A conservation agenda in an era of poverty

Keynote Address
October 7, 2003

Steven E. Sanderson

Dr. Steven E. Sanderson is President and CEO of the Wildlife Conservation Society (WCS) in New York City. Prior to his appointment in 2001, he was Dean of Emory College, Faculty of Arts and Sciences, at Emory University in Atlanta. He received his Ph.D. in Political Science from Stanford University (1978), with a specialty in Latin America. He has been involved with the organization of scientific cooperation on the environment, through the Social Science Research Council, the International Geosphere–Biosphere Programme, and the NRC Oversight Committee on Restoration of the Greater Everglades Ecosystem. A former Fulbright Scholar, Dr. Sanderson has also held fellowships sponsored by the Rockefeller Foundation, the Woodrow Wilson International Center for Scholars, and the Council on Foreign Relations. In addition to several scholarly books about Latin America, his recent publications are "The Future of Conservation," **Foreign Affairs** *(September 2002); and "The Contemporary Experience of Wild Nature and its Importance for Conservation," (June 2003).*

It is a delight to be included in the ambitious and important program of this conference, in such a beautiful part of the world. I am not an expert in the specific subjects of this conference, but I do represent an organization that is devoted to the protection of great landscapes such as the Serengeti and Yellowstone systems, as well as the sustenance of the wildlife they support. I also grew up on the western slope of the Rockies in Colorado, and I lived my first 13 years in and around the Gunnison/Crested Butte area and in Montana during the late 1940s to 1960. During that time I experienced the transformation of Crested Butte from a sleepy mining and ranching community to one that boasted a tourist economy, and then ecotourism.

I should also add that the bison restoration in the West was sponsored by the New York Zoological Society, our founding organization, and began at the Bronx Zoo. My office is there, and directly across the great court is the historic Lion House where Theodore Roosevelt and William Hornaday, our founding director, created the American Bison Society to repopulate the American West with Bronx Zoo bison. Incidentally, the bison exhibit at the Bronx Zoo was one of the first naturalistic exhibits in any zoo in the world—a 20-acre prairie in a temperate woodland, which hosted the genetic bison stock that populated a lot of this country. So, when you see bison in Yellowstone or the Flathead country, you are looking at the descendants of proud New Yorkers.

I am filled with admiration for the principal speakers at this meeting, from whom I have learned so much. Dan Flores, Richard Leakey, Tony Sinclair, and Lee Talbot, as well as others on the program represent the very best in natural history, science, and conservation action. Whatever our individual strengths and weaknesses, our work together in coming years is extremely important to the future of life on Earth.

My message to the conference is partly a pessimistic one. From the standpoint of conservation, which is at the intersection of science and public purpose, the temper of the times is not very good. The public commitment to conservation is a muddled one, and it has real implications for our work together as scientists, scholars, and public servants. In Johannesburg last year at the World Summit on Sustainable Development, the world appeared very publicly to walk away from the commitments it had made at the Earth Summit in Rio in 1992, and which had begun at the pathbreaking summit in Stockholm in 1972. By the end of the Johannesburg Summit, conservation had been almost completely obliterated from the public consciousness of the multilateral system in favor of yet another rendition of sustainable development.

This year, the World Parks Congress in Durban, South Africa, was a troubling and difficult exercise, in which conservation was hardly invoked with pride. The chosen theme, "Benefits Beyond Boundaries," should have reiterated a commitment to extend the impact of protected areas to their surrounds. Instead, the discussion turned into a confused, rambling discussion that focused on the elimination of the hard edges of protected areas, which we have strived to create over decades of time, and which we should be proud to have achieved: 10% of the world's terrestrial surface under some kind of protection. Somehow, credible international conservationists who had worked hard to create those protected areas now positioned themselves more conservatively, to support a much more restricted notion of protected areas that would have "no net negative impact on local peoples"—without so much as a definition of what a "local people" was, much less what "no net negative impact" might mean. Conservationists know well that when there is a publicly contested question of the allocation of natural resources, stakeholders claiming to be local spring up all over the place, with varying degrees of legitimacy. So, for the conservation community to make such arbitrary and unspecified stipulations was disturbing. Additionally, some advocates for indigenous peoples argued—without so much as a word of opposition—that protected areas had been the worst thing ever to have happened to them. The Congress, apparently acquiescing to such categorical statements, conceded that protected areas had to be justified by economic and social criteria, not conservation or ecological integrity. There was very little mention of the achievements of the conservation community or its historic goals. And, in fact, there was a great deal of homage paid to the rural development community, despite the fact that the broad concepts of development offered in the post-World War II era have failed to prove their sustainability or their value to the truly poor.

These issues have been almost uncontested in the rush to promote poverty alleviation in the new millennium. The United Nations (UN) and the multilateral development community goals for the new millennium barely mention conservation. In fact, in the millennium development goals of the UN and the World Bank, sustainable resources with respect to human development have actually taken the place of conservation. The World Bank's new forestry sector policy has shifted from conservation to human poverty alleviation, after a decade of staying out of financing projects in tropical moist forests because the bank itself (along with its many critics) became concerned with the negative impact such projects might have on the all-too-rapid process of tropical deforestation. The argument for returning to forestry sector loans appears to be that somehow, 10 years later, the world knows enough about achieving sustainable forestry practices throughout the world. The evidence for this claim is missing.

The desire to relieve the world of extreme poverty is a laudable social goal. It is implicitly valuable to human life on Earth, and close to the hearts of those of us who work in developing countries, but also in the American South and West. Poverty is a difficult, degrading human condition that needs attention of the kind that the millennium development goals are paying. And it bears directly on who we are as conservationists. Conservation, like poverty, is a cultural concept, and our culture is concerned with human social progress. As the eminent conservationist Richard Leakey has said in his writing, he is not sure he would be so conservation-minded if he were hungry and cold.

However, something or some force in the global community has led the world to believe that conservation of protected areas should be responsible for bearing a great deal of the burden of economic development and local poverty alleviation in the world. How we came to that is a matter of great mystery, especially since the economic growth and development of much of the world has led to a protected areas system that is a tiny fraction of the terrestrial biosphere. The remainder, for better or worse, has been open to development and has been rapidly transformed in the last century, with increasing speed in the post-World War II period. Now, in Equatorial Africa and South and Southeast Asia, where much of the world's rural poverty is concentrated, plans for poverty alleviation depend on increasing agricultural productivity in existing land, using more energy and water, and intensifying livestock husbandry in fragile lands.

The goals of hunger alleviation require that such improvements must accrue to local peoples, as well, but the history of agricultural productivity and the Green revolution during the post-World War II era do not inspire confidence. After all, in 2003, 75% of the world's poorest populations [were] in the countryside after 50 years of agricultural development. Even in the Greater Yellowstone Area, we can find evidence of local peoples being crowded out or hurt by what appear on the surface to be good ideas for development.

I believe this process around the world is the product of shortsighted economic development ideas, a continuing emphasis on sectoral economics in the face of decades of environmental failure, and a reading of past and future that is more convenient than true. In the American West, much of the so-called local protest against environmental restrictions actually is a stalking horse for large-scale energy, mining, agricultural, and more recently, tourist endeavors that often displace people to less attractive areas where they now staff the service sector for the rich interloper. The issues are posed as local, but they are often national (in the case of energy) or global and corporate, in the case of subsidies or mineral permits.

In any case, wild nature in our time has been converted into a contested area that is debated, not in terms of nature itself, but purely in terms of economic potential. It is my hope that our work together in the future will be controversial in the best sense, pushing flaccid and poorly-argued concepts out of the way in favor of sharper ideas, good science, and plans for conservation. And the first way to do that is to ask how all this happened, and how current forces are arrayed, so that we assess how we act most appropriately. When one looks at the history of any natural system that is human-impacted—and that certainly applies to the focus of this conference—one has to grant a big swath of ground to politically-infused memory. History as we know it is quite often the political use of facts or phenomena in the past to create myths and opportunities for the future.

In the case of natural resource systems, quite often there is a direct political use of natural phenomena, so that a flood on the Mississippi River produces greater effort to engineer flood control. Likewise, in the aftermath of the degradation of the Everglades, the federal government and the State of Florida are investing billions of dollars to recreate the Everglades, restore it, and re-engineer it, and, in fact, re-plumb it. Whether in the Everglades or the Mississippi, history becomes the reinvention of failure as success.

Similarly, in the international community, rural development and human poverty alleviation are reinvented failures now parading as successes. The ostensibly new tools, mechanisms, and models for rural development in the world today go back to the 1940s and 1950s. The only thing that is missing is the intellectual leadership of the post-war economic development theorists, who really led the way to a new way of looking at human progress. Missing also is a serious self-conscious critique of the failures of rural development in our time. River basin development of the kind now in play in the Mekong River Basin is, in fact, similar to projects from the 1960s and 1970s that were emblems of environmental disaster. Integrated rural development projects, increased inputs, credit availability, and agricultural intensification, the integration of agriculture into commercial markets and livestock production—these are all old, old ideas, dogged by as much failure as success. The community-based development ideas bandied about today are not much different than those in practice in Vietnam under the French.

Turning to the landscapes under consideration in this meeting, wilderness and preservation in Yellowstone and Serengeti were invented concepts, invented for specific political purposes. In both places, wilderness and preservation were concepts that did not take into account aboriginal presence. And so they have been, as we have learned over the last hundred years, demonstrably false as explanations of the natural systems of the Rocky Mountain West and East Africa. There has also been a reinvention of the explanation for our current condition, in which the extirpation of wildlife in wild systems has been blamed on the poor. Maurice Hornocker will tell you that cougars were shot out of the American Southwest by 1925, and it was not by the poor.

But the conversation today in the global community insists that poverty leads to degradation and species extinction. Conservation, as the argument goes, stands in the way of economic development and so must be pushed aside in favor of sustainability. Conservation has been reinvented not as a promise for the future, but an obstacle to economic success, and so instead of building on the 10% of global lands under some kind of protection, they and their protectors are indicted for keeping people out and keeping people poor. And in landscapes like Yellowstone or Serengeti, or the Mekong or Congo Basins, there is proposed what Dan Flores has referred to as a leap from extractivism to ecotourism without the intervening steps. So that in the Congo Basin, one of the most demanding and difficult deliverables that the conservation community is charged with over the next dozen years is to transform what is essentially a logging economy into an ecotourist economy in which there will be no disadvantage to the tropical forested countries of the Congo Basin and, in fact, there will be a clean sustainable future based on European, American, and South African tourism.

The conservation community may welcome the opportunity to make this historic shift, but it requires a standard never demanded of other, less conservation-minded economic agents. To go from logging directly to ecotourism is extremely difficult, just as it was extremely difficult in Crested Butte, Colorado, to go from coal mining to ecotourism without asking about the income gap or the dislocation of local peoples. I can promise you, you cannot find many of the people who lived in Crested Butte when I was born living there today, and I don't mean just that they've all died. Their families are not there. And it was because of the income gap. Likewise, the residents of Aspen today are not those of past generations. To the extent they remain, they are dotted along the valley road to Glenwood Springs. And so on.

There is not a given socio-economic benefit to changing an economy from an extractive base to an ecotourist base. The potential conservation benefit is much clearer. If conservation actually does have to do with human landscapes as well as natural landscapes, someone has to develop viable, realistic human benefits from the economic changes being proposed. And it must be done "on the run," as an ersatz model of economic development with putative ecotourism carving up the landscape.

It is worth noting, too, that conservation has become derivative of human use because the public agencies charged with conservation are also charged with satisfying the public. Nowhere in this world is it harder to satisfy the public than in the United States. The public agencies charged with protecting national forests, public lands—the Forest Service, the Park Service, Bureau of Land Management, all of the public agencies—have to respond to what people want, as expressed through organized civil society and the political process. So, conservation goals become derivative of human use practices. Perhaps no better case exists than the ongoing controversy over winter use rules for snowmobiles in Yellowstone. Twenty years ago it was not an issue; but now, more than 100,000 people use Yellowstone Park in the winter every year. The impact of that use is a fundamental issue for Yellowstone and for the National Park Service.

Similarly, in the early 1990s a survey was conducted of visitors to Yellowstone. People asked to rank what they liked about Yellowstone mentioned most often walking outside, going to the visitor center, and shopping. One imagines that in 1872, there must have been something else on people's minds when Yellowstone was created. While one might approve or disapprove of the hierarchy of consumer demand, national parks cannot be divorced from public satisfaction. That fact is etched on the Roosevelt Arch. The Park Service is not charged with telling the American people what they should insist upon in the parks. But the consumer is a new stakeholder in protected areas, in a way that might not necessarily serve the interests of conservation.

This confusing and distressing place in the history of conservation has come to us thanks to a lack of leadership on all sides. By that I mean that no organization or political consensus has emerged to seize the agenda for conservation in these great landscapes in the way that there must be. In the absence of such convincing hegemonic leadership, society risks a catastrophic compromise in which no one would be satisfied, in which all of the belligerents would butt heads for a period of time, and in which no public policy solutions would be stable.

In conservation today we may be witnessing a convergence of weakness on all sides, development, economic growth, and conservation—from the multilateral to the local political forces in conservation that pull at the complex issues under consideration at this conference and beyond. Wildlife biology is in a tragically weak position, though getting stronger. It is of enormous importance to conservation, but only about a half-century old. The monographic studies and continuous databases on wildlife rarely stretch beyond the life of an individual animal, 8 to 10 years, and some of the longest continuous observations are 20 years. That shallowness in chronological time means that wildlife biology does not have explanations for many of the long-term consequences of different conservation strategies.

Wildlife biology also suffers from the skepticism of public authority. Public authorities view science with a jaundiced eye. Sometimes science plays a positive role in helping define the terms of reference for a public ecosystem restoration. In the Everglades, National Park Service biologists and independent scientists are looking at snail kites and crocodilians, and the hydrologists at salinity and sheet flow, all of which contributes to the creation of models that will drive that restoration. Unfortunately, the role of science is circumscribed in the Everglades, too. When those models cross the political or public policy line, they are pretty readily kicked back across the line or discarded. For example, the restoration of a truly natural Everglades ecosystem by definition of the restoration plan cannot prejudice water availability or flood control for the populations of Floridians outside the Everglades boundaries. The restoration is delimited politically by the very human impacts that degraded the system in the first place. It is not censorship or bad faith, necessarily, but science with a complicated political value assigned to it is often unwelcome. Far better than the Everglades is the case of the Intergovernmental Panel on Climate Change, where despite the scientific consensus and the moderate tone of the panel, the political use of science in public discourse is problematic.

Beyond the uneven experience with domestic public authority, conservation biology does not articulate well with the multilateral development assistance community. Conservation does benefit in some ways from official development assistance, or multilateral development strategies. But it is not an exaggeration to say that conservation has little role in setting their institutional agendas. Conservationists understand little and have even less of a role in multilateral trade, structural adjustment, and international finance. We simply are not at the table.

Some of this arranged irrelevance is the fault of applied science itself, especially its truncated scope. Wildlife biology has been very confused historically about people. Protected areas have been demarcated without regard to local people. Indigenous peoples and frontier folk alike have been demeaned by some protectionist strategies or dislocated by well-meaning conservationists. In the United States and in pre-independence Africa, wilderness and preservation were concepts that were developed without regard to people.

Conservation science has little reputation in the social science community, which itself understands little about natural systems. Social science invests little in knowing anything about wildlife or wild lands. Social scientists tend to spend very short field stints and to fix economic or social equilibrium rather than explore its dynamics. Social scientists in the academy—like their life science counterparts—have no management accountability, which conservation organizations and public agencies do. And they have generally failed to acknowledge or write up successfully the failures of rural development.

Public agencies are burdened by uneven levels of capacity and discretion, and extremely political environments in which to work. The multilateral community does not appear to have any accountability for the projects it supports. While criticism abounds, it is difficult to imagine a circumstance in which the multilateral development banking system will actually be held to account for its loans and project ideas. The same can be said of the World Trade Organization, the International Monetary Fund, and numberless regional development authorities. Combine that lack of accountability with the endless infatuation with hopeful rhetoric and a recipe for adventurous experiments is ready. One might readily include the quest to eliminate half of the world's poverty by the year 2015 in that category.

Non-governmental organizations, for their part, completely lack political legitimacy. However important the work of NGOs, they are always in the position of never having been elected or legitimated by any political process. NGOs are able to work only as long as they are convenient to those in power.

What is to be done? It is an important question, because conservationists have failed to produce a positive agenda that the world can accept and be enthusiastic about. Conservationists can cleave to their core mission by creating models of the kind that are being discussed at this conference, models that integrate human social variability into natural system models. That requires an integrative science that does not yet exist. It does not make sense to talk about the human side of the question separately from the natural side of the question, nor to hold meetings about conservation priorities without a joined social and natural science community.

The community that gathers around these questions has to work at multiple scales, to think about distal drivers, not just local drivers. That also means understanding globalization more seriously. Recently, Montana cattle prices spiked because of BSE [Bovine Spongiform Encephalopathy] in Canada, and the embargo on the imports of cattle from Canada. Since that time, prices have reversed again, thanks to the appearance of BSE in the American West. Forces like that have impact on natural and social systems all the time. And yet conservation does not consider multiple scales for research. Yellowstone is not simply a park, but a linked landscape from the Elk Refuge all the way up into Canada.

In addition to working in an integrative fashion, conservationists must keep their boots muddy. Many organizations in this world do conservation by proclamation. Real conservation must be groundtruthed, and conservation actors must create a contingent model for conservation action as well as scientific observation along the lines of strong, adaptive management principles.

In the end, the community of conservation science, and the science of protected areas and these great landscapes, must cleave to the mission of conservation: the sustenance of wildlife and wildlands in changing human circumstances. As Clifford Geertz would say, that has to be "lit by the lamp of local knowledge." But it always has to refer back to larger objectives. This community I am addressing must be the best, but with a clear set of outcomes in mind. The positive alternative is a science for conservation in small, out of the way places that is associated with human betterment. It can be done, but it's not easy. Conservation can inspire people to care about wild nature, people who are alienated from wild nature in every facet of their modern life. Conservation can educate young people to science in an applied way that excites them, rather than in the classroom with principles of science. Conservation can create a positive concept of wildlife health, addressing everything from how prey densities may affect populations of lions in the Serengeti to the sources of chronic wasting disease in the American West.

Finally, conservation can represent two-track diplomacy, working in systems where it is very difficult to work politically. By linking science and community development to positive outcomes, conservation can create alternative pathways to formal diplomacy. Does the proclamation of Iran as part of the Axis of Evil make the conservation of the remaining populations of Persian cheetah less important?

Above all, conservation has to represent the integrity of mission, of conservation, knowledge creation, and stewardship, and a vision of a future in which people and nature can co-exist. That's a very bright promise, a very demanding agenda. But it's one that I believe all of us at this meeting share. It crosses from academic to applied organizations, and from private NGOs to public agencies like the National Park Service. I congratulate you on being a part of it, and look forward to your deliberations, which undoubtedly will help us all.

Thank you.

Understanding ecosystem processes for conservation and management

Superintendent's International Lecture
October 7, 2003

A.R.E. Sinclair

Anthony R.E. Sinclair is a Professor of Zoology and Director of the Centre for Biodiversity Research at the University of British Columbia. Born in Zambia, Dr. Sinclair spent his first 10 years at Dar es Salaam, Tanganyika (now Tanzania) on the tropical African coast, later moving to Blantyre, Nyasaland (now Malawi). He holds a Ph.D. from Oxford University, was the recipient of a NATO Fellowship for work in Tanzania from 1966–1969, and was a research scientist with the Commonwealth Scientific and Industrial Research Organization in Australia from 1970–1973. Dr. Sinclair is an international leader in the study of the ecology, population dynamics, and community structure of large mammals. His 30-year study of hoofed mammals in East Africa has shown how such populations are regulated. An expert in ecosystem dynamics, Sinclair has played a central role in the management and conservation of large herbivores around the world. Dr. Sinclair's books include **Serengeti: Dynamics of an Ecosystem** and **Serengeti II: Dynamics, Management, and Conservation of an Ecosystem.** His scholarly articles have appeared in scientific journals including **Ecology, Oikos, Conservation Biology,** and the **Journal of Animal Ecology.**

Introduction by Yellowstone National Park superintendent Suzanne Lewis

The Superintendent's International Luncheon, initiated at the very first conference in this series, has always served a special role. No matter what the focus of the conference, whether ecological or cultural, whether wildlife species or geographical feature, we set aside this occasion to take the long view, and the far view. Previous speakers in this series have introduced us to the workings of conservation on several continents, and have thereby always enriched our grasp of the local subject matter.

Because this year's conference is by definition international, our planning committee admits that they dithered briefly over what to do about this occasion. Finally, they resolved that the best thing was just to keep doing what has worked so well in the past—invite some recognized leader in the world of conservation research and turn that person loose to exercise one extraordinary personal vision for us.

Once that was decided, Tony Sinclair's name immediately arose. Your agenda and abstracts program contains a nice biographical sketch, noting some *of his most important publications, his long research experience in Africa and Australia, and his great breadth of vision as an ecological thinker. These facets of his career make him a natural choice for this lecture, but it is probably his long and little-known connection with Yellowstone's ecological research that made us most eager to bring him here today.*

Long-time research staff here in Yellowstone tell me that in the late 1970s, when the controversial experiment now popularly known as "natural regulation" was still getting underway, one of the texts you were most likely to see being passed around in the research office was entitled The African buffalo: a study in resource limitation of populations, *by one A.R.E. Sinclair. This milestone study, with its examination of the magnificent grazing system of the Serengeti, seemed vitally relevant to the questions then being asked about Yellowstone's own large, complex, northern ungulate range.*

Yellowstone ecologists of the time communicated with Dr. Sinclair, and eventually he joined our own Doug Houston and two other scientists in publishing iconoclastic and irreverent papers on the ecological sciences. In 1982, when Houston completed his own landmark study of the northern Yellowstone elk, it was only fitting that the foreword was written by Tony Sinclair.

At the conclusion of that foreword, Dr. Sinclair made a statement that still rings true and warms the hearts of those of us who are responsible for real-life, on-the-ground wildlife management. He said, and I quote, "Since we can never know all the facts about a situation, we can never be sure that management is necessary nor that its results will be what we predict: we must manage in an air of uncertainty."

For all our lengthy and tremendous research efforts here in Yellowstone, we still breathe just that kind of air every day, and we are forever in Dr. Sinclair's debt for helping us understand that it is just such uncertainty that drives us to think, and learn, and do the best we can.

Ladies and gentlemen, Tony Sinclair.

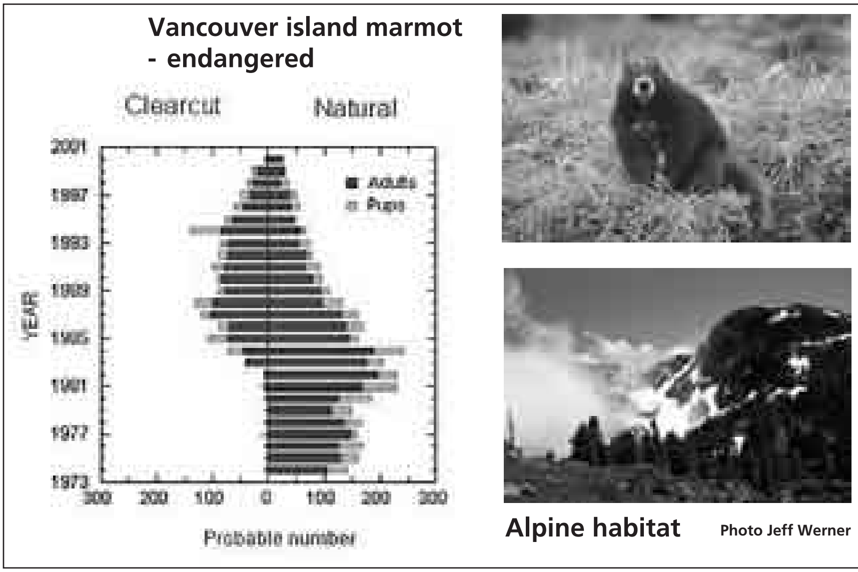
First, I must say thank you very much, Suzanne, for not only your gracious invitation to come here, but also that you knew way more than I thought you should know about me. Those papers were supposed to be anonymous. I don't know how you knew about that. I would also like to thank the other members of the organizing committee, John Varley, and Glenn Plumb, and a whole bunch of other people that I can't spend all the time thanking. But thank you very much indeed; it's a great pleasure to be back. It's 25 years now since that first visit, and it's been extremely interesting to see how things have changed. Not just in the biology, but also in the way people are thinking and talking.

I went to Kruger Park last year. It was exactly 20 years after I had been invited the first time. And there was an almost exact parallel change in the way people were thinking, and the way they were doing things in those parks. So I consider this as a really heartwarming experience to see that people are flexible and that they're looking for differences.

I thought what I should do today is, rather than talk directly about Serengeti, let alone Yellowstone—you know much more about it than I do—that I should pick on some interesting aspects of ecosystem management. So I'm going to talk about science. I could have talked more about people and parks, and I wasn't aware of the great emphasis which I've now heard from these talks about that, so I'll confine some remarks about people and parks to the panel discussion at the end [of the conference]. In the meantime, I'd like to go over some examples of ecosystem management. I'm going to start out simple, and then we'll gradually get to more complex situations. And really, the sort of sub-heading for this talk could be, "cautionary tales—things are not always what they seem to be."

I'm going to start with my colleague and good friend Graeme Caughley, who encapsulated I think nearly all problems to do with the biology side of management, rather than the people side of management, by saying that we could basically call all problems in terms either of too many, too few, or how many—that is, harvesting. I'm not going to address the third of those. But I will consider those first two aspects. The real issue is this: that when we have a problem to do with a species, we recognize that that species is embedded in a community, and in an ecosystem. Despite that, we almost never actually apply management taking that into account. It's nearly always single-species management that we're dealing with. I think you can all think about your own work in that context. The problem is that if we do that too blindly, we'll end up getting some surprising results, and it's because of that that I'd like to work our way through some of these issues.

Vancouver Island marmot is Canada's only truly endangered species. We have lots of others, but they basically live in America, and we don't recognize anything south of the border. So I don't count those. The Vancouver Island marmot is now down to 20 animals. It's declined, as you see from the graph [slide 1], from about 200 in the last 10 or 15 years or so. Before that, of course, it was a lot more common. Currently, the real issues are that a single wolf can go in and gobble up three or four of them in a summer, and that's a huge proportion of the remaining population. And there's a tremendous public outcry concerned with "shoot the wolves" or "don't shoot the wolves," depending on whether you like wolves or not, and whatever else is around, golden eagles and so on. I happen to be in charge of a major program looking at the research there, and we contracted a paleoarcheologist—a paleobotanist—to go and look at the habitats of these animals. Within a fairly short time, he's come back and said, "we have found remains over a much larger area," and that this area was alpine habitat—that's where they like to live—and that this



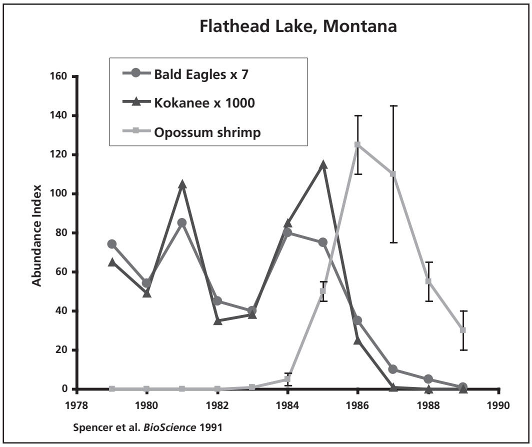
Slide 1.

has been progressively declining for the last 10,000 years.

So that really raises the issue: if we deal with predators, we're just talking about the symptom of the problem. Sure, when you get down to 20 animals, predation is—if you know anything about the dynamics of predation—is going to drive them extinct. So we do have to do something about that. But if that's all we do, then we're never going to solve this problem. On the other hand, should we be dealing with habitat, that is, alpine habitat, or should we in fact be thinking about climate change? What really is the issue in this particular case?

Therefore, we have to put these kinds of problems into a much bigger perspective, not only in terms of the space and the other species involved, but also the timescale. I'm going to therefore start with a community, and look at the simplest possible interactions. Nearly all of us recognize that when there's a problem of a species, it's going to be imposed upon by something directly related to it—either its food supply or its predators. What is less understood is that there are indirect effects. There are longer food chain effects that can be playing a part, and if we don't consider that, we can come up with all sorts of strange results.

Here is an example of the population of bald eagles at Flathead Lake in Montana. Bald eagles are there in numbers dependent upon the Kokanee salmon. Kokanees are sort of land-locked sockeye salmon. For the first few years in this example [slide 2], you see that there are lots of bald eagles, and they depend on lots of Kokanee. Now, it is known from many other lakes



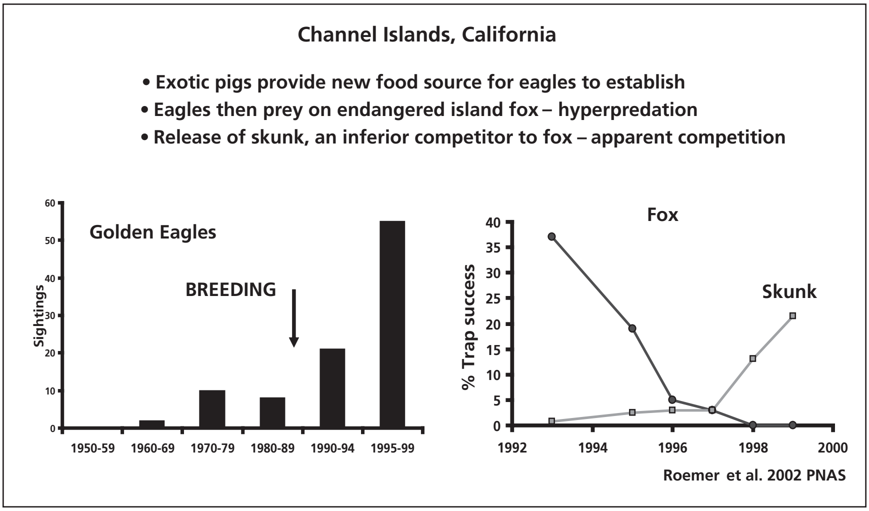
Slide 2.

that Kokanee love eating a particular shrimp called the opossum shrimp. It's an indigenous, even an endemic species that occurs in oligotrophic lakes around this part of the world. Where they have introduced opossum shrimp, Kokanee really eat it in large amounts, and their numbers go up, and so fishermen can catch more.

So they decided to introduce opossum shrimp, in 1968, to the Flathead Lake. Well, what you see is that as the opossum shrimp went up, the Kokanee salmon went down, and so did the bald eagles. It turned out that instead of the salmon eating the shrimp, the shrimp actually became a competitor for the cladocerans and other species that the Kokanee had originally been feeding on. And for some reason that we don't know about, the Kokanee didn't eat the shrimp. So the shrimp became the competitor, the dominant competitor, and down went the Kokanee. This was a completely unexpected result. So it's important, therefore, to be aware that things don't always come out the way you expect them. They got what we call a perverse result.

That, in a sense, is what we could call a bottom-up effect. Now, if we looked at top-down effects, such as predators, predators have a whole range of possible different effects in communities, and I've listed a few of these here. Some of them we can call hyperpredation, apparent competition. Predation, because of its non-linear effects, can cause collapses of prey, or the reverse—it can cause outbreaks of prey—and we can get what we call multiple states in communities. These complexities mean that the way you manage a particular species is often counterintuitive. In the Channel Islands off Santa Barbara, California, we had a situation where exotic pigs were released. They roamed around these islands for some time in small numbers, but as exotics often do, all of a sudden they started to increase after many decades of being in low numbers [slide 3]. That provided a prey base for golden eagles to first visit, and then settle on those islands. Previous to that, golden eagles had not been able to live on the Channel Islands.

As a consequence of the golden eagles' appearing, we saw a decline in the island fox, which is an endemic species. So here we have a problem of too few. As it turns out, the golden eagles were feeding on the island fox, so this



Slide 3.

is hyperpredation as a consequence of now having an additional prey base, namely the pigs, that allowed the eagles to increase their numbers. Then, we got an increase in a non-threatened species, the skunk, which was being kept down by the fox. And so the consequence of putting in an extra prey resulted in a turnover of the species communities, again a result that was not expected, or wanted.

I mentioned multiple states, and I think it's important to understand that because of the way predators work, we can actually end up with more than one way that a community is brought together. There are several types of examples of this. Most of them are produced by top-down effects from top predators, but it doesn't always have to be that way. I'll just give you one example from Serengeti. I will mention Serengeti from time to time in this talk, but my intention, actually, is to draw examples from all over the world.

We have the situation, in Serengeti, of elephants feeding on plants. I'm not going to go into all of the details here—I just don't have time to do that—but essentially, we've got two states. We've got an elephant state with grasses, and when they have the grasses, they're actually pulling up baby trees. They go in line abreast, and literally weed out these tiny little trees, and they're so good at doing this that they can actually completely clean out a grazing swath. This [slide 4] is in the Mara Park, and the Mara Park doesn't have regeneration of acacia trees. Go south into Serengeti proper, and for other reasons, we have had an outbreak of trees, and we now have a situation where elephants are feeding on bigger trees [slide 5].

We therefore can look at two situations within the same ecosystem—the Serengeti—where we have grass and elephants feeding on baby trees, and they

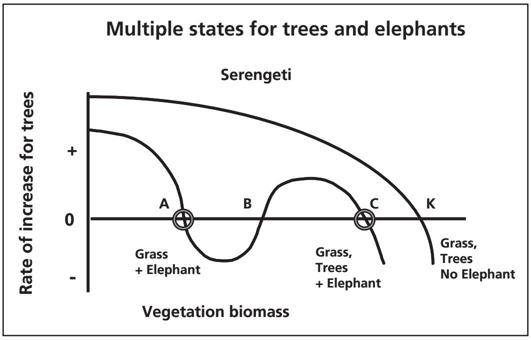
Slide 4.

Slide 5.

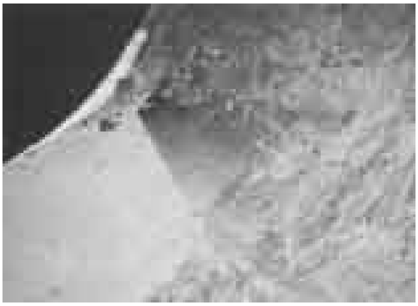
keep the tree population down. This graph [slide 6] basically illustrates what's going on with the rate of increase of the prey, which is the trees, against the tree biomass. One situation is where the S-curved line is above zero—here, it means that the tree population is increasing. Below the zero line, the tree population is decreasing. And where they intercept at zero, there's a steady state. It doesn't mean that that's where they sit the whole time; it means there is a tendency toward a steady state. And so here, we see that we've got a grass-and-elephant state.

There is the other state that I mentioned, where we have grass, trees, and elephant. And we can be in both states in the same system at the same time and have the same species present. But the combination is different. The way you get from one to the other requires a perturbation. In our case, the perturbation that actually knocked it down from elephants and trees to elephants and grass was, in fact, fire. We've actually been able to go through the cycle more than once, and we've gone back up now to the situation where we've got elephants and trees, and the perturbation that was required there was poaching—knocking out the elephants. In the 1980s, 80% of the elephants were knocked out in the Serengeti. But that didn't occur in the Mara side of this system. There's a difference in management, and we can look at that difference in management as an experiment to tell us what's going on. In effect, this ecosystem has three stable states. It has one where we have grass and trees, and no elephants; one with grass, trees, and elephants; and one with just grass and elephants.

Not all places in Africa, of course, will have this; it's actually quite unusual to find this situation. Most other places simply have



Slide 6.



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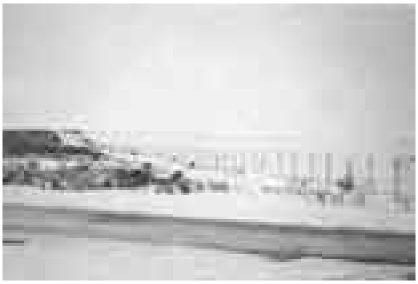


Slide 8.

two: one without elephants, and one with. A grass-and-elephant one would be, say, present in Uganda. One with trees and elephant would be characterized by, say, Tsavo National Park, Kruger National Park, or Chobe.

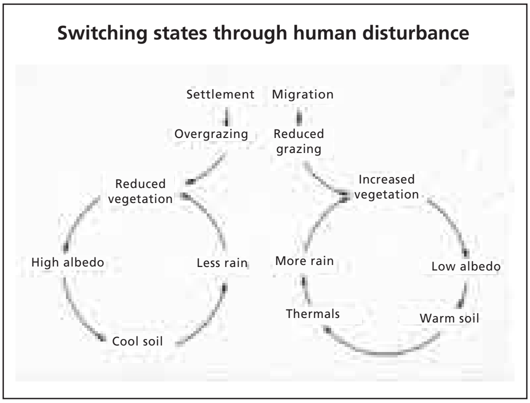
Now I'm going to give you another example. This is an infrared image of the Israeli–Egyptian border in the Negev desert [slide 7]. It's a thermal image, so the dark means warm and light means cold. You can see the boundary by the change in vegetation. This is what it looks like from the ground [slide 8]. On the left, we have a blanket of arid-type vegetation which keeps the soil surface warm. On the right, we have no vegetation because of a difference in the grazing pressure we have on the Egyptian side—Bedouin grazing. They were excluded on the Israeli side for something like 20 to 30 years, and the consequence of that was that there's a difference in the albedo—that is, the reflectance of the two habitats—and that difference led to differences in the thermal uprising and the amount of moisture in the air.

Consequently, we can recognize that there are two basic systems [slide 9]: in the one on the right, we have little grazing, and vegetation, as on the Israeli side—low reflectance, warm soils, thermals, and rainfall which maintains the vegetation. This is a positive feedback loop. On the left, we impose overgrazing, which is a perturbation. We take out the vegetation and get high reflectance and less rain, which means we get continued desert conditions. This is also a positive feedback loop. So both of these are stable situations, and they jump one to the other by a perturbation, in this case the overgrazing.

So that's an example of a multiple state. It is also an example of a perverse state, because there's one that you would normally recognize you would want, and the other that you would recognize you don't want. It's easy to fall into that trap if you don't understand the complexities of both the abiotic and the biotic connections in that system.

To go on, I've been talking about food chains, and now I'm going to get a step more complex and talk about communities. Communities, of course, are a big subject, and every single one of these slides would require a lecture, but I can't do that so I'm just going to [ask you to] remember that communities are not just made up of a bundle of species all thrown together. They are made up of species which are not all equal. Some are more important than others. Some important ones we call dominant species, and they structure the environment for other species, and provide components of the food chain. I won't say much more about that, but they also can contain what we call keystone species.

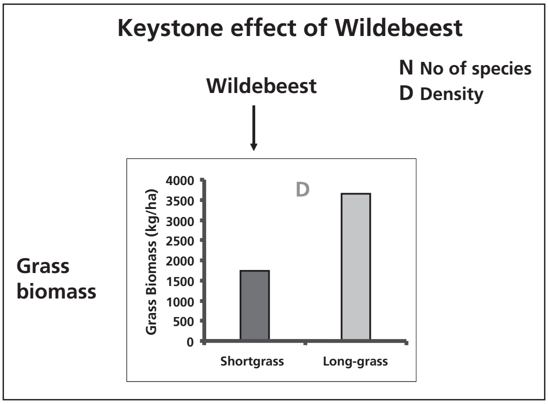
A keystone species as a concept is somewhat controversial, but we do have to recognize that there are some species which even in small abundance have major impacts on the whole community. I'll give you another example from the Serengeti, of the wildebeest doing this. The wildebeest is a keystone species. Even though it's in great abundance, its biomass relative to the vegetation is quite trivial. Wildebeest like eating shortgrass, and they go around more like lawn-mowers than anything, and keep the grass short if they can. When they are on the plains they occur in large numbers, and in that fashion they will have a major impact on certain parts of the plains. It's the eastern plains where this impact is greatest; in the western plains, their impact is not so great.



Slide 9.

We happen to know from historical evidence that these plains were not always impacted by wildebeest. Therefore, we can say that when the plains are in this configuration of very short grass, there is actually a plethora of small flowering dicots, herbaceous species, to the extent that they take up 40% of the area. If you drive across there, you don't really notice it unless the flowers are out. But it is, in fact, really quite considerable that only 60% of that area is actually grass. We can tell that because we had an exclosure that was up for about 10 years, and in that time, we got a changeover of the grass community. Up until then, we always thought that the shortgrass plains were edaphic, due to the volcanic surroundings. But it turns out that's not the case, and it turns into long-grass plains when the wildebeest are removed for long periods, as they were in the first half of the century.

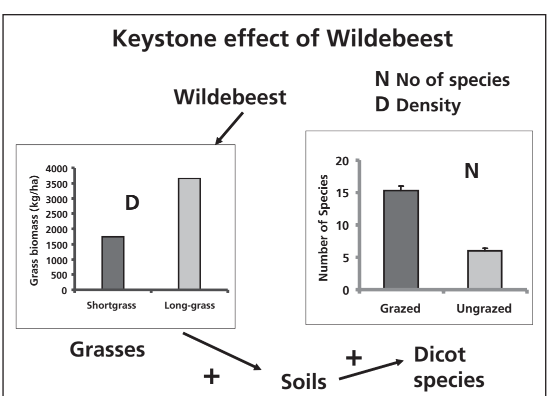
I want to show you a few interesting components of this system. As I said, there's a change in biomass of the grass, so we can compare the long-grass areas now, which are the same as the long-grass areas that used to be on those



Slide 10.

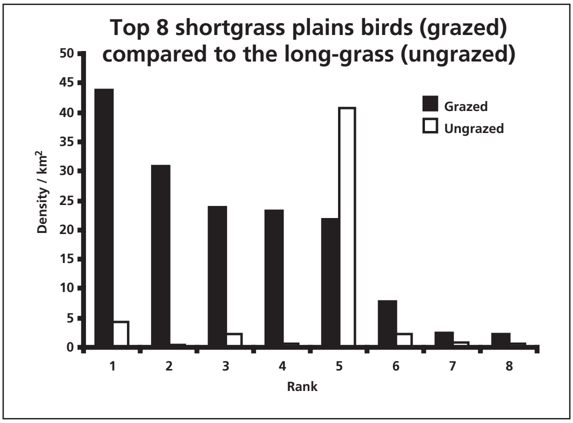
plains 50 years ago, and we know that from that experimental exclosure, with shortgrass plains, the biomass of the grass is half or less than the biomass in the long-grass area. If we look through the competition, long-grass excludes flowering herbaceous forbs, and so if we remove the grass, keep the competition down by grazing, there's an increase in the number of dicot species, as I mentioned [slides 10 and 11]. This is actually an underestimate; there are probably twice that number of herbaceous species now. So we get a huge diversity of herbaceous plants on the shortgrass plains that are simply not found on the long-grass plains.

Now, we have butterflies. Butterflies like flowering plants, and we find that the density of butterflies in the shortgrass plains is something like 100 times the density in the long-grass plains. The different structure of that vegetation also houses a different structure of bird fauna, so things like the capped wheatear, for example, like shortgrass. Things like the rufous-naped lark like long-grass, and we can see, if we do our counts correctly, changes in the composition of this bird fauna. There's something like 50 species, but if we just take the top eight or so, you can see that we look at the fate of the shortgrass species when we get to long-grass [slide 12]. Nearly all of these shortgrass species which are in high density drop out, and only one of them actually increases when you go from grazed areas to ungrazed.



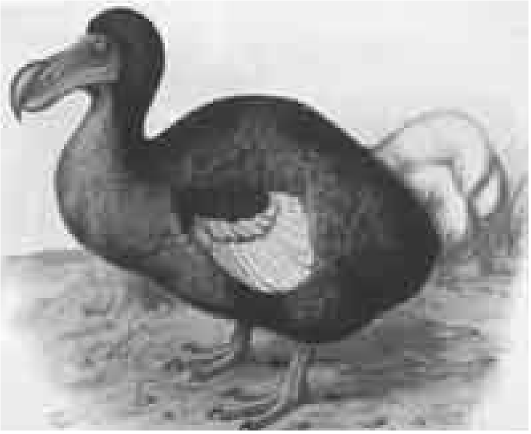
Slide 11.

Now, we've tracked the ripple effect of wildebeest through many other components of this system, and we're still looking further and further, into the insects, for example. In fact, I was interested to see that Robin Reid is now looking at bacteria, and I think that's an area where we should maybe encourage her to come and look on our plains as well. In essence, then, the wildebeest impact is spread not just across the mammals, but across every component that we have so far been able to measure. That is a truly keystone effect, and the result is that we get increases in diversity in some aspects, and we get decreases in diversity in other aspects.



Slide 12.

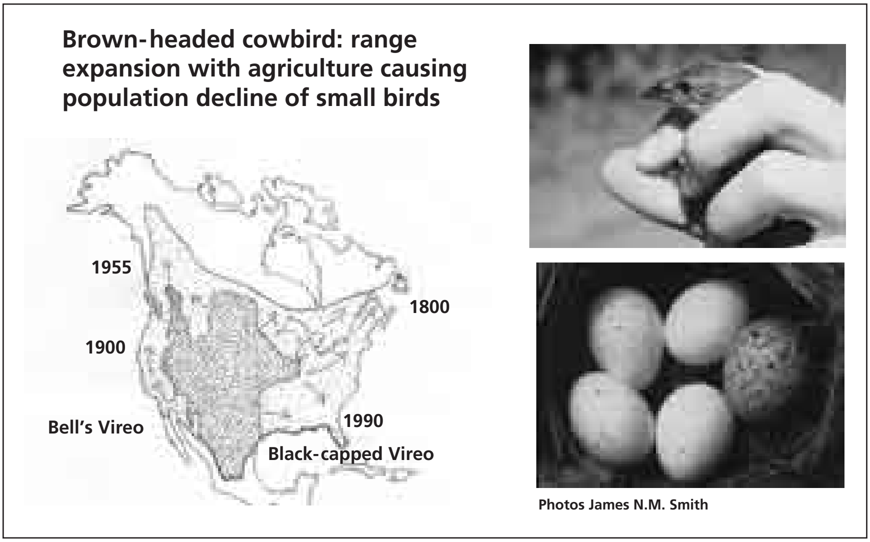
On top of this, we have to recognize that part of the not-all-species-are-equal component in communities is that some species are completely dependent on others. This is what we call co-evolved links, and I'll just give you one quick example here. This is taken from Mauritius, where there's a tree called the *Calvaria*. Up until 1977, this tree was never known to germinate; in fact, it was on its last legs. It was about to go extinct because the trees were getting too old. Luckily, a wise chap called Stan Temple, of Wisconsin, figured out what the problem was, and he got some turkeys to eat the seeds of this plant. (Well, actually, he sort of had to ram the seeds down the turkey, because they were rather big and the turkey didn't really like to eat them.) When, eventually, the seeds came out the other end, they germinated for the first time that people had ever remembered since the invasion of that island in the 1600s. [Temple] did that because he figured out that there was a bird on that island called the dodo [slide 13], which went extinct 200 years ago. [The dodo was] a large flightless pigeon of several kilos—I think it's 10 kilos or something quite enormous—and this was the bird to which the trees



Slide 13.

had become closely linked. The trees had evolved so that this was their way of transportation, of getting those seeds around the island. This big, flightless pigeon just sort of waddled around and dropped the seed. Now, of course, they've got better ways of getting these seeds to germinate, and they don't have to torture poor turkeys to do it. But it really brought home the fact that if you lose one part of a community, you may well lose other components of the community, because they're dependent on the first part. There are other examples, but I don't have time to go into all of this.

There are such things as mobile links; that is, we have to manage systems for other species that come and go. One of the clearest examples that I heard



Slide 14.

today was from Robin Reid, where at the Nairobi park, the migrants spend their time in the wet season outside of the park and then have to come back in. And Robin didn't mention, but it looks strangely as though that migration route is going to be cut very shortly. And if that's the case, then the park is basically going to lose its major grazers, and essentially will cease to be a proper functioning system. Now, that's simply an interpretation, because I didn't hear from Robin what's actually happening in terms of managing and keeping those corridors open. [To] manag[e] a system, one has to look beyond the borders of that system.

Another case is the cowbird problem. In America, cowbirds were confined to a particular area, which is the stippled area [slide 14], until agriculture came along and cut down all the trees around about in the west and in the east. When the trees were cut down and agriculture came in, the cowbirds spread. Cowbirds are parasitic birds; they lay their eggs in other birds' nests. As a consequence of that, they started to lay their eggs in the nests of species that had never been exposed to these parasites. In particular, two of them are now threatened: the black-capped vireo and the bell's vireo, which are collapsing as a consequence of the cowbird parasitism. So here what we have is a perverse result, as a result of human activities outside of a system bringing in something that causes the community to start changing its shape and resulting in a problem.

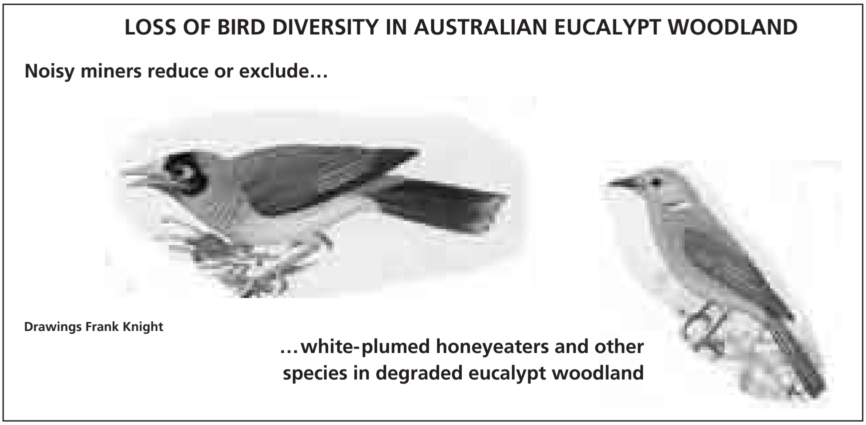
Ecosystem Processes
- **Hydrology, flux and storage**
- **Biological productivity**
- **Biogeochemical cycling and storage**
- **Decomposition**
- **Biodiversity and Stability (resilience)**

Slide 15.

Communities, of course, are dependent upon the abiotic environment, and on the disturbances that go on in that environment. Those disturbances are very important in shaping the community. This is one audience that I don't have to tell that to; I just thought I'd mention it. Obviously, fire is one of them; flooding in other systems. Herbivory is a kind of perturbation (a biotic perturbation). These things have all sorts of important controlling effects on the system. For example, if competition is reduced, species diversity is increased through the process we call intermediate disturbance. Both fire and grazing act as disturbances, and in moderate amounts they create not only an increase of diversity, but also a more patchy (heterogeneous) environment that forms new niches for other species. But we also have to remember that disturbances operate at different rates. We can have fast rates of disturbance, or very long-term ones. And we have to be aware of the timescale of these disturbances. If you're not, you can either manage wrong or you're forever chasing your tail because you're one step behind what's going on.

A nice example of the long-scale events that have to be taken into account is that of the habitat for the pandas. Pandas basically eat bamboo and only eat bamboo, and it's unfortunate that this bamboo tends to flower at long periods of 20 years, and they flower synchronously over large areas and then die—very large areas, way bigger than any reserve that the panda lives in. So all of a sudden, the panda is confronted with having no food whatsoever in its reserve. Management, therefore, has to take into account that they have to have reserves over a big enough area so that they can get food or transport animals from patch to patch so as to take into account the synchrony and timescale of this kind of disturbance.

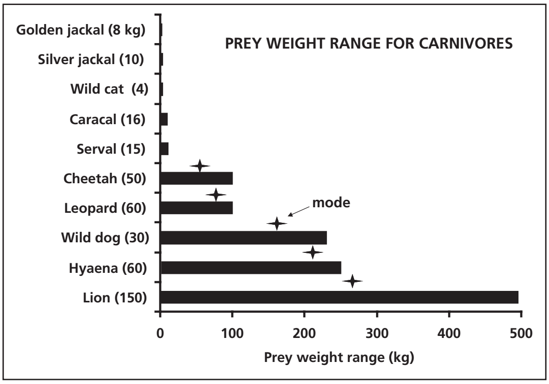
Now I get onto ecosystem processes. Ecosystems are not just descriptive properties; there are rates of flow in these systems. This is a list of some of those sort of things: hydrology, productivity, and so on [slide 15]. I'll just give you examples of a couple of these. One is how, if you don't bear in mind



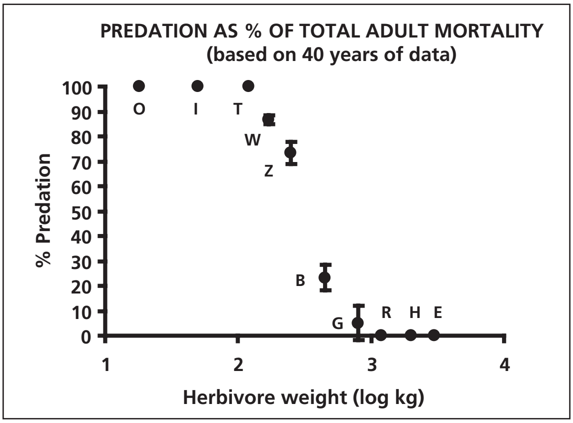
Slide 16.

these processes, things can go wrong. To bear in mind these processes means you have to know something about them. [For instance,] most of southern Australia was covered in eucalypt forest before Europeans got there. Europeans have, in the last 150 years, systematically cut down nearly all of it, particularly in western Australia, for the wheat belt. So there are only tiny little patches left. It now turns out that those trees were actually extremely useful, because they were drawing water from the water table and transpiring it, thereby keeping the water table down. Cut down the trees, nothing draws the water down, and it comes up to the surface and evaporates. When it evaporates, it then deposits salts that it has picked up on the way up through the water table, and now we've got salinization and the collapse of just about everything because those plants can't tolerate high sodium. This problem now is Australia-wide. It's not just a local problem, it covers everything. And so the Australians are now going back to planting eucalypts all over Australia again.

It's wise to learn from these lessons; obviously, it's easy to be wise in hindsight. But we should be paying attention to how these systems work. Another example, also from eucalypt woodlands in Australia, involves a group of birds called the honeyeaters. Normal woodland in Australia is quite dense, and it has



Slide 17.



Slide 18.

a large range of honeyeaters. Cut down the woodland, and what happens is that one particular honeyeater, the noisy miner, dominates and excludes most of the others, including the white-plumed honeyeater [slide 16, right]. These small honeyeaters are insect eaters. They keep down insect pests, and as a consequence of the tree cutting, the remaining trees in the area are now suffering major outbreaks of insects, and there is what's called dieback, which eventually kills the trees. So this is a breakdown in the system as a consequence of losing species, which is a consequence of opening up the structure in the vegetation.

One other aspect of this: I've just shown you how a system can break down if you start breaking up the community. What we've just discovered in the Serengeti is how we can actually create stability, or rather not how we create, but how the system creates stability by having a diversity—in this case, a diversity of predators and prey. This slide [17] illustrates the species prey weight range of a series of different carnivores, from lions down to very small ones. What you see is what we call nested niches of predators. Small predators eat prey that are also eaten by the larger predators, but they have a smaller range. Now, this has a particularly important effect upon the prey, of course, because if you're a small prey, you tend to be faced with rather a large number of predator species. So some small mammal species will be confronted with as many as seven different carnivores, whereas very large ones have very few. That means we can say that small prey are likely to be predator-limited, whereas large prey are food-limited.

This is important because before this, we have not been able to predict when we're going to get predator limitation and when we're going to get food limitation. This is really the first time we've been able to see that. Now, we've got measures of the amount of mortality imposed on different sizes of these ungulates which we've accumulated over 40 years, and we see a pattern that is predicted by that previous one [slide 18], so that all of the adult mortality of these small prey are accounted for by predators. There's a sudden dropoff; there's a rapid threshold change from predator limitation to prey limitation. This has only just come out, and we think that this pattern actually creates stability, and that if you start to lose the diversity of the predator guild and of the prey guild, then you'll start to get disruptions, and then you'll start to see either outbreaks of prey or collapses of prey.

I'm just going to say a quick word about applying some of these aspects. Essentially, what I've talked about really has to be applied in natural systems, and for the benefit of conservation. But to do this, we have to think about conservation in two different areas. One is the protected areas, and the other is community conservation. I detect, not only here [at this conference] but elsewhere, that there is some sort of polarity in this argument. And I've never understood why, because it seems to me we have to have both. The reason is that protected areas are required, absolutely essential for certain groups of species. We're going to lose the major predators if we don't have protected areas. Certain rare and endangered species require complete protection, and so on. At the same time, we have to have areas which we call benchmarks to judge the impacts we're having outside. Robin Reid's example of comparing pastoral areas vs. non-pastoral areas is a classic example. Without doing that comparison, we won't be able to interpret what goes on. This is, to me, the most fundamental reason why we have to have protected areas; it is an insurance policy for our whole well-being on this planet.

Slide 19.

The example of having a baseline, I think, couldn't be more clear than this: Africa went through decadal cycles of major droughts and major famines. They were in the 1970s, 1980s, 1990s. They were about every 10 years, as I said, and they had been blamed on the drop in rainfall. It turned out that this was completely wrong. We understood that

Slide 20.

because, in the middle of this drought, when people were dying in large numbers, one of the NASA interpreters of LANDSAT saw what has come to be called the green polygon [slide 19]. It's a very poor image; that was the best we had in those days, 30 years ago. They looked at this; they said "Wow, what's this green thing right in the middle of this drought area in Mali?" They went down, and here they discovered it was a ranch of 200 square kilometers [slide 20]. That ranch had cattle on it, didn't have any water supply to it, yet the grass was green, about a meter high. Outside, there was no grass at all; this white area is just sand. This was exposed to nomadic peoples and their grazing, and by having that baseline—that control, if you like, it showed that it wasn't the abiotic environment that was doing this. Rather, it was a biotic impact from the grazing, and this was actually the first clue that this was a man-induced situation. That is why we have to have baselines.

However, protected areas cannot protect everything. Just by a simple species–area relationship, we know that if we had as much as 10% of the world protected, we would lose at least 50% that's not included. That means we have to be thinking about conserving other areas as conservation areas, what we would call community conservation areas. So it's absolutely essential that we go outside of parks to look for our conservation. Nevertheless, it must be recognized that community conservation areas are limited in their capacity to conserve. They generally conserve those species that are able to tolerate human impacts, often those ones which are most common and need the least amount of protection. And so it turns out that there's pros and cons on both sides, and we have to have both of them.

So what do we say about Caughley? If we are going to do anything, we have to be aware of a number of important aspects. We have to know not just [about] food chains, but some of the more unexpected interactions that go on in communities. Some of these things, these complex interactions, involve multiple states, and of those states, it is not always obvious which ones we have to manage for. Ecosystems are shaped by natural disturbance, and we have to manage for their frequency. Ecosystems are always changing; that's an important point. You cannot manage for the status quo. You have to be able to allow the flexibility to allow the system to change. If you don't do that, then you're going to get into trouble. Complexity leads to the biodiversity, which feeds back onto ecosystem structure and function and maintains our systems. And if we're going to maintain systems, we have to be able to protect them. We have to stop the large-scale abuses that humans are doing to our environments, and why do we need to do that? Because it's the only way we're ever going to be able to understand whether what we're doing to our environment is good or bad.

Thank you.

Ungulate grazing systems compared between the Greater Yellowstone Area and East Africa

Francis J. Singer, Linda C. Zeigenfuss, and Robert Stottlemyer

Abstract

The wild ungulate grazing system of the Serengeti has become known for its large number of compensatory responses of grasslands to herbivory. Grazing lawns develop as nitrogen processes are accelerated on repeatedly-grazed sites and production of previously-grazed grasses are stimulated. GYA ungulate winter ranges similarly support the largest assemblages of large grazing herbivores in North America, but these ecosystems have cool, continental climates, not tropical climates; the elevations are montane versus the low elevations of the Serengeti; and productivity is much less. Can these GYA grazing systems develop some of the same dramatic compensatory responses to grazing that the Serengeti ecosystem has?

We review recent research in the Jackson Valley, Wyoming, grazing system and the long-term record of research on Yellowstone's northern winter range. Strong compensatory responses to grazing were observed in both areas. Grazed grasslands in Jackson Valley generally produced more biomass, aboveground nitrogen (N) yield was higher, and N processes were accelerated, including nearly doubled N mineralization rates, larger N pools, and higher plant N concentration. Fine root activity, seed production, seed viability, recruitment, and replacement rates were also higher on grazed sites in these study areas.

We conclude that GYA grazing systems are as resilient, responsive, and adaptive to intense herbivory by large assemblages of native ungulates as are Serengeti grasslands. YNP's northern winter range is subjected to relatively low offtake only during the winter dormant season, unlike the Serengeti. The Jackson Valley experiences substantial winter and growing season offtake, yet the system remains largely productive, vigorous, and sustainable.

Introduction

The wild ungulate grassland-savanna grazing ecosystem of the East African Serengeti is a textbook example of positive compensatory responses to grazing. Largely through the research of Sam McNaughton, Anthony Sinclair, and their co-workers, the Serengeti ecosystem has long been recognized for stimulation of aboveground production of grasses following grazing by wild herbivores; grazing facilitation by guilds of wild herbivore species; development of grazing "lawns" through repeat grazing events; increased rates of nutrient turnover; and increased concentration of nutrients by repeat grazing (Bell 1970; McNaughton 1979; 1983; 1984; 1985; Sinclair and Norton-Griffiths 1979). Grazed graminoids in the Serengeti have higher uptake rates of nitrogen, and higher rates of photosynthesis per unit of plant tissue than do their ungrazed counterparts (Ruess et al. 1983; Ruess 1984).

East African grasslands have been recognized to possess a long evolutionary history of grazing by large ungulate herbivores (McNaughton 1985). About three million individuals of 27 species of ungulates occupied the Serengeti region in recent times (Sinclair and Norton-Griffiths 1979; McNaughton 1985). Major grazing species are wildebeest (*Connochaetes taurinus*), zebra (*Equus burchellii*), Thomson's gazelle (*Gazella thomsonii*), buffalo (*Syncerus caffer*), and topi (*Damaliscus lunatus*). Ungulates of the Serengeti graze the diverse vegetation in a serial manner, and/or in different ways, thus reducing competition amongst a highly diverse grazing fauna. The succession of grazers includes examples such as: (1) zebras following wildebeests and grazing patches that the wildebeests ignore; and (2) gazelles focusing on short re-growth of plants previously grazed by wildebeests (Bell 1970).

Greater Yellowstone Area (GYA) ungulate winter ranges support the largest assemblages of large grazing herbivores in North America, and have been typified as the "Serengeti of North America." GYA ecosystem ranges have cool, continental climates, with short growing seasons of only about 75 days. The Serengeti of East Africa, by comparison, is a tropical ecosystem with the potential for year-round growth that is mediated by a wet-dry season precipitation pattern. Elevations of GYA winter ranges are montane (1,500–2,600 m) compared to low elevations in East African grasslands (1,135–1,800 m). Aboveground production of most grasslands in the GYA is predictably only 1/5–1/4 the production (60–200 g/m^2) of the most productive Serengeti grasslands (600–900 g/m^2). However, the fact that both the Serengeti and the GYA support large and diverse populations of grazers makes them interesting counterparts for comparison.

Traditional views of GYA grazing systems

Montane grasslands of the interior northern Rocky Mountains, such as GYA ungulate winter ranges, have long been viewed as sensitive to even light grazing. Intermountain grasslands and those located west of the Rocky Mountain chain are typically dominated by C3 bunchgrasses and other non-rhizomatous grasses. Examples include bluebunch wheatgrass (*Pseudoroegneria spicata*), Idaho fescue (*Festuca idahoensis*—in the U.S., replaced by rough fescue [*F. campestris*] near and north of the Canadian border), and Sandberg's bluegrass (*Poa secunda*). This area, referred to as the Agropyron Province, lacked large herds of mammals throughout the Holocene, and was felt to have less evolutionary history of, and fewer adaptations to grazing than North American Great Plains grasslands (Mack and Thompson 1982; Milchunas et al. 1988). Grasses that use the C3 photosynthetic pathway are considered less grazing-tolerant than are the C4 grasses more typical of the Great Plains (Caswell et al. 1973).

The classic, and often cited, studies of Pond (1960) and Mueggler (1967) reported high sensitivity of the three common grasses to grazing (especially spring grazing) in the montane grasslands. Traditional views held that the short growing season, combined with low productivity in mountain grasslands (such as the GYA), did not allow adequate plant re-growth and storage following repeated grazing cycles each season (Platou and Tueller 1985). Fescue grasslands were felt to be seriously impacted by grazing. Grazed fescue grassland soils were drier and warmer during the summer, while grazing reduced the weight of roots and the forage yield (Johnston et al. 1971).

In contrast to the GYA, the Great Plains' mid- and shortgrass prairies are typified by C4, sod-forming, rhizomatous or stoloniferous grasses (*Bouteloua gracilis, Pascopyrum smithii, Buchloe dactyloides*). This area was suspected to have a much longer evolutionary history of grazing by large herds of ungulates, especially bison (*Bison bison*) (Mack and Thompson 1982; Platou and Teller 1985; Milchunas et al. 1988). Grasses of this area predominantly use the C4 photosynthetic pathway (Table 1), which is thought to confer grazing resistance. They incorporate more silica bodies, are more fibrous, and have lower nutritional content than C3 grasses (Caswell et al. 1973; Platou and Tueller 1985).

Table 1. Presumed grazing-resistant ecosystems (Serengeti, Great Plains) compared to presumed grazing-sensitive systems in the Greater Yellowstone Area

	Grazing-resistant		Grazing-sensitive	
	Serengeti	Great Plains mid- and short-grass prairie	Northern YNP	Jackson Valley
Rainfall (mm)	350–1,200	250–610	300–550	430–640
Elevation (m)	1,135–1,800	300–1,200	1,600–2,600	1,850–2,600
Percent grasslands	40		55	37
Predominant photosynthetic pathway	C_4	C_4	C_3	C_3
Major grass growth form	sod-forming	sod-forming	bunchgrass	bunchgrass
Grass reproduction	vegetative & seed	mostly vegetative	seed	seed
Growing season	76 days to continuous	90–129	74–121	36–76
ANPP (g/m^2)	960	180–400	60–120	45–300
N yield consumed (g/m^2)	3.9–5.6	n/a	1.1	0.84
Ungulates/km^2	120	n/a	16–21	2–71
Number of ungulate species	27	3–4	6	6
Major grazers	wildebeest, zebra, gazelle, buffalo	bison, pronghorn, now cattle	elk, bison	elk, bison

Ungulate grazing could be harmful to plants and soils. Trampling and hoof action may increase soil compaction, increase sediment yield, and increase soil bulk densities. Root biomass and seed production are widely held to be reduced by grazing (see reviews by Ellison 1960; Belsky 1986). Plant production, plant sizes and shapes, and plant recruitment rates can be dramatically reduced by grazing (Dyksterhuis 1949; Pond 1960; Jaindl et al. 1994). Bare ground increased about 11–18% on grazed areas in YNP, and 17% in Jackson Valley (Coughenour 1991; Singer 1995; Zeigenfuss et al. 2003) as compared to ungrazed exclosures.

However, ungulate grazing may also affect annual net primary production (ANPP) through higher nitrogen excretion by ungulates and greater N retention in the system. Any decline in N or other nutrient cycles or pools is potentially serious to grazing ecosystems, because some pools may take decades or even centuries to accumulate. Nitrogen is typically limiting to plants in most terrestrial ecosystems. Its abundance is closely tied to soil fertility, soil organic matter, and soil water retention. Large changes in N abundance may alter plant species composition (Ritchie et al. 1998).

The primary objective of this review is to answer the question, "Can these GYA grazing systems develop some of the same dramatic compensatory responses to grazing that the Serengeti grasslands do?" In order to answer that question, we first compare the sustainability of GYA montane winter ranges to other well-studied North American and East African grasslands and shrublands. Second, we inspect GYA grasslands for any acceleration or deceleration of nitrogen processes. Third, we inspect the GYA for any stimulation of aboveground production of graminoids due to grazing. Our two study areas in the GYA are the northern winter range of Yellowstone National Park and the grassland winter ranges of Jackson Valley, Wyoming.

Study areas

Northern ungulate winter range of Yellowstone National Park. The northern range of Yellowstone National Park encompasses ~1100 km^2 in the park (82%) and the Gallatin National Forest (18%) along the Montana–Wyoming border in the northwest corner of Wyoming (Figure 1). Elevations range from 1,600–2,400 m. Average 30-year (1971–2000) annual precipitation near park headquarters in Mammoth, Wyoming, was 37 cm (Natural Resources Conservation Service Data), but higher sections of the range receive closer to 55 cm annually (Singer 1995). Mean 30-year summer (June–August) temperature was 15.8°C; winter (December–February) temperature was −5.9°C. The growing season is short (74–121 days). The northern range is primarily forest (41%) and sagebrush steppe/grassland (55%). Wild ungulate species include elk (*Cervus elaphus*), bison, moose (*Alces alces*), mule deer (*Odocoileus hemionus*), pronghorn (*Antilocapra americana*), and bighorn sheep (*Ovis canadensis*).

Grassland ranges of Jackson Valley. The Jackson Valley ungulate winter range encompasses ~2267 km^2 of public (Grand Teton National Park, the National Elk Refuge, Bridger-Teton National Forest) and private lands in the Snake and Gros Ventre river drainages north of and surrounding the town of Jackson in northwest Wyoming (Figure 2). Elevations range from 1,850–2,600 meters. The range is 52% forested (46% coniferous, 6% deciduous), and 37% sagebrush and grasslands. The 30-year (1971–2000) mean summer (June–August) temperature in the region was 14.3°C; mean winter (December–February) temperature was −8.9°C (Natural Resources Conservation Service Data). The 1971–2000 average precipitation in the region was 54.1 cm. Growing seasons are very short (36–74 days).

Locations of study sites can be found in Zeigenfuss et al. (2003). Wild

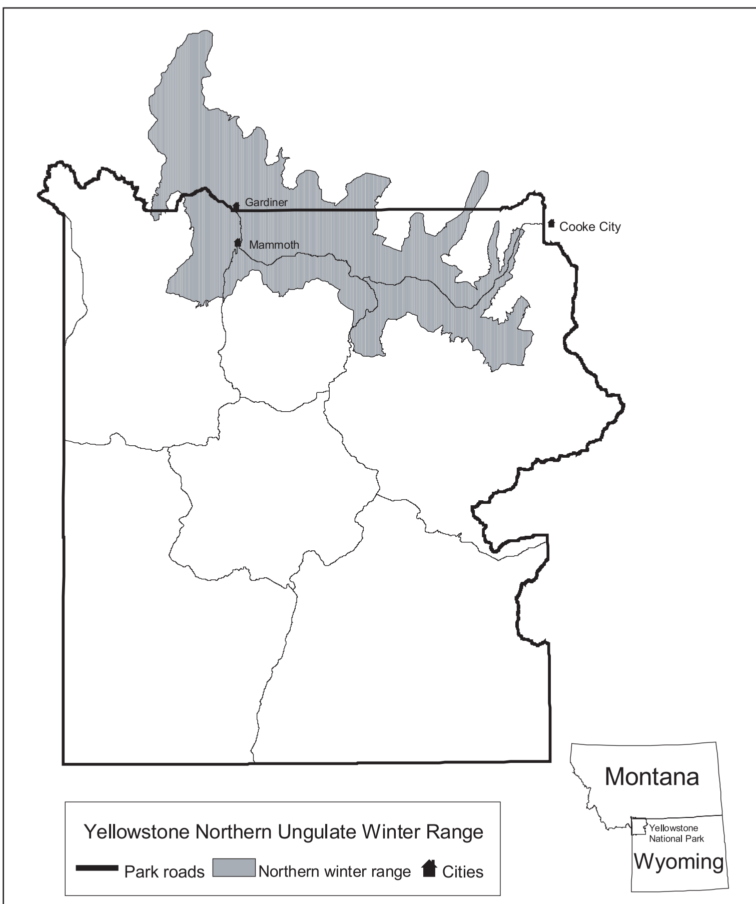


Figure 1. Map of the northern ungulate winter range of Yellowstone National Park.

ungulate species include elk, bison, moose, mule deer, pronghorn, and bighorn sheep. Approximately 36% of this winter range (~98 km^2 in Grand Teton National Park and ~730 km^2 in the Bridger-Teton National Forest) is grazed by domestic cattle during the summer. Elk and bison are the primary wild grazers. A portion of the elk herd and nearly all of the bison herd spend the bulk of the winter months on the National Elk Refuge and three feedgrounds run by the state of Wyoming in the Gros Ventre drainage, where they are fed alfalfa pellets or hay for two-to-three months of the winter.

Sustainability of GYA systems to grazing

Our review suggested that as traditionally viewed, the GYA and other montane grasslands of the interior northern Rockies are more sensitive to grazing than either the Serengeti or shortgrass prairie (Great Plains) grasslands (Figure 3). However, the differences are not nearly as dramatic as previously perceived. GYA and montane grasslands regularly sustained ungulate consumption rates of 45%, while the shortgrass prairie of the Great Plains sustained 66% use (Figure 3). Detrimental levels of use in grasslands followed the same approximate pattern. Use levels of 70% or higher were detrimental for GYA montane grasslands, 80–90% or higher for shortgrass prairie, and 80% or higher for Serengeti grasslands.

Shrubs are generally less tolerant of herbivory than grasses, because they have fewer reserve meristems, nonintegrated modules, and slow, determinant growth rates. Similarly, GYA riparian shrub communities were more sensitive to herbivory than were grasslands (roughly ≥30% annual removal rates of shrubs were detrimental; Figure 3). Several shrub communities with rapid annual vertical growth that were found in burned or otherwise disturbed sites in mesic ecosystems (such as the Great Lakes and northwest U.S.) were the most resistant shrub communities (Figure 3). Shrubs of the sagebrush steppe, such as those found in the GYA, were

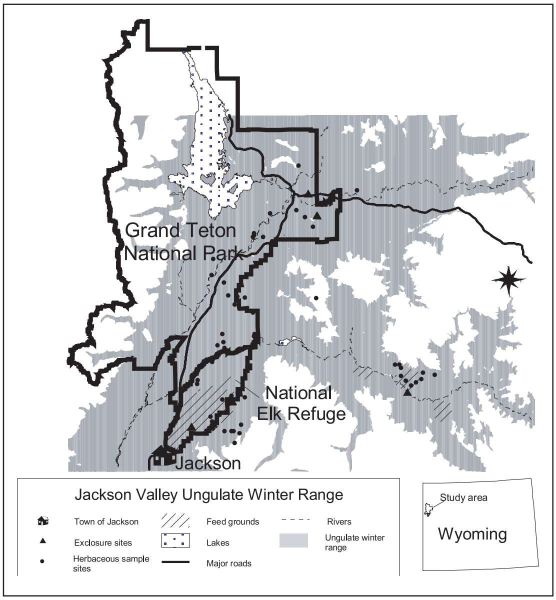


Figure 2. Map of Jackson Valley ungulate winter ranges, Wyoming.

the second-most resistant shrub type to browsing, of those reviewed. Forest understory shrubs were the most sensitive to browsing. Removals of as little as 10% of the current annual growth of forest understory shrubs resulted in dramatic effects on the woody community (Figure 3).

The evolutionary history of grazing in GYA grasslands needs to be reconsidered. Apparently, the grasslands of the GYA are very well-adapted to grazing. Plants may have coevolved with grazing animals (Verkaar 1992). Alternatively, plants may already possess mechanisms that "preadapt" them to repair and replace tissue lost to herbivory (Harper 1977). Examples of preadaptions to herbivory include prostrate growth of some plants, large belowground root reserves (a preadaptation of plants in arid ecosystems), rapid growth rates, and basal meristems. Many adaptations to drought preadapt plants to survive the effects of herbivory. Thus, compensatory responses observed may not necessarily reflect any evolved plant–herbivore mutualisms.

GYA grasses also were observed to be well-adapted to seasonal graz-

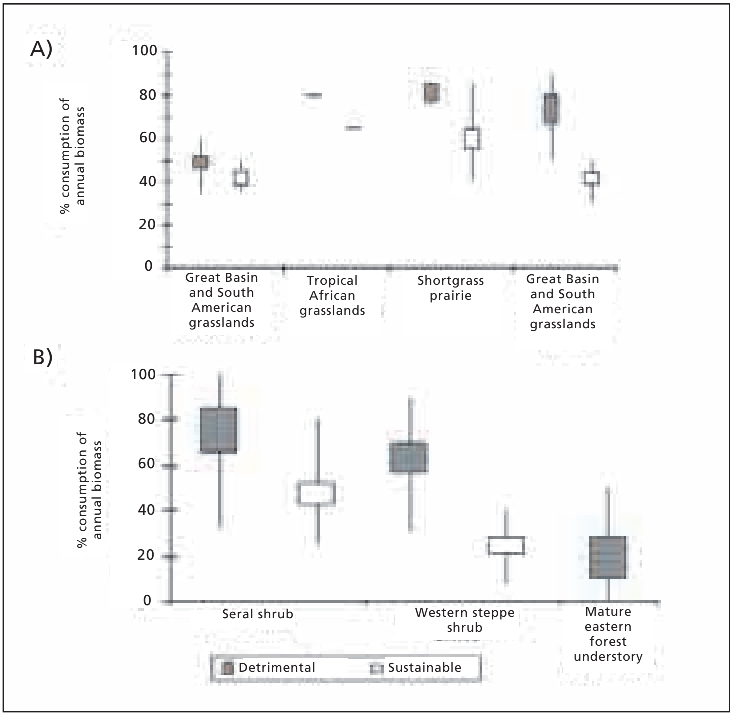


Figure 3. Schematic of percent consumption of herbaceous (a) and shrub (b) species by ungulates that were reported in the literature to be sustainable or detrimental to growth, production, vigor, or fitness components (from Singer et al. 2002).

ing; ungulates preferred sites with greater productivity, and seasonal movements of ungulates resulted in brief, intense bouts of grazing from which plants could recover (Frank and McNaughton 1992). Bluebunch wheatgrass, intensely grazed in the spring in YNP, “caught up” in growth of both aboveground and root biomass by late summer compared to ungrazed counterparts (Merrill et al. 1994). In YNP, no differences were found in sediment yield, soil temperatures, or soil nutrient pools between grazed and ungrazed sites (Lane and Montagne 1996; Singer and Harter 1996; Singer et al. 1998a). Grazing did not influence plant species richness in YNP, and exotic plants did not invade grazed areas, although exotics existed in two areas where they were planted in the 1930s. Exotics also occur on disturbed roadside sites on the northern range. Standing crop biomass of specific plant species was generally not influenced by grazing, except one common grass species and three forbs were less abundant on grazed plots (Singer 1995).

In spite of the compensatory responses to grazing, several more sensitive plant species or groups of species, and several locales were overused by ungulates. These plant communities in the GYA were declining as a result of herbivory by high densities of elk and bison. For example, willow patches in the Jackson Valley consumed at rates of 25–27% of the current annual growth (CAG) were about 60% shorter, and production was about 60% less than maximum values (Dobkin et al. 2002). Percent consumption of ≤17% of CAG appeared to be a safe level of use, and did not reduce current annual growth to levels below those of unbrowsed patches of willows. Unfortunately, browse use in Jackson Valley was highest on the National Elk Refuge, where elk and bison are artificially fed each winter. Seven of 10 samples of willow patches on the refuge revealed excessive use based on these levels. Similarly, some patches of willows on Yellowstone’s northern range were apparently overused. Short, height-suppressed patches of willows were browsed at use levels of 28% of CAG, while tall willows were used at only about one-half that rate, 15% (Singer et al. 1998b).

Some grasslands in the Jackson Valley were also grazed at apparently excessive rates of 80–90%. Production declined and these sites tended to be dominated by exotic grass species (*Poa pratensis, Agropyron cristatum*) (Zeigenfuss et al. 2003). Also, the Wyoming big sagebrush subspecies (*Artemisia tridentata wyomingensis*) found in the boundary line area of Yellowstone’s northern range was browsed at very high levels of 66% of CAG (Singer and Renkin 1995). Heights, numbers, and recruitment of Wyoming sagebrush are dramatically reduced by browsing. Yellowstone’s boundary line area is an area of altered use by ungulates. Migrations of elk out of the park may be curtailed, and some Yellowstone pronghorn do not migrate to the summer range. Late hunts of pronghorn outside the park may discourage movements from park lands, and may also concentrate pronghorns on this

Table 2. Compensatory responses to grazing compared between the Greater Yellowstone Area and Serengeti native ungulate systems

	Africa	GYA	
Compensatory responses	**Serengeti**	**Northern YNP**	**Jackson Valley**
Stimulation of aboveground grass biomass production by grazing	Yes	Yes	Yes
Change	+ up to 3×	+ 21–47%	+ up to 2×
Nitrogen acceleration	Yes	Yes	Yes
Change in net N mineralization	+ ~2×	+ ~2×	+ ~2×
Change N concentration in live grass tissues	+ 9–45%	+ 21%	+ ~2×
Change N yield	+ several ×	23%	n/s
N excreted in feces and urine gN/m²/yr	3.99	+ 0.49	+ 0.38
Net movement of N to winter range (kg/ha/yr)	n/a	+ 0.0606	n/a
Stimulation of belowground (root) production	Yes	Yes	Yes
Change	–19% (shortgrass) +85% (tallgrass)	35	n/a

n/s = no significant difference
n/a = not available or not applicable
From McNaughton et al. 1993; 1998; Frank et al. 1994; Frank and Groffman 1998; Stottlemyer et al. 2003.

area.

Nitrogen acceleration

Acceleration of nitrogen processes has recently been reported for GYA winter ranges. This new information on nitrogen processes published in the last five years is reshaping our view of GYA grassland–ungulate grazing systems. The work reported here, unless specified otherwise, includes not only winter ranges but also a diversity of wet and dry transition and summer range grassland sites. Soil nitrogen mineralization rates were about double on grazed vs. ungrazed winter range sites in YNP (Frank and Groffman 1998; Table 2). This finding of a near-doubling in mineralization due to grazing has been corroborated recently in the southern GYA in Jackson Valley (Stottlemyer et al. 2003), where ungulates excreted substantial amounts of urine and feces annually to the soil surface (Table 2). Migratory ungulates in the GYA also moved nitrogen from summer to winter ranges (Table 2).

The mineralization process provides highly labile, or usable forms of nitrogen to plants and soil microbes. Grazing by native ungulates in the GYA increased these more labile forms of nitrogen for plants compared to ungrazed exclosures through increased mineralization rates (Frank and Groffman 1998; Stottlemyer et al. 2003). Plants respond to this greater availability of N through widespread higher concentrations of N in live plant tissues (Coughenour 1991; Merrill et al. 1994; Singer 1995; Singer and Harter 1996). Typically, N concentrations averaged 21% higher in grasses and upland shrubs—a very substantial increase.

Ungulate grazing may result in the process of nitrogen acceleration on grazed patches. Ungulate feces and urine represent a potentially valuable source of N inputs to the soil, and they provide N in the form of ammonium and nitrate that is more usable to plants. When ungulate excretions come into contact with plant litter, they increase the ratio of nitrogen to carbon, and thus increase the rate of decomposition of senescent plant material (Seagle et al. 1992; Pastor et al. 1993). Plants accumulate the more available N in tissues, resulting in higher concentration of N, and often higher aboveground N yield. Ungulates may thus prefer the more nutritious re-growth of previously grazed plant tissues, resulting in positive N feedback to repeatedly grazed patches. This may result in "grazing lawns" similar to those observed in the Serengeti.

Stimulation of vegetative production by grazing

Overcompensation, defined as cumulative biomass of grazed plants that is greater than that of ungrazed controls, was, until about 1990, suspected to be limited to the Serengeti, to a few special or unique situations, or to where plants were artificially watered or fertilized (Belsky 1986; Detling 1988). However, in the previous 10–13 years, examples have also accumulated in North America for overcompensation or stimulation of ANPP attributable to grazing (Paige and Whitham 1987; Hik and Jefferies 1990), although this evidence has not been without counterpoints (Bergelson and Crawley 1992).

Stimulation of aboveground production of grasslands in YNP, at levels of about 45% consumption of ANPP, has been documented by Frank and McNaughton (1993). These authors attributed this stimulation, in part, to the migratory behavior of ungulates on the northern range that follow newly greening, high-quality forage as it moves across the Yellowstone ecosystem. Similar stimulation, at levels of 40–60% consumption, has recently also been documented for grasslands of the Jackson Valley (Zeigenfuss et al. 2003). Elk and bison on the Jackson Valley winter range also follow the greening of forage in the spring to their higher-elevation summer ranges.

Conclusions

The Serengeti wild ungulate grazing system is tremendously different from GYA ungulate grazing systems. The Serengeti is a tropical ecosystem, with growing seasons up to four times longer, and precipitation as much as two-to-three times greater (except in a few dry shortgrass regions). As a consequence, the aboveground annual production of the Serengeti was four-to-eight times greater, and ungulate densities were six times greater.

Ungulate species diversity is also about six times greater in the Serengeti than in GYA ecosystems. Thus, in many ways, the GYA is not comparable to the Serengeti. However, in spite of these dramatic differences in production, GYA winter ranges demonstrated a remarkable number of positive compensatory responses to grazing that were similar to those in the Serengeti ecosystem. There are several potential explanations for the compensatory responses to grazing observed in the GYA. The movement of nutrients from outside the ecosystem under consideration may explain the compensation (Mazancourt et al. 1998), and elk in the GYA are suspected of transporting nitrogen from the summer range where they gain weight to the winter range where they lose weight (Frank et al. 1994; Singer and Schoenecker 2003). Frank and McNaughton (1992) felt that the strong migratory behavior of elk and bison in the GYA resulted in intense, but short, grazing, and time for plants to recover. This may be an important property of this ecosystem that permits plants to sustain grazing. Grazers in YNP increase rates of root turnover, increase net soil mineralization, and thus facilitate the availability of highly usable N to plants (Frank et al. 2002; Stottlemyer et al. 2003). Both GYA ecosystems were nitrogen-limited, and plants that are strongly nutrient-limited are more likely to respond to ungulate acceleration of nutrient processes.

The stimulation of grassland production observed in the GYA was strongly correlated to sites where nitrogen acceleration (2× higher mineralization, higher decomposition) was observed. Nitrogen acceleration and higher turnover rates of root carbon (Frank and Groffman 1998; Frank et al. 2002; Stottlemyer et al. 2003) apparently explain the stimulation. Thus, coevolution, or mutualism, between grasses and grazers is not necessarily implied for the observed responses.

Stimulation of aboveground production by grazers is very rarely observed (Belsky 1987). When observed, the stimulation has often been attributed solely to unique environmental conditions, including monocultures, rich soils, and continuous wet growing season (Painter and Belsky 1993; Belsky et al. 1993). The fact that YNP grasslands do not possess these conditions makes the findings especially unique.

We stress that these findings of stimulation by no means support, carte blanche, all grazing levels in the GYA. The stimulation occurred only at moderate, and not high levels of grazing, i.e., grazing optimization is implied. We recommend against management that allows the highest levels of grazing, e.g., 70–90% use, such as occurs on a few sites in the Jackson Valley. The apparent overuse of riparian shrubs and trees on some sites on the northern range is a serious ecological issue (National Research Council 2002); however, the recent restoration of wolves to the area is apparently resulting in the height release of cottonwoods and willows (Beschta 2003; Ripple and Beschta 2003; Singer et al. 2003). These recent findings may point to the need for further analysis of grazing effects on shrub communities of the GYA compared to other grazed ecosystems.

References

Bell, R.H.V. 1970. The use of the herb layer by grazing ungulates in the Serengeti. Pages 111–124 in *Animal populations in relation to their food sources*, A. Watson, ed. Oxford: Blackwell.

Belsky, A.J. 1986. Does herbivory benefit plants? A review of the evidence. *American Naturalist* 127:870–892.

Belsky, A.J. 1987. The effects of grazing: confounding of ecosystem, community, and organism scales. *American Naturalist* 129:777–783.

Belsky, A.J., W.P. Carson, C.L. Jensen, and G. Fox. 1993. Overcompensation by plants: herbivore optimization or red herring? *Evolutionary Ecology* 7: 109–121.

Bergelson, J., and M.J. Crawley. 1992. Herbivory and Ipomopsis aggregata: the disadvantages of being eaten. *American Naturalist* 139:870–992.

Beschta, R.L. 2003. Cottonwoods, elk, and wolves in the Lamar Valley of Yellowstone National Park. *Ecological Applications* 13:1295–1309.

Caswell, H., F. Reed, S.N. Stephenson, and P.A. Werner. 1973. Photosynthetic pathways and selective herbivory: a hypothesis. *American Naturalist* 956:465–479.

Coughenour, M.B. 1991. Biomass and nitrogen responses to grazing of upland steppe on Yellowstone's northern winter range. *Journal of Applied Ecology* 28: 71–82.

Detling, J.K. 1988. Grasslands and savannas: regulation of energy flow and nutrient cycling by herbivores. Pages 131–154 in *Concepts of ecosystem ecology*, L.R. Pomeroy and J.J. Alberts, eds., Springer–Verlag.

Dobkin, D.S., F.J. Singer, and W.S. Platts. 2002. Ecological condition and avian response in willow, aspen, and cottonwood communities of the National Elk Refuge, Jackson, Wyoming. Final report by the Independent Science Panel. High Desert Ecological Research Institute.

Dyksterhuis, E.J. 1949. Condition and management of rangeland based upon quantitative ecology. *Journal of Range Management* 2:104–115.

Ellison, L. 1960. Influences of grazing on plant succession of rangelands. *The Botanical Review* 26(1):1–78.

Frank, D.A., and P.M. Groffman. 1998. Ungulate versus landscape control of soil C and N processes in grasslands of Yellowstone National Park. *Ecology* 79: 2229–2241.

Frank, D.A., and S.J. McNaughton. 1992. The ecology of plants, large mammalian herbivores, and drought in Yellowstone National Park. *Ecology* 73: 2034–2058.

Frank, D.A., and S.J. McNaughton. 1993. Evidence for the promotion of aboveground grassland production by native large herbivores in Yellowstone National Park. *Oecologia* 96:157–161.

Frank, D.A., R.S. Inouye, N. Huntly, G.W. Minshall, and J.E. Anderson. 1994. The biogeochemistry of a north-temperate grassland with native ungulates: nitrogen dynamics in Yellowstone National Park. *Biogeochemistry* 26:163–188.

Frank, D.A., M.M. Kuns, and D.R. Guido. 2002. Consumer control of grassland plant production. *Ecology* 83:602–606.

Harper, J.L. 1977. *The population biology of plants*. London: Academic Press.

Hik, D.S., and R.L. Jefferies. 1990. Increases in the net above-ground production of a salt marsh forage grass: a test of the predictions of the herbivore-optimization model. *Journal of Ecology* 78:180–195.

Jaindl, R.G., P. Doescher, R.F. Miller, and L.L. Eddleman. 1994. Persistence of Idaho fescue on degraded rangelands: adaptation to defoliation or tolerance. *Journal of Range Management* 47:54–59.

Johnston, A., J.F. Dormaar, and S. Smoliak. 1971. Long-term grazing effects on fescue grassland soils. *Journal of Range Management* 24:185–188.

Lane, J.R., and C. Montagne. 1996. Comparison of soils inside and outside of grazing exclosures on Yellowstone National Park's northern winter range. Pages 63–70 in *Effects of grazing by wild ungulates in Yellowstone National Park,* F.J. Singer, ed., Washington, D.C.: U.S. Department of the Interior, National Park Service Report NPS/96-01.

Mack, R.N., and J.N. Thompson. 1982. Evolution in steppe with few large hooved animals. *American Naturalist* 119:757–773.

Mazancourt, G. de, M. Loreau, and L. Abbadie. 1998. Grazing optimization and nutrient cycling: When do herbivores enhance plant production? *Ecology* 79: 2242–2252.

McNaughton, S.J. 1979. Grazing as an optimization process: grass–ungulate relationships in the Serengeti. *American Naturalist* 113:691–703.

McNaughton, S.J. 1983. Compensatory plant growth as a response to herbivory. *Oikos* 40:320–336.

McNaughton, S.J. 1984. Grazing lawns: animals in herds, plant form and coevolution. *American Naturalist* 124:863–886.

McNaughton, S.J. 1985. Ecology of a grazing ecosystem: the Serengeti. *Ecological Monographs* 55:259–295.

McNaughton, S.J., F.F. Banyikwa, and M.M. McNaughton. 1997. Promotion of the cycling of diet-enhancing nutrients by African grazers. *Science* 278: 1798–1800.

McNaughton, S.J., F.F. Banyikwa, and M.M. McNaughton. 1998. Root biomass and productivity in a grazing ecosystem: the Serengeti. *Ecology* 79:587–592.

Merrill, E.H., N.L. Stanton, and J.C. Hak. 1994. Response of bluebunch wheatgrass, Idaho fescue and nematodes to ungulate grazing in Yellowstone National Park. *Oikos* 69:231–240.

Milchunas, D.G., O.E. Sala, and W.K. Lauenroth. 1988. A generalized model of the effects of grazing by large herbivores on grassland community structure. *American Naturalist* 132:87–106.

Mueggler, W.F. 1967. Responses of mountain grassland vegetation to clipping in southwestern Montana. *Ecology* 48:942–949.

National Research Council. 2002. *Ecological dynamics on Yellowstone's northern range*. Washington D.C.: National Academy Press.

Paige, K.N., and T.G. Whitham. 1987. Overcompensation in response to mammalian herbivory: the advantage of being eaten. *American Naturalist* 129:407–416.

Painter, E.L., and A.J. Belsky. 1993. Application of herbivore optimization theory to rangelands of the western United States. *Ecological Applications* 3:2–9.

Pastor, J., B. Dewey, R.J. Naiman, P.F. McInnes, and Y. Cohen. 1993. Moose browsing and soil fertility in the boreal forests of Isle Royale National Park. *Ecology* 74:467–480.

Platou, K.A., and P.T. Tueller. 1985. Evolutionary implications for grazing management systems. *Rangelands* 7:57–61.

Pond, F.W. 1960. Vigor of Idaho fescue in relation to different grazing intensities. *Journal of Range Management* 13:28–30.

Ripple, W.J., and R.L. Beschta. 2003. Wolf reintroduction, predation risk, and cottonwood recovery in Yellowstone National Park. *Forest Ecology and Management* 184:299–313.

Ritchie, M.E., D. Tilman, and J.M.H. Knops. 1998. Herbivore effects on plant and nitrogen dynamics in oak savanna. *Ecology* 79:165–177.

Ruess, R.W. 1984. Nutrient movement and grazing: experimental effects of clipping and nitrogen source on nutrient uptake of *Kyllinga nervosa*. *Oikos* 43: 183–188.

Ruess, R.W., S.J. McNaughton, and M.B. Coughenour. 1983. The effects of clipping nitrogen source and nitrogen concentration on the growth response and nitrogen uptake of an east African sedge. *Oecologia* 59:253–261.

Seagle, S.W., S.J. McNaughton, and R.W. Ruess. 1992. Simulated effects of grazing on soil nitrogen and mineralization in contrasting Serengeti grasslands. *Ecology* 73:1105–1123.

Sinclair, A.R.E., and M. Norton-Griffiths, eds. 1979. *Serengeti: dynamics of an ecosystem*. Chicago: University of Chicago Press..

Singer, F.J. 1995. Grassland responses to elk and other ungulate grazing on the northern winter range of Yellowstone National Park. *Northwest Science* 69: 191–203.

Singer, F.J., and R.A. Renkin. 1995. Effects of browsing by native ungulates on the shrubs in big sagebrush communities in Yellowstone National Park. *Great Basin Naturalist* 55:201–212.

Singer, F.J., and M.K. Harter. 1996. Comparative effects of elk herbivory and the 1988 fires on northern Yellowstone National Park grasslands. *Ecological Applications* 6:185–199.

Singer, F.J., and K.A. Schoenecker. 2003. Do ungulates accelerate or decelerate nitrogen cycling? *Forest Ecology and Management* 181:189–204.

Singer, F.J., D.M. Swift, M.B. Coughenour, and J.D. Varley. 1998a. Thunder on the Yellowstone revisited: An assessment of management of native ungulates by natural regulation, 1968–93. *Wildlife Society Bulletin* 26:375–390.

Singer, F.J., L.C. Zeigenfuss, R.G. Cates, and D.T. Barnett. 1998b. Elk, multiple factors, and persistence of willows in national parks. *Wildlife Society Bulletin* 26: 419–428.

Singer, F.J., L.C. Zeigenfuss, B. Lubow, and M.J. Rock. 2002. Ecological evaluation of ungulate overabundance in U.S. national parks: a case study of elk in Rocky Mountain National Park, in *Ecological evaluation of the abundance and effects of elk in Rocky Mountain National Park, Colorado, 1994–1999*, F.J. Singer, ed., Unpublished report.

Singer, F.J., G. Wang, and N.T. Hobbs. 2003. The role of ungulates and large predators on plants, community structure, and ecosystem processes in national parks. Chapter 13 in *Mammal community dynamics: management and conservation in the coniferous forests of western North America,* C.J. Zabel and R.G. Anthony, eds. Cambridge: Cambridge University Press. 732 pp.

Stottlemyer, R., F. J. Singer, R. Mann, and L. C. Zeigenfuss. 2003. Effects of long-term ungulate herbivory on plant and soil nitrogen and carbon, Jackson Hole, Wyoming. Pages 87–118 in *Ecology of native ungulates in the Jackson Valley: habitat selection, interactions with domestic livestock, and effects of herbivory on grassland and willow communities,* L.C. Zeigenfuss and F.J. Singer, eds. USGS-BRD unpublished report.

Verkaar, H. J. 1992. When does grazing benefit plants? *Trends in Ecology and Evolution* 1:168–169.

L.C. Zeigenfuss and F.J. Singer, eds. *Ecology of native ungulates in the Jackson Valley: habitat selection, interactions with domestic livestock, and effects of herbivory on grassland and willow communities.* USGS-BRD unpublished report.

Zeigenfuss, L.C., F.J. Singer, M.J. Rock, and M. Tobler. 2003. Effects of elk, bison, and domestic cattle herbivory on both native and managed grasslands in the Jackson Valley. Pages 28–57 in *Ecology of native ungulates in the Jackson Valley: Habitat selection, interactions with domestic livestock, and effects of herbivory on grassland and willow communities,* L.C. Zeigenfuss and F.J. Singer, eds. USGS-BRD unpublished report.

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Early wildlife and parks research in East Africa: parallels with Yellowstone?

Opening Keynote Address
October 6, 2003

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As an introduction to this conference I have been asked to discuss the early days of wildlife and parks research in East Africa, and possible links with Yellowstone. On reflection this seems particularly appropriate, because I have a background and heritage that combines both areas. My grandfather, C. Hart Merriam, was a naturalist on the Hayden Expedition that explored what became Yellowstone National Park in 1872. Subsequently, as head of the Bureau of Biological Survey, now the Fish and Wildlife Service, he and colleagues such as Vernon Bailey continued with faunal surveys and explorations of the Great Plains and the Yellowstone area. I vividly recall their stories about the wildlife and the area of those days. These memories were reinforced by my father's pioneering work in range and wildlife ecology, and my mother's work with Native Americans. Consequently, I grew up with Yellowstone and the Great Plains an integral part of my heritage.

But at the same time, the East African plainsland and wildlife also loomed large in my early years. My parents knew Martin and Osa Johnson, the explorers whose early movies and National Geographic lectures brought the Serengeti's wildlife riches to American public attention. I had eagerly read accounts ranging from those of the early hunter/naturalists like Selous, Roosevelt, and Percival to Hemingway's Green Hills of Africa. I was drawn intellectually to the spectacles of the plainsland with its wildlife, and also, I must admit, to the romance of safari life.

However, I did not make a conscious link between East Africa and the Yellowstone area until early 1956, when I had the good fortune to work in the Serengeti region. One hot afternoon when car trouble brought operations to a temporary halt, I climbed a small rocky hill overlooking the plains. Sitting in the sparse shade of an acacia, I could see the Ngorongoro Highlands rising mistily beyond the grasslands. Herds of wildebeests and gazelles dotted the plains until they disappeared in the afternoon haze. A pair of jackals trotted across the foreground, hyenas loped between the grazing herds, and vultures wheeled hopefully in the hot sky. I found myself, then, with the curious feeling that I was no longer in the Africa present, but rather that I had stepped back into history. The head-heavy wildebeests could have been American bison with the Rockies rising mistily in the distance, the gazelles our antelope, and the hyenas and jackals our wolves and coyotes.

With the endorsement of Uganda's governor and subsequent personal visits to the Colonial Office in London and the Fulbright headquarters in Washington, it was possible to convince the Fulbright program to accept wildlife research as an acceptable category for Fulbright scholarships. Within six months, we had three outstanding American wildlife biologists working in Uganda—two on the hippos and a third working on a similar problem with elephants in the country's other national park. They proved their value to the park management, so the program was continued and the original biologists and their successors established wildlife research as an integral component of the Uganda National Parks. When the Uganda Fulbright program was completed, the field research center they established at Queen Elizabeth [National Park] was taken over and expanded by English organizations.

Prior to my initial work in the Serengeti, I had carried out research or surveys in North America, Latin America, Africa, Europe, the Middle East, and South and Southeast Asia (Talbot 1960). Nothing I had experienced had thrilled and challenged me as did the Serengeti region. From my first experience in the Serengeti, I had found that other than hunters' anecdotes, virtually no biological or ecological information was available on the area or its fabulous wildlife migrations. It was virtually a blank slate. Consequently, it appeared to me that the most exciting and productive ecological research in the world would be an extended ecosystem study of the greater Serengeti area. In 1959, I returned to East Africa to carry out that study with my then-new biologist wife, Marty, under the sponsorship of the U.S. National Academy of Sciences. Ultimately, and on the request of the governments of Kenya and Tanganyika (later Tanzania), we would spend nearly six years on research safari in the area, with periodic returns over the subsequent 40 years.

We felt that it was only good science to try to find all the previous work from the area and build upon it. Continued literature searches had turned up no new data other than a report by Dr. Pearsall of the U.K., who had made a brief, government-sponsored survey of the Serengeti park boundaries in 1957 to follow up my 1956 survey. In addition, we knew that there had been three brief but as yet unpublished research or surveys in the area, so en route to the Serengeti we visited the individuals in New York, Germany, and Uganda, with mixed results. The fine British ecologist, Frank Frasier Darling, had just made an ecological reconnaissance of the Kenya Mara, and he generously gave us a copy of his handwritten manuscript. A Canadian biologist had made a brief study of Thomson's gazelles in the Serengeti and he showed us his thesis. Bernhard Grzimek and his son, Michael, had visited the Serengeti briefly in 1957, and sought to buy part of it to conserve it. They were told that was not possible, but were given my earlier recommendations for needed ecological research. In 1958, they returned for several months. Michael started the research but was killed in an aircraft crash, and Bernhard made the movie, *The Serengeti Shall Not Die*. We spoke with Bernhard in Germany, and another of his sons advised us on camera equipment.

When we arrived in early 1959, the wildlife research situation in East Africa remained much as it had been three years earlier, except for the Fulbrighters in Uganda. The one biologist as such on the staff of an East African game or parks department recently had been hired for "vermin control" by the Tanganyika Game Department. Not only did East Africa have virtually no solid biological information or research on its wildlife, but it also had no physical or institutional facilities for supporting such research, nor any organized way to handle and disseminate the information that such research might have produced. Consequently, to establish a long-term ecological research program in the Serengeti–Mara region, we basically had to start from scratch and create our own physical and institutional support system.

Take, for example, obtaining the necessary approvals. To do field work in East Africa at that time, one needed approval from the governor's office, and also from the provincial and district headquarters. To carry out research in a park, one needed approval and permits from both the national park and game department authorities, along with their personal endorsement and support. Collections required additional permits. To verify plant identification, one had to make the arrangements well in advance with the Nairobi Herbarium and with the individual botanists. In these, as in most other matters, my previous work and contacts in East Africa and knowledge about how things were done helped us immensely.

By 1959, there were several research centers established by the East African High Commission to assist all three East African territories with agricultural and other development. Two of these, the East African Agricultural and Forest Research Organization (EAAFRO) and the East African Veterinary Research Organization (EAVRO), were potentially interested in wildlife. Both were located in a research park called Muguga about 18 miles north of Nairobi, so we introduced ourselves and our plans to them, and on their invitation we made Muguga our headquarters when we were not in the field.

There were other institutions with potential for assistance in various ways, including the Geological Survey, the East African Herbarium, and the Nairobi University. We spent considerable time initially meeting and consulting with all the East African institutions that we thought might be involved in our study. We also met with all the government officials, including the governors, the provincial and district administrators, heads of game and parks departments, and even the police and central firearms offices. The Mau Mau insurgency was still active in parts of Kenya, and the authorities wanted us both to carry side arms and maintain good security with our weapons.

Kenya's governor graciously gave us authorization to conduct research anywhere in Kenya, except in the Mara. "You will have to make a separate peace with T.B. Major Temple-Boreham," he told us. T.B. was the legendary game warden of Narok District, where the Serengeti ecosystem extends into Kenya. We did make "our peace" with T.B., and we greatly valued his friendship and assistance, as well as those from the Kenya Game Department.

It is hard to overemphasize the importance of meeting and briefing the colonial government officials at that time. Each had absolute control over his jurisdiction. If he liked and supported you, you could do virtually anything and would get invaluable help. If he felt slighted, you would find roadblock after roadblock. In the following years, many researchers tried to maximize their research time by avoiding official visits, and they often rued the day.

One example illustrates. Somewhat later, in Uganda, there were two competitive American wildlife biologists. One, a fine scientist, would arrive by plane, get his land rover, drive directly through the capital and out to his research site, bypassing all the officials so he would not waste time getting to his fieldwork. When the district officer made a half day's safari to visit him at his research site, this scientist felt he had no time to show him what he was doing or give him hospitality. The other biologist, a less distinguished scientist, would spend two to three days in the capital visiting and briefing all the relevant officials. He would then visit the provincial and district officers en route to his research area. And when any official came to his research camp, he took time off to be hospitable and show him what he was doing. The first scientist had immense trouble with virtually everything including permits, supplies, labor, and transport; in the long run, he spent a vast amount of time trying to make things work, and eventually he was refused the right to return to his research site. We once were asked to intercede on his behalf just to get him back into the country. The other scientist received every assistance, and had an open invitation to return any time. In spite of the stature of the first scientist, the second one was far more productive and successful.

Our research area covered roughly 20,000 square miles, including the Mara area of Kenya and the greater Serengeti region of Tanganyika. By 1959, there were two dry weather dirt roads in the whole area, one across the northern edge in Kenya, and the other from the Ngorongoro Crater north to Senonera camp, which by that time was being developed as park headquarters. For our fieldwork we purchased a used land rover, modified it extensively, and collected safari equipment at auctions in Nairobi. The Kenya Veterinary Department allowed us to use a small veterinary house at the far north end of the Mara area, and in Tanganyika the Serengeti National Park allowed us use of an old German scout house. However, most of our time was spent on safari traveling through the study area with our land rover and tent, driving transects, capturing, marking, and following the migrating animals, checking on vegetation stages and fires, setting up plots with soil pits, vegetation transects, and photo points, and generally monitoring the ecosystem. We periodically returned to one of the houses to re-provision, and each six to eight weeks we drove out to spend a few days at Muguga and the bright lights of Nairobi to work up specimens and notes, and re-supply.

For our aerial surveys and censuses we either rented a small plane or used one belonging to a Kenya game warden friend who periodically would fly over and join us. We organized what has been called the first biome study, where we had scientists from over a dozen research institutions in several countries joining us periodically and conducting generally linked research on different aspects of the ecosystem, which we then sought to synthesize into a unified, dynamic description of the Serengeti–Mara ecosystem.

While our relationships with the game departments in Kenya and Tanganyika were excellent, we—and to some degree, most of those who followed us—did find some strains with the Serengeti park wardens. By the time we returned in 1959, wardens' houses had been constructed at Seronera, and there were two wardens in residence along with other staff. While there were virtually no tourist visitors yet, the wardens felt that scientists should obey the rules set up for eventual tourists. Among these rules were no driving after dark, and no driving off the road. This required some negotiating, particularly since there was only one road—a track—at that time. We also had some disagreements on wildlife management. For example, one of the wardens wanted to sight-in his rifles on wild dogs since he regarded them as vermin. And when he was in a bad mood he would go out and shoot every hyena he could find. One morning, for instance, we found the carcasses of nearly 20 hyenas he had shot the night before. The idea that research could provide information of use to management was foreign to the park's staff. They "knew" what they were doing, and did not want any extraneous information or opinions.

Although the Serengeti Park's wardens had little interest in research results, we found that there was keen interest on the part of some staff of the game departments, other resource agencies, and research organizations. A common complaint in developing countries was that foreign researchers would receive assistance and facilities, then leave and take their information with them, bringing no benefit to their erstwhile hosts. So Marty and I made a point of preparing and widely distributing our preliminary findings in the form of mimeographed reports. We also published some of our early findings in the local East African Agricultural and Forestry Journal.

The early 1960s saw a dramatic increase in wildlife research and researchers in East Africa. By 1964, when we did a survey for the United Nations of past and present wildlife research in East Africa, we found that there had been nearly 100 researchers since my first work in 1956 (Talbot 1965). Most of these focused narrowly on some aspects of physiology or behavior and relatively few dealt with ecology per se. However, they illustrated trends and problems in research, some of which have continued.

All were short-term studies, mostly of a few months duration and at most covering two years. Most did not search out previous data. Only a few of the over 200 publications we identified had cited any previous research from the area. We regarded this as poor scholarship, although some of the researchers from England were proud of that approach, saying that it freed them from preconceptions. Most researchers based dogmatic and sweeping conclusions on their short and often narrow research, and where they did note earlier research it was to show how wrong the earlier researchers were because they reported different findings. This behavior showed a fundamental misunderstanding of ecology and of the East African environment.

Over a period of years in East Africa, there are broad fluctuations in precipitation and other weather conditions. A wet year can be followed by a dry one, or several wet ones may be followed by several years of relative drought. Since my first Serengeti work there have been at least three periods of severe drought. Even a two-year study only provides one small window on the range of conditions encountered over a span of 10 to 15 years, much less one of several decades. Differences in weather, in turn, can dramatically affect vegetation growth, species composition, and distribution; and in turn can affect the food habits, population dynamics, behavior, and survival of the wildlife. Fire, livestock grazing, disease, and hunting also affect the system and are in turn affected by the weather. It is only through long-term studies that the true, dynamic nature of East African ecology can be described accurately.

In 1960, the Tanganyika national parks got a new director, John Owen, who had an appreciation of the potential importance of research to the parks. In periodic visits with him, we emphasized the desirability of establish-ing a wildlife research center in the Serengeti that could study and monitor the dynamics of the Serengeti system, coordinate research, seek to provide continuity, and assure that research provided for management needs. Subsequently, with initial funding from Germany and later from the U.S. and U.K., John started the Serengeti Research Institute (SRI), which still exists.

The SRI history continues to illustrate the evolution and problems of wildlife and parks research in East Africa. The facility did provide the researchers who followed us with a ready-made physical and institutional base for their work. However, in part because of the sources of funds, most researchers did their own thing, often with relatively little reference to other research or the needs of the park. Each time I visited SRI in subsequent years, I was told by some researchers that they had little idea of what some of the others were doing. In 1978, [A.R.E.] Sinclair and [M.] Norton-Griffiths edited the first of two compendia of Serengeti research results seeking to bring together the results and "to see where we stand" (Sinclair 1979). They noted, "Until now, management has been based upon either intuition or short-term studies conducted in response to local ecological crises, such as elephants damaging mature trees." They noted the problem of "short term studies too narrow to have provided a proper perspective."

The second Serengeti compendium, *Serengeti II,* edited by Sinclair and Arcese in 1995, further illustrated the evolution (Sinclair 1995). I use both volumes in a graduate seminar on East African grassland ecology, and my students always note the differences between the two books. The researchers in the first often are more dogmatic, they have the answers, and they seem to be seeking an ecological stability, a balance. In contrast, some papers in the more recent volume more overtly recognize the dynamic nature of the ecosystem and the limitations of our knowledge.

This change also reflects the larger shift in ecological thinking. Some call this "the new ecological paradigm." Although it is called "new," the facts have been known by some for many years; but it is only relatively recently that there is more widespread recognition and acceptance of the knowledge. Formerly, the dominant paradigm was that of an ecosystem that was stable, closed, internally regulated, and behaved in a deterministic manner. This was the homeostatic ecosystem cited by some early East African wildlifers, including some of the Fulbrighters. The new paradigm is of a much more open system, one in a constant state of flux, usually without long-term stability, and affected by a series of human and other, often stochastic factors. As a result, the ecosystem is recognized as probabilistic and multi-causal rather than deterministic and homeostatic; it is characterized by uncertainty rather than the opposite.

Ironically, this recognition of uncertainty and instability creates further problems between researchers and park managers. Managers want clear answers. Relatively few researchers in East Africa have tried to provide information for park managers. However, in the past when they did, they were often too short-term, narrow, and concerned with stability to be of much help. Now, researchers who recognize the uncertainties often provide probabilistic information to managers that is often considered to be equally unsatisfactory. In the U.S., the conflicts between what park managers wanted and what biologists provided were abundantly clear when I served on a science advisory board to the director of the U.S. National Park Service, and also when I was offered the position of Chief Scientist to the NPS. In this context, there are clear parallels between East Africa and the Yellowstone.

Another area where there are some parallels but also contrasts between Yellowstone and the Serengeti involves the local residents in and around the parks. When parks were created in both areas, the indigenous peoples were removed, and a major effort of the parks' staffs has been to keep people out. This was the case with the Serengeti National Park, but the Kenya Mara was quite different. In the late 1950s, the Royal Kenya National Parks wanted to make the Mara a national park. We, Major Temple Boreham (T.B.), and others felt this was not the way to achieve effective conservation and provide equitable treatment for the Maasai who lived there.

T.B. worked with the Maasai and I helped with the central government, and a little over two years later we succeeded; the government gazetted the Mara as a "County Council Reserve." In essence, it was a Maasai park. The Maasai agreed to establish a core area adjacent to the Serengeti as pure reserve with no grazing, hunting, or human occupancy, and the parcels of land around it were designated as hunting or photographic areas. The land remained property of the Maasai; they took responsibility for protecting and managing it; they received the fees, provided staff, let concessions, and charged admissions. The government agreed to provide training and assistance. Initially, much of the revenue went to the Maasai around the reserve, with the remainder going to the district. The agreement was that it went for schools and dispensaries, clearly marked to identify the source of funds.

This was one of the first community conservation projects, and it is probably the longest running one. In more recent years, the distribution of the receipts has changed, but the Mara continues to protect the northern part of the Serengeti–Mara ecosystem and its great migrations, and it brings substantial revenue to some of the local people.

So the Serengeti–Mara region has both models, the community conservation one where local people play the major role, and the traditional national parks one that removed local people, and that is parallel to the Yellowstone. It is believed that if the parks can bring benefits to the local people around them, the people will be more likely to support the park rather than the reverse. This principle underlies the idea of "Benefits Beyond Boundaries," the theme of the 5th World Parks Congress just attended by some 3,000 participants from 154 countries in Durban, South Africa. Significant efforts are being made to implement this principle on some of the Serengeti's borders.

There is a rich history of wildlife and parks research that extends back 47 years in East Africa and over 120 years in the Yellowstone. There are differences between the areas, but there are also many parallels. In my view, both areas can benefit from knowledge of the experience—good and bad—of the other. I congratulate the organizers [of this conference] for starting to bring the experience of both together here; I look forward to learning from the rich schedule of talks that await us in the coming days; and I hope that this will be the start of a long and productive association between these two great areas.

References

Sinclair, A.R.E., and M. Norton-Griffiths, eds. 1979. *Serengeti: dynamics of an ecosystem*. Chicago: University of Chicago Press. 389 pp.

Sinclair, A.R.E., and P. Arcese, eds. 1995. *Serengeti II*. Chicago: University of Chicago Press.

Talbot, L.M. 1960. *A look at threatened species*. London: International Union for Conservation of Nature and Natural Resources. Brussels, Belgium, and Oryx, F.P.S. 137 pp.

Talbot, L.M. 1965. Survey of past and present wildlife research in East Africa. *East African Wildlife Journal* 3:61–85.

Yellowstone wildlife watching: a survey of visitor attitudes and desires

Alice Wondrak Biel

Abstract

This paper explores visitor experience and attitudes concerning a variety of wildlife watching issues in Yellowstone, specifically 1) visitor response to seeing wildlife collared for research purposes; 2) visitor desire to feed wildlife; awareness of past history of wildlife feeding in Yellowstone; 3) which wildlife are most desired for viewing; and 4) perceptions regarding the "perfect picture" of a bear in Yellowstone.

In summer 2001, I surveyed 150 visitors at the Old Faithful viewing area using a method of random selection for three-day periods during each of four summer months. Response data were then coded and analyzed using Nvivo qualitative analysis software.[1]

Results indicate that visitors are far less disturbed by seeing collared wildlife than may have been previously thought. They claim not to want to feed wildlife but exhibit a certain amount of cognitive dissonance on that point; are fairly aware of past history of bear feeding; and display a predictable preference for charismatic megafauna. Their aesthetic preferences for the "perfect picture" reveal an interesting conflation of Alaskan and Yellowstone grizzlies, past and present human/bear interactions, and scientific versus popular media influences.

This research refutes the commonly-held assumption that research collaring adversely affects visitor experience in Yellowstone, and therefore has important implications for wildlife research in national parks both here and elsewhere. The results on experiential and aesthetic preferences, and on desire to feed wildlife, are instructive in terms of mapping the intersections of acquired knowledge and personal emotion and experience relative to national park wildlife.

Background

For 60 years or so, Yellowstone was the place where visitors came to feed the bears. People got hurt, bears got killed, and the NPS got sued, but still the park's managers failed to see how it would ever be possible, or even desirable, to end the roadside feeding that was at once so desired and so detrimental. With the 1963 release of the Leopold and Robbins Reports, however, came new ideas about what parks were for and how they and their wildlife resources should be managed, which were interpreted by Yellowstone's managers as necessitating a naturalizing process throughout the park. And that meant getting black bears to stop eating marshmallows at the roadside and extricating grizzlies from the park's soon-to-be-closed open pit dumps.

To some, it also meant removing the colored streamers that some of the park's grizzlies wore in their ears for research purposes, and minimizing the amount of marking (such as ear tags and radio collars) seen on the park's wildlife in the future. Arguments against marking were based on the contention that it gave the animals an "unnatural" appearance that visitors didn't like, and "unnatural" was undesirable at a time when the parks were charged with creating landscapes that represented "vignettes of primitive America." Biologists John and Frank Craighead, who had placed the markings on the park's grizzlies in the course of the groundbreaking studies of the animals, maintained that most visitors never saw the markings, and that many of those who did were more intrigued than bothered by them (this was but one of many things upon which the Craigheads and the NPS disagreed over the years).

In 1968, Yellowstone's rangers finally started enforcing the no-feeding regulations that had existed in the park since 1902, and roadside feeding was ended within a couple of years. By 1971 or so it was uncommon to see a roadside bear, and unhappy visitors were demanding to know where they had all gone. The park generally provided a prescriptive response to these queries, informing visitors that seeing fewer bears leading natural lives was a preferable experience to seeing many bears being denigrated by begging. Did visitors believe it? Some did, some didn't; the process of convincing visitors to "think like an ecosystem" in the wake of the vast policy changes of the past 35 years has been a long one, and the goal of this work was to gauge how far we've come, and catch a glimpse of how far we might have to go.

On the whole, park staff will tell you that although marmots, bighorn sheep, and elk are fed by visitors more frequently than bears are these days, the desire to feed Yellowstone's bears still exists in the hearts of some. That may come as a shock to those of us naïve enough to believe that 30 years of active law enforcement, NPS educational efforts, PBS nature shows, *Grizzly!*-type horror films, and wilderness ideology should have been enough to quell anyone's desire to hand-feed these massive, wild omnivores. But it is so, and what it demonstrates is the strength and lasting power of those images and attitudes that started to develop the very first time people gathered to watch bears eat garbage out behind the Fountain Hotel back in the 1890s. The question that drives this article is, just how strong and widespread is the desire to feed: how well have visitors received the park's anti-feeding messages over the years—is it just the fear of getting caught that keeps them from feeding? Or have visitors learned over the years, whether from park literature or outside sources, of the dangers that feeding brings to both humans and bears, and accepted that knowledge and incorporated it as their own?

The survey

Over the course of 13 days in May–August 2001, I administered a 15-

question survey to a random sample of 150 visitors in the Old Faithful viewing area. The survey assessed attitudes and desires in regard to a number of issues related to wildlife watching in Yellowstone. The initial questions of my survey were designed to get visitors warmed up and thinking about their expectations for their Yellowstone experience, and to measure their level of previous experience with the park. Archival research seems to show that fear of punishment was the primary factor in finally ending bear feeding as common practice in the park. Thus, in a key survey question (about whether visitors wanted to feed bears, and why or why not), punishment was hypothetically eliminated as a potential deterrent to feeding in order to determine whether or not fear of punitive consequences was the reason that today's visitors generally don't feed the bears. The other major question surveyed people's attitudes toward seeing collared wildlife, which remains controversial among researchers and managers today.

Ninety-nine percent of all visitors interviewed were white. Fifty-five percent were female, while 45% were male. Twenty-eight percent were aged 18–29, 27% were 30–45, 22% were between 46–55, and 23% were 56 or older. Respondent household income ranged from less than $10,000 per annum to over $100,000. Sixty-seven percent described themselves as married, 24% as single, and 9% as other (divorced, widowed, or in a long-term relationship). Ten percent of all respondents lived in foreign countries. Fifty-four percent of American respondents were from states west of the Mississippi River, 46% from east of it.

Expectations

To get them thinking about their desires and expectations for their visit, respondents were asked to name three things that they hoped to see while in Yellowstone. Because my research is wildlife-related, visitors who answered simply, "wildlife," or "animals," were prompted as to whether there were any specific kinds of wildlife they were particularly interested in seeing. No specific species were suggested, however—respondents were never asked if they were interested in seeing bears, for example, or wolves. The specific animals named by respondents came strictly out of their own heads. Interviewees were not prompted when giving other general answers, such as "scenery" or "thermal features."

Question: What do you most hope to see while in Yellowstone, if you could name three things? There were a fairly wide range of desired sights, but most could be categorized in terms of either wildlife, thermal features, or natural scenic features. Figure 1 shows the responses that occurred at least 10% of the time, demonstrating that among those interviewed for this project, Yellowstone's most desired sights were Old Faithful, bears, wildlife, thermal features, bison, moose, scenery, elk, grizzly bears, waterfalls, and wolves,

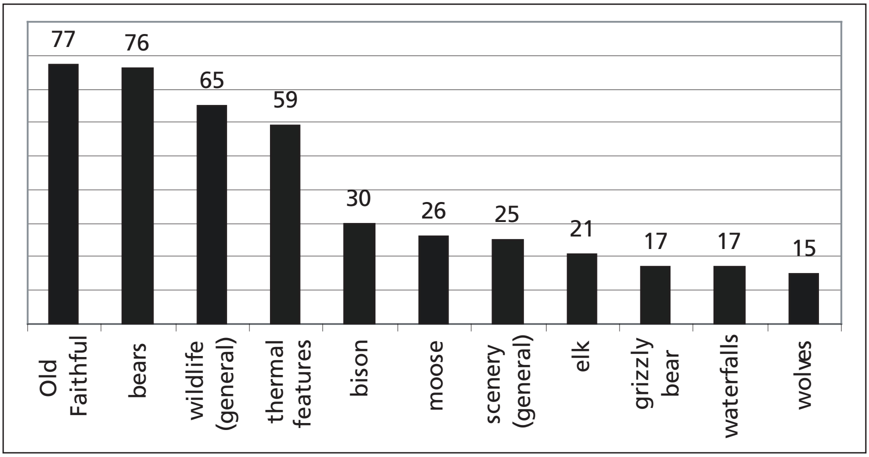

Figure 1. YNP sights that at least 10% of visitors interviewed said they hoped to see.

respectively.[2] Old Faithful and bears appear to remain the park's most popular sights by far, with a little more than half of all respondents naming them as one of the three things they most wanted to see while in the park.

These answers, of course, should be considered within their context. While Old Faithful was the feature mentioned most often (53% of the time), it should be remembered that visitors were interviewed while sitting in front of Old Faithful, waiting for it to erupt, and so were probably likely to remember to mention that the geyser was one of the things they most wanted to see in Yellowstone. Similarly, animals such as bison and elk, although popular in their own right, are also frequently visible along the roads that approach the Old Faithful area from the park's most popular entrance (the West Entrance), and so some visitors may have been simply naming sights that they had already seen. When asked, several did just that. Musing, "well, we saw a bison on the way in, we wanted to see that, and I think a deer…" was not atypical.

The frequency with which visitors mentioned wanting to see a bear, however, (52% of the time) is less likely explained in this way. Bears are not commonly visible along the road between the West Entrance and Old Faithful, and many visitors, when stating that they would like to see a bear, specifically added that they had not yet seen one or did not really expect to see one. Therefore, it seems certain that these visitors associated bears with Yellowstone by reputation, rather than because of recent experience or visual convenience, i.e., because they were looking at them.

Question: On a scale of 1–5, with 1 being not very important and 5 being very important, how important is it to you to see a bear during your visit? In spite of the fact that an impressive one-half of the visitors interviewed had stated, unprompted, that a bear was one of the three sights they most wanted to see, it was not crucial to most people that they see one. When asked to measure, on a scale of 1–5, how important it was to them to see a bear during their visit, the overall average answer was 3.29—somewhere in the middle (this included a "minus 5" from a man traveling by motorcycle who was clearly less than interested in encountering a bear during his visit). Many people added that they would like to see one, "but it wouldn't ruin the trip if I don't," "but I won't commit suicide if it doesn't happen," or "but I know they're hard to see."

Overall, it appears that visitors come to Yellowstone today to see the things they have always come to see; extraordinary thermal features, wildlife—bears in particular—and beautiful scenery. The only average importance of seeing a bear to the overall quality of one's trip would seem to indicate that although visitors still commonly associate bears and Yellowstone, seeing a bear is no longer a driving reason for making the trip, in spite of the fact that they still appear to be one of the park's main attractions in the minds of visitors.

Collared wildlife

The debate over whether wild animals living in national parks and wilderness areas should be collared for scientific monitoring purposes has raged almost since the Craighead brothers pioneered the technique in Yellowstone during the 1960s. Collars and other markers have gotten smaller and less conspicuous over the years, and in order to further minimize their visibility, today's managers even frequently wrap collars in dark-colored tape. Nevertheless, there are those who still hold the line established by Superintendent Jack Anderson (1967–1975), maintaining that any visible marking is deleterious to the viewing experience and makes the marked animal seem "less than wild" because it is an indication of interaction with humanity. In this way, collaring shakes the façade of untouched nature that many people attribute to national parks and wilderness areas.

Other critics point out that collaring requires that animals be drugged and handled, which has in the past proven to be potentially dangerous for both wildlife and managers. Advances in drug technology have greatly decreased the potential for hazard in recent years, but the possibility of injury or death during capture, immobilization, or (in extremely rare instances) afterward still exists. Still others complain that the collars look uncomfortable and that we should simply "leave wildlife alone" and "stop studying them to death;" a rather common expression that originated in the days when animal deaths caused by immobilizing drugs were more common than they are today.

Proponents of collaring maintain that the amount and quality of knowledge that can be obtained from monitoring certain members of an animal population far outweighs the negative visual effects and small potential for danger. Innovations in GPS technology have greatly increased the scope of that knowledge in recent years. Among other things, researchers can now learn the extent of an animal's range, measure its length of life, discover what sorts of food sources might hold it in a certain place for extended periods of time, track its reproductive history, and find out how it uses land throughout the day and night—all of which is valuable information for managers charged with making land use decisions within the Greater Yellowstone Ecosystem and protecting endangered species such as the grizzly. It is important to note that this number of collared animals in the park changes as studies are introduced and concluded.

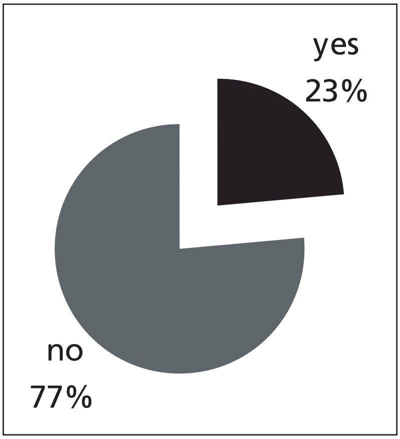

Figure 2. Percentage of visitors interviewed who said they had seen a park animal wearing a radio collar or ear tag.

Question: a) Have you seen any park animals wearing radio collars or ear tags? Roughly 23% of the visitors interviewed believed that they had seen an animal wearing a radio collar or an ear tag (Figure 2).[3] Elk were most frequently noted as having been marked, and as was earlier stated, are a fairly common sight along the road between Old Faithful and the park's most popular (West) entrance.

Question: b) If yes (or "if you did see that"), did that affect (or "do you think that it would affect") your experience of viewing that animal, one way or the other? Make it better or worse? Of those 23% (35 people) who believed that they had seen an animal wearing a radio collar or an ear tag, 77% (27 people) said that seeing the marking had had no adverse impact on their experience of viewing that animal. Visitors who had not seen any animals wearing radio collars or ear tags were asked to imagine their reaction to seeing such an animal. Of those, 86% (97 people) believed that seeing an animal wearing a collar or a tag would have no impact on their experience of viewing that animal (Figure 3). Although those who said that seeing a collared animal would not depreciate

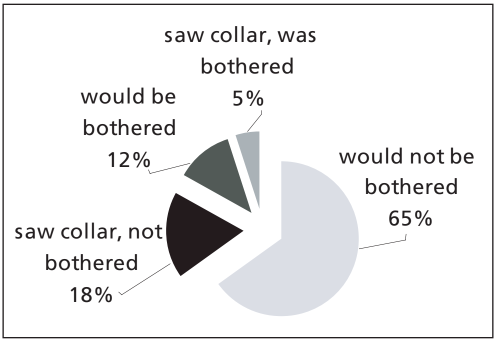

Figure 3. Percentage of people who had, or imagined that they would be bothered by seeing a park animal wearing a radio collar or ear tag.

their experience were not generally prompted to explain why not, 21 of them (17%) volunteered that they wouldn't be bothered because they knew why collaring was done and believed it to be a positive thing. One man went so far as to say that seeing a collar would actually enhance his viewing experience for that reason.

Twenty-three percent (eight people) of visitors who had seen a marked animal said that seeing the marking had adversely impacted their experience of viewing that animal. These respondents were prompted to explain why such had been the case. Three said that the collar had made the animal seem less natural. One person each said that the collar had looked uncomfortable for the animal, that wildlife should be "left alone," and that wildlife should be "allowed to be free." Two people were ambiguous as to their reasons, with one saying that "it would be better to see one without one but I understand why they do it," and the other not specifying a reason.

Of those visitors who had not seen a marked animal but were asked to imagine their reaction, 14% (16 people) said they thought that their viewing experience would be adversely impacted by the marking. These respondents were also asked to explain why this would be the case, with the overall result that 12 of the 24 people total who said that they had been or would be bothered by seeing collared wildlife said that it was because it seemed "unnatural," with one adding that collared wildlife were unsuitable for wildlife photography for this reason. Three people said that they thought the collar would be uncomfortable for the animal to wear, and two each said that "wildlife should be left alone" and that "animals should be free." Two people said that they would be bothered by seeing traces that the animal had interacted with humans, and two people said that they would be bothered because they wouldn't know why the animal was wearing a collar.

Lack of knowledge seemed to be a bit of a problem in regard to collaring. Although they were not asked about their knowledge, a total of 4% of all respondents stated that they did not know why collaring was done, with one respondent initially stating that she would be bothered by seeing a collared animal because "it would make me sad that [the animal] had to wear a collar because [it] had been fed by people" (she changed her mind after her husband explained what the collars were typically used for). Five people were ambivalent about collaring, stating that they knew and appreciated the reasons why it is done, but still didn't like seeing it.

Overall, this research shows that more than four out of five visitors surveyed said that seeing an animal marked for scientific purposes either had had or would have had no impact on their experience of viewing that animal. In fact, in some instances, the long-held contention by some scientists that far from being a bad thing, visitors' seeing marked animals was a positive byproduct of research because it generated public interest in science and wildlife conservation proved to be true. The percentage of people who had actually seen a marked animal and been bothered by it, however, was higher than the percentage of people who had not seen a marked animal but thought they would be bothered by it, reminding us that there is a gap between how people imagine their reactions and what they actually turn out to be. But even among those who had seen a collared animal, more than three out of four said that the marking had had no impact on their viewing experience, indicating that most visitors may not cling as tightly to an ideal of "pure, untouched" Yellowstone as we may have thought they did, or as they actually did at times in the past.

Awareness of bear feeding

This question was designed as a contextual precursor to asking visitors whether they would want to feed the bears today.

Question: Are you aware that several decades ago, it was common for people to see many bears along Yellowstone's roadsides, begging for food? About three-quarters of visitors surveyed (76%) answered that yes, they were aware that people used to feed bears at the roadsides. The 24% who did not know that such was common practice in the past were informed that the activity had always been against the rules but that those rules were not enforced until the late 1960s, and that a visitor in the 1950s might have expected to see between 40–50 bears a day along Yellowstone's roads. Overall, 37% of those who were not aware of roadside feeding were 18–29 (this age group comprised 28% of the total sample), 28% were 30–45 (27% of the total sample), 19% were 46–55 (22% of the total sample), 5% were 56–65, and none were over 65 (combined, 23% of the total sample).

Though they haven't been seen for three decades, the reputation of Yellowstone's begging bears still precedes the bears of today. Visitors' knowledge of this past activity appeared to be correlative to age, with awareness increasing with visitor age. Awareness was low among those from outside the U.S., especially among the younger age groups.

"Would you want to feed a bear in Yellowstone?"

Because enforcement appears to have been the driving force behind ending bear feeding in Yellowstone, and I was interested in finding out whether visitors still had any desire to feed the bears, I asked them whether they would want to feed a Yellowstone bear if they did not have to fear being caught or punished for doing so.

Question: Today, the rules against feeding bears are strictly enforced. But during the years of the roadside bears that I just mentioned, they weren't. If we existed in a kind of vacuum here today, and you could feed bears in Yellowstone today without being afraid of getting caught or punished, do you think that's something you would want to do? Although there are, of course, gaps between what people will say they might do when queried out of context and what they might actually do when placed in the midst of a situation, the results were overwhelming; 95% of visitors surveyed said that no, they would not want to feed Yellowstone's bears, even if they would suffer no legal consequences for doing so. Eight people (5%) stated that yes, if they could do it without fear of reprisal, they would want to feed a bear in Yellowstone.

Question: Why not?

"That's unsafe." Asking "why not" frequently earned me incredulous looks.[2] In sum, 43% of all those who answered "no" cited safety reasons (see Figure 4). Notable responses falling into this category included, "a bear can attack me," "it might kill me or scratch my car," "you don't mess with bears," "I'm chicken," and "you can't have people going around getting themselves killed." It seems clear that twenty-first century visitors to Yellowstone are fairly well aware of the risks associated with bear feeding; a change from notions shared by the people I interviewed separately who had visited during the 1950s and 1960s. Ten percent of all people interviewed said that they would not want to feed the bears for safety reasons alone. Eighty-nine percent of people who said they would not want to feed a bear provided more than one reason why not.

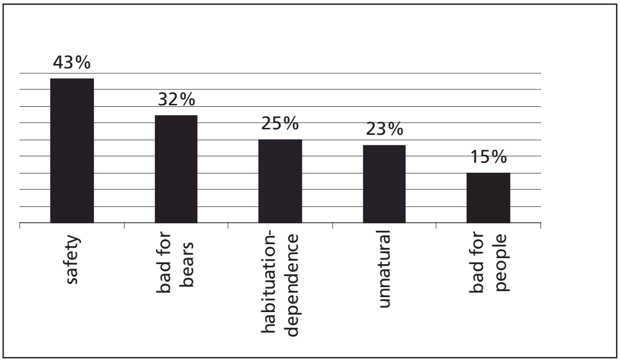

Figure 4. Most frequent answers to the question, why would you not want to feed a bear in Yellowstone? Numbers add up to more than 100% because several respondents provided more than one answer.

"That's bad for the bears." The second-most popular explanation for not wanting to feed the bears related to the idea that bear-feeding is bad for bears. Concerns cited in this category included, accurately, the popular adage that "a fed bear is a dead bear;" 10 people explained that bears that gain access to human foods have to be either relocated or killed, because they will invariably return in search for more and then become hazardous nuisances. Others (25% of those who said no) knew that bears that were fed would become dependent upon human foods, and some worried that they would be unable to survive in the winter, "when there's no one there to feed them." Eleven percent mentioned the possibility that they might even lose their natural instincts and skills for foraging altogether. A third supposition was that human foods would be unhealthy for bears; that they are "not the right food" (8%). In all, 32% of the people who said they would not want to feed bears alluded to the fact that to do so would be to the detriment of the bears.

"That's unnatural." Sixteen percent of those who would not feed said they were opposed to the idea because it was "unnatural" in some way. Thirteen percent said they would not feed the bears because they were "wild," and 8% said that they wouldn't feed because the bears would cease to be wild if they were fed.

"That's bad for people." Fifteen percent indicated that feeding had negative effects on people. The most common responses here had to do with the idea that people feeding the bears today will cause trouble for those who visit tomorrow, in that they will leave behind a habituated bear who may cause property damage or bodily injury in its search for human foodstuffs.

Other reasons for not feeding included "we just want to look, not to touch" (8%), "wildlife should not be fed" (8%), a desire to follow the rules (6%), "that's stupid" (6%, once accompanied by, "If I saw someone doing that, I would hit them"), that would make it like a zoo" (4%), a concern that human feeding would disrupt the cycle of nature (4%), an overall feeling that feeding is "just not right" (3%), and a simple lack of desire to feed (2%).

As with the question of collaring, there was some ambivalence among those who said that they would not feed. In a clear case either of conflicting internal philosophies or of saying what one thinks one should say and then what one really feels, one woman commented, "I know human food is not appropriate for wildlife—wildlife needs to be with the ecosystem as it is. Have they ever thought about selling food that could be used for that?"

Question: Why? Of the eight people who said they would want to feed a bear in Yellowstone, five said that they would do it in order to be able to get close to a bear. The remaining three said that they would feed because "they're hungry," "it seems like the humane thing to do," and "I've just always fed animals. Like squirrels." Four were men and four were women, and half were in the 18–29 age group. Two were 30–45, and one each was 45–55 and 56–65. Three of these visitors lived in Idaho (a rather disproportionate turn of events, as only five respondents total were from Idaho) with the others hailing from Colorado, South Dakota, Wisconsin, New Jersey, and Georgia.

If one of the preconditions for civil obedience of a rule is that its constituency believes in its legitimacy, then the NPS appears not to have a problem in regard to bear feeding, as at least 95% of those interviewed agreed that there are legitimate reasons why people should not feed bears in Yellowstone, and were aware of what some of those reasons are. This conclusion, however, should be taken with the earlier caveat which tells us to mind the gap between

COURTESY FAYE BLACK

Figure 5. Man feeding a roadside black bear in Yellowstone, 1960s.

decontextualized statements and contextualized action, and keeping in mind a 1953 visitor survey by researcher Donald Bock, in which almost everyone claimed to have seen someone else feeding a bear but almost no one would admit to having done it themselves.

It also does not bespeak any need to reduce either the numbers of staff available to patrol bear jams, nor the wildlife warnings that are conveyed via interpretive materials, as this question did not address whether people would approach a bear without the intent to feed. In fact, two people, in the course of emphatically stating that they would want to stay far away from bears, named "50 feet" as being the proper distance—a full 250 feet closer than the 100-yard distance required by law. Surveys have been conducted finding that as a group, Yellowstone's visitors tend to greatly underestimate the distance from which wildlife viewing can be safely conducted. The continuing need for both education and vigilance is shown by the fact that half of those who wanted to feed the bears were in the lowest age group and by the decrease in awareness of past feeding as age increases. In other words, the practical management implications of my results for this question are minimal, except for the fact that we have learned that people are generally aware, at this point, of at least some of the reasons why they shouldn't feed bears. What is more important here are the indications for changing visitor expectations, experience, and attitudes that my results show, as well as the fact that residual desire for bear feeding still exists.

ERIN BENTLEY

Figure 6. The image most frequently described as the perfect picture of a Yellowstone bear.

The perfect picture

The final aspect of my survey research focused on people's vision of Yellowstone and its bears today. To find out how people's view of bears has changed since the days of roadside feeding, I asked people, in my final question, to visualize their ideal photograph of a bear in Yellowstone. And what I found was that although figure 5 might have been the ideal photo a few decades ago, figure 6 represents the ideal photo today. The image of a grizzly, standing in a river, fishing, was described by more people than any other ideal picture, and there were many different ideas. What is interesting is that not many people ever see this in Yellowstone, because it generally takes place in the early morning or after dark in remote areas that are sometimes closed for bear management purposes. Figure 6 is, in fact, is one of the famous fishing grizzlies of Alaska's Brooks River. The popular proliferation of this image through TV nature shows and calendar art is probably what people had in mind when they described the ideal Yellowstone bear picture to me, indicating that today, that ideal image has less to do with a specifically Yellowstone bear than with a more general, fuzzy image of what a bear in the wild is supposed to look like and do. It seems that people aren't exactly sure what to expect or how to visualize a specifically Yellowstone bear today, which in light of the very specific images embraced in the past may not be a bad thing.

Conclusions

This research provides a brief overview of the kinds of expectations and preconceived notions that visitors bring with them to Yellowstone relative to wildlife and bears in particular these days. It also shows that on the whole, Yellowstone's visitors are not particularly bothered by seeing collared or otherwise marked wildlife, that they still strongly associate bears with the park but don't necessarily expect to see them anymore, and weren't even really sure what they should expect to see when they do see a bear. They are aware of the past history of bear feeding in Yellowstone, and although they don't claim to be keen to feed a bear in Yellowstone, the gap between those who would and those who wouldn't gets smaller with youth, and it is the young who are probably the least aware of the park's history in this regard. It is also the young, however, who seem the most incredulous to hear of it. So what we know is that in a relatively short period of time, people generally seem to have absorbed a sort of no-feeding ethic when it comes to bears, and are at least aware of some reasons why they should not feed them.

Overall, in terms of management, all of this paints a pretty positive picture. If I were to make a recommendation, it would be that managers of both wildlife and people in Yellowstone keep doing what they're doing now in regard to the issues discussed here, because for the most part, those efforts seem to be working. That means gearing education toward young people, who need to know what happened in the past as well as how to behave today, and educating visitors in general about wildlife collaring and the reasons why it's done. What they should guard against is laxity, because it's not like this is a project that will ever be completed. As long as there are wildlife and people together in Yellowstone, there will be a continuing need for education and enforcement to work together to ensure the well-being of both.

Notes

[1] Responses are reported in straight percentages based on the 150 people interviewed; no complex statistical analysis was performed, and so it should not be assumed that these results could be extrapolated to reflect the feelings of all Yellowstone visitors.

[2] A vote for "grizzly bear" also counted as a vote for "bear."

[3] It should be noted that this is not indicative of the percentage of animals in the park that are collared, as a single elk standing by the roadside may be seen by hundreds of people a day.

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The snowmachine in the garden: Yellowstone, industry, and the Snowmobile Capital of the World

Michael J. Yochim

Abstract

Preserving park resources while providing recreational access to parks has been an ongoing challenge for [national] park managers. Local communities sometimes have different perspectives and priorities, leading to occasional conflicts with park managers. The winter use history of Yellowstone National Park and the border community of West Yellowstone, Montana, illustrates these challenges and conflicts. Both the National Park Service and West Yellowstone town members have played important roles in constructing the winter landscape and visitor experience in both Yellowstone and the town. While these contributions have been important, certain outside industries have also played a crucial role in that construction. For the town, the snowmobile and hospitality industries have provided the financial backing to dramatically change the town's geography. However, town identity—and perhaps autonomy—have had to change as well. For the park, the snowmobile industry made possible the oversnow experience common to park users today. But, this powerful interest has influenced efforts to craft national park policy. Effective collaboration in park–community problem solving may be compromised by one industry's overriding influence in the area's winter use history and in West Yellowstone.

Introduction

Cooperation, hard work, chance, and industry have combined to make West Yellowstone, Montana, "the Snowmobile Capital of the World."[1] This town of 1,200 residents sits at the 6,666-foot-high West Entrance of Yellowstone National Park, and derives more than 75% of its income from the three million annual park visitors. Since the 1960s, West Yellowstone merchants have increasingly made themselves a winter economy based on snowmobile rentals, with up to 1,400 snowmobiles for daily rental today. Given its history, snowmobiles have come to symbolize values such as independence and self-reliance to the townspeople.

The town's dependence upon, and success from, snowmobiles depends largely on its proximity to Yellowstone National Park and the willingness of the park's administrators to accommodate visitors on snowmobiles. West Yellowstone and park administrators have a long history of cooperating with each other, influencing each other, and depending on each other to make winter tourism in the area possible. Throughout, the snowmobile and (to a lesser extent) hospitality industries have played crucial roles. While these industries have at times provided the capital necessary to make snowmobile tourism possible, they have also zealously guarded their investments. Politicians from Montana and Wyoming support industry efforts to protect snowmobiling, as do most town leaders.

Many scholars, land managers, and politicians today promote "collaborative conservation" as the best way to protect natural landscapes. Secretary of the Interior Gale Norton promotes "communication, consultation and cooperation, all in the service of conservation." Collaborative conservation involves all stakeholders, particularly local residents, in the cause of resource conservation while attempting to address the concerns of all.[2]

Yellowstone's winter use history, West Yellowstone's economic development, and the evolving relationship between the town and park illustrate some of the nuances of collaborative conservation. Efforts by park staff to protect their park and accommodate the town's desires, efforts by townspeople to promote a winter economy, and industry's influences on the process are illustrated as well. Park staff have consistently striven to accommodate West Yellowstone's needs while protecting their park's fabulous resources. Meanwhile, West Yellowstone's leaders have consistently promoted snowmobile-related tourism, though other townspeople have more and more questioned them. Most importantly, industry has played an increasingly influential role not only in park–town relations, but also in directing the future of winter tourism in the area. The story suggests that industry must be recognized as a key player, with an agenda not necessarily supporting either the town's or the park's efforts, in modern and future collaborative conservation efforts.

Snowmobiles arrive in the Yellowstone area

In 1908, the Union Pacific Railroad's rails arrived at Yellowstone's west boundary. Two years later, Gallatin County, Montana, completed a road linking the railroad terminal to Bozeman. Almost immediately, West Yellowstone developed, to provide the arriving and departing visitors with necessary services. Until 1936, when the state began plowing the road to Bozeman, the 50 or so resident households were literally snowbound for the long northern Rockies winter. Winter in West Yellowstone was no laughing matter, lasting at least six months, with bitter cold and 150 to 200 inches of snowfall. In fact, Yellowstone's Riverside ranger station, about a mile inside the park from West Yellowstone, held the country's all-time recorded low temperature (outside of Alaska) for 21 years—66° F below zero.[3]

Such long snowy winters fostered a sense of shared hardship and independence. Town residents in fall laid in a "grubstake" of food—a food cache adequate to last the winter. Without electricity or running water, firewood for woodstove heat was another important essential. Through the long winter, residents socialized, gathering at potlucks and their (two-room) school functions. On their skis fashioned from one-by-fours, heated in a park hot spring and given the proper bend at the tip, they went to the local hills at "the Barns," just inside the park. For all overwintering residents, the one open grocery store ran a tab that could be decreased or increased through one's skill at the regular grocery poker games.[4]

The isolation diminished when the state began plowing the road, but the communal struggle for survival did not. Residents were quick to realize the potential benefits of winter tourism, calling upon the National Park Service (NPS) as early as 1940 to plow the roads into Yellowstone Park. After World War II, though, they began to adapt to the eternal winter in a new way, taking advantage of the park's unplowed roads. They built "snowplanes," the first motorized vehicles capable of traveling on snow-covered roads. These were loud contraptions consisting of a one- or two-person cab set on three skis (only one in front, for steering), with an airplane engine and propeller mounted on the rear. Between January and March 1949, 35 West Yellowstone residents blew into Yellowstone (without ever becoming airborne) on such vehicles. They were thus the park's first motorized winter visitors.[5]

In 1955, a new kind of oversnow vehicle joined the snowplanes: the snowcoach.[6] Snowcoaches were larger vehicles made by the Bombardier Company of Quebec, Canada, capable of carrying 10 people in a heated interior. Calling them a "good tourist gimmick," West Yellowstone entrepreneurs Harold Young and Bill Nichols took up to 500 visitors per winter through the park in their snowcoaches in the 1950s. The modern snowmobile, first mass-produced by Bombardier in 1959, arrived in West Yellowstone in 1963 to become the third kind of oversnow vehicle touring Yellowstone. West Yellowstone's creative entrepreneurs promoted winter visitation as well; for example, in 1964, Young contracted with the Northern Pacific Railway to bring two tours per week from Chicago into the park. Despite the dawning economic opportunity, though, there were still only a few hotels open in winter in West Yellowstone in 1966.[7]

Events from 1966 to 1971 would prove crucial for the development of Yellowstone's winter tourism and West Yellowstone's snowmobile economy and identity. Since the late 1940s, regional politicians had been pressuring the NPS to plow park roads. Their pressure culminated in a congressional hearing on the matter in Jackson Hole, Wyoming, on August 12, 1967, chaired by U.S. Senator Gale McGee (D-WY). At that hearing, virtually every chamber of commerce in the Greater Yellowstone Area (and some from as far away as Utah and Texas) sent a representative or statement in favor of plowing, all reasoning that it would stimulate tourist traffic with consequent economic benefits.[8]

The West Yellowstone Chamber of Commerce's statement at that hearing is of particular interest. The day before the hearing, the chamber's board of directors voted against plowing, but changed their mind on the day of the hearing (perhaps to be in sympathy with the other chambers). Howard

Kelsey, representing West Yellowstone's chamber, indicated the reason for West Yellowstone's initial position in his testimony:

> Two years ago…we had, through the west gate, 994 passengers in the large snowmobiles…Only 64 people went into the park through the west gate on the small machines… Now, this last winter—and I think this is quite significant—there were 4,009 passengers on the large snowmobiles, there were 1,823 on the small snowmobiles, representing a total of 5,332 people that came to West Yellowstone who spent an average of two and a half nights…Now…transforming this into dollars and cents, in 1965, the people who came up for snowmobile rides spent $64,488. This last year they left $296,000 in the community… if…the roads are plowed, this means that the West Yellowstone snowmobile business is a thing of the past, and it's just starting. I mean, any time you can take a recreational industry and in two years project it five times what it was, it is a pretty important index of what can happen.[9]

Kelsey's statement indicates that, by this time, the realization that a new winter economy was possible was dawning on some town residents. His words would prove to be prophetic.

In March 1968, Yellowstone's administrators formalized their park's oversnow policy. Snowmobiles, not automobiles, would be the primary vehicle allowed into the park. Managers reasoned that wildlife would get trapped on the plowed roads, which would resemble linear trenches through the snowscape. Such trenches additionally would be difficult for automobile passengers to see out of, and would trap blowing snow. To foster oversnow visitation, they began grooming the snow-covered roads for smoother touring and opened a lodge at Old Faithful in 1971 (both services continue today). Park managers saw the snowmobile as the solution to the thorny dilemma of how to accommodate winter tourism without incurring the impacts of plowed roads. Snowmobiles allowed people to see the park's wonders, satisfied those pressuring the NPS to open the park, and protected it from automobile impacts.[10]

Administrators were swayed by the increasing importance of snowmobile-related income to West Yellowstone residents. Park superintendent John S. McLaughlin told the NPS Director in 1967 that "there is considerable sentiment around Idaho Falls and West Yellowstone against further opening….[O]versnow vehicle business is more beneficial for these communities" than plowing roads would be. An internal NPS report from 1968 revealed the park's concern about impacts on West Yellowstone as well: "Who would suffer [from plowed Yellowstone roads]? The townspeople of West Yellowstone who have seen the advantages of oversnow travel in the Park, who have encouraged this use, and who have watched the steady growth of travel by this means."[11] Clearly, the snowmobile income West Yellowstone merchants were already realizing was influential, but protecting the park from plowing impacts was as well.

Town residents took another action in the same era, which also served to develop their economy and identity. Montana state law banned snowmobile use on plowed roads, unless an incorporated village passed a law permitting it. Until 1966, West Yellowstone was unincorporated; that year, town residents voted to organize a local government, with a primary reason being to pass the needed snowmobile law. The town council's first formal action was to permit snowmobiles on town roads.[12] Incorporation and welcoming snowmobiles were therefore practically equivalent actions.

Thanks to these town and government decisions, the town's new snowmobile economy took off. The first snowmobile rentals in West Yellowstone opened between 1965 and 1970, mostly subsidized by competing manufacturers attempting to develop consumer markets. A measure of how successful the early rentals were comes from the First Security Bank of West Yellowstone, which opened in 1966. President Dean Nelson hoped to build his bank's total footings to $1 million in two years, but realized that goal in less than three months. Nelson knew that "the winter economy *is* the snowmobile" (emphasis in original). By 1982, the bank's footings had grown to over $10 million, in part due to other important events soon to follow.[13]

In the early 1970s, the Big Sky Ski Resort opened 50 miles north of West Yellowstone, bringing thousands of new tourists into the area. Many such skiers took a day off from skiing to tour Yellowstone on rented snowmobiles. Further, the resort attracted guests from all over the country; no longer were local and regional residents the typical winter visitors. By the 1990s, only about a third of Yellowstone's winter visitors were from the three local states, with most visitors coming from the upper Midwest and the country's more populous states like California, Washington, New York, and Florida.[14] Figure 1 illustrates the exponential growth in Yellowstone's winter tourism in this time period; many of those visitors entered the park through West Yellowstone.

Also in 1972, the West Yellowstone Snowmobile Club was created, and began grooming 125 miles of snowmobile trails on U.S. Forest Service (USFS) land to the west and south of town. These trails, groomed cooperatively with the USFS and State of Montana since 1979, and later expanded to 212 miles, continue to be a major draw for West Yellowstone's visitors.[15] They offer access to backcountry areas where off-trail snowmobiling (along with its associated thrills) is allowed, something Yellowstone does not offer. Similarly,

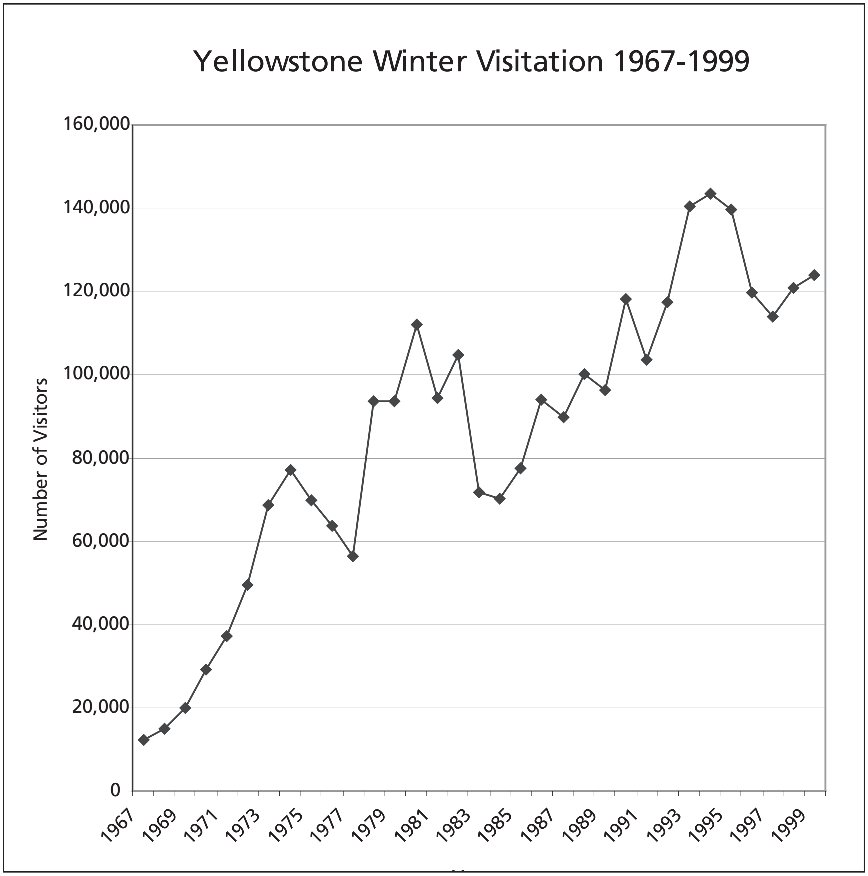

Figure 1. Yellowstone winter visitation, 1967–1999. Source: see endnote 40.

manufacturer improvements in snowmobile reliability facilitated continued growth of West Yellowstone's snowmobile industry in the 1980s.

Another factor instrumental to West Yellowstone's success was advertising emphasizing the new activity's thrill, freedom and independence, along with its masculine prowess, control, and camaraderie. Bars in town proliferated as well, encouraging the realization of such effects. Surveys today reveal that "having fun" is still a prime motivator to snowmobile, and that 66% of Yellowstone's winter visitors are male and younger than all other visitor groups. Other ads even compared snowmobilers to modern-day cowboys, clearly drawing upon Old West mythology to promote the vehicles. The advertising was broad-based, also targeting middle-class families who would be attracted to the package tours that West Yellowstone entrepreneurs developed in the early 1970s. Still, most of the advertising emphasized the thrills, freedom, and masculinity of the activity, as it still does today.[16]

By 1983, West Yellowstone's snowmobile-related income employed 426 residents, who staffed 29 hotels, 11 restaurants/bars, 13 gift shops, 6 service stations, 2 lumber or hardware stores, and 4 realtors. Clearly, by that time, West Yellowstone's economy no longer slumbered in the long winter; it had arrived. It had become so lucrative that some merchants derived more income in February than in any other month of the year, including the busy summer months.[17]

West Yellowstone's experiences with snowmobiles during this time period, as well as the advertising associated with them, gave the vehicles a rich symbolism. West Yellowstone and snowmobiles grew up together, making them an expression of West Yellowstone's sense of shared hardship and entrepreneurship. Snowmobiling became a cherished part of West Yellowstone's identity, the reason that West Yellowstone residents claim with pride to be the Snowmobile Capital of the World. Since snowmobiles made it possible to explore previously closed terrain, they also came to signify independence of mind and the freedom to explore, two core American values. They are to winter as the auto is to the rest of the year.[18]

By the mid-1980s, West Yellowstone had a thriving year-round economy, made possible largely by tourism and, in winter, mainly by the snowmobile. Growing visitation, though, along with the town's promotional efforts, began to produce problems in Yellowstone and gradually developed into one of the region's greatest modern controversies.

Modern challenges

As the number of visitors entering Yellowstone grew throughout the 1980s and 1990s (Figure 1), concerns over those numbers and associated snowmobile impacts multiplied. The growing numbers of snowmobiles created four significant problems that park managers grappled with four times between 1989 and 2003: air pollution, noise pollution, conflicts with other park users, and impacts upon wildlife.

The two-cycle snowmobiles used in the park through 2003 mixed oil with gas for combustion, an inherently dirty process. Each snowmobile emitted many times the pollutants of a typical car, with carbon monoxide, hydrocarbons, and particulates being the pollutants of greatest concern. The large number of snowmobiles entering Yellowstone—an average of 66,619 per winter, peaking over 77,000 in 1992–93—caused near-violations of the federal Clean Air Act at the West Entrance.[19]

Two-cycle snowmobiles also produced high levels of noise. A 2000 study found that Old Faithful visitors could not escape snowmobile noise during the daylight hours, and backcountry skiers frequently reported hearing snowmobile noise as far as 10 or even 15 miles from the closest road.[20] Snowmobiles, then, disturbed the park's winter silence.

Noise and air pollution problems led to conflicts with other park users, notably cross-country skiers and snowshoers, who generally desire quiet conditions. By the mid 1990s, over 100 park visitors sent written complaints annually to Yellowstone. Some of the letter writers and local environmentalists claimed to have been displaced from Yellowstone by snowmobile noise and air pollution.[21]

Finally, snowmobiles and other oversnow vehicles, by using hard-packed roads, had conflicts with wildlife. Park bison learned that such hard-packed roads present energy-efficient travel routes, and consequently used them at times to travel from one grazing area to another. While on the roads, they sometimes obstructed snowmobile traffic, leading some drivers to attempt to pass them, which at times frightened the bison off the road. Such conflicts led to concerns about snowmobile impacts on bison health, numbers, and behavior. Research into this problem produced conflicting results.[22] Still, the obvious conflicts witnessed by park visitors and illustrated in the media have produced great concern among people interested in this issue. Moreover, such conflicts led to a key lawsuit against the NPS, filed in 1997 (see below).

Most of these issues first surfaced in the 1970s, but magnified with the increasing numbers of snowmobiles in the 1980s and '90s.[23] Yellowstone Superintendent Bob Barbee first attempted to address them in the 1990 Winter Use Plan Environmental Assessment. This plan was a comprehensive summary of the existing policies that directed the park's winter management; it made few changes in that management. Park staff felt the plan did not adequately address the growing concerns with winter use, but felt they needed an altered political climate to make major changes.[24]

The plan's authors, however, did insert language that would compel another winter use review. If combined [winter] visitation to Yellowstone and Grand Teton national parks exceeded 143,500 visitors, or if the Continental Divide Snowmobile Trail (a 300-mile snowmobile trail paralleling the Continental Divide and terminating at Yellowstone's South Entrance) opened before the year 2000, then that review would begin. Both triggers tripped in 1993, so the NPS began a second round of winter use planning known as the "Visitor Use Management Process." This was a formal process, with specified steps of action, that land managers followed to examine a controversy and recommend solutions.[25] Although it made some recommendations, it left individual decisions up to the federal land managers. So like the previous plan, it made no major changes in actual policy.

West Yellowstone merchants, watching their livelihood being questioned, began to take what steps they could to solve the air and noise problems (the two most persistent concerns). Service station owners there began selling ethanol in December 1997, which slightly reduces carbon monoxide and particulate emissions by burning more cleanly. More importantly, between 1996 and 2000, snowmobile manufacturers (including West Yellowstone resident Ron Gatheridge) unveiled four different clean and quiet snowmobile prototypes. All of these machines reduced emissions and noise by using four-cycle engines, similar to those in automobiles. Manufacturers marketed some of these models in fall 2000, with some West Yellowstone entrepreneurs acquiring them for rental the following winter.[26]

Natural and social events then combined to produce a climax, the extraordinary winter of 1996–97. Near-record snowfall combined with unusual winter rain to produce an icy snowpack that was impervious to even the largest bison. To obtain food, the park's bison began migrating out of the park (partly using the snowmobile roads) in search of lower elevations and grass with less snow cover. Some of the bison carry brucellosis, a disease that, if transmitted to cattle, can cause a pregnant cow to abort its fetus. To prevent that transmission from occurring when bison came into cattle range outside the park (along with associated negative economic and political consequences), the state of Montana shot or sent to slaughter 1,084 bison by spring 1997. This number represented about a third of the park's herd and was the largest control of bison departing Yellowstone in its history.[27]

Yellowstone's bison are the only herd in the U.S. that has continuously ranged freely in the wild. Their numbers dropped to only 23 before the U.S. Army (administering Yellowstone before 1918) and early conservationists saved them through last-minute efforts around 1900. Today, they are powerful symbols of nature's wildness and of the wisdom of conservation. Seeing them slaughtered called to mind the guilt that many Americans still feel over the original nineteenth-century slaughter and motivated them to protest it and its perceived cause: snowmobiling.[28] The Fund for Animals, a wildlife advocacy group, led the way with a lawsuit in May 1997 alleging that the NPS had failed to follow its Organic Act and several other laws regulating park management. The NPS settled out of court by agreeing to write a new Winter Use Plan and Environmental Impact Statement (EIS).[29]

As this third planning process unfolded, park managers initially proposed plowing the road from West Yellowstone to Old Faithful. Yellowstone Superintendent Mike Finley saw this as a way to weaken the snowmobile industry's influence on park policymaking, but found little support for the idea, even in the environmental community. Instead, Bozeman's Greater Yellowstone Coalition (GYC) developed its own EIS alternative, the "Citizens' Solution for Winter Access to Yellowstone," which proposed to ban snowmobiles and restrict winter traffic to snowcoaches with no additional plowing (this was very similar to Alternative G of the Draft EIS). When the EPA announced in February 2000 that all EIS alternatives except that solution would fail to protect Yellowstone's air quality, Finley found more support for a snowmobile ban from the Clinton administration.[30] By spring 2000, he had formally proposed banning snowmobiles from the park by adopting

Alternative G, but the final decision would wait until late that fall.

By this time, West Yellowstone's position as the "Snowmobile Capital of the World" was secure. Winter visitors spent around $18 million in the community annually, finding almost 1,500 motel rooms available for their use, including many national chains such as Holiday Inn and Ramada Inn. A third of the park's winter visitors entered through West Yellowstone on 70% of the total number of snowmobiles. As much as 85% of the town's winter economy was (and still is) based on snowmobiling tourism.[31] Clearly, a ban on snowmobiling in Yellowstone gravely threatened not only West Yellowstone's economy, but also the town's very identity (according to some, at least).

The proposed ban struck the West Yellowstone snowmobile community predictably hard. Glenn Loomis, owner of a snowmobile rental, responded by saying that banning snowmobiles from the park was akin to "a meteor falling on West Yellowstone." Gallatin County joined with the four other regional counties in developing another EIS alternative that guaranteed continued snowmobile use of Yellowstone, by the new four-cycle snowmobiles. Finally, Montana and Wyoming politicians responded by threatening to introduce a rider overthrowing the NPS's decision or to hold a field hearing to probe the possible ban.[32]

But other West Yellowstone residents responded differently. Jackie Mathews, a flyfishing store owner there, felt that "Yellowstone National Park is not responsible for providing us an income," and encouraged townspeople to look at other alternatives. Another town resident, Doug Edgerton, joined with her to argue that banning snowmobiles from Yellowstone would present a significant economic opportunity for the town, since merchants there could then become the exclusive providers of Yellowstone winter tours (few people own a snowcoach, so visitors would have to tour the park on snowmobiles owned by West Yellowstone merchants). Edgerton later traveled with two other West Yellowstone business owners to Washington, D.C., to deliver a petition containing the signatures of 150 town residents advocating the removal of snowmobiles from Yellowstone. The petition noted that a healthy economy in West Yellowstone depended upon a healthy ecology in Yellowstone, and "West Yellowstone is a resilient community able to adapt and take advantage of changes."[33]

Divisions among West Yellowstone residents over the issue ran deep. In 2001, town voters again revealed their divided feelings on the issue in a referendum intended to implement a snowmobile curfew between the hours of 11 PM and 5 AM. It lost by six votes, 149 to 143. The split in the town is emotional, too. Supporters of snowmobiling have at times ostracized or harassed those who oppose the activity's continuation.[34]

Still, despite the division, those in favor of snowmobile use dominate the discussion in town. A small group of men own a large portion of the snowmobile-dependent businesses there, and often speak out to defend their livelihoods. These men have significant personal efforts, investments, and paid staff to protect. For example, Clyde Seely has lived in West Yellowstone since 1966, and has promoted snowmobile tourism since 1970. In part through these efforts, he has built or acquired numerous properties, including the largest motel in town (the Holiday Inn) and a fleet of 275 rental snowmobiles (also the largest in town) and several other properties. Seely understandably takes some credit for developing the town and its economy, along with his business partner Bill Howell and friend Glenn Loomis.

Local snowmobile boosters, however, increasingly find the voices of industry speaking louder. Since 1995, corporations from Texas and South Dakota have opened four new state-of-the-art hotels in town, forcing many local hotel owners to update theirs.[35] Such recent investments reveal the year-round strength of West Yellowstone's economy, and introduce industry representation to the controversy's table. As events would soon reveal, the snowmobile industry and its advocacy groups also have taken an increasing interest in the region's snowmobile controversy.

So have national environmental groups. The Bluewater Network, a national environmental organization, petitioned the NPS in early 1999 to ban snowmobiles from all national parks in the country. After studying the matter and surveying all of its areas that allow snowmobiling, the NPS confessed "years of inattention to our own regulatory standards on snowmobiles" and then proposed banning snowmobiles from all national parks except the Alaskan national parks, Voyageurs National Park, and Yellowstone/Grand Teton in April 2000, which were exempted because they either had snowmobiling expressly written into their charters or, in Yellowstone's case, were already dealing with the issue in a formal manner.[36]

Finally, on October 11, 2000, Yellowstone administrators announced that they planned to ban snowmobiles from Yellowstone in the winter of 2003–04. Regulations implementing the ban were published on January 22, 2001, but not before the International Snowmobile Manufacturers Association (ISMA) challenged them in court. In the new political climate [after President George W. Bush took office], the National Park Service settled with the ISMA in June 2001, by agreeing to write a Supplemental EIS that would focus on the air and noise impacts of the new four-cycle snowmobiles, which became commercially available after the previous study ended (this, then, initiated the fourth planning effort).[37]

The ISMA lawsuit, coming from a national industry trade group rather than the West Yellowstone Chamber of Commerce, illustrates that snowmobiling in Yellowstone is no longer an issue of importance only to West Yellowstone and the park. The issue has acquired national prominence, making the industry fear that loss of snowmobile access to Yellowstone will result in diminished access to other national parks and federal lands across the country. The snowmobile advocacy group BlueRibbon Coalition, which receives funding from the ISMA and many other snowmobile groups, has especially articulated this concern. The increasing involvement of national environmental groups in the controversy further illustrates the issue's national scope. No longer is the issue so much about West Yellowstone's economic livelihood as it is about the continued viability and appropriateness of snowmobiles in national parks. As much as industry seems to be using West Yellowstone as a pawn in a larger game to retain motorized access to national parks, environmental groups are using the issue in their game to ban the vehicles from them.[38]

In 2003, Yellowstone's new Superintendent Suzanne Lewis announced a new direction for winter use. She and her staff announced that snowmobile use would continue under three conditions. First, the NPS would restrict the number of snowmobiles allowed into the park to numbers approximating average daily usage today (for example, 550 daily from West Yellowstone). Second, all machines must use "best available technology," which uses four-cycle engines to reduce air and noise emissions. Finally, all visitors touring the park on snowmobile must be guided, primarily to ease the wildlife concerns.[39]

The winter use issue in Yellowstone appears to be never-ending. Environmentalists have filed two lawsuits contesting the retreat from the ban (hearings have just begun as of this writing). Publication of the final rule on December 17, 2003, will likely bring yet more lawsuits. Meanwhile, both the NPS and West Yellowstone merchants hold their breath, wondering what the future will bring to winter tourism and their relationship.

Discussion

For over 50 years, winter visitors have found increasing access to Yellowstone's spectacular wonders. Throughout, West Yellowstone entrepreneurs have been important drivers in the process, pressuring the park at times to open while providing necessary visitor services. Snowmobiles (and to a lesser extent, snowcoaches) not only opened the park to winter visitation but also led to the town's incorporation. They are as much a part of the town's identity as are its long, cold winters. Being the winter equivalent of automobiles, it is easy to see that snowmobiles also embody personal freedom, and to predict that banning them from a town with whom they are synonymous will be difficult indeed.

Nevertheless, undercurrents of dissent are evident in the town's deep division over the continued snowmobile controversy. The recent snowmobile curfew referendum exemplifies the split, while its defeat illustrates continued snowmobile primacy. The closeness of the vote, however—in the Snowmobile Capital of the World—may signify a willingness to change.

West Yellowstone exemplifies America in general, which is itself divided on these issues of access and environmental preservation. The West Yellowstone residents opposed to continued snowmobile use may take note of the fact that West Yellowstone began its long association with winter tourism on snowcoaches, long before snowmobiles arrived. They argue that the town's identity rests more on making winter tourism possible than it does specifically on the snowmobile.

Throughout this history, the National Park Service and West Yellowstone together have been crucial in defining the winter visitor experience. Yellowstone Park staff and town residents have had a long, evolving relationship that reflects their basic humanity: the relationship has wandered from support to distrust, from collaboration to shouting, and back again. Most constructive have been the periods of support and collaboration, but growth and learning occur during the difficult times as well. Collaborative conservation is not easy, and must understand human frailty and desires.

The hospitality and snowmobile industries cooperated in making the winter experience possible. In so doing, these industries have remade West Yellowstone from a town that hibernated six months of the year to one that today hums with winter activity. However, those same industries today have significant influence on the future of winter use. They have large investments to protect, and will take the necessary actions. To some observers and residents, those same industries may even manipulate both West Yellowstone and the park for their own, perhaps different, purposes. Increasingly, West Yellowstone seems to be a pawn in industry's larger quest for legitimacy. Any efforts at collaborative conservation must reckon with industry and its economic and political strength.

Conservationists and snowmobile advocacy groups have succeeded in transforming this from a local to a national issue. Conservationists see off-road vehicles like snowmobiles as inappropriate in national parks, while snowmobile advocacy groups defend their access to the park. All groups see Yellowstone National Park as the trendsetter, fearing or hoping that whatever policy the park adopts will transfer to other federal lands. As with its other controversies (like wolf reintroduction and bison management), Yellowstone once again is the fishbowl, this time frozen.

Notes

[1] A distinction it evidently shares with Rhinelander, Wisconsin, where I observed a billboard proclaiming itself to be the "snowmobile capital of the world" in Sept. 1999.

[2] Norton's quote has often been repeated in the press; see <http://www.doi.gov/news/021205.htm> for an example. Daniel Kemmis is one of many scholars promoting collaborative conservation in his book *This Sovereign Land: A New Vision for Governing the West* (Washington, D.C.: Island Press), 2001. See also

Across the Great Divide: Explorations in Collaborative Conservation and the American West, Philip Brick, Donald Snow, and Sarah Van de Wetering, eds. 2001.

[3] Richard A. Bartlett, *Yellowstone: A Wilderness Besieged,* 1985 (Tucson: University of Arizona Press): 63; Janet Cronin and Dorothy Vick, *Montana's Gallatin Canyon,* 1992 (Missoula, Mont.: Mountain Press Publishing Company): 58–59; Aubrey L. Haines, *The Yellowstone Story: A History of Our First National Park,* 1996, rev. ed., 2 vols. (Niwot, Colo.: University Press of Colorado) 2:314; Frank H. Anderson to Superintendent, Jan. 31, 1949, loose file in Box N-158, Yellowstone National Park Archives, Mammoth Hot Springs, Wyoming (hereafter YNPA).

[4] David Warner, "West Yellowstone: Those Good, Bad Old-Time Winters," *Montana Magazine* 57 (Jan./Feb. 1983): 9–11.

[5] Arno Cammerer to Senator Joseph O'Mahoney, Feb. 8, 1940, in File "868 Winter Sports," Box L-46, YNPA; Michael J. Yochim, "Snowplanes, Snowcoaches and Snowmobiles: The Decision to Allow Snowmobiles into Yellowstone National Park," *Wyoming Annals* 70 (Summer 1998): 6–23.

[6] Snowcoaches were known until the mid-1960s as snowmobiles, and as "big snowmobiles" until the mid-1980s, when the "snowcoach" label was coined.

[7] Yochim, "Snowplanes, Snowcoaches and Snowmobiles," 13; George Remington, "West Yellowstone Plans Projects To Make Area Big Winter Resort," *Livingston Enterprise,* Feb. 3, 1966.

[8] Yochim, "Snowplanes, Snowcoaches and Snowmobiles," 7–16; Department of the Interior, National Park Service, Hearings Before a Subcommittee of the Committee on Appropriations, United States Senate, on Winter Operation of Roads in Yellowstone National Park, Ninetieth Congress, Second Session, 1968.

[9] Hearings Before a Subcommittee of the Committee on Appropriations, 59–60.

[10] Yochim, "Snowplanes, Snowcoaches and Snowmobiles," 17–22.

[11] John S. McLaughlin to Director, July 6, 1967, in File D30: "Roads & Trails 1967—Winter Travel in Yellowstone," Box D-166; "Disadvantages to Winter Road Opening–Yellowstone;" in File D30: "Roads & Trails 1968—Winter Travel in Yell. Snow Removal," Box D-164, both at YNPA.

[12] Ray Ring, "Move Over!" *High Country News,* Apr. 1, 2002:10.

[13] Darcy L. Fawcett, "Colonial Status: The Search for Independence in West Yellowstone, Montana," (professional paper, Montana State University, 1993): 21, 27 (source of quote); Calvin W. Dunbar, Testimony Before the Subcommittee on Public Lands and National Parks, May 1983; "Winter Use Plan EA" Box, Loose, Planning Office Files, National Park Service, Yellowstone National Park (hereafter POF).

[14] Phyllis Smith, *Bozeman and the Gallatin Valley: A History,* 1996 (Helena, Montana: Two Dot Press, an imprint of Falcon Press), 290–292; Margaret Littlejohn, Y*ellowstone National Park Visitor Study, 1996* (Moscow, Idaho: University of Idaho Visitor Services Project Report 75, Cooperative Park Studies Unit), POF, 9.

[15] Jean Arthur Sellegren, "Blue Haze: Multi-Use Issues Come to a Head in the Land

of the Buffalo," *Backcountry* (Jan. 1996):52–54.

[16] Bar information from John Miller, "West Yellowstone: Montana's Biggest Little Town," *Bozeman Daily Chronicle,* Feb. 28, 1999; "Having Fun" from James T. Sylvester and Marlene Nesary, "Snowmobiling in Montana: An Update," *Montana Business Quarterly* (Winter 1994):3–8 (quote from 7); camaraderie also mentioned in McMillion, "West Yellowstone packs 'em in for the… Snowmobile Expo," *Bozeman Daily Chronicle,* Mar. 18, 2000; male statistic in *Winter Use Plan Environmental Impact Statement (*1), 91; youth statistic in Littlejohn, *Yellowstone National Park Visitor Study, 1996,* A-1; package tour from Fawcett, 21–27; other snowmobile ads or pictures featured in these *Bozeman Daily Chronicles:* Nov. 20, 1997; Jan. 11, 1998; Mar. 11, 1998; Mar. 18, 2000.

[17] Dunbar, Testimony Before the Subcommittee; Darryl Harris, "Winter Season Extension Needed At Yellowstone," *Snowmobile West* (Sept. 1985):63–64.

[18] James A. Jurale, *History of Winter Use in Yellowstone National Park,* (Master's thesis, University of Wyoming, 1986), 135. See also Randy Roberson, "Data Supports Continued Use of Snowmobiles in Park," *Bozeman Daily Chronicle,* Nov. 5, 1999.

[19] Scott McMillion, "Snowmobiles 'Extremely Dirty,'" *Bozeman Daily Chronicle,* Jan. 9, 1994; U.S. Department of the Interior–National Park Service, "Air Quality Concerns Related to Snowmobile Usage in National Parks," (unpublished report), POF, Feb. 2000:1–2; "Ambient Air Quality Study Results, West Entrance Station, Yellowstone National Park, Winter 1995," (unpublished report), POF.

[20] "Snowmobiles Create Inescapable Roar in Yellowstone," NPCA press release dated Mar. 9, 2000, available at <http://www.npca.org>; Michael J. Yochim, *The Development of Snowmobile Policy in Yellowstone National Park,* (Master's thesis, University of Montana, 1998), 140.

[21] Greater Yellowstone Winter Visitor Use Management Working Group, *Winter Visitor Use Management: A Multi-Agency Assessment,* Mar. 1999, 9–12; Hope Sieck, "West Yellowstone Business Owners Go to Washington, D.C.," *Greater Yellowstone Report* 17 (Summer 2000):22; David Cowan, "Yellowstone Park: Speedway or Sanctuary?" *Greater Yellowstone Report* 14 (Fall 1997):1; Robin Heyer, "When Snowmobiles are Banned, More Skiers Will Come," *Bozeman Daily Chronicle,* Dec. 31, 2000.

[22] See Mary Meagher, "Winter Recreation-Induced Changes in Bison Numbers and Distribution in Yellowstone National Park," 1993, unpublished report, POF; Daniel D. Bjornlie and Robert A. Garrott, "Effects of Winter Road Grooming on Bison in Yellowstone National Park," *Journal of Wildlife Management* 65 (2001):560–572.

[23] Yochim, *The Development of Snowmobile Policy,* 67–75.

[24] U.S. Department of the Interior–National Park Service, *Winter Use Plan Environmental Assessment,* Dec. 1990 (Denver Service Center, Denver); Yochim, *The Development of Snowmobile Policy*, 144; Chris Turk, personal interview by author, June 4, 2003.

[25] Greater Yellowstone Winter Visitor Use Management Working Group, *Winter*

Visitor Use Management, 9–12.

[26] "Marketing Gasohol in West Y. a Savvy Move" (abbreviation in original), *Bozeman Daily Chronicle,* Dec. 11, 1997; Scott McMillion, "Clean Machine," *Bozeman Daily Chronicle,* Mar. 1, 1996; McMillion, "Lean, Mean, and Green Machine" (emphasis in the original), *Bozeman Daily Chronicle,* Mar. 20, 1996; "In Search of a Clean...Machine" (ellipses in the original), *Bozeman Daily Chronicle,* Feb. 25, 2000.

[27] Doug Peacock, "The Yellowstone Massacre," *Audubon* 99 (May/June 1997):42.

[28] See Paul Schullery, *Yellowstone's Ski Pioneers,* 1995, (Worland, Wyoming: High Plains Publishing Company), for an account of these early conservation efforts. The ideas on their symbolic values and the guilt idea are from Dave Price and Paul Schullery, "The Bison of Yellowstone: The Challenge of Conservation," *Bison World* (Nov./Dec. 1993):18–23.

[29] *Fund for Animals et al v. Bruce Babbitt et al.,* May 20, 1997; Settlement Agreement, *Fund for Animals et al., v. Bruce Babbitt et al.,* Civil No. 97-1126 (EGS), Sept. 23, 1997, U.S. District Court, District of Columbia, POF.

[30] Michael V. Finley, telephone interview by author, June 24, 2003; Ron Tschida, "Enviros Offer Plan to Limit Yellowstone Snowmobiles," *Bozeman Daily Chronicle,* Oct. 13, 1999; Scott McMillion, "Winter Use Plan: EPA Gives Cold Shoulder to All Options but Snowmobile Ban," *Bozeman Daily Chronicle,* Feb. 24, 2000; McMillion, "Snowmobiles in Yellowstone May Well Become…a Vanishing Breed" (ellipses in original), *Bozeman Daily Chronicle,* Mar. 14, 2000.

[31] West Yellowstone Chamber, "Sleep," 2002, available at <http://westyellowstonechamber.com/lodging.htm>; National Park Service, *Draft Winter Use Plan Draft Environmental Impact Statement Volumes 1* (Denver: U.S. Government Printing Office, July 1999), 198; Sellegren, "Blue Haze," 54.

[32] Meteor quote from McMillion, "Snowmobiles in Yellowstone May Well Become…a Vanishing Breed;" Will Rizzo, "Counties Agree on Yellowstone Winter Use Plan," *Livingston Enterprise,* Sept. 17, 1999; Todd Wilkinson, "Politicians Play Fast and Loose with the Law," *Bozeman Daily Chronicle,* Mar. 28, 2000; Michael Milstein, "Winter Debate Over Park Use Turns Political," *Billings Gazette,* Mar. 25, 2000.

[33] Matthews quote in Ron Tschida, "Enviros Offer Plan to Limit Yellowstone snowmobiles;" Doug Edgerton, letter to the editor of the *Bozeman Daily Chronicle,* Sept. 14, 1999; petition information in Sieck, "West Yellowstone Business Owners Go to Washington, D.C.," *Greater Yellowstone Report* 17 (Summer 2000):22.

[34] Ring, "Move Over!" 11–14; Finley interview, June 24, 2003.

[35] Ring, "Move Over!" 14.

[36] James Brooke, "A Move to Rid Parks of Snowmobiles," *New York Times,* Feb. 7, 1999; Douglas Jehl, "National Parks Will Ban Recreation Snowmobiling," *New York Times,* Apr. 27, 2000.

[37] Karin Ronnow, "Year Delay in Rules Proposed," *Bozeman Daily Chronicle,* Mar. 30, 2002.

[38] Michael Scott, Executive Director of the Greater Yellowstone Coalition

(Bozeman, Montana), personal interview by author, Apr. 16, 2003; see the following *BlueRibbon Magazine* articles: "BlueRibbon Supporters in 1998," Jan. 1999:8–11; "Help Save Snowmobiling on our Public Lands" (July 1998): 14; Jack Welch, "Fund for Animals Sets Snowmobiling in National Forests as their Next Target" (Nov. 1998):3; Clark Collins, "Green Advocacy Groups Unmasked at Last" (Mar. 1999):2; Viki Eggers, "Recreationists Draw a Line in the Snow" (Nov. 1999):8; "Park Service Announces Snowmobile Ban" (June 2000):6. The group continues to articulate this same concern.

[39] Mike Stark, "Parks Reverse Snowmobile Decision," *Billings Gazette*, June 26, 2002.

[40] Figure is developed from data in Summary Record of Snowmobile Use, Yellowstone National Park, 1966 through Apr., 1978, in Box K-57, File "Winter Activities," YNPA; "Seasonal Visitation Statistics," flyer available from the Yellowstone National Park Visitor Services Office. Data for 1998 and 1999 was downloaded from the official Yellowstone National Park website, <http://www.nps.gov/yell/stats/index.htm>.

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Poster session abstracts

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Modeling land cover changes across the boundary of Yellowstone National Park: use of remotely sensed data, GIS, multiple drivers of change, and multi-model inference and selection.

This poster describes land cover changes since the early 1980s across the boundary of Yellowstone National Park. Attributes of land cover and their spatial pattern of change are described from a series of LANDSAT images using change vector analysis. Environmental and socio-economic drivers are then used to generate a suite of models of change that are implemented with Generalized Linear Modeling (GLM), Generalized Additive Modeling (GAM), and Markov modeling. The suite of models represent a series of multiple working hypotheses describing the effects of spatial variables as a representation of social, economic, and environmental drivers of land cover change in and around Yellowstone National Park. The alternate models produced are evaluated in a process of model selection and multi-model inference, which also allows the relative importance of different drivers to be assessed. Differences in land cover changes within and outside Yellowstone National Park are described through geographic differences between models. In addition to the specific results of the case study, the research demonstrates the use and interpretation of change vector analysis in description of land cover change, the generation of multiple alternative models, the utility of model selection as a mechanism for rating among plausible models that describe patterns of land cover change, and multi-model inference based on a set of models rather than a single model. It is argued that this approach provides a robust mechanism for analysis and interpretation of spatial and temporal changes in land cover based on a wide variety of drivers and is particularly useful in the context of change around National Parks where there may be different drivers that vary geographically.

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Lake Manyara, Tanzania, watershed assessment.

The Tarangire–Manyara ecosystem in northern Tanzania is a well-known area of global biodiversity. Within the ecosystem is a closed-basin waterbody called Lake Manyara, a portion of which is managed as Lake Manyara National Park. In contrast to Yellowstone National Park, which is at the headwaters of several rivers, Lake Manyara National Park is at the terminus of several rivers that drain a 766,700-hectare watershed dominated by human uses. The African Wildlife Foundation (AWF), an internationally recognized conservation organization, is concerned with habitat fragmentation and environmental degradation within the Lake Manyara watershed. Further, they recognize that human use of the watershed is paramount. To address these concerns, they have partnered with local stakeholders and the U.S. Forest Service (USFS) to build and foster a working relationship that will result in improvements in watershed health while maintaining a strong link to societal values. One critical component of the partnership is completion of a watershed assessment. The assessment will result in characterization of the human, aquatic, riparian, and terrestrial features, conditions, processes, and interactions of significant importance. AWF staff is leading the assessment, which includes development of a GIS and associated database. USFS staff is providing technical assistance in watershed science. AWF and USFS personnel sponsored an on-site workshop in December 2002 with approximately 25 stakeholders. The workshop included a watershed science shortcourse, broad characterization of the watershed, and identification of key issues and questions. Future workshops are planned and will focus on comparing current and reference conditions, and formulation of recommendations for improving watershed condition.

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The changing political landscape of the outfitter–guide industry in Jackson Hole, Wyoming.

For many decades, outfitters were largely hunting guides. Now often referred to as outfitter-guides, they guide clients rock climbing, snowmobiling, paragliding, hiking, snowshoeing, helicopter skiing, camera hunting, and most any other sport for which they can obtain a national forest or park permit. The proliferation and diversification of guiding outfits in national parks and forests is indicative of the growth and diversification of outdoor recreation in general. My dissertation research focuses on how the U.S. Forest Service is responding to this growth and diversification, and focuses on the San Bernardino, White River, and Bridger-Teton (BTNF) national forests (in California, Colorado, and Wyoming). The poster I am proposing for this conference focuses on the changing role of outfitter-guides in the regional economy of Jackson Hole, Wyoming, and in the national political landscape. It is based on interviews with representative Jackson Hole outfitters performed in the fall and winter of 2002–03. Jackson Hole outfitter-guides, many of whom operate in the BTNF, Grand Teton, and Yellowstone, have figured prominently in the Jackson Hole political and economic landscape since the region

shifted focus from agriculture to tourism in the early 1900s. Now outfitters are well organized on a national level, hiring full-time lobbyists in Washington and waging high profile lawsuits against the land management agencies. They are also attracting more scrutiny from regional and national environmental groups. This poster will examine the changing political landscape of outfitting, an important and largely non-extractive way of extracting value from a preserved natural landscapes of the American West as well as East Africa.

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Community change on Mount Kilimanjaro.

The geography of the land surrounding Mt. Kilimanjaro, in Tanzania, has changed dramatically over the past decade. Research was conducted during 2002 in three villages at varying distances from Kilimanjaro National Park and Forest Reserve (KINAPA), which officially opened in 1977. The combination of KINAPA on one side and former colonial plantations at the base of the mountain, in addition to a high birth rate, has caused a dramatic population squeeze among the Chagga tribe who live on the mountain. This has resulted in smaller plot sizes for families and overuse of the mountain's water sources. Surveys, ethnographies, and interviews showed that population and environmental changes are causing change at the community level. The land shortage has caused young people to search for other sources of income, such as tourism and small businesses. These jobs are not plentiful and many are forced to migrate to other areas of Tanzania in search of income. This out-migration, plus the population pressure which remains, has caused many to claim the values of the people are changing, despite the strong attachment they feel to their homes and lands. To them, only "God and time" will tell what the future holds.

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A demographic and economic analysis of big game seasonal range acreages and its importance for Wyoming.

This analysis presents demographic and economic information related to enhancing wildlife management information collection beyond the traditional hunting and biological information base. The analysis identifies demographic and economic characteristics of the human settlements in Wyoming Game and Fish Agency management areas for six big game species: pronghorn (*Antilocapra americana*), elk (*Cervus elaphus*), moose (*Alces alces*), bighorn sheep (*Ovis canadensis*), mule deer (*Odocoileus hemionus)*, and whitetail deer (*Odocoileus virginianus*). Census data is compared with U.S. Fish and Wildlife Service wildlife participant profiles to identify populations of interest within the management area. Economic impacts of hunting and wildlife viewing are also assessed. Hunters and wildlife viewers spent over $240 million in expenditures in Wyoming, generating almost $80 million in labor income and 5,370 jobs. The results provide a profile of land ownership, social and economic characteristics of management areas and suggest how wildlife managers can more fully consider social aspects of game management decisions.

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Community and conservation on Mount Kilimanjaro.

One of the most important issues on Mount Kilimanjaro is natural resource use and distribution. Local communities, especially those adjacent to Kilimanjaro National Park (KINAPA), have used and managed these resources for generations, but with the establishment of the national park, resource management and distribution changed dramatically. As recognition of the importance of involving local communities in conservation has grown, both locally and globally, the Tanzania National Parks system has developed a Community Conservation Service to improve local involvement and relationships between park staff and local communities. However, research conducted by Jeffrey Durrant and students from the Department of Geography at Brigham Young University and Abuid Kaswamila and students from the College of African Wildlife Management shows that there is a large gap between the objectives of community conservation and actual practice and understanding. The expectations and needs of local communities for infrastructure development projects usually overshadow any plans for conservation projects. In addition, local communities do not feel they are involved in the planning or decision making processes of the Community Conservation Service. The difficulties of combining community development with conservation as well as limited financial and human resources present formidable obstacles to successful community conservation on Mount Kilimanjaro. However, the need for increased cooperation and benefit sharing is great as local communities still feel they must rely on resources from KINAPA to survive.

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Community attachment and conceptions of place on Mount Kilimanjaro.

The concept of place as a social force has been present in social theories since such theories were first recorded. Recent social theories identify length of residence, economic activities, age, and social status as the most important predictors of attachment to place. However, most of these theories are based on a Western conception of place. While conducting research on Mount Kilimanjaro during the summer of 2002, it became clear that there were distinct differences between how we, as western college students, and the local people we talked to conceived of place. Through important traditions as well as historical, familial and social ties, the people on Mount Kilimanjaro have developed a unique conception of place. Despite population pressure and few livelihood options, we found that people are very reluctant to sell their land, and most would not move even if they had the means. Their attachment stems from historical, agricultural, and social ties to the community and land and is found among people of all social classes, age groups, and distances from KINAPA. This challenges Western theories that age and social class lead to differences in attachment, but it supports theories that length of residence increases attachment, due to the high level of attachment found in those whose families have lived on the land for multiple generations. By better understanding how people in this region view the concept of place, we can better understand how people feel about their homes, land and their relationship to conservation on Mount Kilimanjaro.

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Applying economic geography to the management of big game migration corridors and the lands they cross.

Corridors used by big game herds for seasonal migration are receiving increasing attention from natural resource managers and conservationists. This analysis evaluates location and land ownership issues for migration corridors for six big game species in Wyoming: pronghorn (*Antilocapra americana*), elk (*Cervus elaphus*), moose (*Alces alces*), bighorn sheep (*Ovis canadensis*), mule deer (*Odocoileus hemionus*), and whitetail deer (*Odocoileus virginianus*). Migration corridors are analyzed using the Revised Gap Analysis digital grid to identify corridors that may be impacted by development and human use. Gap Analysis represents four levels of land management status across the state. Status 1 and 2 lands include wilderness, national parks, national monuments, preserves, refuges, natural areas, special interest areas, wildlife habitat management areas, and national recreation areas. Status 3 and 4 lands include national forests, national grasslands, Bureau of Land Management lands, Department of Defense lands, native lands, state trust lands, and private lands. The Gap grid was used to develop a level of protection measure that was assigned to each corridor. Those migration corridors that lie primarily, or in some cases entirely, on Status 3 and 4 lands, are generally at a higher risk of disruption from land and resource development projects. The GIS analysis provides a landscape level profile of where most known corridors are located, land ownership status, and general levels of protection.

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Demographic change in the New West: rural residential development around nature reserves.

Human populations are growing rapidly in rural lands surrounding nature reserves. We currently lack a thorough understanding of the technological and societal changes that are driving this trend. Knowledge of the factors influencing residential sprawl is needed for assessing regulatory implications, economic costs, and ecological consequences of future development. This poster describes the roles of natural resource constraints, transportation infrastructure, and the location of towns and natural amenities in shaping changes in rural home density in the Greater Yellowstone Ecosystem. Our findings indicate that spatial patterns of rural development were most strongly correlated with previous home density, measures of accessibility to services, and environmental amenities. Implications of the results are: (1) new home sites in previously undeveloped areas are a primary factor encouraging further land conversion; thus, the siting of new subdivisions is an important policy decision, and (2) enhancing environmental amenities through land use management can likely stimulate growth while limiting the ecological impacts of development. Another goal of the study was to provide communities and planning agencies with an improved understanding of how and why development patterns occur, as well as a tool for evaluating alternative growth management policies. Thus the Rural Development Simulator (RDS), a spatially-explicit computer model, was constructed and used to simulate future development under different land use planning scenarios. By allowing the impacts of proposed policies, such as zoning and the purchase of development rights, to be systematically evaluated, the RDS should improve the effectiveness of growth management in this region of high ecological significance.

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Defining the dimensions of vulnerability to wildfire in the Greater Yellowstone Ecosystem.

We propose a framework to assess the vulnerability of communities and landscapes to wildfire as a manifestation of linked social-ecological systems. This work synthesizes two distinct bodies of knowledge: (1) fire as an environmental process, and (2) fire as a human-mediated process. Traditionally, wildfire research has evaluated fire as an environmental process. The human role in wildfire, especially in complex regional mosaics of land use, however, has yet to gain a similar level of consideration. The wildfire vulnerability framework considers exposure, sensitivity, and adaptation within the context of biophysical, institutional, and cultural/behavioral subsystems. This approach offers an alternative view to wildfire as a predominantly fuels and weather driven process, potentially identifying a wider range of fire management options and applied research questions designed to better understand the role of fire in complex regional systems such as the GYE. In order to evaluate this framework, we quantified the vulnerability of four regional fire systems (GYE, Colorado Front Range, Mogollon Rim, and Los Alamos/Bandelier NM) and then qualitatively looked at dynamics influenced by climate anomalies. Although the GYE has a relatively lower overall wildfire vulnerability, continued population growth and associated development suggest that GYE wildfire systems are moving toward a higher state of vulnerability as evidenced in the other systems. This approach allows fire managers to prepare for wildfire system changes due to both ecological and social factors. Next steps include additional vulnerability quantification and simulation models of landscape wildfire driven by both social and ecological factors.

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A comprehensive rapid-assessment approach for research agenda development at Yellowstone National Park: Elk (Cervus elaphus).

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Complexity across boundaries-coupled human and natural systems in the Yellowstone northern winter range.

The Greater Yellowstone Ecosystem is a complex natural system. A primary issue in the GYE is the ecology of the northern elk winter range (NEWR), where elk and wolves cross the Yellowstone Park boundary and, thus, between areas managed as “natural” and “altered” systems. Land management inside the park, and development pressure outside park boundaries, suggests that wildlife management plays out on a landscape mosaic dominated by human decisions, values, and economic considerations. The main objectives for this project are to: (1) gain a better understanding of the relationships between ecosystem dynamics and human decision-making, and (2) use this understanding to construct an ecosystem model that facilitates the exploration of plausible future scenarios in a manner that captures the uncertainty associated with complex systems. We are developing integrated, spatially explicit submodels for elk, wolf, vegetation and human development to assess the impacts of climate variability, and land use decisions on the NEWR. These submodels are being developed within the context of a multi-agent system (MAS) designed to model complex adaptive systems. The MAS-based model will be used to simulate alternative states that result from assumptions about decisions, natural conditions, and ecosystem processes. The results will demonstrate the complex nature of a highly integrated ecosystem and the role that climate, human decisions, and natural variability play in producing ecosystem change and/or stability. This poster highlights work in progress for our NSF

Biocomplexity in the Environment Coupled Natural-Human Systems grant.

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Mitigating conflicts between humans and large predators in Africa: challenges and lessons learned.

The most significant cause of the decline in predator populations is direct killing by humans. The African Wildlife Foundation (AWF), working with local communities to conserve habitat for the benefit of people and wildlife in Africa since 1961, will present specific examples from eastern and southern Africa to highlight challenges faced in conserving predators and draw lessons learned to inform future action. Case studies discussed have either benefited from support by or are familiar to AWF. Hindrances to effective conservation abound across predator species and populations, and include inadequate basic knowledge, management in absence of science-based plans, inadequate supporting policy, lack of education about predators and anti-depredation measures, ineffective partnerships, inordinate lack of funds, and inadequate predator-focused programs. In one study, both relative abundance rankings and attack frequencies for each species vary by site. The central issue may not be how much damage predators do (AWF's result suggest the damage is minimal) but rather how people react to that damage or threat—real or perceived. Different predators elicit different responses; relatively little pastoral effort is directed towards eliminating wild dogs, the most endangered species. Across sites, AWF has confirmed that predator populations can rebound, and that solutions for conflict mitigation need not necessarily be expensive. Successful conflict mitigation requires multi-disciplinary approaches integrating scientists, managers and landowners to agree on goals, as well as pooling experiences and resources. Positive aspects of living with predators need to be highlighted through livelihood improvement projects. For reasons ecological, economic, or otherwise, predators are important species wherever they occur.

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The interplay of natural and anthropogenic disturbance in determining distribution of invasive plants: example from the northern range of Yellowstone National Park.

Invasion of non-indigenous plant species (NIS) into natural and managed ecosystems is a widespread problem with potentially devastating ecological and economic consequences. The increased occurrence of NIS is often linked with disturbance. Anthropogenic disturbance is often perceived to have the greatest influence on NIS distribution in bioreserves, but wildfire and wildlife also may play a large role in NIS distribution. Fire is a natural disturbance phenomenon in many ecosystems, and creates favorable sites for establishment and regeneration of flora. Some native species can exploit these conditions, as can some non-indigenous species. Similarly, wildlife have been anecdotally blamed for the spread of NIS. We examined patterns of NIS distribution and associated wildfire and wildlife distributions in the northern range of Yellowstone National Park. Our analysis was specifically designed to understand the processes that link these diverse disturbances that may influence NIS distribution. We have found that vectors of travel associated with roads and trails, and vectors of wildlife movement and fire management are variously correlated with NIS distribution. Our studies on invasive species represent an excellent specific example of how processes transcending park boundaries will require specific knowledge about the processes and challenges of designing integrated and adaptive management plans that also cross the boundaries of the park.

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Approaching the table: a framework for tranforming conservation-community conflicts into opportunities.

Information associated with this poster appears in the earlier chapter by the same title.

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Earthwatch Institute: Conservation and Community Involvement in Samburu, Kenya and Rocky Mountains, North America.

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Attitudes toward conservation on Mount Kilimanjaro.

There have been several different studies of local people's attitudes towards Kilimanjaro National Park (KINAPA) as well as their attitudes towards the Community Conservation Service (CCS) of KINAPA. Surveys of community attitudes have been conducted by Dr. Jeffrey O. Durrant of the Department of Geography at Brigham Young University (summer 2002), Abuid Kaswamila, research director at the College of African Wildlife Management (spring 2002), Andrew Matthias Marandu, thesis for graduation from Sokoine University of Agriculture (2001), and William Newmark in conjunction with the College of African Wildlife Management (1992). These surveys find that attitudes are generally favorable towards KINAPA, although the majority of those surveyed do not feel they have been involved in planning or decisions about conservation or community development. While a majority of residents around KINAPA support the existence of the park, they would also like to see more personal benefits from the park and more alternatives for resource use. In addition, most people feel disappointed that their voices aren't taken into account when KINAPA and the CCS plan and implement community projects. An analysis of people's attitudes towards conservation shows that in general although people understand the concept of conservation and are at least verbally supportive of the park, they also feel dependent on the resources they obtain from the forest and do not feel that they have been given the help or alternatives needed so that they no longer depend on resources that they can now only use illegally.

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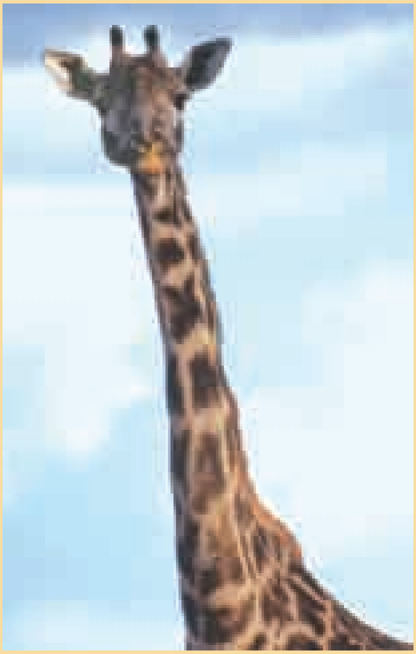

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