YELLOWSTONE SCIENCE

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The Rewards of Adventurism:
An Interview with John D. Varley

Grizzly Bear Nutrition and Ecology

Do (Not) Feed the Bears

NPS PHOTOS

Dr. Thomas Brock at Black Sand Pool, 1995. *Above:* lodgepole pine post-1988 fire succession. *Right:* wolf with bison, 2003.

Look for Winners

SIX YEARS AGO, when John Varley and Wayne Brewster hired me, John gave me a piece of advice. "Look for winners—visionary projects where you can get out ahead of the pack and get some open field running." John took his own advice seriously. He looked for—and found—more than his fair share of winners during his long career in Yellowstone.

John seldom met a science project that he didn't like. He believed in science, that good science helped managers make good decisions, that one of the functions of parks was to host science, that park ecosystems needed to be studied and understood. For John, science wasn't simply his vocation—it was his avocation. I would often see researchers sitting in his office at his table piled high with journals, manuscripts, and books, downloading their discoveries about the park's resources. I suspect John remembers those visits as some of his best moments on the job.

John believed that making scientific information about Yellowstone's resources accessible was as important as gathering it. To that end, he initiated the Greater Yellowstone Biennial Science Conference series and this publication. John held a staggering amount of knowledge about Yellowstone in his head, and he shared it generously. Some of my best memories are of John standing at the edge of Mushroom Pool, telling the story of Tom Brock discovering *Thermus aquaticus,* and how that led to the development of the PCR DNA replication process; John standing at the whiteboard in his office diagramming the geothermal plumbing system that connects LaDuke Hot Springs to Norris Geyser Basin; sitting around his table while he explained the role that desmids play in assessing the affects of atmospheric deposition on Yellowstone's lakes and the use of ribosomal RNA primers for differentiating species.

When John retired in February 2006, he completed a 30-year career as an acknowledged leader of resources stewardship within the National Park Service, a prominent position he earned the hard way by pushing for innovative new resource programs on the ground, where it counts. The thread that runs through all of John's accomplishments is his passion for science and talent for applying scientific solutions to resource stewardship problems. John used science as the most fundamental platform to improve resource preservation, and in doing so changed public attitudes, enabled the positive evolution of park or Service policies, and facilitated the park's ability to initiate actions to solve real-time resource problems. In the three decades John has been associated with Yellowstone's resources, he earned a legacy that few will ever claim: he made a lasting change in the way we in the National Park Service do the business of resource stewardship. And, he did this not once, and not even in one program area, but multiple times across a full gamut of species, resource issues, and program areas.

Big shoes to fill, indeed.

We interviewed John for *Yellowstone Science,* and include it here with an article on grizzly bear nutrition and ecology, and a review of Alice Wondrak Biel's book, *Do (Not) Feed the Bears*. We hope you enjoy the issue.

S. Thomas Olliff
Chief, Yellowstone Center for Resources

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on the cover
John D. Varley fishing on Canyon Creek, summer 1989.
Photo by Paul Schullery.

NPS/AL NASH

A grizzly bear shortly after spring emergence.

FEATURES

DEPARTMENTS

News & Notes

NPS

COURTSEY IGBST

Interagency Grizzly Bear Study Team leader Chuck Schwartz.

Charles Schwartz Receives Research Award

Dr. Charles Schwartz, head of the Interagency Grizzly Bear Study Team (IGBST) since 1998, has received the 2005 Director's Award for Natural Resource Research. The Director's Award recognizes outstanding contributions to scientific programs or published research that furthers the cause of science or natural resource management in the National Park Service. Schwartz, a U.S. Geological Survey biologist based in Bozeman, Montana, has led the IGBST's efforts to advance and document the recovery of the greater Yellowstone grizzly bear population. Research on the status and habitat requirements of the grizzly bear, which has been listed as a threatened species under the Endangered Species Act since 1975, must be done with a scientific rigor that can withstand the scrutiny of both policy makers and grizzly bear advocates. The IGBST provided the analysis on which the U.S. Fish and Wildlife Service based its 2005 proposal to designate greater Yellowstone grizzly bears a "Distinct Population Segment" that qualifies for delisting.

Research by the IGBST has also helped in the development of strategies that will ensure that the grizzly bear population remains viable after delisting and contributed to the growing understanding of how grizzly bears use of the landscape affects other species, including Clark's nutcrackers and whitebark pine as well as humans. Models constructed by Schwartz that demonstrated a quantitative link between road density, the amount of secure habitat, the presence of houses and developed sites, and bear survival will enable national park and national forest managers to establish habitat and road density standards based on bear demographics.

Schwartz and his collaborators have advanced the use of GPS technology, DNA analysis, and other non-intrusive methods for a broader understanding of how wildlife uses its habitat, compared to the limited picture gathered from standard ground and aerial radio-tracking that can only be done during daylight hours and when weather conditions permit. One of Schwartz's innovations was to use DNA genotyping and mercury, a natural toxin that is taken up by the food chain after it has been deposited in Yellowstone Lake by thermal vents, to assess how many cutthroat trout grizzly bears are eating and which bears are eating them.

Between John and Frank Craighead's earlier research and the IGBST, they have amassed the world's longest-running and most extensive database on grizzly bear ecology. The IGBST, which was formed in 1973, serves as a worldwide model for interagency groups pursuing long-term research in the face of pressure from multiple interest groups. The study team includes biologists from the USGS Biological Resources Discipline; Grand Teton and Yellowstone national parks; the Beaverhead-Deerlodge, Bridger-Teton, Caribou-Targhee, Custer, Gallatin, and Shoshone national forests; the Idaho Department of Fish and Game; the Montana Department of Fish, Wildlife and Parks; the Wyoming Game and Fish Department; and the U.S. Fish and Wildlife Service.

Recovery of a large carnivore like the grizzly bear has implications beyond greater Yellowstone, especially as controversy continues over the effectiveness of the Endangered Species Act and its impact on private land use. Schwartz, who has devoted his career to understanding the ecology of large mammals, especially bears, moose, and wolves, has assisted park managers in Grand Teton, Yellowstone, Glacier, Katmai, Kenai Fjords, Glacier Bay, Denali, and other National Park Service units in the Rocky Mountains and Alaska.

Interpersonal Professional Dynamics on the Northern Range

"A number of scientists question the natural regulation management program conducted by Yellowstone National Park," the U.S. House Appropriations Committee noted in 1998. The committee sought to "resolve the issue of population dynamics of the northern elk herd as well as the bison herd" by directing the National Park Service to initiate a National Academy of Sciences review of "all available science related to the management of ungulates and the ecological effects of ungulates on the range land of Yellowstone National Park, and to provide recommendations for implementation by the Service."

The resulting report by the National Research Council (*Ecological Dynamics on Yellowstone's Northern Range*, 2002), did attempt to settle some of the questions. The authors concluded,

for example, that "The best available scientific evidence does not indicate that ungulate populations are irreversibly damaging the northern range." While the National Park Service and the scientific community carry out the NRC's recommendations for additional research, many issues remain unresolved and new ones keep cropping up. These controversies are evident not only in the pronouncements of those critical of Yellowstone management, but in the debates among the park's own scientists. To facilitate frank discussions among park staff at the Yellowstone Center for Resources (YCR), on June 14 this summer, a number of YCR's professional staff aired their opinions while confronting raw data, rainy weather, and their colleagues on the northern range.

Initiated by wildlife biologist Terry McEneaney and Glenn Plumb, YCR's acting chief, Branch of Natural Resources, the field trip took 31 staff members and guests to sites across the northern range where the ecological dynamics of recent years and centuries could be examined and reconsidered. YCR specialists Mary Hektner (vegetation), Terry McEneaney (birds), Roy Renkin (fire, woody vegetation), Paul Schullery (Yellowstone history), Doug Smith (wolves), Rick Wallen (bison), Jennifer Whipple (botany), P.J. White (ungulates), and former U.S. Geological Survey vegetation expert Don Despain were among those present to share their ideas. Everyone agrees that various and somewhat striking changes have taken place on the northern range, but opinions diverge on what is causing these changes and whether any of them may turn out to be of lasting significance rather than temporary conditions or just blips in the long-term data. Will some unbrowsed aspen sprouts in a few locations ever amount to a tree?

Don Despain grappled with long wet willow branches and presented his ideas regarding the possible role of climate change in the lush annual growth that can be identified each year back to the late 1990s. Under the onslaught of his enthusiastic presentation and a vigorous downpour, Despain's audience pulled the hoods on their raincoats tighter and challenged him with other possible explanations. A new junior staff member marveled that despite the opportunity to debate the ecological relationships between wolves, elk, and bison, her colleagues could become so wrought over the role of secondary compounds as a means of herbivory deterrence. Why has "willow release" occurred at some northern range sites and not others? Has the restoration of wolves in Yellowstone triggered a trophic cascade affecting other animal and plant species or is it the climate, students? Terry McEneaney pointed out a golden eagle circling overhead, which perhaps sensed the pending spill of fresh blood.

PAUL SCHULLERY

USGS ecologist Don Despain talks to field trip participants about willow growth near the Lamar River.

Is there causation between the presence of wolves and certain changes, or merely correlation? Were the new beaver colonies on the northern range simply a result of the 150 beavers that were released on the Gallatin National Forest prior to wolf restoration? Do elk stop browsing the aspen and hide out in the conifers when the wolves approach, or is it the crust on the snow that causes both the elk to go up into the conifers and the wolves to venture across the snow? Doug Smith summarized studies done by researchers who had documented apparent changes in elk behavior as a result of wolf presence and were not themselves present to defend their theories. The abundant prey base available when wolves were returned to Yellowstone in 1995 enabled the northern range wolf population to grow to 106 by 2003, but the wolves have declined by nearly half since then, and whatever changes wolf restoration may have triggered may be less striking in the coming years.

Speculation that songbirds might be increasing on the northern range was dismissed by some, but the decline in the moose population could not be ignored. While some of Yellowstone's critics are certain, despite the absence of evidence, that wolves must have

PAUL SCHULLERY

Willow at Crystal Creek. The stems in the foreground show evidence of overwinter browsing by elk.

something to do with the scarcity of moose, those who displayed equanimity in the face of the 1988 fires had to acknowledge that the loss of old-growth forest on the northern range has been hard on moose.

Driving past a covey of park visitors who'd gotten out of their cars to observe something not visible from the road, "maybe it's a releasing willow!" was the unlikely hypothesis offered by a field trip participant. Or perhaps they were watching the bull moose that had been seen there recently. "Yeah," someone else sourly conceded, "but maybe it was the last one."

"I just hope I live long enough to see how it all plays out," said Roy Renkin. The northern range will continue to change long after the current park staff are gone, but these people enthusiastically come to work each day to ensure that someday it will be clear whether the late 1990s marked a turning point on the northern range—and perhaps a turning point for many climate-altered ecosystems—or just a short-term fluctuation.

New Publications Available

The *Yellowstone Wolf Project Annual Report 2005*, is now available from the Yellowstone Center for Resources. This report is also available in pdf format at <www.nps.gov/yell/nature/animals/wolf/wolfup.html>.

Also recently published is *Managing the "Matchless Wonders": A History of Administrative Development in Yellowstone National Park, 1872–1965*, by Kiki Leigh Rydell and Mary Shivers Culpin. This document serves as both the third volume in the Historic Resource Study on Yellowstone National Park and the beginning volume of Yellowstone's administrative history. It is available in pdf format at <www.nps.gov/yell/history>. If you would like a copy of either of these publications, please contact Virginia Warner at (307)344-2230, or virginia_warner@nps.gov.

NPS

Back row (*standing, left to right*): Albert Andrews Redstar, Confederated Tribes of the Colville Indian Reservation; Allen Pinkham, Nez Perce Tribe; Frederick Hoxie, University of Illinois at Urbana; Jerry Mernin, retired YNP Park Ranger; Dave Ruppert, NPS Intermountain Regional Office; Marie Marek, Nez Perce National Historic Park; Alan Marshall, Lewis-Clark State College; Otis Halfmoon, Nez Perce Tribe/NPS Sante Fe Regional Office. Front row (*left to right*): Kim Sikoryak, NPS Intermountain Regional Office; Rosemary Sucec, Yellowstone National Park; Katie White, Yellowstone National Park; Roberta Conner, Confederated Tribes of the Umatilla Indian Reservation; Sandi MacFarland, Nez Perce National Historic Trail.

Nez Perce National Historic Trail Meeting

During the third week of April, staff from Yellowstone National Park's Division of Interpretation (Planning and Media), Yellowstone Center for Resources (Ethnography Program), and the Yellowstone Park Foundation hosted a three-day meeting made possible by a National Endowment for Humanities grant that brought together Nez Perce, academic, and government scholars to identify the interpretive themes of the Yellowstone segment of the Nez Perce National Historic Trail (NPNHT). The meeting provided a rare opportunity for scholars from different fields and backgrounds to gather in Yellowstone to develop Yellowstone's interpretation of the 1877 Nez Perce war. The meeting was part of a long-range park goal to replace several existing but outdated wayside signs related to the 1877 war.

Scholars engaged in extensive and lively discussions about the meaning and significance of the 1877 war and war-related sites in the park. In addition, participants devoted time to the pre-war context of 1877, including the use of the lands that now comprise Yellowstone National Park by Nez Perce; why the Nez Perce came to Yellowstone; and the legacy of post-war pain and suffering, often referred to as "historical trauma." The discussions provided managers with rich and complex information regarding the 1877 war as it traveled through Yellowstone and advice as to how to most effectively and sensitively convey that information to the public.

Transcriptions of the meeting will be used in the development of interpretive signs, brochures, and auto route guide information related to the 1877 war in the park. The information will also be used by the NPNHT in its interpretive services.

YS

PAUL SCHULLERY

COURTESY ANITA VARLEY

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Clockwise from top left: John Varley at Lamar Cave, 1990; John and Anita Varley in Bhutan, 2001; with President George H. W. Bush after the 1988 fires; speaking at the 7th Biennial Scientific Conference on the Greater Yellowstone Ecosystem, 2003.

The Rewards of Adventurism

The YS *Interview with John D. Varley*

JOHN D. VARLEY *retired from the Yellowstone Center for Resources on February 3, 2006, after a career that spanned more than 30 years in Yellowstone National Park. On May 11, 2006, Charissa Reid of the branch of cultural resources conducted an oral history interview with John. This park program, started in 1999, seeks to preserve for posterity the knowledge and reminiscences of park staff. Also participating in the interview were newly appointed Chief of the Yellowstone Center for Resources Tom Olliff, Resource Naturalist Paul Schullery, and Cultural Resources Branch Chief Roger Anderson. This* Yellowstone Science *interview was adapted from that very long transcript, which will be available in the archives collection at the Yellowstone Heritage and Research Center.*

Yellowstone Science (YS): When did you first come to Yellowstone?

JV: The first time was 1948, and I was here in the so-called typical family of five—mom and dad, three sons. I remember many parts of that visit really well—the begging black bears, the Fishing Bridge cabin area and how cold the cabin was in the morning—and Yellowstone Lake was immensely interesting to me, as well as the fish hatchery and the buffalo herds, mudpots, and geysers.

YS: How old were you?

JV: I would have been seven. I came to Yellowstone several more times as a youth after that and later Anita and I came through the park on our honeymoon. The park held many good memories before I ever thought about the park in a

professional role.

YS: Do you remember seeing the Yellowstone Lake fish hatchery in operation?

JV: Oh, yes. I remember the large open part of that fabulous log hatchery building and its long lines of running water with trays of cutthroat trout eggs—and then in another part of the building were the aquariums. They'd go out and electrofish a bunch of nice size specimens of each sportfish species and put them in the aquariums for visitors to see. The son of one of the summer workers called me a year or two ago and told me that the origin of lake trout in Yellowstone Lake was the aquarium fish. The U.S. Fish and Wildlife Service (USFWS) would get rid of them at the end of the summer and the easiest way to do that was to bucket them down the 40 yards between the hatchery and the lake.

YS: They threw the exotics in the lake?

JV: That's one story. Another fellow said the hatchery crew always ate them for dinner at season's end. We have had about a dozen theories of how the lake trout got in the lake but none have any evidence, not even a first-person account. I still think it was an eco-saboteur. We have had several unfortunate introductions into the lake—brook trout and lake trout probably being the most dangerous to our native species. But the timing doesn't look good for the hatchery-origin theory for either species based on what we know about the first appearance of Arnica Creek brook trout—now hopefully extinct—and the population reconstruction of lake trout based on otolith analysis. (*See Munro et al. 2006,* Yellowstone Science *14:2.*)

A Start in Fisheries Biology

YS: Where did you grow up?

JV: I grew up mostly in Salt Lake City, Utah, and graduated from the University of Utah. That's where I met Anita.

YS: When you were young, was your primary interest in science?

JV: I had several competing interests, biology being one of them, but for a long time I wanted to be an artist. During my more practical moments, I wanted to be a veterinarian, forester, or wildlife biologist. I got into fisheries biology mostly on the advice of an old mentor who was the chief of birds for the Utah Fish and Game Department. I wanted to be a bird biologist at one point, but he strongly advised against it. He said, "You love birds—keep them as an avocation, because working with them will ruin it for you." So I went into fisheries and it ruined fishing for me. I used to love to fish. In my early days, fishing had a lot of mystery, always being surprised by the particular species caught, or the size, or the type of lure. I've thought about the mystery for decades—why does working with fish as a profession inhibit your wanting to be a fisherman? I have many colleagues who were both avid anglers and fisheries biologists, but I couldn't do it. It may be that there are no more mysteries down there in the water. In most Yellowstone waters, at least, I know the species, their sizes and age structure, and maybe even what they had for breakfast. Nothing new equals no mystery.

YS: Would you say that a background in fishery biology was good grounding for the ecological issues you faced in Yellowstone?

JV: In many ways, yes. The University of Utah did not offer a fisheries degree, so I was trained largely as a general ecologist. And they had some wonderful professors at the University of Utah that taught me the fundamentals of being an ecologist, and once you were steeped in ecology, the fact that you change ecosystems or species doesn't mean much. I think it was good training because I took bacteriology—two semesters from the medical school, competing with all those medical students. In civil engineering I learned about sewage, pollutants, and pollution control. My favorite botany ecology professor, Seville Flowers, could excite anybody about the world of plants. I guess if I were to redesign my curriculum, I would have taken more economics and political science, because there are, in my judgment, relatively few biological problems in our business. Mostly they are biopolitical problems, and a stronger background in how the democracy worked would have been very good to prepare a person going into this business.

YS: What was your first work as a fisheries biologist?

JV: When I was going to college I worked seasonally for different outfits—Utah Fish and Game starting in 1963, the Alaska Department of Fish and Game in 1960—the first year Alaska was a state. I worked in southeast Alaska, the Alaska Peninsula, and the Aleutian Islands, and in 1962, I went on the upper Yukon River to work for the USFWS on a proposal to dam the Yukon River. It would have flooded the Yukon Flats and created a reservoir that was over 10,000 square miles. It was just huge. The Bureau of Reclamation would fund preimpoundment studies so they could mitigate for the losses of resources they flooded. But mitigation for the loss of the Yukon Flats was a joke, because moose, caribou, and grizzly bears aside, they had these amazing runs of salmon and other anadromous fishes. The adult salmon ran hundreds of miles from the Bering Sea, passed through the Yukon Flats, then all the way into the Yukon Territory of Canada—as I recall, a journey of over a thousand miles. The dam would have been so high there was no way they could pass either the adults upstream or the little smolts downstream. At the time, the engineers couldn't even say if the reservoir would become ice-free in the summer. But the kicker was that the Yukon Flats was a super waterfowl breeding area. It was one giant slough, and being as flat at it was, and with shallow permafrost, the water was standing everywhere. I think I'm remembering this right—that area as just duck and goose habitat would have cost 1.5 billion 1962 dollars to mitigate or replace. They were also running roughshod over the Indians and Eskimos and their traditional practices, and the Canadian interests with salmon and caribou. The environmental effect this dam would have had was staggering. Fortunately, it was never authorized by Congress.

COURTESY ANITA VARLEY

John Varley working with the U.S. Fish & Wildlife Service in Yellowstone, ca. 1975.

I also worked for the [U.S.] Forest Service in Dead Horse, Wyoming, spraying lodgepole pines for mountain pine beetles. You'd select individual infested trees and spray their trunks. It was a pretty expensive program for trees that were, at the time, only good for railroad ties. The pine beetle program went on for years and years and was roughly concurrent with the pricey blister rust eradication program that Yellowstone participated in, but both programs were ultimately judged ineffective and cancelled in the 1960s.

I worked in the field for the Utah Fish and Game Department for seven years. I was the project leader at Flaming Gorge Reservoir and Green River tailwaters, both very popular fisheries. The Flaming Gorge National Recreation Area was originally an NPS area, but later transferred to the U.S. Forest Service. At the time, the hallway whispers said the transfer was a tradeoff when the NPS was given North Cascades National Park, which was created from forest service lands.

First Job in Yellowstone

YS: What was your first job in Yellowstone?

JV: I was looking for a new opportunity and Utah Fish and Game had an opening for a fisheries project leader at Bear Lake—a large and beautiful natural lake that had its own species of cutthroat trout in need of restoration. I really wanted in on that, and I lobbied hard to move from Flaming Gorge to Bear Lake. The agency's only counterproposal was to move me into the department's headquarters in Salt Lake, and that just pissed me off, so I started looking around. There was a job in Yellowstone so I thought, wow, I'd give that a shot. I was lucky enough to be selected, and so in 1972, I came to Yellowstone as a fisheries biologist for the U.S. Fish and Wildlife Service fisheries group. There were 2½ full-time employees then.

YS: Was your first duty station in the Yellowstone Lake area?

JV: Yeah. Anita and I would move the family out there during the summer, and then they'd return to Mammoth Hot Springs for school and I would follow them after we were frozen out of Lake Village. For my three boys and Anita, too, the Lake experience was wondrous. They loved it out there.

YS: What was the fisheries management philosophy in Yellowstone when you arrived?

JV: I would say "in transition." Subsistence fishing was waning and catch-and-release and other low-kill fishing concepts were brand new. Yellowstone Lake particularly, but also the park's rivers and lakes with roadside access, had been meat factories. Subsistence fishing was a practical matter in the nineteenth century, but it became more and more popular, and by the 1930s—the Great Depression period—it was starting to negatively affect the lake's cutthroat population. By the 1960s, annual harvests on Yellowstone Lake were exceeding 400,000 trout per year. That harvest level, together with decades of egg removal and export by the U.S. Fish and Wildlife Service, put the lake fishery in big trouble—what we called "commercial extinction," where you have more and more total fishing-days but you don't catch any more fish. It's a late-stage precursor to an even more serious population collapse. Most of the park's roadside lakes and rivers were in a similar state.

So in the early 1970s, there was a movement afoot in Yellowstone to reduce the impacts of subsistence fishing and there was good science backing that need. Led largely by Superintendent Jack Anderson, who was a dyed-in-the-wool natural resource guy. Jack promoted and facilitated a variety of innovative changes in the park. He was very bold—I mean, he did things that few park superintendents would dare tackle. He stopped the elk, bison, and pronghorn slaughter, weaned bears from garbage and roadside begging, and reintroduced natural fire to the park. Seeing through even one of these badly needed changes would assure any superintendent of having had a "good run," but Anderson oversaw all of them during his term. In my judgment, it constituted an ecological revolution. All of these were controversial issues at the time and annoyed many constituents and politicians.

Opposition to the elimination of subsistence fishing was no less fierce, because it meant telling perhaps 50,000 meat anglers to convert to the no-kill cause or take a hike. The preservation of angling in the park was important to Anderson, being a fly fisherman himself, and he correctly perceived that if sport angling had any chance of survival in Yellowstone—fish were the only resource in the park that were directly

consumptive—it meant going to no- or low-kill fishing. One big issue was hooking mortality in trout because the conventional wisdom was that hooking mortality negates any benefits from catch-and-release. That's how the elimination of bait happened, because any bait that is swallowed causes very high mortality in fish. But in a number of studies we couldn't find significant hooking mortality with either treble hooks or flies. Nobody could believe that treble hooks weren't more lethal than those tiny fly hooks with no barbs, but that's what the studies showed. It was perhaps the first time in park fisheries that regulations were almost entirely scientifically based.

YS: Why did you leave Yellowstone in 1980?

JV: I left for three years and went to Idaho's upper Snake River, which included the Salmon and Clearwater Rivers. My intention, of course, was to save salmon and steelhead in those great rivers. When I arrived there, they handed me a telephone directory of the significant players in the Columbia–Snake Rivers fish business, and it was 178 pages long. As I recall, the players included four states, seven federal agencies, including the power-players Bonneville Power Administration and U.S. Army Corps of Engineers, and 31 Indian tribes with valid fishing treaty-rights. How they collectively came to any decision was beyond my comprehension. The decision-makers were divided into interagency committees who fundamentally didn't agree on anything. There were states rights vs. federal jurisdiction disputes, the whites vs. the Indians, agencies vs. academics, the wild fish people vs. the hatchery people, and everyone disliked Bonneville Power and the Corps, who held all the trump cards because they regulated the dams, reservoirs, and river flows. They controlled both the escapement of young salmon and steelhead and, to a lesser extent, the return of the adults. There were also multiple federal lawsuits underway so that the federal courts often became the fish managers. Federal Judge [George] Boldt even had fish biologists on his payroll. The open commons known as the Pacific Ocean is where the young fish grew into adults and they were at the mercy of giant Asian gillnetting fleets. It was insanity, to say the least. Chinook salmon were regularly represented by tiny runs of perhaps 70 or 100 spawning fish. Sockeye and coho salmon were extinct. Wild steelhead populations were better off than salmon but certainly not robust. If it were not for the politics of energy and transportation, all of these stocks would have been listed as endangered species.

Becoming Chief of Research

JV: It took me a couple of years to figure out that wild salmon couldn't be saved, and then, lucky for me, Bob Barbee hired me to go back to Yellowstone.

YS: As a fisheries biologist?

JV: No, I came back in 1983 as the park's chief of research. All resource management was in the ranger division then but there was also a viable research function in the park—the resident National Park Service scientists, and there were over 100 independent researchers. I think Glen Cole was the first chief park scientist, and he arrived in the late 1960s. He was succeeded by Mary Meagher, and I succeeded Mary.

YS: When you came back, you had a broader job. Did your primary interest remain fisheries?

JV: No. Superintendent Barbee cautioned me against being a fishery hobbyist—some of the best advice I've ever had. When you become a manager over an interdisciplinary group, a person has a tendency to gravitate toward their old specialty. Barbee pointed out that someone else had my old job and I had to let that person and the system work. You have to give people their lead, to use a horse term. If anything, I was so paranoid about having too heavy a hand in fisheries that I probably ignored them more than any of the other various functions that I supervised at the time.

YS: What were the politics in the park like when you came back?

JV: It had changed since the 1970s. The biggest issue, hands down, was the status of the grizzly bear. It was a period I call the grizzly bear wars, when the National Park Service supposedly had secret bear cemeteries where they'd destroy bears and bury them, and that's supposedly what caused them to be listed as a threatened species. It was indeed a difficult time for the bears because they were being weaned from garbage, handouts, and other human foods. According to noted researchers Frank and John Craighead, the bears were going to go extinct by the end of the century. In '83, Dick Knight, the park's bear biologist, was removed from the NPS to become head of the Interagency Grizzly Bear Study Team. He reported directly to the Assistant Secretary for Fish, Wildlife and Parks, but administratively he reported to me. That's as autonomous as a person will ever get in the federal government. It was also in the '80s that the forest service first took their role in grizzly bear recovery seriously, and there were actually forest supervisors who were transferred because they were not serious enough. The park was distrusted by every environmental organization over grizzly bear management. It was a very volatile time.

YS: Because by removing the garbage, the NPS was going to drive bears into extinction? People believed that?

JV: Yes. That is what most people thought then and many still do. But the biggest risk factor to grizzlies then and now is not food-related. It's whether or not a bear resides in a location that allows firearms to be carried by people, and of course the park prohibits firearms.

YS: Wasn't *Playing God in Yellowstone* published in '86? What made you qualified to deal with the politics of all that as chief of research?

JV: I'm sure some would say I wasn't qualified. I was certainly no neophyte with biopolitics by that time in my career, and the politics of fisheries and grizzlies were somewhat the same except with different players. Superintendent Barbee and I had a great relationship, and he relied heavily on his staff as

PAUL SCHULLERY

John interviewing Canadian carnivore specialist Steve Herrero (University of Calgary) during the 3rd Biennial Scientific Conference in 1995.

spokespersons for different issues, so I had to be a quick learner. I liked to think that I had left salmon and steelhead for a simpler world, but then I met grizzly bears…

YS: You jumped right back into the fray.

JV: It's just that Yellowstone is king of frays. Besides the bears, the northern range had been controversial for 90 years, and there was a lot of tension between ourselves and the State of Montana and others over elk management and the condition of the winter range. Trying to change conventional wisdom of any type is difficult, but the conventional wisdom that overgrazing on the northern range was a reality was startling. Scientists both inside and outside the NPS were divided on the question. I had the good fortune of getting a major research program funded, and that—would it be too bold to say?—put the overgrazing conventional wisdom to rest, at least regarding the grasslands and shrublands—perhaps not for riparian areas.

The Conflict Industry

YS: The scale and intensity of these issues as you've experienced them for more than 30 years has always seemed to be escalating.

JV: There are a couple of megatrends I see looking back, and one is the growth of national environmental groups that look over our shoulder on almost every issue and do their lobbying in Washington, D.C., or the federal courts. Yellowstone has always made good copy with politicians, and apparently with federal judges. The Greater Yellowstone Coalition was created in '83, and in their formative years they disagreed with most of what we practiced as management in Yellowstone.

I don't know whether there's a correlation between the growth of environmentalism and the number of lawsuits, but that has been a huge change, and what I would call a second megatrend. Lawsuits used to be quite rare in Yellowstone. I'm not talking about tort claims, I'm referring to big policy lawsuits brought by organized groups that can fund the best lawyers in the business. At one time a year or two ago, I think we had six large lawsuits going at one time, and that's a huge time sink that few people appreciate. I remember sitting in this very room several years ago because I had to prepare a court-ordered administrative record from our files, and it took me the better part of four months to do—just so the opposition in the lawsuit could read about everything that went into the decision. I'm not saying that kind of public oversight is wrong, but it's hugely expensive in both time and money, and takes away from some very important work.

YS: How has the creation of an advocacy establishment—Jack Ward Thomas calls it "the conflict industry"—affected the way business is done?

JV: Bob Barbee may have been the first superintendent who had to deal with "the conflict industry" in a major way. What he and most bureaucrats hate—besides lawsuits—is the sniping and hip-shooting by the advocates. I define

hip-shooting as an advocate telling the media the agency is wrong about some management decision or policy without doing any of the crucial homework necessary to understand it. And it's often done without even so much as contacting the agency and asking, "Why are you doing this?" That was frustrating for us, because if we had talked to the advocates beforehand and explained our rationale, we may not have been shot. Mr. Barbee pushed the environmental organizations and other advocacy groups to call us first to find out why we're doing something or why we're making a change, and after that, if you still disagree with the policy, by all means go to the media or your politician with your beef. The "call us first" plan sounds simplistic, but if the advocates and the agency are at least talking with each other, many problems are avoided on both sides. But as these groups mature, they also get full-time lawyers. Lawyers know the easiest way to trip up an agency is to find a mistake in the agency's legal process for making decisions. For example, an EIS public comment period was supposed to be 90 days and you closed it off at 89 days because, say, day 90 was a Sunday. The agency loses in court and has to start an expensive process over again. But the adovcate/plaintiff has a "win" they use effectively in public relations and the NPS has to pay all their legal expenses. If the advocates win roughly one in four lawsuits of this type, they can essentially pay for their lawyer for the year. This kind of stuff happens. People are rightfully incredulous at the amount of money that we spend on EISes, and a three, five, or seven million dollar EIS is stunning by anyone's measure. But that's what it takes if you want something that is legally iron-clad. Lawsuits and Jack's "conflict industry" are a big change since the 1970s. I remember back in the 1970s, when Glen Cole wrote the first environmental assessment for the restoration of wolves to Yellowstone over a single weekend. Those days are gone.

PAUL SCHULLERY

John Varley (left) in the field with journalists in early summer 1989. Varley was the foremost NPS spokesman on the scientific aspects of the 1988 fires and was interviewed hundreds of times during 1988–1989.

The Fires of '88

YS: Many people in the area not only had a professional but also a very personal experience with the 1988 fires.

JV: True. For me, an example might be t-shirts. It seemed like every Incident Command Team that came in to fight the fires would have to design their own commemorative t-shirt, and many were very clever. Anita and I agonized over buying those t-shirts because they made fun of Superintendent Barbee, the agency, Mother Nature, or whatever. I told her that we should buy them and put them in a box in the garage because there would be a day when we could laugh at those jokes, but we couldn't at the time. We were turned off by them because they seemed to celebrate this monumental disaster we were going through—not a disaster in the ecological sense, but a bureaucratic disaster, to be sure. Bob Barbee would come in some mornings and say, "I expect to see the busses today," which meant they were going to find the bureaucrats responsible for the fires, load us up, and put us in prison in Andersonville, Georgia. We'd go to bed every night saying "God, it can't get any worse than this," and sure enough, next morning it was worse.

YS: From 1972 to 1988, we had had a natural fire policy but no really big fires. But looking back over the history of fire in Yellowstone, it seems predictable that every two-to-three hundred years you're going to have the million-acre year. Was that ever discussed by the people in the know—that it could happen on our watch?

JV: No, and there are good reasons why. Scientists are loathe to extrapolate beyond their datasets, and so the fire models were built within the constraints of the fire conditions they or their predecessors had seen. If you asked Don Despain or Dick Rothermel, "Well, what if?" and it's outside of the historically observed conditions, then you might as well be guessing. It was the fact that 1988 was unprecedented in historical times that gave us the surprise. And recall that most of the first-rate research on fires in the prehistory came after the '88 fires. As a result the models are much better today than they were in 1988.

YS: The park had suppression capability, but in 1988 it didn't matter, because all the king's horses and all the king's men could do nothing about what was going on.

JV: Well, my much-overused sound-bite was that on September 11, 1988, a quarter-inch of precipitation did what 11,000 firefighters, 200-plus pumper engines, 175 aircraft, and $120 million could not do. That relatively minor storm took the wind out of the sails, so to speak—but that's our arrogance and hubris.

YS: Our arrogance was that we could actually control nature.

JV: Well, as a nation we do the arrogance thing all the time. In a category 5 hurricane, the dikes will hold. What if it's a little stronger? Well, they should hold then, too. The year or two after our fires was when Oakland, California, burned, and that was also totally unprecedented. A hot and dry downslope wind from the interior of the west was blowing straight out to the ocean. The hills behind Oakland caught fire and it swept down through those exclusive neighborhoods. I saw it shortly after the fires, and the Californians were going through what we experienced in '88. I mean, it was the disaster-victim-villain story, and the villains are the people who are supposed to keep fire under control. We've got a nation with many fire experts, and their job is to keep fire under control, and they do the best they can. But sometimes they see a fire—like in Oakland, like in Yellowstone—that's bigger than any human endeavor. Then up pops another part of our culture where it has to be somebody's fault. As Paul Schullery said, "Who's to blame, and how shall we punish them?" Whatever happened to so-called "acts of God?"

YS: How far do you think we have come, as a society, since 1988 in terms of our willingness to accept natural fire and understand it?

JV: When the results of Alistair Bath's post-fire surveys came in, they shook me to my foundation. He did a brilliant job of assessing opinions on what happened in 1988. He stood at the gate in 1989 and asked 4,000 people coming in to visit Yellowstone for the first time since the fires, "What do you think you'll see?" And then he asked 4,000 people exiting, "Well, what'd you think? What did you see?" The thing I most remember is that 82% of the park visiting public believed that fire was just as important as water, sun, and soil in keeping Yellowstone alive and well—82%!

YS: What did you learn about the media shaping public opinion?

JV: I learned they didn't have as much influence as I had previously thought.

YS: Because they sold the disaster story and the public didn't buy it?

JV: At least the public visiting the park didn't buy it. We know from sociological studies that the park-visiting public is a different segment of society than the general population. I don't know about the more general American public because I don't think they were ever polled. In the aftermath for me, the fires were two and a half years long, and I talked about fires to many members of the public, and their opinions were more mixed than Dr. Bath found at the gates. There were also many review teams, and I was a co-chair in charge of setting up and nurturing the post-fire ecological review, perhaps better known as the "Norman Christensen Report". There were also congressional hearings, but they were more about special interest opinions than public opinions. I was returning from somewhere out in the park on a Friday afternoon, and I stopped by the superintendent's office and he said, "John, I want you to testify in front of Congress Monday. I'm sorry I can't be there to help you—ha ha ha." It was Congressman Ron Marlenee [R-MT] who got the fires of 1988 in front of the Family Forum Subcommittee, of all places. I'd love to obtain the transcript of that hearing, because I actually agreed with Congressman Marlenee, and it's the first time I ever agreed with him on any subject. His pitch was that if Yellowstone had been logged, then we wouldn't have had this terrible disaster, and so I said, "Well, I agree with you Congressman Marlenee, if there were no trees in Yellowstone, we wouldn't have had those fires."

YS: Did you ever worry that the aftermath of the fires was going to hurt you professionally?

JV: No. I was never asked to do any spin. I was there to try to describe what was happening ecologically, and I was confident we were right. Or at least, I was 98% sure we were right. We had had a lot of fire research in both the Tetons and Yellowstone, and I knew the park was not being destroyed. I knew it was a process of rejuvenation. Joan Anzelmo, the superb public affairs officer during that period, was very good at screening reporters. Three thousand reporters cycled through the park that summer, and she never put me in front of the wrong crowd—the people who were just looking to write the newest torrid headline. Television largely did not *really* want to know what was going on here. But some of the larger newspapers—*The Boston Globe,* the *Los Angeles Times, The New York Times*—had environmental reporters, and they asked all the right questions. They were a pleasure to deal with because they had a scientific background, and so it was a very enjoyable time from that perspective. Some of the larger regional newspapers

PAUL SCHULLERY

With professor of ecology and biology Mark S. Boyce at the 2nd Biennial Scientific Conference in 1993, which focused on the implications of fire in the greater Yellowstone.


NPS

John Varley at the 7th Biennial Scientific Conference, held in 2003, on greater Yellowstone and East Africa.

did well, too. But the controversy went on for a long, long time because, as was pointed out to me by the journalism professor Conrad Smith, reporters played the fires as a disaster-victim-villain story, a story formula actually taught at some university journalism departments. In our case, the fires were the disaster, the park and the American public were the victims, and we, the National Park Service, were the villains.

The Bison Controversy

YS: Not long after that, the bison controversy started in 1989. There wasn't much of a breath there.

JV: There never has been much time to breathe and that's what kept me here for more than 30 years. The thing about Yellowstone that captured me was not any individual species or particular feature; it was the whole of the place and the excitement it fostered, and it was the fact that I constantly had to be learning from the scientists, their papers, and books. So for me, being in a constant educational mode on such interesting subjects—bison, volcanoes, bears, earthquakes, global warming, and, well, you name it—it's been like the world's longest graduate school. New things would constantly come up and I'd feel responsible for knowing something about them. This was before Google, so you had to go visiting or use the telephone and actually talk to people.

But you asked about the bison controversy. The bison controversy "re-started" in 1989. It's actually decades older than that because of the bison's ability to be a good host for the *Brucella* organism. Based on historical observations, the number of bison that left the park has always been proportionately small but fairly frequent. In today's larger herd, the number leaving is proportionately still small, still fairly frequent, but because the total numbers are greater, the number of bison that leave looks like a mass exodus. The megatrend I see is that global climate change has made more of Yellowstone hospitable to bison and has contributed to their having larger numbers. That's the good news. The bad news is that the climate change has also given us rain in December and January, and that was unprecedented in the relatively short history of the park. Now it seems to do it about every other year. Bison evolved to be powder beasts, and rain steals the winter range from them because it forms an ice layer on top of the snow they can't deal with. When this happens, more and more bison are displaced from traditional winter range, and they roam until they find new, more hospitable winter range. This, in turn, sets up a herd memory of the new range. In my view, bison remember every good bite of grass they've ever had and where exactly it was found, just like cattle and horses do. More surprising to me is how they communicate that information to other, uninformed bison, but they do that, too. Somehow they tell their cousins and

aunts and brothers and sisters about this great new range. Perhaps the scout bulls go back and whisper into the cows' ears. I don't know how it's done, but some way or another, once that herd gets a memory of a place, they'll be back, just because they roam, like the song says. They can leave a perfectly good pasture and walk 35 miles to a another perfectly good pasture just because it's time to move.

YS: How many generations does that take? How long before the bison that spent time in the Stephens Creek facility remember it and return?

JV: We thought the capture and holding facility would be a negative memory. The animal rights people thought it would be a positive memory because the bison would like the hay that was dished up to them. But in the wild they've never seemed to be susceptible to handouts. In the '70s, by order of the secretary of the interior, we tried to short-stop a bison outmigration with hay. We hired a helicopter and scattered that expensive hay along the Yellowstone River Trail because that's where they were exiting. They'd sniff the hay, but they wouldn't bite it. The first time we held bison in the capture facility—I think it was 1997—they ate hay for about six weeks because that was the only option for them. In March, when we opened the gates to the pens, the bison ran out and kept running east, much to our surprise. I mean, nobody knew whether they'd have to be pushed out and then come back looking for their free handout.

YS: This year when they opened the pen, it was snowing. The bison went a few hundred yards, but once the snow stopped, they started migrating off into the park.

JV: They are certainly capable of immense learning. When the hunt was going on in the mid-80s outside the park, there was a group of bulls that would go out on the Eagle Creek Flats and graze at night, and then disappear down rugged Bear Creek Canyon during the day as an apparent response to the hunt. There's some intelligence there that surprised me.

Wolf Restoration

YS: When did wolf restoration become a serious part of your job?

JV: Well, there was no specific date but there were some seminal moments—like my conversation with Bob Barbee when he gave the thumbs up on being "a little more vocal." That was about 1984. It was a bold move on Mr. Barbee's part, because Senator Malcolm Wallop [R-WY] had told him in no uncertain terms that he didn't want the W word to leave Barbee's lips, and so Barbee controlled it. It wasn't like we could all speak in an unfettered way, but we could start to talk about it more openly. And so when NPS Director Bill Mott showed up in the park, he agreed to have a wolf restoration briefing. That was huge—we'd never done a wolf restoration briefing for anyone. And it was like every briefing I ever did for Director Mott—you get about seven minutes into the subject and then he takes over and does the rest of the briefing for you. He was amazing that way, and he became a huge wolf advocate.

YS: When did you really think it was going to happen?

JV: 1991. It was in a Senate hearing in Washington, D.C. It was the hearing you'd expect, where various individuals told everybody how horrible wolves were, and then the enviros would get up and say how wonderful they were and what a good idea it was, and the National Park Service testimony was somewhere in the middle. It was a fairly evenly divided group even though we had a Republican administration, because the Democrats controlled Congress then, and we had some Democratic congressmen as supporters—Congressman Wayne Owens [D-UT] was particularly vocal. At the end of the Senate hearing, Senator Malcolm Wallop and Senator Alan Simpson [R-WY] and Senator James McClure [R-ID], each one of them scolded the livestock interests, saying things like, "Well, so, from what I heard you say, you're just going to let this wolf recolonization happen and you're not going to be prepared for it? The wolves are going to come in from Canada and Minnesota and you're gonna be standing flat-footed when they arrive, is that accurate?" Senator Simpson would look

PAUL SCHULLERY

Varley at White Cone Geyser with renowned Kenyan scientist and conservationist Richard Leakey in 2003.

NPS

Panel discussion at the 7th Biennial Conference in 2003. Left to right: A.R.E. Sinclair, John Varley, Lisa Graumlich, Emmanuel Gereta, and Robin Reid.

over the tops of his glasses. "Is that the way you're gonna do it?" And those Senators who were conservative Republicans from western states and had always been anti-wolf, they turned around and got after the agricultural and livestock interests for their uncompromising attitudes. [Former YCR deputy director] Wayne Brewster and I, sitting in the cheap seats in the back, we were both astounded, and that's when I knew that we were going to prevail in the long run.

There were still doubts, because not everyone agreed with McClure's view that we shouldn't let wolves come in and naturally colonize as fully protected endangered animals. I had some lingering doubt until we were standing out at the [Lamar] buffalo ranch moving chain link panels into Rose Creek. I said, "This is going to happen!"

PAUL SCHULLERY

Rocky Mountain Regional Chief Scientist Dan Huff (left), journalist Rocky Barker (center), and John Varley, 1993.

Forming the Yellowstone Center for Resources

YS: When did you make the switch from being the chief of the Division of Research to being the director of the Yellowstone Center for Resources?

JV: In 1993, there was a movement to put all of the Yellowstone park scientists into a new Cooperative Park Studies Unit based at Montana State University. The Division of Research would have been disbanded and some resource management functions being performed by researchers would have been transferred to the Ranger Division. That plan won the day with the superintendent and regional director, but then Secretary Bruce Babbitt came along and trumped all of it. Unrelated to anything we were doing in Yellowstone, the secretary took the scientists out of the National Park Service and put them into a new agency that was initially called the National Biological Survey. That was a severe blow to Yellowstone, because it took away $1.3 million from the park's base budget and 11 permanent researchers who were wholly dedicated to park scientific studies. I'm not sure we ever recovered from that loss. It was probably the biggest blow and reversal by upper management I saw in my Yellowstone tenure. It pains me to say something negative about Secretary Babbitt, because he was such a terrific champion of conservation and environmental issues in every other way. But anyway, that same year—1994—Superintendent Barbee got a blue-ribbon panel to come in and evaluate how we should look at the resource management function now that the scientists were destined to go to the National Biological Survey.

YS: You were the chief of research, but you didn't have any scientists working under you?

JV: Yes and no. I was originally scheduled to be transferred to the Cooperative Park Studies Unit as part of the NBS myself. Barbee's blue-ribbon group was a consortium of managers and science types from the park service led by Stan Ponce, and the regional chief scientist from the Denver Regional Office, Dan Huff, was on the committee. They recommended taking the resource management people who were spread out in four divisions and consolidate them into a single new division. That's when Barbee asked me if I wanted to squeak out of the transfer to NBS and head the new consolidated resource management group. We also got Rick Hutchinson [the park's geologist] out of moving to the NBS, but they wouldn't budge on any of the other employees.

The Ponce Committee advised that without the scientists, we were going to have to upgrade the professionalization of our resource managers, and what that meant was more education and more experience. So we didn't do research anymore during the Clinton administration—at least we didn't call it research. Studies, we did studies. And when we had a job opening we'd fill it with a PhD, so they were studies done by people with PhDs or other advanced degrees. And in a way, we just went about reestablishing science as a basis for providing management recommendations. And now with YCR approaching its fifteenth birthday I look back and think it was the right way to go; it was an experiment that has been largely successful. We professionalized our employees and the way work was done, and we made sure that scientific results were translated into forms that were accessible to the park managers and the public.

Back in the mid-1980s, when the superintendent's staff was having some kind of goal-setting training session, I had to stand up and state the single, most important goal for the

John Varley speaking at a biodiversity conference in Bhutan in 2001.

research division. I declared that I wanted us to build a division that had more influence over the decisions made in the park, and that the division should attain a level of credibility that was so good the next superintendent couldn't come in and dismantle it. For me that would be *the* proof that researchers and resource managers were earning their keep.

YS: Between 1993, when NBS was formed, and 1998 when the National Parks Omnibus Management Act was passed, the park did not have any kind of license to do research. That license from the Interior Department was given to NBS, later to the USGS. Then in 1998, the park was given not only the license but the mandate to use science.

JV: From 1993 to 2000, we didn't advertise that we did science or research, but I honestly believe that no matter what you called it, you had to do studies in order to make credible management recommendations. And whether that's done with a resource biologist instead of a research biologist makes no never mind to me. You still have to professionalize resource management so that you can write credible EISes and so forth—it should all be science-based. Superintendent Barbee believed in that, his successor Superintendent Finley believed in that, and so that's what we did. We hired the first professional curator for the museum, and once you do that the first time—professionalize it—then I like to think it's done forever. You can't go back and do it the old way again.

Building the Cultural Resource Program

YS: You really helped to build a cultural resource program in Yellowstone.

JV: In 1993, cultural resources was like natural resources in the sense that various functional entities were scattered among a number of park divisions. They were always collateral duties to whatever the division's primary mission was. The Maintenance Division had the historic buildings person, the historian was in Interpretation, and so forth. The creation of the Yellowstone Center for Resources consolidated all the cultural positions that the park had. It was one of those wonderful education experiences. The cultural people would come in and say, "I need your approval to do this or that," and I'd ask "Why do you need to do that?" Being the good bureaucrat that I am, I'd say, "What's the legal basis giving us the authority to do that?" And some folks viewed it as some sort of a personal affront, as if I didn't believe them, but I saw it as The Education of John Varley. I mean, we bureaucrats have to spend a lot of time with the law because that gives us the authority to do something, or not. An action has to have a legal basis, otherwise we shouldn't be doing it—is what I've learned from every superintendent I've worked for. And cultural resource management has very powerful legislation as it relates to federal agencies, and I came to know those laws over time. And the more I learned about it, the higher my comfort level with it. It is a very rich field of endeavor.

In every tribal consultation we had, there was a certain amount of the blame game for stealing their country, giving them disease. You had to go through it, and then you could get into something that was of mutual interest and more productive. It was hard, but over time, trust was built up with the tribes and, at least with the regular attendees, they quit publicly blaming us for smallpox. It's been a fascinating process, and the exposure of those Indian children to what their country used to look like is our reward. Some of those reservations have an 80% unemployment rate and a suicide rate that is staggering, and those children have nothing to look forward to, but when they come here with their elders and they're exposed to our interpreters, to people who know how to reach children, they truly give inspiration to those children that may have lasting value. I was very fond of that program, but all of it—the interaction with the historic architect, the collections and library people—has been very rewarding for me because of my exposure to that kind of thinking and a resource element I had never dealt with before.

Microbial Research and Bioprospecting

YS: Something else that you put a lot of effort into is microbial research, bioprospecting, benefits-sharing.

JV: Biodiversity in general has always captivated my interest wherever I was located, and I think it has to do with that

COURTESY ANITA VARLEY

John Varley in Costa Rica.

training that I was talking about earlier, that ecological training, that broad appreciation for things like algae, plankton, and bacteria. There's a whole world out there out that no one ever sees that is hugely important to ecosystems. I always have a bunch of sound bites such as how native grasshoppers ate more forage on the northern range than all of the ungulates put together, and nematodes eat more than grasshoppers. Yellowstone has got the closest thing to pure native biodiversity that there is in our country. It might not be perfect, but it's as close as you can get in the modern day, I think.

Bioprospecting is all about biological diversity or, more precisely, chemical and genetic diversity. In '83 or '84, Mary Meagher told me there were rumors around about people taking thermophilic bacteria from the hot springs and somehow privatizing them, but for a long time it never came up to me in the management of scientific permits. There was a letter from somebody in Idaho Falls saying that someone had taken out a park organism and patented it. This may have been during the fires and it just didn't get acted upon. But what got my attention was when a *New York Times* reporter said to me, "People are coming into the park under the guise of research and taking out native organisms and patenting them. What are you going to do about it?" I said, "Well, I'm gonna call a ranger, or the sheriff. I'll get somebody." And that was my introduction to one of the most fascinating resource issues of my professional life.

I learned about the 1991 United Nations Convention on Biological Diversity—the "Rio Convention"—where 180 countries agreed that each nation should have sovereignty over its biological and genetic resources. Because the industrial world was exploiting the non-industrial world for many of these resources, there had to be an equitable benefit-sharing between the country and people, if any, and the corporation or other entity that was profiting from bioprospecting. President Clinton signed the treaty but it was never ratified by the Senate, and we remain today non-signatories to the convention. And sure enough, there were news reports that the Merck corporation, a giant pharmaceutical, signed a benefit-sharing agreement with Costa Rica. That was the first of many, but unprecedented at the time was the recognition that Costa Rica had sovereignty over its biodiversity, and that if Merck found that part of that biodiversity could be turned into a beneficial market product, then Costa Rica should be cut in on the deal. Merck paid millions of dollars for that privilege, and for many years Costa Rica supplied them with novel bio-compounds. I went down to Costa Rica on several occasions to learn more about how they managed it. One night we went out into the jungle with flashlights—I can't believe I ever did that—I kept thinking of all those poisonous snakes that were active at night. We went to a place where they had strung a white sheet vertically between the trees, tied down all four corners, and then turned bright lights on it. What collected was a billion moths and they'd systematically go through the moth species and collect moth spit with capillary tubes and send them to Merck. Of course, none of the collectors could tell me what Merck's interest was with moth spit, but apparently it was a hot commodity at the time. The collectors were Costa Ricans with high school educations trained and paid by the grant money as parataxonomists. Merck's money did trickle down to the grass-roots, which I thought was great.

Yellowstone has a significant place in what people are calling the beginning of the biological revolution or era because of an enzyme from one of our hot springs organisms. They knew that the polymerase chain reaction (PCR) process would work in duplicating DNA, but they couldn't make it work consistently because they didn't have a stable thermal enzyme—the available enzymes would break down under the heat required. So they got this enzyme from Yellowstone and made the process work really well. With the PCR process, you can make enough copies of a single strand of DNA so it can be studied. PCR and TAQ polymerase was one of the great breakthroughs in the history of biology. The inventor, Kary Mullis, got a Nobel Prize for figuring that out, and the company he worked for sold the patent to another large pharmaceutical, Hoffman LeRouche, a Swiss-based company, and billions of dollars have been made

The thing about Yellowstone that captured me was not any individual species or particular feature; it was the whole of the place and the excitement it fostered, and it was the fact that I constantly had to be learning from the scientists, their papers, and books.

as a result of that discovery.

The *New York Times* reporter was incorrect in that they were not patenting the organism, which would have been unlawful; they were patenting the blueprint for producing Taq polymerase. The Yellowstone organism, *Thermus aquaticus*, was only briefly in the research lab. They found that *T. aquaticus* could produce this enzyme, but they didn't need to grow large cultures of *T. aquaticus* to obtain it. They removed the gene or the gene sequences that produce Taq and inserted it into *E. coli* [*Escherichia coli*], which grow well in a laboratory setting. That way they can grow a room full of *E. coli* overnight and extract quantities of Taq polymerase. There were many attempts in the '90s to find another Taq-type polymerase that could do the work as well or better than Taq so they could get a new patent. And now there's maybe a dozen different polymerases on the market that do similar things. Taq polymerase's patent will expire soon, which means the technology will become public domain.

The Diversa Corporation in California was looking for a way to replace industrial catalysts, which are inorganic substances with difficult disposal problems resulting in Superfund toxic sites, with biological catalysts or enzymes that would be cheaper to produce and easily disposable. They figured they could make a business out of that, and they have. They've branched out into pharmaceuticals and food additives and other things as well. But within two months after signing the first U.S. benefits-sharing agreement in 1997 with the National Park Service, the Department of the Interior was sued and the court proceedings took about 2½ years. I think there were 11 specific counts where the plaintiffs said we had done wrong, and government won all but one and that one was because we didn't follow a NEPA process. The judge was not sold on our argument that allowing research use of park specimens would not have a significant ecological effect. He said, in effect, "Well, that may be true, NPS, but it's a big deal with some people, so you'd better follow the NEPA process." That required yet another expensive EIS that will be released to the public soon.

COURTESY ANITA VARLEY

Anita and John Varley, Peale Island, ca. 1990.

Future Hot Topics

YS: You've talked about how there's been historical precedent and surprise. What do you think will be the hot topics in the coming years?

JV: Well, I'm not sure that any of it is predictable except for two things: I think there will be new diseases and pests established in Yellowstone that will give the resource managers fits, and I think that global climate change, which has already stolen the wetlands from the northern range and changed the frequency of wildfire, will continue. It's unclear what the climate will be, even with all these elegant models being done by the climatologists. There will be some surprises there for the researchers. Whether it's disease or climate change, it will be related to the biodiversity change. Canine heartworm is a good example. It used to be a mild climate disease of dogs and other canines, but now it is moving north and up in elevation. If established in the park, canine heartworm could do a real number on our coyotes, foxes, and wolves. Where you roll the dice is whether it wipes out a population, takes all the wolves or all the foxes or all the coyotes. Then you've got a tragedy. With trout whirling disease, which rarely kills all individuals, you just have to bide your time and wait for the trout population to develop immunity, but I would guess it could easily be replaced by some new plague we haven't even heard of yet.

And I'm not sure that some of the policies that we've had

since bringing ecology into decision-making will stand when there is massive human-caused climate change going on. I mean, this park has no control over what the People's Republic of China puts into the air.

YS: Climate change could be considered a perturbation of the system like an exotic organism that works on both a local and global scale. Shouldn't the priority still be the preservation of wildness even under these big issues?

JV: It certainly should, but in the classic NPS dogma, if it's man-caused change, it's bad—get rid of it—and if you can't get rid of it, then our fall-back strategy would be to mitigate for the change. But climate change is a giant man-caused perturbation that's not something you have any control over as a park or agency. I think the paradigm we've managed for in the past 50 years will have to change in the next 50 years because of climate change, invasive species, and a host of other issues. We've not touched on the importance of preserving the Greater Yellowstone Area, but that's another problematic arena where the human footprint is growing at an unprecedented rate.

YS: You're saying that global climate change could change things so that we can't even think about having a natural system.

JV: Certainly if the more extreme climate models are correct, the NPS dogma will probably have to evolve to something different than what it has been in the last 50 years or so. And I think that is too bad. The cause of pristine wildness was a great one to pursue, but if the Arctic melts, even the Alaska parks won't be immune from massive change.

YS: Taking the long view is risky bureaucratic behavior. Bob Barbee said that "Bureaucracy doesn't reward adventurism." But in your career, you have on many occasions engaged in adventurism, reaching beyond convention to address a problem or a need. For years we weren't allowed to call *Yellowstone Science* a magazine because the parks weren't allowed to publish a magazine.

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Left to right: Roger Anderson, John Varley, Tom Olliff, and Paul Schullery, at the Yellowstone Center for Resources, May 11, 2006.

I think the paradigm we've managed for in the past 50 years will have to change in the next 50 years because of climate change, invasive species, and a host of other issues.

What are the risks and the payoffs?

JV: Well, the risk is that you end up making a lot of enemies inside and outside the agency. We all find our own comfort level within a bureaucracy, and sometimes it works for you and sometimes it doesn't. I've always been rewarded, I think, by my adventurism, and that's because I've mostly had supervisors and mentors who had that particular streak themselves. I've been lucky that way. When I didn't have an adventurous boss, I didn't stay with the job long. I'd like to believe that if I've had a talent, it's seeing things in other people's science that's generally going unnoticed. I've had a penchant for that. And if you extrapolate from their data, or imagine it in a different context, then this and that might happen, and that might fix this problem over there. My favorite argument for wolf restoration was to complete the ecosystem, but I found out that that didn't resonate with most people. I'd compare it with a finely engineered automobile—you attain this vehicle, but it's missing one spark plug wire. You can still drive to Gardiner and back, but it never reaches its design efficiencies until you get the spark plug wire and complete its design. That's how I viewed wolves in the context of this giant ecosystem. I like to fix things, and I like to see things run at their most efficient, and Yellowstone Lake couldn't do that with lake trout, and elk couldn't do that without wolves.

YS: At the beginning of the interview, you said that becoming a fisheries biologist took the mystery out of fishing. Is all the mystery gone from Yellowstone for you?

JV: No. I'm confident that things are going to come up time after time in the future. These new things have kept me going for 33 years, but now it's someone else's turn to enjoy and respond to them.

YS: What are your plans for retirement?

JV: Well, Anita and I are going to get our home to the point where we like it, and I'm going to get the landscaping where we like it, and, at some point, I'll jump back into the fray somehow. I'm sure of that.

YS

Grizzly Bear Nutrition and Ecology Studies in Yellowstone National Park

Charles T. Robbins, Charles C. Schwartz, Kerry A. Gunther, and Chris Servheen

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This grizzly bear is digging for pocket gophers and their food caches. GPS collars, hair snares, isotope analysis, and DNA are being used to gain insights into the nutritional ecology of bears.

THE CHANCE TO SEE a wild grizzly bear is often the first or second reason people give for visiting Yellowstone National Park. Public interest in bears is closely coupled with a desire to perpetuate this wild symbol of the American West. Grizzly bears have long been described as a wilderness species requiring large tracts of undisturbed habitat. However, in today's world, most grizzly bears live in close proximity to humans (Schwartz et al. 2003). Even in Yellowstone National Park, the impacts of humans can affect the long-term survival of bears (Gunther et al. 2002). As a consequence, the park has long supported grizzly bear research in an effort to understand these impacts. Most people are familiar with what happened when the park and the State of Montana closed open-pit garbage dumps in the late 1960s and early 1970s, when at least 229 bears died as a direct result of conflict with humans. However, many may not be as familiar with the ongoing changes in the park's plant and animal communities that have the potential to further alter the park's ability to support grizzly bears.

These changes include the decline in Yellowstone Lake cutthroat trout due to the unplanned introduction of the predaceous lake trout, the spread of whirling disease, and a long-term drought (Koel et al. 2004; McIntyre 1996). Cutthroat trout have been consumed for thousands of years by grizzly bears from mid-May to mid-August, when they spawn in the small streams that flow into Yellowstone Lake (Haroldson et al. 2005). Whitebark pine, one of the most important fall foods of the grizzly bear, is infected with an exotic fungus, white pine blister rust. The high-fat, energy-rich whitebark pine nuts are consumed during the fall when the crop is limited or during

the entire year when the crop is abundant (Felicetti et al. 2003; Lanner and Gilbert 1994). Although blister rust has not killed a great number of trees to date, it has the potential to do so if climatic conditions change and weaken the trees' resistance. Whitebark pines, along with most conifers, are also facing an epidemic of mountain pine beetles. These tiny creatures, which are native to the ecosystem, burrow under the bark and feed voraciously on the trees' living cambium. Trees weakened by summer drought or old age are particularly susceptible. Mountain pine beetles have the potential to kill a significant portion of the mature whitebark pines in the park, although outbreaks have occurred previously. Reductions in the quantity or quality of such high-value foods decrease birth rates, growth rates, and the survival of bears (Mattson, Blanchard, and Knight 1992).

For more than 30 years, members of the Interagency Grizzly Bear Study Team (IGBST) have been investigating grizzly bear biology in the park. Much of the early work was gleaned by tracking radio-collared bears, examining scats and foraging sites, and observing bears in general. In recent years, the IGBST has used the newest research techniques and cooperated with outside specialists in chemistry, genetics, and nutrition to advance the understanding of grizzly bear ecology. The new research techniques used by the IGBST include highly accurate Global Positioning System (GPS) collars that pinpoint a bear's location many times a day, hair snares fashioned of barbed wire that collect small clumps of hair when bears rub against them, and DNA and nutritional analyses that determine the sex, identity, and diet of each bear that left a hair sample. Both DNA and nutritional analyses can be performed on very small samples, such as bone flakes, a drop of dried blood, or a few hairs. Even samples from museum specimens can be used to determine family lineages and diets of bears that died long ago.

One of the major outside collaborations has been with scientists from the Washington State University Bear Research, Education, and Conservation Program in Pullman, Washington. This program is the only facility in the world in which a significant number of captive grizzly bears are held for the purpose of developing new techniques or knowledge that will directly assist in understanding the needs of wild bears. The facility normally has 10–12 grizzly bears, ranging from newborn cubs weighing one and a half pounds to 20-year-old adults weighing more than 800 pounds. Undergraduate and graduate students majoring in the biological sciences have the unique opportunity to work with the captive bears on a daily basis and to conduct field studies as needed.

Quantifying Diets

One of the first studies jointly conducted by scientists of the IGBST and Washington State University examined how diets of grizzly bears changed either as the West was settled or park management changed (Jacoby et al. 1999). For historical


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A grizzly bear rips open a log to feed on the ants inside.

studies, skins and skulls in museums, including the Smithsonian Institution, are valued treasures. However, techniques of scat analysis or direct observation that are used to quantify diets of living bears could not be used on these long-dead bears. The new technique we used to quantify the diets of both living and dead bears is called "stable isotope analysis." Isotopes are different forms of the same element, for example ^{14}N and ^{15}N. They are both nitrogen, but the far rarer form, ^{15}N, has one extra neutron, is non-radioactive, has been on Earth for billions of years, and is preferentially retained relative to ^{14}N when consumed by animals. Thus, bears that have eaten only plants will have less ^{15}N in their hair or bones than will bears that have eaten other animals. It is this ^{14}N-to-^{15}N ratio that allows us to quantify the proportion of plant and animal matter that a bear ate during the past few weeks, months, or lifetime. By feeding the captive bears at Washington State University various diets that included deer, trout, clover, grass, and other foods and analyzing the isotope ratios of both food and bear, we were able to calibrate this technique specifically for grizzly bears. After death, the ratio of rare-to-common isotopes remains the same in properly preserved bones or hair. This technique has also been used to examine how the diets of Egyptian pharaohs and their wives differed from those of commoners and slaves (guess who had the best diet and lived the longest) and to determine when and where corn was first domesticated and became an important part of the human diet.

In our studies, we wanted to know how the diets of bears that might be reintroduced into central Idaho would differ from those that lived there historically. We were able to find the skulls or hides of 10 grizzly bears that were killed in the Columbia River drainage prior to the crash in salmon populations associated with dams, over-harvesting, and other human causes. Locations where the bears were killed ranged from the banks of Puget Sound in Washington, the Cascade Mountains and Blue Mountains of Oregon, to the high

Table 1. Comparative data on grizzly bear diets at different times and places (Jacoby et al. 1999).

	Meat	Plants
Grizzly bear bones from 1,000-year-old packrat midden in Lamar Cave	32%	68%
19th century grizzlies killed in eastern MT and WY	32%	68%
1914–1918, Yellowstone garbage-fed grizzlies	85%	15%
Contemporary Yellowstone adult females and subadult grizzlies	40%	60%
Contemporary Yellowstone adult male grizzlies	80%	20%
Contemporary Yellowstone grizzlies preying on livestock outside the park	85%	15%
Contemporary Alaskan salmon-feeding grizzlies	72%[1]	28%
Contemporary Glacier NP and Denali NP grizzlies	3%	97%

[1]This meat category includes salmon plus terrestrial meat sources, such as moose.

Bitterroot Mountains of Idaho. Hair and bone analyses indicated that all 10 bears consumed salmon, and that salmon provided approximately 60% of their annual nourishment. This level of salmon consumption is identical to that of today's Alaskan bears, such as those in Katmai National Park, that continue to feed on abundant salmon (Hilderbrand, Jenkins, et al. 1999; Hilderbrand, Schwartz, et al. 1999). One can only be amazed at how markedly our natural systems have changed since the time when 16 million salmon returned to the Columbia River drainage and nourished grizzly bears throughout the region. Now, only in the headwaters of the Columbia River drainage, such as in Yellowstone, do grizzly bears exist, and none consume salmon.

We also investigated the historical diets of Yellowstone grizzly bears. The oldest grizzly bear bones that we found came from a 1,000-year-old packrat midden excavated from the Lamar Cave. Due to the efforts of this hard-working packrat that had a fetish for bones, we know that meat (everything from ants to trout and elk) provided 32% of the nourishment for those grizzly bears and 68% came from plants (everything from roots and leaves to berries and nuts) (Jacoby et al. 1999). That distribution of dietary meat to plants is identical to what we found for five grizzly bears killed from 1856 to 1888 in eastern Montana and Wyoming (Hilderbrand et al. 1996).

From 1914 to 1918 when many hotels were feeding kitchen scraps to attract grizzly bears for tourist entertainment and local towns had open-pit garbage dumps, the park's grizzly bears switched to 85% meat, 15% plants. After all such feeding ended by the early 1970s and bears were forced to return to natural foods, the diets of young bears of both sexes and adult females returned to the levels observed 1,000 years ago (~40% meat, 60% plants). Adult males have continued a more carnivorous life (~80% meat, 20% plants) (Jacoby et al. 1999). Large males can prey more efficiently on the park's elk and bison or claim the carcasses of animals that died from other causes. Bears that have been killed for preying on livestock outside the park had diets that were 85% meat, 15% plants. These levels of meat consumption are in contrast to those of grizzly bears in Glacier National Park and Denali National Park, where plant matter provides 97% of their nourishment (Table 1). Thus, for grizzly bears, the opportunity to consume meat differentiates the Yellowstone ecosystem from many other interior ecosystems where bears must feed primarily on plants. Cutthroat trout are one of those meat sources.

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A bear defends a bison carcass from other scavengers. Meat provides approximately 80% of adult male grizzly bears' annual nourishment in Yellowstone National Park.

Cutthroat Trout

One of the great wonders of Yellowstone Lake has been the native cutthroat trout. In recent years, cutthroat trout have spawned in at least 59 of the 124 streams flowing into Yellowstone Lake. The trout that weigh 1 to 1.5 lbs when spawning are easy prey for bears, otters, eagles, and dozens of other animals, as many of the streams are narrow and shallow. A study conducted in the late 1980s concluded that at least 44 grizzly bears fished for cutthroat trout, female bears made more use of this resource than did males, and 90% of the bears' diet during

the spawning season was trout (Mattson and Reinhart 1995; Reinhart and Mattson 1990).

The conclusion that females were making more use of the trout than males suggests that trout may have been an important food for females with cubs. Grizzly bear mothers with new cubs benefit from good food resources when they emerge from their winter dens. Studies at the Washington State University Bear Center determined that grizzly bear milk has 4.5 times more fat and 17 times more protein than human milk. While each cub consumes about three-quarters of a pint per day of this very concentrated milk during hibernation, mothers must quadruple milk production to sustain the increased growth of cubs once they emerge from the winter den (Farley and Robbins 1995).

PHOTO COURTESY IGBST

Hair snares allow scientists to collect grizzly bear hair samples in a non-intrusive manner without trapping or handling the bears. The bear pictured here is investigating a scent lure inside a barbed-wire hair snare.

However, lake trout were discovered in Yellowstone Lake in 1994 and found in substantial numbers by 1995. Lake trout have probably been in the lake for more than 20 years, and illegal introductions may have occurred multiple times from the mid- to late 1980s through the 1990s (Munro, McMahon, and Ruzycki 2001). Adult lake trout are highly efficient predators of cutthroat trout (Donald and Alger 1993; Gerstung 1988). Each adult lake trout consumes 50 to 90 cutthroat trout annually (Schullery and Varley 1996). Lake trout have significantly reduced or eliminated native trout populations in other waters where they have been introduced. Lake trout could reduce the cutthroat trout population in Yellowstone Lake by as much as 90% (McIntyre 1996). Lake trout, unlike cutthroat trout that spawn in small streams in late spring and summer, spawn in the deeper water of the lake and are therefore not accessible to bears and other wildlife (Schullery and Varley 1996). In a follow-up study in the late 1990s after lake trout had become well established, 74 grizzly bears visited cutthroat trout spawning streams, but the sex ratio of those bears was dominated almost 2:1 by males (Haroldson et al. 2005).

To determine if female grizzly bears were still consuming fish, we needed to find non-intrusive ways to individually sex and identify each bear visiting cutthroat trout spawning streams and measure how many trout those specific bears consumed. This was not an easy task as grizzly bears are wary, often forage at night, and may feed at many locations separated by great distances. Thus, we could not visually count trout being consumed, nor could we depend on older techniques, such as scat analyses.

Food chains of most aquatic ecosystems, whether marine or freshwater, tend to accumulate heavy metals. While we often think of heavy metals in aquatic ecosystems as pollution, recent studies by U.S. Geological Survey scientists have found naturally occurring mercury in the Yellowstone Lake food web. That discovery turned out to be our answer to determining how many cutthroat trout each bear ate, even though we never saw many of the bears and never trapped any of them. Yellowstone Lake cutthroat trout have 508 parts per billion (ppb) mercury, whereas elk, bison, plant foliage, roots, and other grizzly bear foods have less than 6 ppb (Felicetti et al. 2004). For comparison, tuna, salmon, shrimp, and many other marine-derived human foods contain less than 200 ppb, although shark and swordfish typically contain 1,000 ppb. Fish

PHOTO COURTESY IGBST

Grizzly bear hair collected on barbed-wire hair snares can be used for both isotope and DNA analysis.

with more than 1,000 ppb cannot be sold in interstate commerce, and the FDA recommends that people limit their intake of such fish to one serving per week (ATSDR 1999).

From other studies investigating the consequences of mercury consumption, we knew that mercury tends to be deposited in hair as it grows. The questions that we needed to answer were 1) do grizzly bears eating mercury-laden fish also deposit mercury in their hair and 2) does the mercury content of the hair directly reflect the amount of trout that has been consumed? By feeding the captive grizzly bears held at Washington State University known amounts of trout taken from Yellowstone Lake, we found that mercury was deposited in their hair and that the amount of mercury in small hair samples was directly related to the number of trout that each bear had eaten.

But how were we going to collect hair samples from large numbers of wild grizzly bears without trapping them, which we wanted to avoid? For this, we were able to capitalize on information learned from the field of DNA analysis. Because bears are constantly rubbing against plants or ducking under fallen timber or low-hanging branches, they treat barbed wire as just another impediment. Barbed wire that is either wrapped on a rub tree or strung about two feet off the ground along a trail or stream will snag small clumps of hair as bears pass underneath. This very simple technique allowed us to collect large numbers of bear hair samples from all around Yellowstone Lake. By using the same DNA identification techniques routinely used by criminal investigators and our newly developed relationship between trout consumption and hair mercury content, we could identify each individual bear visiting a trout stream, determine its sex and whether it was a grizzly bear or an American black bear, and determine the amount of trout that it had consumed. We found that male grizzly bears consumed five times more cutthroat trout than did females. Of the bears that consumed the largest amounts of trout, 92% were males. Thus, this food resource had largely been taken over by male grizzly bears (Felicetti et al. 2004).

While a total count of cutthroat trout in Yellowstone Lake is impossible, all signs indicate that the cutthroat trout population has declined in recent decades. In addition to predation by lake trout, whirling disease and drought have contributed to a reduction in cutthroat numbers. For example, total numbers of spawning cutthroat trout counted at a weir on Clear Creek, a backcountry stream on the east shore of Yellowstone Lake, declined from more than 70,000 in the late 1970s, to a maximum of 14,000 per year between 1997 and 2000, to fewer than 1,000 in 2005 (Haroldson et al. 2005; Koel et al. 2004). Similarly, while in the late 1980s grizzly bears were consuming an estimated 21,000 cutthroat trout per year (1.6% of the spawning population), our studies using mercury analysis of hair showed that trout consumption by grizzly bears had dropped to only 2,200 by the late 1990s, or an average of fewer than 30 trout per bear living around Yellowstone Lake (Felicetti et al. 2004). Thus, the average grizzly bear was consuming fewer cutthroat trout than the average adult lake trout.

Beginning this fall (2006), we will initiate a four-year study to determine if female grizzly bears are still consuming cutthroat trout, and if not, why. We are also interested in determining how successful they've been in replacing this important spring food with alternative foods. We've hypothesized that when spawning cutthroat trout were in the hundreds of thousands, all bears were able to use this food, as it far exceeded what could be consumed. However, as the numbers declined below what was necessary to meet the needs of all bears, large males increasingly dominated and perhaps defended this food resource (Haroldson et al. 2005). In the new study, at least six grizzly bears and six black bears will be trapped each year around Yellowstone Lake in large culvert traps and fitted with GPS collars, spawning streams will be censused weekly for cutthroat trout, remote cameras will be mounted on the streams to record how bears are interacting with each other, and hair snares will be established on the streams to identify which species, sex, and individuals are feeding on trout, and ultimately how many trout are being consumed. This information will be used by park managers to evaluate and perhaps intensify the current lake trout control program. If cutthroat trout cannot be saved, plant matter is likely to become a much more important dietary component to the park's grizzly bears.

Whitebark Pine Nuts

Whitebark pine nuts are by far the most important plant food eaten by the park's grizzly bears. The pine nut story is particularly interesting, in that grizzly bears depend on small red squirrels to harvest the cones and bring them down to the ground where bears can feast. When pine nuts are abundant, bears tend to be in the high-elevation areas where whitebark pines grow and are, thus, far from human developments and conflict. In years of pine nut failure, grizzly bear mortality can


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Grizzly bears depend on red squirrels to harvest and cache whitebark pine cones.

be three times higher than in good pine nut years, as the bears are forced to forage more widely and closer to people (Mattson, Blanchard, and Knight 1992).

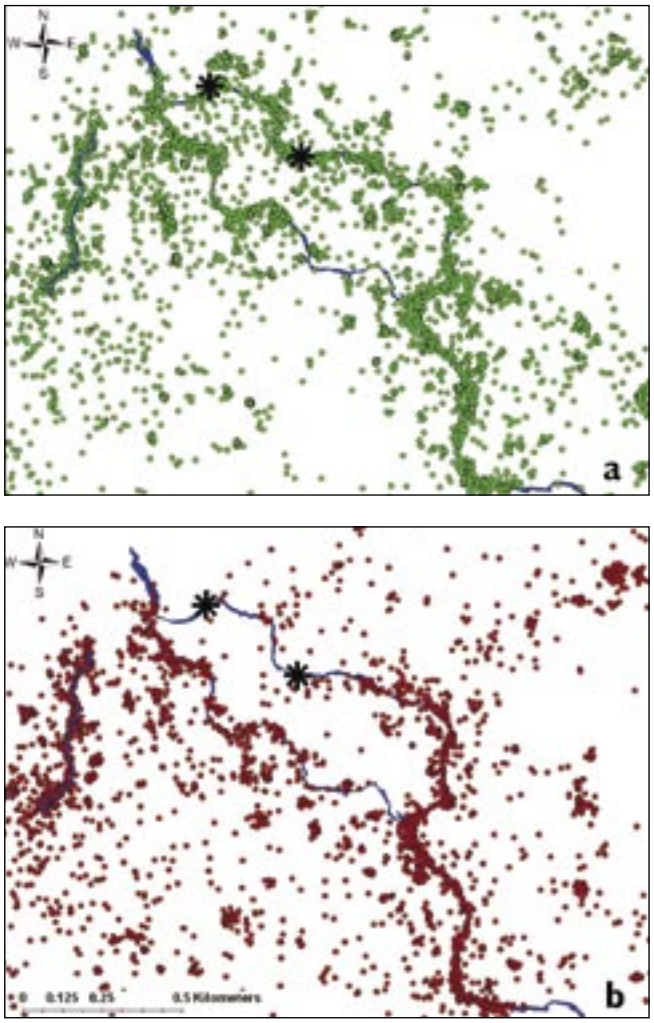
In addition, female bears that have fattened during the previous fall on good pine nut crops typically produce litters of three cubs compared to twins or singletons after falls of few nuts. The link between increased cub production and great pine nut years occurs because fatter females produce more cubs that are born earlier in the winter den and grow faster because mom produces more milk. The average (290-lb) adult female grizzly bear in Yellowstone can gain as much five pounds/day when feeding on pine nuts, which are 28% fat. The amount of fat accumulated in a single day of feeding on abundant pine nuts in the fall can meet the needs of a hibernating adult female for five days if she has cubs, or for nine days if she does not. Thus, the potential reduction of whitebark pine would likely be even more significant than the loss of trout, which are a spring and early summer food.

Whitebark pine nuts are by far the most important plant food eaten by the park's grizzly bears.

In a separate study (Felicetti et al. 2003), we wanted to quantify the nutritional value of pine nuts to the park's grizzly bears. Whitebark pine cone production varies dramatically between years. We needed to find some element that occurred in pine nuts that did not occur in the bears' other foods, was absorbed when nuts were consumed, and ultimately was deposited in the bears' hair in proportion to the amount of nuts consumed. Fortunately, whitebark pines concentrate a rare sulfur isotope (^{34}S) that occurs in the nuts' protein and is deposited in the bears' hair. When there were at least 40 cones produced per tree, pine nuts provided 97% of the annual nourishment for the park's grizzly bears. The breakpoint for good versus poor years was about 20 cones per tree.

Grizzly Bear–People Interactions

A quick survey of hunting magazines featuring stories of attacks on humans by bloodthirsty grizzly bears can make any of us paranoid at the thought of hiking in Yellowstone. In a study that we recently completed in a densely forested area of Alaska, we wanted to know how grizzly bears respond to fishermen and ecotourists (Rode 2005). Our experimental ecotourists were one to seven college students that we employed to hike through the forest each day to the banks of a small stream full of thousands of spawning sockeye salmon. Once there, they sat, observed, and recorded grizzly bear activity. Using the same techniques that we will apply in Yellowstone, we determined



COURTESY K. RODE, S. FARLEY, AND THE ALASKA DEPARTMENT OF FISH AND GAME

Figure 1. Comparison of the use of an Alaskan stream containing thousands of spawning sockeye salmon by five collared bears during (a) a control period with no human activity and (b) a 24-hour treatment period with students sitting at the locations marked with an asterisk. The small circles are the GPS locations where each bear was at a specific time.

that 33 grizzly bears visited that particular stream during the spawning season, 7 of which were captured and fitted with GPS radio collars. Because salmon provided 66% of the bears' annual nourishment, the students were sitting at the bears' dinner table. However, the bears vacated the portion of the stream where just one student was sitting (Figure 1). Even though bears were all around the students and could be heard catching fish in other portions of the stream, the students saw grizzly bears for less than 1 hour out of 288 hours of observation. From these studies, it was clear that the bears avoided humans and that even a single human can displace grizzly bears from high-value feeding sites.

In 1983, Yellowstone National Park began closing areas of high-density grizzly bear habitat for part or all of the period

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GPS collars allow scientists to pinpoint grizzly bear feeding sites.

when bears are not denning. Known as Bear Management Areas, these closures were intended to eliminate human entry and disturbance, prevent human–bear conflicts and habituation of bears to people near prime food sources, and provide places where bears can pursue natural behavioral patterns and social activities. Four areas around Yellowstone Lake where grizzly bears are known to forage for fish are closed during the trout spawning season. Over the years, the park has received challenges to these closures, with specific requests to open such areas to human entry. Given the reduced abundance of fish around Yellowstone Lake, we hypothesize that Yellowstone bears are far less likely than those observed in Alaska to voluntarily leave important, high-quality food resources due to the presence of people and therefore the potential for bear–human conflict is real.

To help understand the importance of the Bear Management Areas around Yellowstone Lake, the foraging patterns and travel routes of the bears fitted with GPS collars will be studied. The collars will be programmed to record each bear's location every 15 minutes. To understand how humans use the area, we will use the same technology by providing campers and hikers with hand-held GPS units to track their movements and activities after the seasonal closure. Although the humans will not be in the area when bears are eating fish, the study will help us understand how both bears and humans use these areas.

Summary

Biologists now understand many facets of the biology of the Yellowstone's grizzly bears. While we continue to examine home ranges, movements, births, deaths, and other typical wildlife parameters, our vocabularies have changed to include terms such as GPS collars, isotopes, isotope ratio mass spectrometry, DNA, polymerase chain reaction, and atomic absorption spectrometry. Many of these new techniques have allowed us to learn more about Yellowstone bears without the bears realizing that they were subjects in a scientific study. One museum curator commented that these new techniques have given life and meaning to their long-dead specimens, as he could now talk about their diets and family lineages. However, because the foods and therefore the well-being of the park's grizzly bears will always be changing, we must continue these studies for as long as Yellowstone National Park exists and grizzly bears roam its beautiful landscapes.

YS

DARIN WATKINS

COURTESY IGBST

Charles T. Robbins (left) is a professor in the Department of Natural Resource Sciences and the School of Biological Sciences at Washington State University in Pullman. He has spent more than 30 years studying the nutrition of wild animals. In the picture, he's shown with one of the captive grizzly bears held at the Washington State University Bear Research, Education, and Conservation Program. This particular bear (Mica) was hand-raised from six weeks of age for physiological measurements, including blood sampling, without the use of anesthetic drugs. **Chuck Schwartz** (right) works for the U.S. Geological Survey at the Northern Rocky Mountain Science Center in Bozeman, Montana. He is leader of the Interagency Grizzly Bear Study Team, an interdisciplinary group responsible for long-term research and monitoring of grizzly bears in the Greater Yellowstone Ecosystem. Chuck worked for the Alaska Department of Fish and Game for more than 20 years. He has worked on programs with grizzly bears in Alaska, Russia, Pakistan, and Japan. His research with large mammals has included moose as well as brown and black bears and focused on ecological issues of predator–prey dynamics, carrying capacity, and nutrition and physiology. Chuck holds a BS in Agriculture/Natural Resources from Ohio State University, and an MS and a PhD in Wildlife Biology from Colorado State University.


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CHUCK BARTLEBAUGH

Kerry A. Gunther (left foreground, with Mark Haroldson) is Yellowstone National Park's Bear Management Biologist. He oversees bear–human conflict resolution and bear research and monitoring throughout the park, and has worked in the park for 24 years. He has also worked in grizzly and black bear research and management for the U.S. Forest Service and the U.S. Fish and Wildlife Service. Kerry holds a BS in Biology with minor studies in Earth Sciences from Northland College in Wisconsin, and an MS in Fish and Wildlife Management from Montana State University. **Chris Servheen** (right foreground, with Tom Radandt) has been the Grizzly Bear Recovery Coordinator for the U.S. Fish and Wildlife Service (USFWS) for 25 years. He coordinates all the research and management on grizzly bears in the lower 48 states and works with biologists in Alberta and British Columbia. He holds a BA/BS in Zoology/Wildlife Biology from the University of Montana, an MS in Wildlife Biology from the University of Washington, and a PhD in Forestry/Wildlife Biology from the University of Montana.

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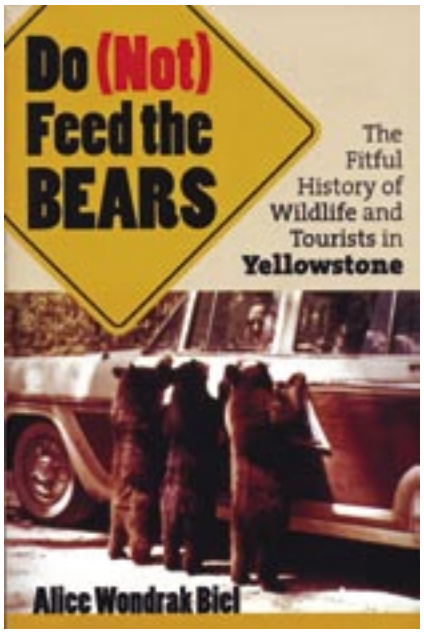
Book Review

Do (Not) Feed the Bears: The Fitful History of Wildlife and Tourists in Yellowstone by Alice Wondrak Biel

James Pritchard



(Lawrence, KS: University Press of Kansas, 2006. xiv plus 186 pages, acknowledgments, introduction, photographs, notes, bibliography, index. $29.95 cloth, $15.95 paper.)

IN *Do (Not) Feed the Bears,* Alice Wondrak Biel has pulled apart and illuminated layers of language, culture, and nature in a most compelling fashion. What's unique and very special about this book is the author's skillful fusion of management history, shifts in scientific perception, cultural attitudes about animals, and the changing relationship between bears and people in Yellowstone. Wondrak Biel's story highlights the shifting images of bears using scientific, official, and popular sources.

During the early days of the National Park Service (NPS), Director Steven Mather and YNP Superintendent Horace Albright made efforts to provide reliable opportunities for tourists to see wildlife. Feeding bears by the roadside was quickly established, became an institution of sorts, and was terribly difficult to change. Bear feeding began (before the NPS era) as hotels tossed out their kitchen scraps on a regular basis. These incidental feedings eventually grew into nightly "bear shows." Special amphitheaters were built, notably at Otter Creek, near Canyon Village. Nightly, bears would appear as if on cue, entering stage left to perform their roles as entertainers for a curious and thrilled public. A ranger provided an interpretive talk as the bears consumed the edible garbage. Tourists at cabins also fed the bears, and the custom spread into auto camps and to the roadside.

Public misperception of the bear as docile and "tame" facilitated roadside feeding. That conception was created by images and a narrative about bears, from popular sources, concessioners, and the NPS, emphasizing the unusual experiences to be had in Yellowstone. Feeding the bears wasn't too risky, the rationale went, if the tourist wasn't foolish about it. The price paid for thousands of photographs of vacationers feeding bears was not only a steady stream of personal injury and property damage reports, but also a continual toll of bears removed from the park or killed in "control actions." From 1931 to 1942, 354 bears were destroyed in Yellowstone, and from 1955 to 1965, 349 bears were killed in control actions.

During the 1920s, some rationalized that only a small minority of bears "misbehaved," and if individual bears were removed, all would be well. Wondrak Biel illuminates the hubris involved in humans choosing acceptable bear behaviors while people gave or withheld food. In 1932, the National Park Service's Wildlife Division speculated that the park had a more systematic problem. NPS officials also began to consider less artificial ways to present wildlife to the public. In 1942, with the support of biologist Olaus Murie and NPS Director Newton Drury, park Superintendent Edmund Rogers (1936–1956) ended the bear shows. Horace Albright protested, but a new interpretation of what constituted a reasonable opportunity for tourists to see wildlife won out. The author suggests a shift from "human-oriented conservation to a 'nature-oriented' preservation" was a prerequisite for shifts in bear policy (p. 49). Admitting a problem existed with bear–human relationships in the park was a significant step. Superintendent Rogers sought to shift the image of the bear away from that of picturesque highwayman, and the park began to portray bears as dangerous, going beyond the idea that the act of feeding was risky. Broadsides pictured a new and more intimidating image of a "horror" bear.

Although a system-wide prohibition on feeding animals was enacted in

NPS, YELLOWSTONE NATIONAL PARK, DANECKI, YELL 27353-7

Visitors at the Otter Creek bear feeding grounds, ca. 1930s.

1938, the traveling public continued to feed the bears by the roadside. Why did it take so long for the "do not feed the bears" warning to take hold? Reluctant to suggest there were hazards in traveling through Yellowstone, the park unwittingly sent mixed messages for some time. Using Yogi the Bear in 1961 as a friendly way to convey information in brochures implicitly conveyed impressions that bears were cute and reasonable creatures, hence the associated warning that bears were dangerous didn't make intuitive sense. Visitors were "more inspired to own comic messages…than to obey them" (p. 56). Secondly, the no-feeding regulation was loosely enforced for many years. As long as the practice was widely viewed as relatively harmless, officers seemed reluctant to hamper tourists' vacations by issuing a ticket, instead giving a warning. So many tourists were feeding the bears during the 1950s that officers only had time to ticket the most flagrant offenders. Finally, tourists just didn't seem to comprehend the message that bears could be dangerous.

During the administration of Jack Anderson (1967–1975), the NPS put all the pieces together; information about bears must be presented often and in a variety of ways, warnings had to be very blunt, and enforcement had to be consistent and hurt people's pocketbook. The magical "atmosphere of the roadside carnival" involved an illusion that people could be "the true companions of wild bears," and once the enchanting spell was broken, the habit of roadside feeding came to a rather abrupt end (p. 147). Cultural shifts in thinking about nature meant that the public was ready to give up bears that entertained (and a predictable and packaged experience) in favor of bears that were in some sense natural (and a new unpredictable kind of experience). The graphical and textual imagery of bears in NPS information portrayed a "bear of the imagination" that "wanders a landscape of the mind," suggesting an encounter full of potentiality (p. 136–37).

This was the era when Anderson and biologist Glen Cole led NPS policymakers to the decision to close Yellowstone's garbage dumps. John and Frank Craighead's research in Yellowstone (1959–1971), suggests Wondrak Biel, was a "watershed of both knowledge and acrimony" (p. 76). To understand how NPS managers and the Craigheads could see the situation so differently, we must recognize "the wholly different measures by which each camp was defining success or disaster" (p. 108). The idea of an ecosystem bear replaced the notion of a Yellowstone or park bear, thanks to the Craighead's pioneering use of radio-collars, which revealed the great distances bears traveled.

Wondrak Biel brings us up to date on the science and status of the grizzly bear, and provides insight into how the most vociferous criticisms of park management have used the grizzly bear "as a means to tap into broader cultural attitudes about government arrogance and incompetence" (p. 131). During the superintendency of Robert Barbee, science came to compose the dominant narrative of the bear, yet "ended up being no more universally accepted than any other narrative structure in Yellowstone" (p. 133). Bears have emerged "as a component part and defining element" of the Greater Yellowstone Ecosystem, and as much as people want to see bears, a sighting is "no longer a required element of a fulfilling trip to Yellowstone" (p. 137). Wondrak Biel thoughtfully discusses today's pressures on bears, including residential development and backcountry recreation.

Through time, Yellowstone's visitors have sought their own visions of wild nature. The act of watching wildlife, Wondrak Biel's readers will agree, has taken substantially new forms, involving new understandings of wildlife ecology. This nuanced, perceptive, and delightful book is a significant addition to wildlife literature and will deservedly attract a wide audience, including readers of *Yellowstone Science*.

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FROM THE ARCHIVES

"On September 11, 1988, a quarter-inch of precipitation did what 11,000 firefighters, 200-plus pumper engines, 175 aircraft, and $120 million could not do. That relatively minor storm took the wind out of the sails, so to speak—but that's our arrogance and hubris."

—John D. Varley, 2006

NPS, YELLOWSTONE NATIONAL PARK, YELL 34589

Mammoth Fire Brigade, September 1967.

YELLOWSTONE ASSOCIATION

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In this issue

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NPS

The whitebark pine, a high-elevation tree whose pine nuts are an important food for grizzly bears.

Coming this fall, *Yellowstone Science* explores Moran Point, and early microbe hunter Charles Walcott.

YELLOWSTONE SCIENCE

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