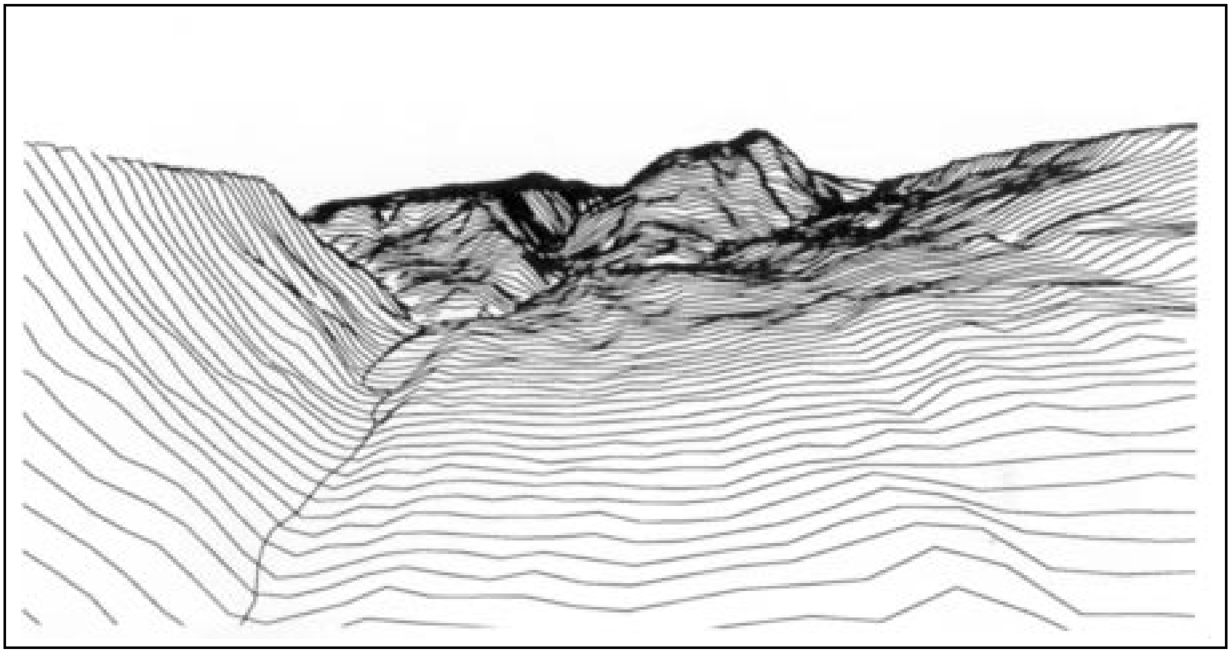
Yellowstone Science

A quarterly publication devoted to the natural and cultural sciences



Understanding Landscapes

Wolves! wolves. wolves?

Documentary Ecology

Elk Calf Perils

Volume 1 Number 2

NPS/Jim Peaco

The Big Picture

This issue of *Yellowstone Science* devotes much of its attention to interdisciplinary studies. Henry Shovic and his colleagues invite us to explore the remarkable potentials of landscape modeling, Tom Tankersley takes us on a tour of one of the American conservation movement's most extraordinary documentary legacies, and we report on the first-ever humanities conference focused entirely on Greater Yellowstone research.

These are all signs of a growing interest in--and need for--cross-disciplinary research in Yellowstone. Whether it be a geologist showing an ornithologist how crustal uplift in central Yellowstone Park might affect the nesting success of pelicans in southern Yellowstone Lake, or a historian hypothesizing on the role of Native Americans in prehistoric Yellowstone's animal communities, or a team of researchers from half a dozen disciplines pooling knowledge to investigate vegetation history, it appears that communication across traditional academic boundaries is not only on the rise, it's here to stay.

Documents in the Yellowstone Archives tell us that even before 1900, managers and defenders of the park occasionally perceived it on this grand scale. They saw the park as a reservoir of "game" whose annual outward migrations would perpetually stock surrounding hunting lands, and, much like the Adirondack Park, a great flood-control device whose vast unharvested forests would moderate the release of high-country water to the best advantage of settled country downstream.

Each generation since then has enriched those early appreciations of landscape function. Judging from the observations and predictions of Shovic, Tankersley et al., much more enrichment lies ahead of us.

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Biscuit Basin Leak; see page 21

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On the cover: GIS-generated view of the Gardner River drainage in northern Yellowstone National Park, looking south from several hundred feet above the 45th parallel bridge. Vertical relief has been doubled to highlight topographical features. See landscape modelling article beginning on page 2. Courtesy of Montana State University Geographic Information Analysis Laboratory, Bozeman, Montana.

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Yellowstone Science is published quarterly, and submissions are welcome from all investigators conducting formal research in the Yellowstone area. Editorial correspondence and requests for information about how to receive this publication should be sent to the Editor, *Yellowstone Science*, Division of Research, P.O. Box 168, Yellowstone National Park, WY 82190.

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A New View of an Old Land

The promising future of landscape ecology in Yellowstone

Ansel Adams photo of Mt. Sheridan from the Mural Project, courtesy National Archives

by Henry Shovic, Mark Johnson, and Helen Hadley Porter

In the past, we often visualized wildland ecosystems from some relatively narrow perspective, such as the home range of a threatened species, or the site of a specific vegetation type, or the distribution of a certain soil classification. The "grizzly bear ecosystem," the "lodgepole pine ecosystem," or the "Cryoroboll-Cryochrept ecosystem" were representations of geographical areas based on one element of the setting that seemed most important to someone at the time they were defined.

As our understanding of wildland ecosystems increased, and as the human pressures on those systems intensified, the limitations of this narrow approach became apparent. For example, the grizzly bear ecosystem is a combination of high-elevation landforms, the habitats of many other animals, and myriad vegetation types and soils, and it exists in the face of an ongoing level of human disturbance. The challenge we face, now that we appreciate this complexity, is finding ways to organize and analyze the information we have accumulated.

It is also becoming apparent that the spatial arrangement of ecosystems is at least as important as their individual characteristics. For example, though the individual ecosystems in the Greater Yellowstone Area are unique, their configuration in relation to each other (that is, how they fit together and interact) makes them much more valuable than a listing of their individual characteristics might at first reveal. This whole really is greater than the apparent sum of its parts. Again, the challenge is finding ways to understand and measure the character and value of the whole.

The relatively new science of landscape ecology embraces this broader view. When we picture landscapes in our minds, we tend to imagine a scenic panorama, or just a large area of land in general. Many interpretations are possible, but all have in common a holistic view of the land.

By most formal definitions, a landscape has the following characteristics: 1) repeating patterns of vegetative and soil ecosystem types, 2) similar climate, geomorphology(landform characteristics), and 3) types of disturbances--either natural- or human-caused.

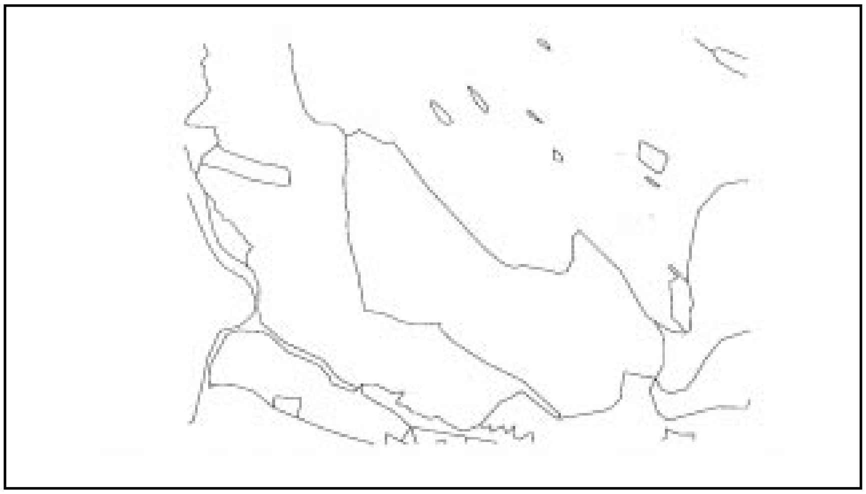
These landscape systems repeat themselves in great numbers across a region, and are a square mile or more in size. Resident animals and plants live in these landscapes, not merely in a single vegetation type, or a soil type, or even a climatic type.

Yellowstone National Park is a vast collection of such landscapes. Its uniqueness and importance are the result of the broad diversity and spatial connections of these landscapes, which are relatively free from human disturbance.

The diversity of Yellowstone is often subtle. Most of the land is covered in lodgepole pine forests, but there is much diversity in the landscapes that occur within that vegetation type. Some areas are in relatively flat, plateau-like terrain, while others include very steep breaks or mountainsides. Therefore, for the purposes of scientific inquiry, it is often beneficial to view them as a collection of interrelated landscapes (or landscape ecosystems) rather than as one large ecosystem.

In addition to new landscape perspectives for studying our wildlands, methods are emerging to represent their complexities. Geographic information systems (GIS) have revolutionized our ability to organize and view large amounts of data. The technology is now available to deal with the large data sets required, and this technology is accessible to all users willing to learn the sometimes difficult systems. Using GIS to produce maps (and some rather good looking ones) is now relatively common. A competent technician can now produce maps that are of high visual impact in a variety of motifs.

But GIS can be much more than a map making system, creating ever more individual "layers" of information. The exploration of the analytical capability of these tools has just begun. Each layer (for example, soils, vegetation, slope, climate) represents a part of the landscape. Though these systems combine in complex ways, and cover large areas, a GIS can easily integrate them, thus simulating landscape ecosystems. The potential is tremendous for the visual and quantitative representation of these landscapes, thus multiplying the usefulness of all layers in science and management.



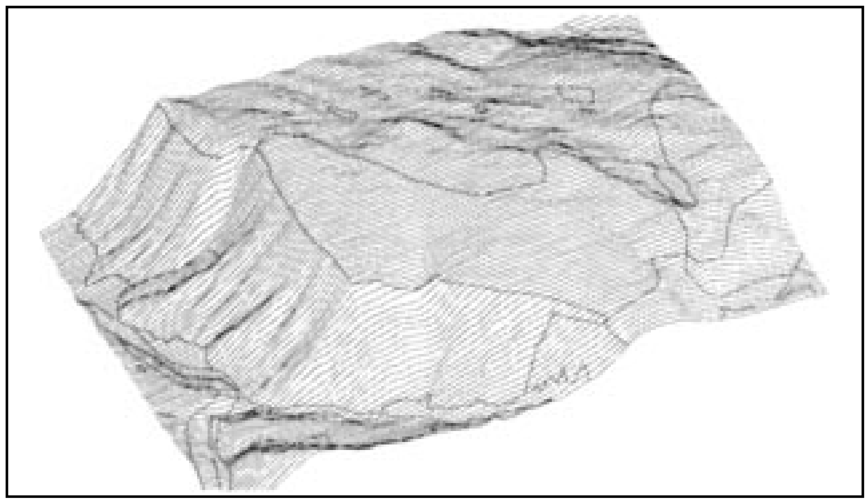
Planimetric (two-dimensional) view of the Mt. Everts area, just east of Mammoth Hot Springs. The lines on this map delineate the various landform/soil matrix combinations (known as map units) that occur on this landscape. For the purpose of this illustration, the map units have been left unlabelled (north is the top of the image). All GIS images in this article are courtesy of the Montana State University Geographic Information Analysis Laboratory, Bozeman, Montana.

A Three-Dimensional View

This year, some of us initiated a project designed to add to our knowledge base of ecosystems in Yellowstone. This is a cooperative project between the Division of Research in Yellowstone, the GIS Laboratory in the park, and Montana State University Geographic Information Analysis Laboratory.

Thanks to this project, we now have the beginnings of the newest Yellowstone GIS layer: detailed landforms (geomorphology) and soil matrix composition. Landforms are identifiable combinations of related surface features. Soil matrix represents the unconsolidated, earthy material that rests on the bedrock. Both are necessary to complete the Yellowstone soil survey, and to support other related research efforts.

Landforms in this layer are inherently visual entities. They are combinations of characteristics of slopes, aspects, and elevations. Written descriptions and "flat" maps of them are useful, but three-dimensional images have much more impact, and are often much more readily understood. A GIS has the capacity to portray these landforms in a three-dimensional view. Each landform can be visualized, described, and named mentally with only slight effort.



In this image, the map units portrayed in the upper illustration are here draped over a three-dimensional topographic model of Mount Everts. Notice that the long, narrow map units along the bottom (southern) edge of the image are now revealed as following a distinctly visible drainage (in this case, the Lava Creek/ Gardner River system, tributary to the Yellowstone River).

Landscape Modelling

The next logical step is to use the GIS to portray not only landforms, but landscapes. We propose to integrate the various parts of Yellowstone's landscape ecosystems--soils, vegetation, landforms, and many others--into one easily usable and visual model.

The individual parts have already been studied intensively. We know a great deal about such things as large mammal distribution, road systems, vegetation types, historic structures, and stream systems. However, we have difficulty studying the integrated whole, partly because it has been almost impossible to portray that much information in a comprehensible fashion.

Many of the parts of the whole--that is, many of the specific elements of the Yellowstone setting--are now layers in our GIS. What remains is to integrate them, using the immense data storage,

A GIS Primer

The abbreviation GIS stands for Geographic Information System. A GIS is any information management system that can 1) collect, store, and retrieve information based on its spatial location (that is, its location in a given space); 2) identify locations within a targeted environment that meet specific criteria; 3) analyze this information; and 4) display the selected environment either graphically or numerically before or after analysis. Most GIS systems are computer based and are capable of handling large amounts of data.

Like most special disciplines, the world of GIS has its own vocabulary. There are two common kinds of GIS. "Raster" systems break a land area into small cells, or "pixels." All information is referenced to those cells. "Vector" systems group similar land areas into polygons, which are usually much larger than cells. The kind you choose depends on your needs.

A "layer" or "coverage" is a GIS spatial data base that contains map features that have a common reference system. This means each layer portrays a set of features that can be overlaid on the other layers. Picture a set of maps, each showing different features of a landscape; one may show rivers, another roads, another buildings, another vegetation, and so on. The GIS can superimpose and manipulate such maps, adding many elements not possible with simple flat clear overlays.

A "planimetric" representation is a two-dimensional depiction of a layer. The road maps sold in gas stations are probably the most common planimetric representations most people deal with. Elevation is shown schematically by contour lines or point elevation markers.

A "three-dimensional" representation is a layer or layers "draped" over a simulated topography, usually based on an elevation layer. The image on the cover of this issue of *Yellowstone Science* is a three-dimensional simulation of topography around Mammoth Hot Springs.

Geographic Information Systems are only as good, or as helpful, as the data they are fed. Before a GIS can analyze or otherwise use a set of data, the data must be collected, usually through a variety of traditional field techniques, such as a soil survey or a vegetation mapping project, in which researchers create maps (planimetric representations) that are then "digitized" so the computer can work with them.

A GIS requires a relatively powerful computer system. A personal computer (PC) can run a GIS for small projects with a DOS operating system, 2 megabytes of memory, a speed of 16 megahertz, and disk space of 40 megabytes. A large, complex project requires a computer with a more powerful operating system (for example, UNIX) memory greater than 32 megabytes, processor speeds faster than 25 megahertz, and disk space greater than 1 gigbyte (1,000 megabytes).

Henry Shovic

analysis potential, and information display power of the GIS.

This potential model for Yellowstone provides a structure for organizing and displaying the large number of layers in a realistic and usable way. This model would be accessible to all scientists, resource managers, and the public. The analytical power of the GIS would be harnessed to increase each layer's usability when combined with other layers.

One of the limitations of hand drawn maps (or for that matter, of single-layer maps drawn by the GIS) is that each map has a required theme. A soil scientist might desire a map that emphasizes soil-map units with some description of vegetation types. A plant ecologist might believe that habitat types should be the central focus, with secondary descriptions of slopes and soils. Both maps are alternative representations of an ecosystem, firmly biased towards a particular use or need. The advantage of GIS is that it can produce maps on many alternative "themes," with identical accuracy and reliability. The basic landscape model does not change. Rather, the maps created from that model vary with the viewpoint of the user.

Applications

The landscape model can be composed of layers of data from research, resource management, planning, interpretation, maintenance, visitor protection, or administration, meaning that the model can also benefit all aspects of the park operation. Picture, if you will, a three-dimensional map that could portray any combination of information on geology, topography, roads, human developments, historical activity, location of cultural resources, average snow cover, animal movements or locations, vegetation condition, fire history, and human-use patterns. This visually interesting and easily understood portrayal would be supported by quantitative data and would be centralized in a usable format. Not only could researchers correlate activities and information, but all park divisions could share information on historical, contemporary, and

NPS/Jim Peaco

GIS in Yellowstone

The Geographic Information Systems Laboratory in Yellowstone National Park has been operational for almost four years and has produced numerous map products. Examples include maps of the Greater Yellowstone Area grazing allotments on U.S. Forest Service lands, grizzly bear habitat maps, detailed burned-area maps of the 1988 fires, and an ongoing soil survey. Two workstations and two PCs are used to run both raster and vector geographic information systems. The system has plotting, laser print, and paintjet capabilities, and is capable of working with both simple and very complex projects.

There are more than 16 different layers currently in the system, including preliminary soils data, habitat type, vegetative cover type (both before and after 1988), temperature regimes, bedrock geology, surface thermal features, precipitation, administrative boundaries, roads, streams, lakes, slope, aspect, and elevation. Some layers include the entire Greater Yellowstone Area. New layers are being added regularly.

The use of GIS has evolved substantially from the early projects. It was initially used merely to produce output from digitized maps, for example, a general soils map. These maps were manually made and digitized to enter as a layer in the GIS. *The 1988 Preliminary Burned Survey of the Greater Yellowstone Area* was a hybrid between manual mapping and GIS manipulation. In 1989, the *Yellowstone National Park Burned Area Survey* was completed entirely in a GIS format, using satellite data and digitized, manually interpreted aerial photographic data.

The ongoing soil survey of Yellowstone moves one step further, using a complex system of rules to produce a new soils layer entirely within the GIS system, with no manual interpretation of aerial photographic data. The proposed landscape model of Yellowstone, discussed in the accompanying article, is the next logical step, using existing layers to produce new models of landscape ecosystems.

Henry Shovic

even proposed conditions, and depict it draped on the landscape.

The potential for three-dimensional landscape modeling is endless. A few examples might help suggest the range of functions.

With sufficient data on roads, vegetation types, and ponds, we could graphically display the landscape of the Mammoth area as if the viewer were flying over the complex (see for example the image on the cover of this issue of *Yellowstone Science*, which shows an extremely simplistic view of a few elements of the setting).

The interpretive opportunities alone are considerable; imagine being able to give visitors an aerial tour, not merely of the drainages, but of the seasonal movements of various animals, and how those movements are related to snow cover, temperature, timing of vegetation growth, hiking activities, fire history, and any number of other factors.

Planners could likewise find the system very useful. Such a landscape model would permit visual perspectives on proposed developments. With the GIS capability for depicting the view of any given site from any other given site (as well as from any altitude above any given site), planners could determine the visibility of a proposed structure by including it in the GIS landscape view. They could "draw it into" the model, experimenting with a variety of size and height structures until the least obtrusive design was identified.

Wildlife biologists may be interested in evaluating habitat for potential species introduction. The GIS is capable of extracting the location of landscapes with required habitat components, as well as their spatial relationship to other critical components. The GIS could select geographic areas that have the appropriate relationships and graphically depict them for further analysis.

Research personnel could use the landscape model to apply site specific predictive models to an appropriate area. The process of choosing study sites would be simplified by selecting three-dimensional views having landscape characteristics of interest and importance, thereby saving valuable field time and enhancing applicability.

An investigator could aggregate landscapes to any level of generalization in order to customize map products to research needs. New indices of landscape configuration could be developed; for example, a "remoteness" index could be generated to measure the degree of isolation of any feature or set of features from human activity areas. The list of potential uses is limited only by the development and degree of usability of the underlying landscape model.

Making it Happen

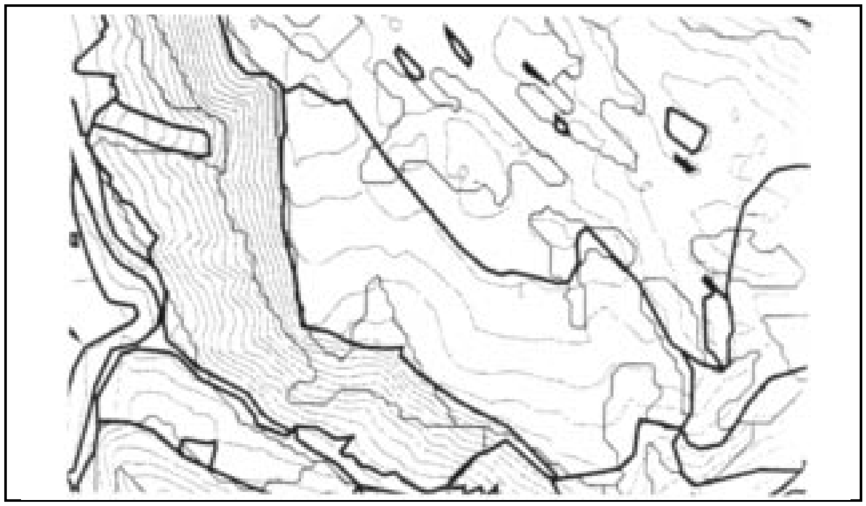
What we have been describing here is more than a dream. The technology, tools, and much of the raw information exist already, and all three are constantly being refined and improved upon.

Yellowstone is poised to take on a remarkable challenge: integrating a host of datasets, from clear across the scholarly disciplines, into one dynamic system that will empower all aspects of park operations to previously impossible levels of interaction. As so often happens, the obstacle is not technological or scientific, but fiscal.

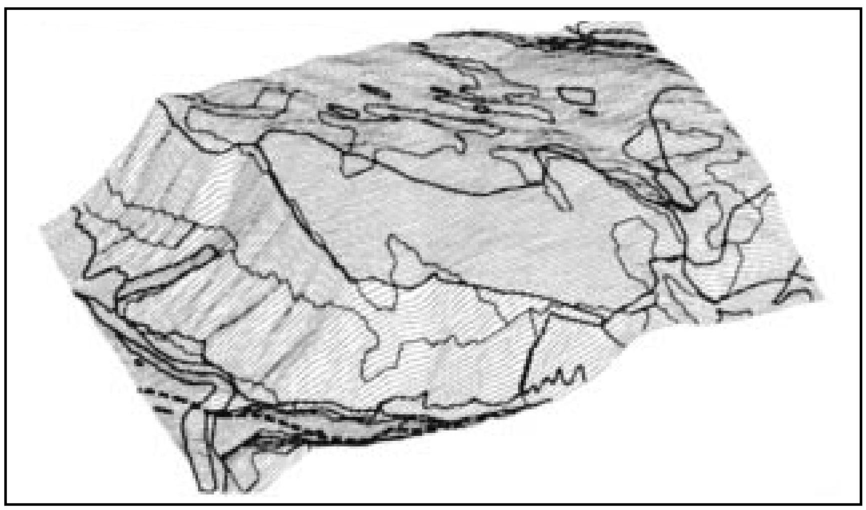
Perhaps the interdisciplinary breadth of the model should serve as our example. Rather than attempt to wring enough money for this project from one agency or institution, the most productive and sensible course would be for a broad-based support system, in which many interested parties contribute according to their abilities and needs.

It is our hope to pursue such avenues for developing the model, and we would be pleased to hear from fellow investigators who share our ambitions for this work.

Contact us, in care of the senior author, Henry Shovic, Gallatin National Forest, P.O. Box 130, Bozeman, Montana 59715.

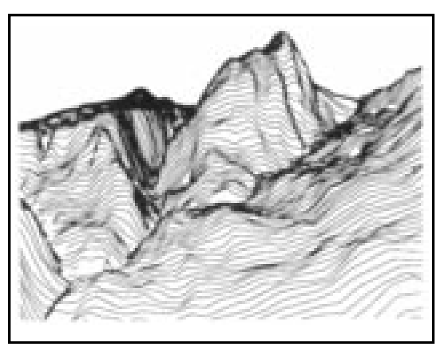


In this map of the same Mt. Everts area, habitat types and contour lines are added to the landform/soil matrix map shown on the upper map on page 3. Because it is two-dimensional, the image is relatively confusing and does not give much visual "feel" for the landscape. Slope, aspect, and slope curvature must be inferred from the contour intervals and directions. These problems are largely solved in the image below.



A three-dimensional representation of the same data layers, with roads (dotted lines) added. Slope and aspect are now obvious. Rangers, planners, resource managers, and researchers in many fields will readily imagine many other layers of information, such as cultural resource sites, wildlife migratory patterns, picnic areas, and backcountry use patterns, that could be added to maps of this type.

Henry Shovic works for the Gallatin National Forest and Yellowstone National Park, and is currently overseeing a soil survey of Yellowstone. Mark Johnson, Yellowstone Science *writer and researcher, is with the Research Division in Yellowstone National Park. Helen Hadley Porter teaches writing in the English Department at Montana State University, Bozeman.*



Yellowstone Science Interview:
Bert Harting

Dishrags and Popcorn

The short perilous life of an elk calf

Renee Evanoff

It has long been known that many Yellowstone elk calves do not survive their first year of life, but little was known about the exact extent or the causes of this mortality. From 1987 through 1990, wildlife biologist Bert Harting, of Bozeman, Montana, took part in a study of elk calf mortality in Yellowstone Park. Working under principle investigator Frank Singer of the National Park Service, Bert supervised many of the field activities of a team whose unusual challenge was to capture newborn elk calves, radiocollar them, and follow them through their first year of life. We especially appreciated Bert's candid descriptions of the learning processes that go into field work; the story is both instructive and entertaining. The following interview with Bert was conducted in December of 1992. Ed.

YS Let's start with the crew. How many people were involved?

BH We had about 8 people from the Student Conservation Association, volunteers, who were essential to the completion of the project. They were students from back east, mostly. We trained and supervised them, and they did a lot of work on horseback, and spent a lot of time in the wilderness.

YS What an adventure for them.

NPS photo

Bert Harting during this interview in his office at the Greater Yellowstone Coalition, Bozeman, Montana.

BH It was, and they were terrific people, every single one of them over the four years of the study.

YS Who else was involved?

BH The study was a cooperative effort between the National Park Service and the U.S. Forest Service. The Forest Service field investigator was Dan Tyers, a wildlife biologist on the Gardiner District of the Gallatin National Forest.

YS Of course, the northern Yellowstone elk herd has been controversial for a long time, and your study was part of the Congressionally funded initiative to try to settle some of the long-standing questions about this herd and its effects on the range. Why was studying elk calf mortality an important part of that?

BH To learn more about what regulated the population. It had been known for a long time that there was pretty high mortality in the elk calf population over the summer. There were data from back in the sixties when animals were being trapped and removed. A lot of the animals were pregnancy tested [*which shows reproductive rates--Ed.*]. There was also information from Barmore's and Houston's work [*William Barmore, NPS biologist in the 1960s, and Douglas Houston, NPS biologist in the 1970s*], Frank Singer's predecessors, on the calf ratios in the early spring and then again in the fall. Doug Houston had documented low cow-calf ratios in the fall, and our main objective was to learn what portion of the calf crop failed to survive the summer, and why.

YS Where did you go for advice and ideas on how to get the job done?

BH Frank had worked in Alaska on a caribou calf study, and so he brought some expertise, and a lot of the techniques used in Yellowstone were taken from earlier studies elsewhere. We also consulted with the people at Telonics, the company that made the radiocollars.

YS What made the collars a special concern?

BH We wanted them to fall off after a set period of time, and we wanted them to tell us when the animal died. We also wanted them to be expandable, because when these elk calves are young, they grow rapidly.

YS How can one collar send a different message from a live elk than from a dead one?

BH These are motion-sensing collars; there's a switch inside them that indicates if the animal has moved or if it has been completely stationary. When the animal quits moving, the switch inside the collar changes the pulse rate, and we know immediately that something has happened to the animal.

YS Yellowstone is a mighty big place, and elk are pretty good at hiding their calves from predators. How did you go about finding brand new elk calves?

BH Despite all the earlier studies, we still had a lot to learn. We initially intended to capture all of our elk calves from horseback.

YS We better make this clear right away; that sounds like the Old West, with lariats and pounding hooves, but you don't mean chasing them down and roping them or jumping on them.

BH No. One of the major objectives was to disturb these calves as little as possible. We didn't want to cause any disruptions between the cow and the calf, and we also didn't want to disturb the herd at large.

The idea was to get to a good vantage point on horseback at daybreak, often before daybreak, and use binoculars to scan areas where we suspected there would be some new calves. We had quite a bit of information on the traditional calving areas, from the work of Houston and Barmore, and the rangers were really helpful, especially the guys who had been around a long time, like John Donaldson and Joe Fowler. Frank did several reconnaissance flights in a Super Cub with Dave Stradley and Bill Chapman [*contract pilots who frequently work with park researchers--Ed.*] to locate likely calving areas.

Frank Singer weighing an elk calf.

The elements of a low-impact capture included latex gloves, which served several purposes. They prevented passing one calf's scent to another, thus ensuring that cows recognized their calves. They also limited human scent on the calf to reduce risk of abandonment by the cow as well as to avoid attracting predators.

YS Where did the study take place?

BH We had two main study areas. There was a lower-elevation study area around Gardners Hole, on the western side of the northern range, and a higher-elevation study area in the Lamar Valley, from Tower Junction up the Lamar River, Soda Butte Creek, and Cache Creek.

YS Why two study areas?

BH The elk in those two areas have different migratory patterns, and there's a difference in the density of predators. It's been suspected for a long time that those different segments of the population behaved differently, and so the population regulatory mechanisms may have been fairly distinct between the two areas.

YS So what was a typical capture like?

BH We'd go in early in the morning, generally in teams of three to four people--always at least two people per capture team. We'd glass the area with binoculars, looking for calves or for cows that were behaving suspiciously.

YS Most people may not be able to imagine a cow elk looking suspicious; what did they do to make themselves noticeable?

BH Usually a cow that was about to give birth, or just had given birth, was a loner. In some cases we were lucky and we'd see her walk over and nurse the calf. Sometimes, as she became aware of our presence, she'd glance back and forth to a certain area, suggesting to us that the calf must be bedded there. Another clue was that a cow would trot back toward a certain area.

Once we had a pretty good idea of where the calf might be bedded, we would move in on horseback. We'd systematically work through the sagebrush, in either a spiral or a criss-cross pattern. Sometimes, because of the clues the cow gave us, we'd go right to the calf. Other times, we'd search for half an hour and, though we were still pretty certain that there was calf bedded there, we'd abandon the search. We didn't want to keep the cow separated from the calf for long.

YS Did the cows stay pretty close during the search?

BH Yes. Most of the time the cows trotted off a little ways and looked back at us and barked.

YS What did you do when you found the calf?

BH Usually the calf would be hunkered down next to a sagebrush; when they're bedded they either curl up like a dog or flatten out with their head sort of between their legs. The person that spotted the calf would motion to the other person, pointing to where it was. Then we'd back off a little ways, tie up the horses, and go in on foot, usually one person from each side. Eventually, one of us would grab the calf.

YS Where did you grab them? On the shoulders?

BH Yes. Ideally the calf would never even get up.

YS So they wouldn't have a chance to struggle.

BH Right. We never injured a calf out of all the 131 calves that we captured during the study.

YS Did you have any jump up?

BH Yes. Dan Tyers developed an informal terminology to describe their behavior. After a couple of frustrating noncaptures where the calf escaped, Dan said, "You know, I think we're dealing with two different populations of elk calves here. For lack of a better term, I'll call one set dishrags. They're the ones that just lie there, that you can pick up and they just dangle. And then there are the popcorn. The popcorn are the ones that you get close and right when you least expect it, just like a kernel of corn that's finally gotten hot enough, they pop up straight in the air and they're just gone."

They ran so fast that if we could grab them in about ten seconds of pursuit we would, but between 24 and 48 hours of age, their stature and stability improved so much that we couldn't capture them any more. In fact, we didn't really want to, because the idea was to capture calves as young as possible so that we could learn what the causes of death were, and most of those causes, predation for example, were most pronounced on the very young calves.

YS What did you do once you caught a calf? What all were you interested in?

BH We documented everything on a form, including the characteristics of the site: slope, aspect, topography, vegetation type, how far the calf was from trees, how far away the cow was, the behavior of the cow, and so on. Keeping track of the cow was important, because if the cow was obviously vigilant about the welfare of the calf, then we were pretty sure that they would be reunited successfully.

Of course we needed to age the calf. Earlier studies had shown what to look for: if the teeth were still fully covered by a thin membrane connected to the gums, the condition of the dew claws and the feet, and if the calf was wet or had matted hair because the cow hadn't had time to clean it up. In some cases the afterbirth would still be there.

We would also weigh the calf, because we knew from other studies, and it proved to be true in Yellowstone, that the birth weight of the calf was an important factor in its summer survival.

YS How long did all this take?

BH The average capture time, from when we grabbed the calf until we let it go and cleared out of there, was a little more than eleven minutes the first two years. It dropped to around six minutes over the four years of the study.

YS Did you also get better at finding them?

BH Yes. Pretty quickly, we discovered the calving areas that are used year after year. There were spots in Gardiners Hole, for example, that we could go back to almost any morning and capture a new elk calf, but we didn't want to hit those areas so frequently and so intensively that we were going to disrupt the calving activity there. We just learned how to identify the characteristics of a good calving area.

YS What were they?

BH Cows like to have a good vantage point to watch for predators. They also need to have good shrub cover, like sagebrush or cinquefoil.

YS Speaking of cover, your study spanned the fires of 1988. How did the loss of cover affect cows in the calving areas?

BH Cows tended to avoid the burned areas and hide their calves in unburned shrub and tree patches. Apparently, there are a number of factors involved in a cow's decision of where to give birth, and good cover is one of the most important considerations.

It would be interesting to know if the calves learn those calving sites by some maternal education, or if there are other factors that draw them back to those sites when they grow up and have their own calves.

YS What you have described so far still sounds pretty routine, but I gather that in some aspects of the study your learning curve was pretty steep as you figured out how to get the job done.

BH There was lots of learning. Our ambition was to put out 30 collars the first year, 15 in each study area. About 10 to 14 days into the study we realized that we weren't going to accomplish that objective unless we changed our methods, because we weren't getting enough calves by searching for them on horseback.

So we started capturing from helicopters, which was much more efficient, both in terms of time expended and in actual cost. We caught about two-thirds of the calves with the helicopter.

YS How did the helicopter affect the elk.

BH Actually, it was much less disruptive for the elk because it took so little time. Each year we were able to make all of the helicopter captures in two days, rather than spreading them out over two weeks or more if we used horses.

YS When did the captures take place?

BH We captured the first calves around May 18, and by about the 12th or 15th of June calving was pretty much over.

YS Why did the helicopter work better?

BH We could cover a lot more country a lot faster. We'd spot a single cow, and rather than watch her for an extended period of time, we'd watch her just a minute, and get an idea of where the calf might be.

Occasionally, the helicopter would disturb the elk and they would start to get up and move away with the calves. If there was a newborn calf this would be no problem, because they were so slow and unsteady that we could still set down and just walk over and pick them up. In cases where the calf was maybe a day old and could move a bit better, then we would get the cow and calf in the prop wash of the helicopter, and usually that would be enough to cause the calf to immediately bed down.

YS After the first year did you use horses at all?

BH From about May 20 to June 1, before there were enough calves on the ground to justify using the helicopter, we'd work on horseback and pick up a few calves. After that first year, we always scheduled the helicopter for two days. The first day would be May 31 or June 1, and the second day would be 7 to 10 days later.

YS Did you feel confident that most of the calves got back with their mothers?

BH In most cases, the calves reunited immediately with the cow. As we worked on the calf, we'd turn it so that it was aimed at the cow. We would get on the opposite side of the calf as soon as we were ready to release it, and it would get up and naturally run away from us and toward the cow.

Out of all those 131 calves we captured, we had only four where abandonment was suspected--where we felt like it was even a possibility. Even in those cases, we never absolutely established that a calf died because it was abandoned.

YS Most of the cows must have stayed in sight.

BH Usually they did. Sometimes we'd have a timid cow that would move out of sight, over the top of a rise.

YS But that's not outside the realm of their behavior anyway; they leave the calves a lot.

BH Right. Lots of times in the nursery groups there's what is called a sentry cow that will remain behind and stay closer to the calves while the other cows forage. There will be six to a dozen calves bedded together and one cow will stay behind to alert the rest if any predators come by.

But cows also bed calves down individually and just trust to luck. One time Dan Tyers and I were up on Cache-Calfee Ridge. I was working on one side of a big group of trees and Dan went another direction. I stopped my horse for a second to glass an area, and very faintly heard Dan yelling, "Bert! Bert!" I rode back as fast as I could, and I saw Dan down in this little basin, where he'd found an elk calf.

He had tied up his horse and was down in a linebacker position, squared off with an elk calf that was just standing there staring at him. The calf would move a little ways, Dan would move a little ways, then the calf would move the other way, and Dan would move the other way, and neither of them was gaining any ground whatsoever. It was a complete standoff between Dan and this funny little elk calf. So I tied up my horse and joined him, and then the two of us were squared off with the calf and not gaining any ground.

This went on for a couple minutes, until finally I had an inspiration. I bleated like a cow elk, and the calf walked right up to me, so I grabbed it.

After we finished with the calf and it ran back to its mother, Dan said, "You know, that was really kind of a sick thing you did. You were like a mother terrorist."

Another time Dan and I spent four hours up on Mount Norris without seeing any cows. Finally, we tied up the horses and sat down on a knob to eat lunch. While we were sitting there, here came a cow and calf elk out of a grove of trees, and because we were just sitting quietly, she didn't see us. When she was about 150 feet in front of us, she bedded the calf down and walked away. We just put down our lunches for a minute, and walked down there and captured the calf.

YS But in a trial-and-error project like this there must have been some pretty interesting problems. Care to share any of those?

BH The least successful methodology was probably the volleyball net methodology. We were running into so many of the popcorn calves, the ones we weren't able to capture, that somebody came up with the idea that two people with a net could capture them if someone would run them toward the net.

The only net on hand was a volleyball net, and so we carried this long net around on our horses for three or four days. But the sagebrush was usually so thick that you couldn't get the net down to ground level. We ran several calves under the net before we gave up.

YS How did you detect mortalities?

BH We had our contract pilot, Bill Chapman, fly the areas every morning, usually at dawn during the peak of the predation period, and again at dusk. He'd monitor the calves from the air and give the locations so we knew if they'd moved since the last radiolocation. He'd also note if he could see them with a group of cows, so we knew they hadn't been abandoned.

Most important, he'd monitor the signal to check if there was a mortality pulse or an active pulse.

YS The mortality pulse only signalled lack of motion. How could you tell a sleeping calf from a dead calf?

BH That took some adjustment. The first year, the switch time on the collars was only one hour, and that turned out to be too short; sometimes the cows would nurse and bed the calves, and the calves wouldn't move at all for more than an hour. That meant we got some false mortality signals.

Once we had a mortality signal we could count on, we had our act together to where we could mobilize the forces very rapidly. The more time that elapsed between the mortality and when we got to the site, the less likely we were to be able to determine absolutely what the cause of death was. We were able to get on the horses and be out in the field in an hour, usually less.

YS Grizzly bears must have added some spice to the investigations.

BH We had to exercise a lot of caution, because grizzlies were the greatest cause of summer mortality. Both Dan and I had worked for the Interagency Grizzly Bear Study Team, and Frank had done work in grizzly country in Alaska and Montana, so we were pretty familiar with bears We had to be careful that we didn't walk into a fresh kill with a grizzly bear still bedded in the trees 20 feet away. In some cases it was obvious we were in there right on the heels of the bear.

Once it was safe to enter the area, we'd park the horses, move in, and just start going through it with a fine-tooth comb. Sometimes it was a real trick just to find the calf carcass, because at close range telemetry gets pretty strange; you get a lot of signal bounce as the signal gets strong, so that the ability to discern the direction with the antenna gets pretty poor.

When we found the collar, we'd start searching for signs of what caused the mortality. We'd look for tracks. We'd crawl around trying to find hair samples. If there was blood on the vegetation, or if there was blood smeared on the carcass hair, or blood on the collar, that suggested that the animal was alive and able to bleed when the predator hit it, as opposed to the animal dying from some other nonpredation cause and being scavenged later.

YS How could you tell which predator had been involved?

BH Bear mortalities were distinctive in a number of ways. They tended to skin the elk calves. We'd find the hide inverted backwards, just peeled back as if it was cased by a trapper. They'd rip it open at the hindquarters and just tear it off. Most of the bones would be crushed. Sometimes the only bones we'd find would be a rib or two, or the hooves.

Bear mortalities also tended to show more sign of disturbance. We'd find the vegetation completely flattened, and the dirt would be more disturbed.

At a bear kill, the calf skin would usually be lying there more or less intact; it wouldn't be torn up. A bear would rip the whole hide off, whereas coyotes would have to tear it apart.

Rita Habermann, Student Conservation Association volunteer, holding a "calf casing" that is typical of a grizzly bear kill; the whole skin, with feet, head, and even collar, were in one piece. Below: Bert on Cache-Calfee Ridge recording data near a calf carcass, assumed to be the remains of a golden-eagle kill (see page 12).

Where it became tougher was being sure that the bear or the coyote was the cause of death--that's the distinction between predation and scavenging. And that's where we had to do some real bioforensics, if there is such a word. We examined the vegetation to see if there was any blood around. We examined the calf, to see if there was any kind of subcutaneous [*under the skin--Ed.*] hemoraging, because if the animal was still alive when the bear or the coyote started to take it apart, we'd be able to see the bruise around the site of the clawing or bite.

Even then, sometimes the predators made it impossible for us to figure out what had happened. We had a really puzzling mortality on Cache-Calfee Ridge. We detected the signal in one direction and followed it, but suddenly the signal was from another direction. At the same time, the signal was changing back and forth from mortality signal to active sign. We finally figured out that adult coyotes had preyed on the elk calf, at a site that we never did determine, and either they or the pups brought the collar back to the den. They had just been playing with it.

YS You reported one eagle kill. How did you determine that an eagle did it?

BH There was an eagle feather or two at the site, and it was obviously a predation because of the hemorrhaging and the blood around the site. Later we sent the collar back to Telonics, and when they took off the tape around the main part of the collar, you could actually see where the talons of the eagle had punctured it. They're incredibly strong.

YS Did you ever arrive while the coyotes were still on the carcass?

BH That happened a number of times. In some cases, the calf had the bad luck to wander near a coyote den; several calves were killed right in the vicinity of coyote dens.

The scattered condition of this carcass, caused by scavengers, demonstrated how difficult it often was to determine the true cause of death. The radio collar (small white box near right edge of photograph) worn by this calf was later found to be punctured by the talons of a golden eagle.

YS So when you tallied up all the data, what did you find?

BH We had 31 percent summer mortality, and another 20 percent died during the winter.

YS Was that summer mortality mostly in the first few weeks of life?

BH Yes. Virtually all of them happened within 28 days. The predation rate rose linearly between 3 to 10 days and then it started to taper off from 10 days to 28 days. Bear predation happened up to about 28 days, and coyote predation went up to about 22 days. The one lion predation was on a calf nearly a year old. We didn't have any mortalities between the 43- and 188-day period. In other words, if a calf survived that long, then it had a free ride until winter. That early period, from birth to about 10 days, was the period of the most intense mortality, and most of that was due to predation. That was the period when the predators seemed to be homing in on the elk calves and that's been well described by the Frenches [*Steve and Marilynn French, of the Yellowstone Grizzly Foundation--Ed.*] and others. We saw the same thing.

YS What else killed them?

BH We had several cases of disease and starvation during the summer, including one stomach torsion in an uncollared calf that we incidentally found in Gardiners Hole. Most of the winter mortalities, about 15 calves, were from malnutrition, and another four calves were harvested by hunters in the fall or winter north of park.

We also had one late-winter mountain lion predation. That was really the only mountain lion predation that we documented, though we know from Kerry's [*Kerry Murphy, of the Wildlife Research Institute, studying mountain lions in Yellowstone--Ed.*] studies that mountain lions prey extensively on calves.

YS So if you're an elk calf, what are your best hopes of survival?

BH Animals that were born early in the calving period stood a better chance of surviving than animals that were born late. Predation intensity seemed to increase, as the predators discovered there were elk calves available. Also, the calves with the heavier birth weights had higher survival rates, probably for a variety of reasons. They were more mobile. Judging from how much better the large calves were at outrunning biologists, they were probably better able to outrun a predator.

YS What do you think were the limitations of the study?

BH You know how different things are every year in the park; you go out there in the spring and there's still about 10 inches of snow on the ground on the Blacktail Plateau, and the weather's horrendous. Other years it's not. I don't think that four years was really enough to fully cover the entire battery of possible climatic/population scenarios if you really wanted a complete portrayal of what goes on.

YS Did you trap enough animals for a good sample?

BH We actually got an average of a little over 30 calves a year, and I think that was a good number. We were able to do good analysis with good statistics with 30 animals a year. Obviously it would have been great to have 50 or 75, but we wouldn't have been able to keep up with them given the resources and personnel we had.

YS What questions would you like better answers to?

BH There were some things that I'm still really intrigued by. We captured a lot more male calves than female calves, especially in the Lamar, where we caught significantly more male calves than females. That's a puzzle. Studies of red deer and mule deer suggest that the ones that conceive later tend to give birth to more males than females. Also, animals in poorer condition tend to conceive later than animals in better condition. That suggests that the cows on the eastern end of the northern range may be in poorer condition, on the average. It's an intriguing scenario.

YS What about the calves that didn't die--the ones that were still wearing collars after a year? How long do they have to wear them?

BH Those collars were designed to fall off. They were stitched with a canvas band in them, where the thread or the band itself would rot.

YS Did the signal last long enough that you could pick them up after they fell off?

BH We did pick them up, which was important because they were a $350 dollar item and could be reconditioned and used again.

Bert Harting is currently with the Greater Yellowstone Coalition in Bozeman, Montana, as the Greater Yellowstone Tomorrow Project Assistant. The scientific paper containing the complete results of this study, co-authored by Frank Singer, Kate Symonds, and Bert Harting, was nearing completion at the time of this interview.

Renee Evanoff

Photographs for this article by Dan Tyers unless otherwise credited.

Below: Yellowstone Superintendent Horace Albright and elk calf, 1923.

NPS Photo

NPS/Jim Peaco photos

The Yellowstone Archives

A study in documentary ecology

by Tom Tankersley

Our quest to understand the resources of Yellowstone National Park and the relationship between those resources and humankind seems endless. Because of the diversity of Yellowstone's resources, and because of the region's rich human history, research concerning Yellowstone National Park has many dimensions. Billions of years are reflected in the geological history, millions of years are reflected in the biological history, and thousands of years are reflected in the cultural history of Yellowstone National Park.

Since the last glacial period, more than 10,000 years ago, humans have been left many kinds of records in Yellowstone. The prehistoric record lies silent in the landscape, awaiting archeological discovery and evaluation. While much of the Native American story is lost to us, the oral traditions of the Bannock-Shoshoni, Crow, Nez Perce, Blackfeet, and other people of the region, as well as the early journals and other records of EuroAmerican travelers, provide a foundation for current documentary resources.

Following the survey of Yellowstone by the Hayden Expedition in 1871, which scientifically verified Yellowstone's unique properties for a doubting world, Congress established Yellowstone National Park on March 1, 1872. Unfortunately, Congress created the world's first national park without appropriating funds for its management, and so for 14 years the administration of the park fell into the hands of well-intended and often ignored civilian superintendents, who left relatively few records.

To the Rescue

As knowledge of the wonders of Yellowstone spread, and population in the region expanded, it became apparent that good intentions and noble efforts were not sufficient for the protection of "Wonderland." In 1886, as if staged by a Hollywood producer, Captain Moses Harris arrived at Mammoth Hot Springs with Company M of the 1st U.S. Cavalry to rescue the park from destruction through lack of interest. Not only were these blue-clad champions armed with sabres and Spencer carbines, they brought in their caissons an arsenal of bureaucracy, and bureaucracy thrives on documenting itself.

Unlike the archeological record of previous millennia, and unlike the wild tales of wandering and wondering mountain men, these military records never lack for fascinating detail: the daily activities, management decisions, and philosophical development of park management from 1886 until 1918. They also now provide baseline data about park resources, data being put to uses that those vigilant soldiers could not have imagined so long ago.

The records generated by Captain Harris and subsequent military superintendents have been preserved through a combination of luck and foresight. In 1916, when the army was turning the administration of Yellowstone over to the newly created National Park Service (NPS), future superintendent and park service director Horace Albright was on hand to insist that records pertaining to the administration of the park remain. For many years, the army records and early NPS records were stored in closets and sheds throughout the park.

The National Archives Act in 1935 was a step in the right direction, but it only brought about half-hearted and less than ideal management of the park's historic record. The objective of the National Archives Act was to provide a systematic and centralized process for the preservation of records that documented government administration. However, in Yellowstone, records were placed out of sight and out of mind until the 1960s, when park historian Aubrey Haines began consolidating the records from scattered locations.

Aubrey, who was working on his milestone two-volume history, *The Yellowstone Story*, at the time, may have done park history as much of a service by saving all this material as by writing his highly regarded books. Prior to Aubrey's efforts, there were even instances when records packed for shipment to the National Archives were inadvertently sent to the incinerator, and Aubrey himself noted that some early document boxes were singed, having been rescued from the flames at the very last second.

The surviving records provide a remarkable wealth of information that documents the operations, programs, special events, and evolving philosophy for the management of the park.

The Yellowstone Park Company records represent perhaps the most exhaustive surviving documentation of any long-term concessioner in the history of the national parks.

A Yellowstone Satellite

Since 1977, Yellowstone National Park had a special relationship with the National Archives and Records Administration. Yellowstone serves as a satellite branch of the National Archives. The extraordinary nature of this relationship, and the significance of the archives, become apparent in this arrangement, because only four other collections hold this satellite status: West Point Military Academy, Annapolis Naval Academy, the Spanish Land Grant records in New Mexico, and the Five Civilized Tribes records in Oklahoma.

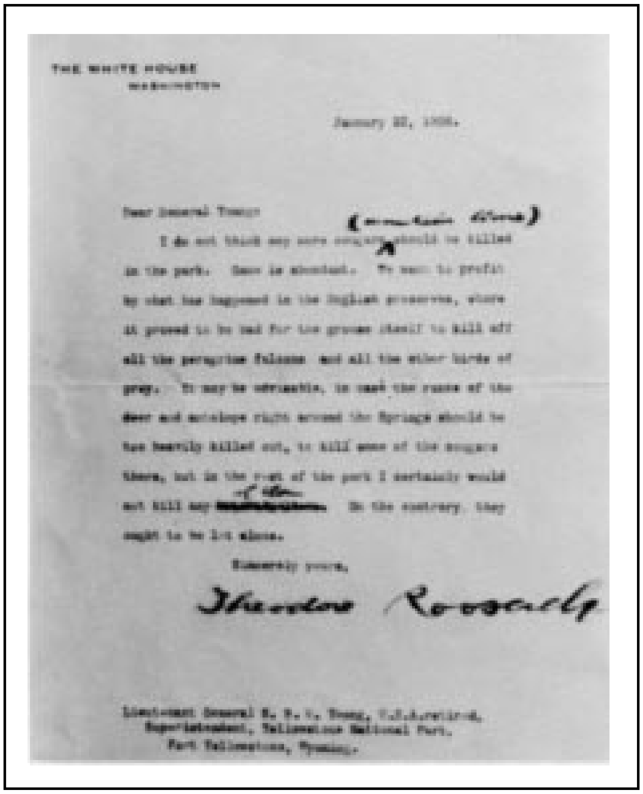
Records in the Yellowstone Archives are organized into 13 series, which reflect the various periods of park administration and concessioner records. Obvious major chronological divisions include the management of Yellowstone National Park by the U.S. Army between 1886 and 1916, the Yellowstone Park Company from 1900 to 1980, and the NPS from 1916 to the present.

The Army in Yellowstone

The U. S. Army records are organized as one series. This one 75 linear-foot series includes records from the establishment of the park to the establishment of the NPS. While relatively few records represent the period prior the arrival of the army in 1886, this series provides a comprehensive documentary biography of the 30 years of army administration.

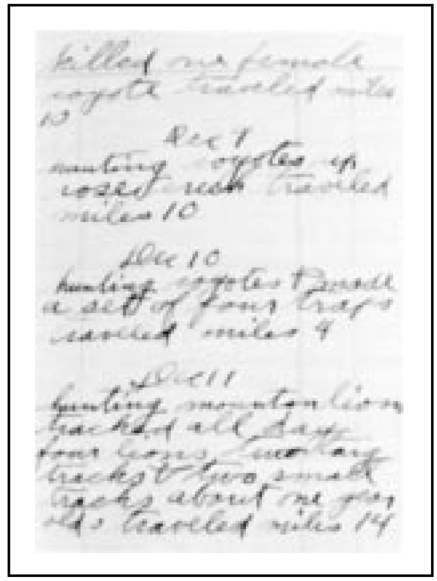
Under the military administration, policies were established concerning the management of concessioners, wildlife, fires, visitors, and violators of park regulations. The management of Yellowstone by the army was accomplished without benefit of an established policy, and so serves as a reflection of prevailing philosophies and attitudes at any given time.

These first managers generally focused their energy on the needs of specific resources, rather than worrying about broader concepts such as ecological systems. To a large extent, the military management of Yellowstone was accomplished through trial and error. Though successful in many ways,



THE WHITE HOUSE
WASHINGTON

Theodore Roosevelt



killed one female
coyote traveled miles
13

Dec 9
hunting coyotes up
[illegible] traveled
miles 10

Dec 10
hunting coyotes & made
a set of four traps
traveled miles 4

Dec 11
hunting mountain lion
tracked all day
four lions two large
tracks & two small
tracks about one year
olds traveled miles 14

The archives chronicle the complex evolution of park management. In 1908, President Theodore Roosevelt wrote the superintendent about not killing too many predators, but, as excerpts from this 1915 scout's diary show, predator control was daily business for years thereafter.

there were several problems in this relationship.

First, the assignment of troops for the management of the park was an unorthodox mission, one not conducive to maintaining the sorts of skills and disciplines required of troopers. Second, from the standpoint of the Secretary of the Interior, military management was not considered to be a permanent arrangement. Though well intended and often quite effective, the military administration was not equipped to provide the expertise and skill necessary for management of natural resources.

Through the records in this series, we can trace the dilemmas facing the military superintendents, and gain an intimate understanding of the daily function of the army in this unusual assignment. Soldier station reports reveal the daily operations of the park; scout diaries reveal resource management objectives, as well as local conditions encountered by patrols; entrance station logs reveal visitation trends and the states of origin of visitors. Superintendent's annual reports reveal not only the processes but the rationale for locating and building roads.

This 75 linear-foot series of military records has also been placed on microfilm through a cooperative agreement with Montana State University. The films are available at the Yellowstone Research/Reference Library and at the Montana State University Libraries, or through inter-library loan.

Historic Concessioners

The Yellowstone Park Company Records are also organized as one series. Among the concessioners associated with Yellowstone National Park, none have enjoyed as long or as politically involved a relationship with the federal government and the public as did the Yellowstone Park Company. The company's roots date back to the 1880s, and its association with the Northern Pacific Railroad.

Though in various forms and pieces this concession operated under several names, including Yellowstone Park Transportation Company, Yellowstone Park Camping Company, Yellowstone Park Hotel Company, Yellowstone Park Lodge and Camps Company, they all fall under the archival umbrella of the Yellowstone Park Company.

The Yellowstone Park Company operated in Yellowstone until their lease was terminated in 1980. At that time the United States Government purchased all of their property--everything from hotels to vehicles to pillow cases to a wealth of administrative records. The files in this series were included in this transfer.

The Yellowstone Park Company series consists of approximately 175 linear feet of files, ledgers, and inventories, the bulk of which cover the years between 1920 and 1960.

This series has recently been organized and inventoried. Its wealth of information has yet to be tapped by scholars or administrators. For example, architectural historians will at last be able to answer long-standing questions about the renowned architect Robert Reamer's involvement in remodeling the Mammoth Motor Inn in the 1930s.

The National Park Service Records

There have been many changes in the management of Yellowstone since the National Park Service was created in 1916. These changes have been the result of an evolving philosophy, and the NPS materials in the Yellowstone

Recently acquired mobile shelving allows for greatly increased storage capacity; a few turns of each shelf's crank handle will open any section desired.

Archives are the documentary biography of this evolution, an extraordinary resource for scholars in many disciplines.

Eleven series, encompassing more than 560 linear feet of record, document the past 75 years of management. These series employ the present file system of the NPS and are organized in the following subjects: Administration and Management, 52 linear feet; Concessions, 12 linear feet; Development and Maintenance, 32 linear feet; Fiscal, 4 linear feet; History and Archeology, 8 linear feet; Interpretation and Information, 28 linear feet; Lands and Recreation Planning, 12 linear feet; Natural and Social Sciences, 56 linear feet; Personnel, 4 linear feet; Law and Legal Matters, 72 linear feet; Forestry, 280 linear feet. These records are an incredible source for understanding management priorities and objectives, as well as for learning just what existed in physical property and operations.

History and Science in Partnership

Yellowstone's natural resources have a history too. The management of natural resources is specifically reflected in three series, but probably no other event in the history of Yellowstone has been as thoroughly documented as were the 1988 fires. The Forestry series includes more than 200 feet of fire records.

Lands and Recreation Planning records are the primary source for issues relating to water rights and boundaries. Natural and Social Sciences records will facilitate research on broad issues, such as elk and bison management, or a host of tightly focused topics, such as coyote stomach contents between 1927 and 1938, or pocket gopher management in 1946. Whatever the scope of a new research project in Yellowstone, there is probably a historic record that will illuminate the researcher's path.

Following the Federal Records Disposition Schedule established by the National Archives and the NPS, all permanent records are transferred from the park's active central files directly to the park archives when eight years old. In addition, the archives serves as a repository for retired field records, often essential in resource inventories and research.

The Future

The volume of records maintained in the Yellowstone Archives is growing rapidly. More than 300 linear feet of records currently being held in the Rocky Mountain Regional Records Center in Denver will soon be "repatriated" to the archives.

As historians gain a better understanding of how they might assist scientists, and as scientists become more dependent on historical research and methodologies, the resulting interdisciplinary cooperation will result in profoundly significant new uses of the archives. Data Base software, GIS programs, and CD Rom's are increasing the ease of manipulating the data contained in historic records.

The Yellowstone Archives is located in the Albright Visitor Center, along with the Yellowstone Research/Reference Library, and the park's museum collection, both of which also complement research efforts.

The Archives and Research/Reference Library are open Monday, Wednesday, and Friday from 1:00 to 5:00, Tuesday and Thursday from 8:30 to 12:00. The library may be reached at 1-307-344-2264, and the archivist at 1-307-344-2261. Special arrangements for use of rare collections may be made by contacting us in advance. Use of archival materials, as well as of rare library and museum materials, follows accepted professional standards of supervision.

Tom Tankersley has worked in several NPS historical sites, and has been Yellowstone's historian-archivist since 1989.

NEWS & notes

Workshop Considers Greater Yellowstone Humanities Research

NPS

MSU Vice President Bob Swenson welcomes workshop participants.

On December 10 and 11, 1992, humanities specialists met at Montana State University in a workshop entitled, "The Humanities and the Greater Yellowstone Ecosystem: Defining a Research Agenda."

The opening event was an evening address by A. Hunter Dupree, George L. Littlefield Professor of History (Emeritus), Brown University, on "Federal Science Policy and the National Parks." Dr. Dupree, author of the authoritative book *Science in the Federal Government* (1957), presented a broad-ranging view of Yellowstone's place in modern resource-management thinking.

In his welcoming remarks, MSU Vice President for Research Bob Swenson emphasized the need for an expanded humanities component in Greater Yellowstone research. Observing that "science asks what and how; the humanities ask why," Swenson noted that increasing interest in and pressure on Greater Yellowstone provide compelling cause for deeper understanding of the cultural issues that influence the direction of the region.

The workshop was attended by about 40 specialists and scholars in such disciplines as archeology, anthropology, oral history, archives, library sciences,, park management, and environmental history. Round-table sessions were devoted to "History and the Greater Yellowstone Ecosystem," "Preserving Greater Yellowstone's Historic Record," "Oral History in the Greater Yellowstone," and "Archeology and the Greater Yellowstone Ecosystem. The Yellowstone Center for Mountain Environments hosted a luncheon, at which Dan Flores, Hammond Professor of Western History at the University of Montana was the guest speaker.

Concluding remarks were by Gordon Brittan, Regents Professor of Philosophy at Montana State University. Brittan said that the workshop "undermined old divisions between cultural and natural history," and that "we need a humanities research agenda because the humanities and the sciences, in an environmental perspective, cannot be sharply separated." He concluded that "a main result of the conference was a broadening of disciplinary boundaries, the result of a deeper reflection on the ways in which the sciences and the humanities contribute to the answering of ecological questions."

The program committee, in consultation with the moderators of the round tables, is preparing an agenda of research directions and needs for Greater Yellowstone, to be circulated in 1993.

The workshop was sponsored by Jim and Anne Banks, along with the Department of History and Philosophy (MSU), the Yellowstone-MSU Cooperative Park Studies Unit, the Yellowstone Center for Mountain Environments, the Yellowstone Association, Montanans on a New Track for Science, and the Museum of the Rockies.

Research and Resource Management Reorganization Underway

In January of 1993, Superintendent Robert Barbee convened an interdivisional team to advise him on a restructuring of the Research and Resource Management functions in the park. This meeting was the culmination of several months of deliberations and meetings in the park, beginning with a special NPS review team that analyzed these park operations in August of 1992.

The details of the reorganization are incomplete at press time, but the following elements should be of interest to all Yellowstone researchers.

The current Research Division will dissolve, with its personnel going to two other management entities, depending upon their duties. Research-grade scientists will be assigned to one or more university Cooperative Park Studies Units (CPSU). It is anticipated they will be supervised by a CPSU unit leader, whose supervisor will be the regional chief scientist in the Rocky Mountain Regional Office, Denver. The CPSU arrangement has recently been adopted as the norm throughout the service.

Non-research-grade personnel will become part of a newly created, and as of press time structurally undefined, resources unit under park administration. Current researchers will in all likelihood notice little change in their relationship with Yellowstone. *Yellowstone Science* will report on this reorganization as it continues.

Sue Mills

Margaret Holland Retires

In October of 1992, the Research Division said farewell to our long-time management assistant and budget analyst, Margaret Holland, who was retiring after a long career of federal service. Margaret first came to the division in 1979, and very quickly became a central force in the operation. For many visiting researchers, especially those who dealt with the division long-distance by phone or correspondence, Margaret truly was the voice of research in the park.

At her farewell party, Division Chief John Varley listed her essential professional role in the management of a rapidly growing division, but all of us who worked with her will remember her just as much for her quick sense of humor and her wisdom about human nature.

Margaret brought a great and consistent cheerfulness to our offices. Whichever of the park's constituencies was certain the sky was falling, whatever the controversy d'jour, Margaret never failed to remind us of the extreme importance of other things, like laughing on a regular basis, and remembering each other's birthdays and other special events in our lives. Whether in the smoke of 1988 or in the endless wrangles of bureaucracy, Margaret always helped us keep our sense of balance.

Margaret and her husband Dave, who also recently retired from the National Park Service, will be indulging their joy in traveling for some time, and will likely settle on their property outside of Bend, Oregon. They will both be missed by their many Yellowstone friends.

Wayne Hamilton Honored for Yellowstone Research

Yellowstone Research Geologist Wayne Hamilton was named scientist of the year in the Rocky Mountain Region of the NPS for 1992. The nomination cited Wayne's innovative work in mapping geothermal aquifer boundaries, especially as that work influenced ongoing dialogues about geothermal development near the park. The nomination also pointed out a little-known but far-reaching contribution of Wayne's to the course of the geothermal development issue, as follows:

"It was largely due to his scientific perceptions and foresight that in 1987, all of Yellowstone National Park, rather than merely the immediate vicinity of prominent geothermal features, was defined as a significant geothermal feature. It was that unprecedented but crucial breadth of definition that gave the National Park Service the leeway to adopt an adequately comprehensive view of just what resources needed protection in Yellowstone Park during the congressional debates of 1991."

Among Wayne's other achievements were the development of an annual symposia on physical sciences in Yellowstone, the creation of the Yellowstone Physical Sciences Laboratory, and pioneering research into the paleohistory of the park's groundwater systems.

Report to Congress on Wolf Reintroduction

"Wolves for Yellowstone? Volume IV," a 750-page report to Congress contributed to by many researchers, is now available. The report contains 18 new studies in prehistory, history, economics, disease, prey base, taxonomy, livestock depredation, management, and a variety of other topics, all part of the ongoing Congressionally mandated research effort to determine the possible effects of reintroducing wolves to Yellowstone National Park.

The studies were conducted by 20 investigators from the NPS and several universities. Investigators were not asked to evaluate the desirability of wolf recovery, but to answer specific questions relating to wolves and their effects.

A 16-page digest that summarizes the report very briefly, is available at no charge from the Superintendent, P.O. Box 168, Yellowstone National Park, Wyoming 82190. The 63-page executive summary of the report, entitled "Wolves for Yellowstone? Volume III, Executive Summary" ($5.00), and the report itself ($20.00) can be purchased from the Yellowstone Association, P.O. Box 117, Yellowstone National Park, Wyoming 82190.

Greater Yellowstone Archeology Symposium

A symposium on archeology in the Greater Yellowstone Area will be held in conjunction with the annual meeting of the Society of American Archeologists, April 21-24, in St. Louis, Missouri. For more information, contact Ken Cannon or Melissa Connor, Midwest Archeological Center, Federal Building, Room 474, 100 Centennial Mall North, Lincoln, Nebraska 68508-3873.

Research Fire Escapes

A small prescribed research fire was set on the Buffalo Plateau in Yellowstone Park on Wednesday, September 23 at 2:30 p.m. The fire was intended to burn grasses and sagebrush within a 4-acre containment line. However, a spot fire driven by high winds jumped the fire line, resulting in a wildfire that burned 480 acres, 99 percent of which was in grasslands. The fire was variously reported in the media; this review may be of interest to our readers.

Following the 1988 fires, considerable effort has gone into studying fire-driven changes in ecosystem processes. One project, entitled "The Interaction of Fire, Vegetation, and Large Mammalian Herbivores on Yellowstone's Northern Range," was underway in the area of the prescribed burn, under the direction of Dr. Samuel McNaughton of Syracuse University.

Dr. McNaughton and his colleagues, under contract with the NPS, have been studying the flux and recycling of nutrients after a fire. Because many chemical reactions, such as nitrogen mineralization and other elemental reactions relating to soil nutrient availability, occur soon after a fire, the investigators determined it was necessary to "recreate" a small fire to measure reactions as they occurred.

On the morning of the prescribed burn, the spot forecast called for a high of 72°F minimum relative humidity of 25 to 30 percent, and winds from the southeast to southwest at 3 to 6 mph, gusting to 12 mph. Based on that morning's weather forecast, an approaching cold front with stronger, gusty winds was not expected to arrive until Wednesday night or Thursday morning. However, pre-frontal winds arrived about 3:00 p.m., much earlier than predicted. A 30-mph gust hit the burn and caused a spot fire across the

NPS/Jim Peaco

The escaped fire burned 480 acres on the slope just east of Hellroaring Creek; in this view, the Little Buffalo Creek drainage is on the far right. Three acres of forest burned on the west end (far left) of the fire. The planned research burn is the small horizontal band of black just downhill from the main burned area.

blackline. Seven personnel with water and tools were on the spot fire in less than a minute, but the burn could not be stopped, and was declared a wildfire.

Retardant and smokejumpers were ordered from West Yellowstone, Montana, and a 20-person park crew was called out. Because conditions were too windy for jumping, smokejumpers drove to Tower Junction, then flew to the scene by helicopter. Fire retardant was dropped four times, to prevent the fire's northeast corner from entering timber and to minimize the fire's progress in grass along the west flank.

By 7:13 p.m., 99 percent of the fire was out. By late evening, crews were focusing on mopup in the 3 acres of timber that were affected (2 of these acres were burned in 1988), and were controlling burning grass on the west flank. On Thursday, heavy rains allowed all personnel to leave the area.

The Ecological Implications of Fire in Greater Yellowstone

The Second Biennial Scientific Conference on the Greater Yellowstone Ecosystem

September 19-21, 1993
Mammoth Hot Springs
Yellowstone National Park, Wyoming

Mail abstracts to:
Conference Committee
c/o Research Division
P.O. Box 168
Yellowstone National Park,
Wyoming 82190

Abstracts due by May 1, 1993
Registration information will be provided in subsequent announcements. Session will be held at the Mammoth Hot Springs Hotel.

Call for Papers

Another Wolf?

On September 30, 1992, a moose hunter in the Fox Park area of Teton Wilderness, just south of Yellowstone Park, shot what he believed to be a coyote running with similar animals. It was black, and weighed 92 pounds. The hunter then concluded it might be a wolf and reported the kill to Yellowstone Park rangers at a backcountry patrol cabin.

The male canid did look like a wolf,

NPS/John Mack

but because biologists have not documented wolves in the area recently, and because escaped wolf-dog hybrids are a possibility, the U. S. Fish & Wildlife Service (USFWS) conducted extensive tests to determine if naturally dispersing wolves had reached the Yellowstone area from northwestern Montana. The carcass was sent to the USFWS Forensics Laboratory in Ashland, Oregon, for testing. The testing regime consisted of 1) a necropsy to collect forensic information; 2) skull analysis, which contributes to morphologic assessment of species and subspecies; and 3) DNA analysis in an attempt to identify hybridization or relationships to existing wolf populations.

The necropsy revealed the animal was in excellent condition. There was no physical evidence that the animal had been in captivity. Analysis of stomach contents revealed that the animal had fed on an elk before its death.

Based on examination of the skull's characteristics, Dr. Ron Nowak, U. S. Fish and Wildlife Service mammalogist in Washington, D. C., concluded that the animal was 2.5-3.5 years old and was not a coyote or dog. Dr. Nowak reported that skull measurements "fall within the range of variation of *Canis lupus*, but some are considerably smaller than what would be expected for a male wolf of the current population in western Montana." While stating that "it is reasonable to suppose that the specimen represents dog-wolf hybridization," Nowak also said that "other alternatives can not be ruled out. The animal could conceivably be an unusually small representative of the west Canada-Montana population, or it might be a member (somewhat inbred?) of a population that had survived in the wild in the Yellowstone area or that had been released from captivity."

DNA tests completed after Dr. Nowak's report was submitted suggest that the animal was not related to wolves from Montana or western Canada. The forensic lab also concluded that the animal was not a coyote-wolf or gray wolf-red wolf hybrid. Because domestic dogs are most closely related to gray wolves, DNA tests could not conclusively determine if the animal was genetically related to domestic dogs. Additional testing will compare the animal's genetic make-up with that of Yellowstone wolves killed near the turn of the century. Additional comparisons with dog DNA will be also be made.

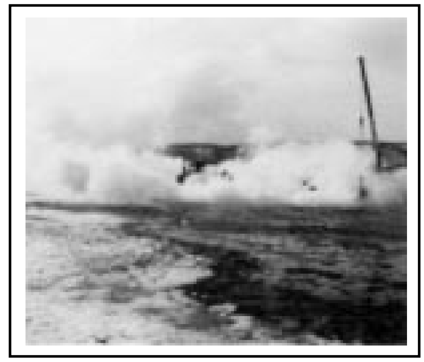
Several days after the Fox Park incident, several rangers reported seeing similar animals in the region. Ground surveys were conducted by experienced wolf biologists immediately after, with a fresh cover of snow, yet no signs or activity suggested that wolves were in the area. Also, wolf biologists agree that the dead animal was not the canid photographed by Busch Productions, Inc., and reported in our previous issue.

Biscuit Basin Drill Hole Springs Leak

On November 5, 1992, Yellowstone Park Research Geologist, Rick Hutchinson, discovered that a research drill hole near Biscuit Basin, drilled in 1967, was vigorously billowing steam from the concrete box enclosing it.

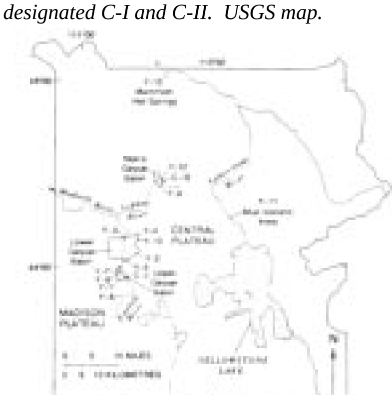
In 1967 and 1968, the U.S. Geological Survey drilled a total of 13 research holes (named Y-1 through Y-13) to

NPS/Jim Peaco photos



Above: Front-end loader and work crew were engulfed in steam as they unlocked and opened the lid covering the drill hole. Crew members wore fire suits and helmets for safety. The obscuring steam required NPS personnel to remove the padlock by feel. Below: The temporary valve assembly is in place, with steam rising 16 meters as the crew prepared to plug the drill hole. The vertical valve was open so pipe could be connected to a horizontal deflector valve that would divert steam away from the valve assembly.

Above: Steam was deflected through a horizontal pipe to allow workers to see and avoid being scalded. The drilling rig, attached to the temporary valve assembly, removed scaly deposits and obstructions from inside the casing before high-temperature cement was pumped under pressure into the drill hole. Steam in the (left) background is from the area of Cauliflower Geyser, Below: Yellowstone Park, showing sites of research drill holes and associated geothermal areas. U.S. Geological Survey holes are numbered Y-1 to Y-13 in order of drilling. Holes drilled by the Carnegie Institute of Washington in 1929-30 are designated C-I and C-II. USGS map.



study geothermal dynamics of aquifers in the park. A great deal of data was obtained from many of these holes, but as data collection was completed or valves and casings presented potential threats, six of the holes were permanently plugged, and one self-sealed by internal deposition of minerals.

Y-8, the drill hole that recently leaked, was approximately 503 feet (154 meters) deep. Hutchinson estimated that it probably failed less than 2 hours before it was discovered. Park managers were notified immediately, and a park volunteer, Mary Ann Moss, monitored the eruptive activity of nearby Rusty Geyser to determine if any changes developed in its behavior; none did. A drop in the water level of Jewel Geyser (across the Firehole River) occurred about a week later, but there were no apparent changes in the geyser's intervals. Both geysers will be monitored, and the remaining five drill holes will be examined in the spring.

On November 12, Tonto Drilling Services, Inc. from Salt Lake City, Utah, and NPS personnel opened the box covering the drill hole. The unhampered column of steam and water rose about 52 feet (16 meters). Inspection revealed that a corroded casing below the valve assembly was the source of all discharge.

On November 20, NPS personnel and crew members of Tonto Drilling Co. used guy lines to position a specially constructed valve/deflector pipe assembly over Y-8. Both vertical and deflector pipe valves were opened to channel steam through these vents. The valves were closed and the drill hole was filled with a high-temperature cement. This spring, the area of the drill hole will be covered and reclaimed.