# Yellowstone's First Millipede

*A small animal illustrates the very large world of Yellowstone research*

by Rowland Shelley

One hundred and twenty-three years after it was established, the world's first national park has recorded its first representative of the arthropod class Diplopoda. The Arthropoda, the largest animal phylum, includes invertebrates with jointed appendages and exoskeletons; the five major classes are the Crustacea (shrimp, crab, lobsters, and many small freshwater and marine organisms), Insecta (insects), Arachnida (spiders, scorpions, ticks, mites, etc.), Diplopoda (millipedes), and Chilopoda (centipedes). Insecta, Arachnida, Crustacea, and Diplopoda are now known from Yellowstone (the first representative of Diplopoda is described below), although they are inconspicuous in contrast to the large, prominent vertebrates that are obvious to visitors.

This leaves the park without a centipede, and in an effort to close this void, I ransacked my reprint files searching for a published record from Yellowstone. I finally found *Nadabius vaquens* Chamberlin and Wang (1952), described from a single male collected on August 13 , 1940, at "Mt. Washburn, Yellowstone Park, Wyoming." Mt. Washburn, at 10,243 feet, one of the highest points in the park, is in the north-center of the park off the north loop road about midway between Tower-Roosevelt and Canyon Village. Yellowstone is therefore the type locality for this small centipede species, and to the best of my knowledge *N. vaquens* has not been reported or collected again. The location of this specimen is unknown, and it may be lost. It is not listed on the printout of chilopod type specimens at the National Museum of Natural History, Smithsonian Institution, Washington, D.C., the largest centipede repository in the Western Hemisphere, nor those of other major repositories including the American Museum of Natural History, New York, or the Museum of Comparative Zoology, Harvard University. If the specimen is indeed lost, a chilopodologist will eventually have to collect another male on Mt. Washburn, of course with permission of the park staff and a collecting permit, to establish the identity of this species.

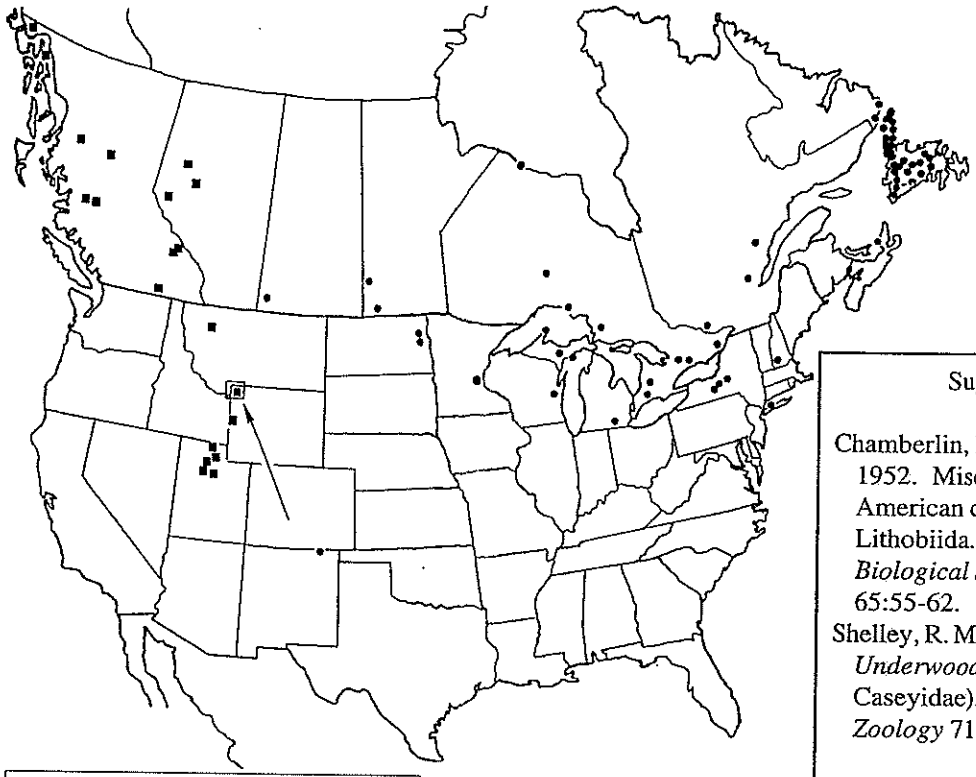
Millipedes and centipedes are closely related, as their bodies are composed of a head and numerous trunk segments; however, they differ in many features, most conspicuously the number of legs. Adult millipedes have from 34 to 750 legs (17 to 375 pairs, the high number occurring on a California species), with two pairs or four legs on most segments; adult centipedes, however, have from 30 to 382 legs (15 to 191 pairs), with one pair or 2 legs per segment. Millipedes feed primarily on decaying plant material, while centipedes are carnivores and prey on smaller organisms, particularly insects. Millipedes are harmless and defend themselves with a variety of noxious chemicals secreted by defense glands on most segments. Centipedes, however, inject poison into their prey by means of "poison claws" located beneath the head. Some centipedes in the southwestern American deserts grow to 6-8 inches and can deliver a painful bite, but *N. vaquens* and the other species that may be anticipated in and around Yellowstone are too small and weak to pierce human skin.

More research in the park in recent years has focused on the smaller organisms of Yellowstone's ecosystems, for example such insects as beetles, ants, mosquitoes, and mayflies. I now announce the discovery of *Underwoodia tida* Chamberlin (it has no common name), which was formally published in my generic revision in 1993. Almost surely, no tourist or casual visitor will ever see this cryptic millipede, and rarely will park rangers even find it; however, it is as fundamental to its niche in Yellowstone's environments as the bison and elk are to theirs. Four female specimens of *U. tida* were collected at an unknown site in the park on August 23, 1957, by Dr. H. S. Dybas and deposited in the holdings at his institution, the Field Museum of Natural History, Chicago. In contrast to the many large, colorful American millipeds, *U. tida* is small and inconspicuous, being about 1/4 inch (6-7 mm) long and a drab mottled brown in color; it has approximately 102 legs (51 pairs).

The habitat in which the Yellowstone specimens were found is not indicated on the label in the vial, but *U. tida* has been encountered elsewhere in moist leaf litter near streams, under rocks, and under fir logs in relatively dry meadows. Its distribution extends from the Rocky Mountains to the Pacific Coast in Canada and southern Alaska, the northernmost sites being in the extreme northwestern corner of British Columbia, nearly in the Yukon, and in Jasper National Park, Alberta; the species ranges southward down the Rockies into the lower 48 states, the southern limit being the Wasatch and Oquirrh Mountains near Provo, Utah.

Although a substantial millipede fauna exists along the Pacific Coast in the north-

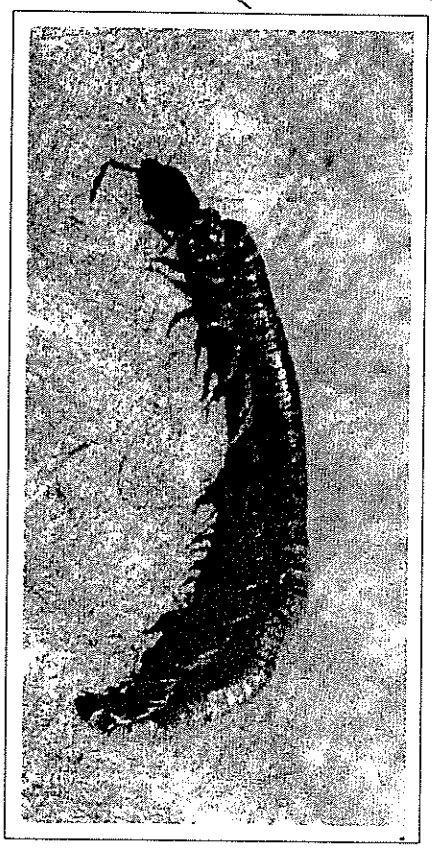
*Distribution of* Underwoodia *in North America. Dots,* U. iuloides*; squares,* U. tida. *The Yellowstone record is denoted by the arrow. Map courtesy of Rowland Shelley, North Carolina State Museum of Natural Sciences.*



Suggested Reading


Chamberlin, R. V., and Y. M. Wang. 1952. Miscellaneous new North American centipeds of the order Lithobiida. *Proceedings of the Biological Society of Washington* 65:55-62.

Shelley, R. M. 1993. The milliped genus *Underwoodia* (Chordeumatida: Caseyidae). *Canadian Journal of Zoology* 71:168-176.

*Female specimen of* Underwoodia tida. *Photo courtesy of D. J. Lyons, North Carolina State Museum Exhibits Designer.*

western United States and southwestern British Columbia, the faunal diversity increases dramatically as one moves southward into warmer climates of the United States and, ultimately, the neotropics. *Underwoodia* is therefore an exception to this rule in that it is more common in the north and one of the few truly boreal diplopod genera in North America. It occurs in a broad band across the northern United States and Canada from the Atlantic to the Pacific (see map), and it exhibits a trans-Beringian distribution pattern as it also occurs in the easternmost part of Asia. *Underwoodia iuloides* (Harger), the other North American species, extends eastward from the Rockies to the Atlantic Coast in New England and the maritime provinces of Canada. It is the most abundant native millipede in Newfoundland, and its northernmost records are from southern coastal Labrador and the south shore of Hudson Bay in northern Ontario. The southernmost locality, surprisingly, is in northeastern New Mexico, over 1,000 miles from the closest known site, in North Dakota. The third species, *U. kurtschevae* Golovatch, occurs widely in the Russian Far East, including the area around Vladivostok, Sakhalin Island, the Kurile Islands, and the Kamchatka Peninsula.

This discovery also reveals the diffuse nature of Yellowstone-related research. My field sampling, sponsored primarily by the National Geographic Society, has covered much of the western United States and Canada, and most of the distributions of the millipedes that can be anticipated in Yellowstone. As part of this research, I surveyed all known collections in both countries and discovered the Yellowstone specimens in the Field Museum holdings. Dr. Dybas, an entomologist, collected the millipedes incidentally 38 years ago while on a collecting trip, and they had resided undiscovered in the Chicago institution until I found them in a small vial that was buried in a large jar with dozens of vials of miscellaneous millipedes. This discovery of a new animal for Yellowstone was made not in the park, but in a building hundreds of miles away.

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*Yellowstone Science Interview:*
*Sam McNaughton*

# Grazing and Yellowstone

*Renee Evanoff*

*For the past several years, Dr. Samuel J. McNaughton, a professor of botany at Syracuse University, has been leading studies of various aspects of the ecology of Yellowstone's Northern Range. Dr. McNaughton's long experience with the grazing systems of Africa's Serengeti has resulted in many important publications on ungulate-plant interactions there, making him a recognized leader in the ecology of such systems. He was interviewed by* Yellowstone Science *during the park's biennial scientific conference at Mammoth Hot Springs in September 1995.*

*YS*: A perennial hot topic here in Yellowstone is overgrazing. You've now put in several years directing research projects on the park's Northern Range, so you've had time not only to watch this debate, but also to participate in it. A memorable part of your participation occurred in 1991, at our first scientific conference, when you were a keynote speaker.

One of the questions from the audience went something like this: "Dr. McNaughton, based on your research with large grazing systems in Yellowstone and the Serengeti and Argentina and those other places, do you consider Yellowstone's range overgrazed?"

*SM*: And as I recall, my answer went something like this. Based on the ecosystem standards—that is, by the standards of the processes that are going on, in terms of primary productivity of rangelands and the amount that is consumed by the elk and bison—I do not. Because, although people have said that Yellowstone is not the North American Serengeti, in terms of the level of consumption it is very similar to the Serengeti.

So you actually could say that Serengeti is Africa's Yellowstone, or, Yellowstone is North America's Serengeti. I think

they're very similar.

*YS*: Did you decide to do research in Yellowstone because it was similar to the Serengeti?

*SM*: In a way. The reason I came to Yellowstone was an idea. It was an idea that was born of ten years of research in the Serengeti. In my experience with the African grazing systems, I learned that the large native grazers, by that I mean the wild large mammals, don't trash out the system that they depend upon. Yet the history of *domestic* large mammals all over the world is that they *do* trash it out.

The fundamental problem in all rangelands is what is elsewhere called "bush encroachment," which we in the United States call "brush invasion." The best example of that in our history was in the southwest—in Arizona, New Mexico, and western Texas in the late 19th Century. Settlers introduced large numbers of livestock onto what really were pretty lush grasslands. Then the bottom fell out climatically. The herds weren't reduced by the people who managed them; they were reduced by death, but not before they had trashed out the entire Southwest. And the record is very clear: livestock grazing turned those decent desert grasslands into mesquite bushlands.

Now, here's the idea that brought me to Yellowstone. Why hadn't elk, which people purported were overpopulated in Yellowstone, and bison, which people also purported were overpopulated, trashed out the park's rangelands? Well, that is what I came here to try to find out.

*YS*: The very fact that someone said that Yellowstone's rangelands weren't trashed out made quite a few headlines in 1991; it's still pretty widespread "common knowledge" that Yellowstone is overgrazed.

*SM*: But the graduate students who have worked with me have provided plenty of evidence that these grasslands are holding their own just fine under all this grazing pressure.

*YS*: But have they answered your question of why the elk and bison aren't doing to Yellowstone what the cattle did to the Southwest?

*SM*: They have provided evidence to suggest that the difference between livestock use of land and wild ungulate use of land has to do with mobility and timing. Livestock only move when humans move them, and humans decide when and where they will move. Wild ungulates have coevolved with their range, and they follow its productivity in a much more complex way.

Here in Yellowstone, the elk follow the productivity of the grasses up the slope. Douglas Frank, who was my first graduate student to work here, described the springtime plant productivity as a "growth pulse," in which plant greenup moves uphill, with the ungulates tracking it for the best forage, all the way up to the high country, which is their summer range.

*YS*: Livestock don't generally get to move that freely.

*SM*: No, ranchers can't work like that. They have summer ranges, say on lands leased from the B.L.M. or the Forest Service, and they do move their stock up there, but two things are different. One is the level of stocking, which is much lower in wild herbivores than it is in livestock. Look how dispersed Yellowstone elk are in the summertime. The northern herd, which is packed into a relatively small low-elevation area in the park and to the north of the park in the winter, spreads out across the whole northern half of the park, and clear down to Yellowstone Lake. Their summer range is huge. On the other hand, livestock tend to be more condensed on their summer ranges, and one of the consequences of that clumping of animals is lots of bad effects: they consume too much from a given location, and they trample too much. This isn't to take a cheap shot at the livestock industry; what they are doing works for them. But their use of the range does not mimic the kind of use that the range evolved to handle best.

And the second difference is the responsiveness of the animals. These wild animals have evolved to track this productivity in a way that is beneficial to them. But we as human beings don't do that when we're herding our livestock. We know roughly when the summer forage will be good, but we don't know it as well as the elk do, and we lag behind as these wild animals track the waves of vegetation productivity and quality. The elk are on it just at the right time to take the best advantage of the volume of it, and the peak nitrogen and mineral content of it. And that is the thing that we haven't learned yet.

*YS*: What made you curious about Yellowstone?

*SM*: Well, of course I heard people talking about Yellowstone having too many elk and bison, and how the range was being trashed. But I thought about it, and said, "Now wait a minute; I don't see all this brush coming in and invading the range in the park."

*YS*: No, in fact Yellowstone is experiencing just the opposite—brushlands are declining, if anything.

*SM*: Right. But that's not how overgrazing goes. In the classic overgrazing scenarios, the brush comes in. That's the story of overgrazing everywhere. I've seen it in Australia, I've seen it in Africa, I've seen it everywhere. If you have overgrazing, what you have is brush coming in, and it knocks out the food source of the ungulates. So I wondered, why isn't that happening in Yellowstone?

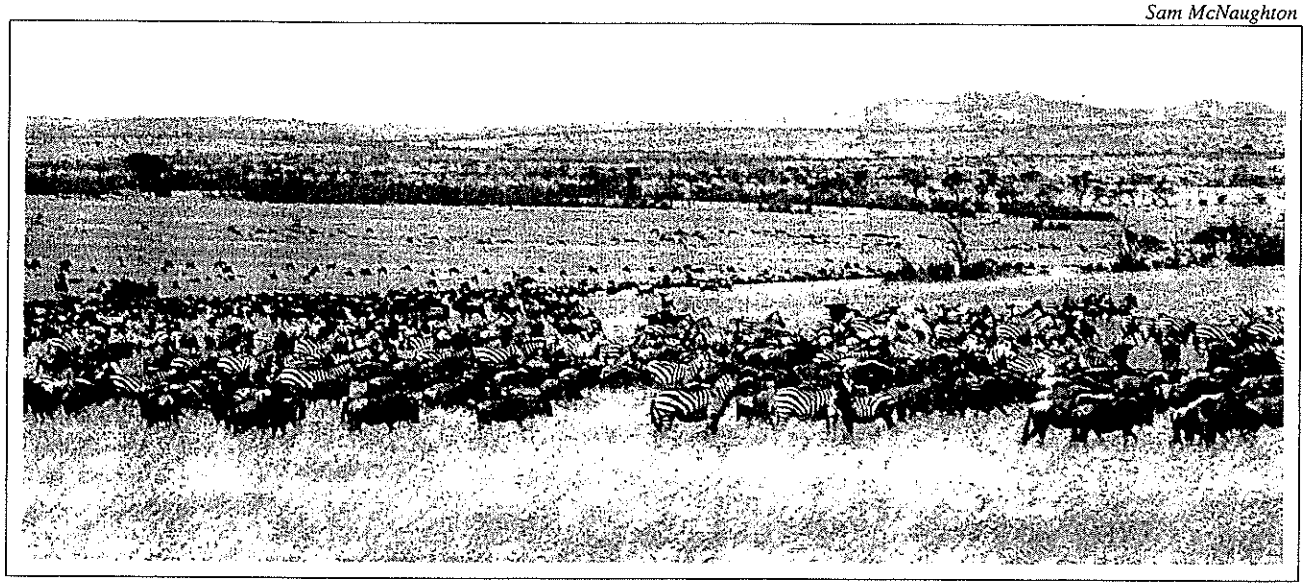
I'm a plant ecologist, but I'm also an ecosystem ecologist. To me, the point is the ecosystem. Is the system functioning, or are things breaking down? Is plant productivity deteriorating? Are we getting an invasion of unpalatable plants, or breaking down mineral processes and soils so that the rate of nutrient recycling is going to pot? That's what I'm looking at. And I don't see that in Yellowstone. Therefore, as a grazing system, this is a healthy one.

*YS*: But what is happening out on the Northern Range is very complex. Willow and aspen have undergone a well-advertised decline, if not in abundance at least in height.

*SM*: Willow and aspen are good examples of how we need to examine the context of this place if we want to understand what's going on. What are the contrasts here? What should we look at? What should we examine in order to test for that purported deterioration we hear so much about?

Many people say that the elk are damaging willows along the streams, and that they're knocking out aspens. Well, maybe, maybe not. But, just because a willow is hedged by elk browsing it doesn't necessarily mean something is wrong with the system. In fact, that willow's growth rate and rate of forage production may be higher than it would be if it *wasn't* hedged.

Sam McNaughton



*Serengeti*

I don't have the answer to that because I don't study willows. But I think that people who make that sort of case ought to examine it in the context of ecosystem processes.

It's just not reasonable to say that because a willow is hedged, therefore something is wrong. The grasslands are hedged, too, right? But we call that grazing. We expect it, and the studies I've been involved in here don't indicate that it's causing the grasses to be in poor health. Just the opposite: the evidence indicates that hedging keeps the grass at a growth stage that has a higher productivity and a much higher forage quality, and still stabilizes soil processes. These heavily grazed grasses in Yellowstone are producing more forage, and better forage, than they would if we knocked all the elk out of here and had grass that was waist high.

*YS*: Except for gardeners and the people who work in wildland range ecology, there apparently isn't much appreciation for how plants respond to "predation" by grazers, and how many factors there are that influence that process. What studies like yours show us is that plants are active players in the process, having evolved literally in the teeth of heavy grazing pressure. But what they also show us is that there are a lot of subtle factors involved in keeping the system running.

*SM*: When I first went to the Serengeti, I went into the Chief Park Warden's office and I said, what would you like to know from my research? And he said, well I'd like to know what the carrying capacity of the Serengeti is for big mammals. Now keep in mind that until I went to the Serengeti, I'd been a lab guy. I was grinding up plants and that sort of thing, with a white coat on. And all of a sudden I looked out the window, and thought, whoa, what am I doing in here? So I left the lab behind and got out in the real world of the Serengeti.

But even when I got there, I had this total disdain for natural history. I thought if you couldn't put a number to it, you didn't know it. But very quickly the Serengeti taught me that though there are lots of things here that I can know, I'm never going to be able to attach a number to them. But I hadn't learned that yet, and so my response to the Chief Park Warden was, no problem, I'll be back to you in a year with the answer to that question. I know it doesn't sound very intelligent, but I understood quantification, and I figured, okay, it rains a certain amount, and the soil has a certain fertility, therefore the grass would grow so much and the animals could consume so much. From that information we can simply compute the carrying capacity. This is arithmetic, right? We can just sit down in the lounge and work this out with a pencil on a napkin. No problem.

Then I did my first experiment. I put up a fence around an area that large mammals had grazed, and another couple of fences around where they hadn't grazed. My first insight: vegetation was regrowing at a tremendous rate where they'd grazed, but where they *hadn't* grazed it's all senescing out and turning into dead plant tissue and litter. Well, this sort of changes things. I mean, this is not what I'd expected it to do. So, I went to work on this, and asked what's the regrowth potential? And it turned out that the regrowth potential is pretty substantial.

What Ben Tracy, the current graduate student, has been working on here in Yellowstone, 22 years later, is nutrient recycling—that is, how the energy in the grassland system moves from the ground to the animals and back to the ground again. Here's what the mammals do. They eat forage that, if they didn't eat it, would turn into dead stuff with low nutritional quality, with a slow rate of decomposition that would cause it to accumulate in the grasslands. When they eat that forage, they turn it into nutrients that they recycle through feces and urine, and that sets the stage for regrowth. The regrowth may not happen right now; it may happen next season. And that's what's going on here. One of the things that Doug Frank showed is that the forage on the Northern Range, which is winter range, regrows much better if it's been grazed than if it's been fenced.

*YS*: Why is that?

*SM*: Well, if it's not been grazed, you get

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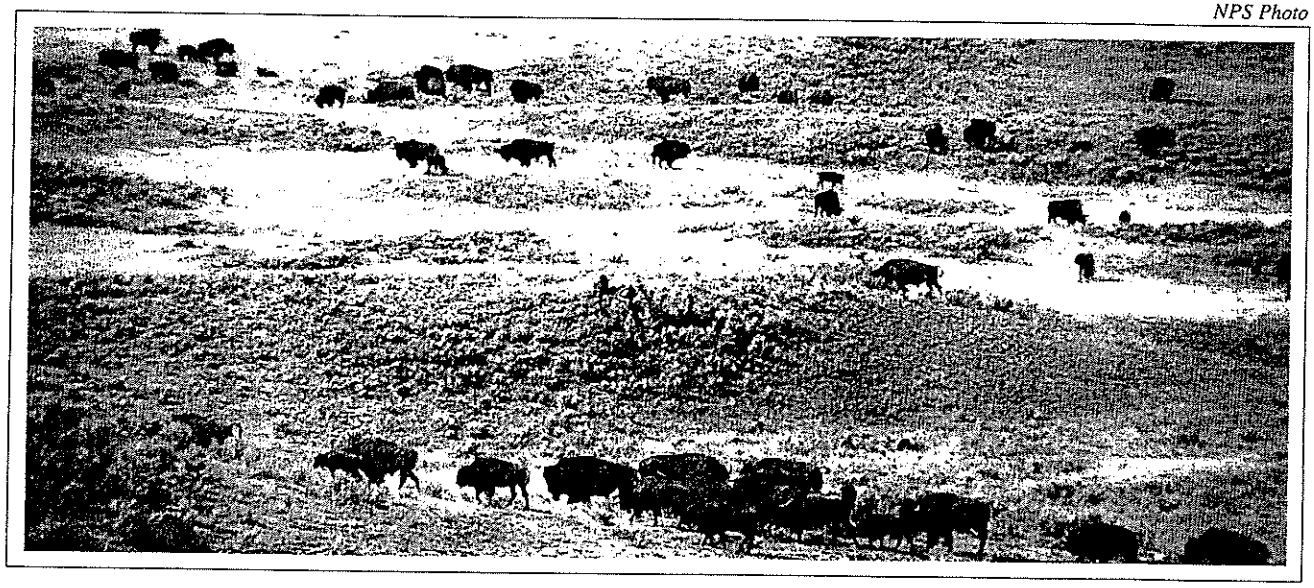


*Yellowstone*

all this buildup of dead stuff, right? It shades out the developing plant tissue, and no nutrients get recycled by the grazing ungulates. The result is that everything sort of stagnates. There's lots of evidence that grazing enhances plant growth, but a lot of people are unable to accept that lack of grazing in the grasslands that are adapted to grazing leads to stagnation of those grasslands. Only two things will prevent that stagnation, and get the system running again. The grassland either goes through ungulates or it goes through fire. One of the two.

*YS*: One way or another it's going to get its nutrients recycled?

*SM*: Right, and I think that I'd rather see it run through a process that turns it into biomass of ungulates.

*YS*: One of the interesting aspects of Doug Frank's description of what ungulates do to a range had nothing directly to do with what they eat. He pointed out that not only do ungulates run plant matter through their system, or recycle it, as you put it, but also they actively affect the whole plant environment. The example he used was that elk, simply by walking around on the soil, "tiller" the surface with their hooves.

*SM*: That's right. The problem is that everybody tends to think that grazing operates like a lawnmower; it just cuts the tops off the plants and has no other effects. But that's not how it works at all. The animals are doing all sorts of stuff out there. They're walking, they're laying down, they're urinating, they're defecating, and everything.

*YS*: Their actions are rearranging the whole top layer of soil and life.

*SM*: Right. It's not like these animals are just out there chomping down plant material and sending it to Philadelphia. They're eating it and then recycling it, every day, all the time they're on the range.

*YS*: Our friends in commercial range management come to Yellowstone now and then, look over the Northern Range, and very confidently announce that "This range shouldn't look like this." Then they point at some intensely managed commercial range somewhere else as the ideal to which we are not measuring up. When you ask them how they know what it should look like, they refer you to their professional standards, which are based on a long experience with the best way to get the most livestock growth from the land. They can tell you in inches or centimeters how tall the various grasses should be. These are bright people, too; no one can say they haven't worked hard to get their standards. They just can't see why Yellowstone should be different.

*SM*: You know, "should" is a very dangerous word in resource management. If you say it should look a certain way, you're implying that you have a basis of comparison with some presumably right appearance for the Northern Range. In order for me to know if their "should" is somehow the right one for Yellowstone, I have to know the context in which they define it.

I'm really a processes person. An ecosystem has both a state and a process. State is what you see out there on the ground at any given time. Process is what happens as the ecosystem changes from one state to another. If somebody tells me that it "should" look a certain way, then they are going to have to explain to me what the processes are that lead it to that state, and why the processes must lead it to that state instead of to some other state. Otherwise, I have no basis to evaluate their judgment on.

*YS*: So far, much of the conversation between Yellowstone's range ecologists and managers on the one hand and commercial range ecologists and managers on the other has been pretty dysfunctional. Yellowstone people object to having commercial range standards dictated to the park because they don't think that a wildland range, with a full assortment of wild ungulates, necessarily will look anything like a carefully managed commercial range that feeds only livestock. That isn't to say there's something inherently wrong with either approach; only that they are very different in what they want to achieve. Yellowstone researchers say that native ungulates don't follow the same rules as livestock, and don't treat their range the same as livestock do. But we've actually had commercial range

people respond to that by saying, well that may be true, but the Northern Range still shouldn't look like it does. It's as if the two groups talk such different languages that they can't even communicate any more.

*SM*: This is like someone looking at the painting "Starry Night," and saying, hold on, starry nights don't look like that to me! So, what's happening here? Unless the people who have a particular definition of "should" can tell me how they got to that definition, that the state they prefer is the correct state for the range, I can't deal with it. If they can tell me the processes that lead to their "should," and why I must believe that it's the right "should," then we're going somewhere. Then I can say, okay, maybe Van Gogh had some vision problems or something. Otherwise, I can't help them.

*YS*: Another engaging dialogue over Yellowstone's grazing system revolves around the question of whether or not it's like the Serengeti. Those who say it isn't emphasize the far greater number of grazing species on the Serengeti. Can you explain that disagreement?

*SM*: The Serengeti is tropical 1,500-meter elevation system, in an area that there weren't all the Pleistocene extinctions that affected North America. Sure there are more species in the Serengeti, and those species obviously do different things. Yellowstone doesn't have that diversity of grazers. There are no giraffes here in North America, and no elephants. Maybe it'd be good if you had some elephants knocking down some trees once in awhile, but you don't; the North American mammoths are gone. But process-wise, in terms of the productivity of this system—a mountain plateau, in the north temperate zone, with a severe climate and high levels of consumption by herbivores—it is exactly the same. Compared to the Serengeti, it may have lower productivity and lower consumption, but it is fundamentally on the same trendline as all the African data that we have.

Now, people say there's no predators in Yellowstone like in the Serengeti, but there are lots of predators. You just have to go down to Gardiner during hunting season: there are elk predators and there are bison predators right outside the borders of the park. Now, we've got the wolf back, and something is going to happen. We don't know what, but it's going to be something important. Either wolves are not going to have an impact, which is interesting, or they are going to have an impact, which is also interesting. So this is a grand experiment. I mean I can't think of another experiment like this in a national park, where a major predator has been reintroduced. Can you?

*NPS Photos*

*YS*: No, not like this. It's the first time a large predator has been returned to a western park.

*SM*: Look at the world as a whole. I can't think of anyplace in the world where anybody has ever done this, where they've taken a big predator, and said we're going to put this back in and see what happens.

*YS*: Do you care to speculate on how it will go?

*SM*: Well, I think they're going to kill a lot of elk and bison, but I don't think those animals are predator limited. I think you'll still have a lot of elk and bison.

*YS*: But there are already a lot of predators here. The coyotes and grizzly bears kill a third of the new elk calves every year. Grizzly bears, black bears, mountain lions, and coyotes all prey on the ungulates. Some of us wonder if there's already so much "background noise" in the predator-prey system, with all these predators and all these prey species, that it will be very difficult to sort out what difference the wolves really make in the ungulate populations.

*SM*: I think that's right.

*YS*: In fact, the environmental variables facing any life form in a place like Yellowstone—a large, relatively wild area—are so complex that, as you suggest, even predation might sometimes be only a minor factor. If Yellowstone ever returns to what used to be thought of as normal winters, the ungulate numbers are going to drop considerably, and it's predictable that the wolves are going to get the blame.

*SM*: You've already seen that. After the fires of 1988, when something like 40 percent of the northern elk herd died either from hunting or from winterkill, people tended to blame the fires, but the fires had less to do with it than the return of a real winter. Ungulates count heavily on good grazing in order to build up their reserves. If they don't get that good grazing, they're in trouble, and a lot will die in the lean season that follows.

*YS*: That has always been controversial in national parks; people like the idea of a wilderness reserve, but they don't want it to be quite so wild that nature takes a significant toll in dead animals.

*SM*: I don't think there's anything wrong with animals starving. It's part of the way the system works. Some people don't like to see it, but that's the way nature is.

*YS*: It's also nature's way of responding to the elk "overpopulation problem" we hear so much about.

*SM*: Maybe what the parks should do about this whole controversy about there being too many animals is ask the people. Well, it's their park, right? It's one of our society's best ideas, a real work of genius. Maybe we should let the people vote. Tell them what the options are, and what the consequences of those options are as well as we know them. Then hand them a questionnaire at the entrance stations and ask them: do you want to see more elk, or more wolves? Do you want your biomass in willow and aspen, or in elk and bison?

*YS*: Is that what it comes down to? Are the choices really that simple?

*SM*: Not really. I was speaking rhetorically, to suggest what the basic elements of the system are. I don't think we have to choose absolutely between the ungulates and the vegetation. The system will make those choices for us if we let it. It looks to me as if the vegetation *and* the ungulates are doing pretty well out there.

*YS*: Sometimes Yellowstone is presented to its constituents as if its problems are unique. What about these other big grazing systems like the Serengeti; do they have this debate?

*SM*: Oh, absolutely! Everyplace I've been, there are two diametrically opposed

views about national parks or other reserves. One view says let the system operate as independently as possible, and the other view calls for total intervention. The South Africans have done very well at intervention. They have parks bigger than Yellowstone, bigger than Serengeti, totally fenced. Nothing can get in, nothing can get out, and they have quotas for everything: how many kudu there should be, how many wildebeest there should be, you name it.

*YS*: There's that word "should" again.

*SM*: Right. Only their control is so absolute that they often can make it work the way they want it to.

*YS*: How did *they* decide what was right?

*SM*: I have a theory about that. I think everybody tends to want their reserve to be the way it was when they first saw it.

*YS*: That certainly was the prevailing standard for most parks in the United States for a long time. It was assumed that we should preserve them in the form they were when white people first saw them.

*SM*: But historical standards don't work either. You can track down the first photographs of Yellowstone, from 1871, and study them, and say, okay, here's what the photos show us about vegetation and wildlife, so it's our job to make it that way. We have to arrest things in that state. But not only is that against the laws of nature, it doesn't make any sense. The world isn't like it was in 1871. The climate is not the same. Everything has changed.

Let me tell you about Kruger National Park in South Africa, the best-managed national park in the world, or at least the most intensively managed. Some years ago, the wildebeest population got too high, at least according to the management targets, as they call them, and so they started killing wildebeest. Eventually, they got the wildebeest back down to the defined target, so they stopped shooting them. But the wildebeest numbers kept declining, and got below the lower end of the acceptable numbers as defined by the management target. So to correct for it, they decided they'd better go out and shoot some lions, so that predation on the wildebeest would ease off. But even after that, the wildebeest continued to decline. Well, eventually what they discovered was that the wildebeest population is anticyclic with the wet and dry periods. During dry periods, the wildebeest increase, and during wet periods, they decrease. The wildebeest had their own targets, and we just didn't understand them. It had little to do with the lions. And that's the thing; there are always hidden things in nature.

The point is that we have to be really confident that we understand what's going on before we start interfering. If we make the decision that the range is degraded in northern Yellowstone, we'd better be very clear about what the new targets are. I don't see clear alternatives emerging from these viewpoints that say there are too many elk. I mean, I see a lot of hand grenades coming across the transoms of the park's managers, but there's nothing especially constructive there in terms of justifying another approach.

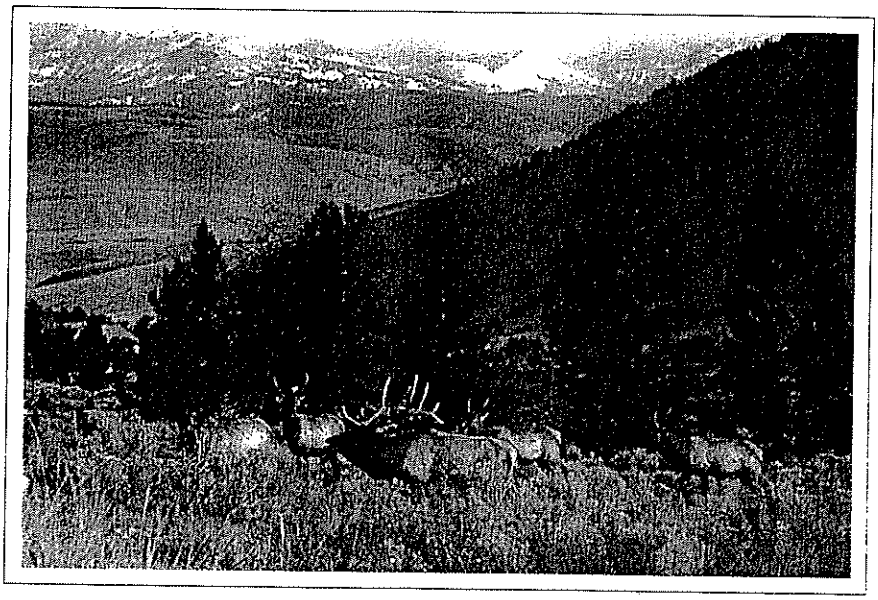
*YS*: Some say that Yellowstone's whole history can be seen as a big, kind of undirected experiment, where we have to do a great many things wrong to learn the right way to do it. We suppressed fire, we killed predators, we stocked exotic fish, we slaughtered thousands of elk, pronghorn, and bison, or we fed those same animals, and each time we eventually learned that in some way our actions were a mistake. Other people think we now know enough to decide to take such aggressive actions all over again, and insist that we do. Looking back on all this unintentional experimentation, and what it's brought us, and considering what your studies have shown, do you think we as a society are getting better at this? Will we ever really figure out what we "should" do in national parks?

*SM*: Hold on! Don't forget that you're talking to a professor here. Do you know what professors do? We profess! I have to believe that we're getting better!

*YS*: Well then, assuming that we are learning, what could we do to make the process by which we decide what to do next less painful?

*SM*: It would make a big difference if we could take the rhetoric out of it. That's the problem. It's those people who say, "This is what it should be," but without a sufficient basis to justify it. There's the problem, and this is what education fights. "This is what it should be." "But why?" "Well, because I say so."

The real challenge that park managers face is that the problems involved with the elk, however anyone defines those problems, have to be faced now, even though your information may be incomplete. I don't have to face that; I just profess. Your critics don't have to face that; they have the luxury of standing back and pointing out what you "should" do with no real risks to themselves. Like my experience on the Serengeti, there were a whole lot of things I knew about, but I didn't know well enough to put numbers on them. Whether you have numbers or not, you have to decide what to do.



### Wolf Restoration to Continue if Budget Negotiations Allow

As of mid-December, plans were underway to continue wolf restoration in both Yellowstone and central Idaho this winter. Because of cuts in federal funding, a combination of private and federal funding will support the capture and transport of wolves from Canada to both areas, following procedures developed and successfully tested last winter. As of early January, though the second furlough of federal employees had ended, it was not clear if funding would be provided to the U.S. Fish and Wildlife Service for this project.

This year, efforts to capture and radio collar Canadian wolves will be focused in northeastern British Columbia (last year's wolves were brought from Alberta). Then, in January, Canadian and U.S. Fish and Wildlife Service biologists will capture wolves from the packs previously located in December, radiocollar them, and relocate the collared wolves (approximately 30 of them, from several different packs) following the same release procedures as last winter. The wolves released in Idaho will again be "hard-released" (without a period of acclimation in a pen), and the Yellowstone wolves will spend up to ten weeks in acclimation pens prior to release.

In late summer and early autumn, park staff again prepared the acclimation pens. Two of last year's pens, at Rose Creek and Crystal Creek, were repaired and left in place, while the Soda Butte pen was moved to the Blacktail Plateau, and a fourth pen was constructed near Nez Perce Creek, a tributary of the Firehole River in central Yellowstone. Biologists are concerned about placing new wolf groups in areas already occupied by last year's wolves, who generally established home ranges near their acclimation pens. That consideration, and considerations relating to the group structures of the new wolves, will influence which pens, as well as how many pens, will be used this winter.

Wolf project biologists and their advisors consider last year's restoration efforts to have been very successful and instructive, and so this year's introductions will follow the same plan. Biologists will visit the pens approximately twice a week to provide road-killed ungulates as food and to check on the animals and their pens. Otherwise, observations will be extremely limited, and the areas immediately around the pens will once again be closed to visitor activity. The wolves will be released in late March or early April, prior to any denning activity by breeding pairs. Wolves in the Nez Perce Creek and Blacktail Plateau pens would be released on site; both areas were historically known to be occupied by wolves, and the Firehole Valley, like the Northern Range, supports resident herds of elk and bison.

### Montana Man Convicted of Killing Wolf #10

On October 25, 1995, a jury deliberated less than two hours to find Chad McKittrick, of Red Lodge, Montana, guilty of killing, possessing, and transporting a wolf. The wolf was #10, the male from the Rose Creek pen, whose mate, #9, gave birth to eight pups near Red Lodge shortly after his death. Biologists discovered the wolf's death after his radio collar transmitted a mortality signal. The collar was later found near a public road, and an informant told the U.S. Fish and Wildlife Service of the carcass's whereabouts and of McKittrick's actions. Investigators then searched McKittrick's residence, finding the skull and hide of #10.

McKittrick could be sentenced to as much as six months in prison and fined up to $25,000 for his actions, which violated the Endangered Species Act. Maximum penalty for the transportation count, a high misdemeanor, is a year in prison and a $100,000 fine. As of mid-December, McKittrick had not been sentenced.

### Soda Butte Wolves Kill Hunting Dog, Anger Ranchers

On Friday, December 8, the U.S. Fish and Wildlife Service received a call that a pet lion dog (a Walker hound) had been killed by wolves on private land 15 miles southeast of Nye, Montana. On the previous Wednesday, December 6, the Soda Butte pack (five adults and one pup) were located by airplane in the Absaroka-Beartooth Wilderness, in the Stillwater drainage, Custer National Forest, but a Friday flight was unable to locate them in that area. The dog was killed about 20 miles from the pack's last known location, in an area the pack had not visited before. A flight on Saturday, December 8, established that the wolves were in the area where the dog was killed.

Animal Damage Control (a bureau of the U.S. Department of Agriculture) investigated the incident and confirmed that wolves were responsible for the dog's death, the third known wolf-caused death of a dog since wolf recovery began in Montana in about 1982.

The wolf recovery plan calls for management actions if wolves are repeatedly involved in problems with domestic livestock or pets, but, according to Ed Bangs, U.S. Fish and Wildlife Service gray wolf recovery coordinator for Montana, "this is not a depredation situation that would require control. The wolves did not seek out a pet nor are they likely to cause repeated depredations on domestic dogs."

Ranchers, on the other hand, regarded the unannounced arrival of the wolves on private land a breach of trust, because they had been assured by federal officials that they would be notified if the wolves approached their lands. The appropriate notifications (to the U.S. Forest Service and Montana Department of Fish, Wildlife and Parks) had been made of the pack's location on December 6, but as the wolves have repeatedly demonstrated, they may move long distances in a very short time, between surveillance flights. When the December 8 flight did not locate the Soda Butte pack in its December 6 location, biologists mistakenly assumed the pack had moved back toward the park.

By late December, the Soda Butte pack had moved back toward the park. In early January, they were spending most of their time east of the park on wilderness lands.

### Rose Creek Wolf Pup Killed by Vehicle

At about 7:00 p.m. on December 19, Wolf #22 was hit by a delivery vehicle near the Buffalo Ranch in Lamar Valley. The nearly eight-month-old black pup was one of eight siblings born to the Rose Creek alpha female (#9) in late April near Red Lodge, Montana. Shortly after the birth, the female and the pups were relocated back to the Rose Creek acclimation pen. Her mate (#10), was illegally killed shortly before the birth, and it was judged necessary to relocate the family away from the developed area, so that biologists could help her with the initial months of rearing the pups. The mother and pups were released from the pen on October 11, and were often sighted in the Lamar Valley and near the Buffalo Ranch.

"This is a very unfortunate incident because the loss of any animal from this tiny population is a great loss to the restoration program," Superintendent Mike Finley said. "The young male, which weighed 65 pounds at death, was in excellent condition. Number 22 would have been a great asset to the recovery process." He urged visitors to be extremely cautious while driving in the park at night.

Necropsy studies will be conducted, for the scientific and educational value in terms of genetics and parasites. No action was anticipated against the driver of the vehicle.

### Wolf #3 Kills Sheep

Yellowstone-area livestock herds suffered their first losses to predation by the new wolves the second week in January. A ranch on the Dry Creek Road, southwest of Emigrant, Montana, reported a sheep killed and another injured in Monday, January 8, and another sheep was found dead on Friday, January 12. The latter sheep was the only one confirmed to have been killed by a wolf.

A wolf was not sighted in the area until Thursday, January 11, but could have been in the area for several days because the federal government shutdown and weather conditions had reduced the number of tracking flights biologists were making. On January 11, a flight confirmed that Wolf #3, a yearling male from the Crystal Creek group, was in the area. On Sunday, January 14, predator control agents of the Animal Damage Control agency, working with Yellowstone biologists, captured the wolf by netting it from a helicopter, then tranquilized it and moved it to the Rose Creek acclimation pen. Ed Bangs, U.S. Fish and Wildlife Service wolf recovery project leader, said that #3 might have been attracted to the Emigrant area by a large colony of captive wolves kept on private property in that area.

Under the rules of the reintroduction plan, a wolf killing livestock will be given a second chance; if it kills livestock again, it will be removed from the population. As of January 17, #3 was still being held. Among the options being considered for him were relocation to a remote part of the park, perhaps in the southern portion, and pairing him with a new female from this year's Canadian trapping program, which was underway at the same time. The ranchers, whose loss of sheep was finally determined to be at least two and perhaps as many as four, were assured that they would be compensated for their losses. Defenders of Wildlife maintains a fund for this purpose.

In late December and early January, biologists reported that the dispersal of young wolves from the established packs appeared to be underway. This dispersal is an anticipated event; usually at this time of year, some of the yearlings leave the pack and begin to wander more on their own. Wolf #12, a member of the Soda Butte group, has also been reported making long-distance trips, including one to public lands southeast of Yellowstone National Park.

Unlike the recent incident in which members of the Soda Butte group killed a dog near Nye, Montana, there were apparently no complaints about the quickness of agency reaction to the situation; the wolf was caught very quickly after the incident. However, Montana Governor Marc Racicot has stated his objection to the continuation of the Yellowstone wolf recovery program.

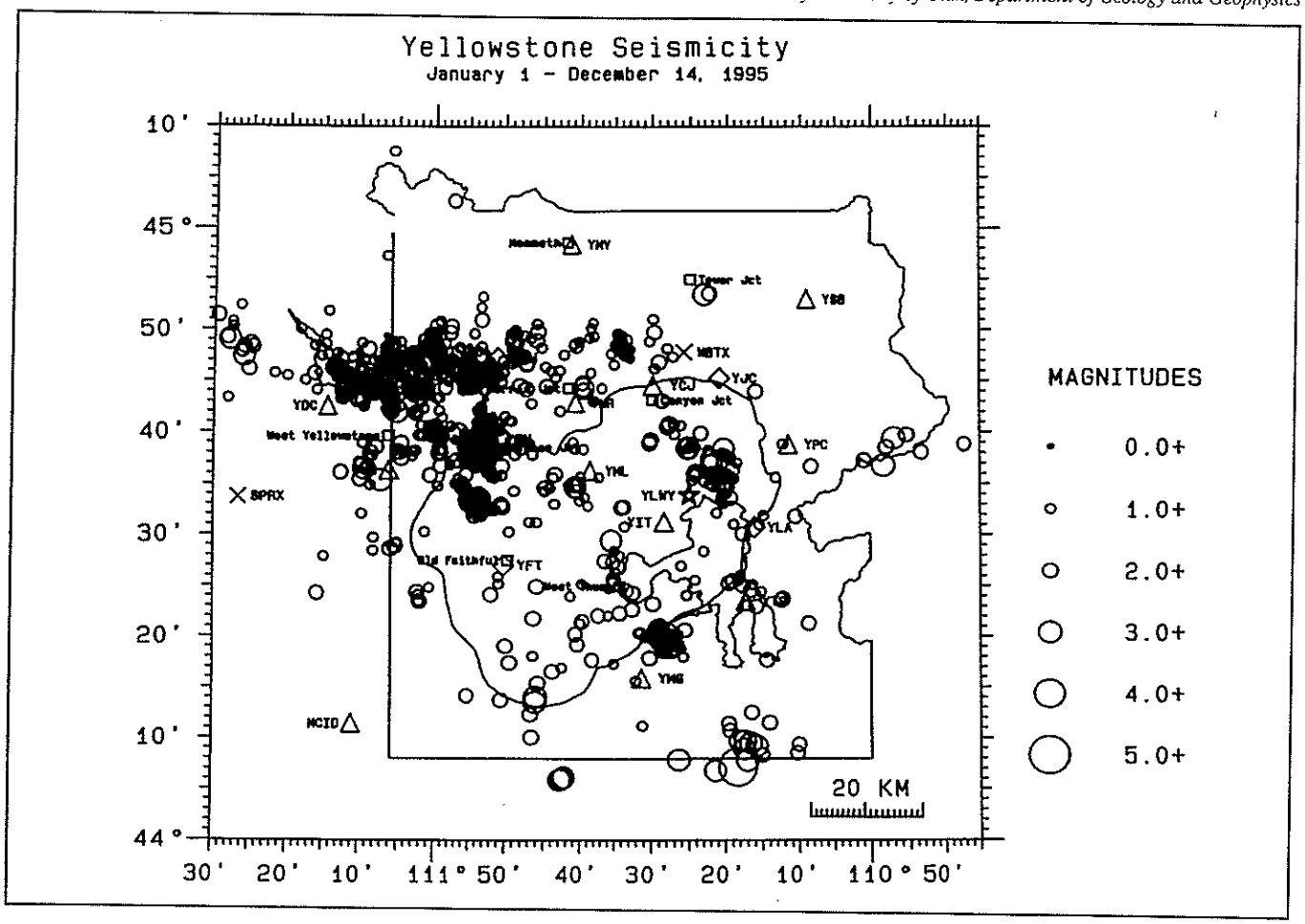
### Marvin Jensen New Assistant Superintendent

On December 1, Yellowstone Superintendent Mike Finley announced the selection of Marvin O. Jensen as the new assistant superintendent. Jensen replaces Joseph Alston, who left more than a year ago to become superintendent of Glen Canyon National Recreation Area.

*NPS Photo*

Jensen is 55 years old, and received his B.S. in range management from Utah State University in 1963. He began his 32-year federal career with the Bureau of Land Management that year, as a range conservationist at Kanab, Utah. His first position with the National Park Service was as unit manager at Grand Canyon National Park. He has also been a management assistant at Sequoia and Kings Canyon National Parks (1981-1987), superintendent of Kenai Fjords National Park (1987), superintendent of Glacier Bay National Park and Preserve (1988-1994), and superintendent of the Mojave National Preserve (1995). Jensen and his wife, Mary Lynn, have two grown children. He began work in Yellowstone in late December.

Courtesy University of Utah, Department of Geology and Geophysics



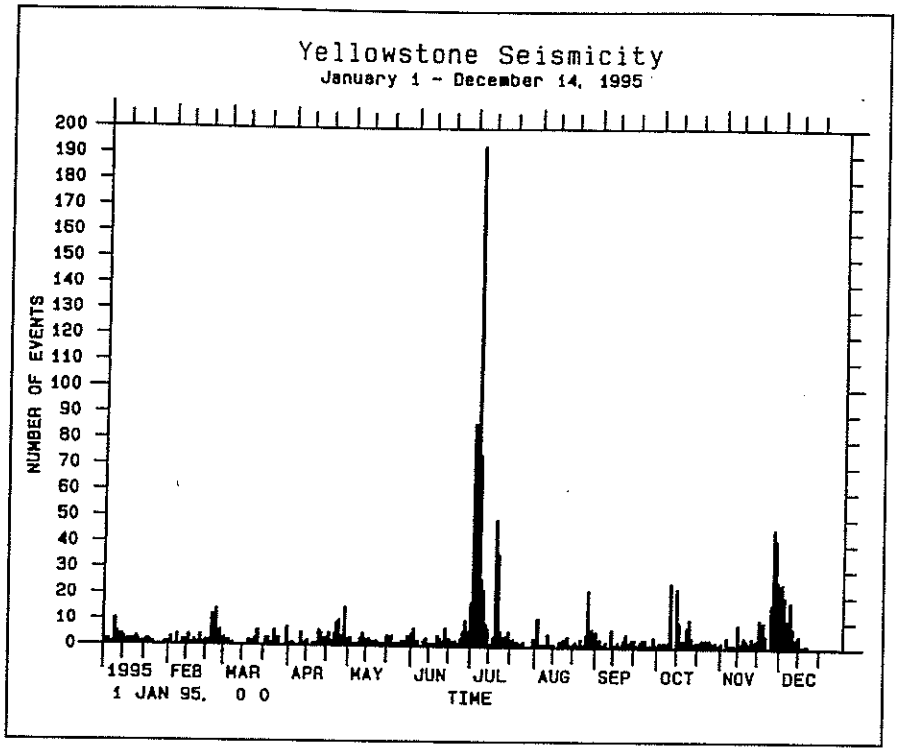

*Above: Epicenter map of ~1600 earthquakes (circles) located from January 1 through December 14, 1995, in the Yellowstone National Park (YNP) region. The open triangles and diamonds represent the locations of YNP regional seismograph network stations operated by the University of Utah. Opposite: Time histogram of earthquake activity in the Yellowstone National Park region for the same time period. A swarm of several hundred earthquakes occurred in early July, just west of Madison Junction.*

## Earthquake Swarms Along Caldera Boundary

On July 4, 1995, Dr. Robert Smith, University of Utah researcher who has studied Yellowstone's geology for many years, alerted park that the west side of Yellowstone, near the boundary of the Yellowstone caldera, was experiencing a very intense earthquake swarm. The unusual activity began on June 30, and the earthquakes were clustered near Mount Haynes (just south of the Madison River). The swarm started out with about 700 events per day, with magnitudes up to 2.5 on the Richter Scale. Activity subsided in frequency until July 4, when it increased to about three or four events per minute. None of the earthquakes were felt, and Yellowstone Research Geologist Rick Hutchinson observed no unusual changes in geyser or hot spring activity.

This most recent swarm of earthquakes occurred only a mile or two northeast of an April-May swarm. Smith described the July swarm as in line with a 1985 swarm, and part of a persistent trend of earthquakes that occur along a line extending from the Pitchstone Plateau in southern Yellowstone, northwest past Old Faithful.

A smaller swarm with more felt earthquakes occurred starting on September 28 and continuing into early October. Smith summarized the swarm as occurring on the northeast side of Mt. Sheridan (the southeast side of the Yellowstone caldera), "very near the point where the projection of the north-trending Red Mountain fault intersects the mapped caldera boundary. U.S.G.S. [*U.S. Geological Survey*] geologists have mapped a post-caldera collapse rhyolite vent located in the epicentral area.... We do not know the source of the earthquakes, but they could be related to such plausible mechanisms as: 1) down-dip tectonic earthquakes on the eastward projection of the Red Mountain fault, 2) earthquakes occurring in response to fault motions associated witht the interaction of the caldera boundary fault with the Red Mountain fault, 3) earthquakes that may be related to a zone of weakness that may be associated with the fault and the volanic vent, 4) earthquakes associated with the Heart Lake geyser system (which is very close to the epicenters). The earthquakes could also be related to hydrothermal fluid migration and hence may have affected the temporal and volume discharges of this geyser system."




The largest earthquake in this swarm was a 4.3 on the Richter Scale; Grant Village staff reported feeling about half a dozen of the quakes. Smith said that "this year's rates of earthquake occurrence are well above the annual average." The last year in which this rate of earthquake occurrence was achieved was 1985.

### Yellowstone Experiences Shutdowns

As a result of various stages of this winter's budget impasse, Yellowstone National Park was significantly affected by the two "shutdowns" of the federal government. The first shutdown, which ran from Tuesday, November 14 until the following Monday morning, had relatively little imact on park operations because the park was largely shut down anyway. The roads had been closed for the winter, and were not scheduled to reopen for winter (oversnow) traffic until December. The road across northern Yellowstone was kept open for public access to the communities of Silver Gate and Cooke City, Montana, near the Northeast Entrance. The Albright Visitor Center and the Mammoth Hot Springs Campground were closed, and the park was closed to all recreational activities.

The second closure began on December 17 and ended on January 6, and had much more severe effects on the park and its neighbors. At the beginning of the closure, visitors at the Old Faithful Snow Lodge were asked to leave, and the Mammoth Hot Springs Hotel was not permitted to open. The timing of the closure, over the winter's major holiday period, was reported to have major effects on many businesses in the park and in nearby communities. Estimates of total losses were not available in time for this report.

On January 6, all park and concessioner facilities reopened to visitor use. "Park staff are pleased to be back at work and are anxious to get back to serving the public," said Superintendent Mike Finley. "This closure has been difficult not only on our staff, but our many concessioner and community friends. However, we have found a silver lining in this dark cloud through the overwhelming support we've received from the communities, concessioners, our local and state governments, and our own federal employees. Banks have offered low interest loans to employees, and creditors have been willing to work with park employees during this time of uncertainty." In a January 6 statement about the national park system, NPS Director Roger Kennedy said that "Our jubilation at opening visitor facilities in the parks is tempered with profound regret at the damage done to our employees and our neighbors."

Though the funding measure that was approved for the parks does allow for all park facilities to remain open through September 30 (the end of the NPS fiscal year), the funding status of many parts of the parks' operations remain unsettled. Only those park operations directly related to visitor services have been approved so far. Many Yellowstone programs, including those related to resource management and research support, are apparently not covered by the funding.

### Court Rules on Grizzly Bear Recovery Plan Lawsuit

On September 29, a U.S. District Court Judge ruled on a lawsuit filed concerning the 1993 *Grizzly Bear Recovery Plan* issued by the U.S. Fish and Wildlife Service. The court held in part for the plaintiffs, the Fund for Animals et al., and in part for the defendants, Secretary of the Interior Bruce Babbitt et al. The plaintiffs had argued that the plan was inadequate in a number of ways. The court held that it was not immediately necessary for the government to designate critical habitat or linkage zones for grizzly bears, and that the plan was sufficient in addressing site-specific management actions for grizzly bear recovery, such as road density standards, in the several recovery areas in the lower 48 states.

However, the court found that insufficient information was provided by the government to justify as "objective, measurable criteria" the methods outlined in the plan for monitoring populations, and to explain how the planned conservation strategy (now being produced) would demonstrate the existence of adequate regulatory mechanisms to protect bears and their habitat if the species were to be delisted from protection under the Endangered Species Act.

The court also questioned the government's decision not to list the Cabinet-Yaak grizzly bear population as endangered rather than threatened. The court gave the U.S. Fish and Wildlife Service 90 days to reconsider those portions of the recovery plan found to be insufficient.