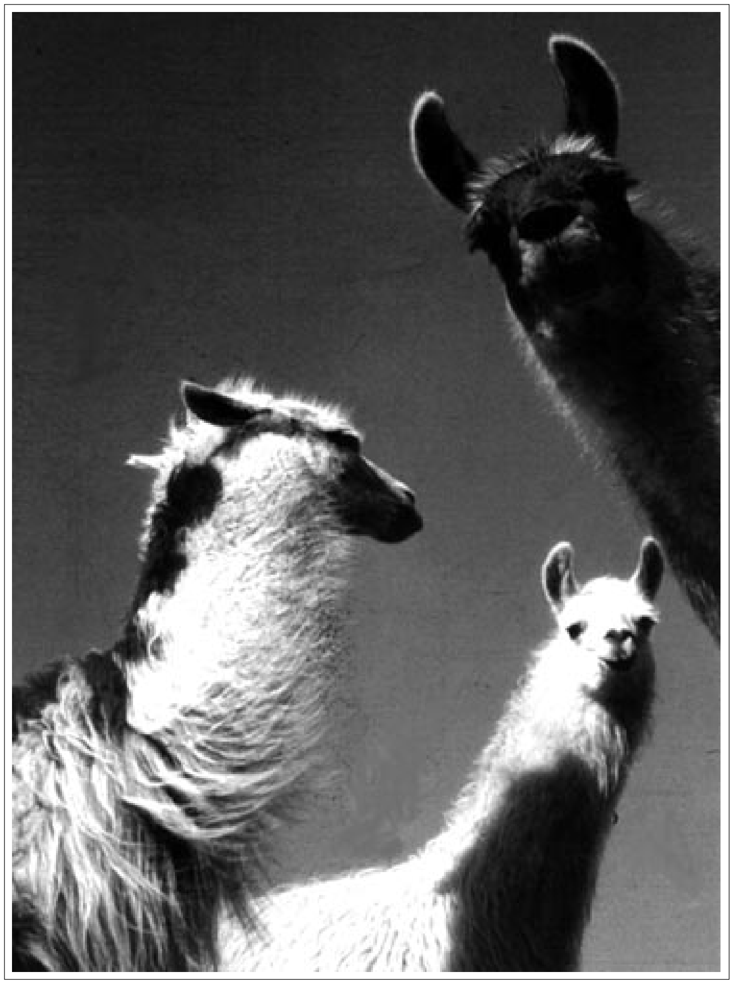
Yellowstone Science

A quarterly publication devoted to the natural and cultural resources



How Wilderness Users View Llamas

Land Snails in Aspen Groves

Fire, Grass, and Grazers

Writing About Wolves

Volume 5 Number 3

The Objective is Objectivity

NPS photo

I have always had the notion that science (and scientists) should be objective, ever asking questions and seeking to refine the answers and pose new questions. One of the persistent criticisms we hear in Yellowstone is that we lack science upon which to base management decisions. Or that the science we do have is not objective and is biased or somehow tainted because we hire or control the scientists that do research in the park. Non-agency or "outside" scientists are viewed as more pure, more objective in their posing of hypotheses and in their analysis of information they collect in or about the state of the park.

It's only my opinion (but then, it's my column) that in Yellowstone (and, in four other national park units in which I have worked) many park managers, resource specialists, interpreters, and researchers are quite open to questioning the policies, conclusions, and science that have gone before. The scientists working in and outside the park pride themselves on their independence, no matter who signs their paychecks. (Some have also laughingly pointed out to me that, while they strive for objectivity in testing their hypotheses and analyzing their data, they, like other humans, have biases based on their training, personal experiences, perceptions, and attitudes.) Of the 250 research projects under permit in Yellowstone National Park in June 1997, 48 percent were supervised by college or university professors or personnel and 22 percent by researchers of corporate, private foundation, or unstated affiliation. Only 11 percent of the projects were directed or conducted by park staff, and another 18 percent by other federal or state agency scientists.

Featured in this issue are findings from three independent research projects in the park. To the growing debate over the nontraditional use of llamas as backcountry pack stock, Dale Blanha and Kari Archibald offer results of a survey of recreationists. Mindful of conflicts between user groups and of breaking with tradition, managers can use such information, in combination with research on natural and cultural resources, to help manage human use.

Contentious issues, like the recurring debate over the state of Yellowstone's northern range and the effects of fires on the landscape, demand that we consider various scientific viewpoints. Ben Tracy shares his conclusions on how fire benefits the productivity of sagebrush grasslands and associated grazing animals. In contrast, Dorothy Beetle observes destructive changes in aspen groves and associated populations of land snails attributed to fires and ungulate grazing.

As former park superintendent Bob Barbee once said, "on an issue of any substance at all, the scientists will almost certainly disagree." For our readers, as for park managers, perhaps the point is not to expect agreement but that we will objectively listen to and present different researchers' voices and viewpoints in *Yellowstone Science.*

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A quarterly publication devoted to the natural and cultural resources

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On the cover: Llamas, up close and personal, courtesy Stanlynn Daughtery of Hurricane Creek Llama Treks, Inc. and the International Llama Association. Above: A Yellowstone wolf. This issue will update you as to the status of the Yellowstone wolves to date. See the Book Reviews *page 13 and* News & Notes *page 17. NPS photo.*

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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Fire Effects in Yellowstone's Grasslands

Large Grazers and Fire Affect Ecosystem Processes

NPS photo

By Benjamin Tracy

The large scale of Yellowstone's 1988 fires, which burned almost 45 percent of the park, led to many questions about how the ecosystem would recover. Although only two percent (about 32,000 ha) of the total burned area, grasslands provide the most forage for the park's large herbivores such as elk and bison. Some hypotheses suggested that burning might increase forage abundance and quality and, as a result, increase the carrying capacity of Yellowstone's range. That is, burned range would support more animals than unburned range because it would provide more food. If the 1988 fires had such an effect, this information would be important for resource managers responsible for monitoring large herbivore populations.

Factors Affecting Grassland Productivity

Many studies have shown that burning can increase the productivity of grasslands and alter the foraging behavior of large grazers. Such positive responses are often related to the removal of plant litter by burning. For example, the accumulation of plant litter in grasslands where neither fires nor significant grazing occur may prevent emerging plant shoots from receiving sufficient light to grow substantially. Plant litter accumulation also acts as an effective soil insulator, which can foster or impair plant growth. On the negative side, this insulation keeps soil relatively cool, which slows the decomposition of organic material and means that plants will have less nutrients for growth. On the positive side, some studies have shown that decaying plant litter produces toxic substances that leach into the ground, reducing plant growth. Fire eliminates these toxic effects and plants often respond to the burning off of accumulated litter by becoming more productive.

In addition, ash deposited on the soil after a burn is usually concentrated with many nutrients which plants take up, becoming more concentrated with nutrients themselves. Many studies have shown that large grazers will react to this situation by preferentially grazing the nutrient-rich forage. The survival and reproductive success of large herbivores may therefore improve if the animals can consume productive, nutrient-rich forage from burned areas. Improved forage quantity and quality may be particularly beneficial in ecosystems like Yellowstone where grazers must often survive harsh winters on limited food.

Research Plan

The overall goal of my dissertation research, under the guidance of Dr. Sam McNaughton at Syracuse University, was to learn how fire, particularly the fires of 1988, might affect the aboveground productivity of plants, the cycling of nutrients, and grazing by large herbivores in several Yellowstone grasslands. This article summarizes my findings concerning grazing and aboveground production during the 1991-1993 growing seasons.

My study sites included winter, transitional, and summer range for elk and bison; each site was typical of most sagebrush grasslands in the park. The winter range site was located on the northern range near Hellroaring Creek, where elk and bison graze from late fall to spring. The transitional range site was located near Swan Lake Flat, which small numbers of elk (n = 20 to 30) use for 3 to 4 weeks in the spring before moving to their summer range. The summer range site was located in Hayden Valley, which is grazed mostly by bison from early spring to fall. For the last two years of my study, I also did some work near the Grant Village area, comparing processes in a forest and meadow mosaic. At these sites I usually confined my sampling to two matched study plots, one in a burned area and one in an unburned area, so that the only potential difference between the plots was a fire effect.

I measured aboveground net primary production (ANPP) and grazing intensity by setting up exclosures (1.5m x 1.5m) at each study plot starting after snowmelt each year. At monthly intervals, I clipped vegetation in a quadrat randomly located inside and outside each exclosure, and then moved the exclosures to new grazed locations in the study plot. I dried and weighed the clippings (the aboveground biomass) from each quadrat and, at the end of the growing season, summed these monthly measurements. I considered ANPP the positive increment in biomass accumulation over the growing season. Because the exclosures were moved to new grazed areas each month, the ANPP calculated for them reflected forage production in the presence of large grazers. I determined grazing intensity (the proportion of aboveground biomass removed by grazers) by comparing the difference in aboveground biomass inside and outside the exclosures.

Initial Results

The first data set from my study, for the summer and winter range sites, was ready for analysis in 1991. (The transitional range site was added later.) The 1991 results showed that the ANPP and forage consumption by elk were significantly greater on burned areas, but only on the winter range site (Figure 1A and 1B). The data suggested that burning increased the productivity of the winter range site which, perhaps as a result, enticed elk to graze more on the burned area relative to the unburned area. But why were similar fire effects apparently absent on the summer range?

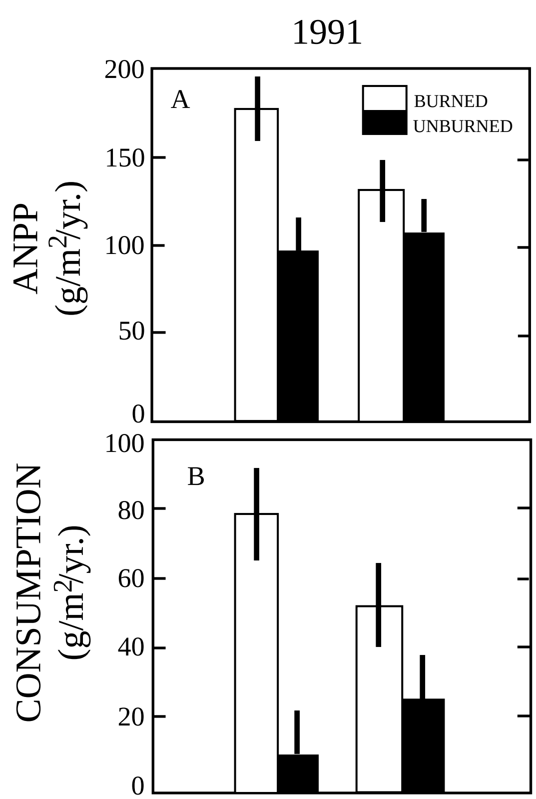
Several explanations for the different effect on winter and summer range sites are possible, but the most likely involves burn intensity. The winter range site burned more intensely than the summer range site in part because grazers move off winter range in the spring. This allowed grazed plants to regrow and likely provided more fuel when the 1988 fires struck in late summer. On the summer range, in contrast, grazers removed most of the potential fuel as they grazed and, as a consequence, the fires were not intense enough to produce a sustained burning effect. Indeed, by 1990 it was almost impossible to tell that the summer range site had been burned only two years before.

When Fire Effects Disappear

By 1992, burning effects could no longer be detected in any of the study sites, suggesting that burning effects, if present at all, persist for no more than three years postfire in most Yellowstone grasslands. But other interesting patterns did emerge from the data sets for the 1992 and 1993 growing seasons. Figure 2 compares ANPP and grazing intensity for the three types of range. Aboveground production and grazing intensity were clearly lowest on the transitional range. Other variables associated with nutrient cycling (e.g., the amount of available nitrogen in the soil) showed a similar pattern among the study sites.

I believe that the differences among the three ranges result primarily from how intensely each is used by grazers. As expected, more animals grazed and deposited waste on the summer and winter range sites than on the transitional range. Because grazer dung and urine contain abundant nutrients for plants, plant growth may increase as a result. I believe that the greater input of nutrient-rich waste to summer and winter ranges contributes to making these ranges more productive than transitional range. Of course, other variables associated with the physical environment (e.g., climate and soils) could

Figure 1A and B. ANPP and forage consumption by elk on burned and unburned areas on the Yellowstone winter range.



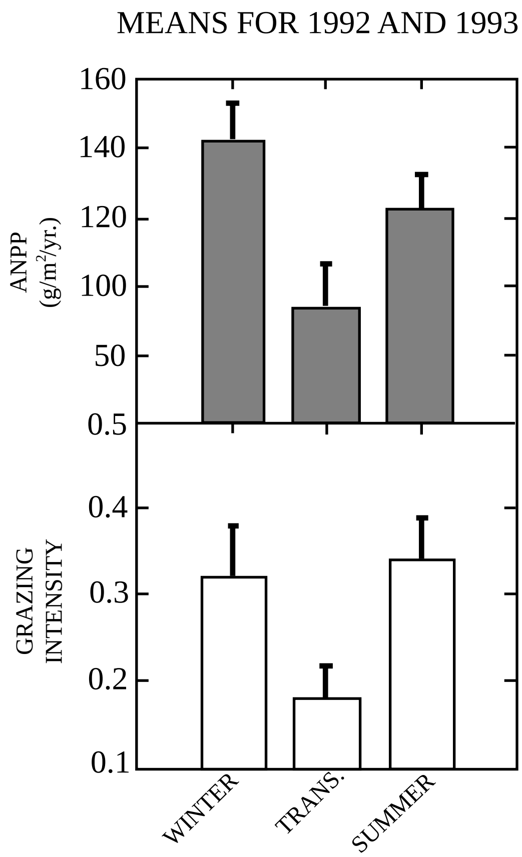


Figure 2. Comparison of ANPP and grazing intensity for three types of range.

Photos Ben Tracy

The author collecting dung at a sampling site.

The 1992 experimental burn on the winter range site.

help explain these results, but these variables were quite similar among the three study sites when the data were taken. I conclude that large grazers and the physical environment are likely equally important in affecting certain ecosystem processes in Yellowstone's grasslands.

An Experimental Burn

Because this study was initiated in 1990, I had no data on immediate burning effects for the first year following the 1988 fires. In 1992, with help from the Fire Cache and the [former] Division of Research, an experimental burn was conducted for my project on the winter range site. This burn provided a unique opportunity to compare processes in four areas, each possessing a different fire history: an area burned in 1988 (B88); an area burned in 1992 (B92); an area burned in both 1988 and 1992 (B8892); and an area with no recent fire history (UB).

Figure 3 shows ANPP and green forage consumption by grazers the spring after the experimental burning. Plants growing on areas burned in 1992 produced the most aboveground biomass, demonstrating that burning can increase production in the short term. In addition, plants growing on recently burned areas were more highly concentrated with nutrients when elk were grazing the site. This finding was surprising, because instead of heavily grazing the recently burned areas which had productive and nutrient rich forage, as I had expected, elk grazing the winter range site that spring ate relatively little green forage and did not consume more forage in recently burned areas. I believe the elks' avoidance of the productive regrowth in the burned areas may be attributable to a large lupine (*Lupinus sericeus*) bloom, which burning seems to promote. Indeed, many grasslands burned in 1988 supported much lupine the year after the fire. Figure 4 shows peak lupine biomass in 1993. Areas that burned the previous year, and even the area that burned in 1988, supported more lupine biomass than the area with no recent fire history. Many lupine species are known to accumulate toxic alkaloids in their aboveground tissues, and elk may avoid areas with high densities of lupine for this reason.

In a Grassland-Forest Mosaic

Although sagebrush grasslands comprised the main focus of this study, they make up a relatively small proportion of the park. About 80 percent of Yellowstone's landscape is covered by conifer forest. While elk and bison obtain most of their forage from grasslands, they also graze some herbaceous plants in the forest understory. Because most of the area that burned in 1988 was forest, I wanted to collect some data on fire and herbivore interactions in a forested area and compare them to the same processes in an adjacent grassland.

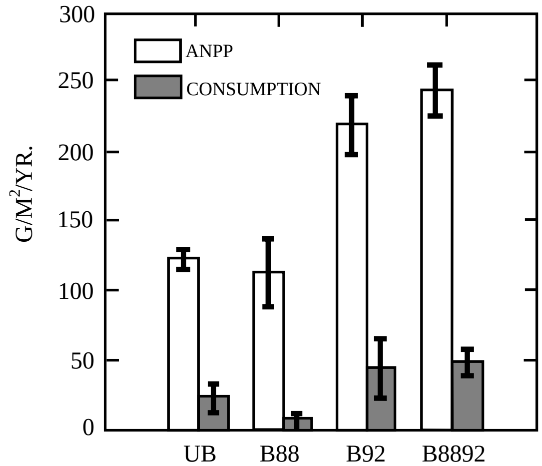


Figure 3. ANPP and green forage consumption by grazers the spring after the experimental burn.

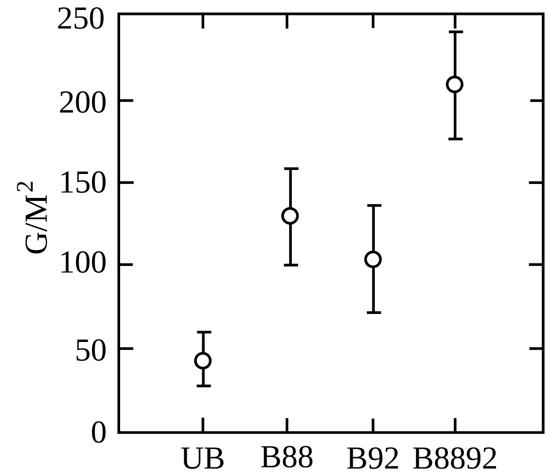


Figure 4. Peak lupine biomass in 1993.

Interspersed within conifer forests in the Grant Village area are meadows used by elk in the summer. I obtained some interesting data from several forest-meadow sites in the 1992 and 1993 growing seasons. Determining whether the elk preferentially grazed burned areas over unburned areas was difficult because elk consumed little aboveground biomass on the study sites. However, herbaceous plants growing beneath burned forest produced almost three times more biomass then corresponding plants beneath unburned forest. This striking difference, evident even five years after the 1988 fires, was mainly caused by one grass species (*Elymus glaucus*) that grew in the forest understory. No such differences in aboveground biomass were found in burned and unburned meadows. Patterns in nutrient cycling followed a similar trend: significantly higher in the burned forest compared to the unburned forest, but similar in burned and unburned meadows.

When fire removes much of the forest canopy, more sunlight can penetrate into the understory. This situation, combined with the deposition of nutrient-rich ash to forest soils, probably set in motion a series of events that produced long-lasting effects measurable in both aboveground production and rates of nutrient cycling. Elk, however, avoided grazing these highly productive areas during the growing season, perhaps because the dominant grass (*Elymus*) is unpalatable to them. Under some circumstances forage quality may be more important than quantity in attracting elk to graze certain areas.

Conclusions

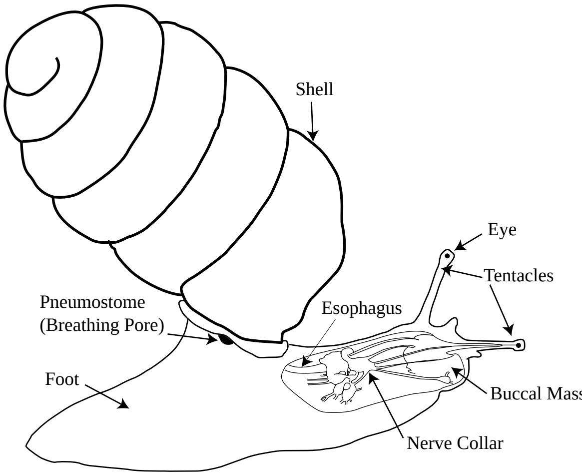
The research conducted after the 1988 fires sheds much light on how fire affects ecosystem function in some of Yellowstone's grasslands. Overall, the sagebrush grasslands appear very resilient to fire. Fire had either positive or neutral effects on aboveground production and the cycling of nutrients. Although burning can increase the productivity of grasslands, the duration of these effects may differ depending on the region. In this study, fire effects were strongest on winter range, but not apparent on summer and transitional range. Burning effects associated with the aboveground production of understory plants and the cycling of nutrients may persist for longer periods in forested areas.

Large grazers will preferentially forage in previously burned areas because of the productive and nutrient-rich nature of plant regrowth, unless burning stimulates the production of unpalatable plants, as probably occurred following the experimental burn and at the Grant Village study site. After burning effects disappear, large grazers still strongly effect ecosystem processes across the Yellowstone landscape. My data suggest that the productivity of Yellowstone grasslands results in part from how intensely these areas are used by the large grazers.

In closing, I should note that this study was conducted over several growing seasons that were relatively wet; fire followed by drier conditions could show different effects than those summarized here. If future fire research is to be conducted in Yellowstone, an effort should be made towards understanding fire effects under such conditions. If fire frequency increases in response to a potential warming trend in the climate, it will be important to understand how fire effects the Yellowstone ecosystem under both dry and wet conditions.

Ben Tracy is a post-doctoral research associate at Syracuse University with an interest in terrestrial ecosystem ecology and plant-animal interactions. He has been studying how elk affect Yellowstone ranges since 1990.

Recolonization of Burned Aspen Groves by Land Snails



by Dorothy E. Beetle

Land mollusks play an important role in forest productivity, although they usually pass unnoticed. They are part of the invertebrate fauna that busily convert leaf litter and fallen logs into soil nutrients. Litter in aspen groves provides habitat for these snails that feed on living and dead vegetative material. In turn, snails are included in the diet of small mammals and birds.

The mollusks of Yellowstone are not unique to the area, being found in suitable habitats elsewhere. Even in suitable habitats their distribution is spotty. Early malacologists who collected in Yellowstone listed the species they found, without further data. Others who were studying a particular genus noted which of its species were found in the park. In my experience, deciduous forest trees such as aspen generally have a greater abundance and variety of snails than coniferous forests on more acidic soils. The limited cover of sage-grassland also has fewer species than aspen stands.

A Primer on Snail Ecology

Most Yellowstone mollusks are tiny, ranging in size from 1.5 mm to nearly 30 mm. Within their thin shells, land snails have a fleshy mantle covering a coiled body. The body contains a digestive, circulatory, and nervous system, and reproductive organs. The animal glides along over a mucus trail it secretes, using the muscular contractions of its foot (*see diagram*). The mouth, enclosed in a buccal sac, contains a tough muscular radula that bears many rows of minute, pointed teeth. The radula rasps back and forth over food to break it into tiny pieces to swallow. As the teeth are worn, they are discarded and the radula unrolls a bit to bring new teeth to bear on the food. Eye spots on the antennae are sensitive to light and movement. The land snails are hermaphrodites with male and female organs which exchange sperm. Most lay eggs, but *Oreohelix* is an exception. Its young are retained in the oviduct until attaining 3 to 4 mm in diameter; then they are born alive. Under the stress of brief confinement and being held overnight for identification, eight adults birthed 54 young *Oreohelix*. *Oreohelix* grows very slowly, requiring about 5 years to attain a size of 20 or more millimeters.

The length of life for the various species of land snails is rarely recorded in the literature. However, with unfavorable moisture and temperature conditions, they go into a resting period that may extend for months. The aperture of the shell is glued by mucus to a bit of leaf or bark. I have kept *Oreohelix* alive in containers for as long as eight years, including rest periods. In the laboratory, the tiny *Pupilla* have been maintained for several years.

Snail movement by itself is very slow. There is very little chance that, by themselves, snails could move across a pine forest or sagebrush-grassland to another aspen grove. Their small size allows for some passive dispersal by wind or heavy rains. Under favorable moisture conditions, small snails may climb into the hair of mammals or feathers of birds and be carried from one grove to another.

Sampling for Snail Survival After the Fires

The fires of 1988 that raged across considerable acreage in Yellowstone National Park raised the question of survival of mollusks in the burned aspen groves. Since no preburn data exist, I planned a five-year study of snail populations in both burned and unburned aspen groves. Sampling was done in 1989 and selected sites were examined in 1990, 1991, and 1994 to determine survival and population regrowth.

A printout from the naturalist's office

showed where aspen had occurred before the fires. Groves were located in the northernmost portion of Yellowstone, particularly around Mammoth Hot Springs, Bunsen and Sepulcher peaks, and on both sides of the road east to the Lamar Valley. Scattered aspen grew north of the West Entrance beyond Duck Creek. Quite a few of the aspen marked on the printout were remnant strings of aspen too open to offer the cover needed by snails, or were small, isolated clones. Using the Yellowstone map showing burned areas, 18 sites were selected and sampled in 1989.

Eight sites were chosen for subsequent study. Those selected were several mildly burned groves, an unburned hillside, another where all the trees were killed and many blown over by a jet wind during the fire, plus a completely destroyed grove. A site near Mammoth Hot Springs was contiguous to unburned aspen from which migration might occur. We obtained snails for identification by handpicking and gathering leaf litter. Snails live in the leaf litter and can be obtained by sifting through fine mesh screens.

Variation Among Different Groves

An extensive aspen forest on the slope of Sepulcher Peak had escaped the flames. *Oreohelix subrudis*, plus seven other species of snails, were present in the leaf litter and under logs in 1989. *Oreohelix* were abundant and extended downslope into the sagebrush. The snail population had not changed by 1994.

Beyond Mammoth Hot Springs was an aspen forest, some of which had been lightly burned. The thick ground cover held eight species in 1989; a sample of snail population before the fire. In 1990, a low spot in this grove held standing water in which a freshwater snail, *Lymnaea (Fossaria) modicella* was active. Freshwater snails have a body similar to land mollusks and come to the surface to breathe. This *Lymnaea* has been found previously in park waters and may live in the overflow from the spring where the water has cooled. In 1994, the water was gone. While the land snails were all present, no *Lymnaea* were seen. They probably had burrowed deeply into the mud.

Photos Dorothy Beetle

Some of the sites sampled include, clockwise: A string of live aspen lightly burned in the Lamar Valley; an exclosure along Bunsen Peak road (1994); same road showing bare foreground where fallen trees had burned to ash; and a completely destroyed grove with numerous dead Oreohelix *shells (no recovery by 1994).*

Although the strings of aspen near Crystal Creek in the Lamar Valley were quite open, seeps on the hillside kept the ground boggy. Here we found the largest number of snail species (11) of any site sampled in 1989. We were surprised to find a freshwater snail, *Physa megalochlamys,* which has a limited distribution, in the small creek. No additional mollusks were found in 1990, although *Oreohelix subrudis* was under logs with a dark-banded form that has been called *O. subrudis obscura*. By 1994, the hillside was considerably drier, and *Physa* was now absent. Aspen suckers seen previously had been grazed to the ground. The mollusk population had declined.

A grove along the Bunsen Peak road had suffered a hot burn. Standing trees had been partially burned through the trunks, yet managed to leaf out in 1989. Where trees had fallen during the fires, they had burned to ash, leaving only outlines of their forms. Tangles of aspen suckers had sprung up. Only three species of snails were present in 1989. By 1994, the badly burned aspen trees had died and suckers had been grazed to the ground by ungulates. Without the aspen litter the mollusks had died out.

The hillside beyond Floating Island Lake had a mix of large aspen and pine. A light burn had left live trees with charred bases. Previously fallen trees, a tangle of aspen suckers and many shrubs made walking difficult. Damp conditions and abundant litter offered good snail habitat. Five species were found on uncharred rotten logs and a few on charred ones. These species were found again in 1994.

Land Mollusks found in Yellowstone's Aspen Groves

Species Scientific Name	Common Name
Oreohelix subrudis	Subalpine snail
Microphysula ingersolli	Spruce snail
Euconulus fulvus	Brown hive snail
Retinella (Nesovitrea) electrina	Amberglass snail
Hawaiia minuscula	Minute gem
Zonitoides arboreus	Quick gloss snail
Vitrina alaskana	Glass snail
Deroceras laeve	Meadow slug
Discus cronkhitei	Forest disc
Discus shimeki	Striate disc
Punctum minutissimum	Small spot
Oxyloma retusa	Blunt amber snail
Catinella spp.	Amber snail
Pupilla muscorum	Widespread column
Vertigo modesta	Cross vertigo
Vertigo gouldi	Variable vertigo
Columella alticola	Toothless column
Vallonia cyclophorella	Silky vallonia
Vallonia gracilicosta	Multirib vallonia
Zoogenetes harpa	Boreal top
Cionella lubrica	Shiny spire

Freshwater Mollusks found in Aspen Groves

Physa megalochlamys	(No common name)
Lymnaea (Fossaria) modicella	Rock fossaria

On the south slope of Bunsen Peak, all the trees in what had been a large stand of aspen had been burned. Apparently a jet wind during the 1988 fires had broken many trees near the base and blown them over in the same direction. Only a few burned *Oreohelix* fragments were found in 1989. No snails were found in 1994.

One completely destroyed grove we examined was simply bare ground. No evidence of trees remained. Even tree roots below ground had been burned to ash so that we sank into ash were roots had been. Some fireweed had sprouted. This must have been an excellent habitat for snails prior to the fire. The grove lay in a hollow alongside a stream. Scattered over the ground were more burned *Oreohelix* shells than we found at any other site. No other snails were seen, although the fire probably destroyed any evidence of them due to their small size. Digging into the burn, we found one live *Discus cronkhitei* about 23 cm below the surface under a pile of rock. Five years later in 1994 there were no aspen suckers, only a few herbaceous plants. No live mollusks were present. As the area is surrounded by lodgepole pine and Douglas-fir, it is most probable that the conifers will invade what was an excellent aspen grove.

A Summary of Snail Recolonization

A total of 21 land species and two freshwater snail species were identified in both burned and unburned sites between 1989 and 1994. Each site had a mix of different snails along with *Oreohelix*. The usual number of species present in any grove was 3 to 5. Only two damp sites held 8 and 11 species, numbers indicative of favorable litter, soil, and moisture.

The random distribution of species from one grove to another suggests that snails may have been brought into a site by animals or birds bedding or feeding there. It is also possible that in the past there was an extensive aspen forest and the groves we see now with their varying assemblages of mollusks are remnants.

In 1989, all the mollusks listed in the table were found in unburned sites. Burned groves held a few live species and fragments of others. From 1990 to 1991, where mature aspen had survived, mollusk populations had declined somewhat. No new species were present, nor had burned groves added populations. After two dry years, by 1994, many aspen had died without replacement and snails were no longer present. No evidence of migration was found into burned groves.

Deterioration of aspen groves is a serious problem for the snail population. The limited expanse of aspen in Yellowstone before the fires indicates they are dying out. Aspen reproduces largely through suckers from its roots, while fire stimulates regrowth, extensive gnawing of tree trunks and grazing of aspen suckers by elk results in the decadence of aspen groves. This eliminates habitat for the mollusks. Aspen in drier areas may be replaced by sagebrush-grassland. In more moist areas, lodgepole pine and Douglas-fir could invade remnant aspen (Bartos and Mueggler 1979, DeBogle 1979). These plant associations would provide different habitat for other mollusks (Karlin 1961).

My thanks go to Stephen Welty and Richard E. Pillmore for their assistance in fieldwork. R. Pillmore drew the snail diagram.

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Dorothy Beetle is a retired planetarium director who, in her spare time, has studied land and freshwater mollusks in Wyoming since 1949, publishing eight papers on these mollusks. She reported sifting through aspen leaf litter on her hands and knees to study these often overlooked animals.

Backcountry Llama Packing

What Do Other Wilderness Visitors Think?

Above: Crossing the Bechler River at Three Rivers campsite, Bechler Canyon, Yellowstone National Park. Photos courtesy Dale Blahna.

by Dale J. Blahna and Kari S. Archibald

The Llama Debate

The use of llamas as recreational packstock has increased dramatically in many western wilderness areas during the last ten years. A 1990 survey conducted in two California wildernesses by the U.S. Forest Service's Intermountain Research Station found that about one-quarter of the hikers and one-third of the horseback riders encountered llama groups during their visits. While llama use is somewhat localized, it is expanding dramatically as the number of commercial and private packers increases.

This new mode of backcountry travel has sparked a debate that is both scientific and emotional. Opponents believe that llamas cause unacceptable social and physical impacts, including increased trail erosion, vegetation impacts, and the introduction of exotic plant species (in llama feces and fur) and wildlife diseases. In addition to the potential for trail congestion, some people feel that the use of llamas is inappropriate because they are neither traditional nor indigenous to North American backcountry. Some horseback riders object because horses become edgy and may bolt at the sight of llamas.

Llama supporters argue that the physical impacts are actually *advantages*. They point out that:

F Llamas have much less impact on soil and vegetation than do traditional packstock, and substituting llamas for horses or mules (for backcountry trail and riparian work, for example) would actually reduce backcountry impacts.

F There is no evidence of problems related to the introduction of exotic plants or disease in the wild, and some existing research actually disputes these claims.

F Visitors usually react positively to seeing llamas in the backcountry, and that while wilderness use may increase, llama packing allows greater access for traditionally under-represented groups such as women, children, handicapped persons, and older visitors. (See "Further Readings" for more on the pros and cons of llama packing.)

Because little research had been done on backcountry llama impacts until recently, management actions have been inconsistent and sometimes reactionary, which tends to fuel the debate. For example, while Yellowstone National Park allows private and commercial llama packers (some rangers have even used llamas for maintenance work), Arches and Canyonlands national parks banned all use of llamas in 1994 because of the possible risk of transmitting Johne's disease to bighorn sheep. The International

Llama Association and several independent scientists countered this claim, but the parks upheld the ban in 1995 with no further explanation or evidence of physical or social impacts. (See NPS 1995 Briefing Statement and ILA 1996 Fact/Issue Summary Sheet for more information on this debate.)

COMPARING LLAMA CLIENTS TO HIKERS AND HORSEBACK RIDERS

Characteristic	Trailhead Survey: Hikers (*n* = 209)	Trailhead Survey: Horseback (*n* = 113)	Llama Clients (*n* = 326)
Mean age	37	45	47
Female	34%	32%	62%
Minor disability (e.g., knee or back injury, asthma)	13%	16%	18%
Major disability (e.g., heart condition or back surgery)	1%	2%	2%

Surveying Opinions in the Yellowstone Region

To document the number of hikers and horseback riders who saw llamas in the backcountry and their perceptions of llama-related problems, we used trailhead and mail surveys to collect information about the attitudes of wilderness visitors in the Yellowstone region in 1993 and 1994. We focussed on two areas that receive relatively heavy llama use and present an interesting contrast: the Targhee National Forest's Jedediah Smith Wilderness, which is on the western range of the Teton mountains, just south of Yellowstone and west of Grand Teton National Park, and Bechler Meadows in the southwest corner of Yellowstone. The Jedediah Smith Wilderness is used primarily by local, rural residents, while the Bechler Meadows is a more heavily used recreational backcountry destination. Only 18 percent of the Bechler visitors travel with packstock, compared to nearly half of the Jedediah Smith visitors.

We contacted visitors at trailheads as they were leaving the backcountry and asked them to participate in a mail survey. Surveys were sent to 454 visitors, and the final results are based on 337 useable responses (Bechler: *n* = 182, Jedediah Smith: *n* = 155), representing a 74 percent response rate.

Because there were only nine llama packers in the trailhead survey, we did not use their responses to come to any definitive conclusions about llama packers' characteristics or attitudes. Instead, we conducted a separate, non-random survey of the clients of 14 commercial llama packers in Wyoming, Idaho, Montana, Oregon, and Washington. We received 326 useable surveys from a sample of 354 people, and compared these results to the trailhead surveys of hikers and horseback riders in Bechler Meadows and the Jedediah Smith Wilderness. While it is possible that the characteristics of the growing number of people who are traveling with their *own* llamas differ from those of clients of llama packers, we have no data to indicate how significant their numbers may be.

Characteristics of Llama Packers

The llama-packing clients in our study were similar to wilderness visitors in general: they were uniformly Caucasian and tended to be from middle- and upper-middle class backgrounds. In most socio-economic characteristics, the llama clients were more similar to hikers than to horseback riders. Compared to the Bechler and Jedediah Smith visitors, the llama clients were even more likely to be highly educated, have white-collar occupations, earn more than $50,000 per year, and live in an urban area. However, the llama clients also had some characteristics in common with horseback riders: they were older than the hikers and slightly more likely to have physical disabilities that may hinder their use of the backcountry.

The main difference between the llama clients and the hikers and horseback riders was that two-thirds of the llama clients were women. Most of the llama clients have had wilderness experience—more as hikers than horseback riders—but less overall backcountry experience in the last five years than did the visitors in the Bechler and Jedediah Smith study.

These data tend to support the belief that a more diverse group of visitors is attracted to llama packing, or at least *commercial* llama packing, especially women and older visitors. But they are not new to the backcountry. Llama packing may help provide access for those who have a small amount of experience or are less able to tackle the backcountry on their own. Thus, it appears that llama packing may increase backcountry visitation somewhat, but not dramatically, and it will not attract large numbers of nontraditional users. This conclusion could change if llama *owners* are significantly different from this sample, if special user groups begin to embrace llama packing as a means of backcountry access, or if the expense of owning or packing with llamas decreases in the future.

Trailhead Responses

Encounters. Very few of the 337 respondents to the trailhead survey had had experience with llamas at the time. Only 9 were travelling with llamas during that trip, and only 15 had been on a llama packing trip in the last five years. Nearly one-third (99) of the respondents, however, had met llamas on the current trip, including 29 percent of the Bechler visitors and 32 percent of the Jedediah Smith visitors. As in the California surveys mentioned above (which used the same question format), horseback riders (22 percent) were more likely than hikers (17 percent) to have seen llama packing groups.

Problems. The perception of llama-related problems was very low for hikers and horseback riders in both study areas.

tional" uses in the parks.

Hikers and horseback riders in both study areas gave the most support to the managerial equity items ("Use regulations should be the same for llamas and horses" and "Limits for llamas should be the same as for horses"). Safety problems ("Safety problems exist when llamas meet horses on the trail" and "Llamas should be led off the trail when meeting horses") received the next highest level of agreement overall, especially for horseback riders. They ranked the two safety items as the highest of the 15 by a wide margin. Both hikers and horseback riders were more likely to agree on the statement "Llamas cause little impact on the resources" than with statements on negative physical impacts (llamas may introduce disease and exotic plants or compete with wildlife). Hikers were more likely than horseback riders to feel that llamas were "appropriate" in the backcountry, while horseback riders were more likely than hikers to agree that llamas cause social conflict in the backcountry.

Visitor Perceptions of Backcountry Problems

Problem	Overall Mean (Scale: 1 = no problem to 5 = big problem)	Ranking of Problem (1-18 scale): Bechler	Ranking of Problem (1-18 scale): Jedediah Smith
Horse manure on trail or in camp	2.01	1	5 (tie)
Horse/mule trail impacts	1.94	2	5 (tie)
Too many people at certain locations	1.73	5	4
Litter	1.65	7 (tie)	2
Meeting horses on trail	1.64	3	10 (tie)
Too many horses on trail	1.61	4	14
Human vegetation damage	1.52	6	8
Too many large groups	1.48	7 (tie)	9
Cattle grazing damage	1.42	15	3
Sheep grazing damage	1.44	18	1
Too many hikers on trail	1.44	9	12 (tie)
Not enough firewood	1.41	10	12 (tie)
Human waste disposal	1.39	11	7
Meeting llamas on trail	1.32	14	10 (tie)
Too many llamas on trail	1.28	13	15
Low flying aircraft	1.25	12	16
Llama trail impacts	1.19	16	17
Llama manure on trail or in camp	1.17	17	18

From a list of 18 potential backcountry problems, llama-related issues were ranked 14th ("meeting llamas on the trail"), 15th ("too many llamas on trail"), 17th ("llama trail impacts"), and 18th ("llama manure on tyhe trail or in the campsite") These did not differ significantly between the two study areas. While none of the 18 items were considered to be very serious problems, horse and mule impacts were listed as four of the top ranked problems by Bechler visitors and by hikers who ranked "horse manure" and "horse and mule trail impacts" as the top two problems by a relatively large margin. For example, hikers rated horse manure 2.53 and horse trail impacts 2.49 on a five-point impact scale.

Conflict. Two types of questions adapted from past studies of wilderness behavior were used to investigate the possible conflicts between traditional visitors and llama packers: To what extent did meeting horses/hikers/llamas interfere with your trip? And, did you like or dislike meeting hikers/horses/llamas? Data were reported only for visitors who actually encountered each type of group.

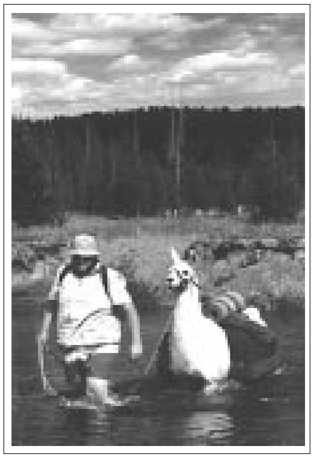
Hikers rated encounters with llamas more negatively than encounters with other hikers but more positively than encounters with horses: 20 percent of the hikers said they disliked meeting llamas (24 percent for horses) and 36 percent said llamas interfered with their trip (51 percent for horseback riders). Horseback riders, on the other hand, rated contacts with other horseback riders most positively, followed by encounters with hikers, and then llama packers: 28 percent said they disliked meeting llamas and 43 percent said llamas interfered with their trip. So while the horseback riders objected more than the hikers to meeting llamas in the backcountry, their attitude toward meeting llamas is similar to that of hikers meeting horses.

Acceptability. Social acceptability is a complex topic. Using a five-point Likert scale, we asked respondents the extent to which they agreed or disagreed with 15 statements designed to assess five aspects of llama packing: 1) physical impacts, 2) social conflict, 3) philosophical appropriateness, 4) managerial equity, and 5) safety. These dimensions were derived from the *Limits of Acceptable Change* wilderness planning process used by the Forest Service and the National Park Service for managing "nontradi-

Implications for Wilderness Management

While these data will not end the llama packing debate, they do provide insights into the visitor perspectives. Traditional wilderness visitors do not view llamas as a major intrusion or problem in the backcountry. Hikers who encountered horses and llamas indicated that the physical and social impacts of horses are more problematic than those of llamas. Horseback riders had some serious concerns about the social aspects of meeting llamas in the backcountry, but they were even less troubled than hikers about the physical impacts.

The horseback riders' concerns appear to result from potential safety problems and, to a lesser extent, questions about the appropriateness of llamas in the backcountry. Hikers had neither of these concerns, and appeared to consider llamas as acceptable in the backcountry as horses. Thus, it could be a mistake to zone the backcountry to restrict all packstock to certain areas, which could exacerbate the potential for conflict if horses and llamas are forced into closer proximity. If



A hiker making good use of the pack llama "Willie" during a river crossing at Bechler Ford in August of 1991.

zoning is needed, it might make more sense to zone one area for horse use and another for hiking and llama packing.

Another important finding of the study was the extent to which both hikers and horseback riders agreed that wilderness regulations should treat llamas and horses the same. Wilderness managers should not assume that a new or "nontraditional" activity like llama packing will be unacceptable to current visitors. To prohibit llama packing because of perceived social or physical impacts without solid evidence would be unfair, especially since most of the potential for social conflict in these two study areas (and probably most backcountry areas) is between horseback riders and hikers. Specific sources of conflict can be identified and addressed. Furthermore, general physical impacts should not be used to justify restricting llama use because one could argue equally well that the impacts of horseback riding are perceived by visitors to be greater than those of llamas. (This perception is supported by recent research conducted at the University of Montana by Tom DeLuca and William Patterson IV.)

In the absence of evidence of negative physical or social impacts, it seems that managers should give llamas and horses equal access and use an educational approach to reduce potential conflicts and physical impacts from both modes of travel. To minimize conflict, horseback riders should be informed when llamas are in the backcountry. Llama packers should be made aware of potential safety problems and appropriate behavior when meeting horses—such as leading llamas off the trail and keeping them still until the horses pass.

FURTHER READING

For information on the general pros and cons of backcountry llama packing:

Russell, R.A. 1993. Developing a strategy in the Forest Service for the use of llamas as alternative pack stock. Unpublished paper prepared for the Professional Development for Outdoor Recreation Program at Clemson University, Clemson, S.C.

USDA Forest Service, Pacific Northwest Regional Office. 1992. Llama use policy background data: Questions and answers related to llamas. Discussion paper, USDA Forest Service Region 6 Office, Portland, Oreg.

For research results on the social effects of llamas:

Blahna, D.J., K.S. Smith, and J.A. Anderson. 1995. Backcountry llama packing: Visitor perceptions of acceptability and conflict. *Leisure Sciences* 17:185-204.

Watson, A.E., M.J. Niccolucci, and D.R. Williams. 1993. Hikers and recreational packstock users: Predicting and managing recreation conflicts in three wildernesses. Research Paper INT-468, USDA Forest Service, Intermountain Research Station, Ogden, Ut.

For research results and discussions of the biophysical effects of llamas:

International Llama Association. 1996. Fact/issue summary sheet on the Southeast Utah Group llama ban. Prepared by the ILA Packing Committee, Denver, Colo.

Patterson, W.A. 1996. The influence of llama, horse, and foot traffic on soil erosion from established recreation trails in Western Montana. Unpublished M.S. thesis, University of Montana, Missoula.

USDI National Park Service. 1995. The restriction of domestic livestock use in Canyonlands and Arches national parks. Briefing Statement of the NPS Southeast Utah Group, Moab, Ut.

The infrastructure for an educational approach already exists at the Bechler trailheads. Rangers meet with all overnight visitor groups at the trailhead to give an interpretive talk on recreational impacts, wilderness philosophy, and safety issues. At more remote locations, signs and pamphlets are being used by agencies to encourage minimum impact travel methods. Llama safety, conflict, and impact information should be added to this information where appropriate.

And finally, the most proactive way to minimize the potential for horse-llama conflicts is to familiarize horses with llamas. Once horses become familiar with llamas, they are less likely to get nervous when they see llamas in the backcountry. Resource managers should work cooperatively with local llama and horse owners to offer workshops on horse and llama safety and conflict issues in areas that receive horse and llama use.

Acknowledgements

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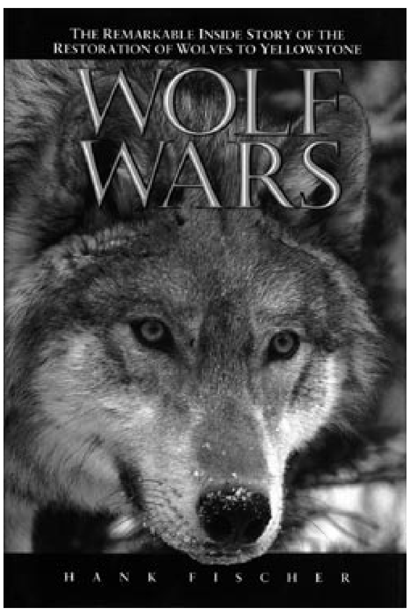
Dale Blahna is an associate professor in the Forest Resources Department at Utah State University. Kari Archibald is a doctoral candidate at Utah State and the Recreation Education Department Chair at Ricks College.

Book Reviews

by Norm Bishop

When the potential effects of restoring wolves to Yellowstone were evaluated in the early 1990s, more than 160,000 people expressed an opinion on the draft environmental impact statement. Although the number of people who've gone on to produce books on the subject is not quite so vast, a great many books have been written since the first shipment of Canadian wolves arrived in Yellowstone in 1995. The four reviewed here are quite different, but are all useful in answering a variety of questions about the wolves and how their restoration began.

Wolf Wars, by Hank Fischer, Falcon Press, Helena and Billings, Montana, 1995, 183 pages. $12.95 (softcover).



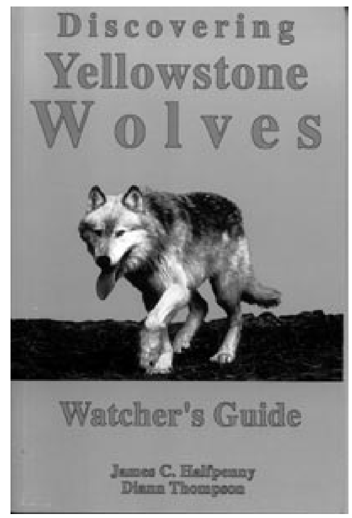
As the northern Rockies representative of Defenders of Wildlife, Hank Fischer was the forward observer for conservationists in the long artillery duel over restoring wolves in this area. His story begins by taking us along on a flight to capture wolves in Canada and then documents the long war against wolves in the West and the attitudes that war produced. He reports on scientists and teachers such as Adolph Murie and Aldo Leopold whose investigations and writings changed public attitudes toward wolves, and examines the role of pioneering wolf scientists—Douglas Pimlott, Durward Allen, David Mech, even fiction writer Farley Mowat—in producing the change of mind that resulted in the Endangered Species Act. Then he introduces the Northern Rocky Mountain Wolf Recovery Team, its stars and its detractors. The book portrays the breadth and depth of opposition to wolf restoration, quoting then- Senator Malcolm Wallop telling former Yellowstone Superintendent Bob Barbee: "Don't even think the 'W' word." Fischer made the rounds of regional Congressional delegations, looking for a ball-carrier, and found unlikely allies in Senator James McClure of Idaho and Congressman Wayne Owens of Utah. Another unexpected champion was William Penn Mott, Reagan's appointee as National Park Service director. Having learned the importance of public support to win political backing, the author promoted the first attitude survey of Yellowstone visitors toward wolf restoration and arranged to get the Science Museum of Minnesota's "Wolves and Humans" exhibit to Yellowstone in 1985.

After several wolves killed five cows and nine sheep near Browning, Montana, in 1987, Mott suggested that conservationists could reduce controversy and demonstrate good faith by sharing ranchers' economic burden. The Defenders of Wildlife agreed to compensate ranchers for livestock lost to wolves in the northern Rockies.

After several years of stalling, Congress authorized preparation of an environmental impact statement (EIS) on reintroduction of wolves to Yellowstone and central Idaho. Fischer recognized that although the EIS was not designed to be voted on, from his perspective it needed "votes" to support the wolf reintroduction proposal, so he and his organization spent considerable effort to engender public support.

But the wolf wars are not over yet. Fischer explains who is suing the government about wolf recovery and why, and reflects on the consequences of the Endangered Species Act and the National Environmental Policy Act. He considers the process of Yellowstone wolf recovery a bad example of species restoration because it was too long, too expensive, and too confrontational. He concludes that we need a process for resolving endangered species issues that brings people together instead of dividing them. Fischer's book illustrates the struggle of wills that led to reintroduction, the philosophies, and the personalities involved.

Discovering Yellowstone Wolves: Watcher's Guide, by James C. Halfpenny and Diann Thompson, A Naturalist's World, Gardiner, Montana, 1996, 58 pages. $10.50 (softcover).



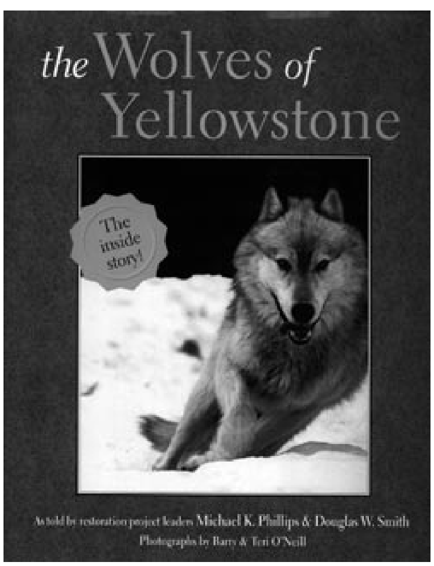
At specific events we hear, "You can't tell the players without a program!" James Halfpenny and Diann Thompson have given wolf watchers the program, with some up-close and personal looks at the wolves and some excellent wolf natural history as well, all in a readable pocket encyclopedia.

They tell how to watch wolves safely and considerately, and how to keep the animals safe, too. They identify the family trees of the wolves and their life histories through May 1996. They tell the pack composition of wolves released in 1995 and 1996. Using photographs of the wolves, they show which are the alphas, adults, yearlings, and pups. They provide maps showing where the packs have spent their time since release. From film by cinematographer Bob Landis, they bring us the drama of a kill by two yearling wolves in the Crystal Creek pack.

In snapshot album form, we learn of "People and Events and Views from the Field." The authors brief us on the history of wolf restoration, the reintroduction process, and where the wolves came from. They compare hard and soft releases, noting that as predicted, wolves held in pens and then released traveled fewer miles back toward Canada than did the wolves released without acclimation in Idaho. They explain how to tell wolves from coyotes, and provide the basics on wolf biology, evolution, taxonomy, ecology, growth, and development, all with imaginative graphics and tabulation. Book sections include "Who's Who in Restoration," and "A Note from Restoration Leader Mike Phillips," who lays out the post-release studies needed, speaks to the lack of funds available to carry out the studies, and lists organizations through which interested people can help.

Halfpenny and Thompson offer wolf watchers a means of recognizing and enjoying the wolves, as well as a good primer on wolf ecology. Because pack composition has shifted and additional pups have been born in 1997, an insert is available that will be sold with future books to bring the wolf data up to date though May 1997. Serious wolf watchers can hope these annual updates continue. All told, this is an admirable little publication.

The Wolves of Yellowstone, by Michael K. Phillips and Douglas W. Smith, Voyageur Press, Stillwater, Minnesota, 1996, 125 pages. $24.95 (hardcover).



This book is billed as "The inside story!" and it is. It's also an adventure story—about the individuals involved in the restoration—and it includes their different perspectives on their roles and experiences. Michael Phillips was wolf restoration leader for Yellowstone National Park, and Douglas Smith the project biologist. The book is told in their voices, with sidebars from many other voices involved in the restoration. This enables the reader to meet the participants.

Barry and Teri O'Neill furnished the striking photographs and founded the Call of the Wild Foundation to raise funds, provide information, and generate support for wolf restoration. In attempting to record the historic moment the first wolf left an acclimation pen, they pioneered wolf photography under extraordinary conditions: "Night shot. No flash. No moon. No way." But, with five cameras, three shutter beams, and three relay remote units, they succeeded in getting "180 photographs of a startled biologist."

Although the book reports in some detail on the technology and procedures of capturing, holding, releasing, and monitoring wolves, the authors not only avoid techno-speak, they wax poetic and philosophical, and share their rationale about why they did things the way they did. Phillips takes us through the processes of translocation, acclimation, and release. He recounts the relocation of wolves from Alberta and British Columbia to Yellowstone and central Idaho and how the wolves' safety and health were assured by a veterinary staff. He mentions the financial support from the Wolf Education and Research Center in Boise, Idaho, Defenders of Wildlife, and private donors, without whom the federal government could not have covered the costs of capture and translocation in 1996.

Smith shifts our attention from the tensions of last-minute legal wrangling to a description of the wolves themselves: BIG, including a 130-pound male and a 115-pound female from British Columbia in 1996. Smith narrates the efforts involved in constructing the acclimation pens which would hold the wolves long enough to discourage them from trying to return home. Feeding wolves for 10 weeks was a monumental task, but the acclimation worked; Smith tells how after several days of chewing on the fences, the wolves adapted to captivity, eating all the road-killed wildlife hauled to them and even breeding in the pens. That the wolves had acclimated was further demonstrated when the pen doors were opened. The wolves didn't leave immediately, except for alpha male #10 in 1995, who surprised the wolf project team by howling at them outside his pen as they approached.

A description of the killing of male wolf #10 takes us back to the war on wolves that took place even in Yellowstone. Number 10's death received great attention because he was the first Yellowstone wolf to be killed, outside the park by a "local" Montanan, and because the wolf left a brood of newly born pups on private land. The case of #10 highlighted the conflicting viewpoints that many greater Yellowstone area residents hold about wolves. Recognizing that wolf restoration is not just a biotechnical process, Phillips writes, "We can ensure that wolves are restored in a manner that is respectful of local folks...Without local support, or at least local tolerance, the restoration program will forever remain a struggle."

It took 10 days for the Crystal Creek wolves to ease out of their pen. Smith writes: "Slowly, and on their terms, the wolves were making the transition from captivity to freedom…This was perfect." What would the wolves do? Where would they go? Smith recounts how he learned the wolves' markings and personalities during acclimation. After release, the wolves stayed near the pens for several days, then explored north, returned, and settled down again in the park. Acclimation in the pens appeared to deter the wolves from making long trips to the north, as wolves released without acclimation in Idaho did. Pack by pack, wolf by wolf, radio locations enabled Phillips and Smith to track the day to day movements of the wolves. And from April to July, up to 4,000 park visitors watched the wolves in Lamar Valley.

In describing the November 1995 kill of a crippled elk cow by two yearling wolves, Smith observes, "The myth, the hatred, and love of wolves largely stems from how we view their killing…Indeed, a world without suitable wolf country would be a world not worth inhabiting." He presents wolves as predators and as feeders of scavengers—ravens, magpies, coyotes, and grizzly bears. "The wolf kills are a boon to the ecological community of Yellowstone."

Phillips recounts the lessons he had

learned in restoring red wolves in North Carolina and in dealing with wolves that kill livestock. He relates to the livestock owners, and sees the positive side of the demise of the first Yellowstone wolf to be removed for depredation.

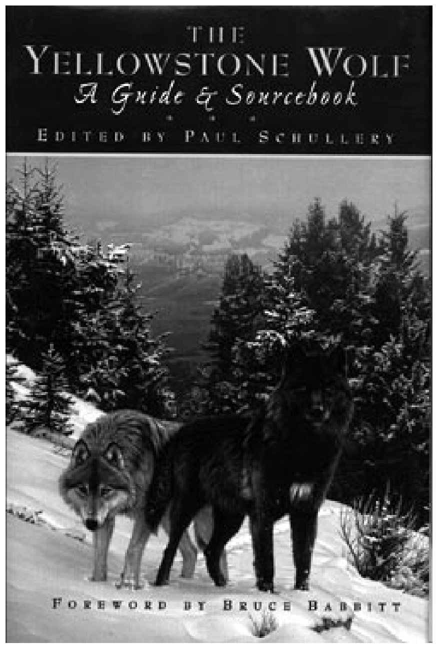
The final chapter tells the dramatic story of interaction between the Soda Butte wolves, a cow moose, and a grizzly bear, as a hint of the biological significance of wolf restoration: "to reshape ungulate populations, with considerable direct and indirect influences that ripple through the ecosystem…Elk and deer are what they are due to eons of attendance by wolves."

Comments from fifteen players in the wolf restoration drama are sprinkled liberally through the book. Here are a few examples:

- Upon touching the wolf she was carrying to the pen, Mollie Beattie, the late director of the U.S. Fish and Wildlife Service, said, "I was moved by the feel of that inch circle of fur and flesh as by any deep mystery of the earth seen in its fullness. An instinct of the rightness that the wolves were here now swept over me."
- Wildlife veterinarian Mark Johnson described his role as providing "healing for wolf populations long persecuted; healing for Yellowstone and Idaho ecosystems…; and healing of a distracted culture…"
- After helping to load the Canadian wolves bound for Yellowstone and central Idaho, wolf scientist L. David Mech said "I heaved a huge sigh of relief. And of elation and joy…My companions and I stood misty-eyed as we watched the plane disappear southward on its historic mission. Wolves had returned to the West."

The book tells readers the status of Yellowstone's wolves up through early 1996, after which time readers must seek other more current information sources to keep track of the success of the project. The authors note that "In December 1994, no wolves inhabited Yellowstone…It is entirely conceivable that fifty wolves will lay claim to Yellowstone and its environs by Christmas 1996." (The actual count turned out to be 53, and would grow again with another season of wolf denning and reproduction to come in spring 1997). And the wolves are becoming more integral players in the ecosystem dynamics of the Yellowstone area every day.

The Yellowstone Wolf: A Guide and Sourcebook, edited by Paul Schullery, High Plains Publishing Company, Worland, Wyoming, 1996, 354 pages. $32.50 (hardcover).



As a writer-editor, an interpreter, and a historian, Paul Schullery is a professional, and this work shows it. Schullery says that the book was written to counter the common knowledge mythology that arises around an important biopolitical event like wolf restoration. One such myth: "See, the Feds told us they'd keep the wolves all in the park, and they didn't—can't trust 'em." Nowhere in any written publication or oral presentation did the federal officials involved in wolf restoration say any such thing. In fact, they repeatedly emphasized that the reintroduced wolves would not stay in the park, and included all of Wyoming and large parts of Montana and Idaho in the experimental population area. That's the sort of information you'll find documented in this book.

What is offered by no other Yellowstone wolf book is Schullery's precise historical accuracy and solid documentation, coupled with an interpretation of the historical context. No other author has the breadth, depth, and grasp of Yellowstone's distant and recent past. By studying, among other things, nearly 200 writings of the period 1806-1881, the paleontological record, and related scientific works, he discerned that wolf populations in Yellowstone, (quoting Superintendent Norris, 1881) "were once exceedingly numerous in all portions of the Park," and that they had been greatly reduced by 1880, long before an apparent resurgence of wolves was met with a determined effort to eliminate them. In fairness, Schullery warns us that his book "has a different purpose than a narrative history. This book will give you a good idea what many participants in the Yellowstone wolf story have said, but no one book can tell it all." So, he includes a list of 23 suggested readings.

After summarizing recent wolf research and natural history, Schullery presents the archeological and paleontological evidence to undergird the historical evidence that wolves are indeed native to Yellowstone. He incorporates scientists' discussions of prey bases and the effects restored wolves were predicted to have on their prey. One conclusion, Schullery points out, "is that the Greater Yellowstone Ecosystem provides an exceptional prey base....Another is that…there is no reason to expect the sort of apocalyptic havoc presented by some opponents of wolf restoration. A third…is that this system…is so complex that whatever effects wolves will have will be hard to measure with much precision, because of the 'background noise' of all the other factors that are at play." The book has 58 chapters that get into wolf control and management, law and policy, and the arrival and release of the wolves. Schullery's book is a must for the person who needs the documentary history of Yellowstone's wolves and their restoration.

Norman Bishop, a recently retired Yellowstone National Park resources interpreter, recounts numerous memorable moments along the path of wolf restoration: following hundreds of wolf tracks, seeing and hearing the wolves, watching them kill elk, chase coyotes, and tease grizzly bears—each a once-in-a-lifetime experience.

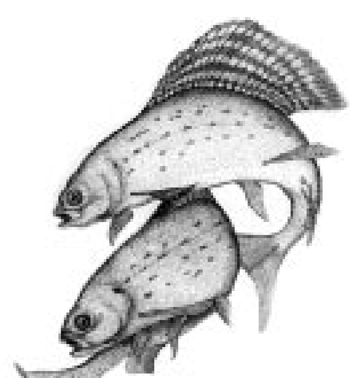
Memorials Honor Park Geologist

A memorial fund in honor of the late park geologist, Roderick A. Hutchinson, has been established to support geothermal research in Yellowstone. Interested persons may send donations to The Rick Hutchinson Geothermal Research Fund, c/o Public Affairs Office, P.O. Box 168, Yellowstone National Park, Wyoming 82190.

Also, a symposium entitled "Geoscientific Studies in Yellowstone National Park in the 1990s—A Symposium Honoring the Late Rick Hutchinson, Park Geologist, 1976 to 1997" is planned for the American Geophysical Union (AGU) meeting in San Francisco, California, this winter. Rick regularly attended the annual meeting to represent Yellowstone and keep abreast of developments in his profession. The symposium will provide an opportunity to gain a better understanding of current geologic and hydrologic conditions in the park and of the natural processes that are bringing about change in and around Yellowstone. The seminar is being organized by Dr. Robert Fournier, consultant and retired U.S. Geological Survey (USGS) employee; Nancy Hinman, Department of Geology, University of Montana; and Mike Thompson, also retired from the USGS.

Park Proposes Native Fish Restoration

Yellowstone National Park has released a proposal and environmental assessment that outlines the alternatives and rationale for restoring indigenous westslope cutthroat trout and fluvial Arctic grayling to park waters. Westslope cutthroat trout remain only in remnant groups or as hybrid populations with exotic rainbow or other races of native cutthroat trout. Although grayling exist in lacustrine form in Grebe and Cascade lakes, the fluvial form no longer exists in the park and is extremely limited in its historic range in the upper Missouri River drainage. Although no site-specific plans have been developed, methods of restoration may require restocking natives into streams in which exotic fish species have been removed by electrofishing, chemical treatment, netting, trapping, and/or sport fishing. Restoration may also require constructing barriers to prevent re-entry into a project area by exotic species. Initially, native species restoration would focus on small tributary streams of the Madison, Gallatin, and Gibbon rivers. The pilot reintroduction project for westslope cutthroat trout would occur in Canyon Creek, a small tributary of the Gibbon River just downstream from Gibbon Falls. According to a 1889 fisheries inventory, Canyon Creek was the easternmost extent of historical westslope cutthroat trout range in Yellowstone National Park and contained an abundant population of cutthroat. By the mid-1970s, the cutthroats were gone from Canyon Creek, probably due to competition with non-native fishes. Canyon Creek was chemically treated to remove non-native trout and a barrier was constructed as part of an attempt to restore Arctic grayling in the mid-1970s. Although the grayling restoration failed, westslope cutthroat restoration is expected to succeed due to the high-quality trout habitat in the creek. It is anticipated that, once restored, westslope cutthroat trout would drift downstream from Canyon Creek and potentially contribute to the establishment of a mainstream population.



John Varley

Comments on the fisheries restoration proposals should be addressed to: Natural Resources, Native Fishes EA, P.O. Box 168, Yellowstone National Park, Wyoming 82190.

Biologists Testing New Method of Studying Grizzly Bears

In 1995, a cooperative pilot study to sample DNA from grizzly bear hair was begun by the Yellowstone Grizzly Foundation (YGF), the Interagency Grizzly Bear Study Team (IGBST), and Yellowstone National Park. One objective of the study is to develop an alternative method for estimating minimum grizzly bear population numbers within portions of the ecosystem. The study is testing hair-collection corrals as a cost-effective way and non-intrusive method of collecting bear hair for DNA analysis and estimating the number of bears using a sample area. Currently researchers must trap and radio-collar bears to derive a minimum population estimate.

In 1996, the study was expanded to include the Wyoming Game and Fish Department and the Shoshone National Forest and concentrated on determining the most effective, easy-to-handle lure for attracting bears to the hair-collection corrals without giving the bears a food reward. Hair-collection corrals consist of four-pronged barbed wire strung tightly around three to four trees. Colored flagging is tied inside the corral as a visual lure and a tree in the center of the corral is basted with attractant suspended four meters above the ground. Each clump of hair pulled from a barb (considered one sample) is picked off with a gloved hand, put into labeled envelopes, and sent to a lab for DNA extraction and analysis. Eight hair collection sites were placed in the Hayden Valley, 16 in the Shoshone National Forest, and 36 in the Bridger Teton

National Forest. Of the four potential bear attractants (blood, rumen, fatty acid scent, and commercial shellfish scent), blood appeared to be the best scent for attracting bears to the hair-collection sites.

This year, with funding provided by Canon USA, Inc., the study will include selected Yellowstone Lake spawning streams studied from 1985-1987. The 1997 revisits will determine individual bear use by track measurements and will cross-check these findings with the number of individual bears found using the streams through samples from hair-collection corrals. Fourteen corrals have been set up on nine spawning streams. Each stream is visited at least once every two weeks by biologists who count the number of fish in the stream and bear-associated fish remains, measure bear tracks, note other animal tracks and stream width and depth, collect bear scats for food content analysis, and check hair-collection corrals.

Cutthroat trout, an important food source to grizzly bears during the trout spawning season, are imperiled by the increasing numbers of lake trout, which have proliferated since their illegal introduction into Yellowstone Lake. This year's research will also look at changes in fish numbers and associated bear use of these streams since 1987.

Physical Sciences Conference to Be Held in September

An interagency conference, featuring topics related to continuing studies of baseline geochemistry, natural features, and historic mining activities in the Soda Butte Creek watershed will be held September 9-11, 1997, at the YACC facility in Yellowstone National Park. The conference invites papers and presentations from the fields of geology, geochemistry, geographic information systems (GIS), geologic mapping, geothermal resources, geophysics, biology, biochemistry, hydrology, and limnology related to the theme. For more information, email mhektner@nps.gov, or contact organizer and moderator Daniel Norton of the USGS at MS 973, P.O. Box 25046, Federal Center, Denver, Colorado 80225, (303) 674-5150.

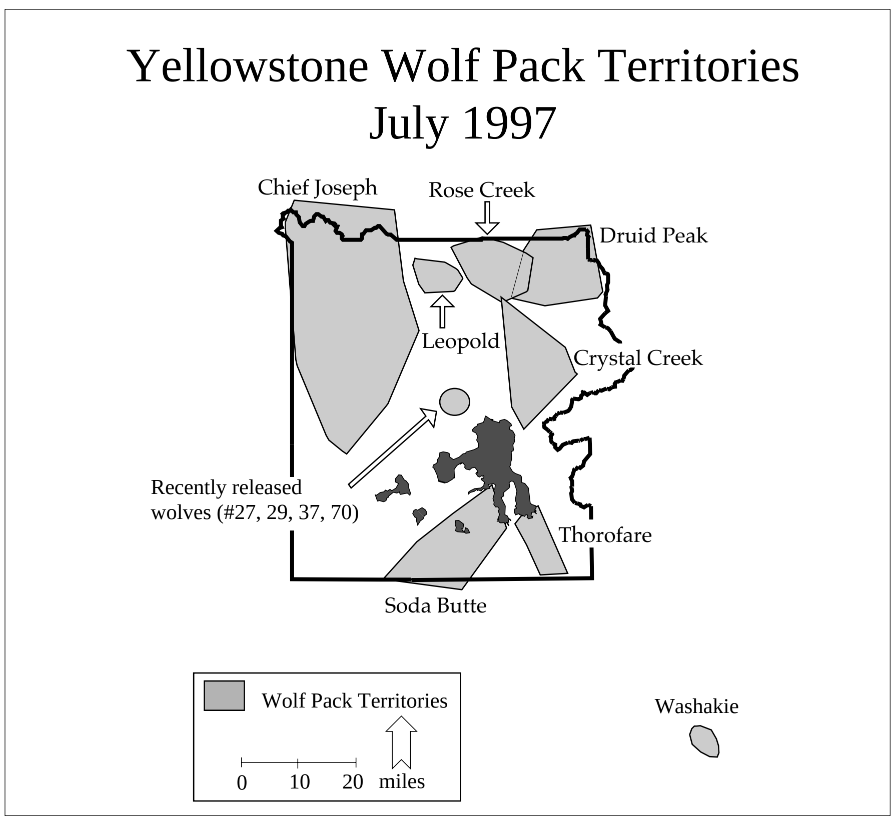
Wolf Population Thriving

The gray wolf population in and around Yellowstone National Park has thrived since restoration began in January 1995. Wolf project staff conduct aerial telemetry flights to monitor the wolves' movements about once a week. Crews also monitor several dens through ground observations and use of telemetry. As of July 1, 1997, the whereabouts of at least 45 free-ranging wolves were known; another four to five wolves were not being regularly radio-located. Although only nine established wolf packs exist, at least 12 females had litters this spring. Three of the packs had produced multiple litters which, while documented in the literature, is unusual. Biologists do not attempt to determine the number of pups produced if such observations would disturb the wolves. It may be next winter before the number of surviving pups is determined for many of the packs.

Most, but not all, of the Yellowstone area wolf population are radio-collared. Biologists are hoping that the alpha pair of each pack and 30 to 50 percent of the wolves born in the wild each year will be captured and radiocollared to facilitate monitoring and research. Trapping would occur in mid-winter when pups were large enough to be safely trapped and collared.

The Rose Creek pack produced three litters this spring, but a two-year-old female was killed in an apparent encounter with the Druid Peak pack on or about April 19. Her den contained the remains of four pups that had died of exposure and malnutrition. Two other females also established dens and produced litters of seven and nine pups; the pack also includes at least seven adult members. The Druid Peak pack contains six adult wolves tending two dens in the Lamar Valley; at least five pups had been observed by early July. In the Leopold pack, the alpha pair and three yearlings remain in the Blacktail Plateau area where they tend a litter of at least five pups.

The Crystal Creek pack includes a breeding pair, which has lived in Pelican Valley since summer 1996, and an unknown number of pups. Two adult females and a yearling male and female in the Soda Butte pack remain in the Heart Lake area, where they wintered. The old alpha male of the pack died of natural causes in March after fathering another litter of pups.



The Chief Joseph pack produced two litters of five pups each in the northwest corner of the park this spring. One of the adult females died in July of natural causes, leaving two remaining adults. The newly named Thorofare pack wintered south of Yellowstone Lake, apparently killing moose, and denned near a beaver colony on the Yellowstone River. The den site, with an unknown number of pups, was flooded out and relocated during spring runoff. This pack includes an adult female and the male originally referred to as part of the short-lived Lone Star pair; his original mate apparently died of thermal burns shortly after release in 1996.

A wolf pair that wintered together and denned northwest of Dubois, Wyoming, has been named the Washakie pack. They are tending an unknown number of pups.

A wolf formerly of the Chief Joseph pack has formed a new group in the western portion of the park that includes some of the Sawtooth yearlings. As of mid-July this group was being referred to as the Nez Perce/Sawtooth yearlings.The original Nez Perce alpha female was summering in Hayden Valley with several other wolves released from the Nez Perce pen on June 9, 1997. The group included an adult male, a two-year old juvenile and two yearling males until one of the latter was hit by a vehicle and killed on July 14, 1997.

Several lone wolves were also being monitored around the ecosystem.

To date, 24 wolves have been killed or removed from the wild in greater Yellowstone since wolf restoration began. This includes 4 that died in collisions with vehicles, 1 removed by managers for livestock depredation, 2 killed legally by ranchers who caught wolves preying on livestock, 4 that were killed illegally, 7 that died of natural causes, and 4 pups that died in the dens, 1 that was injured in a management trapping effort and subsequently sent to a captive facility, and 1 killed in coyote trap. During planning for wolf reintroduction, biologists predicted 10 percent of the wolves in the recovery area would be removed in agency control actions, and that another 10 percent would die from various causes. The original estimate was that 27 wolves would exist in each reintroduction area by the fall of 1996.

The first technical report, summarizing activities and data from the first two years of the project, is being prepared for release later this summer, along with a monitoring plan and guidelines for research on wolves. Other planned publications will describe the demographics and behavior of Yellowstone's wolves, wolf-elk interactions, and wolf predation on bison. The project is making extensive use of volunteer staff and developing a scholarship in honor of Mollie Beattie.

New World Mine Deal Not Settled

While visiting Yellowstone in August 1996, President Clinton announced a proposal to stop the New World Mine, a large gold, silver, and copper mine planned by Crown Butte Mines, Inc., three miles outside the northeast corner of Yellowstone near Cooke City, Montana. The federal government agreed to give $65 million worth of federal properties to Crown Butte in exchange for the mine properties. From the $65 million, $22.5 million must be returned to the project site for cleanup of existing pollution.

Efforts to swap land or mineral reserves have fallen through because of problems finding and liquidating comparable properties. In March 1997, the White House proposed to give Crown Butte $65 million in cash from revenues generated by existing federal coal, oil, and gas leases in Montana. Royalty losses from this deal would have been offset with cuts in payment to farmers in the Conservation Reserve Program. Crown Butte agreed to this offer, pending Congressional approval, but it met with fierce opposition from Midwest legislators. Another holdup is that as part of the buyout agreement, Crown Butte must turn over title of its lands to the federal government. Crown Butte leased portions of land in the New World Mining District owned by Margaret Reeb, a Livingston, Montana resident, who has not agreed to sell her lands to anyone. In May, the White House and Congress agreed that funds for the deal should come from the Land and Water Conservation Fund, established in 1965 "to assist the States and federal agencies in meeting present and future outdoor recreation demands and needs of the American people." The fund is supplied primarily by sales of federal surplus real properties, a small part of motorboat fuel taxes, and Outer Continental Shelf revenues from leasing of oil and gas sites in coastal waters. The act stipulates that not less than 40 percent of every annual appropriation from the fund go toward acquisition of recreation and conservation lands specifically authorized by Congress within national parks, wildlife refuges, national forests, and Bureau of Land Management areas. The $65 million for the Crown Butte buyout was to have been part of a larger budget proposal providing $700 million in the Land and Water Conservation Fund over the next four years. In June, the House Appropriations Committee passed a budget measure but failed to earmark the $65 million. The Senate could still approve the funding and will likely consider matters connected with the mine settlement in July.

Keeping Ourselves Green

We appreciate the concern expressed by alert readers that this magazine is not printed on recycled paper. Despite our failure to display this information in every issue, *Yellowstone Science* has since its inception been printed on recycled paper with a linseed oil-based ink. The current stock used contains a minimum of 50 percent recycled fiber, including 15 percent post-consumer fiber.

Early Fishing in Yellowstone

Until recently, we had no hard evidence that prehistoric people in Yellowstone used fish for food. Although nets, spears, and weirs are not necessary to catch cutthroat when they are spawning, inventories along the Yellowstone River have recovered glacially rounded cobbles with notches on opposite sides which are typically interpreted as net sinkers—used to hold a net in place in a large stream or other body of water.

At two sites tested along the Yellowstone River in 1989, bulk samples were removed for water screening in the laboratory, a process that pushes sediment through a fine screen to recover very small materials, including fish and rodent bones. At one site, sucker (*Catostomus* sp.) and unidentified fish bones were found in the matrix from a roasting pit, along with bones representing ten taxa. Bones were identified from elk, bison, indeterminate deer, antelope, or sheep, mountain sheep, and a variety of rodents. This cooking feature dates to 1180 years B.P.

At a second site, one test unit contained more than 1,100 faunal specimen representing 15 taxa, including grouse, bison, deer, bighorn sheep, ground squirrels, and two fish, trout (*Oncorhynchus* sp.) and a sucker. Because of surface erosion, it was not possible to identify the sucker bone to species. (Three species of sucker are currently present in the waters of the Yellowstone ecosystem.) The cultural deposit from this site probably dates from before A.D. 562-676 due to the high probability for mixing of young and old charcoal in the radiocarbon sample.

Fish remains have been rare in archeological sites for at least three reasons. Yellowstone soil tends to be acidic and therefore destructive of bone. Also, very little excavation or testing has been done, and because few of the excavations that have been done expected to recover fish bone, the fine screening necessary to recover it was not used.

As more archeological inventory and evaluation is conducted along the Yellowstone River in the coming years, investigators will tailor collection procedures to increase the likelihood of recovering fish bone. Fish bones were recovered in archeological context in Grand Teton and Glacier, and net sinkers have also recently been found in Grand Teton, Glacier, and Waterton Lakes national parks. As researchers learn how and where to look for prehistoric fishing, they are likely to find more of evidence of this activity.

Researchers to Try and Detect Bison *Brucella* from Blood DNA

A consortium of independent molecular biologists is investigating a highly sensitive and specific diagnostic test for detecting the bacterium *Brucella abortus* from blood and environmental samples obtained from ongoing bison research in Yellowstone using the Polymerase Chain Reaction (PCR) technique. The investigators also plan to conduct a genetic sequence analysis of wild and domestic strains of *B. abortus* to determine the extent of its genetic diversity. Much of the equipment, reagents, and technical skills needed for the project have been generously provided or loaned by cooperators. Since December 1996, they have set up a PCR field lab at Yellowstone; collected more than 200 samples of bison blood for future DNA analysis; collected 19 strains of *Brucella* species' DNA for comparison using gene-sequencing technology; obtained six PCR primers and developed protocols for determining whether *B. abortus* DNA can be detected from unknown samples; and begun to compare strains of *B. abortus* from wild bison and domestic cattle to genotypic differences.

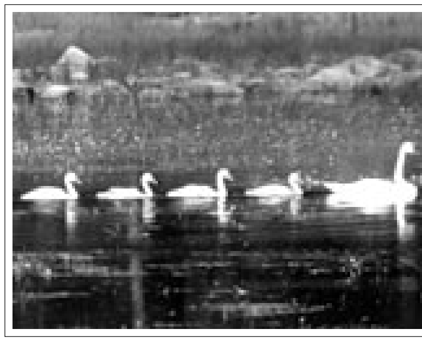
The results of this research should contribute information to help answer questions about the pathogenicity of brucellosis and the risk of disease transmission between wild bison and domestic cattle—issues that relate to long-term management of bison in and around Yellowstone National Park.

More Information Needed about Lynx

In May 1997, the U.S. Fish and Wildlife Service reassessed the status of Canada lynx (*Lynx canadensis*) in the contiguous United States. The agency found that the presence of lynx could only be confirmed in four states—Montana, Wyoming, Washington, and Maine—and that the magnitude of threats to the remaining small population of Canada lynx in the lower 48 states is high and ongoing. The review concluded that listing of the lynx as a protected species under the Endangered Species Act was warranted, but precluded by higher priority listing actions in the region.

Park staff receive occasional reports of lynx observations within or near Yellowstone National Park; however, sighting reports are difficult to confirm due to the variability of sighting conditions and observer knowledge and experience. According to Consolo Murphy and Meagher (in press), physical evidence of the presence of lynx in the park is almost non-existent. A search of museum specimens revealed no lynx taken from within the park present in Yellowstone's natural history collections, and the park's photo collection contains no lynx photos taken locally. The Smithsonian Institute's collections include one lynx skull collected in Yellowstone in 1904; unfortunately, no site-specific location information is on the specimen tag.

Trumpeter Swans' Existence Remains Tenuous



Trumpeter swans remain in Yellowstone National Park only in low numbers, and with little nesting success. Of five nesting attempts in 1997, three have failed as of a July 8 aerial survey, which revealed only 23 adults remaining in the park.

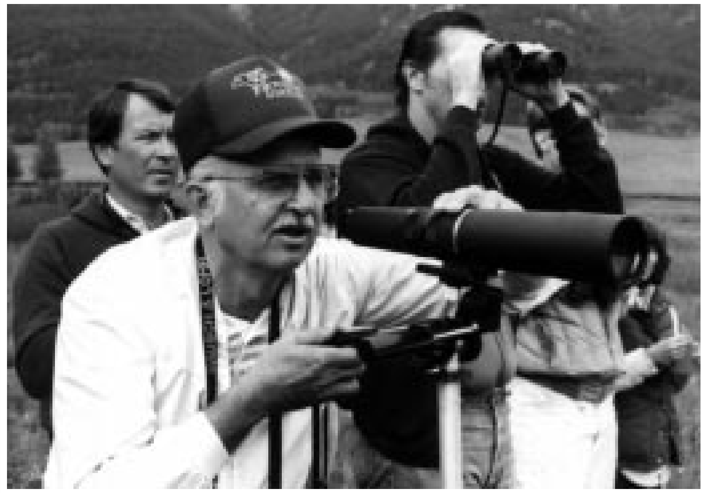
Swans at Seven Mile Bridge, between Madison and West Yellowstone on the park's west entrance road, have been rewarding visitors with viewing opportunities for years. This spring, in spite of record flooding on the Madison River, the resident pair of trumpeter swans hatched two cygnets from five eggs. The nest's success was aided by installation of a floating-nest platform constructed by the park's bird biologist, Terry McEneaney, with assistance from area maintenance staff. Unfortunately, around June 30 the two cygnets disappeared, probably victims of predation; however, human disturbance has not been ruled out. Anyone with information about the cygnets' fate is asked to contact (307) 344-2222 or write Terry McEneaney at P.O. Box 168, Yellowstone NP, Wyoming, 82190.

Errata

In the previous issue of *Yellowstone Science,* Vol. 5(2), an editorial error was made in the article on **Harlequin Ducks: Noble Ducks of Turbulent Waters.** The opening sentence should have read: "The setting is a rainy *winter* day along the rocky coastal shores of the Pacific Northwest." As explained in the article, harlequin ducks are essentially a sea duck and only *summer* in Yellowstone; they migrate elsewhere for the winter. The editors regret the error, which should not reflect on the author of the article.

Yellowstone Institute Instructor Dies

Photo courtesy Yellowstone Institute



Long-time Yellowstone Institute instructor and former ranger-naturalist Richard F. Follett died on July 1, 1997, after a year-long battle with cancer. He was 61. Dick, an award-winning elementary school teacher from Santa Rosa, California, worked as a seasonal ranger-naturalist at Mammoth Hot Spring from 1970-1976. Among his other accomplishments, he helped develop the Fort Yellowstone living history program. He then became an instructor with the Yellowstone Institute, returning the next 19 summers to teach his very popular bird class. Dick was the author of two national park bird books, one for Yellowstone-Grand Teton, the other for Crater Lake. Through his deep devotion to Yellowstone and the quiet strength and wisdom he shared so freely, Dick introduced many people to the park's wonders. In the best sense a member of the Yellowstone family, Dick leaves a legacy of many friendships and a heightened public awareness of all the park stands for. He is survived by his wife, Peggy, four children, and fourteen grandchildren. Donations in his memory can be made to the Yellowstone Institute, P.O. Box 117, Yellowstone Park, WY 82190 (checks payable to the Yellowstone Institute—Dick Follett Memorial).

PUBLICATIONS AVAILABLE

The Yellowstone Center for Resources has established a report series to help convey information about natural and cultural resources in Yellowstone. In addition, special reports may be produced on key issues. Copies of these reports, while the supply lasts, are available via email: HTraucht@nps.gov or by calling (307) 344-2203.

Special Reports:
Yellowstone's Northern Range: Complexity and Change in a Wildland Ecosystem. YNP, 1997.
Effects of Grazing by Wild Ungulates in Yellowstone National Park. Singer, F.J., ed. NPS, 1996.
The Yellowstone Lake Crisis: Confronting a Lake Trout Invasion. Varley, J. and P. Schullery, eds. YNP, 1995.

Natural Resource Series:
YCR-NR-96-1 *Thermophilic Microorganism Survey.* YNP.
YCR-NR-96-2 *Soils of Yellowstone National Park*, by A. Rodman, H. Shovic, and D. Thoma.
YCR-NR-96-3 *Landforms of Yellowstone National Park*, by H. Shovic.
YCR-NR-96-4 *Long-term Sagebrush Dynamics and Ungulate Use at Selected Locations on the Northern Range of Yellowstone National Park*, by J. E. Norland and J. J. Reardon.
YCR-NR-96-5 *Pronghorn Distribution in Winter 1995-1996,* by J. and E. Caslick.
YCR-NR-96-6 *Grazing and Competition in Montana Grasslands*, by L. L. Wallace.
YCR-NR-97-1 *Beaver Survey, Yellowstone National Park 1996* by D.W. Smith, S. Consolo Murphy, M.K. Phillips, and R. Crabtree.
YCR-NR-97-2 *Geothermal Resources of Yellowstone National Park, 1993-95* by T. Thompson and R. A. Hutchinson.
YCR-NR-97-3 *Geologic Publications and Articles Related to Yellowstone National Park: An annotated bibliography* by R. A. Hutchinson.

In preparation:
YCR-NR-97-4 *Wolf Restoration in Yellowstone National Park, 1995-1996: Progress Report* by M.K. Phillips and D. W. Smith.
YCR-NR-97-5 *Paleontological Resources of Yellowstone National Park* by V. Santucci.

People and Place: The Human Experience in Greater Yellowstone

Fourth Biennial Scientific Conference on the Greater Yellowstone Ecosystem
October 12-15, 1997
Mammoth Hot Springs Hotel, Yellowstone National Park
Wyoming 82190

The Conference Series

The National Park Service and Montana State University-Bozeman are pleased to sponsor the Fourth Biennial Scientific Conference on Greater Yellowstone. The purpose of the conference series is to encourage wide-ranging, high caliber research on the region's cultural and natural resources by providing a forum for scholars from all disciplines to present and discuss research findings. In honor of Yellowstone National Park's 125th anniversary, this conference will be devoted to an examination of the human experience in the region with particular emphasis on understanding and preserving Yellowstone's cultural resources, architecture, literature, photography, and the history and philosophy of the national park idea.

The Aubrey L. Haines Luncheon and Lecture

This lecture, presented for the first time at this conference on the Greater Yellowstone, honors Yellowstone's foremost historian and author of *The Yellowstone Story*. This year's lecture will be given by Peter Nabokov, Department of World Arts and Cultures of the University of California, Los Angeles.

The A. Starker Leopold Lecture Series

This lecture series honors the memory and distinguished career of A. Starker Leopold (1913-1983) a leading ecologist and advisor to the national parks. T. H. Watkins, Wallace Stegner Professor of Western American Studies, Montana State University-Bozeman, will present this year's Leopold Lecture.

The Superintendent's International Luncheon

During each biennial conference, the Superintendent's International Luncheon and Lecture seeks to place the Greater Yellowstone in global context by providing comparative insights from around the world. Donald Worster, Hall Distinguished Professor of History, University of Kansas, will present this year's luncheon address.

Dessert Reception and Lecture

Following a dessert reception, a lecture by noted historian of the American West Patricia Nelson Limerick (invited).

Registration

To register, visit the conference website at http://www.montana.edu/wwwcf/BCGY/ or call (406) 994-3333.

Yellowstone Science
Yellowstone Center for Resources
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Yellowstone National Park, WY 82190

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