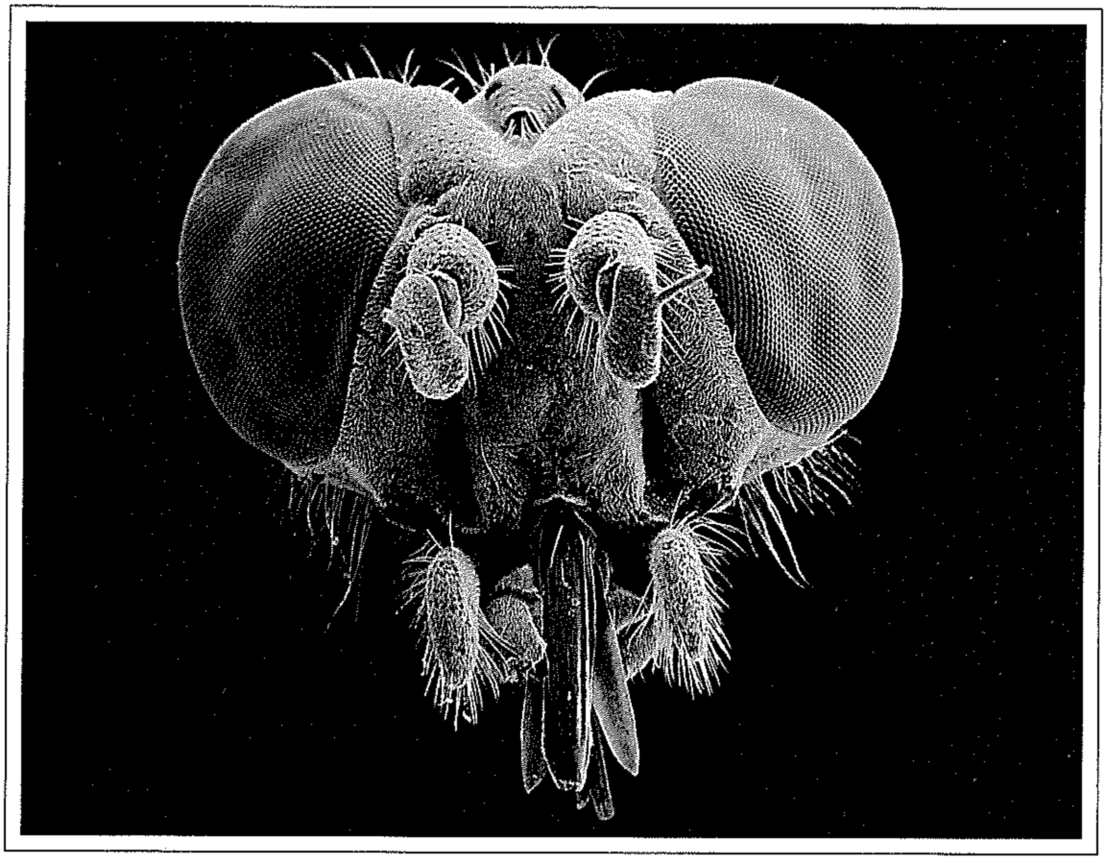
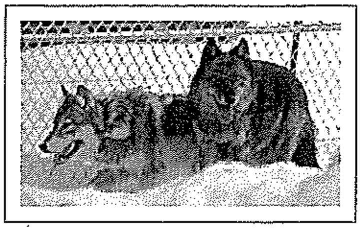
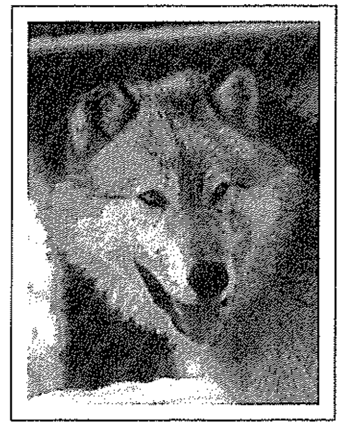
Yellowstone Science

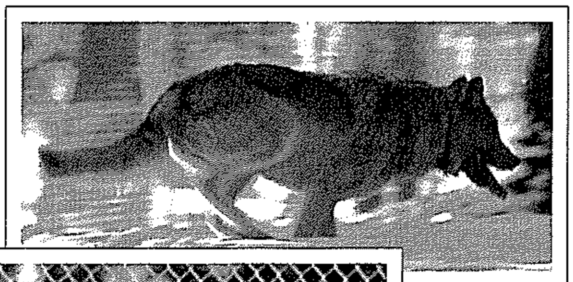
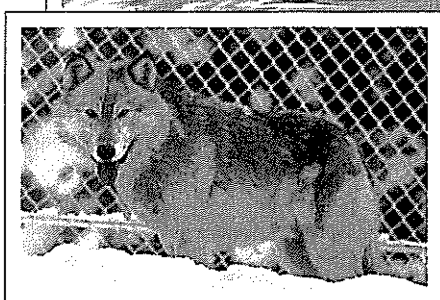
A quarterly publication devoted to the natural and cultural sciences



Yellowstone's Snipe Flies
Searching for Ptarmigan
Watching Grizzly Bears
Wolves at Work

Volume 3 Number 2

A Gallery of Wolves

It is a mighty understatement to say that there is a lot of interest in Yellowstone's new wolves, and so we will continue to provide updates on what's new with wolf restoration. However, we know that the interest operates on more than the straightforward informational level; news is important, but so are other kinds of impressions. With that in mind, we offer here a less formal presentation, so that you can see who is causing all this excitement. PS

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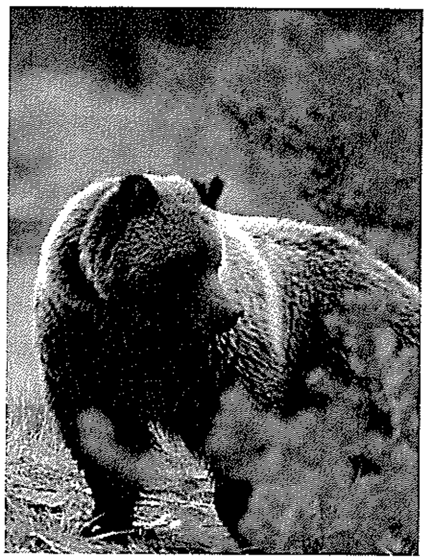
Volume 3 Number 2 Spring 1995

Marilynn French



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On the cover: Scanning electron micrograph (38X) of the head of a female snipe fly (Symphoromyia)*, showing the mouthparts that caused so much annoyance and misery among Yellowstone visitors in 1994. See article on page 2. Photo courtesy of John Burger, University of New Hampshire.*

Yellowstone Science is published quarterly, and submissions are welcome from all investigators conducting formal research in the Yellowstone area. Editorial correspondence should be sent to the Editor, *Yellowstone Science*, Yellowstone Center for Resources, P.O. Box 168, Yellowstone National Park, WY 82190.

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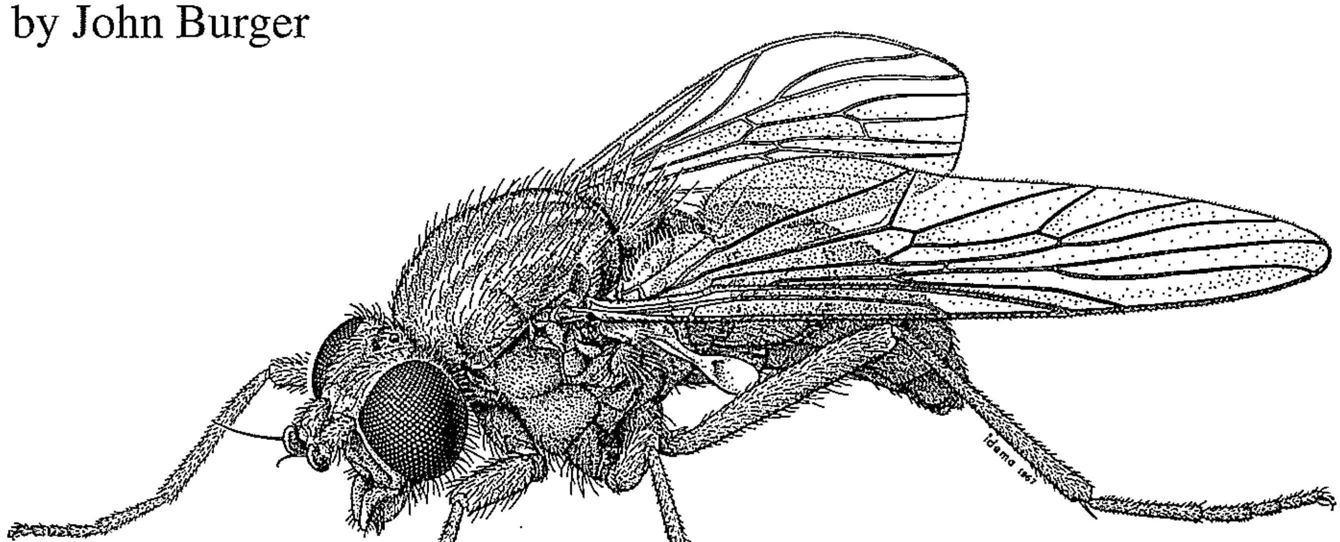
Yellowstone's Snipe Fly Summer

by John Burger



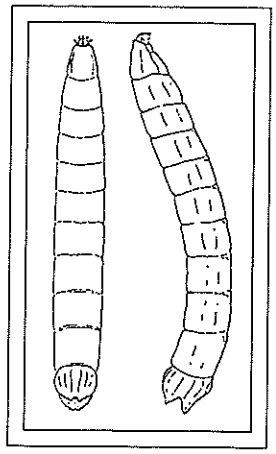
For people and wildlife accustomed to dealing with the usual array of blood- sucking insects in Yellowstone-mosquitoes, buffalo gnats (black flies), horse flies and deer flies, no-see-ums (punkies), and stable flies (biting "house flies")—1994 was the year of the snipe fly. Snipe flies? Whoever heard of snipe flies? Well, almost no one, at least by their accepted common name, except for a few insect specialists, and occasional biologists who are curious enough to inquire. Yet these flies are notorious in some areas of western North America for their swarming habits and painful bites, and 1994 was a banner year for these usually obscure flies in the Greater Yellowstone Area. In fact, they were more abundant and pestiferous than at any other time in recent memory, and perhaps since the mid-1960s.

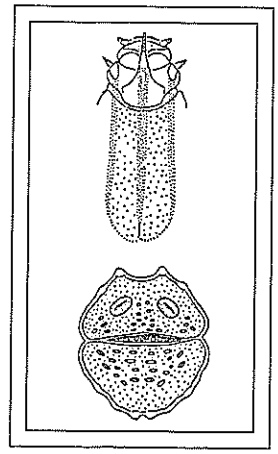
Possibly the most remarkable thing of all is that biting snipe flies, despite being serious pests locally, have been so little-studied by specialists, in contrast to mosquitoes, horse flies, and deer flies, that we cannot yet determine how many species actually occur in North America or consistently identify all specimens accurately. There are several reasons for their obscurity. Biting snipe flies comprise only one relatively small genus of rather small, drab flies in the large and diverse family Rhagionidae, all of whose members are called snipe flies, and almost all of which do not feed on blood. Biting snipe flies are not known to transmit diseases of wildlife, domestic animals, or humans (although this has not been studied). They tend to be only locally abundant, with several to many years between serious outbreaks. They are difficult to identify accurately. What do we know about these flies in general, and their activities in Yellowstone in particular?

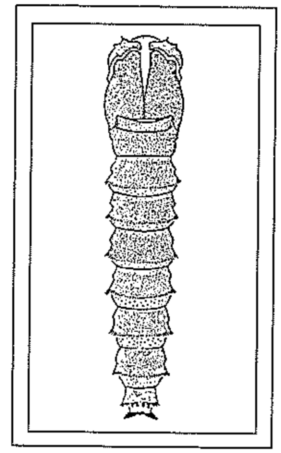
Biting snipe flies belong to the genus *Symphoromyia*, which means "accompanying fly," an appropriate description of their persistent swarming and biting habits. There are about 30 described species in North America, and probably a number of as yet indescribable species. Biting snipe flies in Yellowstone are gray, brown, or black, and can be recognized by the kidney-shaped terminal antennal segment with a thread-like projection on the upper surface, stout thorax, long, slender legs, unmarked wings, and slender, tapered abdomen. Their flying and biting habits are similar to deer flies (genus *Chrysops*, family Tabanidae), but deer flies in Yellowstone are black, or yellow and black with long, slender antennae, larger chunky bodies, and dark markings on the wings.

Life Cycle

Little is known about the life cycle of *Symphoromyia* species. Most of what we know of the immature stages comes from studies by Kathryn Sommerman in Alaska. The eggs are 1 to 1.5 millimeters long (.04 to .06 in.) and off-white in color, becoming light brown before hatching. Eggs are laid on vegetation or on damp soil surfaces. The larva, when fully grown, is 12 to 16 millimeters (.47 to .63 in.) long and has a light-colored, 12-segmented cylindrical body. The front of the larva tapers to a slender, retracted head. The last body segment is deeply cleft, and the upper and lower surfaces are lined with sclerotized (hardened), semi-circular yellow-brown plates. The upper plates have two large brown spiracles used for respiration. Larvae have been collected from steep, well-drained slopes facing south, southeast, or southwest, in sheltered areas that are drifted with snow in winter, often in depressions with willows or alders. Larvae are predators, feeding on the larvae of soil-dwelling insects, including each other. The larva passes through at least three stages before transforming to the pupa. The pupa is 7 to 15 millimeters







Opposite: Female snipe fly, from "Agriculture and Agi-Food," from Manual of Nearctic Diptera, Volume I, *coordinated by J. McAlpine, B. Peterson, G. Shewell, H. Teskey, J. Vockeroth and D. Wood; reproduced with the permission of the Minister of Supply and Services Canada, 1995.*

Right: Two views of the snipe fly larva. Except where otherwise noted, illustrations and photographs for this article were provided by author.

Middle: The long retracted head of the larva, and the deeply cleft plates of the last body segment, viewed from the end.

Far right: Pupa of the snipe fly.

(.28 to .59 in.) long, has a freely movable abdomen, and is light brown initially, becoming nearly black just prior to emergence of the adult fly. The pupal stage lasts about 2 weeks. Little is known about the length of the life cycle; it is generally presumed that there is one generation per year.

Adult males do not feed on blood, are short-lived, and are rarely seen. They differ from females in having the eyes very large and nearly touching in the center of the head, and have more hirsute (hair-covered) bodies. Females have piercing-sucking mouthparts adapted for feeding on fluids, including blood.

Structure of the Mouthparts and Feeding Behavior

The mouthparts of female biting snipe flies are heavily sclerotized and are adapted for piercing, cutting, and anchoring, all of which assist them in ingesting blood. The broad labrum (lip) serves to provide support for the piercing stylets during biting. The paired mandibles, shaped like the blade of a sword, are used for cutting and penetrating the skin of the host, and for penetrating capillaries. The paired maxillae have retrorse (backward–pointing) teeth for anchoring the mouthparts during feeding. Blood oozing into subcutaneous tissues is ingested through the sponge-like labellum at the tip of the labium.

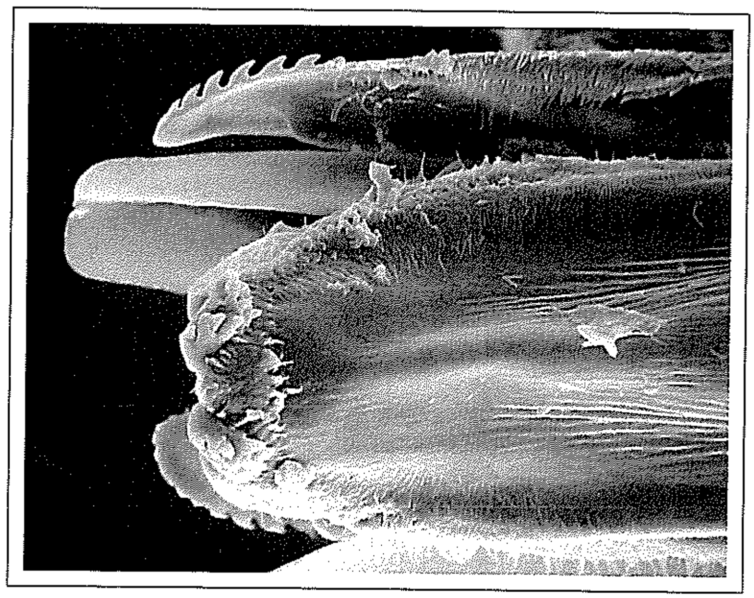
Symphoromyia females can be persistent and painful biters. The pain is associated with the large cutting mandibles. Unlike related horse flies and deer flies, biting snipe flies tend to approach the host silently. Once settled, they are not easily disturbed, and often can be picked off or crushed while they feed. Often there is local swelling following a bite and there may be intense itching for several hours, possibly associated with the introduction of saliva to lubricate the mouthparts during piercing. Bites can cause severe reactions in hyperallergenic people.

Some species seem more prone to feed on humans than others, especially in western North America. An eastern species is abundant in my front yard in New Hampshire but, while they will land and crawl on my arm, I have never been bitten. They will feed readily on dogs, however. Preferred areas for attack on humans seem to be the head, neck, arms, and hands, although all areas of the body can be attacked. Biting on exposed fingers is particularly painful where there is little flesh, such as on the joints and knuckles. When abundant, females may form swarms around the head and body, and, even if not biting, can be extremely annoying.

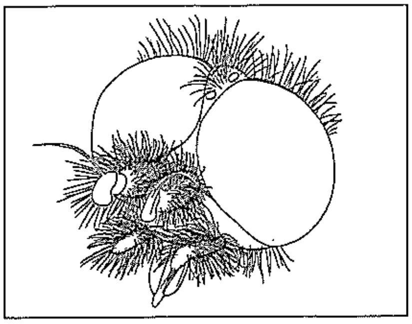
Biting Snipe Flies in Yellowstone

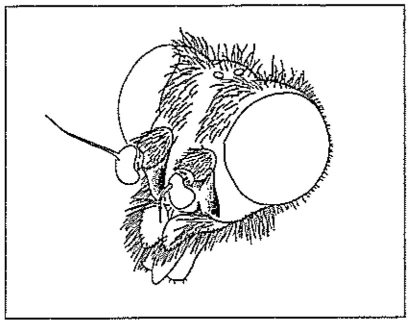
At least five species of *Symphoromyia* occur in the park, although because the taxonomy of this genus is still unsatisfactory it is likely that additional species may occur there as well.

Park personnel and local residents commonly refer to biting snipe flies as "deer



Scanning electron micrograph (573X) of the labrum and maxillae of Symphoromyia flavipalpis. *Notice especially the "retrorse teeth" on the outer surface of the maxilla; these backward-pointing teeth ensure a firm grip on the victim's flesh.*





The heads of a male (left) and female (right) snipe fly. Notice the larger eyes and hairier aspect of the male.

flies" or "buffalo flies," as well as various less polite names. Deer flies do have similar biting habits, but have larger, heavier bodies, and distinct dark markings on the wings. The term "buffalo fly" is used by specialists to refer to a species of biting fly that attacks water buffalo in Asia, and is a relative of the "horn fly," *Haematobia irritans* (family Muscidae), that attacks cattle in North America. Perhaps the most colorful name I have heard applied to snipe flies in Yellowstone was "those little gray bastards," by Jack McDonald, who worked at Silvertip Ranch just north of the park boundary. The trip by wagon to the ranch was along Slough Creek, an area notorious for large numbers of snipe flies.

The most abundant species of biting snipe flies in Yellowstone are *Symphoromyia flavipalpis* in relatively open country, primarily in the northern part of Yellowstone, and *Symphoromyia pachyceras* in forested areas of the park, above 2,100 meters (7,000 ft.). A third species, *Symphoromyia atripes*, is much less abundant and occurs primarily at higher elevations, usually above 2,400 meters (8,000 feet), in forested areas and in subalpine meadows.

The magnitude of snipe fly biting activity depends on year-to-year fluctuations in their populations. In an "average" year, biting activity begins about July 1, rapidly increasing during the first half of July, and reaching a peak during the last two weeks of July. Abundance gradually decreases during the first half of August, but the flies can still be locally abundant. Populations decline slowly during the last half of August and usually disappear entirely by the beginning of September. In a non-outbreak year, there may be only sporadic biting activity throughout the summer, with only one or two flies occasionally attempting to bite. In outbreak years, the seasonal change in abundance is very conspicuous, with up to 25 to 50 or more flies attacking at a given time during peak activity in favored habitats.

Snipe Fly Habits and Habitats in Yellowstone

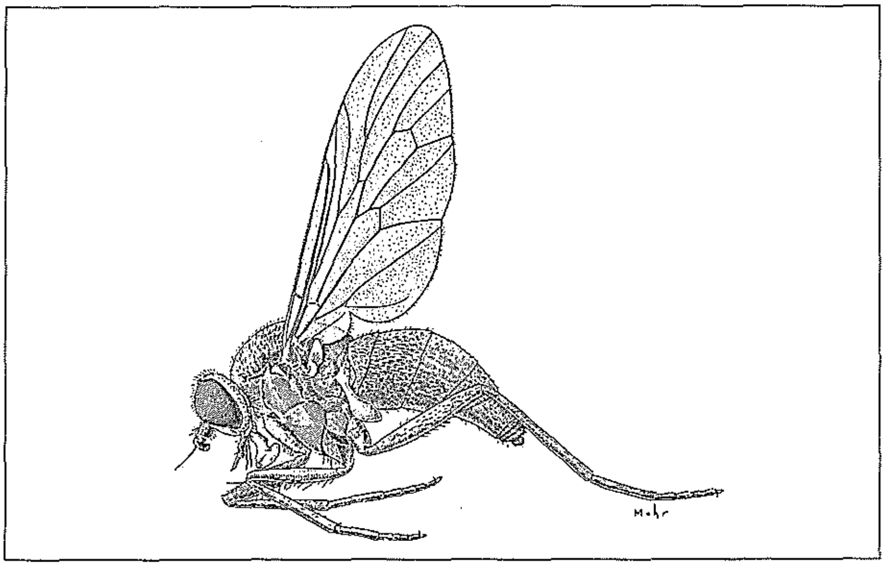
In open areas of sagebrush-grassland, stream bottoms, and in meadows in the northern part of Yellowstone, *Symphoromyia flavipalpis* can be so abundant that it is difficult to remain in one place for long without intense irritation and annoyance from bites or swarming of flies about the head and body. Swarms of 25 to 50 flies around people or horses are not uncommon in years of unusual abundance in areas such as Slough Creek valley, Lamar Valley to Soda Butte, and along the road to the northeast entrance. Once in 1967, I experienced a swarm of 75 to 100 flies circling my head and body on the lower slopes of Druid Peak, between Lamar Ranger Station and Soda Butte. Swarms were also attacking mule deer in the same area, causing them to seek shelter in heavy timber.

In forested areas, *Symphoromyia pachyceras* also occurs in very large numbers, but annoyance tends to be spatially localized. Observations made during the 1960s in the Lamar River drainage revealed that biting snipe flies in forested areas congregate in specific sites along animal and hiking trails. The trail between the Cold Creek patrol cabin and the Upper Lamar patrol cabin (at that time located southeast of Saddle Mountain, on the Lamar River) had three "fly belts" (a term borrowed from research on tsetse flies in Africa) along the trail. Each "belt" occupied about 200 to 300 feet of trail. In each of these belts, flies would swarm around me and my horse, attacking my head and arms and the horse's head and neck. Areas of trail between these belts had relatively few snipe flies.

In common with horse flies and deer flies, snipe flies rest on vegetation along the trail and fly out and around passing animals, attracted by movement. These snipe fly belts appeared to be associated with areas of blowdown or dead trees, where older trees had fallen and were being replaced by younger growth, providing relatively open spaces adjacent to the trail. Snipe flies were less abundant in older growth forest. Biting activity also was particularly intense at the edges of meadows in mixed spruce-fir and lodgepole pine forest.

Clothing seems to inhibit biting, possibly because the mouthparts of snipe flies are relatively short and seem not to penetrate clothing readily, in contrast to mosquitoes and horse flies. Preferred areas of attack for horses seem to be the head and neck. Bison, elk, moose, and mule deer are attacked most frequently on the head and upper part of the body. Because snipe flies make a relatively large entrance wound when feeding, blood often oozes from bite areas after the fly has completed feeding. Horses often exhibit considerable local swelling on the head and neck when bitten repeatedly.

Snipe flies in Yellowstone vary greatly in abundance from year to year, as do deer flies. The reasons for this fluctuation are not clear. For example, 1967 and 1994 were particularly bad years for snipe flies, but 1966 and 1990 to 1993 were not at all remarkable. In 1967, June was very rainy, but July and August were unusually dry. Snipe fly populations may be affected by long-term weather patterns, soil moisture, winter snowpack, and by predators, parasites, and pathogens. A combination of a relatively dry fall, which could enhance larval survival by reducing mortality due to pathogens, followed by a relatively snowy winter that protects developing larvae in the soil, followed by



Female of Symphoromyia atripes, *one of the less abundant species of snipe flies in Yellowstone, which prefers forested and meadow habitats at higher elevations (above 8,000 feet.).*

a relatively wet spring that enhances soil moisture and larval survival, followed by a relatively dry summer that enhances adult activity might result in high adult populations. This is entirely speculation at present, but because unusually high populations of snipe flies in Yellowstone mercifully occur at irregular intervals, it is likely that a series of interlocking biotic and abiotic factors is responsible for year to year changes in adult abundance.

A question frequently asked in 1994 was whether the 1988 fires may have contributed to subsequent high snipe fly populations. This seems unlikely because there were no unusually "bad" snipe fly years until 1994. It is possible, however, that by opening up forests, the fires may indirectly benefit snipe flies, because they seem to congregate in relatively open areas along trails. Whether the fires created favorable breeding habitat is unknown.

Day to day changes in biting intensity are less of a mystery. The most intense biting activity occurs after two or three days of dry weather without the usual afternoon and evening thunderstorms that sweep through the park. This occurs most commonly with the passage of high pressure weather systems from the west. Snipe fly daily activity occurs during daylight hours in full or partial sunshine from about 10 a.m. to 5 p.m. Fly activity is depressed or absent on cloudy, cool or rainy days. Abundance varies greatly from place to place. On one July day in 1994, I was attacked unmercifully in open sagebrush-grassland near Snow Pass, but I saw not a single snipe fly the same day along the Madison River near Madison Junction.

Effect of Snipe Flies on Wildlife

The effects of large snipe fly populations on wildlife and wildlife behavior in Yellowstone has not been studied, except for observations on seasonal movements of bison in the 1960s. In her study of Yellowstone bison, Mary Meagher noted the abundance of small, gray flies in the Upper Lamar and Mirror Plateau areas in 1965, and in Upper Lamar and Hayden Valley in 1967. She concluded that these flies may have influenced Upper Lamar bison movements during the summer months, and possibly might explain their concentration for two weeks in late July and early August along the eastern boundary of the park in 1967.

Why should snipe flies, in particular, be more annoying to animals than other bloodsucking insects? Unlike larger horse flies and deer flies, they are not easily dislodged once they begin feeding. They can attack in very large numbers, much larger than horse flies and deer flies. Their approach is silent, apparently not triggering the usual avoidance response seen in horse fly attacks. They are relatively small and inconspicuous, thus less likely to be noticed by animals. Their bites (at least to humans) are quite irritating, producing local swelling and itching that may persist for hours to days. Bison react to snipe fly attacks as they do to other nuisance flies, stamping their feet, herding together, frequently using dust wallows, and rubbing against trees. The cumulative irritation due to large numbers of snipe fly bites may cause animals to seek shelter in heavy timber or to move to higher elevations where fly activity is reduced.

Avoidance of Snipe Flies

Periodic high populations of snipe flies are a fact of life in Yellowstone, but there are some measures that can reduce their annoyance to humans. Repellents that are effective against mosquitoes and other biting flies (usually containing diethyltoluamide, DEET) will not repel snipe flies. Some of the newer "natural" repellents that contain oil of citronella may be partially effective, but have not yet been tested against snipe flies. The best protection is to wear clothing that covers all exposed areas of the body. A broad-brimmed hat will discourage most flies buzzing around the head, and a bandanna will protect the neck area. In areas where flies are particularly abundant, gloves also are useful. Livestock can be partially protected with commercially available repellents containing oil of citronella or contact insecticides such as pyrethroids, although these materials may be less effective when snipe fly populations are particularly high.

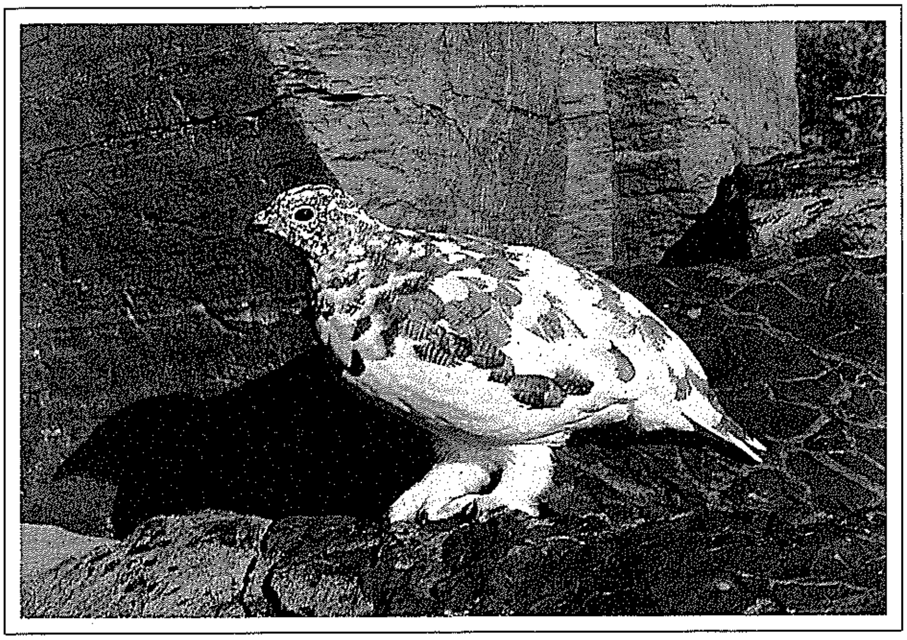
Conclusion

Much remains to be learned about the habits and biology, as well as the taxonomy of *Symphoromyia* species in Yellowstone, particularly what factors contribute to their abundance in particular years, and their influence on movements and behavior of wildlife populations.

John Burger is a professor of entomology at the University of New Hampshire, who has also offered to write us a broader article about many of the other "bloodsucking denizens" of Yellowstone.

The White-tailed Ptarmigan in Yellowstone

Searching for a high-country phantom



by Terry McEneaney

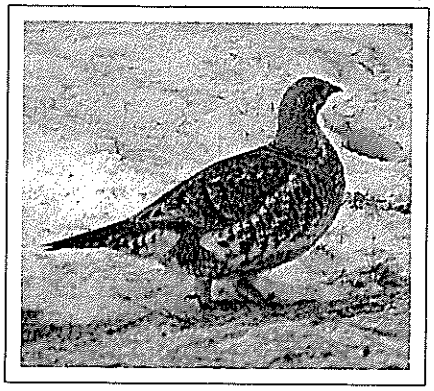
The white-tailed ptarmigan (*Lagopus leucurus*), the most diminutive grouse in North America, is easily distinguished by most people for two reasons. First, it has the ability to transform from brown plumage in the summer to white plumage in the winter, and second, it lives its life in the high alpine areas of western North America. Yellowstone is noted for its large amounts of snow, long drawn-out winters, and being a high-elevational plateau. A perfect place for white-tailed ptarmigan, you might say. There is genuine confusion as to the status of the white-tailed ptarmigan in Yellowstone. The purpose of this article is to clear up that confusion.

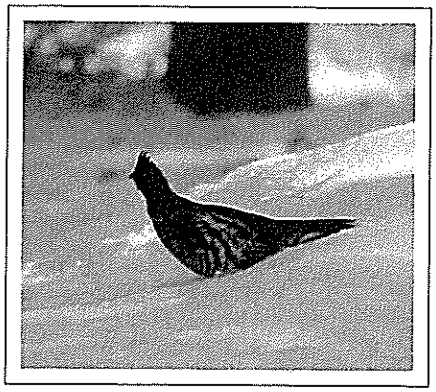
The information presented in this article is based on historical data and my own modern systematic searches of the Yellowstone high country. But before looking into the historical records, it is important to understand scientific thinking about the current status of this species.

In 1993, *The Birds of North America* series, sponsored by the Philadelphia Academy of Natural Sciences and the American Ornithologists Union published an article on the white-tailed ptarmigan showing the current distribution of this species to include Yellowstone National Park. Other publications, such as *A Birder's Guide to Wyoming* (1993) and *The National Geographic Field Guide to North American Birds* (1987) also show the range of the White-tailed Ptarmigan to include Yellowstone National Park. On the other hand, Peterson's *Field Guide To Western Birds* (1990) shows a range map with a question mark where Yellowstone National Park is located. *Game Management in Montana*, an outstanding publication produced by the state of Montana in 1971, indicated white-tailed ptarmigan being located just northeast of Yellowstone National Park, in the Beartooth Mountains.

Above: A genuine white-tailed ptarmigan photographed by the author in Glacier National Park.

Now that we may be totally confused by the information presented in the field guides, we need to examine the historical records to determine their validity. In my opinion, of the several records available on the white-tailed ptarmigan in Yellowstone, only two records have any substance. The first recorded sighting was by Milton Skinner in 1927 on Quadrant Mountain, and an 1941 report by Lee Coleman described three grouse-like birds seen at a very close distance on Electric Peak. Both men were longtime local residents with extensive field experience in the region. Skinner was also the author of an early monograph on the birds of Yellowstone.





Other grouse species in Yellowstone, such as blue grouse (far left), and ruffed grouse (left), also occasionally have many white flank feathers, which may have confused some past observers into believing they saw a white-tailed ptarmigan.

Since 1982, I have searched a high percentage of the alpine areas of Yellowstone National Park and have not yet found a white-tailed ptarmigan. The historical records and recent field guides show white-tailed ptarmigan occurring in Yellowstone, but systematic field surveys failed to find white-tailed ptarmigan. How can this be?

Part of the reason for the confusion over the white-tailed ptarmigan is because the bird is difficult to identify, particularly if the observer is inexperienced with the species. This is especially a problem in Yellowstone because the other grouse species found here sometimes have very atypical feather patterns not adequately described in field guides. For example, ruffed grouse (*Bonassa umbellus*) in Yellowstone have unusual amounts of white on their flanks, which can result in confusion between them and white-tailed ptarmigan.

Blue grouse (*Dendragapus obscurus*) in Yellowstone also possess large amounts of white on their flanks, making identification from field guides very confusing. Blue grouse in Yellowstone possess another characteristic not mentioned much in the literature: they have a habit of venturing far out onto sagebrush, where they are misidentified as sage grouse. And sometimes blue grouse venture above timberline into the alpine areas, and can be misidentified as white-tailed ptarmigan. This is especially true on the summit of Mount Washburn, where inexperienced visitors annually report white-tailed ptarmigan on the summit. Every report of ptarmigan on Mount Washburn from 1986 to the present has turned out to be a blue grouse.

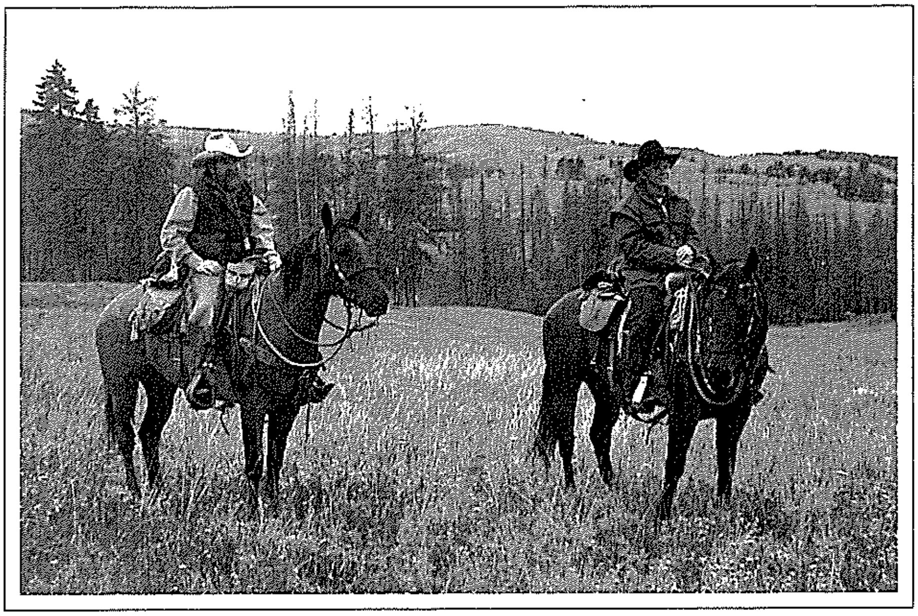
With that background, let's take a closer look at the two most reliable records of the white-tailed ptarmigan in Yellowstone. The most recent record, an October 1941 observation of three grouse-like birds at close range on Electric Peak by then-ranger Lee Coleman, has some problems. Coleman decided that these birds were white-tailed ptarmigan because they were "grouse-like birds, plumage intermixed with white (one third of total surface), and feathers covering the toes." The weaknesses of this observation is that blue grouse in Yellowstone show similar characteristics, and that by October, white-tailed ptarmigan are primarily white in color. A further problem is that Coleman found the birds at 8,500-foot level on the north flank of Electric Peak, and the area described in this observation is located in conifers, increasing the probability that the birds observed that day were most likely blue grouse.

Proof of the existence or nonexistence of the white-tailed ptarmigan in Yellowstone really comes down to one observation. Milton Skinner's 1927 observation was as follows: "A single individual was seen on the top of Quadrant Mountain, above timberline and about a half a mile from the nearest tree." There is no detailed description of the bird in question; rather, the observation is based on the fact that it is "above timberline and about a half mile from the nearest tree". Milton Skinner was a good ornithologist, but did he really see a white-tailed ptarmigan? No one will ever know for sure. But I can offer a series of possibilities or explanations as to what Milton Skinner may have found.

The possibilities include: 1) Skinner made an observation of an erratic white-tailed ptarmigan, members of the grouse family have been known on occasion to fly unusually long distances; 2) Skinner never really observed the bird at all, but perhaps was recording a sighting that someone else turned in to him (he was a park naturalist for some years); notice that he did not say "I observed" but rather "a single individual was seen"; or, 3) the white-tailed ptarmigan described by Skinner in 1927 was mistakenly identified. Could it have been a glue grouse? Who knows what went on that day? We do know that the current confusion regarding the presence of the white-tailed ptarmigan in Yellowstone is now largely based on this one questionable and poorly documented observation.

Given the habitat requirements of the white-tailed ptarmigan, namely expansive alpine areas above timberline, and rocky terrain with moist vegetation interspersed with willow alpine plant communities, it is unlikely that the white-tailed ptarmigan is a resident of Yellowstone. A viable breeding population does not currently exist. Despite the extensive fieldwork I have conducted here in Yellowstone, the numerous studies conducted in the alpine areas of the Beartooth Mountains by P. Hendricks, D. Pattee, R. Johnson, and N. Varley, and the less formal observations of hundreds of people who venture into the high country, reliable sightings of the white-tailed ptarmigan have not occurred. Until more detailed reliable information is collected on the white-tailed ptarmigan in Yellowstone, such as archaeological evidence or recent sightings by qualified observers, all field guides and scientific publications should refrain from depicting Yellowstone as definitive habitat for the white-tailed ptarmigan. Meanwhile, I will continue to search for the phantom bird of Yellowstone's most hostile environment, the alpine zone.

Terry McEneaney is Yellowstone's bird management biologist and author of several books about birds, including The Birds of Yellowstone *(1988),* The Birder's Guide to Montana (1994), *and* The Uncommon Loon (1990). *This article is based on a paper presented to the Montana Academy of Sciences in 1994.*



Getting Past "Wow"

Grizzly Bear Natural History Goes High-Tech in Yellowstone

Yellowstone National Park has been the site of several important bear studies, starting with Olaus Murie's brief but foresighted study of the "bear problem" in the 1940s, and including the pioneering Craighead project of the 1960s and the long-running Interagency Grizzly Bear Study Team project that has been underway since 1973.

Steve and Marilynn French, founders of the Yellowstone Grizzly Foundation, have been conducting research on the grizzly bears of the Greater Yellowstone Ecosystem since 1983. The Frenches have become very well known in both scientific and popular circles, and have received numerous awards and honors for their work on behalf of bear conservation through public education. This interview, conducted in October 1994, explores many aspects of their project, especially the unique mixing of traditional natural history studies with the latest wildlife monitoring and research techniques. It only touches lightly on some of their recent work, such as their involvement in mitochondrial and nuclear DNA analysis of bears. We hope to persuade Steve and Marilynn to write something for us on that and other subjects as more of their work is published. Ed.

YS**:** Unlike most researchers who come to Yellowstone with a pretty clear plan of how they want to proceed, you kind of grew into your study. You just started out with an interest in bears, and eventually it turned into a scientific study. In the long run, did that help?

SF**:** Yes. It helped because we didn't come in with the traditional formal training; we didn't know what we were supposed to be seeing. We came into this whole thing sort of innocently, and we started out with the tools that we had available: the seat of our pants which we sit on while we watch bears. Our eyes and our butts, and that was about it.

YS**:** How did you get from abject ignorance to accomplishing something?

SF**:** We went through a stage in the early days where our first response to each bear we saw was "Wow." That's what most people go through at first, just the amazement of seeing the bear at all. From that we progressed, and instead of just seeing the bears we started *observing* the bears; that transition came about almost unconsciously. After so many "Wows" not only did our resolution get better, but also our peripheral vision got really good and we started seeing things that were happening *around* the bears.

YS**:** But that's still a long way from doing science. How did it go from intelligent observation to active analysis?

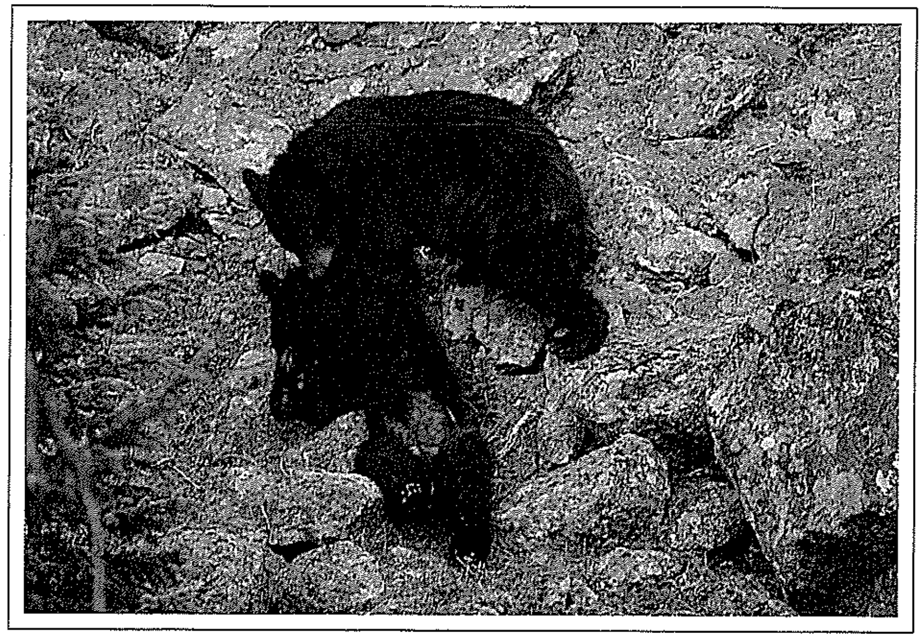
SF**:** We both have scientific backgrounds; science isn't the exclusive domain of wildlife ecologists. After a while, we decided that this is great that we're seeing these bears, but it's a shame if the process is limited only to our personal emotional reactions.We realized that we should collect these observations in a scientific manner, so that they could be shared in a way that would mean something to others.

I think that after so many years of doing this we are probably in a better position to see the true deficiencies not only of our own methodology, which is based on observing individual unmarked animals behaving, but also of other methodologies, like those employed by a computer jock somewhere in a lab analyzing radio relocations on a map.

MF**:** There's an analogy involving how you see a house. If you look at one side

Opposite: Marilynn and Steve French on their horses, Buster and Bandit, doing field work on Blacktail Plateau, 1994. Right: The male black bear described below, dragging the female black bear it had just killed.

All photos accompanying this article are courtesy of Marilynn French and the Yellowstone Grizzly Foundation, unless otherwise noted.



of that house, you're only seeing a part of it. But if you have somebody over here looking at this side, somebody over there looking at this side, and somebody on top, and they share what they're learning from all those different perspectives, you end up with a pretty good picture of the whole house.

***SF*:** So we're learning about social dynamics of grizzly bear through many hours of direct observation...

***MF*:** ...and at the same time, Dick Knight's [*Leader of the U.S. Interagency Grizzly Bear Study Team*] analyzing demographic data from all the years of radio relocations, and somebody else is looking at habitat and vegetation. When we're all communicating and everybody puts their findings together, we get a much better picture of the whole thing.

And there are still so many other unknown aspects of the picture. What about anatomy? How does the anatomy of the bear reflect what's going on the field? What's inside this bear? What kind of bugs are in it? How does it fight off those bugs? There's so much more.

***SF*:** You've got to keep it open minded; that's the key.

***MF*:** Never assume anything, and never get defensive.

***YS*:** How does defensiveness happen?

***SF*:** If somebody challenges you, you tend to get defensive. In fact, if somebody challenges you, the best response is to challenge your own thoughts, instead of being so defensive. We've probably learned more from having people challenge us. When we give talks, and offer our opinions, if everybody just sits there and says, "Oh that's great, that's wonderful," we haven't learned anything from that presentation. Three or four years into this study, we were sure we knew about bears. I mean, we had short concise answers for everything. But since then our answers have gotten longer and fuzzier, with a lot of conditions.

***YS*:** Give us an example of how that learning process has worked.

***SF*:** We can tell you a story on ourselves that we haven't admitted to many people. Researchers may have scientific principles as guidelines, but remember that we're human. We're subject to our own cultural biases, and we still do our research in an aura of human emotions. We experience our world and our research on a visceral level, and we can never deny that. I don't care how good of a scientist you are, you'll always have that within you.

***YS*:** So what's this story on yourselves that you're so embarrassed about?

***MF*:** We were out in the field one day, and we heard a ranger on the park radio report that a black bear cub had been hit by a car at Gibbon Falls, and that the mother was carrying it away. We knew we had to see this. Well, we got there, and sat down and started making notes and watching. As we watched, we kept saying, "Oh my God, this is terrible; look at that poor thing...."

***SF*:** We even told each other we could see the sorrow in her eyes as she was dragging her cub....

***MF*:** I hate to admit this.

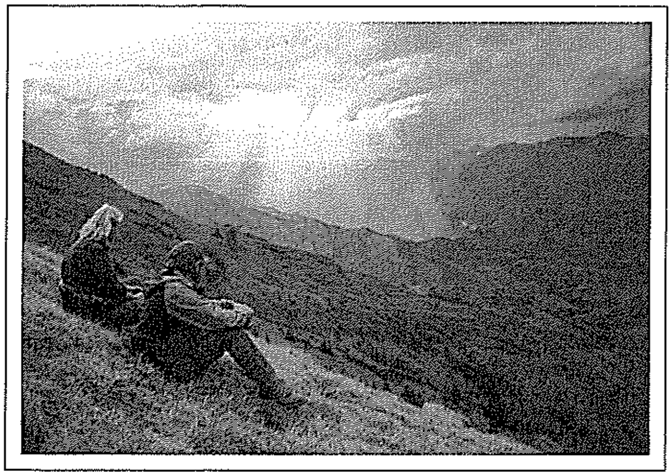
***YS*:** But our readers will love it.

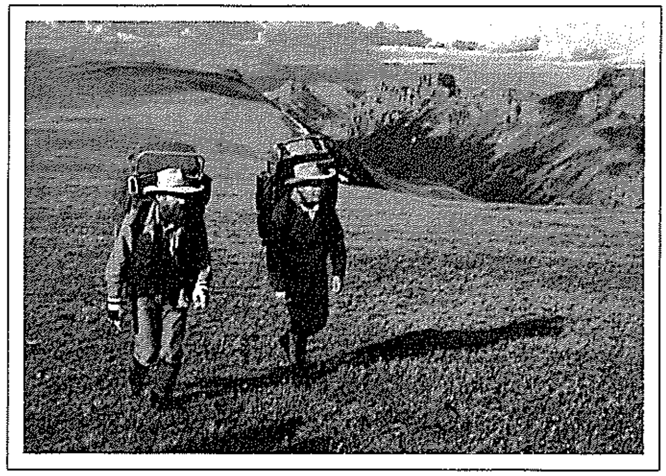
***SF*:** Yeah, well, there we were, watching through our spotting scope, talking about the sorrow in the eyes of this mother bear, and how sad she must be, and then all of a sudden she turns, and her crotch is exposed, and I said, "Marilynn, that sow's got an erection." For the last hour we'd been sitting there imagining all this motherhood stuff, and now we see she's not a mother bear at all. We believed she was a sow because of the report by the ranger, so we saw what we thought we were supposed to see.

Later, we actually found a guy, a park visitor, who saw what really happened. The male black bear encountered this smaller black bear, which we later determined was a female; the two bears had a fight, and the male dumped her in the river and drowned her. He held her head under the water, and when she was dead he proceeded to drag her body up the hill, where over the course of the next three days he consumed her.

***YS*:** One of the things we try to achieve in *Yellowstone Science* is a little less sanitized version of how scientists actually go about their work. Through stories like that one, we sometimes succeed beyond our wildest expectations.

***SF*:** Let me keep this in perspective. When I started studying bears here, I was





In recent years, the French's study of bears feeding on moths at high-elevation sites has taken the researchers and their crews to some of the most spectacular country in the ecosystem.

a scientist, but that didn't mean I knew what I was doing around bears. I had worked in nuclear physics before I decided to go back to school in medicine, and so I have a really strong scientific background, but when it came to bears I only knew a little more than the tourists.

***MF*:** Remember some of our first hikes in Yellowstone?

***SF*:** Oh, God! We'd do really stupid things: we'd find dead carcasses and walk right up to them. I'm sure we ran bears off some of those carcasses and we didn't even know it.

***YS*:** Speaking of not knowing things, didn't you stumble into the middle of the grizzly bear controversy the same way?

***MF*:** In about 1979, we came to park headquarters at Mammoth, wanting to learn more about bears. We found the research office in the administration building, and we told them that we wanted to see all the recent scientific papers on the grizzly bears in Yellowstone. Needless to say we were treated rather coldly. Frank Craighead's book *Track of the Grizzly* had just come out, and we got this response, like, "Who the hell are you?"

***SF*:** But we kept asking questions. We were told by a ranger-naturalist at a campfire program that there were 400 grizzly bears in Yellowstone. We didn't know whether that was true or not; our only question was, where are they? We just wanted to see them. We were out there looking for them, and we couldn't find them. We weren't part of anybody's political agenda, we just wanted to know.

***YS*:** From such a rocky start, how did you finally starting learning about bears?

***MF*:** Eventually we were able to gather more information, and finally we came upon a catalog from the Yellowstone Institute, which said that Steve Mealey [*former Interagency Grizzly Bear Study Team member who wrote his M.A. research on Yellowstone grizzly bear food habits in the 1970s*] was teaching a course about grizzly bears, so we tried to sign up.

***SF*:** But by the time we found out about it, it was the week of the course, so we had to wait a year before we took it.

Understand that by now we had spent five summers in Yellowstone looking for grizzly bears and never seen one. And we weren't looking the way the average tourist would. We truly were getting up at the crack of dawn, and we were staying out until pitch dark. We ate most of our meals at 10 o'clock at night after we'd gotten back. But we didn't have a search image, and we didn't know where to look.

MF: We were actually looking in the lodgepole forest.

SF: Right. We would drive from Canyon to Norris, because we had this idea that the road went through woods and bears live in the woods. We spent hours driving along looking in the woods for bears. We had no idea how to look for bears. To this day we've only ever seen one grizzly bear on that road. Of course, we just had a pair of $29.95 K-Mart special 7X35 binoculars that were unfocused and smudgy, and we didn't have the search image in our minds to allow us to see bears even if they were out there.

***YS*:** But that first Yellowstone Institute class was what got you on the right track?

***SF*:** That week we got to know Steve Mealey, and we really hit it off. He took the class out to look for bears, and he knew where they were and how to see them. Right away we started seeing bears, and it was all different for us: "Oh, so that's where you look for them! Oh, so that's what they look like!" We hadn't seen any bears in five years, and in five days I think we saw 32.

***MF*:** Steve put us onto the right places, and he also gave us a better understanding of management, and how it works, and how to work with it, so we didn't get crosswise of people for no good reason.

***YS*:** After that, it seemed to happen very quickly that you became well known for finding and filming bears.

***SF*:** I think the precipitating event that led to what we do today was one of those incredibly fortuitous accidents. I don't know why, but in 1983 we bought one of the first home video cameras, a big heavy one. I don't even know why we had it. And for some strange reason we had bought this Celestron telescope for looking at stars, and just the week before we got to the park that year, I happened to see that there was this attachment you could use to hook it up to a video camera. I bought it, and it was still in the box in the van. When the bear class was over, we said our good-byes and we went up Antelope Creek [*the Antelope Creek drainage is east of the road on the north side of*

Mount Washburn] to look for bears.

Now that we knew what we were doing, all of a sudden grizzly bears were everywhere. There was this one bear with a limp; he had an injured front paw. He was still pretty good at chasing elk calves, but he was a little scrawny; probably a young adult male. We pulled up at Antelope that day, and looked out, and there was this little male and another bear and they're fixin' to mate!

This male was only about half the size of this female, and we saw how he probably got injured, because she was really biting him and giving him a hard time. I was frantically trying to get this adaptor unpacked and figure out how it worked. I finally got it together and put it on the tripod, and videotaped mating bears for 37 minutes. Well, right away the word got out that we were filming bears. The new park superintendent, Bob Barbee, asked if we would mind bringing the tape over to headquarters and showing it to a few people.

***MF*:** When you look at it now you wonder, how could these people be excited about this?

***SF*:** But it was great natural history footage. And now that we knew how to find bears, and we had all this time on our hands, we could go out with this contraption and film these bears. We were invited to more meetings, and we got to know Dick Knight and John Varley [*then Chief of Research*], and they were really great, and offered to help us however they could.

***YS*:** When did your observations and filming turn into what could be called data collection?

***SF*:** The year after that class we started to see things like elk calf predation by grizzly bears, and we decided we ought to keep a journal. It gradually evolved and got more formalized. I keep going back to this, but one of our assets was that we had a lot of free time. We knew how to find bears and we got better at it as time went on.

***MF*:** I think one of the things that was kind of neat was that we were dispelling some of the myths.

***YS*:** The late 1970s and early 1980s were a time when it was very fashionable to say that there were no grizzly bears left in Yellowstone. When you appeared with all this amazing footage, it did tend to quiet that extreme rhetoric down.

***MF*:** And you know, people would probably not have believed us if we didn't have the proof on film.

***SF*:** Neither one of us had any formal training with cameras. We didn't even have a still camera for three or four years after that! We saw film as a research tool.

***YS*:** But didn't those visual images tend to overwhelm the information you were gathering?

***SF*:** To this day, even after we've been published in respected scientific publications, and presented papers at two of the international bear conferences, somebody will say, "Oh, the Frenches; they're bear photographers."

***MF*:** One of the things that really helped change that was when we met Steve Herrero [*University of Calgary ecologist and bear researcher, author of the book* Bear Attacks].

***SF*:** We had heard about Steve, and he came to Yellowstone to participate in a Yellowstone Institute Class. He had heard that we were seeing a lot of bears, and he asked if he could spend some time with us. He said that what he'd like to do is see some bears preying on elk calves, because he had seen it a couple times in Canada and had found a couple other calves that he thought bears had killed, and he was thinking of writing a paper about it.

***YS*:** At that time, most people thought it was an unusual thing to see.

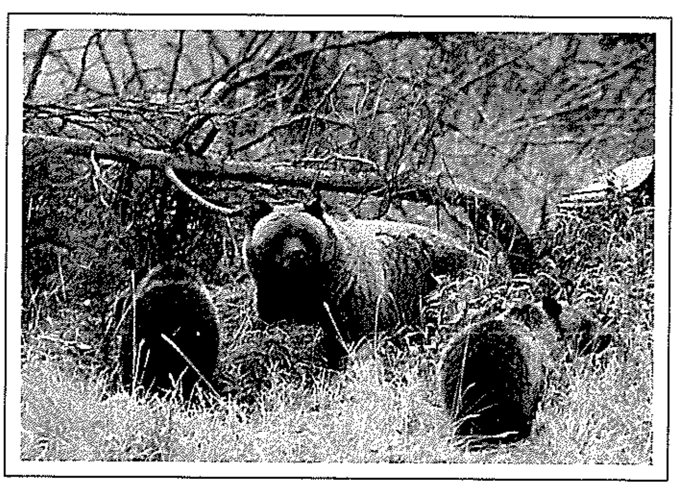
***SF*:** Right. He asked us if we'd seen elk calf predation, and we said we'd seen 30 or 40 episodes. He was amazed.

***MF*:** So we told him, "Yeah, we'll do that."

***SF*:** I think we saw two episodes the very first morning we took him out. It doubled his data base just like that. So he asked us, "Why don't you write this up?" We said, "Well when we get enough data we will." He couldn't understand that because it was so unusual for anyone to see it at all, and here we were with all these unpub-

Below, left: Bear savvy, patience, and very powerful spotting scopes and camera lenses have enabled the Frenches to capture the home lives of grizzly bears to an extent never before achieved in Yellowstone.

Below, right: Since the 1960s, when the trout population of Yellowstone Lake was collapsed by overfishing, stricter fishing regulations have resulted in a dramatic recovery of trout, adding an important item to the diet of grizzly bears.



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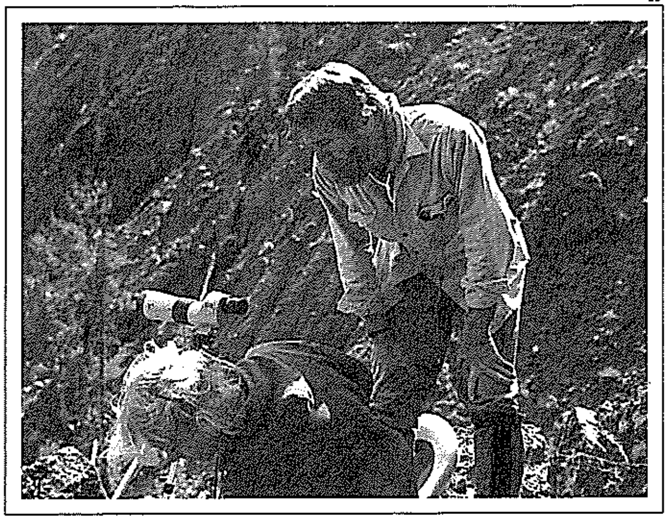


Ted Wood

In wildlife observation, patience is a virtue, whether in watching for bears (left) or waiting out a hailstorm at 11,000 feet (right).

lished observations. But from our perspective, we wanted to have 100 or 200 episodes before we presented a paper.

MF**:** I think by that point we had read just about everything that was available on grizzly bears, and we felt that there were some real problems in writing up conclusions based on just a few examples.

SF**:** So we decided that when we presented a paper it would be based on a lot more observations, because we knew that three or four observations really would get you into trouble about drawing conclusions. Steve Herrero kept hounding us, saying that "You guys have more data on this than anybody anywhere," so at the bear conference in 1989 we finally presented our first paper. It turned out that Kerry Gunther [*NPS biologist in Yellowstone*] was gathering similar observations at the same time, so suddenly Yellowstone was contributing a huge amount of new information on predation.

YS**:** Have you continued to add more observations since then?

SF**:** We're now up to more than 300 predation episode observations, and we will eventually write an addendum to that first paper.

YS**:** That first presentation at a scientific conference must have seemed like a big step for people who had started out as hobbyists.

SF**:** It was. I mean, who were we to be in the midst of this crowd of world-famous bear biologists? So we did something different. You're only given 20 minutes to talk, so we gave them 10 minutes of solid background and then I said, "The bear will tell you more about elk calf predation than we could possibly tell you." Then we showed them 10 minutes of 16 mm movies of bears taking elk calves. Predation after predation.

MF**:** The response was overwhelming. People were writing about it but had never seen it. At the conclusion of the conference, five papers were cited as being especially noteworthy, for being groundbreaking, and ours was one of them. That was really neat.

YS**:** It seems that for all the problems you've had with people confusing you with photographers, rather than recognizing that you're doing research, those films you've made are going to be invaluable.

SF**:** One of our projects when we get so old and rickety that we can't get out into the field is to go back and produce volumes, maybe digitally, on certain aspects of bears. The idea is that you could go to the library and check out this book and an accompanying tape, or CD ROM or whatever the technology is by then, and get all the background information as well as seeing it take place. So the film will continue to be a research tool for a long time, as well as an educational tool. However, having said that, I will tell you that I have not filmed a bear in two years. When is the last time we took a picture of a bear?

MF**:** Last year. I think it has become less important as a tool for us in getting our point across to different kinds of audiences. It was vital when we started.

YS**:** Are you reaching the point where you've filmed so much, and taken so many still photographs, that there isn't that much new to photograph?

MF**:** That's part of it. You quickly realize that there are only certain kinds of pictures that will be useful for audiences. On the other hand, you know that even a picture of a bear at a great distance still has lots of reference values.

SF**:** We have literally thousands and thousands of slides that no one has ever seen that really mean a lot to us and have some scientific meaning as well. The same is true with the movies. We've probably got 200 hours of film, but I've never shown more than 30 minutes of what I have.

MF**:** And we're always saying to each other, "I will not spend another dime on another picture of a black dot in the field. I will not do that." And every time we take a camera out we do just that.

SF**:** On our 16 mm movie camera, every time I push the button, just to get a work print is $20.00 a minute.

YS**:** Speaking of the black dots, the hardest part for most people is still finding them in the first place. You had the advantage of experience, but the IGBST made radiotracking equipment available to you, so you could locate the bears that they had collars on. Did that help much?

SF: When Dick Knight first gave us the telemetry gear and asked if we would mind keeping track of any of his bears we happened to locate, we thought we'd struck gold. But we found out real quick that chasing a radio signal to get a bear's general location isn't the same as actually seeing that bear. We discovered we were much better off to stay with a bear we knew, because maybe we'll just watch him feeding and digging all day, but maybe he'll give us that 10 minutes of absolutely incredible, once-in-a-lifetime information.

MF: We were much better off without the radiotelemetry. It was useful in other ways, like allowing us to identify a radio-collared bear if we were already watching it, but it didn't help us find many bears.

SF: We would miss twenty bears trying to find this one radio collared bear. We got so damn tired of hearing that little beep. It told us the bear was right out there, but we couldn't see it. It just didn't work in the real world, when you're trying to see the animal.

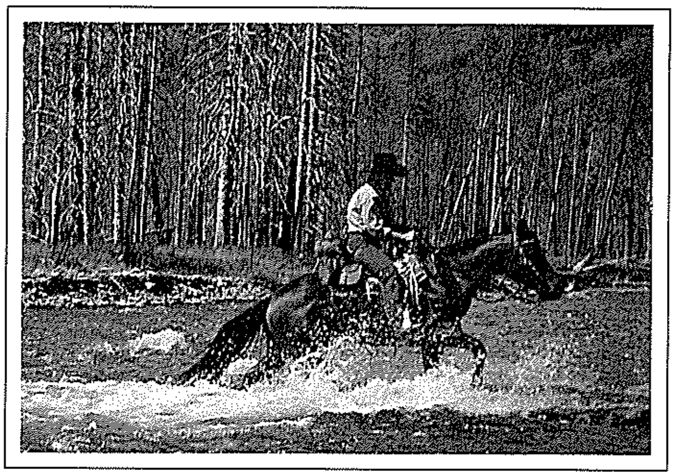
YS: Let's get back to watching a bear. Things can happen pretty fast among wild animals. How did you learn to distinguish what you needed to write down, and what wasn't important?

SF: A good example is elk calf predation. We knew we could go to certain locations and see bears preying on elk calves. But we soon realized that we also needed to understand what those same bears were doing when they were not eating elk calves. And we learned that there is so much that you might not see the first time. When we started filming bears, and had the chance to sit down later and literally hand crank the film through frame by frame, we could see so much more. We could actually look at a sequence of events and see all the things that happened; it really unclutters your mind.

YS: You've mentioned developing a "search image," which is a mental knack that allows someone to pick a certain thing—in this case a bear—out of a landscape. Did reviewing the films help sharpen that image?

SF: It did, but it also helped us to improve our peripheral vision when an event takes place. We'd watch a film, and suddenly one of us would say, "Did you see that calf? That other calf that was only 10 feet away when the bear took the calf we were watching?" We were so absorbed in watching part of the action that we didn't see the other things the animals were doing.

YS: You two have been credited with bringing traditional natural history study back to Yellowstone bear biology. By spending hundreds of hours observing the animals, you remind people of an earlier generation of researchers, especially Adolph and Olaus Murie, who did so much important research in national parks earlier in the century. But though you have revived interest in those traditional methods, and have proven their



value, you've also discovered the limitations of just sitting and watching. Now it seems that you're working in both worlds: the traditional observations and the modern high-tech methods, including radiotracking of some of the bears that eat moths at high-elevation sites. How did that happen?

SF: After observing bears for several years, we understood that there were incredible limitations to what information we could obtain. We worked as closely as we could with the other bear researchers; for example, we went out with the habitat analysis specialists and their crews so that we could learn more about what they were doing, and we spent a lot of time with the various trapping crews—the IGBST, Montana Department of Fish, Wildlife and Parks, Wyoming Game and Fish—so that we understood bear handling. That really helped a lot, and we traded a lot of ideas and information.

But there were two things that really bugged us about the limitations of our approach. One was that though we could identify some bears as individuals, there were others that we couldn't. We didn't see them often enough, and so if we saw them the next day, we couldn't always be sure if it was a bear we knew. We didn't know where they went and what they were doing when we weren't watching them.

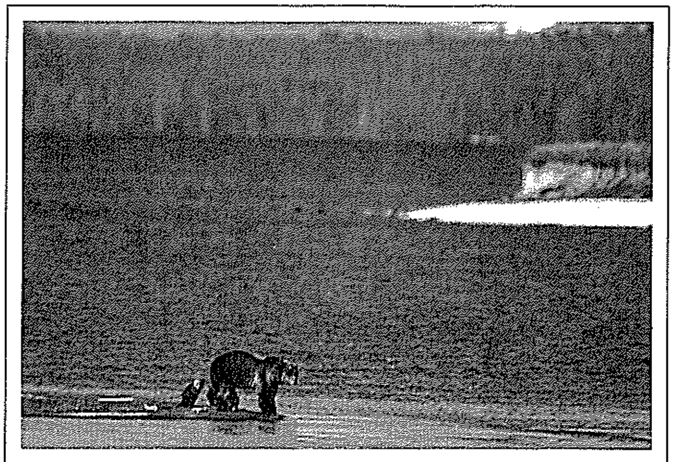
The second thing that really threw us was that most of what these bears do happens either in the woods or at night, where we just couldn't see them. Spending as much time as we did watching the bears made us all the more aware of all the things we just couldn't know about them.

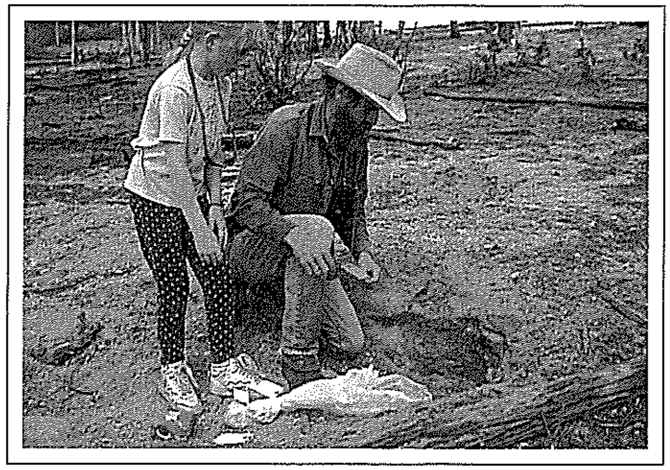
And so we started looking around trying to figure out how to cover all that time when we couldn't see them. It's a complicated question, because the answer that seems obvious is that you radiotrack them. But the radio relocation data is all collected during daylight, when bears are most likely to be inactive. It's great information for establishing the overall home range of a bear, and what a bear does during the day, but it misses a whole world of details. Besides that, the weather tells you when you get to fly. I don't care what your study design says, if the weather doesn't cooperate you won't get the data.

MF: Because we and our crews spend so much time watching bears at some high-elevation sites, we know that all sorts of things happen to a bear on the ground between those airplane flights that give you a few radio locations.

YS: You have now spent several summers observing the feeding activities of grizzly bears who feed at army cutworm moth concentrations, especially at high-elevation sites on the east side of the Greater Yellowstone Ecosystem, and it seems to have been this work, more than any other aspect of your study, that made you realize you needed a more comprehensive way of gathering information.

SF: We thought that there had to be a better way to combine the information that was being gathered. Therefore, on our moth study, it's not that we've given up on the behavior observations, because





Left: Sow grizzly with two cubs, on shore of Yellowstone Lake. Above: Steve and daughter McKenzie examining a site where grizzly bears were digging in mineral soils.

we're going to continue that, but we have a lot more to work with. Between the IGBST, the Yellowstone Grizzly Foundation, Montana Department of Fish, Wildlife and Parks, and the Wyoming Game and Fish Department, we had an incredible data base on the grizzly bears of Greater Yellowstone. This bear population has the most thoroughly documented demographics of any bear population ever studied; we really know a lot about where they go and what they do. But amazingly enough, we had practically no demographic data on all these dozens of bears that were eating moths. After all these years of study and trapping and radiocollaring by all these researchers, we had only ever seen one collared bear at the moth-feeding sites.

***YS*:** That is pretty amazing, when several dozen bears in a well-studied population congregate like that and none of them has a collar. You'd expect more of them to be collared, in proportion to the number of bears that are collared in the whole population.

***SF*:** It does kind of make us wonder what is going on there. That's why we've expanded into that arena. Dick Knight trapped some of these moth-eating bears for us, so we can get some data on them.

***MF*:** But we're not limited to our own observations and the radiotelemetrey. One of the things that we're going to do now is get into GPS [*Global PositioningSatellite*] tracking even more. That's one of the things we hope to have next year. We're going to get involved with a Wyoming Game and Fish GPS project down in the Tetons this year.

***YS*:** How much more precise is GPS than radiotracking?

***SF*:** It's infinitely better. You can get within 3.5 meters sometimes, and you can get your locations within 15 minutes.

***MF*:** That's really important, because one of the things that has really frustrated us in trying to understand what these bears are doing is that so many things happen between any two points as they travel. A lot of the radio relocations are pretty imprecise, and when you get out to the area where the bear was located, and you find evidence of bear activity, you really don't know if it was left by the bear you're radiotracking.

***SF*:** We have always tried really hard not to interfere with the bear's activities. That's why we use spotting scopes and long lenses. We don't want to influence what we're seeing. And so, even if it was safe to do so, we can't follow a grizzly bear around 10 feet away and record what it is doing 24 hours a day. This technology will get us as close to that as we possibly can.

So we're going to purchase two GPS collars next year for some preliminary work. We'll put one on a bear and use the other one as the control. We'll carry it out into different habitats and test the satellite's ability to locate it accurately.

***YS*:** So what you are really doing is using all of that technology to improve your ability to do what you wanted to do in the first place: get the most accurate possible natural history information.

***SF*:** That's right. Technology is necessary because we can't follow a grizzly bear all year from the time it leaves the den until it enters it again.

***YS*:** Or have a video camera mounted on its forehead.

***SF*:** A "grizzly cam." We thought about that. In fact, we checked into that technology. We thought about that because David Letterman has a "monkey cam" on his television show. He's got a trained monkey that comes roller skating out every now and then with the camera on his back. We still think that a "grizzly cam" might be possible some day, but the technological problems with doing it in a wilderness with a live feed are pretty formidable.

***YS*:** There would probably be some esthetic objections out there too; a grizzly bear wouldn't look much like the traditional monarch of the wilderness with a little TV camera perched on top of its head.

In the past couple of years, you've become very involved with a team of DNA researchers at the University of Utah, in efforts to clarify the family tree of the bears. That has some really exciting applications for Yellowstone.

***SF*:** Not just for Yellowstone, but for bears worldwide. This technology is going to result in a whole new understanding of bears. But in Yellowstone, there's this question that has seemed urgent to a lot of people, about the genetic health of this isolated population. There's

concern about the genetic diversity of this population; is there a problem? If so, how do we resolve it? This new technology is going to help define the genetic diversity of bears here and everywhere else. As long as everybody is speaking about this only on theoretical levels, we'll never resolve it. My theory and computer model will always be different from your theory and computer model. We now have technology that will get us past that and specifically identify the issues.

YS: Give us an example of the issues.

MF: There are many, and they relate directly to management. Understanding the genetics of these bears is going to help us a lot in studying the bears feeding at these alpine moth sites. In order to know how these bears live, and therefore what is needed for their conservation, we need to know more about their social hierarchy and behavior. If we have a way of keeping tabs on some of them with a GPS, and we know the lineage of these individuals, we can learn a lot.

Once we have a technique for identifying individuals, we can better understand social interactions. Unlike studies that start with an identifiable individual bear and go forward in time through its offspring, we can go backward to that bear's ancestors. Of course the holy grail of the DNA research is that we can extract DNA from any part of the animal, including scat, and the holy grail is to do a nonintrusive, economical, population census than heretofore has been done.

For example, when we see a subadult bear on a moth slope, and that bear moves within 30 feet of a sow nursing her cubs, and the sow doesn't react defensively, what does that tell us about the relationship between the subadult and the sow? At present, all we can do is wonder if maybe the subadult is a former cub of that same sow, and so she isn't threatened by it. Once we get the genetics to the point where we can know the relationships of these bears, and the GPS will help us define their activities and their habitat use, we can apply those things to all kinds of management situations.

YS: Something that used to be said a lot more than it is now is that Yellowstone's grizzly bears have been studied enough: 10 years by the Craigheads, more than 20 by the IGBST, and more than 10 by your Yellowstone Grizzly Foundation. If that viewpoint is still worth arguing over at all, it appears that what you're saying here is that we've only begun to integrate all the different kinds of knowledge we need if we're really going to understand how to protect the bear.

SF: There's even more to it than that. It isn't just trying to understand the bear as we see the bear today. We're trying to understand a bear that's been subjected to amazing pressures in the past century, probably like nothing the species encountered in its previous 10,000 years.

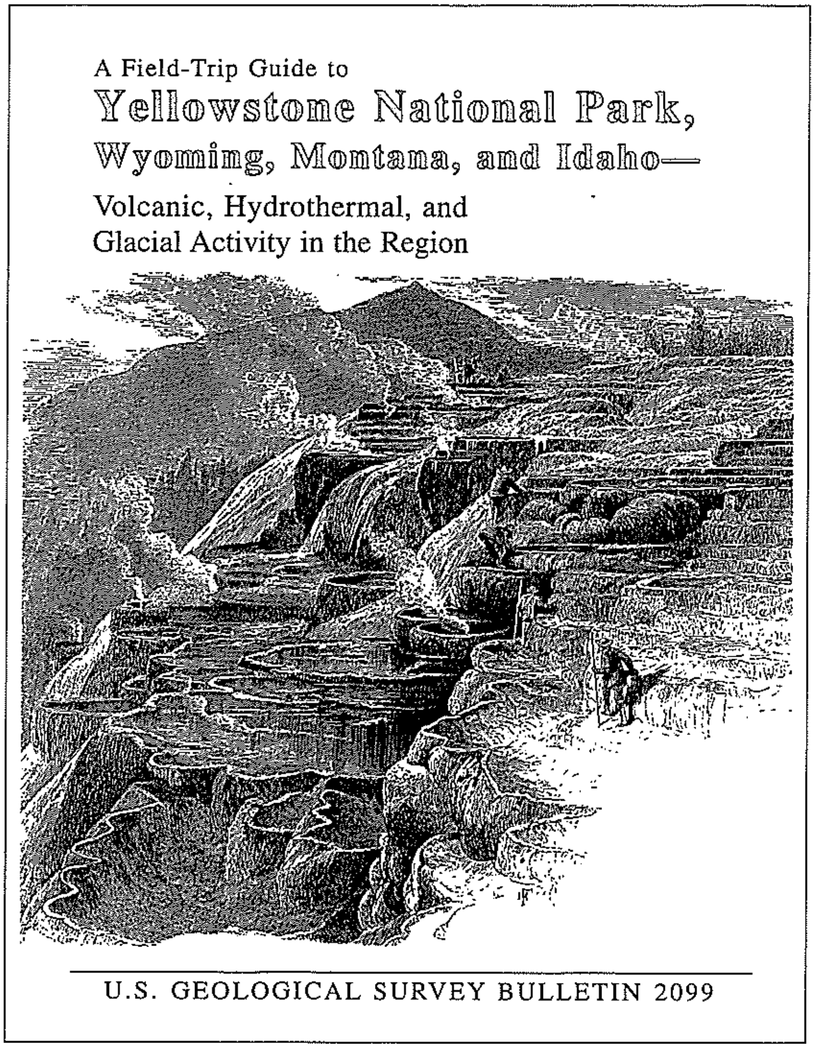
For starters, there's all the change that has occurred recently in this bear population. In the past 30 years, the grizzly bears have gone from a dump-fed population to a free-ranging population, a radical alteration in eating habits and nutrition. At the same time, fisheries management changed and the cutthroat trout population has recovered and is now an important native food source. And now there are lake trout in Yellowstone Lake, threatening to change that food source again, for the worse. Ungulate management has changed completely since the 1960s, from a time when bison and elk numbers were kept very low to a time when they're very high; research by the IGBST and by us has documented how the bears have worked to adjust to those new food sources. It's only been 20 years ago that sport hunting for grizzly bears stopped in the Greater Yellowstone Ecosystem; closing that hunting season certainly changed mortality patterns and may have changed bear behavior. Any one of these things can be regarded as a big shock for a wildlife population, and the Yellowstone grizzly bears have experienced them all at once. We think the bears are still adjusting to those events, and if they do tend toward some equilibrium, they're not there yet.

But then look at it in the long view. Plot out the last 10,000 years of grizzly bear presence in North America, and then plot out the human population on the same time line. The human effects have always been there to some extent, but look at the changes in the past 150 years. I think it would be very naive to assume that the Greater Yellowstone grizzly bear population, after everything we've put it through, has its ecology and behavior all sorted out and is at some kind of equilibrium. We've seen these bears learn and change steadily for the past two or three decades. Why would that stop now?

Grizzly bears should continue to surprise us with behavior we haven't seen before, but it shouldn't surprise us that they continue to surprise us. Whether it's their use of fish or elk calves or army cutworm moths, or whatever is going to happen next that we haven't imagined yet, we will still be in a very dynamic relationship between bears and people for a long time, until we're dead and long beyond that.

Book Review

Field Trip Guide to Yellowstone National Park, Wyoming, Montana, and Idaho Volcanic, Hydrothermal, and Glacial Activity in the Region. U.S. Geological Survey Bulletin 2099. By Robert O. Fournier, Robert L. Christiansen, Roderick A. Hutchinson, and Ken L. Pierce. Washington, D.C., 1994. 42 pages; $ 6 .00 (paper).



Reviewer's Caveat: The authors are friends and co-workers of mine for whom I have the greatest respect.

This field-trip guide was developed for an international symposium on water-rock interactions, an arcane subject, held in July 1992. Emphasis is accordingly placed upon geochemistry and hydrology of Yellowstone's geyser basins. In spite of this focus, the guide is an excellent companion for the park visitor whose interest in Yellowstone geology extends beyond curiosity regarding the time of Old Faithful's next eruption.

Why? Because the authors are first-rate scientists who have spent many years studying not only hydrothermal features but the volcanic and glacial events that produced the Yellowstone we see today. They describe in relatively simple terms what the interesting geological features of the park are, how they were formed, and how they are related. Color and black-and-white photos plus simple maps and diagrams enhance the reader's understanding of the text.

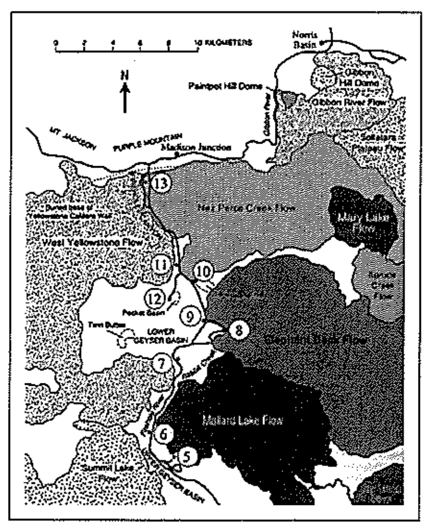
The guide is arranged as a series of numbered stops beginning in Grand Teton National Park and extending around Yellowstone's Grand Loop. Under each stop a brief statement describes the subjects to be discussed. There follows a detailed description. Also, there are beautifully concise summaries of Yellowstone geology. One can read *Introduction To Yellowstone* (pages 3-5) and have a very clear idea of Yellowstone's evolution and why geysers and hot springs are so numerous. On page 12 is a description of how geysers work that is gin-clear and brief; the best I have read.

This is an easy guide to surf. You can skim the pages to find what you need skipping over what you don't. But be warned: when I tried this approach, my eyes were constantly grabbing onto some detail, and I would plunge into the text where I had no intent of being.

The text contains some unfamiliar words, as you would expect, but the authors have snared most of them in the glossary. But not all. Hydrolysis reactions and enthalpy-chloride reactions evaded their net, and I suspect you will find others.

I wish the guide included a map of northern Jackson Hole. Much of the glacial geology described there is almost unintelligible without such a map.

And I think you will find (as I did) that the scientific convention of citing references ad nauseam intrudes upon the communication between writer and reader in an irritating way.



That said, I don't think you will find such a happy combination of technical and nontechnical writing by such knowledgeable authors in a sensible format anywhere in the bookstores of the Greater Yellowstone Ecosystem. Buy it promptly before it goes out of print, as it certainly will.

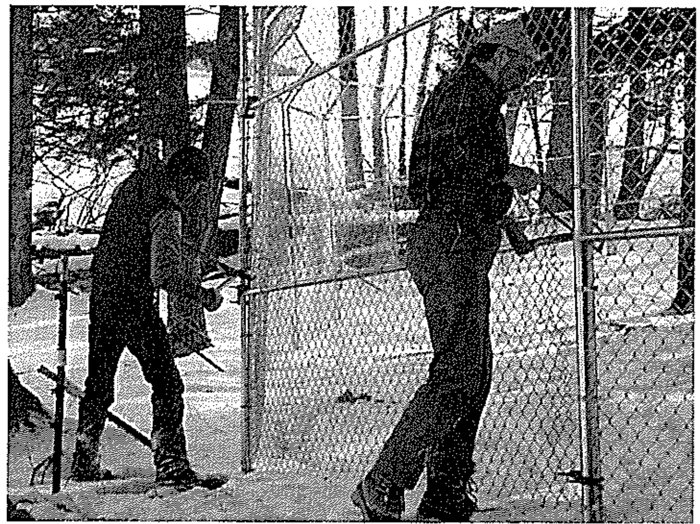
John M. Good
Yellowstone National Park

Wolves Released: Learning Accelerates

In the previous issue of *Yellowstone Science*, we reported the arrival of 14 wolves from Alberta in Yellowstone. Eight were placed in acclimation pens on January 12, and six more were added on January 19. The acclimation period of approximately two months was a time of learning both for wolves and humans. For the wolves, there was a period of a week or so during which they tested and fought the pens (through chewing and digging) until determining that getting through the fences was not possible. For the humans, the arrival of the wolves began a great experimental and educational process, which will continue for the duration of the restoration effort and beyond.

The wolves were usually fed twice a week. A variety of road-killed wildlife (elk, deer, and moose) and wildlife killed in management control actions (bison) was collected for wolf food. The same mule-team/sled combination used to transport the wolves to the pens was used to haul the meat. At no time during the acclimation process was there any indication of habituation of the animals to human presence; they invariably became agitated when people approached the pen, and their obvious inclination was to keep as far as possible from humans.

The wolves showed no disinclination to eat, however, and cleaned up the carcasses quickly. Efforts were made to remove as much of the nonedible material from the pens when the wolves finished, in order to reduce the chance of attracting scavengers. This became a potentially important matter in February, when unseasonably warm weather led to the emergence of some of the park's grizzly bears; radio collared bears were located within a few miles of pen sites, but no tracks of bears were observed near pens. Tracks indicated that mountain lion, coyote, and elk did investigate the Crystal Creek pen, and one other animal investigated a little too closely. On January 31, biologists taking meat into the Soda Butte pen found the remains of a red fox that had somehow gotten in, probably attracted by the meat. This fox became



NPS Photos

Above: NPS Wolf Restoration Project Biologist Doug Smith (left) and U.S. Fish and Wildlife Service Ecologist Dave Mech cutting an opening in the Soda Butte pen.
Right: NPS Wolf Restoration Project Leader Mike Phillips (left) and U.S. Fish and Wildlife Service Northern Rocky Mountain Wolf Coordinator Steve Fritts carrying meat to the Crystal Creek pen site.

the first known predation by Yellowstone's new wolves.

The last legal hurdle for release of the wolves was cleared on March 19, when United States District Court Judge William Downes denied a motion for a preliminary injunction against the release. The motion was filed by James and Cat Urbigkit, concerned citizens from Wyoming, on the grounds that the Department of the Interior did not adequately consider the possibility of an existing wolf population, which might be harmed by the introduction of additional wolves. It has long been the position of the U.S. Fish and Wildlife Service and the NPS that because no pack activity and only isolated possible sightings of wolves have occurred, there was no reason to believe that a resident wolf population existed. This case and two others still pending will go to court later this year, so there are still legal challenges to the freedom of the wolves.

At 3:45 p.m. on Tuesday, March 21, the gate of the Crystal Creek pen (containing six wolves from the first shipment) was locked open, and meat was placed near the entrance to draw the wolves' attention to the opening. Over the next few days, the wolves showed great reluctance to approach or pass through the gate. This behavior was repeated to a lesser extent by the three wolves (two females from the first shipment and one male from the second) at the Rose Creek pen, which was locked open at 4:45 p.m. the next day. Learning from these experiences, biologists did not even try using the gate at the Soda Butte pen (which held five wolves, all from the second shipment); they just cut a hole in the fence right away, at 4:01 p.m. on Monday, March 27. The openings at all three pens were equipped with remote sensors, in hopes that the wolves' departure would be signalled to biologists, who also could track the wolves' movements with the radio collars that all the wolves are wearing.

The wolves' reluctance to rush to freedom the moment the gates were open created a good bit of confusion and even anxiety in some circles, resulting in some unfortunate and uninformed media stories (including one by radio commentator

Paul Harvey) about "welfare wolves" that were accustomed to the public dole and unwilling to fend for themselves. However unjust such remarks may have been to human recipients of welfare, they missed the point of how interesting all this was. The wolves had begun our education.

A number of factors may have contributed to the wolves' hesitancy. Wolves in all three pens tended to avoid the area of the gates even before they were opened, apparently associating that part of the pen with the humans who moved in and out of the gate twice a week with food. The gate, whether open or closed, was still in what the wolves probably saw as the humans' part of the pen. Another factor may have been the wolves' own skill at learning the limitations of the pens when they first arrived. After two months of circling the pens and learning exactly where they could move, it may have taken a few days for the wolves to recognize what the open gate meant. With these thoughts in mind, and hoping to make the wolves' departure from the pens as comfortable as possible, biologists returned to the Crystal Creek pen on Thursday, March 23, and cut a second opening in that pen, near the wolves' "comfort zone" (that area where they spent their time), some distance from the gate.

How wolves perceived the pen became a subject of much discussion among biologists and other staff. These wolves had never been exposed to such an enclosure, much less to any openings in it. As Yellowstone Center for Resources Assistant Director Wayne Brewster observed, "We don't know that they view that hole as a way to go *out*; for all we know they might see it as going *into* something else." And, as Wolf Project Leader Mike Phillips said, "We don't know what the wolves see or whether they even know that the gate is open. We don't know if they know what open *is*."

The more important issue, however, was not the time the wolves spent deciding to leave the pens; it was what that time meant. It meant, the biologists generally agreed, that at least to some extent the acclimation process had worked and the wolves were not inclined to start immediately on a long-distance hike. It was believed to be very important that the wolves be able to make their own decisions when they left the pens. If they rushed from the pen because of human presence, there was fear that this initial "flight stimulus" could increase the chance they would move a long distance.

On Friday, March 24, the motion sensor at Crystal Creek registered a movement through the opening at 9:14 a.m., followed by several others over the next few hours. The group apparently began to move in and out of the pen at that point (wolf project biologists are still referring to the three pens' inhabitants as "groups" rather than as "packs" because they may not really be packs yet; it is not clear how the wolves will sort themselves out socially, and the result may not be the same groupings they had in Alberta).

At Rose Creek, the motion sensor was acting up, and so it was less certain what the wolves were doing (and the sensors were also susceptible to being triggered by ravens or other animals), but for the first two days radio collar signals indicated that the wolves were either in or close to the pen. On Friday, March 24, biologists decided to cut a hole in this pen as well, but as they approached it (carrying a deer carcass to place outside the hole), they saw that the male, wolf #10, was standing on a hillside near the pen. As he saw them approach, he began an extended howl, and, as Phillips said, "when we realized he was outside the pen we dropped the meat and hightailed it out of there."

Within a few days, all three groups had moved several miles from their pensites, but were by no means settled down. On April 3, all but one of the Crystal Creek group were about 5 miles northeast of the confluence of Cache Creek and the Lamar River, and the other, a young male, was still near the pen. By March 30, the Rose Creek group had moved into Gallatin National Forest, about seven miles north of the park boundary on upper Buffalo Creek, and stayed there a few days. By April 4, the young female had moved back south almost 20 miles, and was near the Crystal Creek Pen, while the older female and the male were east of the confluence of Cache Creek and South Cache Creek. The Soda Butte group left the pen about two days after the hole was made in their pen, and spent most of their time along Soda Butte Creek and the Lamar River. This group left the clearest evidence of successful predation, taking and partially consuming two elk. There is no shortage of food, including large numbers of elk and other species, as well as recent winterkills.

And so the wolves are free, and are exploring the area. The longer they do so, the less likely they are to make the long and perilous excursions characteristic of some releases. It is a process of great fascination and considerable suspense; when the gates were open, the restoration process entered a dramatic new phase, in which the wolves make most of the decisions. Every day brings fresh news, and renewed interest in questions only the wolves can answer: Will they stay out of trouble? How will they deal with each other when they meet? Where will they settle? And, though biologists believe that the odds are not good so soon after the stress of being captured and held in a pen—will there be any puppies this spring?

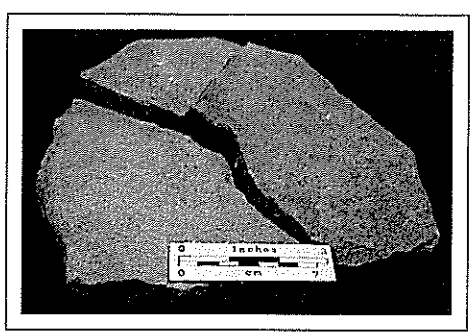
How to Help the Wolves

Public enthusiasm for the wolves has expressed itself in many ways, including a number of unsolicited donations from individuals, and a number of inquiries from people wanting to make such donations. A procedure has been established through which tax-deductible donations may be made; all money will go directly to supporting wolf restoration. Checks should be made payable to the Yellowstone Wolf Recovery Fund, and sent to the Yellowstone Association, P.O. Box 117, Yellowstone Park, WY 82190.

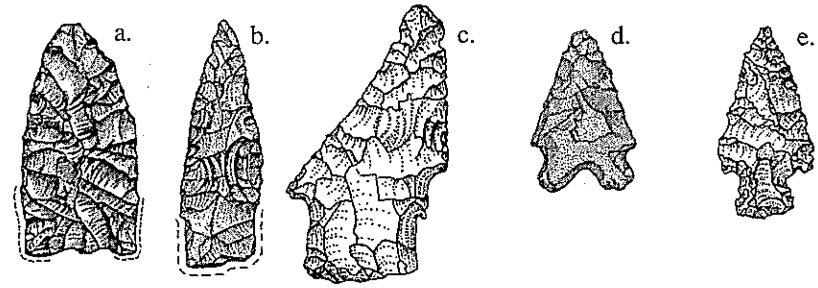
Blood Residues on Prehistoric Stone Artifacts Reveal Human Hunting Activities and Diversity of Local Fauna

The archeological profession has recently developed yet another technique for filling in our understanding of life in prehistoric Yellowstone. Kenneth Cannon, an archeologist with the NPS's Midwest Archeological Center, in Lincoln, Nebraska, writing in *CRM* (This stands for Cultural Resource Management) 18(2) and *Park Science* 15(2), reports that it is now sometimes possible to determine what kinds of animals were being killed (and presumably) consumed by ancient people, through the study of blood residues on their tools. The analysis technique has been developed and is conducted by Dr. Margaret Newman of the University of Calgary. Cannon explains that "the technique used is a modified version of crossover immunoelectrophoresis (CEIP) analysis, used by the Royal Canadian Mounted Police Serology Laboratory (Ottawa) and the Centre of Forensic Sciences (Toronto) for identification of residues in criminal cases."

Analyses of 78 stone tools (points, drills, flakes, scrapers, and a metate, or grinding stone) collected from various spots along the west and north shores of Yellowstone Lake in the past few years resulted in positive results (that is, identifiable traces of blood) from 23. Bison, deer, elk, sheep, rabbit, bear, felid (cat), and canid blood were all identified. The technique will not yet allow for identifying individual species within a group, so that it is not possible to determine, for example, if the bear was a grizzly or black, or the canid was a coyote, fox, or dog.



A sandstone metate, or grinding stone, from near Steamboat Point along Yellowstone Lake, tested positive for elk blood.



Five Yellowstone Lake-area projectile points that tested positive for various mammal species' blood antisera: a) Late Paleoindian obsidian point, 9,000 years BP, tested positive for bear; b) Late Paleoindian chalcedony point, circa 9,000-10,000 years BP, tested positive for rabbit; c) chert Cody knife, about 9,000 years BP, tested positive for bison; d) basalt Oxbow-like point, about 5,000 years BP, tested positive for deer; and e) obsidian corner-notched point, 1,380-1,500 years BP, tested positive for canid. Dashed lines along base of first two points indicates extent of grinding.

These are exciting results for several reasons. For one, they hint at a subsistence based on numerous species. As Cannon wrote, "Diversity of faunal species, in contrast to the bison-dominated Plains economy, appears to be a hallmark of prehistoric mountain economies." However, Cannon tells *Yellowstone Science* that the sample size is too small to be conclusive on this question.

Another reason these finds are interesting is that they suggest yet another way we can learn more about which species of mammals were present in Yellowstone's past. There has been great disagreement and misconception about the prehistoric wildlife of the Yellowstone area, and these artifacts provide a rare glimpse at what animals were present and being killed by humans. Knowing which animals were flourishing also tells us certain things about the plant communities they would depend upon, which suggests the character of the climate at the time, and so every little piece of information is at least suggestive of many other elements of the setting.

A third reason is the nature of the evidence. For example, a sandstone metate, a tool usually associated with the grinding or processing of plant parts, contained elk blood, suggesting it was perhaps used in the making of some sort of pemmican. It also appears that coarser materials, such as sandstone and cherts, may make the most promising preservers of blood. Cannon explained that "the capillary action which embeds the residue in the stone tool may be more effective on coarse-grained materials."

In response to our request for additional information, Cannon provided us with a list of ages for some of the artifacts. These dates ranged as far back as 9,000 to 10,000 years before present (BP) for an obsidian point with rabbit blood, 9,000 years BP for a chert knife with bison blood, and 8,500 to 9,000 years BP for an obsidian point with bear blood. Deer are represented at 2,500, 4,500, 5,000, and 7,000 years BP.

Lake Trout Workshop Offers Harsh Realities

On February 15-17, the NPS and the U.S. Fish and Wildlife Service (USFWS) hosted a special workshop of nationally known managers and ecologists to consider the lake trout crisis in Yellowstone Lake. As readers of our Fall 1994 issue will recall, lake trout, a nonnative fish, have been discovered in Yellowstone Lake, where they pose a serious threat to the native cutthroat trout.

Ecological reverberations through the Yellowstone ecosystem are predicted to be grave, with serious effects on a wide variety of native carnivores, including grizzly bears, bald eagles, pelicans, osprey, and many other species. Equally serious consequences face the regional sport fishery, a multimillion dollar industry, if the lake trout are as effective in decimating the native trout of Yellowstone Lake as they have been in several other large western lakes.

The workshop participants were asked to consider several interrelated questions, including the risk posed by the lake trout and the probable current status of the lake trout based on investigations to date. The workshop, which was chaired by Dr. Jack McIntyre, retired U.S. Forest Service biologist, reached consensus or near consensus on many important points, concluding that the lake trout are well established in the lake, with at least three age classes known (represented by fish of 8, 12, and 17 inches in length), and probably at least a few larger brood fish producing these younger fish. It seems probable, however, that none of the offspring of the largest fish have yet spawned, and when that happens the lake trout population will grow rapidly in size.

The workshop participants concluded that if the lake trout are not suppressed in some way, in 20 years they will cause a 50 to 80 percent reduction in the cutthroat trout, and that if they are suppressed, they will cause a 10 to 30 percent reduction. It was pointed out that in several other lakes where lake trout were introduced on top of native cutthroat trout populations, the native fish were eventually reduced to 10 percent or less of their original numbers. Dr. Robert Gresswell, workshop participant and longtime Yellowstone Lake researcher, said that with no protection for the cutthroat trout, only a relict population would remain, and "in terms of the ecology of the Yellowstone Lake ecosystem, it would be turned upside down."

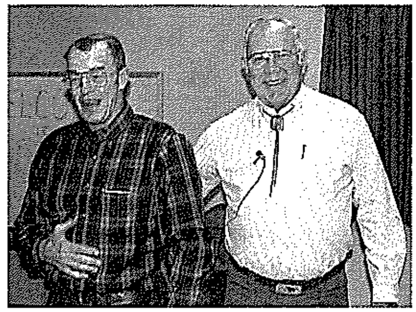
Unfortunately, there is no known way to eradicate the lake trout, so containing them would have to be a permanent fixture in the Yellowstone aquatic resources management program. As McIntyre put it, "It's a forever kind of project." A management plan is currently being developed, and we will report on that in a future issue.

Fire Conference Abstracts Available

For those not willing to wait for the publication of the proceedings of our September 1993 conference "The Ecological Implications of Fire in Greater Yellowstone," the 48-page *Agenda and Abstracts* of this conference is available from the Yellowstone Association, P.O. Box 117, Yellowstone National Park, WY 82190, for $2.95. This booklet, which was given to all registered attendees at the conference, contains the agenda as well as the abstracts of 72 papers presented during the two-day conference.

Jerry Mernin Wins Wilderness Management Award

Mike Murray



Jerry Mernin (left) and NPS Rocky Mountain Regional Director John Cook following the presentation of Jerry's Wilderness Management Award.

Many Yellowstone researchers and friends will be pleased to hear that longtime Yellowstone Ranger Jerry (Gerald E.) Mernin has received the first annual NPS "Individual Champion of Wilderness Management" Award. The award was presented to Jerry by Rocky Mountain Regional Director John Cook on February 7 during the winter Resource Management Workshop at Mammoth.

Among other things, Cook observed that Jerry "has energetically sustained his dedication to the park's backcountry throughout three decades of service in the same park. He continues to be actively involved in a leadership role in the evolution of Yellowstone's backcountry management programs, including minimum impact stock practices and the commercial outfitter program. Perhaps the most fitting tribute to this individual is to say that he is an outstanding example of a long tradition of dedicated backcountry rangers in Yellowstone, dating back to the days of the U.S. Cavalry."

In his nomination of Jerry, Yellowstone Chief Ranger Dan Sholly struck a more personal and equally persuasive note, observing that Jerry's "boots, chaps, and riding tack are comfortably supple from 'experience'; backcountry patrol cabins in his district are well maintained and reliably stocked with Rainier ale; his Stetson flat hat is a little bent from too many October storms; he is known to travel the trails with a box of doughnuts that he 'made himself' and he knows many campfire tales that are not tales at all, but actual events in the history and lore of Yellowstone that he has been a part of."

Mernin, who, it might be added, occupies a similarly important leadership role in the frontcountry of Yellowstone, has been described as having achieved legendary status at an earlier age than any other Yellowstone ranger. He has been a district ranger for the past 17 years, currently serving in that capacity for the Snake River District.

Yellowstone Microbe Conference, September 17-21

Dr. Lynn Rothschild of NASA, Ames Research Center, using isotopic phosphorous to determine DNA replication in the pink filament community at Octopus Springs. Photo courtesy Bob Lindstrom.

Yellowstone has been much in the news about scientific discoveries relating to life in park hot springs, and for debates over the appropriateness of private commercial access to and development of these unusual resources. The first Yellowstone-related conference on these subjects, "Biodiversity, Ecology and Evolution of Thermophiles in Yellowstone National park: Overview and Issues," will be held at Old Faithful September 17-21, 1995.

The growing interest in thermophiles and in the "bioprospecting" associated with them has prompted this meeting, with the specific objective of facilitating research and communication. The symposium will address recent advances in microbial evolution research, microbial diversity and evolution, and biotechnological potential and management of these resources.

Space is limited, so if you are interested in attending or in receiving more information, please contact Bob Lindstrom, Yellowstone Center for Resources, P.O. Box 168, Yellowstone National Park, WY 82190 (307) 344-2234, FAX (307) 344-2211, EMail: Bob_Lindstrom@nps.gov).

Some Recent Wildlife Counts and Surveys

A variety of recent wildlife censuses and surveys are in. The annual early winter elk census for Yellowstone's Northern Range, completed on December 21, 1994, resulted in a count of 16,791 elk. Of these, 5,249 (31 percent) were outside the park. Conditions were not the best for the count, because temperatures were warm and there had been little recent snowfall. The census is conducted by an interagency group, the Northern Yellowstone Cooperative Wildlife Working Group.

Beaver and their activities were also surveyed last year. In the summer and fall of 1994, NPS Resource Management Specialist Sue Consolo-Murphy and Biological Technician Robb Tatum surveyed about 251 miles of riparian areas, including 75 lakes and stream segments in the five major drainages of the park. They reported sightings of at least 20 individual beavers in 13 locations, and 44 active lodges. At least 28 lakes, streams, or stream segments had signs of both current and old beaver activity, indicating to Consolo and Tatum "persistent occupation by beaver" in many of the areas previously surveyed in 1989.

The annual road-kill report is more startling than usual. Motorists in Yellowstone set a record in 1994, killing 148 large mammals. The average for the previous years since 1989, when records were first kept, was 108. The total of 148 amounts to something near a large animal a day during the park's peak tourist months. The most numerous species was mule deer (51 killed), but elk were not far behind (49). Coyotes were third most numerous (19), and moose fourth (12). The statistics suggest that simply being huge is little defense; drivers killed 11 bison. U.S. Highway 191, between West Yellowstone and the northeast corner of the park, accounts for about 7 percent of the park's roads, but 39 percent of the road kills. The second highest road-kill rate was on the Madison to West Entrance Road, and next was the Norris to Canyon Road. The probable lesson is that the straight roads with the faster traffic have the highest kill rates.

Yellowstone Park's Bird Management Biologist Terry McEneaney reports that the 1994 Molly Islands Colonial Nesting Bird Census was conducted in mid-May, early June, early August, and early September. The Molly Islands consist of two small islands appropriately named Rocky Island and Sandy Island at the lower end of the Southeast Arm of Yellowstone Lake.

American white pelicans arrived very late this year, and initiated courtship and nesting immediately upon arrival. On Rocky Island, a total of 147 American white pelican nests were initiated, but only 40 pelican pairs were successful in rearing young to the fledgling stage. Double-crested cormorants, which typically nest on the highest points of the island, fared remarkably well. Only 10 of 80 cormorant nest attempts failed to produce young. Caspian terns also did quite well in 1994. A total of 22 ternlets fledged from 15 nests, while of the 151 California gull nest attempts only 140 pairs were successful in rearing young.

On Sandy Island, a total of 592 American white pelican nests were initiated, but only 90 pelican pairs were successful in raising young to the fledgling stage. Of the 45 double-crested cormorant nests that were initiated on Sandy Island, only 35 of those nesting pairs were successful in rearing young.

There were a number of surprises on the Molly Islands in 1994. There were a record high number of pelican nest attempts, yet the production was relatively low (210 fledglings). The low production could be a function of the low number of cutthroat spawning in the tributaries of Yellowstone Lake this year.

Old Faithful Eruption Interval Increases Again

Rick Hutchinson, NPS geologist in Yellowstone, reports that Old Faithful Geyser's average eruption interval has continued to increase in recent months, and as of December 1994 was a record 79.11 minutes. For most of the park's history, the interval was around 66 minutes, but in the past 15 years it has almost always been more than 70 minutes, rising to 75 minutes more recently. Now, 57 percent of all intervals equal or exceed 80 minutes, and 100-minute intervals are no longer unusual.

Geysers are influenced by a variety of forces. In the case of Old Faithful, earthquake activity (both local and farther off) and changes in water temperature or supply may change the frequency or duration of eruptions.

Amazing as it may seem to people with healthy minds, vandalism is a continuing problem for people concerned with the future of Old Faithful, as a variety of foreign objects have recently been retrieved from the vent.

Plant Conference Proceedings Published at Last

We are inexpressibly relieved to report that the proceedings of our first biennial scientific conference, "Plants and Their Environments," have at last been published by the NPS Natural Resources Publication Office (a branch of the U.S. Government Printing Office). This 347-page volume contains 22 papers and 13 abstracts from the conference, which was held September 16-17, 1991, here at Mammoth Hot Springs.

Those who attended this conference may remember that all people who paid the full registration fee were promised a copy of the proceedings. By the time this issue of *Yellowstone Science* is printed, we hope to have contacted all registrants (or their heirs), and have a copies in their respective hands. If, however, you attended the conference and have not heard from us, please let us know by writing or calling Sarah Broadbent, Yellowstone Center for Resources, P.O. Box 168, Yellowstone National Park, WY 82190 (307) 344-2233.

The proceedings can be purchased by sending $20.00 to The Yellowstone Association, P.O. Box 117, Yellowstone National Park, WY 82190. All proceeds will go to future conference costs.