates to a meadow community. The prehistoric vegetation could have been similar to the modern setting.

48YE1383

Site 48YE1383 is situated at an elevation of about 2,377 m (7,800 ft) on the southwest shore of Yellowstone Lake. The modern vegetation includes conifers and a meadow. A specimen identification sample, FS 12, and flotation sample, FS 6, were analyzed from Feature 1, a Late Archaic period hearth (Table 2) (Gish 2011b). FS 12 was identified as pine. The flotation sample yielded lodgepole pine needle fragments, spruce needle fragments, aspen/willow wood, pine family/juniper wood (most likely pine), and unidentified Dicotyledoneae wood (Table 5).

The results, then, indicate a variety of woods and conifer needles were used as fuels in the hearth.
Ecologically, the pine suggests a dry setting, while the spruce indicates more mesic conditions, and the aspen/willow implies either successional vegetation or riparian growths along the lake. Apparently, a variety of habitats were accessible locally during the Late Archaic period. The vegetation seems more varied than today, but the information on the modern vegetation is limited, and change is not necessarily indicated.

48YE1332
Site 48YE1332 is located on the west shore of the South Arm of Yellowstone Lake at an elevation of about 2359 m (7,740 ft). The modern vegetation includes pine, probably other conifers, grasses, and forbs. A single flotation sample, FS 24, was analyzed from a fire-cracked rock and charcoal concentration, which dates to the Middle/Late Archaic transition.

FS 24 yielded pine wood, one lodgepole pine female cone scale fragment and needle fragments, spruce needle fragments, and a fir needle fragment. All of these reflect fuels in the feature. Ecologically, the remains suggest variable dry and moist conditions in the site vicinity. The setting might have been comparable to the modern situation.

48YE1588
This site is situated along the west shore of the Southeast Arm of the lake at an elevation of about 2,365 m (7,760 ft). The modern vegetation includes pine, possibly other conifers, grasses, and forbs. A single specimen identification sample, FS 37, was analyzed from the fill of a stone circle, which dates to the Late Prehistoric period.

FS 37 consisted of five pieces of wood charcoal, which reflect fuels used within the feature. All five pieces were determined to be pine. Ecologically, the prehistoric setting appears to have been dry, and possibly comparable to the modern situation.

48YE1499
Site 48YE1499 is situated at an elevation of about 2,377 m (7,800 ft), and the modern vegetation includes conifers and a meadow. The site is located near the confluence of Trail Creek and the Yellowstone River on the far southeast corner of Yellowstone Lake. A single flotation sample, FS 15, was analyzed from a Late Prehistoric hearth, Feature 14 (Table 2) (Gish 2011b).

The flotation sample produced needle fragments of lodgepole pine, limber pine, and spruce, pine and aspen/willow wood, and two unidentified Diocotyledoneae seeds (Table 5). Ecologically, the lodgepole and limber pine materials imply a dry location, while the spruce suggests moist conditions, and the aspen/willow indicates successional or wet habitat vegetation. Apparently, a variety of habitats occurred across the site in the past. Most of the burned remains relate to fuels in the hearth, while the two seeds suggest small seed processing for food.

24PA1081
Site 24PA1081 is located northeast of Gardiner, Montana, at an elevation of 1,829 m (6,000 ft) near Little Trail Creek (MacDonald and Maas 2011). The modern vegetation includes grass and sagebrush, with conifers and juniper nearby, and deciduous trees along the creek. A specimen identification sample, FS 235, and a flotation sample, FS 131, were analyzed from a Late Prehistoric hearth, Feature 3 (Table 2) (Gish 2011b). Additionally, a flotation sample, FS 167, was evaluated from Excavation Level 4 in Test Unit 2, and a specimen identification sample, FS 176, was examined from Excavation Level 5 in Test Unit 2. These contexts also date to the Late Prehistoric period.

FS 235 from Feature 3 consisted of two pieces of aspen/willow wood and one piece of alder (Table 5). The flotation sample, FS 131, yielded pine wood, alder, and unidentified Diocotyledoneae wood. One lodgepole pine female cone scale fragment also was found.

The flotation sample from Excavation Level 4 produced pine family/juniper wood, pine wood, a lodgepole pine female cone scale fragment, and one juniper seed fragment. The specimen identification sample from Excavation Level 5 consisted of several pieces of wood; the six largest are pine.

Ethnobotanically, most of the remains point to fuel use at the site. The juniper seed fragment, however, implies food processing. Juniper berries can be eaten raw, boiled, dried and ground for meal, or used for tea and flavoring (Table 7). Ecologically, the pine and juniper indicate dry conditions, while the aspen/willow and alder wood probably reflect plants growing along Little Trail Creek. In general, the prehistoric and modern vegetation settings could be similar although the sagebrush
component is not represented in the Late Prehistoric contexts.

The 24PA1081 results can be compared with the two sites previously studied from the Gardiner Basin region (Gish 2010, 2011a; MacDonald and Hale 2011). Sites 24YE355 and 24YE357 are at lower elevations in sagebrush steppe vegetation with pine, juniper, western mountain ash, and willows along the nearby Yellowstone River.

The four pollen records from Late Archaic hearths at 24YE355 are dominated by pine with members of the Cheno-Am group or grass of secondary value followed by sagebrush (Table 9) (Gish 2010, 2011a). Greasewood (Sarcobatus) is present in all the counts, and the occurrences suggest dry, alkaline conditions, and also a high water table. The Cheno-am representations also could relate, in part, to salinity-tolerant shrubs. Ecologically, then, the vegetation at 24YE355 in the past might have been shrubby, with pine limited to non-saline areas, despite the dominance of pine in the pollen rain. There are few suggestions of plant use, with the exception of Cheno-Am and greasewood in one hearth, Feature 4 (Table 9). Elsewhere, flotation samples from this site, which were analyzed by Kathryn Puseman, yielded a variety of exploited plants including conifers, sagebrush, riparian taxa, and small seeds (MacDonald 2008:139-140, 145-146, 149-150).

The two pollen records from 24YE357 are strikingly different. Non-arboreal taxa dominate in FS 106 from a Middle Archaic period hearth, Feature 4.2. Several of the categories appear culturally enhanced, which could be suppressing the arboreal pollen proportions to some extent, but the arboreal representations, like pine, still seem low naturally (Table 9) Gish 2010, 2011a). In contrast, FS 124, from a Late Archaic hearth, Feature 8.1, has a much higher value of pine co-dominant with Cheno-Am pollen followed by sagebrush and grass. Greasewood pollen also was recorded, and the results are suggestive of a prehistoric setting like that at 24YE355. The two very different records at 24YE357 echo the findings at 48YE381, where pine values were lower in Middle Archaic counts than in Late Prehistoric samples.

Ecologically, then, the settings at 24YE355 and 24YE357 were probably more saline than that at 24PA1081, although also dry. Conifers, shrubs, and riparian vegetation were accessible locally at all three sites. Ethnobotanically, use of small seeds or greens is illustrated palynologically at 24YE355 during the Late Archaic, and at 24YE357 during the Middle Archaic. Small seed use also is documented in the macrobotanical analysis of Late Archaic features at 24YE355 (MacDonald 2011). Most of the macrobotanical remains, however, reflect hearth fuels. This is also the case at 24PA1081, although the recovery of the juniper seed suggests food processing.

Conclusion

The environmental and ethnobotanic results from the 14 Yellowstone Lake sites and three Gardiner area sites are summarized in Table 9. The paleo-ecology column lists taxa by dominance plus wet habitat indicators. The paleo-ethnobotany column lists plants by taxonomic order.

The most abundantly represented taxa in the macrobotanical samples are lodgepole pine, pine, and limber pine, followed by spruce and fir (Table 5). All of these items reflect the use of fuels, with the exception of a lodgepole pine seed fragment at 48YE1660. Sagebrush, aspen/willow, alder, and rose wood also were used for fuel at various sites. Food items are sparse throughout, and many of the fragments could not be identified specifically due to a lack of well-preserved morphological details. Grass use, however, is indicated at 48YE380 and at 48YE1660 during the Late Archaic period. Sedge and Cheno-Am are further documented at 48YE380, along with unidentified plant remains. Wild-buckwheat was utilized at 48YE1384 during the Late Prehistoric period. Further, unidentified small seeds were utilized at 48YE1499 during the Late Prehistoric, and at 48YE380 and 48YE1660. Bud remains also were found at these latter two sites, suggesting some processing of greens. Juniper was used for food at the lower elevation site, 24PA1081.

Three of the key taxa in the pollen samples are pine, sagebrush, and grass, although there are contrasts over time (Figure 2). Temporal variability is well illustrated at 48YE381 where initially high values of non-arboreal taxa in the pollen column decrease as pine forests expand during the Altithermal up through modern times. This trend is mirrored, in part, in the features at 48YE381. At 48YE549, there also appears to be a contrast between the Late Prehistoric and modern vegetation, with more
sagebrush in the past, although no sagebrush was documented in the macrobotanical samples from the site. At 48YE380, both the pollen and macrobotanical samples suggest vegetation in the Late Archaic period was comparable to the modern setting of sagebrush, conifers, and meadow openings. The pollen results from all three sites suggest plant use, with sagebrush and small seeds or greens at 48YE380, sagebrush and a larger variety of herbaceous plants at 48YE381, and sagebrush at 48YE549 (Table 9). At 48YE380 and 48YE549 the inferences are, in part, verified by the macrobotanical results. This is not the case at 48YE381 where macrobotanical remains in the previous study were sparse and limited to conifers (MacDonald and Livers 2009:204). Interestingly at 48YE381, the pollen results suggest continued utilization of non-arboreal resources against a background of major ecological changes from Early Archaic through Late Prehistoric times. As pines and conifer forest expanded, the proportions of non-arboreal plants declined. Sagebrush and grasses were both affected. Although conifer forest offers its own variety of subsistence resources, like edible pine seeds, a depletion of non-arboreals almost certainly affected prehistoric subsistence activities. Locations where such resources persisted might have been particularly important in the regional subsistence pattern at higher elevations. The value of non-arboreal food resources also is apparent at the lower elevation sites with use of Cheno-Am and greasewood plants suggested at 24YE355 and exploitation of several members of the sunflower family indicated at 24YE357.

References Cited


