The YS *Interview*

Park Botanist Jennifer Whipple and Yellowstone's Herbarium

NPS/VIRGINIA WARNER

Yellowstone National Park Botanist Jennifer Whipple, at the stereoscope in her new work space in the Yellowstone Heritage and Research Center.

SOME PEOPLE ARE ALREADY FAMILIAR *with Yellowstone's large museum, library, and archival collections, but may be more inclined to associate them with cultural resources such as photos, rare books, documents, furniture, and art. The collections, of course, also contain many natural history artifacts, including wildlife mounts, geologic specimens, and—another fascinating collection that also made the move to the new Heritage and Research Center—the park's herbarium. Long housed in rows of unassuming metal cabinets in various park locations, the herbarium is a treasure. Herbarium specimens document the presence of plants in the park over time, and the history of plant collecting in the park, making it an incredibly valuable resource for staff, researchers, and visitors.*

The herbarium's primary caretaker is professional botanist Jennifer Whipple, of YCR's Branch of Natural Resources. Jen's position is such a dynamic mix of natural history museum curator and practicing botanist that it was formerly included in the Branch of Cultural Resources under the museum curator, with whom she still works closely. During the summer field season, Jen makes collections and performs surveys for various park projects. She spends the winter writing reports, identifying plants, and preparing specimens. Yellowstone Science's *Tami Blackford recently plucked Jen from the flurry of the move and the summer field season to talk about plants, their preservation, and what they can teach us about the park, now and in the past.*

YS: Jen, tell us about yourself and how you got interested in plants.

JW: I was raised on a ranch in Northern California, near the Oregon border, inland, and I was always interested in natural history in general. It was pretty obvious from early on that I was into collecting things. I collected rocks, bird nests, lichens—just about anything that could walk into my bedroom, did. My mom's thing all through elementary school was, "I'll be so glad when you outgrow your collections, Jen!" There was a point, in about high school, when she quit saying it, and resigned herself to the inevitable. I got interested in plants specifically because I was trying to find out what things there were on our ranch. We had this marvelous, rocky hillside behind the house that had all these neat plants on it, and I couldn't find them in any of the wildflower guides. As I got more interested, my folks kept giving me wildflower guides for birthdays and Christmas. It turned out that the rocky knoll behind the house was serpentine, and a place of high endemism. "Endemic" is an entity that only occurs in a particular, restricted place, such as a plant that is "endemic to the state of Wyoming." The reason I couldn't figure out what the plants were, was that they were very localized endemics. By the time I knew that much, I was hooked. I was going to be a botanist by the time I was in high school. By the time I was in college, I had a collection of 900 vascular plant specimens.

YS: How did you end up in the National Park Service?

JW: When I was 9 or 10, we went to visit Lassen Volcanic National Park. I heard a naturalist giving a talk about the volcano, and decided, "I want to do that." I tried to get into the National Park Service by just putting in applications while I was in college—got nowhere—then heard about the Student Conservation Association, and so I worked for the Naturalist Division at Grand Canyon as an SCA. The next year, I put out several applications, and got a job at Jewel Cave National Monument in South Dakota. I developed a bad case of bronchitis from being in the cave—going down to about 47°, then back up to 90°+—and the doctor said that I shouldn't work in a cave again, so I needed to find a new job. I put out 33 applications to 33 national parks that winter, and the first job offer I got was from Yellowstone, which delighted me because Yellowstone was my first choice.

YS: Why was it your first choice?

JW: Yellowstone's geysers fascinated me from the first time I saw pictures of them when I was in elementary school. I was so intrigued by Yellowstone when I was eight, that I railroaded my family into taking a vacation to the park, which only increased my interest.

YS: When did you start working in the park?

JW: I started as a naturalist/interpreter at Old Faithful in the summers of 1974 and 1975. Then, in '75, I went back to get my master's degree at Humboldt State University.

YS: In botany?

JW: It actually was an MA in biology with a specialization in vascular plant taxonomy. Then I married [former Yellowstone geologist] Rick [Hutchinson] in May of 1979, and he was in Yellowstone. Anyway, I've been here ever since. I volunteered working in the herbarium for what was then called the Biologist's Office, which later became the Research Office. I started working for the Research Office as a biological technician in 1985. I was mostly [former biologist] Don Despain's seasonal employee until I got my permanent job as the park's botanist in 1993. I've been living in the park now for over 25 years.

YS: It's been said that Yellowstone reflects a diversity of environments, being "on the edge" of several ecosystems. How does the park's habitat diversity affect the types of flora found here?

JENNIFER WHIPPLE

Yellowstone's flora is generally typical of central Rocky Mountain flora.

The most unusual component of Yellowstone's vegetation is associated with the park's geothermal systems.

JENNIFER WHIPPLE

Yellow monkeyflowers growing in a thermal area at West Thumb Geyser Basin.

JW: Yellowstone is basically on the spine of the Rockies, and as a result has a rather typical flora for the central Rocky Mountains. But because we have some low elevation areas, such as the area near Gardiner, [Montana], we have elements of both Great Plains and Great Basin floras coming in and affecting the vegetation. Most of Yellowstone is, of course, a volcanic caldera. Rhyolite flows and relatively recent volcanics do not create a highly diverse flora; the more different types of rock in an area, the more floral variation you're likely to have. The northern part of the park is probably the area that has the greatest diversity, because it has the most diversity of rock types.

The most unusual component of Yellowstone's vegetation is associated with the park's geothermal systems. The thermal systems themselves are remarkably diverse. We have systems that are very acidic, that are alkaline, and that vary in pH—and so we have some unique assemblages of species associated with these thermal areas, as well as some very interesting individual species. For example, because of the warm ground, we have populations of certain Great Basin species that may have come here in warmer climate periods and now are tied in with thermal grounds, which are the only places they're found in the park.

JENNIFER WHIPPLE

Yellowstone has species, such as Ross' bentgrass, that occur nowhere else in the world.

But the whole plant community itself is very interesting. We have rare plants that occur nowhere else in the world besides in Yellowstone. Examples are Yellowstone sand verbena and Ross' bentgrass. We are the wettest part of the state of Wyoming, stretching from the northern part of Grand Teton north and west into the Bechler area of Yellowstone, and so there are several species that occur in Yellowstone and nowhere else in the state. We also end up with things that are typically found in northwest Montana and the panhandle of Idaho that have jumped down here to Yellowstone.

YS: So part of the park's unusual floral composition is simply a result of the great size of Yellowstone, and part of it is the geothermal influence.

JW: Part of it's the size, but the geothermal aspect is the thing that makes it most interesting. We may actually have less plant diversity in the park because we've had a lot of things happen here relatively recently from a geological perspective. By the time the place gets blown up a couple of times by volcanoes and then gets scraped off with glaciers, you may have lost a lot of species that you will never know about.

YS: Why does the park have a herbarium?

JW: We have a herbarium for two main purposes: to document the arrival, extirpation, and/or persistence of plant species in the park, and to be able to identify plants. Park personnel, in general, are going to recognize the major mammal species when they see them. But because there are so many species of plants, not many people can identify those that are stuck under their nose. It's a relatively rare expertise, and there are fewer people all the time in academia (because of the increased focus directed at the molecular level of work), that can actually recognize things when they see them, either in the field or as pressed specimens. So having the herbarium and having this type of expertise here in the park is very helpful—for our own staff, other agencies, and outside researchers. The herbarium is a very valuable resource, and it's used a lot.

YS: Describe what the herbarium is.

JW: Basically, it's a collection of plant specimens. There are about 10,000 vascular plants, fungi, lichens, and mosses, etc., in the collection.

YS: What is included on a plant specimen?

JW: Typically, a plant specimen is the entire plant, including leaves, flowers, fruits (if available), and roots. The best way to handle a tree, as opposed to an ephemeral little wildflower, is not necessarily the same. Obviously, with large plants, such as trees, a specimen will be modified to include, perhaps, a branch or portion of the plant with flowers or fruits (if available). A tall, herbaceous perennial, such as cow parsnip, may take up several sheets of herbarium paper, which is 11½ x 16 ½ inches. A specimen can either be glued, taped, or actually sewn to the paper. There are various mounting methods, and some work better for one type of specimen than another. The specimen should have a label listing the name of the specimen along with where it was collected, date, and now, with GPS systems,

NPS/VIRGINIA WARNER

This herbarium specimen shows the original label, plus annotation labels that document changing opinions about the correct scientific name.

NPS/VIRGINIA WARNER

This specimen shows the parts of the entire plant. Adequate material is needed to demonstrate variation.

we'll be including the GPS coordinates. Today, a label will also generally include habitat, elevation, associated species, and perhaps rock or soil type. You also have the name of who collected it, and ideally a personal collection number. Each plant collector also maintains a field notebook that documents where they were, when they were there, what they collected, what it was growing with, and maybe the habitat type. The information in the collector's notebook is tied to the specimen by the collection number.

The collectors' field notebooks can become very important. From the collection notes of Aven Nelson, who was a professor at the University of Wyoming at the turn of the century, and a very important botanist in the Rocky Mountain West, we can get a feeling for how common some of the weeds were in the park when he was collecting in 1899. We have his specimens of this particular type of falseflax (*Camelina sativa*), and his collection notes say, "Very abundant in some places on the roadside." We cannot find that species in the park today. So we know that it was an apparently common weed along at least one stretch of the road, and what probably happened is it's been out-competed by more competitive weeds that have come in since. But the collection notebook gives some parameters of what was going on at the time. At the same time, collectors in the latter part of the nineteenth century tended to be much more casual about noting details than we expect today. One collector from the 1910s and 1920s would come in and do a major collecting trip every year, and he's got labels that say

You can look at a 200-year-old herbarium specimen and it will look much the same as a specimen mounted last year.

"Yellowstone National Park near Gardiner." That gets to be a lot of terrain. Re-locating these sites is problematic at best.

YS: Are the notebooks kept with the specimens?

JW: No, not always. Field notebooks are an important resource and are typically maintained at whatever institution a particular plant collector was affiliated with.

YS: How durable are herbarium specimens?

JW: If you've tried to make a dried flower arrangement, you know how things fall off of it through time, and it just kind of shatters into pieces. So by pressing the plants, we basically make them flat so they can be put on a piece of paper. If you handle the paper carefully, the specimen won't break or shatter much. You still have to be very careful with how you handle herbarium specimens. But the neat thing about a herbarium collection is that as long as insects or moisture don't get into it, and the specimens are correctly mounted on acid-free, 100% rag-type paper, and they're handled with the right types of glues, the specimens are very durable and can last for a long time. You can look at a 200-year-old herbarium specimen and it will look much the same as a specimen mounted last year.

NPS/VIRGINIA WARNER

Pressed plant specimens must be handled with care if they are to remain viable over time.

YS: What are herbarium specimens mainly used for?

JW: One of the most important uses of specimens is for plant identification. For example, when you bump into something out in the field and don't know what it is, you can collect it, press it, and later take it to the herbarium. Then you might go, "well, gosh, I think this is a buttercup, but I don't know what buttercup this is." So first, you run it through a buttercup key [a tool for identifying an unknown species based on successive choices between contrasting statements]. Then you go, "gee, the key asked about the length of the petals, but it's late in the year and the petals have all fallen off." So you've reached a fork in the key where you have to continue in both directions, resulting in two possible identifications. Then you can pull out both specimens, from both sides of that key, see what they look like and go, "oh yeah, *this* is what I've got, not that." Sometimes it's a lot more complex than that, because although the plants are distinct, it's sometimes very hard for us to tell them apart. The characteristics that separate them are very cryptic. It's interesting, challenging.

YS: Do you keep just one specimen of each species?

JW: Common misconception—people often think we just need one specimen of something, but all one specimen does is document the presence of that plant in one place at one time. In the case of exotic species, for example, we know from herbarium collections from before the beginning of the twentieth century that common timothy was already present in the park in 1897. That's an incredibly important piece of information. Then every specimen from that time on basically documents its spread to a different place.

Another thing is that plants don't always look the same. For instance, the common native chickweed can be more than 10 inches tall on the northern range, but it also occurs above 10,000 feet as a component of alpine tundra. At that point, it might be only an inch or two high, and the whole look of the plant, including the leaves, is different and more compact. If somebody is doing a research project in the alpine tundra, to be able to recognize the species they're going to need to see a specimen from high elevation. We can also get variation according to whether or not something is growing out in the open or under the forest. If you don't have a lot of light underneath the lodgepole forest, a plant may have a very open, sparse, growth form, whereas if it's out in broad daylight, it might be very stout. Seasonal variation is important, too. If a researcher is trying to figure out what elk are grazing in the fall, you need to have material that demonstrates what a plant looks like when it's coming into bloom, and what it looks like when it's in full seed. Additionally, a species may vary genetically at different elevations, locations, or on different substrates, so having specimens that demonstrate the range of variation in appearance is very helpful.

YS: How many plant species occur in Yellowstone?

JW: We have around 1,360 taxa in the park, including over 100 rare plants and more than 200 exotic plant species.

YS: What do you mean by taxa?

JW: We have 1,360 taxa, but we have only 1,280 species. Many of the species that occur in the park have more than one variety, or subspecies, that are also present in the park, therefore the number of entities, or taxa, is greater than the number of species. So when a botanist says the number of taxa, that's basically a way of saying that we have this many different entities that are recognized in the scientific literature. For example, sulfur buckwheat (*Eriogonum umbellatum*) has three different varieties that occur in the park. The widespread variety (*Eriogonum umbellatum* var. *majus*) has dense, bright green leaves and cream-colored flowers. The rarely encountered variety in the Upper and Lower Geyser Basins (*Eriogonum umbellatum* var. *cladophorum*) has bright yellow flowers, while another entity (*Eriogonum umbellatum* var. *dichrocephalum*) has sprawling to upright, dull green leaves and cream-colored flowers. Therefore, while there is only one species in the park, there are three separate taxa.

YS: Do you think there are still a lot of plant species that have yet to be reported in the park?

JW: Any time I see something and I don't know what it is, I collect it. I definitely have places that I target, but most of my summer fieldwork is project-related. Right now we've got

JENNIFER WHIPPLE

Short (1–2 inch) yellow monkeyflower plants growing on thermal ground.

JENNIFER WHIPPLE

Luxurious, tall (1-2 foot) yellow monkeyflowers along a cold stream.

the Inventory and Monitoring [I&M] program, and for that we need to document that we have found at least 90% of the vascular species that occur in the park. There's no question that we are over that point, but there are definitely species that are, for instance, known in Grand Teton, or out in the Shoshone National Forest, that could easily occur in Yellowstone but haven't been documented yet. During most summers in average years, we'll probably find one to 10 new species in the park, but when we are close to 10 new species, a lot of times those are new exotics. With the native species, it's probably one to five a year, and we're becoming less likely to find a lot of new things, just because we have looked more and more. But even a hundred years from now, I suspect we will still be locating new species. There won't be a lot of them, but every few years or so we're going to find something just because Yellowstone is a very big place and a lot of it is backcountry with limited access, and we just don't spend a lot of time in certain parts of the park.

Another thing is that most people assume that we know everything, that we know exactly which species occur in the U.S. and we know exactly how they're related to one another. That is a long way from the truth. Our knowledge of the flora in North America is nowhere near as detailed as it is, for instance, in Europe, where information on the flora has been accumulating for many centuries. There's just a tremendous amount we don't know.

YS: Are there any specimens that document the presence of a species that has disappeared from the park?

JW: Yes. We've got specimens collected in the latter part of the nineteenth and early twentieth centuries of plants that we cannot find in the park now. There are several possible hypotheses for this. Of course, the species may have been more common and was extirpated from the park due to construction, road-building, or some other disturbance. There is also the possibility that the species was inadvertently introduced to the park and only persisted for a few years, or that a specimen could have been mislabeled and actually wasn't collected in the park. When there is only one specimen documenting the presence of a species in the park, there are questions about its validity and whether or not to include this species in the park flora.

YS: What can you tell us about the history of the plant collecting in Yellowstone?

JW: You can just imagine: Yellowstone's found, made a national park, people start hearing about the geysers, the incredible thermal features, and every botanist is going, "If I can figure out a way, I'm going to get to Yellowstone, and I can collect some plants while I'm there and justify my trip." And so a lot of big-name botanists visited Yellowstone in the latter part of the nineteenth century, and those herbarium specimens are literally all over the world in herbaria in various locations. The earliest specimens appear to have been collected in 1871 during the Hayden expedition by Robert Adams, Jr. Early collectors typically were tied to some institution, or had personal collections. Most of that early material, including the Hayden expedition specimens, was eventually deposited in herbaria back east such as the Smithsonian and the New York Botanical Gardens.

Greater Yellowstone Inventory and Monitoring Network

The National Park Service's Natural Resource Inventory and Monitoring Program is a service-wide initiative designed to help park managers acquire the information and expertise they need to maintain ecosystem integrity in the approximately 270 NPS units that contain significant natural resources. Resource inventories constitute a critical first step, informing park managers about the nature of the resources. Subsequent monitoring programs allow managers to more effectively detect changes and quantify trends in the condition of those resources. This network consists of four park units located within and around the Greater Yellowstone Ecosystem, which includes parts of Idaho, Montana, and Wyoming. These units include Bighorn Canyon National Recreation Area, John D. Rockefeller, Jr., Memorial Parkway, and Grand Teton and Yellowstone National Parks.

I think exotics are the biggest threat to the national parks.

JENNIFER WHIPPLE

JENNIFER WHIPPLE

Dalmatian toadflax (left) and musk thistle (right) are exotics found in the park.

NPS/VIRGINIA WARNER

Various floras are used to help identify plants in the Yellowstone area.

The first actual flora [an enumeration of the plants of a specific region, e.g., Yellowstone] of the park was published in 1886, by a man named Frank Tweedy, and it was remarkably accurate and complete. He did extensive collections in the park in 1884–85, and he also went back and looked at the herbarium specimens that had been collected by earlier collectors. He obviously didn't collect everything that we know about today, but his flora is a very good starting point for finding out when weeds first started arriving in the park, and baseline plant presence information.

There were a lot of collectors from that point until about the turn of the century, including some very big name botanists, like Aven Nelson, Per Axel Rydberg, and Charles Edwin Bessey. Rydberg and Bessey visited the park and collected extensively in 1897, resulting in the publication of *Catalogue of the Flora of Montana and the Yellowstone National Park* in 1900. Nelson basically spent most of the summer of 1899 collecting in the park with his brother, Elias. A botanist friend of mine was in the herbarium in Calcutta, India, and he went to pull out a North American species, *Lupinus argenteus,* which is the silvery lupine that is a very common species here in Yellowstone. He pulled it out, and the very first sheet on the pile was collected by Nelson from Yellowstone National Park. In India!

The next flora was done by [W.B.] MacDougall and [Herma] Baggley, which first came out in 1936, with a second edition in 1956. Herma Albertson was hired as a naturalist and later married then Chief Ranger, George Baggley. The most recent flora was Don Despain's, in 1975. Right now, as part of the I&M project, we're actively looking at coming out with an annotated checklist of what we know is currently in the park, because there's a tremendous amount of things that have been found in the last 30 years or so.

YS: Do you have plans to write an updated flora?

JW: Yes. The first step is the annotated checklist, which I will hopefully have done in late 2005. I've also started working on the keys for the flora, such as the rushes. I try to squeeze it in around my other deadlines.

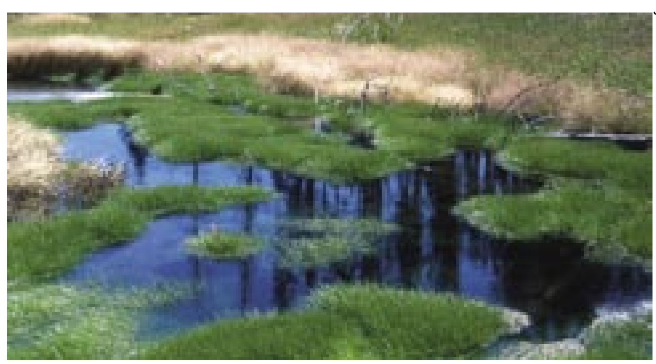
YS: When did the park start maintaining a herbarium?

JW: Yellowstone itself didn't actually start collecting specimens routinely for a herbarium until the 1920s. The oldest specimen that is in the herbarium, I think, is from 1910. Much earlier, in 1883, President Chester Arthur, [21st President of the U.S.], visited the park. He collected some wildflowers and pressed them during his visit, but they are kept in the museum collection because of their historical significance, rather than being part of the herbarium collection.

YS: Do you add to the collection every summer field season?

JW: What we're trying to have with our collection here in Yellowstone is at least one representative specimen of every taxa that occurs in the park. We're also trying to use the herbarium to document the arrival and spread of exotic species, so our current collecting is actually somewhat biased toward exotics in order to document what is happening, because it's a huge problem. I think exotics are the biggest threat to the national parks. People tend to look at Yellowstone as this wide-open, pristine wilderness, but the whole look of it has changed from 200 years ago.

We are also trying to pick out the holes that we currently have in our collection and make an effort to collect those species. A lot of the people who collected for the herbarium in the early years tended to collect the showy species—the wildflowers. We're trying to make sure that we have an even coverage of the sedges, the grasses, the things that most people don't tend to look at carefully, which actually, from a Yellowstone perspective, are some of the more interesting plants in the park. The Bechler area has been undercollected, partly because botanists don't like getting their feet wet much more than anyone else. But I've found more new records for the park, often, by getting out and getting wet. My boots sometimes never dry out, and my feet start smelling like rotting boots. I have even gone swimming to collect plants. I actually swam out to a beaver lodge once to see what was growing on top of it and found a species not yet reported in the park.



JENNIFER WHIPPLE

Warm springs spike-rush, a rare plant, in a thermally influenced wetland.

YS: Are people doing plant research in the park supposed to provide you with voucher specimens collected during their research?

JW: Yes. There is a tremendous amount of park material that has been collected, since even before the park's establishment, and lies scattered in institutions all over the country. Regretfully, Yellowstone, as well as other parks, has no way of tracking all of this material. Because of this, today, anything that's collected in a national park is legally the park's property, and everyone, including me, needs a collecting permit. The storage location of such specimens, however, is a decision between the park and the investigator. With the additional storage space now available in the HRC, we will be able to accept many more voucher specimens than before.

YS: When you get voucher specimens, where do you store them?

JW: They are stored right along with the regular specimens, and marked as having been collected for so-and-so's particular project.

YS: How is the herbarium organized?

JW: There are a couple of different, traditional ways that plant specimens have been organized in herbariums. One has been according to what was considered the best guess of evolutionary relationships, though different experts had different schemes. Because of this confusion, for small herbaria, like Yellowstone's, the easiest thing to do is to have it alphabetically organized by plant family, genus, and species. That's how we've had our collection organized for the last 20 years. Say a researcher comes in and would like to see all the material of Ross' bentgrass, which is an endemic grass only known from the thermal areas in Yellowstone. It's all stored together, no matter when or by whom it was collected. Therefore, a researcher can immediately locate all the material that we have for that species.

You can now use techniques similar to DNA-fingerprinting that provide a better understanding of how some disparate plant groups are related to each other.

YS: Do scientific plant names stay stable enough over time to prevent confusion?

JW: The reality is that there's a lot of variation in how things are handled, for instance, state-to-state, because the different state floras were written by different authors who didn't necessarily agree on species delineation or correct nomenclature. Let's take bitterroot, which is the state flower of Montana and was a very important food source for some Native Americans. The bitterroot here in Yellowstone typically have petals that are bright, bright pink. If you go to Craters of the Moon, not that far from us [in Idaho], to our eyes, the petals are white. If you go through the whole distribution of bitterroots, sometimes the plants are upright when they're in bloom, sometimes the blooms are on the ground, but virtually everybody agrees that this variation is within the concept of *Lewisia rediviva*. The classification of many species, though, is quite controversial, with different treatments being routinely used by different experts.

Another really interesting thing happening right now is the explosion of new information from genetic techniques.

Park naturalist Arthur Hewitt, working in the herbarium in 1958, when it was located in the Albright Visitor Center basement. Behind him are beautifully made wood herbarium cabinets, in contrast to today's metal cabinets, which are designed to be more insect-proof. These wooden cabinets were likely custom made in the 1930s, as the park started to increase the quality of the care of its collections.

NPS/VIRGINIA WARNER

Pressed plant specimen storage in the HRC.

You can now use techniques similar to DNA-fingerprinting that provide a better understanding of how some disparate plant groups are related to each other. The most important resource previously available for understanding evolutionary relationships between plants were the flowers, but flowers are very rarely preserved in the fossil record. This lack of evidence has forced botanists to depend primarily on analyses of contemporary species, and to make guesstimates about what the relationships are between different flowering plants. The information coming in from these genetic methods is changing how we're looking at some of the plant families. The demarcations of some plant families that have been very constant for the last century or so are becoming more plastic. That's going to present an interesting conundrum about how specimens are arranged in herbaria. There's going to be a lot of flux for quite a while as more and more information comes in.

YS: Where was the park herbarium stored over the years?

JW: I'm not sure exactly where it started out, but according to Mary Meagher, [retired research biologist who was museum curator from 1959 to 1968], it was in the central area of the basement of what is now the Albright Visitor Center from at least the 1930s. After Mary arrived, the herbarium moved to the second floor in the same building. Later, the herbarium moved to a different building, then to the third floor of the administration building, where it was located until the 1990s. In 2000, the herbarium moved to the Yellowstone Center for Resources building. And, of course, this summer, it has moved to the HRC, where we hope it stays for a long, long time.

NPS/VIRGINIA WARNER

Mushroom storage in the HRC.

NPS/VIRGINIA WARNER

Fungus specimens, such as these mushrooms, are handled and stored differently than pressed vascular plant specimens.

NPS/VIRGINIA WARNER

Lichen, mosses, and liverwort storage in the HRC.

NPS/VIRGINIA WARNER

A moss specimen.

YS: Why was the herbarium moved to the HRC? I've heard it referred to as a "working curatorial collection."

JW: The herbarium is actually a part of the museum collection, and specimens are accessioned and catalogued into the museum collection just as any other museum object would be. However, the herbarium is kept separate from the main museum collection in order to allow for the unique uses that are particular to herbaria. Not only is the collection active, but NPS personnel, the public, and outside researchers need to have and are allowed easier access to the specimen than is usual for museum objects.

The new facility is a fantastic improvement for the herbarium.

YS: In your new space at the Heritage Center, do you have room for at least 25 years of growth in the herbarium collection?

JW: Yes. Definitely. The herbarium space has been so constrained for so long that we've pretty much had to focus only on vascular plants, because that was where we had the most use going on, and the most need. But we've got a collection of bryophytes, which are things such as mosses and liverworts, lichens, and we also have fungi. We even have a few specimens of algae. Now, we're going to be able to expand our lichen and bryophyte collections, and start a conifer cone collection, which we've never had. So we'll be able to fill in some of the holes that we haven't been actively collecting for, because we just didn't have space to store them.

YS: Are there other advantages to your space in the new building?

JW: Yes, one important improvement will be that the collection will be better protected. As I mentioned before, the two things that can really foul up a herbarium collection are insects and flood events or water damage. Hopefully, we can keep the second from happening. The first one is an active problem; we have gotten insects into the collection at least twice in the past. The second time happened while I was here. Swallows were nesting all around the administration building, and the bed bugs started marching two-by-two and dropping on employees' desks and stuff. So they fumigated the whole building for the bugs and that, fortuitously, also annihilated the insects in the collection. We have just moved the whole collection, and we have no idea whether or not we've got bugs in there. I hope we don't. We keep sticky pads in the individual cases so if something starts crawling around, we can just check the sticky pads to determine their presence. Hopefully, with the new facility, nothing will be able to get in.

Packing up the old herbarium in the Yellowstone Center for Resources building in Mammoth Hot Springs.

The most exciting aspect of the new building, though, is the processing space. We have a vegetation lab room downstairs where we can store plants while they're drying, and keep our field-related gear. Fresh material is not allowed upstairs to reduce the chance of an insect infestation. Upstairs in the herbarium storage, we'll be able to set up a processing line and store things in all stages of processing, which we haven't had room to do before. We've been able store things, but we haven't been able to spread out and actually mount specimens and process them into the collection. This is why we have a backlog of 2,000–3,000 specimens. And now we're going to be able to get those specimens into the main collection and accessible to staff and researchers. The new facility is a fantastic improvement for the herbarium.

YS: Are you all moved in now and getting back to work?

JW: Not completely. There's a lot of reorganization that needs to be done, taking advantage of the additional space. We should be up and running in plenty of time for next year's field season!

YS

The herbarium movers in the new HRC herbarium, which does have room for 25 years of growth in the collection.

The Bridge Bay Spires

Collection and Preparation of a Scientific Specimen and Museum Piece

Russell L. Cuhel, Carmen Aguilar, Charles C. Remsen, James S. Maki, David Lovalvo, J. Val Klump, and Robert W. Paddock

Introduction

YELLOWSTONE NATIONAL Park has served the public as a source of wonder, amazement, and education for more than 125 years, yet has far from exhausted its bounty of stunning scientific discoveries. While some may be of purely scientific interest, many are suitable and appropriate objects of public appreciation as well. Geological phenomena are particularly appealing in both the scientific and visitor arenas. Many such treasures lie discretely hidden below the frequently tumultuous waters of Yellowstone Lake (Marocchi et al. 2001), and it is clear that numerous revealing features have yet to be discovered. An incidental observation by National Park Service (NPS) archeologists in 1996 has been systematically pursued during the last five years to finally produce a specimen of probable hydrothermal origin that will provide awe and insight to scientists and visitors alike.

That Yellowstone Lake harbors intriguing hydrothermal features should come as little surprise to anyone. Walking, for example, on the West Thumb Geyser Basin boardwalk, it is not difficult to imagine Fishing Cone as only one of a complex of underwater bubbling pots and geysers. Likewise, the smoking, malodorous beaches of Mary Bay only hint at the wealth of active vents under the surface, though vigorous bubblers are clearly visible only a few yards from shore. Nor are all of the interesting features active today: in fact, there is much to be learned from relict structures that shed light on past geological processes. However, the harsh conditions of Yellowstone Lake's geothermal regions have restricted access to only a few experienced and persistent groups of explorers. In 1999, active collaboration between the NPS and a long-standing program of the University of Wisconsin–Milwaukee Center for Great Lakes Studies (CGLS), Marquette University (Milwaukee), and remotely operated vehicle (ROV) contractor Dave Lovalvo succeeded in bringing one of the lake's secret riches (literally) to light.

EASTERN OCEANICS AND CGLS

Backlit by green sunlight at depth, a solitary spire emerges from the turbidity at Bridge Bay in 1996.

Discovery of the Spires

The story began with a team of NPS archeologists searching parks nationwide for relicts of previous area inhabitants. During their 1996 acoustic surveys for submerged artifacts in nearshore areas, they ran across an unexpected series of shallow depth soundings in about 60 feet of water near the Bridge Bay marina. Alerted by these scientists, the CGLS team went to the site to investigate. The Bridge Bay area had received little attention because of its apparent lack of active hydrothermal venting, but the plot from the depth sounder piqued our curiosity (Figure 1). A seemingly straight line of tall features jutted abruptly out of an otherwise featureless plain, much as some geysers of the Old Faithful area protrude from barren landscapes. The form was much more suggestive of accretional (building up) rather than erosional (wearing down) action, possibly during long-past geological activity. Using one of the last dive days of the season, Tony Remsen, Jim Maki, and Dave Lovalvo deployed the ROV from the NPS research vessel *Cutthroat*. Their first dive landed near enough to the structures for rapid visual investigation.

The visuals were stunning. Through the dim green "fog" of somewhat turbid nearshore water, ghostly shapes emerged; up close, it suddenly became obvious that they were towering columns of hard rock. Among the lot, graceful individual spires

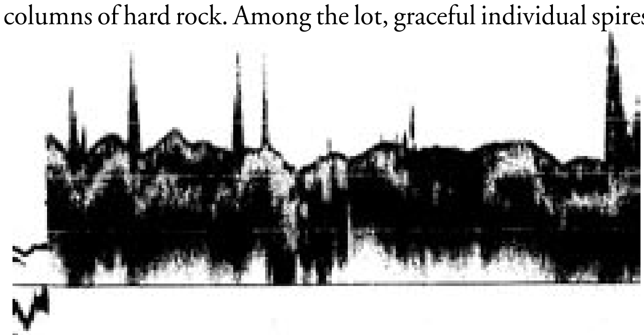


Figure 1. Bridge Bay spires are clearly visible on 1996 depth sounder charts from the R/V *Cutthroat*.

loomed on the monitors like stalagmites, with clusters of spires resembling ancient castles interspersed among the string. In the camera's lens, the structures varied from mere nubs to towers over 15 feet high, many covered with luxuriant growth. Well infused with natural sunlight at this depth (45–60 feet), large populations of algae covered the sides and tops of the spires. A variety of animals, including colossal examples of freshwater sponges, also made the spire surfaces home (Marocchi et al. 2001). As is common in the Yellowstone Lake geoecosystem, the spires' organismal encrustation hid the true nature of the underlying features. To understand what had been found, actual physical samples were going to be necessary. Likewise, the area required some level of protection, as evidence of damage (possibly from boat anchors, for example) was found during the initial video observation. A no-anchor zone was established by the NPS, followed by negotiations to raise a piece of the spire field for scientific investigation.

Operating under a new, two-year grant from the National Science Foundation (NSF) in 1998–99, the CGLS team worked with NPS representatives to establish a procedure for obtaining and investigating a spire sample. Collecting even a small intact structure was well beyond the capabilities of the available ROV. Yellowstone National Park resource management coordinator Dan Reinhart agreed to arrange an expedition of NPS divers to collect a specimen in the late summer of 1998. However, due to scheduling constraints, the dive would have coincided with the last working day of the group, which would have endangered satisfactory preparation of the sample for transportation and analysis. The collection was postponed until the 1999 field season.

The spire fields and underwater vent work of the CGLS group expanded to include involvement by the U.S. Geological Survey (USGS) and their associates. The USGS group, led by Drs. Lisa Morgan and W.C. "Pat" Shanks, had already done extensive mapping of Yellowstone Lake's magnetic properties. Further inspired by the Bridge Bay structures, they mounted a detailed survey of bottom topography during the summer of 1999. The first transects, in the northern basin area that includes Mary and Sedge Bays, led to the discovery of many more, significantly larger, and extensive spire fields reaching to 100 feet tall (Elliott 2000). These observations enthused the group all the more about collecting a sample for study. Yellowstone staff likewise wished to obtain a display specimen.

Collection of a Spire Specimen

Late in the summer of 1999, their wishes were fulfilled. On a somewhat dreary, overcast day, Dan Reinhart and NPS divers Wes Miles, Rick Mossman, and Gary Nelson boarded a landing-craft-like vessel captained by Dave Hall and headed out with the *Cutthroat* to the Bridge Bay site. Observers from the CGLS team and the USGS were also aboard. Once the features were located by sonar, the divers donned their cold-water gear (Figure 2), slid delicately off the bow into the water, checked their underwater cameras, and descended into the murky deep. From above, we could follow their progress by the trail of bubbles. Twice they surfaced—once with bags of water collected next to the base of a spire, and once bringing small pieces of "spire rubble" from scraps possibly damaged by previous anchoring. The spongy, porous, fragile fragments aroused substantial excitement: these were not at all like the hard vent pipes we had so often collected with the submersible! Clearly, different mechanisms had been involved in the creation of these spires.

Then, somewhat disappointing words came from the divers: the small intact spire they wanted to collect was firmly rooted in the muck and couldn't be budged. One more try, please! Rob Paddock quickly fashioned a rope sling that would provide support for the probably very delicate sample—if it could be freed from its ancient home. After a seeming eternity, the large air bubbles at the surface were pushed apart, first by a gloved hand, and then by a rubber-encased head, with thumbs up. The divers and boat crew struggled to lift the catch of the day out of the water and into a bubble-wrap-lined cooler (Figure 3). Much like pulling a tooth, the divers had rocked the 2½-foot mini-spire until it broke loose from confinement. The site of adjoinment to other structures, well below the sediment–water line, was evident as an exceptionally white spongy area on one side (Figure 3). What a find! The divers had a right to gloat over their day's work. Everyone present, including scientists from the CGLS, Marquette University, USGS, and NPS were anxious to examine the collection, but a rocking boat was certainly not the place to do it!

The spire was unwrapped on a desk at the Aquatic Resources Center at the park's Lake station. Maki and Aguilar picked at the nooks and crannies for leeches, worms, sponges, and samples for bacterial analysis. Shanks, Morgan, and Klump prodded chips and fragments, looking at the intriguing layered structure of the apparently siliceous (glass-like) form. All marveled at the complicated swirls of mineral deposition visible on the exterior. What mysteries would be solved, or would arise,

RUSSELL CUHEL

Figure 2. NPS divers (L–R) Rick Mossman, Gary Nelson, and Wes Miles discuss sampling plans at the Bridge Bay site.

RUSSELL CUHEL

Figure 3. In a cooler on board, the intact 2½-foot specimen exhibits a white zone of attachment to an adjacent structure near the base.

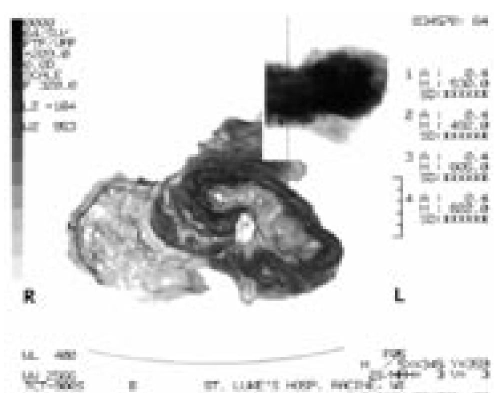
from examining the interior? Were secrets of the origin of spires and some history of Yellowstone Lake lying only millimeters away, in the center? Once again, patience was required. Even during the short evening celebration, chips dried out to amazing lightness and could be crumbled easily between the fingers. It was evident that special precautions would be necessary to ensure that everyone received an uncompromised sample for their specific uses.

The spire was obviously much stronger when saturated with water, so for transport by truck to Milwaukee, the intact specimen was heavily encased in bubble wrap and soaked with Bridge Bay bottom water. Upon return to the CGLS, there was discouraging news from the NSF: the renewal proposal for work in Yellowstone Lake had not been funded. While this did not dampen the enthusiasm for working up the year's collections, it did require a further dedicated effort to secure support for further research. During 2000, the spire waited in a walk-in refrigerator while grant-proposal writing took precedence. At last, Carmen Aguilar, with co-investigators Cuhel, Paddock, Maki, and Charles Wimpee, obtained three more years of financial support through the NSF's "Life in Extreme Environments" program. Also during 2000, Drs. Lisa Morgan and Pat Shanks of the USGS garnered funding from their own agency and the NPS to continue their high-resolution mapping of the lake bottom and magnetic anomalies. During the summer, they surveyed the area between West Thumb and Bridge Bay as well as the deep canyons east of Stevenson Island. The impetus was still strong for analysis of the spire, but how should the very fragile piece be handled? Its interior structure was still completely unknown.

Preparatory Investigations

Is there a doctor in the house? By chance, Jim Maki's wife, Kay Eileen, is a doctor with St. Luke's Hospital in Racine, Wisconsin, and they came up with the idea of running a non-destructive CAT scan to analyze density on "our baby." The anxious "parents"—Jim Maki, Tony Remsen, and Val Klump—waited in the control room as the intact specimen was examined at 5-mm intervals. Almost 150 images were obtained, providing a detailed picture of the interior density structure upon which we would base our sectioning. One such view, taken just above the sediment–water interface portion, is shown in Figure 4. Dense areas are darker, while soft, porous material is lighter in this rendering. The location of the section is shown as a line about one-quarter of the way up from the base (upper right). In the main image, the left-hand, lighter bulb is the white area in Figure 3 above, and extends to only about one-third of the height of the main spire component. The exposed edge of this section was very low-density, exceptionally white sinter with thin layers of hard, white crust meandering throughout. This portion appears almost to exude off the side of the main spire to the right. The main segment (dark oval) had a substantially denser external structure, with several nearly white circular features that might have indicated vertical conduits within the column. These possible tubes did not continue to the point of the spire; rather, they became smaller and finally vanished about halfway from the bottom.

Collectively, the images provided a pre-cutting, cross-sectional map of the spire's interior, and we opted to make four cuts to provide (1) one-half of the spire with cross-section for the NPS; (2) one quarter for the USGS for their mineralogical analyses; and (3) one-quarter for the CGLS research team. The question now was, how? It was indisputable that the material was extremely fragile. Several concerns included the use of cutting oils, binding of the spire while moving across a cutting table, and possible fracturing of the material from the stress of cutting. Because it appeared to be primarily composed of silica, we consulted George Jacobson, a glass artist at Les' Glass in New Berlin, Wisconsin. George had just produced a fabulous etched rendition of a deep-sea hydrothermal vent scene on glass shower doors for us, and he was world-renowned for his leaded glass panels and other forms of plate glass work. Given the pictures of the specimen and the goals we had set, he



ST. LUKE'S HOSPITAL, RACINE, WISCONSIN

Figure 4. An X-ray cross-section of the spire at about one-third of the length from the base (vertical line on inset) reveals spongy, low-density (lighter shades) sinter in the bulb to the left side. The adjoining main spire section shows rings of higher-density material (darker shades) surrounding sinter with possible pores or conduits (white).

instantly sent us to Scott Cole, who worked in a water-jet saw facility at KLH Industries in Germantown, Wisconsin.

During our initial visit, Scott described the advantages of the water-jet saw for our application. It consists of a fine orifice nozzle (3/64") through which a mixture of high-pressure water (55,000 pounds per square inch) and finely ground garnet is directed at the subject material from close range. Powerful enough to do filigree work in stainless steel while leaving satin-smooth edges, the instrument has several major benefits. First, there is no blade to bind on the work; the water jet cannot snag on regions of suddenly-changing composition. Second, the nozzle is moved over the work, rather than pushing the work through a cutting edge. Third, the composition of the cutting material (water) and the abrasive (garnet) are chemically pure compared to machine cutting oils, and can be readily analyzed. The water is not recirculated, so the material is not in contact with waste from previous jobs. Fourth, the material need not rest on a hard surface. The tool cuts into a large water bath with wood slats across it. The work may be placed on the wood, on foam or any softer material, or on a bed of tissue: the saw will cut through that as well. A disadvantage was that in thick material, the physical broadening of the stream with distance means some loss of material at the bottom of the cut. But watching a current job with stainless steel, we were convinced that a test with some of the larger fragments was in order.

The first test piece was a nodule about three inches thick. Although it was somewhat more dense than the spire itself, the hard mineral component seemed to have the greatest degree of difficulty. This kind of material was apparently well represented around the outer crust of the spire, based on the acoustic scans. Jet saw technician Brian Bagget helped us nestle the fragment into a foam bedding on the cutting pond, after which we discussed setup. Normally, the jet saw is fully automated. A design is read into a computer-aided design file in the computer, registration points are identified on the work, the height above surface is set, and then the program runs the nozzle through the x–y coordinates of the design, much like a plotter on paper. For our job, the cut itself was to be linear, and it was the height above base, to follow the contours of the spire surface, that had to be varied. With more than nine years of jet saw operational experience, Brian felt that manual control of the z-axis (height of the nozzle) during a constant-rate, straight-line run would work best. He would be able to keep the nozzle close to the surface, minimizing stream broadening, without having to make a large number of thickness measurements with subsequent programming. His efforts with the fragment proved his expertise. A very flat cross-section was obtained that both preserved the detail of interior pits and pockets, and maintained intact areas near the upper edge, where fractures left thin, brittle plates of mineral. A second piece of smaller size, representing the silica sinter (light, porous material), also cut very cleanly and without any "shivering" that might have obliterated delicate interior features. The demonstration convinced us that this was the method of choice. An appointment for an estimated three-hour session with the actual spire was made, and we took samples of the water and the garnet abrasive for analysis.

Sectioning of the Spire for Science and the Public

To expose the interior of the sample to best advantage while retaining an undisturbed external segment for each sample, the plan was to cut across the rough bottom, or "root," to provide a flat base and cross-sectional view. Then, the low-density silica "bulb" on the side would be removed. A subsequent longitudinal section would provide a full-length half-spire for the NPS, and lengthwise cutting of the remaining half would give the USGS and the CGLS each a representative section for analysis. Scott Cole helped set up the spire on the cutting pond for bottom removal. Using a straight-line progression, technician Brian Bagget kept the nozzle as close as possible to the work, which was especially important at the fragile trailing edges of the cuts (Figure 5). The best support was thin plywood, with a sheet of light foam packing material under the spire, because the jet cut through the support with minimum backsplash.

Anxious as we were, the first cut across the base turned out beautifully. Figure 6 shows the fidelity of the CAT scan (Figure 4, above) to actual composition, with a very low-density silica mass—the "bulb"—to the left, and the harder, apparently conduit-like structure to the right. The dark areas surrounding the orifices resemble iron sulfide precipitates; analysis is currently in progress. The sample was rotated 90°, and the low-density bulb was cut off parallel to the long axis of the specimen. Using the large, flat edge for stabilization, a lengthwise axial cut was started up the center of the main spire. Slight expansion of the jet stream made a thin but decidedly V-shaped channel, but material loss was mostly confined to the softer silica material rather than the conduit segment of greatest interest.

PHOTOS THESE PAGES BY RUSSELL CUHEL

Figure 5. The water-jet saw finishes a transverse section across the bottom of the spire with the nozzle held close to the surface of the object.

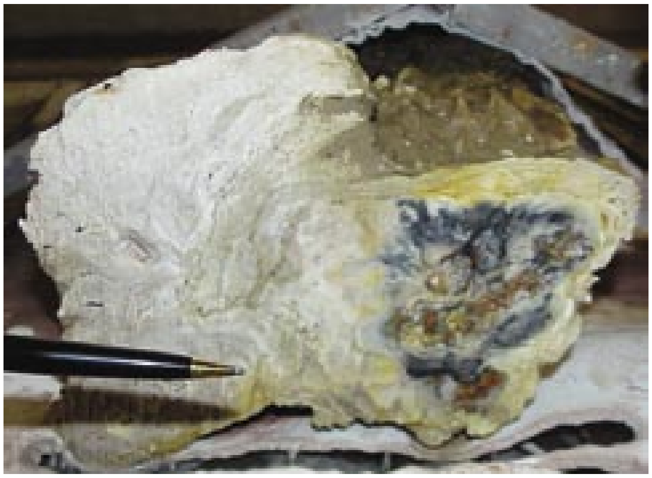


Figure 6. Cross-section of the spire viewed from the bottom reveals the porous sinter on the left and the harder main spire with dark precipitates to the right. Pen segment is three inches long.

Technician Brian Bagget carefully maneuvered the nozzle close to the specimen all along the path. The water-jet saw was especially valuable at the very tip of the spire, where the delicate silica was most susceptible to disintegration. Moving this piece through a conventional sawblade would have been a great risk to the integrity of the fine structure near the tip.

Excitement and suspense replaced anxiety as the two pieces were carefully pulled apart. Was this form the result of accretion by seepage of geothermally enriched water? Was it a product of vigorous venting through an orifice? Or was it simply mounded into shape from adjacent sediment? The first view of the interior revealed a definitive conduit-like feature extending from the base to about one-third of the way to the tip. A thin shell of hardened material surrounded a pipe plugged with granular reddish-brown material, perfectly preserved in the sectioning. A close-up of the base region (Figure 7) shows the conduit and its contents clearly, but the feature disappeared

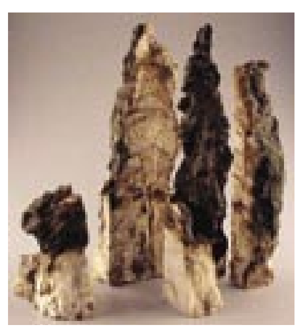
Figure 7. A close-up of the presumed conduit at the base (left) of the spire shows the thin enclosure filled with heterogeneous material.

halfway up the length of the tower. Surrounding the pipe, and accounting for most of the upper half of the spire, was more of the lower-density, silica-like material. There were bands of dark precipitate throughout the porous component, including two apparent "shells" at different distances from the exposed exterior surface. No single mechanism appeared to explain the structure; rather, it appeared as if a combination of geochemical and geophysical forces worked to shape the object. In cross-section, this half elegantly displays the interior structure of the spire, and when rotated 180°, the original view of an undisturbed specimen as seen in Yellowstone Lake is retained.

The final cut would provide the material for scientific research at the USGS and for the CGLS. The "less beautiful" of the two halves was supported over the cutting pond, and the idle nozzle run along the center of the conduit to the tip, with alignment perfected by Brian Bagget. Starting at the base, cutting this thinner section resulted in much lower loss of material on the downstream edge of the work. Each quarter-spire contained components of all of the visually apparent features for detailed investigation. Again, the tool proved valuable, as the "blade" separated two sections in the very thin, fragile spire tip area.

Final Disposition of the Sections

An exploded view of the product is shown in Figure 8. A line from the sediment–water interface can be seen clearly on the forward sections. New homes of the pieces are (clockwise from center) Yellowstone National Park, CGLS, USGS, and CGLS. Of the two research quarters, the one containing both the conduit and the adjoining section of silica bulb was sent to the USGS scientists, while the smaller quarter and disjoined bulb fragment were retained in Milwaukee. Among the many analyses underway are high-resolution electron microscopy with elemental analysis; radio- and stable isotopic age determination and geochemical formation studies; mineralogical examination, and others. Results of the combined efforts will resolve some of the mysteries surrounding the formation of the spires, as tentatively described in a *Science* "News Focus" article of mid-2001 (Krajick 2001).



RUSSELL CUHEL

Figure 8. Spire segments arranged in exploded view as they existed in the field, emphasizing the contrast between exterior (forward, right) and interior (rear) composition.

Resource Considerations

Detailed scientific analysis is not necessary to recognize that the Bridge Bay spires are both awesome and delicate. Only recently discovered, though probably thousands of years old (research in progress), it is now clear that there must be a balance struck between protection of the resource and access for public viewing. In the words of Yellowstone Center for Resources Director John Varley, "It would be the most spectacular part of the park, if you could see it" (cited in Krajick 2001). In the lake, the spectacular views (Marocchi et al. 2001) are shallow enough for sunlight to penetrate, but are accessible only by SCUBA diving. Even so, just the seemingly rugged exterior is visible, and it will be only through the park's eventual display of the sample that visitors can glean the complexity of the spires' long history. With the hundreds of much larger spires later discovered by the USGS in the northern end of the lake (Elliott 2000), there exist several opportunities to develop a "spire preserve." A remaining challenge might be to provide viewing possibilities without the requirement of diving, thus increasing the breadth of public access while simultaneously protecting the features from accidental or intentional vandalism. This challenge extends beyond the spires to numerous and diverse hydrothermal geoecosystems throughout the lake (Marocchi et al. 2001; Remsen et al. 2002). For example, NPS divers or ROVs might collect a video survey of spire fields that could be played at a visitor center from CD-ROM or endless-loop video. Many other scenarios may be envisioned. Certainly, the events depicted in this article have elevated the Bridge Bay spires from "mounds of rubble" to geological features containing some of the keys to understanding Yellowstone Lake's past. Research in progress by all involved agencies will serve to augment the already great contribution of Yellowstone Lake to awareness of Earth's geoecosystem functions.

YS

Acknowledgments

We are grateful to Yellowstone National Park supervisors John Varley, John Lounsbury, and other personnel (especially at the Aquatic Resources Center at Lake) including but not limited to Dan Mahony, Jim Ruzycki, Rick Fey, and Harlan Kredit. The group is particularly thankful for access to NPS dormitory facilities, which housed us efficiently. This work was supported by NSF Environmental Geochemistry & Biogeochemistry Program grant 9708501, NSF Life in Extreme Environments grant 0085515, NSF Research Experience for Undergraduates Program grants OCE9423908 and OCE9732316, and National Undersea Research Program grant UCAP 96-07. We also thank W.C. "Pat" Shanks and Lisa Morgan of the USGS for their unflagging interest and enthusiasm sharing their results from the bathymetric surveys of 1999 and beyond. Contribution number 426 of the University of Wisconsin–Milwaukee Center for Great Lakes Studies. The authors also thank All Saints Health Care and St. Luke's Hospital of Racine, Wisconsin, for donating the CAT scan time to analyze the spire.

This article was previously published in Anderson, R.J., and D. Harmon, eds. 2002. *Yellowstone Lake: Hotbed of Chaos or Reservior of Resilience? Proceedings of the 6th Biennial Scientific Conference on the Greater Yellowstone Ecosystem.* October 8–10, 2001, Mammoth Hot Springs Hotel, Yellowstone National Park. Yellowstone National Park, Wyo., and Hancock, Mich.: Yellowstone Center for Resources and The George Wright Society.

References Cited

Elliott, Craig. 2000. Yellowstone's Atlantis? Yellowstone Lake surrendering long-held secrets. *Yellowstone Discovery* 15(2): 1–3.

Krajick, Kevin. 2001. Thermal features bubble in Yellowstone Lake. *Science* 292: 1479–1480.

Marocchi, Sory, Tony Remsen, and J. Val Klump. 2001. *Yellowstone Lake: Join the Expedition!* Whitefish Bay, Wisc.: Hammockswing Publishing.

Remsen, Charles C., James S. Maki, J. Val Klump, Carmen Aguilar, Patrick D. Anderson, Lorie Buchholz, Russell L. Cuhel, David Lovalvo, Robert W. Paddock, James T. Waples, James C. Bruckner, and Carl M. Schroeder. 2002. Sublacustrine geothermal activity in Yellowstone Lake: studies past and present. Pages 192–212 *in* Anderson, R.J., and D. Harmon, eds. *Yellowstone Lake: Hotbed of Chaos or Reservoir of Resilience? Proceedings of the 6th Biennial Conference on the Greater Yellowstone Ecosystem.* October 8–10, 2001, Mammoth Hot Springs Hotel, Yellowstone National Park. Yellowstone National Park, Wyo., and Hancock, Mich.: Yellowstone Center for Resources and The George Wright Society.

RICHARD BEAUCHAMP

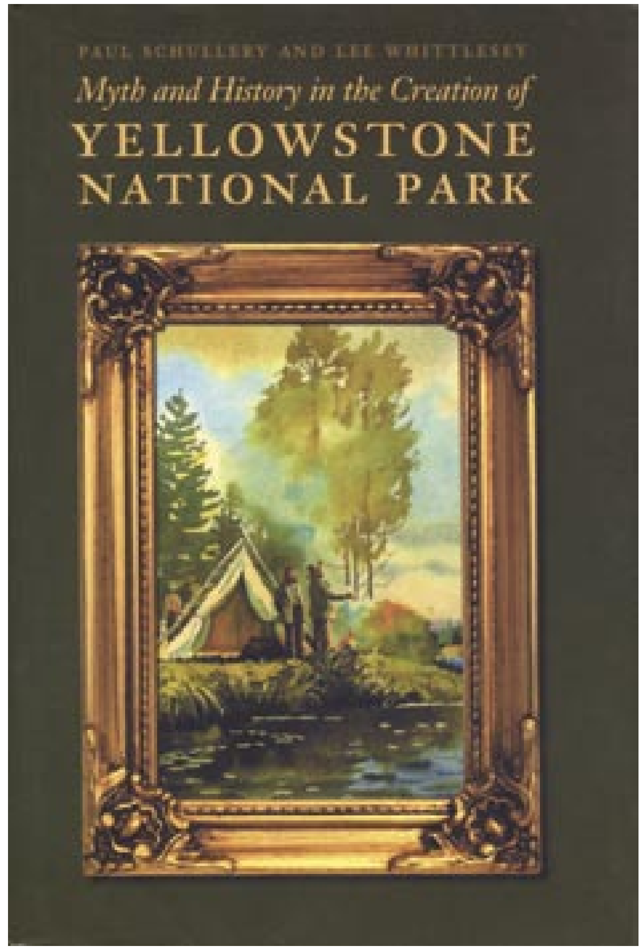
Typical Yellowstone Lake vent team: *Top:* Dave Lovalvo (ROV engineer), C.C. "Tony" Remsen (UWM PI), Mike Lawlor (MU undergrad.), Carl Schroeder (MU graduate student). *Middle:* Carmen Aguilar (UWM PI), Russell Cuhel (UWM PI/PD), James Maki (MU PI), Valdean Klump (UWM helper). *Bottom:* Patrick Anderson (UWM Tech), J. Val Klump (UWM PI).

Since the mid-1980s, a team of scientists and students from the University of Wisconsin–Milwaukee and Marquette University have worked with ROV engineer Dave Lovalvo (Eastern Oceanics, CT) to explore underwater geysers and fumaroles in Yellowstone Lake. In collaboration with YNP personnel from the Yellowstone Center for Resources and the Aquatic Resources group at Lake Station, annual efforts and sampling skills improved from initial surveying supported by NOAA's National Undersea Research Program to large scientist–student teams through major funding from the National Science Foundation in the late 1990s. Raising the Bridge Bay spire was part of an interdisciplinary program on geochemistry of YNP hydrothermal systems headed by UWM.

Book Review

Myth and History in the Creation of Yellowstone National Park by Paul Schullery and Lee Whittlesey

Kim Allen Scott



(Lincoln, NE: University of Nebraska Press, 2003. xv plus 125 pages, acknowledgments, introduction, illustrations, notes, bibliography, index. $22.00 cloth.)

HENRY DAVID THOREAU once likened the correction of commonly believed falsehoods to cleaning hardened mortar from used bricks, claiming "it would take many blows of a trowel to clean an old wiseacre of them."[1] The sage of Concord was correct in his assessment of the persistence necessary for such work, but he left unsaid the possibly high cost of such cleaning to the wielder of the trowel. Questionable stories from the past clinging to the foundation bricks of modern institutions can adhere with a tenacity sustained by society's deepest held values, and a person who attempts to closely examine those stories proceeds at their own risk. In extreme cases such a person can be vilified as a heretical iconoclast, as Paul Schullery and Lee Whittlesey have so painstakingly described in this fine study, *Myth and History in the Creation of Yellowstone National Park.* In their narrative the authors wield the trowel of correction accurately and fearlessly, refusing to hide the blemishes that might cause many writers to shrink from the task.

On the night of September 19, 1870, the members of the Washburn-Langford-Doane expedition through the Yellowstone country camped at the junction of the Firehole and Gibbon Rivers. They had just completed a journey through a wilderness that differed radically from anything they had ever seen and they gathered around the fire for what would be their final evening together. In a book he published 35 years later, Nathaniel P. Langford claimed that a resolution was reached by the men around that riverside campfire to forsake personal claims on any of the land they had explored and to individually work toward setting Yellowstone aside as a national park. The tale of heroic self-sacrifice reached spontaneously by a colorful gathering of explorers became so embedded in the history of the park that Langford's story was repeated and embellished in print, spoken word, and even theatrical reenactment well into the 1960s. Yellowstone's keepers actively encouraged acceptance of the campfire story, going as far as erecting a monument on the site and naming a nearby mountain to commemorate the event.

But a problem arose once historian Aubrey Haines carefully analyzed the evidence purporting to document the campfire story: he found it simply did not exist. Haines had worked for the National Park Service since 1938, and while serving as Yellowstone Park historian in the early 1960s, he engaged in writing a definitive history that gave him just cause to question Langford's story. Langford's original diary, from which he allegedly published his book, could not be found within the archival collection of his personal papers, and Haines noted that none of the other diarists present at that 1870 campfire even mentioned such a discussion taking place. Haines also discovered that Langford's claim of having actively promoted the national park idea during subsequent speaking engagements in the eastern states simply could not be corroborated.

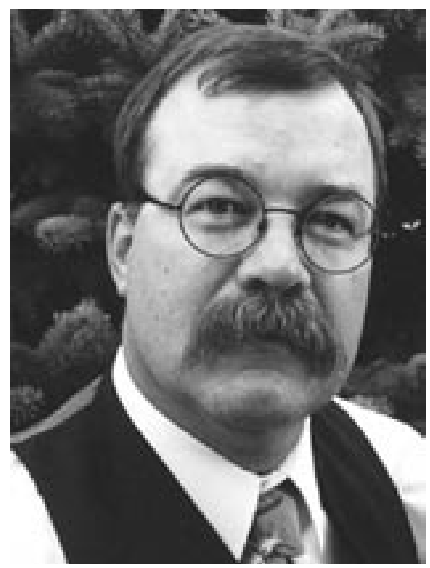
When Haines began to challenge the long established celebration of Yellowstone's birth, officials in the National Park Service reacted with surprising vehemence. Haines suddenly found himself transferred from Yellowstone to a post at the Big Hole National Battlefield in 1964, and while serving out his virtual exile, his old position as park historian was abolished. In 1966, he returned to Yellowstone to assume a vacant job slot as a "geologist" and continue work on his history of the park, but the reaction against Haines's revisionist view of the campfire story would have repercussions far beyond his eventual retirement in 1969. Publication of his two-volume work, *The Yellowstone Story*, was delayed until 1974 and even then Haines had to agree to soften his criticism of Langford's campfire tale. "It is our opinion that *The Yellowstone Story* is the single most important book ever published about Yellowstone National Park," claim Schullery and Whittlesey. "That the park's friends were almost denied access to it just because of an in-house quarrel over the interpretations in a few of its pages still amazes and appalls us." (pp. 67–68).

Myth and History in the Creation of Yellowstone National Park describes the high price paid by Aubrey Haines for his historical integrity and analyzes piecemeal the evidence to explain why the Yellowstone historian came to the conclusions he so fearlessly advanced. But beyond that story, this book suggests the underlying reasons how such a vendetta against the accurate interpretation of Yellowstone's origins occurred in the first place. Accurately defining the word "myth," Schullery and Whittlesey demonstrate how the deeply felt need of societies for epic representations of past events fits so perfectly in the Yellowstone creation story. Myths tell us who we are as humans and how we factor in the natural world. By giving hope to those inclined to believe in the better angels of our nature, myths celebrate heroes who bestow on mankind the benefits derived from their extraordinary adventures. If one considers the modern conservation movement as a sort of secular religion, the belief in altruistic explorers who renounced personal gain for the sake of future generations has tremendous mythical appeal and a resilience that defies historical criticism. As former Yellowstone superintendent Lemuel Garrison is quoted on the campfire story, "If it didn't happen we would have been well advised to invent it. It is a perfect image." (p. 35).

Myth and History in the Creation of Yellowstone National Park is a remarkable book on three levels. First, it is a carefully researched external criticism of the records (or lack thereof) on which the campfire story is based, and in so doing it is an excellent example of historical scholarship at its best. Second, the book unabashedly examines the consequences endured by Aubrey Haines for his role in practicing that same sort of historical scholarship. This is an extremely delicate task for the authors, who have both been in the employ of the National Park Service for many years, and have placed themselves in the unenviable position of having to describe some of the more unsavory aspects of its administration. The fact that the book succeeds in this delicate task is a testament to the skill with which it is written. Finally, the book examines why those who love the park so dearly needed the myth of its creation in the first place. It is not too far a stretch in pointing out to readers that the myth of Yellowstone's creation continues to live alongside a more factual interpretation because it serves a purpose as a "heroic metaphor" for those who need it.

But in consideration of Aubrey Haines's experience, *Myth and Creation* finds its most suitable heroic subject. The thoroughness of Haines's scholarship was matched by his grace in reacting to the consequences of his work. Toward the end of his long and productive life, Haines looked back with exceptional charity on his Yellowstone ordeal and declared, "It came out all right!" In this regard, perhaps Haines is a better example of Thoreau's metaphorical trowel rather than the man who uses it to clean the hardened mortar of falsehood. After the Concord philosopher finished preparing the brick for his Walden cabin, he paused to examine the tool and said, "I was struck by the peculiar toughness of the steel which bore so many violent blows without being worn out."[2]

YS



COURTESY OF AUTHOR

Kim Allen Scott is the Special Collections Librarian at Montana State University, Bozeman, and author of numerous articles on the trans-Mississippi Civil War and Montana frontier. His biography of Gustavus Cheyney Doane, the leader of the military escort that accompanied Langford through Yellowstone in 1870, will be published by the University of Oklahoma Press. Scott lives in Bozeman with his wife, Jayne, and sons Benjamin and Jacob.

Endnotes

[1] Henry David Thoreau, *Walden or Life In The Woods*, 3rd ed. (New York: New American Library, 1961), 162.

[2] Ibid.

Nature Notes

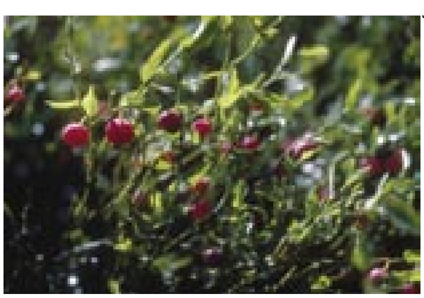

JENNIFER WHIPPLE

Musings from the Berry Patch

Sue Consolo Murphy

I'VE BEEN BITTEN by the berry bug. Each year, it's more serious, this drive to get into the woods, to look at patches found last year or the year before that, to check their progress each summer month and place mental bets with myself on how they'll do this year, when they'll ripen, and how much fruit they'll actually bear.

First, often as early as late June, come the *Fragaria* spp., the wild strawberries, whose tiny white flowers and reddish vines cling to the ground, occasionally leading to even tinier morsels of red. Next are the raspberries, *Rubus idaeus,* whose prickly bushes I accuse of deliberately seeking the steepest, driest slopes and rocky crevices, no doubt to discourage predatory pickers like me, the bears, and other things from plucking their soft seedless fruit. And the large-leaved red thimbleberries, *Rubus parviflorus,* which are much easier to grab but often fall apart before one can even taste their tarter flavor. Most likely to produce a crop in any given year, it appears, are the humble *Vaccinium scoparium*, the grouse whortleberry, whose leaves and red-purple berries carpet the forest floor. Abundant and sweet, these fruits tempt mostly the desperate or lunatic berry-picker, or my small children, who do not dwarf the wee berries so much as I. A lunker is the size of a pinhead—the fancy pearl ones that graced my grandmother's sewing box—yet this species shows, not insignificantly, in the lists of plants eaten by the massive grizzly bears that roam the greater Yellowstone landscape. It conjures up a ludicrous image in my mind of a 500-pound bear delicately munching a berry-and-leaf salad.


JENNIFER WHIPPLE

Massive grizzly bears love the wee grouse whortleberries.

As we turn the corner from summer heat toward the chill air of fall, I can find *Sambucus* spp., the tart purplish-black elderberries of my Midwestern childhood that some neighbor took en masse from their umbrella-like stems and added enough sugar to make wine, or pie. But my favorite are the huckleberries, the blue low-bush *Vaccinium caespitosum* that gives little notice of its potential, then seems one day—in a rare August—to burst into abundant production in the open slopes at the base of granite peaks. And the taller huckleberry, *V. membranaceum*, that basks in the shade of the firs and spruces and hugs boulders and hides under the willows that line the streambanks. Biologists I've asked couldn't say for sure, and the berry books express confusion about just what makes for good huckleberry habitat—fire is good, and/or clear cuts, or some shade and just the right mix of sun and moisture, of which greater Yellowstone gets less than the maritime-influenced areas from western Montana to the Cascades, where berries grow big and more predictably each year. When I want serious berries to store for winter, I head for that western country, and bring home full containers for the freezer.

Grand Teton and surrounding Jackson Hole have areas with abundant hucks, especially in a wet summer like that of 2004. Yellowstone is not great berry habitat, they tell me, the vegetation specialists and the bear biologists who've tracked radio-collared bruins to feed sites and collected scats. They've produced charts and graphs and percentages of food by season and digestibility, by protein content and high caloric value. During their study of grizzly bears in the 1960s, the brothers Craighead figured that berries were the fifth most important group of foods and, in later comparing their work with subsequent research in the park, that they declined in importance to grizzlies of the 1970s and 80s. I wonder at this change, whether it might be due to warmer, drier weather in the many drought years the ecosystem has recently experienced, or to other changes—recovering trout populations, larger numbers of elk and bison, better study methods and larger sample sizes. Then again, I've yet to see a bear or its scat in my berry patches, and I wonder at that, too. Have I scared them off, or stolen their potential winter stores? Do they mind that I'm there competing with them? More likely, as Paul Schullery once wrote, the fascination is one-way, the bears not caring one whit about me and my small wanderings of feet and mind.

In my own personal corner of the ecosystem, on private and forest land outside Yellowstone's northeast corner, I first encountered huckleberries in 1995—it's imprinted on my brain as the time just after my first child was born and my wanderings were limited

JENNIFER WHIPPLE

Prickly red raspberry bushes grow in steep, dry, rocky places.

to the short distance I could go from my family's cabin in between feedings for a hungry weeks-old babe. I recall the whortleberry bushes having been there all along, blanketing the ground under the old spruces and firs. But the others—how could I have missed those berries for the previous decade? Had they been there all along, so close at hand? Or, was this some burst of berry response to the 1988 fires that removed so much overstory and even a few cabins in our neighborhood? Each year, I find more bushes, not far from those I knew before, amazing and embarrassing me that I didn't see them sooner. I am honing my search image, coming to recognize what looks like good habitat without even yet seeing the plants and, when I find them, screaming silently to myself, "Ah hah! I knew it; there's a patch! How will *it* do this year, how will it rate compared to this other patch, and that one?"

Though I proudly count the years by my "haul"—one year a meager two cups of hucks, another a very respectable two or three gallons—and I enjoy making jam or huckleberry pie, it's not the "take" that I really value. In my generalist way I've skated across the landscape, looking somewhat surficially at everything, whereas in my professional life I'm surrounded by specialists who delve into detail and thrive on pursuing ever deeper into their subject matter. I've often felt like a fish out of water among them, these experts in plants and carnivores and archeology and geothermal things. But in familiar berry patches I look closely and repeatedly, marveling at the subtle differences from year to year. *That* year, the patch across the creek showed no flowers, not a tiny berry. The *next* year, it was a banner crop; we sat on rock after rock and reached around us in a 360° circle and picked until our fingertips were purple and the zip lock bags full. Most years, the patches under the unburned forest produce the most, I suppose because they hold the moisture in the dry summers; I can feel the cold air draining down the creek, in the rare shade of an unburned grove of firs. But some years, like this one of the wet June, those overlooked *V. caespitosum* spit out quart after quart from their three-inch-high plants, clinging to the open, burned hillsides.

It's a good passtime, I think. As my children grow, they keep watch with me, the older one eager to out-pick the rest of us, the younger content to eat all she finds, but both easily entertained. We mark the months in anticipation of each year's berry crop, and it gives us an excuse to go out and search, week by week, on old trails and new. I relish the attention on small details, the intense focus I've seldom desired to place on one species or work project, and which does not fit my mid-level managerial role. Searching for them, I'm reminded that perspective is so important—viewed from one angle, a patch yields little, yet by moving and looking from another direction or height I can see plums that I'd previously missed. I find contemplative hours that are otherwise hard to come by, and think of the passage of time, the subtle differences in sites and situations one year to the next. I make my own working hypotheses, and lean toward the belief that what I see resulted from those memorable fires, so vivid in my own mind that each year, I forcibly count and think, how could it be *16* years now…it was only *yesterday* that the Storm Creek fire raged across the landscape and torched our decadent old trees, then merged with Clover Mist to drive the firefighters out of their camp in the dead of night…

My berry patches are my own research project, one on which I need never publish. A hobby growing toward, I believe, a not unhealthy obsession, though I may yet hear from "Berry-pickers Anonymous." I roam my wild gardens that compensate for the fruit I cannot plant in the yard of my government quarters. They remind me, not unkindly, of my transition from young, idealistic ranger to middle-aged pragmatist. Of the career path I chose and the niches I happened upon, like a new huckleberry find. Of the lessons of nature, the unpredictability of life events, and the ever-present beauty in small things, often dwarfed in the vast and spectacular landscape of greater Yellowstone.

YS

COURTESY OF AUTHOR

Sue Consolo Murphy is Chief of Science and Resource Management in Grand Teton National Park. She is also a former branch chief of cultural resources in Yellowstone, where she spent time helping to plan the Heritage and Research Center, as well as a former editor of *Yellowstone Science*. Before that, she spent eight years as a resource management specialist with the natural resources staff in Yellowstone.

From the Archives

William Henry Jackson's Liberty Cap photograph.

Thomas Moran's Liberty Cap watercolor.

*"—my friend, Thos. Moran, an artist of Philadelphia of rare genius, has completed arrangements for spending a month or two in the Yellowstone country, taking sketches for painting. He is very desirous of joining your party…and accompanying you to the head of the Yellowstone. I have encouraged him to believe that you [would] be glad to have him join your party, & that you would in all probability extend to him every possible facility. Please understand that we do not wish to burden you with more people than you can attend to, but I think that Mr. Moran will be a very desirable addition to your expedition, and that he will be almost no trouble at all, and it will be a great accommodation to both our house [Jay Cooke & Co.] & the [rail]road, if you will assist him in his efforts. He, of course, expects to pay his own expenses, and simply wishes to take advantage of your cavalry escort for protection. You may also have six square feet in some tent, which he can occupy nights…"**

—letter from Jay Cooke's office manager to Dr. Ferdinand V. Hayden, head of the first government-sponsored exploration of the Yellowstone region in 1871

With that, artist Thomas Moran accompanied the 1871 Hayden expedition in the interests of the Northern Pacific Railroad Company and Scribner & Co. Publishers N.Y. During his two-month trip, he sketched dozens of watercolor studies that later served as the basis for paintings. Hayden, the Northern Pacific Railroad, and others soon began promoting the idea that Yellowstone should be protected and preserved as a national park. Moran's watercolors, along with William Henry Jackson's photographs from the 1871 expedition, were taken to Capitol Hill and shown throughout the halls of Congress and before the Congressional Committee. Moran's sketches were the first color images of Yellowstone that had ever been seen in the East. The Jackson and Moran images were later reported to have played a decisive role in the debate that led to the 1872 establishment of Yellowstone as the first national park. Just three months after its establishment, Congress appropriated $10,000 for the purchase of Moran's 7' × 12' "Grand Canyon of the Yellowstone" to be displayed in the Senate lobby. It now resides in the Department of the Interior Museum in Washington, D.C. Yellowstone's collections include 22 works by Moran, and more than 500 works by Jackson, which now reside in the Yellowstone Heritage and Research Center.

*from *YNP: Its Exploration and Establishment* by Aubrey L. Haines, p. 101. U.S. Department of the Interior, NPS, U.S. GPO, Washington D.C., 1974. From A.B. Nettleton to Hayden, June 7, 1871. NA Microfilm 623, reel 2, frame 0120.

Support
Yellowstone Science

Our readers' generosity helps to defray printing costs.

Please use the enclosed envelope to make your tax-deductible donation. Make checks payable to the Yellowstone Association, and indicate that your donation is for *Yellowstone Science.*

Thank You!

Dona McDermott, archivist at Valley Forge National Historical Park, rehousing women's elk-skin gloves that are part of Yellowstone's museum collection, now in the Heritage and Research Center.

In this issue

This winter, *Yellowstone Science* looks back on the first 10 years of the park's wolf restoration program.

YELLOWSTONE SCIENCE
Yellowstone Center for Resources
PO Box 168
Yellowstone National Park, WY 82190

CHANGE SERVICE REQUESTED

PRSRT STD AUTO
US POSTAGE PAID
National Park Service
Dept. of the Interior
Permit No. G-83