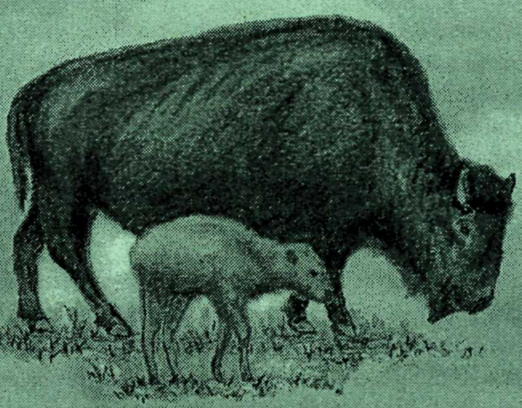
The Buffalo Chip

Resource Management Newsletter
Yellowstone National Park
Early spring 2003



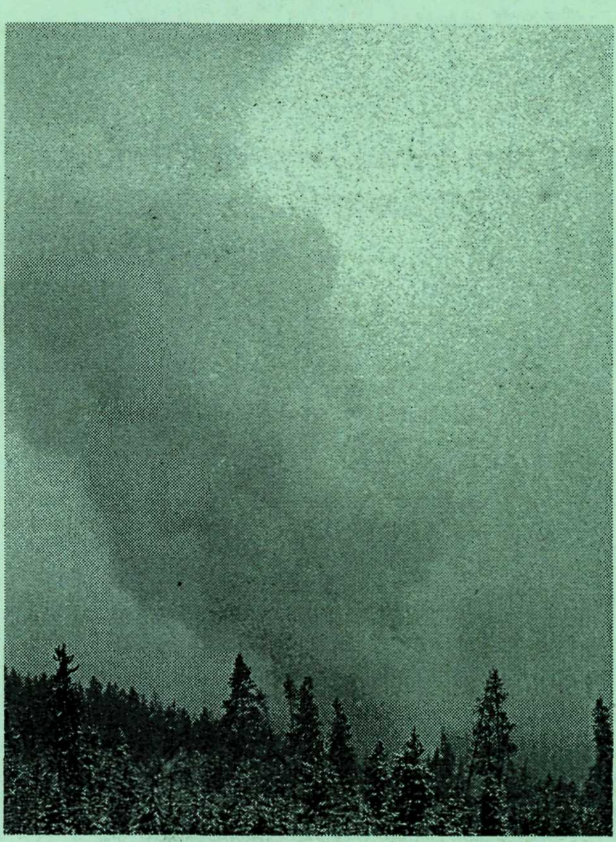
What's inside

What's Up at Norris?

STEAMBOAT PUZZLES SCIENTISTS

by Cheryl Jaworowski, Virginia Warner, and Alice Wondrak

NPS PHOTOS



Steamboat Geyser erupts

Scientists are examining data that may or may not indicate a recent major eruption of Steamboat Geyser—at this point, no one is quite sure. On March 26, at about 9:45 a.m., YCR staff received a report that the geyser was in its steam phase. Despite overcast conditions and light snow showers that morning, the plume was clearly visible from the Norris Geyser Basin trailhead *(above)*.

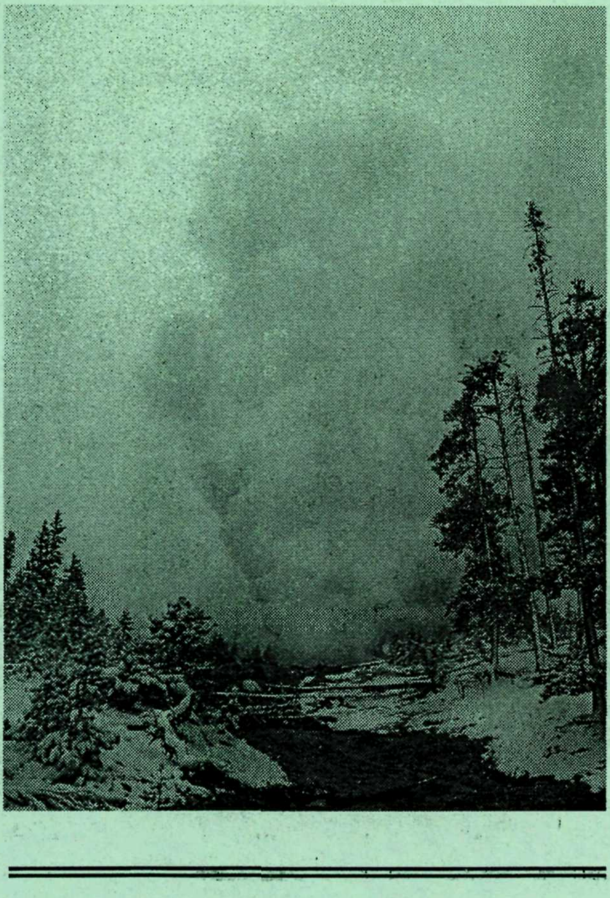
Since its first known eruptions in 1878, major eruptions have occurred numerous times over periods of a year or two, followed by decades of relative inactivity. Steamboat is the world's tallest geyser; major eruptions can reach 250 feet in height, dispersing thousands of gallons of water in less than 20 minutes. An only slightly less dramatic steam phase follows the water phase. At the source of the steam, the deep rumbling within the cone is registered more as a physical sensation than an aural one.

So what happened? Based on eyewitness accounts of the steam phase, visible evidence in the vicinity of Steamboat, and data collected by on-site temperature monitors, this most recent eruption was unusual. Instruments recorded increased amounts of water on Sunday, March 22, and again on Wednesday, March 26. It's possible that there were a series of minor eruptions, with numerous pulses of water.

Or there may have been one eruption unlike any known eruption that has occurred in the past. Park geologist Henry Heasler said the data certainly indicates that this eruption was not typical.

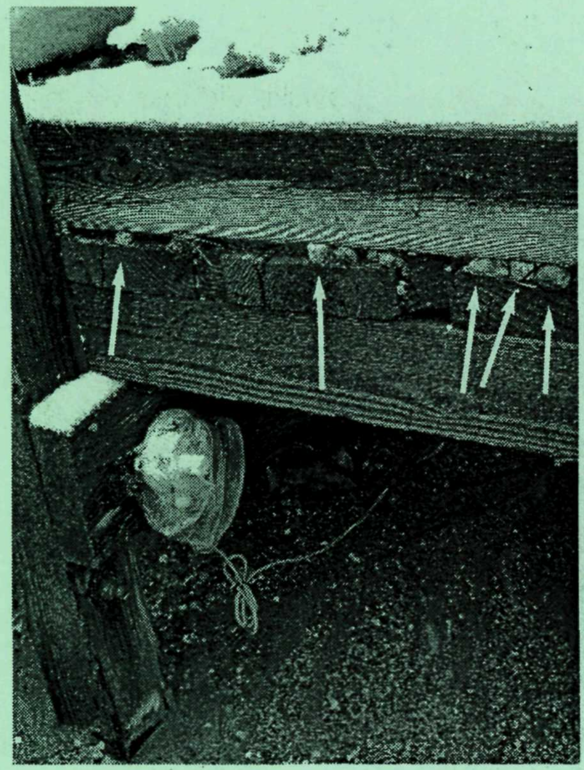
Geomorphic effects

When Steamboat erupts, water flows down both a main and a secondary channel. In this case, the majority of the water flowed south down the main channel (below). Scientists visiting the site on April 1 noted pine needles and branches along the sides of the main channel, indicating the level of water that had recently transported coarse debris downstream. At the footbridge that crosses the main channel about 80 meters downstream from the geyser, the width of water flow varied from 4.1 to 4.6 meters.



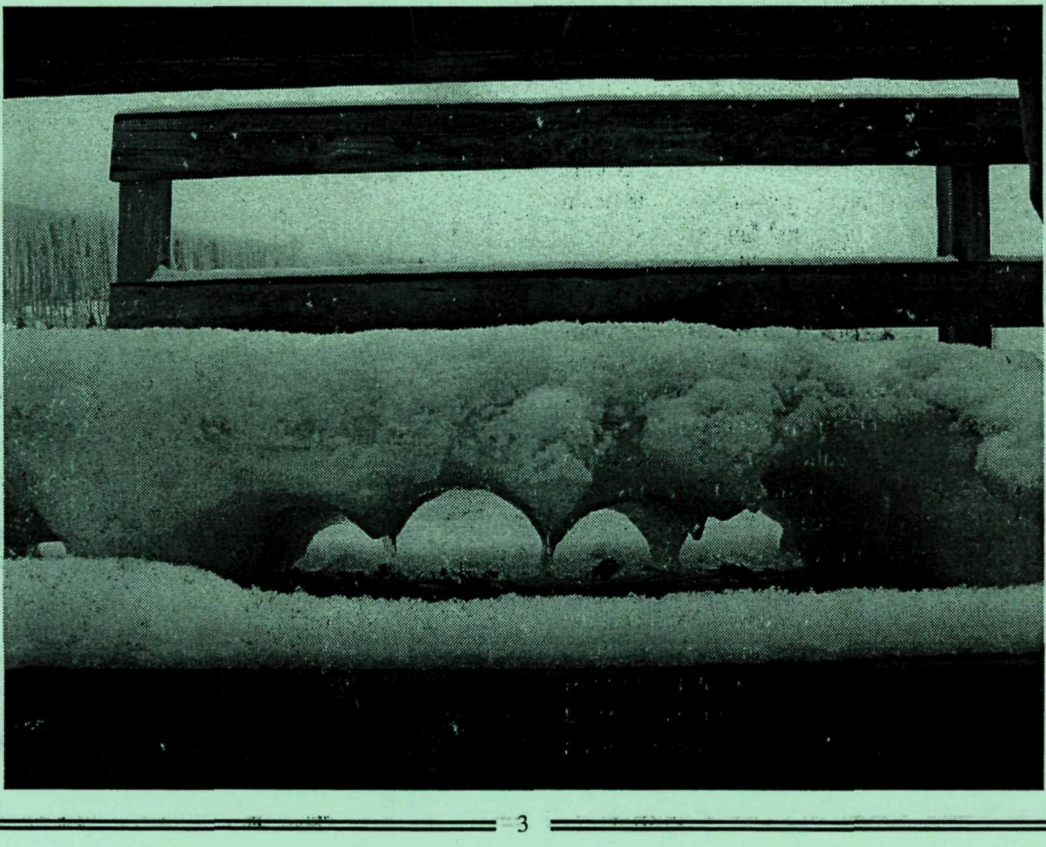
Update

Steamboat Geyser erupted again between 03:53:00 and 03:54:30 on the morning of April 27, 2003.



Data from this temperature logger *(above left, right),* deployed under the footbridge that corssees the main channel about 80 meters downstream from Steamboat, showed a pulse of hot water (71°C) arriving at the logger between 32 minutes 30 seconds and 33 minutes 30 seconds past midnight on March 26. As the water flowed down the main channel, it buried the logger's temperature sensor (attached to the end of the wire), and deposited angular debris (cobble-to-sand-size particles) on top of the footbridge *(above right).* The depth of water flowing over the footbridge must have been at least 0.7 meters high, because the distance between the ground and the first horizontal 2×4 of the railing of the footbridge is 0.7 meters.

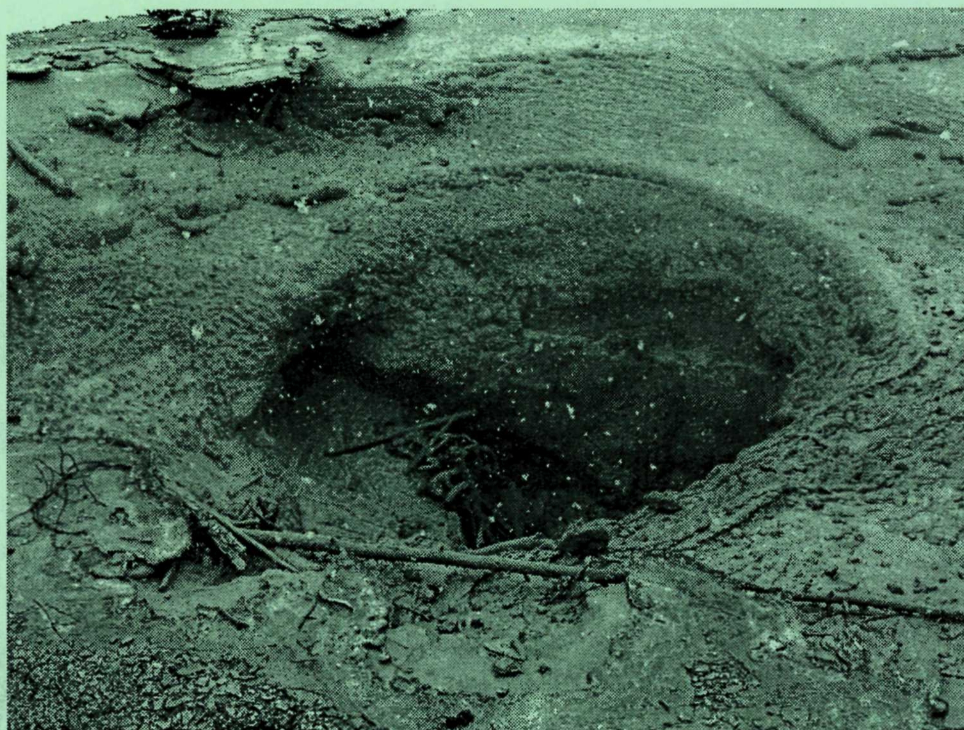
There are other clues that some kind of eruption occurred. *Below*, it appears that mud, debris, and heated water washed over the boardwalk, melting through the bottom of a strip of packed snow.



(Above, left) YCR cartographic technician Steve Miller transfers data to a portable card to be shuttled back to the YCR. The recorded information will help determine what occurred here. Did Steamboat have a major eruption, or were there a series of smaller events?

A close-up *(above, right)* of the pocket-sized "Hobo Shuttle," which reads the information from the data logger in the field and then saves it to be downloaded to a desktop computer in the YCR.

(Below) Downstream from the footbridge, the debris was deposited as a fan-shaped landform, varying from a width of 8 meters near the footbridge to a maximum width of 47 meters, approximately 27 meters downstream of the footbridge. The floodwaters piled up pine needles (0.5 to 2 cm deep) around the base of pine trees in the middle of the debris fan. Floodwaters also carved an anastomosing channel system into the debris fan. Measurements of a few sinuous channels carved into the debris fan by the recent flash flood from Steamboat were as follows: 2 cm wide by 0.3 cm deep, 7 cm wide by 0.1 cm deep, 2.5 cm wide by 0.6 cm and 5 cm wide by 0.5 cm deep.



The hydrothermal "plumbing" beneath Cistern Spring *(above),* and Steamboat Geyser, approximately 100 meters to the northeast, is directly connected. An eruption of Steamboat causes Cistern to drain. At around 11:45 a.m. on the morning of March 26, (when this picture was taken), its crater was nearly empty, indicating a recent Steamboat eruption.

Erosion and deposition near the Tantalus gauge

Approximately 2.2 kilometers downstream from Steamboat Geyser, a stream flow gauging station exists. In the vicinity of the Tantalus Creek gauging station, the recent floodwaters eroded thermophilic material in Tantalus Creek and deposited it on downed trees across the creek. At the gauging station, thermophilic debris deposited on fallen trees and a mud line on the upstream side of the gauging station indicate that floodwater from Steamboat's latest eruption was approximately 6 inches higher than the water level on April 1. The mud line at the gauging station was approximately 6–7 inches below the top of the weir. Along the banks of Tantalus Creek, mud from floodwaters also was deposited but the muddy floodwaters apparently did not flow over the stream gauge.

Scientists are still analyzing the data from Steamboat Geyser's recent activity. The exact nature of the event has not yet been determined. If a major eruption did occur on or before March 26 *(left)*, it would be the third major eruption in the past eleven months. For more information on monitoring activities at Norris Geyser Basin, visit http://volcanoes.usgs.gov/yvo/monitoring.html.

NEW THERMAL FEATURES AT NORRIS

by Henry Heasler

On March 10, 2003, interpretive ranger Brian Suderman was driving from Canyon to Mammoth and reported seeing clouds of steam in an area west of Nymph Lake that previously had no thermal activity.

On March 15, Jennifer Whipple, Steve Miller, and Henry Heasler visited the area to survey the new features. They are on the west side of Nymph Lake *(Figure 1)*, are easily visible from the Mammoth–Norris road *(Figures 2 and 3, next page)*, and can be heard from the road. The features consisted of a series of forceful fumaroles trending north over approximately 100 meters. The number of vents, exact distance, and bearings were not determined due to deep snow, dangerous conditions, and the amount of steam obscuring visibility.

The new features have covered trees within three meters of the vents with debris. A much larger area is covered by a fine powder associated with the continued forceful venting.

The features are located in a stand of one- to two-meter tall lodgepole pine *(Figure 4, next page)*. Trees are still green immediately adjacent to the 1.5 meter-wide, 1 meter-deep main vent. The temperature of the main vent was 91.6° Celsius.

Due to the superheated nature of these features; rapidly evolving vents associated with forceful fumarolic activity; unknown gases and unknown composition; and very fine particles being emitted, this area is considered dangerous and not recommended for travel.

Yellowstone National Park
Nymph Lake Area

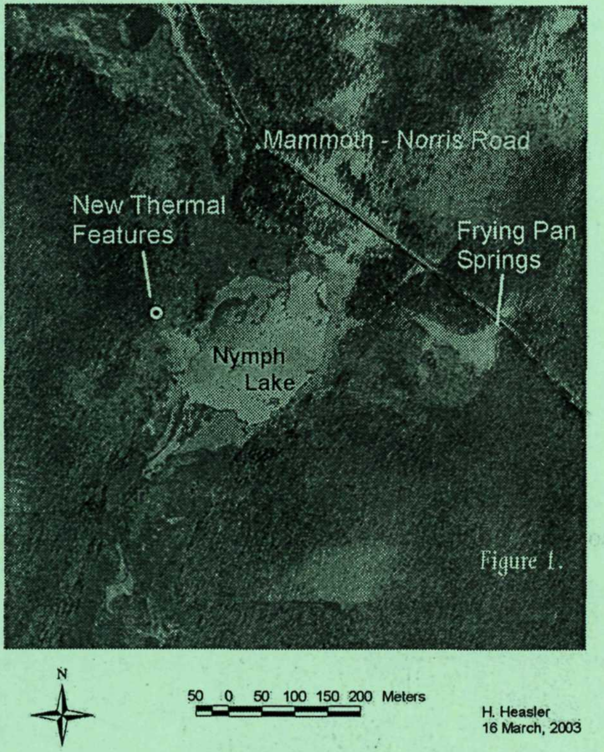


Figure 1.

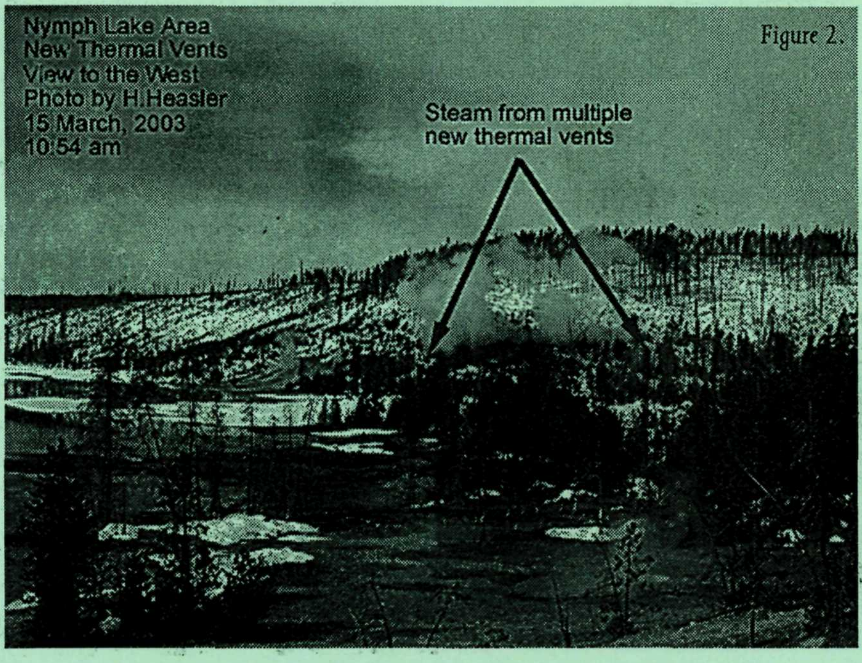


Figure 2.

Figure 3.

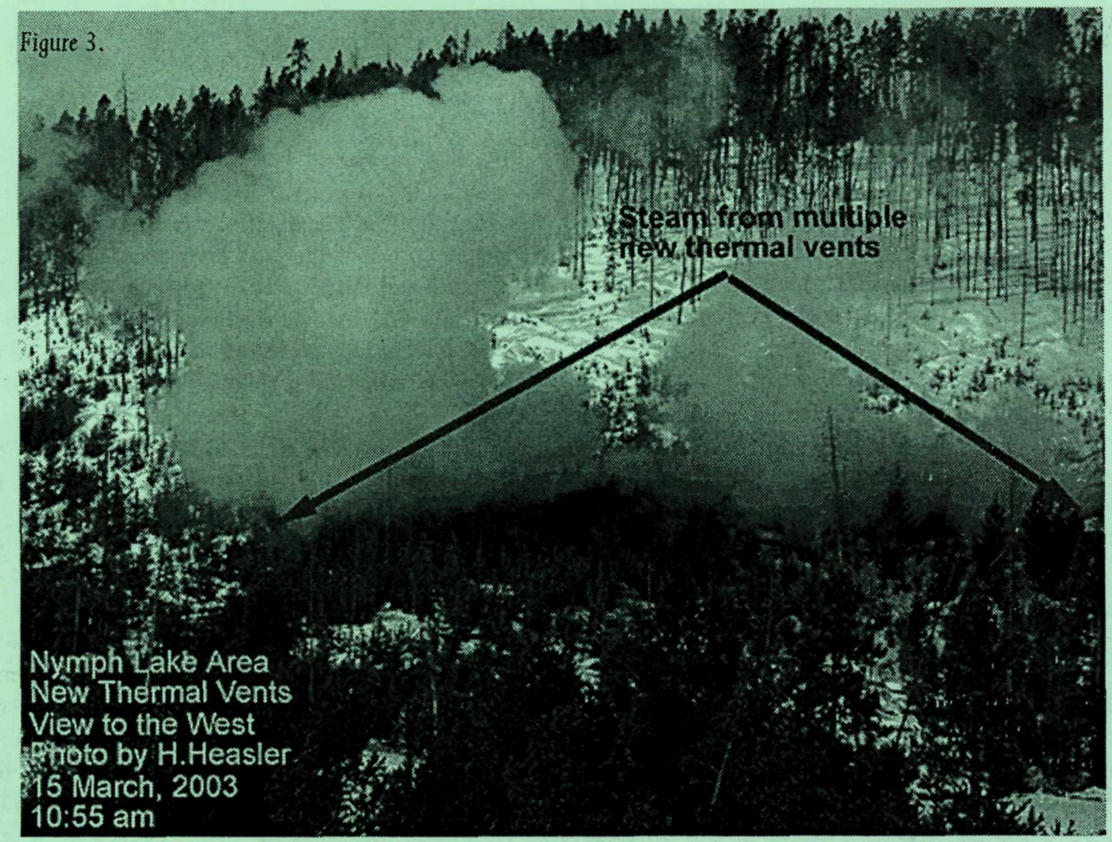
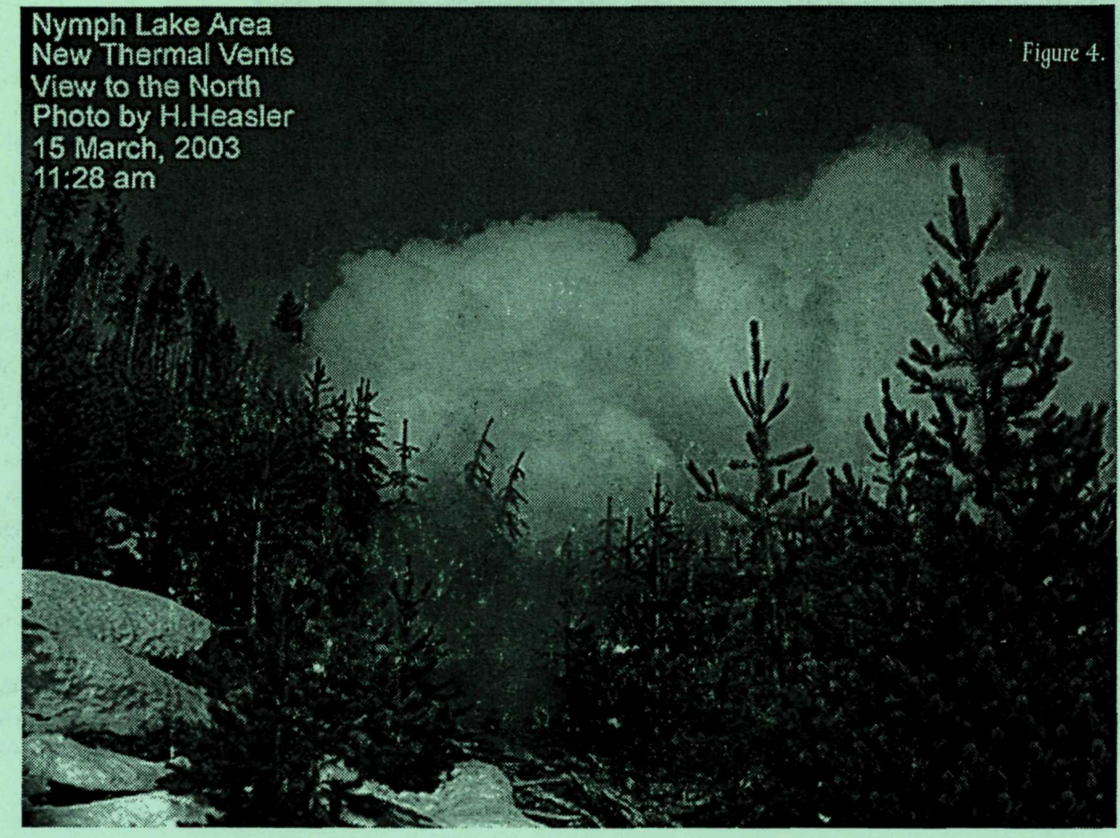


Figure 4.



Horace Comes Home

by Alice Wondrak and Steve Tustanowski-Marsh

In late April, the curator's office received a huge cardboard tube typically used for shipping concrete pillars. Inside? Something a lot more meaningful, by the name of Horace. As it turns out, "Horace" is the hide of a bison by another name, "Old Tex," who did not, in fact, have anything to do with Texas.

All clear? Here's the story:

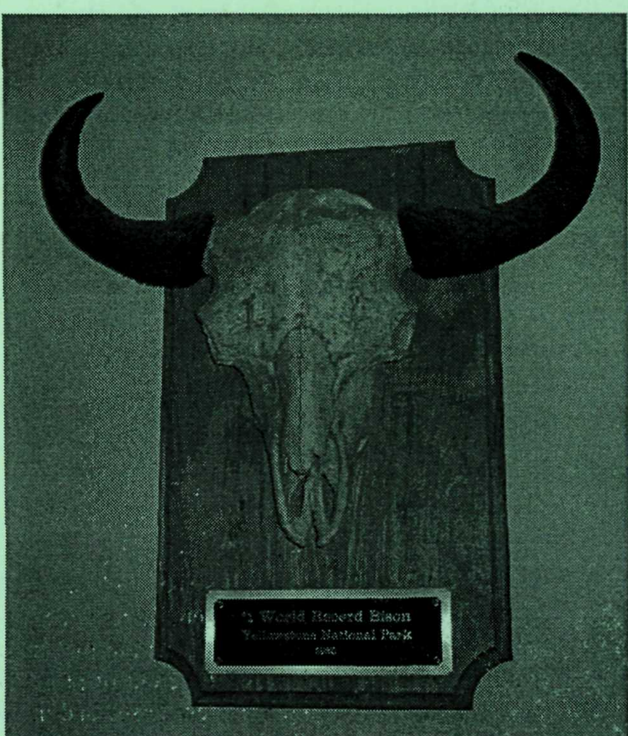
In the early part of the 20th century, a bison known as "Old Tex" was raised at the Lamar Valley Buffalo Ranch . Brought to the park in the belly of a pregnant cow bison from northern Montana, Old Tex was one of the bison that helped regenerate Yellowstone's bison population, and is an ancestor to today's herd. In 1925, Chief Ranger Sam Woodring shot Old Tex, reportedly because he had begun to behave in a manner that was both dangerous to Buffalo Ranch personnel and destructive to the ranch's infrastructure (*i.e.,* fences). Old Tex was a massive bull; he still holds the Boone & Crockett Club's record for bison size. A resin cast of his skull is on display in Yellowstone's Chief Ranger's Office.

After Woodring shot him, Old Tex was skinned, and his skull has remained in the park (now part of the museum collection) since then. His hide, however, began a cross-continental journey that lasted almost 80 years and found him in three different NPS sites. First, Woodring sent the hide to former Yellowstone superintendent, then-NPS director, and Woodring's close friend, Horace Albright (hence the name, "Horace"), in Washington, D.C. Horace (the hide) remained in Albright's possession until a friend of his from the Morristown National Historic Park in Morristown, New Jersey, asked if he could have it for an interpretive display replicating George Washington's tent. Albright agreed, and the hide was off to Morristown, where it remained until it was determined that it was a little out of place both in New Jersey and in Washington's tent, at which point Horace was offered up for transfer to another NPS facility. When park officials at Grand Portage National Monument (Grand Malais, Minnesota) expressed an interest, Horace found a new home and a new function; in Minnesota, he became an educational tool for the monument's interpreters.

YNP ARCHIVES

In 2002, an employee at Grand Portage contacted Yellowstone to ask if the park would want Horace back, since he had little direct relationship with the midwestern site. Because of the object's inimitable significance to the history of American conservation, Yellowstone, the NPS, and Horace Albright, the park's museum staff enthusiastically agreed, and began work on the transfer. Although there is little doubt that Old Tex's skull and hide have finally been reunited, museum staff are interested in having DNA testing conducted on both objects to confirm that they were once parts of the same animal. They plan to display the skull of Old Tex along with Horace, his hide, in the new Yellowstone Heritage and Research Center scheduled to open in 2004.

NPS PHOTO



Previous page: Old Tex at the Buffalo Ranch, circa 1904.

Above: A resin replica of Old Tex's skull hangs in YNP's Chief Ranger's Office (above).

Right: Ending his journey where it began, Horace awaits unpacking in the Curator's Office.

NPS PHOTO

Sick Calf Provides Observation Opportunity

by Alice Wondrak and Mark Biel

At around 8:30 a.m. on April 19, the Bison Ecology and Management Office (BEMO) received a report of a stillborn calf near the roadside at Blacktail Plateau that was born sometime around 7 or 8 am. Although NPS policy generally dictates that such animals be left in the environment to serve as nutrition for carnivorous wildlife and surrounding vegetation, there are exceptions, usually for purposes of human safety or, opportunistically, for scientific research. In this case, law enforcement rangers correctly thought that BEMO staff might want to collect the calf and take it to a veterinary diagnostic laboratory in Bozeman, Montana, in order to determine whether brucellosis or some other natural factor might have been the cause of this potential abortion or stillborn event.

BEMO personnel arrived at the site at around 9:45 a.m., met with the reporting law enforcement ranger, and headed toward the calf, whose mother was still standing over it. A slow approach, coupled with minor hazing, did little to persuade the cow to move away from the calf, and upon closer inspection, we discovered that the calf was, in fact, still alive. We immediately backed off, retreating to a knoll across the road where two local wildlife cinematographers were videotaping the event.

For the next three hours, we took the opportunity to observe the behavior of the cow and several other members of the herd present at the site. There was much of interest; soon after we retreated, several adult bison gathered around the calf, nudging it *(see picture)*. This was significant, as recent research by Montana Fish, Wildlife and Parks biologist Keith Aune shows that brucellosis transmission in bison tends to occur in this "horizontal" fashion (*e.g.*, through incidental contact with expelled fetal and/or afterbirth materials) much more frequently than in a "vertical" fashion (*e.g.*, from cow to calf through milk during nursing). This represents a departure from conventional wisdom based on what we know about brucellosis transmission in cattle, where most transmission occurs in the "vertical" manner. Aune attributes the prevalence of horizontal transmission in bison, in part, to the bison's more social and curious nature. Another factor is that bison calves tend to nurse at a more constant rate than cattle, meaning that bison cows rarely "bag up" (experience distended udder) in the manner of domestic cows.

After the other adults moved away, the calf's mother nudged and licked the calf, then walked away from the calf, looked back at it, possibly in an attempt to get the calf to follow her, and returned. This happened two more times, after which the cow continued to stand over the calf, licking and nudging it, and occasionally shaking her head to defend it from two interested ravens. She eventually bedded down next to the calf. Through binoculars and the high-powered lens of an accommodating cinematographer, we barely could see the calf's side rising and falling with breath, and every so often it slightly moved its head or feet. It appeared unlikely that it would ever stand up, however, and it eventually died late on April 20. Law enforcement rangers continued to monitor the fetus in hopes of collecting it, but the cow still stood guard in the vicinity of the calf.

NPS PHOTO

Bison most commonly acquire brucellosis through horizontal transmission, for instance through incidental contact with expelled fetal and/or afterbirth materials. Bison are curious animals and, as is seen here, will often investigate calves that are stillborn or sick upon delivery. The calf is lying at the feet of the bison on the far left.

On the morning of April 21, BEMO staff returned to the birth site in hopes of collecting the fetus, but scavengers had made off with and consumed the calf sometime during the night.

Late Winter Bison Count

by Mark Biel

On March 20 and 24, 2003, Bison Ecology & Management Office (BEMO) staff conducted the late winter bison population monitoring flights. The purpose of these flights is to determine the late winter/early spring population estimate for the Yellowstone bison herd. This then determines which management actions are available to the state and federal agencies that are responsible for implementing the Interagency Bison Management Plan. When the late winter bison population count (usually conducted in March or April) shows that the herd is over 3,000 animals, bison leaving the park may be shipped to slaughter without being tested for brucellosis in order to bring the population down closer to 3,000 animals. The target population of 3,000 was established in an attempt to try to prevent a mass migration out of the park should severe winter weather drive animals to lower elevations *(see "Why 3000?" in the Midwinter 2003 issue of* The Buffalo Chip*).*

Methodologies

The total number of bison counted on this survey was 3,013 animals on March 20, and 3,003 animals on March 24 (Table 1). However, this does not mean that this is the estimated bison population inside Yellowstone National Park. Poor observation conditions in Hayden Valley and the Firehole River drainage may have resulted in an undercount of as many as 200-300 animals, because in these regions, bison may be in timbered and/or geothermal areas, where they are almost indistinguishable from the ground. We believe the actual population abundance is near the upper end of the 95% confidence interval (Table 2).

Table 1. Actual number of bison observed on March 20 and 24, 2003 aerial surveys.

	March 20, 2003			March 24, 2003		
Area	**# Bison Observed**	**# of groups**	**Range of group size**	**# Bison Observed**	**# of groups**	**Range of group size**
Northern Range	***978***	***66***	***1-109***	***1,044***	***57***	***1-94***
Pelican Valley	***198***	***34***	***1-43***	***188***	***16***	***1-41***
Mary Mountain	***1,837***	***108***	***1-100***	***1,771***	***85***	***1-229***
Hayden Valley	668	45	1-80	389	23	1-55
Nez Perce Creek	130	12	1-34	136	14	1-38
Old Faithful/Firehole	791	32	1-100	976	29	1-229
West Side	248	19	1-36	270	19	1-43
Total	**3,013**	**208**		**3,003**	**158**	

Table 2. Bison population estimates based on number of bison observed on two aerial surveys in Yellowstone National Park using sighting probability models described in Hess, 2002 (see below).

Population Estimate (95% Confidence interval)	**Model used to generate estimate**	**Flight data used to generate estimate**
3,090–3,690	Detection Probability	March 20, 2003
3,050–3,510	Detection Probability	March 24, 2003
2,970–3,580	Replicate Count	March 20 and 24, 2003

The purpose of conducting multiple population monitoring flights over a short period of time was to conduct a high-effort survey and estimate population abundance. This within-season replication accounts for counting errors should anomalous weather/sightability conditions occur during one or both of the survey days. As described in *Hess, S.C. 2002. Aerial survey methodology for bison population estimation in Yellowstone National Park. Ph.D. dissertation, Montana State University,* our high-effort surveys were corrected using both detection correction and replicate count models, with 95% confidence intervals to estimate abundance.

Detection correction model

A detection correction model was used to make separate population estimates with data from each flight. This model assumes that at least 1 animal from each group of bison is located during the flight (however, this may not be the case for these flights, as several groups located in timber may have been missed and not counted). For the March 20, 2003 flight, the number of bison observed was 3,013. When these raw data were corrected by taking into account the habitat where the animals were observed (*i.e.*, forest, burned forest, thermal, or open areas), the 95% confidence interval for the population was 3,086–3,691 bison (Table 3). The model estimated that 94.5% of the bison population was detected.

NPS PHOTO

Bison observe their observers at Gibbon Meadows, spring 2003.

For the March 24, 2003 flight, the number of bison observed was 3,003. When these raw data were corrected by taking into account the habitat where the animals were observed, the 95% confidence interval for the population was 3,053–3,508 bison (Table 3). The model estimated that 96.0% of the bison population was detected on the second flight.

Replicate count model

The replicate count model was used to estimate the abundance of bison in the northern range, Pelican Valley, and Mary Mountain survey areas separately, and the results were summed to provide a population abundance estimate. This model varies from the detection probability correction model by assuming that during winter months, an observer will only find 92% of bison groups during aerial surveys. Based on the data from the March 20 and 24, 2003 flights, the replicate count model estimates the bison population abundance at between 2,970 and 3,580 (Table 4).

Table 3. Detection correction for bison population monitoring flight in YNP, March 20 & 24, 2003.

	March 20, 2003	March 24, 2003
Point Estimate	3,189.4	3,128.7
95% UCI*	3,691.3	3,508.8
95% LCI**	3,086.4	3,053.3
Number Detected	3,013	3,003
Percent Detected	94.5%	96.0%

**Upper Confidence Interval*
***Lower Confidence Interval*

Table 4. YNP bison population estimate based on March 20 & 24, 2003 flights and analyzed using a replicate count model.

Area Surveyed	Point Estimate	95% UCI	95% LCI
Northern Range	1,100.4	1,242.4	958.4
Pelican Valley	210.0	231.6	188.5
Mary Mountain Area	1,963.5	2,105.5	1,821.5
Total	**3,273.9**	**3,579.5**	**2,968.4**

Anomalies and conclusions

The Hayden Valley and upper Firehole River drainage areas were the most difficult areas in which to count bison during these flights. In Hayden Valley, 22–24% of observed bison groups were in either thermally-influenced or forested areas on March 20 and 24, respectively. In the upper Firehole River drainage (not including groups located in the Nez Perce Creek drainage), 87–100% of observed bison groups were in either thermally-influenced or forested areas on March 20 and 24, respectively. It is likely that the groups located in timber or geothermal habitats in these two areas were undercounted due to difficulty in discerning individual animals from the coloration of the ground. The thermal features in these areas produce a large amount of steam, which also hides animals from aerial observers. When combined with the dark, wet soil (that does not contrast well with the dark hair of the bison) common in these areas, all of these factors make bison difficult to locate and accurately count. As a result, the numbers of bison observed between the two flights correlate moderately well in all locations except Hayden Valley and the upper Firehole River drainage (Table 5). In these two areas, the discrepancies account for approximately 200–300 bison. The number of bison observed in the Nez Perce Creek drainage was similar on both flights (130 vs. 136); thus, it is unlikely that large numbers of bison migrated over Mary Mountain during the three days between observation flights. Therefore, because survey conditions in Hayden Valley and the upper Firehole River drainage may have caused us to undercount by as many as 200–300 animals, we believe the actual bison population abundance is near the upper end of the 95% confidence interval reported (Table 2).

Table 5. Bison numbers observed by geographical areas during population monitoring flights in Yellowstone National Park, 2002-2003.

Geographical Area	Total number of bison observed			
	11/5/02*	11/6/02*	3/20/03*	3/24/03*
Northern Range	*722*	*701*	*978*	*1,044*
Outside Park	0	0	33	36
Hellroaring/Mammoth/Reese Creek	2	17	211	310
Tower Jct. to East end Lamar Canyon	563	557	631	613
Upper Lamar (East end Lamar Canyon to Round Prairie)	36	34	45	39
Swan Lake Flats to Roaring Mountain	121	93	58	46
Pelican Valley	*499*	*498*	*198*	*188*
Mary Mountain	*2,560*	*2,405*	*1,837*	*1,771*
Hayden Valley	1,552	1,385	668	389
Old Faithful/Firehole/Nez Perce Complex	312	307	921	1,112
Norris to Madison	321	334	113	171
Madison Jct. to 7-mile Bridge	107	87	106	10
7-mile Bridge to West Entrance	268	292	29	89
Outside Park	0	0	0	0
TOTAL BISON COUNTED	*3,781*	*3,604*	*3,013*	*3,003*

* Calves not counted or attempted to be distinguished from adults during this flight.

WATERCOLOR MYSTERY SOLVED!

by Sean Cahill

A watercolor by a previously-unidentified artist that has been in the park's museum collection since 1998 has recently been identified as the work of Rudolph Wendelin. Wendelin (1910–2000) was an artist who worked for the U.S. Forest Service from 1933 until his retirement in 1973, and was best known for his illustrations of "Smokey the Bear." Although he was not the originator of "Smokey Bear," it was under Mr. Wendelin's guidance after World War II that the bear changed from an animal with a long snout, fangs and fearsome claws to a bear with more human features. By the 1950s, the bear (now with the middle name "the") sported a ranger's hat and denim blue jeans. His paws had become hands, in which he always carried a shovel, to better protect America's forests.

NPS PHOTO

"to be set apart as a great national park," by Rudolph Wendelin.

The Wendelin painting in the museum collection is titled "to be set apart as a great national park," and depicts the "Langford campfire story" of 1870, where, according to legend, the idea of making Yellowstone a national park was first discussed. The Forest Service presented this painting to the NPS in 1972 to commemorate Yellowstone's centennial. According to Paul Schullery, it was displayed for a number of years in the Superintendent's conference room, and more recently in the Public Affairs Office.

Numerous inquiries to various sources in an attempt to identify the artist (whose signature is on the painting but illegible) initially proved fruitless. As luck would have it, while doing some browsing through our collection of scanned images for a photo request, I happened upon an image of the painting with the artist's name clearly written below. After the artist's name was established, additional inquiries were made, one of which was forwarded to Wendelin's daughter, Elizabeth, who was able to provide the title of the work, as well as copies of her father's files with a wealth of other information about the painting's history.

In turn, the curatorial staff is assisting Ms. Wendelin in tracking down a bust of John Muir sculpted by her father, based on a 1960s commemorative postage stamp also designed by Wendelin. The Muir bust was presented to former NPS Director George Hartzog in 1966, in honor of the Park Service's 50th anniversary.

Now that the watercolor has been identified, it may be used as the cover illustration of an upcoming book by Lee Whittlesey and Paul Schullery on the "Madison Creation Myth," to be published by the University of Nebraska Press. The newly-acquired information on this significant and important painting will also be added to the accession and catalog records, and will undoubtedly prove extremely useful to future researchers and others interested in Yellowstone National Park's art collection.

Yellowstone Project Wins Award for Excellence in NPS Archeology

by Ann Johnson

On April 17, Drs. Annalies Corbin and William J. Hunt, Jr., received the John L. Cotter Award for the Marshall/Firehole Hotel Underwater Archaeology Project at this year's George Wright Society meeting in San Diego. Dr. Corbin is the Executive Director of the Partnering Archeology with Science and Technology (PAST) Foundation and Assistant Professor, Program in Maritime Studies, East Carolina University. Dr. Hunt is an archeologist at the NPS–Midwest Archeological Center.

Dr. John Cotter was a pioneer in the field of historical archeology, and had a long and distinguished career in the National Park Service. Agency staff established this award as inspiration for student and professional archeologists to continue Dr. Cotter's model of excellence. Only one award is given each year.

Project overview

In response to a lack of tourist services in the park's interior, the original Marshall's Hotel was built in 1880 on the west side of the Firehole River, at its junction with Nez Perce Creek. In 1884, proprietor George W. Marshall built a second hotel on the Firehole's east side. New cottages were added in 1887, making the hotel complex was the first "tourist town" constructed in a National Park—the "granddaddy," so to speak, of modern tourist facilities at Canyon, Yellowstone Lake, and Old Faithful. The hotel was replaced by more luxurious accommodations at other locations in 1891, but its site relates to the national park system's developmental history in that it is directly associated with a fundamental purpose of the National Park Service—providing for the enjoyment of park resources. Until recently, the site was believed destroyed by an early 19th century road barrow pit, but archeological investigations in 1993–1994 demonstrated the hotel continues to exist as nearly invisible archeological features. Archeologists also discovered an unusual riverine component derived from hotel occupants' disposal of trash in the adjacent Firehole River.

Although the land-based portion of the site is not in excessive danger, vandals and poachers are rapidly destroying the underwater component. In response, the Marshall/Firehole Hotel Underwater Archaeology Project was created as a cooperative NPS/PAST Foundation venture, partially funded through an NPS-Intermountain Region Challenge Cost Share grant. Participants included archeologists and volunteers from Yellowstone National Park, PAST Foundation, NPS-Midwest Archeological Center (MWAC), East Carolina University, the Lincoln (Nebraska) Public Schools Science Program School, and the public.

Project objectives were to (a) identify the range and locations of archeological resources at the site; (b) determine apparent functional associations when possible; (c) reconstruct the hotel's landscape/land use plan; (d) identify past and current park, public, and natural impacts; (e) recommend interpretation alternatives; and (f) provide an educational opportunity for the public to participate in and learn about archeology. This project was innovative both in design and detail because it marked the first comprehensive underwater survey of an historic site in a thermal river, and provided a first glance at how Yellowstone's highly dynamic thermal environment affects cultural material and its preservation.


YNP ARCHIVES

Marshall's Hotel, 1884.

Evaluation criteria

(a) Exemplary, multidisciplinary archeological research design: The project utilized "tourism" as the most logical context for studying, assessing and interpreting most historic sites within park boundaries. Although unprecedented as a subject of historical archeological inquiry, tourism has been a topic of anthropological inquiry for over 30 years.

Tourism represents the single largest movement of human populations outside wartime, and is therefore a powerful force for cultural contact and change. Further, the forms and goals of tourism shift through time and vary between cultures. The fact that archeology has traditionally directed the greater portion of its research toward issues of cultural change makes tourism an excellent subject for archeological inquiry. This approach provided a context for understanding and assessing the significance of an extremely diverse group of historical archeology created as a byproduct of a park's operation.

Interdisciplinary participants included curators and the park's thermal geologist, who performed analysis of the "concretions" on encrusted artifacts removed from the Firehole River. The concretions were identified as bacterial biofilm, a little-understood living phenomenon.

NPS PHOTO

Teachers and students used various means to locate artifacts in the river.

(b) Involvement of students who performed work elements that contributed to project goals: The project crew was almost entirely composed of 10 high school students and two teachers from the Science Focus Program of the Lincoln [Nebraska] Public Schools, based at the Folsom Children's Zoo and Botanical Gardens. Two crew members were undergraduate and graduate student volunteers. Students and teachers received instruction in archeological goals, method, and artifact identification. This instruction noted that maintaining detailed records of all the work done at a site is an important component of archeological fieldwork. Accordingly, project participants recorded their daily activities and experiences in their own journals. Excerpts from a number of these are posted on the PAST web site at www.pastfoundation.org.

(c) Thorough scientific methods, technologies and appropriate specialists' studies are integrated with curatorial standards to meet project goals: One of the unique aspects of the 2001 Marshall Hotel/Firehole River project was its focus on evaluating a material culture assemblage impacted by a thermal environment; factors never studied prior to this investigation. Conservation and analysis techniques at East Carolina University were adjusted to work within the environmental issues associated with the site. In the curation lab, staff developed a new technique for cleaning artifacts from thermal waters that may be applicable to artifacts from other freshwater alkaline deposits.

In particular, concretion samples were examined with the aid of former park geologist Nancy Hinman. The concretions were glued together by a living mass of bacteria that eats iron and manganese. Although thermal geologists were aware of this phenomenon in the park, archeologists were not, and there is little literature on it. The bacteria eat iron and magnesium, so that historic ceramics in these concretions were perfectly clean and their surfaces and cores retained integrity, whereas metal specimens were eroded. The full possibilities presented by this discovery are still being imagined, but if these bacteria could be grown in the lab, it might be possible to use them to clean historic ceramics.

(d) Development of public education program to share results and benefits with local populations: The PAST Foundation is a nonprofit organization that promotes and facilitates historical and cultural education, protection, and advancement associated with archeological sites.

(e) Active consultation or involvement with affiliated indigenous communities with associations to the project area: In fall 2000, the upcoming underwater project was discussed with tribes attending the Native American Consultation meetings at the park, but there were no expressions of interest or concern.

In the case of the Marshall Hotel, the related community primarily consisted, instead, of visitors (tourists) to Yellowstone National Park. The project was adjacent to major picnic and fishing areas, and field activities drew the attention of many of these visitors. About 4,000 received passive and/or active interpretation about the project. Information was posted in clear view so that the visitors could read about the Marshall Hotel and its significance; project goals; research questions; and resource protection, and see pictures of typical artifacts. At least one project member was always available to field additional questions and comments. Visitors were very interested in the project.

(f) Dissemination of project results: To date, products of this project include a wide variety of papers presented at national and international forums; poster presentations; television and newspaper articles and programs; a Master's thesis; and a technical report.

Conclusions

Three components, or distinct periods of use, may be present in this historic archeological site. The earliest is represented by a glass bottle that has been dated to 1840. At this time, it is not known if this indicates a fur trade camp or was brought to the site decades later. The second component represents the Marshall Hotel (1880 to about 1894), and the third is related to 1920s auto tourism. The documented damage and removal of artifacts from the Firehole River between a pilot study in 1999 and the fieldwork in 2001 is severe. The smaller quantity of artifacts in the riverine portion of the site has dramatically decreased the site's artifact content. For more information on this project, visit http://www.pastfoundation.org/.

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Information was provided to interested visitors through posters and personal contacts.

New Cody Complex Radiocarbon Date

Buffalo Chip readers will probably associate the archeological Cody Complex with the Osprey Beach site on Yellowstone Lake. However, there is a newly-recognized Cody Complex component (occupation) adding to documentation of the Cody Complex people's use of the park.

The deepest (of 7) cultural horizon at the Malin Creek site (24YE353) has been radiocarbon dated at 9400+60 radiocarbon years before present (BP) (Beta-177460). This date compares very favorably with the date from Osprey Beach (9350 BP), and is older than the 8800 BP date for the middle (4th deepest) component. We do not know if this is the deepest component, and anticipate going back to this site in 2004 for further excavations. The Cody Complex is the best-known and most frequently-found Paleoindian culture here.

Annual Bighorn Sheep Classification Ground Survey, Winter 2002-2003

by Dan Reinhart and Jim Caslick

On January 14, 2003, the annual bighorn sheep classification ground survey was conducted on winter range from Mt. Everts in Yellowstone National Park to Point of Rocks in the Gallatin National Forest. This survey is an effort of the Northern Yellowstone Cooperative Wildlife Working Group (NYCWWG). Since 1992, the Working Group has also conducted spring helicopter surveys of bighorn sheep ranges in the Gardiner Basin (Yankee Jim Canyon to Mammoth), and in 1995 extended that survey route into the Lamar Valley in Yellowstone National Park. The objectives are to determine ratios of lambs and rams to ewes, and to observe the condition and distribution of bighorns that occupy the Gardiner Basin area during winter. Participants from the U.S. Forest Service, Montana State University, and National Park Service surveyed the routes. Weather conditions this year were clear-to-high overcast, 35–40° F, with a light breeze. Ground conditions varied from mostly bare ground to patchy snow.

These ground surveys have been conducted annually since 1979 *(Table 3)*, using established survey routes. Depending on the terrain and visibility from roads, routes were surveyed either from vehicles or were hiked by observers. On each route, at least one observer had surveyed that route last year. All participants recorded their sheep observations on a standardized data form. Six previously established routes were surveyed this year. Five of these routes have been surveyed annually for at least 10 years. This is the fourth year that the LaDuke Spring/Basset Creek Trail was surveyed.

The total number of sheep classified this year was 75, and included 24 rams, 41 ewes, 8 lambs, and 2 unclassified. Ratios were 20 lambs/100 ewes and 59 rams/100 ewes *(Table 1)*. No coughing sheep were observed.

A two-year study of impacts of human activity on bighorn sheep in Yellowstone was completed in December 1998. At the outset of this study in 1997, K. Ostovar fitted 4 young rams and 14 ewes with radio collars designed to break away in approximately two years. This year, 3 collared sheep were observed *(Table 2)*.

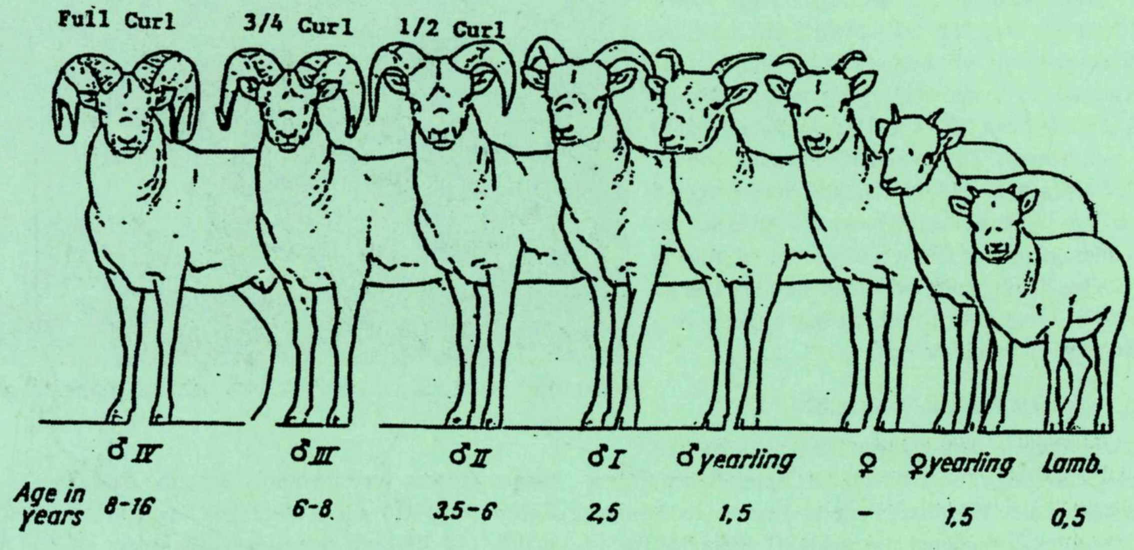

Table 1. Bighorn Sheep Classification Ground Survey, January 14, 2003.

	Rams					Ewes		Lambs	Unclass.	
Location	IV	III	II	I	Yrlg.	Adult	Yrlg.	Lambs		Total
McMinn Bench, 45th parallel north to Rescue Cr. TH, Gardner Canyon east wall	2	2		1	5	15	3	3		31
W of Rattlesnake Butte to Rescue Cr. TH on Gardner R.		2			1	6				9
Cinnabar, MT, to north end of Sepulcher Mt. to Point of Rocks	3	4	3		1	17		5	2	35
Palmer Mt. Rd., W side of Deckard Flats										0
Palmer Mt. Rd., E side of Deckard Flats, Yell. R. trail to Gardiner, MT										0
LaDuke Spgs. to Basset Cr. Trail										0
Total	5	8	3	1	7	38	3	8	2	75

Table 2. Collared bighorns observed during cooperative winter classification ground surveys.

	Collared Mar. 1997	Observed Dec. 1997	Observed Dec. 1998	Observed Jan. 2000	Observed Dec. 2000	Observed Jan. 2002	Observed Jan. 2003
Rams	4	3	2	3	1	0	1
Ewes	14	11	5	1	2	0	2

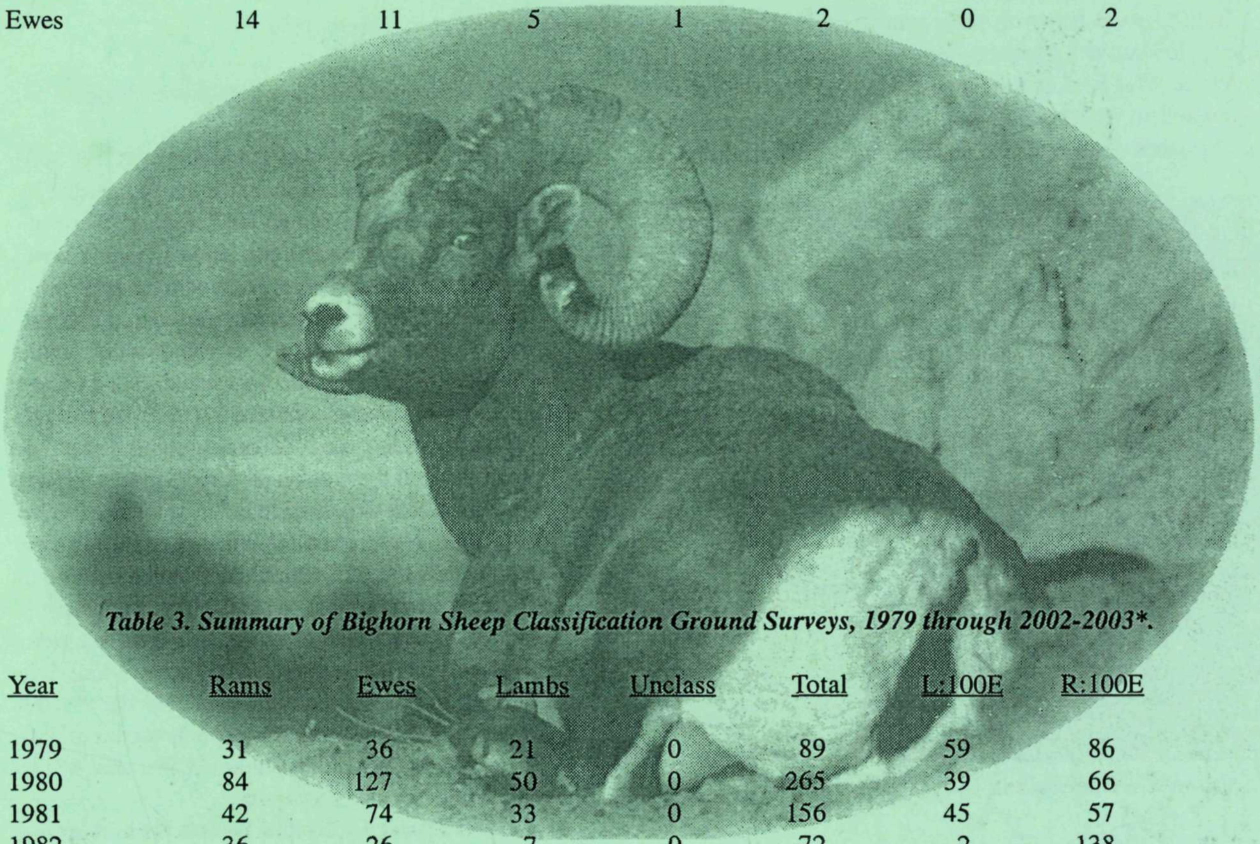

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Table 3. Summary of Bighorn Sheep Classification Ground Surveys, 1979 through 2002-2003*.

Year	Rams	Ewes	Lambs	Unclass	Total	L:100E	R:100E
1979	31	36	21	0	89	59	86
1980	84	127	50	0	265	39	66
1981	42	74	33	0	156	45	57
1982	36	26	7	0	72	2	138
1983	21	15	2	0	38	13	140
1984	21	19	6	0	46	3	111
1985	25	24	10	0	59	42	104
1986	48	33	12	0	93	36	145
1987	40	45	33	0	108	73	89
1988	40	55	22	0	117	40	73
1989	47	69	5	0	121	7	68
1990	58	82	8	3	151	10	71
1991	29	28	10	2	69	36	104
1992	39	45	12	9	105	27	87
1993	33	35	11	0	79	31	94
1994	33	49	21	4	115	43	68
1995	50	46	14	6	116	31	109
1996	38	52	13	0	103	25	73
1997	38	52	7	0	97	13	73
1998	28	26	10	3	67	15	108
1999*	24	22	6	5	57*	23	109
2000*	12	22	6	0	40	27	55
2001*	12	14	5	0	31	36	86
2002*	24	41	8	2	75	20	59

** includes new area (LaDuke Springs/Basset Creek Trail).*

A Brief History of the Golden Gate Viaduct

by Mary Shivers Culpin and Alice Wondrak

In 1883, work began on a new route from Mammoth Hot Springs to Gardiner, Montana, through the Golden Gate and along the West Fork of the Gardner River. The project was completed in seven months, during which workers used 1,275 pounds of explosives and fired over 1,300 drilled shots to excavate 14,000 cubic yards of solid rock. This dangerous section of road was completed without loss of life or injury. The new road reduced the original route by 1.3 miles, saving travelers anywhere from two hours to ½ day, depending on the type of wagon and load. It also reduced the ascent to Swan Lake Flat and enabled loaded wagons traveling in opposite directions to pass with relative ease.

YNP ARCHIVES

Original wooden bridge built in 1885, circa 1900.

Because the canyon's nearly vertical stone walls prevented an excavated roadway, a 228-foot wooden trestle was built. Lieutenant Dan Kingman of the Army Corps of Engineers noted in his report for 1885 that the "natural stone monument at the end of the trestle" marked what "visitors have called the Golden Gate." Four years after the completion of the road, the wooden trestle was strengthened with new timber supports and road-bearer cross beams.

Turn-of-the-century renovation

By 1899, Hiram Chittenden was becoming skeptical of the road's integrity:

"through this canyon is mostly cut in side of cliff. For 200 feet it passes over a wooden bridge. This bridge is about fifteen years old and has reached its limit of safety. It will have to be condemned by the close of the season...an accident here would have appalling consequences." Chittenden proposed to put in a series of concrete arches, covered with regular macadam roadway 16 feet wide and a solid parapet 3 feet high, at a cost of around $10,000. He also proposed to widen the road again, arguing that "the road through the canyon is in most places too narrow for teams to pass each other, and there are two short turns where the view ahead is abruptly and completely cut off." Chittenden wanted not only to widen the road so that "it shall everywhere be passable by two teams abreast," but also to make it much wider at the sharp curves. At the same time, the steep grade would be eliminated, "and the whole made to conform to the grade and approaches of the new bridge." Chittenden predicted that this solid rock work would be very costly.

The next year, Chittenden felt that the bridge excited "general uneasiness and concern among the traveling public," and although still safe, it was felt that the bridge's reconstruction might as well be taken up at once. Chittenden

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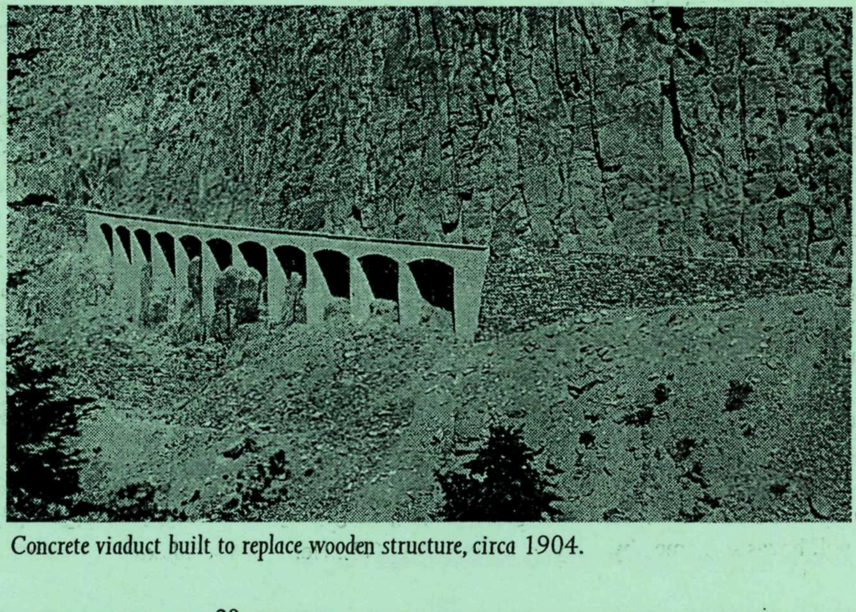

Concrete viaduct built to replace wooden structure, circa 1904.

Errata

Page 20 of the early spring 2003 issue of *The Buffalo Chip* stated that the Golden Gate is located on the road segment between Mammoth Hot Springs and Gardiner, Montana. Golden Gate is actually south of Mammoth Hot Springs, on the Mammoth-to-Norris road.

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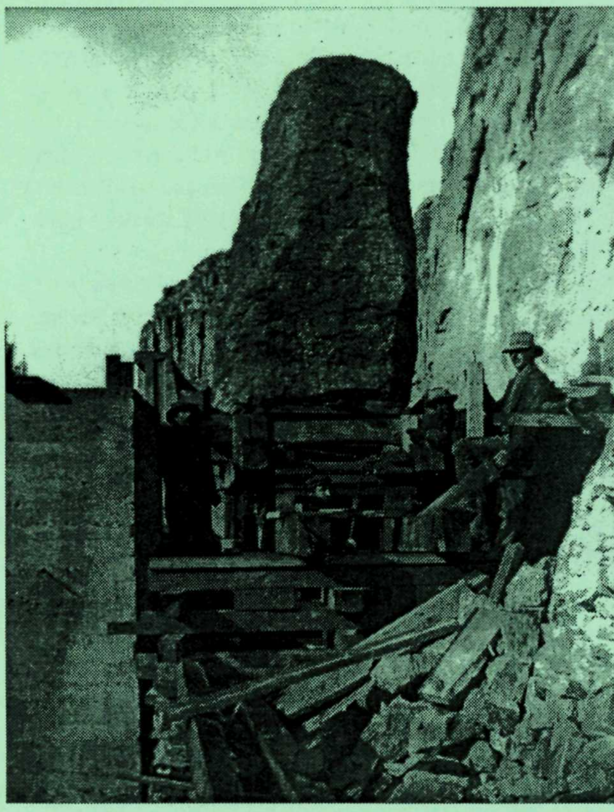

Moving the Pillar of Hercules, 1933.

decided to replace it with a concrete viaduct in a series of arches. The piers were spaced 18 feet from center-to-center, and three feet thick. The arches were reinforced with steel wire netting placed four inches above the lower surface of the arch and extended 3.75 feet on each side of the crown. A parapet wall 42 inches high above the top of the arch was provided on the side opposite the cliff. It was given a thickness of 12 inches at the top and 16 inches at the crown of the arch. To strengthen it further, four pieces of four-foot-long, 60-pound steel rail were placed obliquely so as to extend through the concrete. The materials used were Atlas Portland cement, and a natural mixture of gravel and sand found on Swan Lake Flat, 3/4 mile from the work.

Gale-force winds roared through the canyon during most of the construction, forcing crews to work only from daybreak to about 11 a.m. Lack of rain also created an excessive dust problem. And of course, the geography of the area, with a steep vertical cliff on one side and a 20-75-foot drop on the other made Golden Gate a perilous project for workers. Tourist traffic was rerouted on a temporary road via Snow Pass for four weeks, until about the last month of construction, when traffic moved through the canyon.

The large stone at the canyon's entrance, sometimes known as the Pillar of Hercules, received special attention during this construction. According to Lee Whittlesey, the monolith was so-named by early park interpreter G.L. Henderson, who "saw the pillar as a sentinel guarding the gate into the upper regions of Yellowstone." Whittlesey writes that the rock was moved during several of the bridge's renovations, and this time was no exception. Chittenden:

"The changes involved in the new structure necessitated the removal of...the large rock that stood at the entrance to the old bridge and partially blocked the roadway that divided it and the cliff. As it was the unanimous desire of those familiar with the park that this unique and picturesque feature be retained, the rock was broken off, lifted about 6 feet to the new grade, moved out about 6 feet and down the road about the same distance, where it was set up on a new foundation consisting of a square column of concrete 3×3 feet and 24 feet high. The whole foundation was then covered up, so as to remove all evidence of its artificial character. This rock weighed about 23 tons and its removal took place on the steep face of an unstable cliff; it had to be managed with great care. It was done under the direction of Foreman Robert Walker, with a force of 4 men. The whole operation consumed 5 days and cost $80."

1930s renovation: the tunnel!

Chittenden's viaduct served the traveling public for the next few decades. In 1926, plans for its improvement began to be made, and in 1930, a request was made for Bureau engineering. The Bureau recommended a combination of a

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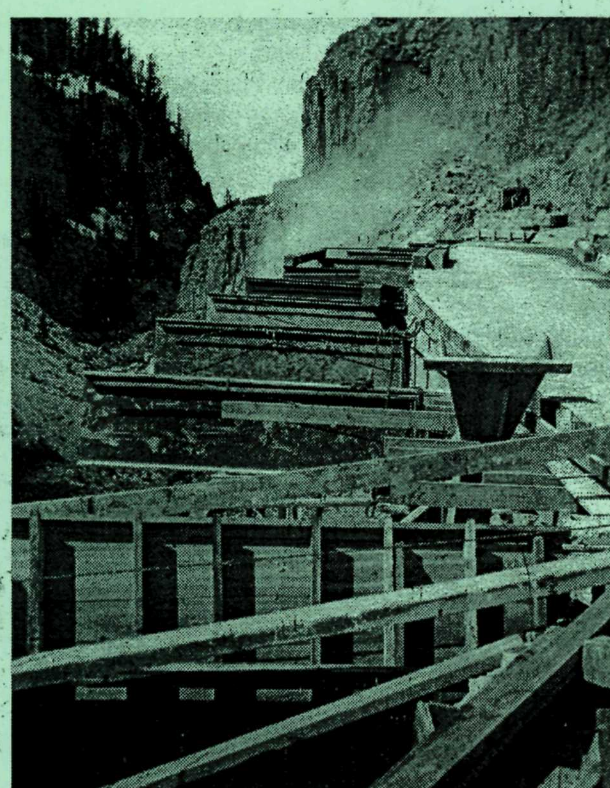

Roadbed extension under construction, May 1933.

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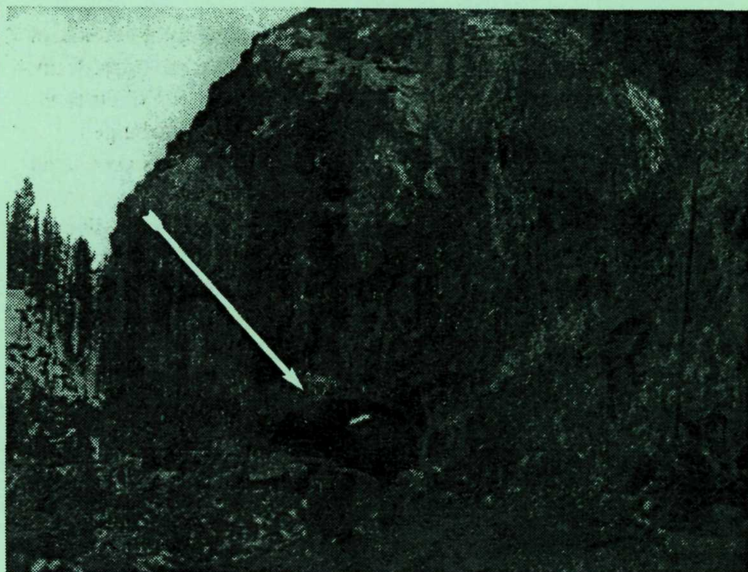

The 1933 project initially included a tunnel near the viaduct. Collapse of the tunnel during construction forced crews to "daylight" the road.

falling onto the road in front of the tunnel. It was necessary at this time for the shovel to move around the point to the outside at upper end of tunnel and load this slide material, but weather conditions were so severe the men could not stand to work there, and so all activities were discontinued until the weather moderated.

From December 1, 1932, to February 19, 1933, weather conditions were very severe, with considerable snow and extreme cold, the thermometer registering a minimum of –62° at one time, and a high wind blowing almost incessantly through the canyon. Keeping air lines from freezing up, and getting machinery started in the mornings, was difficult at best.

By March 9, 1933, weather conditions had modified sufficiently to permit work to be carried on, and excavation was timed on the tunnel. Excavation of the tunnel was completed on March 20, 1933, with a total length of 90 feet as compared with the original planned length of 100 feet.

tunnel and a viaduct calling for sixteen 18-foot spans of steel and reinforced concrete, concrete box-and-metal pipe culverts with masonry headwalls, a masonry retaining wall, and hand laid rock embankment. The project was awarded to the Morrison-Knudsen Company on October 20, 1932.

The contractor set up camp in a previously-occupied area about one mile below the end of the work. Workers constructed frame bunkhouses, an office, and a mess house, with several tents serving as additional bunkhouses. Approximately 55 men worked on this project, which began on October 29, 1932. By the middle of December, excavation of the tunnel's east portal was finished, and the actual tunnel project began. Engineer E.O. Anderson:

"Small pioneer tunnels were driven to a distance of 28 feet on each side at spring line, and then cross-cut at the inside end and the excavation of the roof made, working outward toward the portal. This was done to avoid overbreak and a possible cave-in, as the rock was badly seamed and shattered. As the rock was excavated, timber lining was placed consisting of 12×12 posts and cross members set at four-foot intervals, with timber logging filling the space behind.

By February 19, 1933, tunnel excavation was completed, with the exception of the last seven feet on the upper end. In removing this last seven-foot section, a cave-in, or slide occurred, and this portion sheared off,

During the month of May, water from melting snow running into the cracks and crevices above the east portal of tunnel, and then freezing and thawing, caused the rock to start working at this point. A few small slides occurred, and timbering in the tunnel was observed to be taking considerable weight. Additional posts and braces were set to strengthen the timbering, and men [began] prying off rock to reduce the weight above the timbering in an attempt to avoid a cave-in, but on May 22, 1933, the tunnel [failed], resulting in the loss of all except 16 feet on the upper, or west end. A change order was issued eliminating the completion of the tunnel from the contract, and the point where the tunnel was originally planned is now to be designated as a quarry site for surfacing and when completed, will be a daylight cut.

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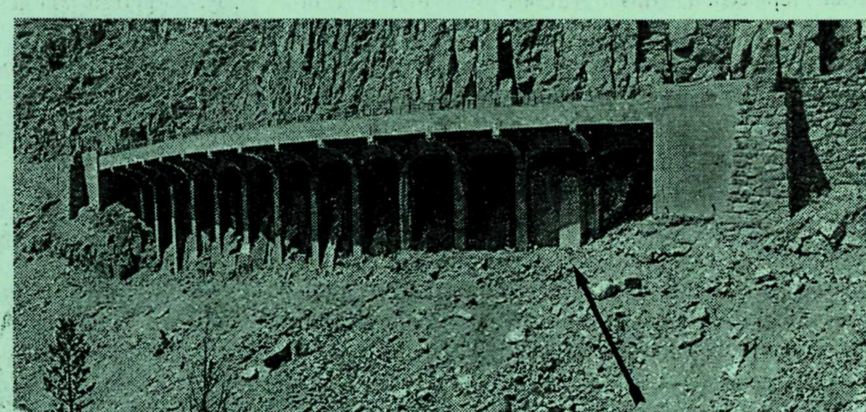

Underside of viaduct, 1933. A concrete pier from 1900 viaduct is visible in the second arch from the right.

After completion of the tunnel excavation on March 20, 1933, work was pushed on the viaduct in order to have the north half ready for traffic when the park opened. Footings for columns were excavated and poured, steel columns set in place, and cross girders and reinforcing steel placed. Concrete was poured as fast as excavations were made and forms

YNP ARCHIVES

The 1959 Hebgen Lake earthquake caused rockslides that blocked the road at Golden Gate. August 17, 1959.

and steel placed. The north half of the viaduct was completed on May 10, 1933, and opened to traffic on May 26, 1933. The south half was completed on July 15, 1933."

The 1933 viaduct was built over and outside of the viaduct it replaced. In terms of support, it was structurally independent of the old viaduct, and its roadway was 24 feet wide. As part of the project, old roads and old drainage structures were obliterated. The total project was completed on August 16, 1933, at a cost of $115,631. The final surfacing was completed on July 17, 1934. Also in that year, a stone parapet was added at the location of the tunnel.

1959: earthquake!

In 1959, the Hebgen Lake earthquake caused considerable damage to the masonry guardrails and embankments near Gibbon Falls; in the Golden Gate Canyon; at Undine Falls; and at Overhanging Cliff. Much of the guard wall had fallen off or was cracked in the joints, and embankments had slipped and bulged. In the Golden Gate Canyon, slides blocked the road, and portions of the guardrail were lost or damaged to such an extent that it had to be replaced.

A contractor was hired to perform rehabilitation and reconstruction of the guard wall, including correction of alignment and elevations, construction of reinforced foundations for all new stone masonry, stabilization of embankments by new reinforced concrete base under bulged sections, and the grouting of slipped embankments above and around such bulged sections. The park granted permission to the contractor to salvage some additional rocks for the masonry from old quarries and storage dumps near Norris Geyser Basin, Midway Geyser Basin, and Undine Falls. For safety reasons, work was started in most places by removing old, damaged masonry along the road edge above the embankments. New foundations were established along the corrected lines and elevations. The embankment above and around bulges and cavities was stabilized with grout and after the concrete cured, the bulges down under were excavated and properly repaired. All new guard wall foundations were made to overlap into solid ground or into rock formations, spanning over 80 to 170 feet of existing embankment.

1977: modern times

That work was completed during the 1960 season. In 1977, a new, six-span continuous girder bridge with concrete deck replaced the old viaduct. The 327-foot long, two-lane bridge is 30 feet wide from curb to curb, and constructed of steel on concrete base railings. In 1984, falling rocks necessitated the repair of holes in the deck, and damage to the stone parapets. The bridge is in good condition today. As part of a larger nomination for the park's Grand Loop Road, the Golden Gate viaduct will soon be proposed for inclusion on the National Register of Historic Places.

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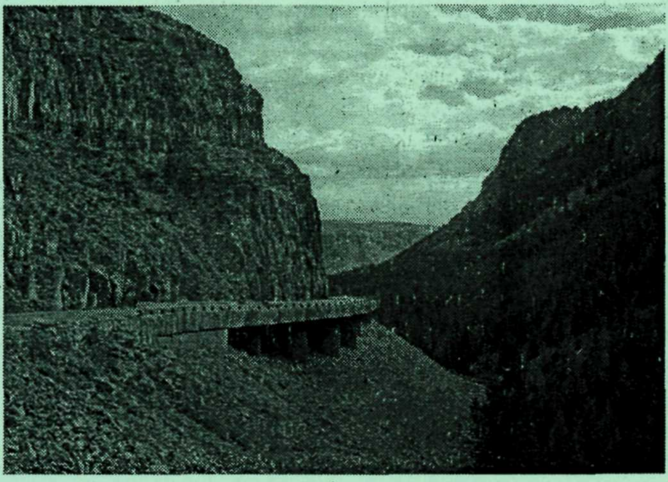

Golden Gate viaduct, 1976. The viaduct retains this appearance today.

...News Briefs...

2003 Late Winter Classification of Northern Yellowstone Elk

The Northern Yellowstone Cooperative Wildlife Working Group conducted its annual late-winter classification of northern Yellowstone elk on March 24. Biologists used a helicopter to classify a total of 4,200 elk as bulls, cows, or calves in specified sampling areas through the entire northern winter range during the one-day survey. Northern Yellowstone elk winter between the northeast entrance of Yellowstone National Park and Dome Mountain/Dailey Lake in the Paradise Valley.

Estimated sex and age ratios for the population were 12 calves, 4 yearling bulls (*i.e.,* spikes), and 18 adult (*i.e.,* branch-antlered) bulls per 100 cows. The estimated ratio of 12 calves per 100 cows is similar to the late-winter ratio of 14 calves per 100 cows during 2002, but less than the range of 22 to 34 calves per 100 cows observed during the previous six years. The causes of this year's low recruitment are most likely predation and drought-related effects on maternal condition and calf survival. The Working Group will continue to monitor trends of the elk population and evaluate the relative contribution of various components of mortality, including predation, environmental factors, and hunting.

Bison Capture Operations Outside North Entrance

During the first week of March, bison capture operations began at the Stephens Creek capture facility outside the North Entrance for the first time since 1996. Under the final state and federal Records of Decision for the Interagency Bison Management Plan (IBMP) signed in December 2000, and the December 2002 IBMP Operating Procedures, when the bison population in late winter/early spring is over 3,000 animals, and they are moving onto lands where cattle are being grazed near the North Entrance, they will be captured in the Stephens Creek facility and sent to slaughter facilities. The November population estimate was approximately 3,800.

The IBMP and the IBMP Operating Procedures use a variety of methods along the north and west boundaries of the park to limit the distribution of bison and to maintain separation of bison and cattle on public and private lands. It also allows some bison on certain public lands where cattle are not grazed.

The first response to bison approaching the north boundary is to haze them to keep them inside the park. However, after attempts at hazing the bison become ineffective and unsafe, it may become necessary to begin capturing the animals. Hazing occurred during the previous few weeks on numerous occasions.

A total of 231 bison were captured at the Stephens Creek facility and sent to slaughter facilities. Meat, heads, and hides will be donated to Native American groups/individuals and other social service organizations.

Smith Wins NPS Director's Award

Doug Smith, Yellowstone's Wolf Project Leader, recently won the 2002 Director's Award for Natural Resource Management. Congratulations, Doug!

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