

Seeking a Scientific Approach to Backcountry Management in Yellowstone National Park

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Abstract—Three criteria are used to assess how Yellowstone's wilderness managers incorporate science into management: preciousness, vulnerability and responsiveness to management. Four observations are proposed. First, where scientists lead, managers will follow. Scientists that leave the best trail will be followed most closely. Second, managers need to refocus efforts on landscape-scale impacts, and they need scientists to give them the techniques to do this. Third, managers need to refocus efforts on impacts to visitors. Finally, managers need to refocus efforts to assess cumulative effects; however, scientist must first develop usable, accurate models.

Yellowstone Park staff began developing the park's first Backcountry Management Plan in 1991 using a Limits of Acceptable Change model (Stankey and others 1985). During the planning process, we relied on existing wilderness science to identify indicators of resource and social conditions, inventory and set standards for those conditions, identify management actions, and outline monitoring programs. While working on the plan (which was never signed and remains a draft), we focused science-based management efforts on site-specific impacts. Since the draft plan was completed in 1994, we have worked on several plans that influence wilderness conditions, including the draft Winter Use and Commercial Services Plans. We have also made or are making decisions on several proposals for new types of use, ranging from goat packing to whitewater access on Yellowstone's rivers. In each case, concerns about landscape-scale impacts have superseded concerns about site-specific impacts, needed science is missing, or managers are unaware of science that is available. In this paper, we discuss what we learned during and since the time we developed the backcountry plan about the science available to managers, how we tried to incorporate that science into our wilderness management, and where we think more work is necessary.

The National Park Service (NPS) does not have a strong tradition of incorporating science into management decisions (Sellers 1997). The agency has, however, recognized the need for better science-based management. In *National*

Parks for the 21st Century: THE VAIL AGENDA, the NPS (1991) recommended that the agency "must engage in a sustained and integrated program of natural, cultural, and social science resource management and research aimed at acquiring and using the information needed to manage and protect park resources." In 1998, Congress authorized and directed the NPS to "assure that management of units of the National Park System is enhanced by the availability and utilization of a broad program of the highest quality science and information" (National Parks Omnibus Management Act of 1998).

There is a clear delineation between science and science-based management. Managers are not, for the most part, conducting original research; we are not testing hypotheses. That is simply not our role. We depend on scientists to conduct original research that we can apply to management decisions. We use their information to develop policy, create regulations, implement inventory and monitoring schemes for assessing local conditions, choose indicators of resource and social conditions, set standards and assess management techniques. Stoltenberg and others (1970) state "the value of the resource scientists must ultimately be determined by how much their efforts increase the efficiency of the resource manager." They go on to outline the major purposes of natural resources research: first, to "develop new alternatives for the resource manager;" second, to "answer questions of fact that arise during management;" and third, to "answer questions of fact that arise during resource research, since it is only after some of these basic questions have been satisfactorily answered that the first two objectives can be achieved most efficiently." As wilderness managers, we have found that the available science is strong in some areas, but weak or nonexistent in others of considerable concern to us or our user groups.

Background

More than 95 percent of Yellowstone National Park's 2.2 million acres is considered backcountry. Seven designated wilderness areas administered by the U.S. Forest Service adjoin the park. In accordance with the 1964 Wilderness Act, a wilderness study was completed for Yellowstone in 1972. It recommended that more than two million acres of Yellowstone National Park be designated as wilderness. This recommendation was recently updated under President Clinton's Lands Legacy Initiative. Although Congress has not acted on these recommendations, the land is managed so as not to preclude wilderness designation, in accordance with NPS *Management Policies* (1988) and Yellowstone's

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Master Plan (1973). Yellowstone's backcountry has not been developed, with the exception of a relatively sparse trail system, a network of designated campsites and 43 patrol cabins and lookouts, most of which are historic.

Presently, the park has 90 trailheads, more than 900 miles of trails, and 302 designated backcountry campsites (with a total capacity for 316 individual parties). More than 45,000 visitor-use nights were recorded in 1998. The majority of use occurs between June and the end of September.

Few records pertain to backcountry use and management prior to 1973, when Yellowstone developed its present system of managing overnight backcountry use through a designated-campsite permit system. Previously, campsites were not defined or established; however, overnight camping and fire permits were required. A central backcountry office was created to record and track campsite use. Yellowstone developed operating procedures for backcountry management in 1974. From 1973 to 1982, backcountry use generally increased, peaking in 1977 and again in 1981, with 55,331 and 55,030 visitor-use nights per year, respectively. Backcountry use then declined by approximately one-third between 1982 and 1986. Since 1987 (except for 1988 when most of the backcountry was closed due to fires), human use has increased steadily and currently exceeds 45,000 visitor-use nights each year. No permits are as yet required for day use.

Stock use began to increase as early as 1986 and, with the exception of 1988, climbed through 1993, when it leveled out. Stock use is currently approximately 8,000 use nights per year, the highest level since records began to be kept in 1973.

Day use was monitored in 1992. Use levels varied, depending on trail location and distance from the trailhead, and ranged from zero to 109 people per day per trail. Overall, we estimate that the level of day use is approximately four times the level of overnight use.

A reservation system for commercial outfitters was implemented in 1985. In 1999, the park had 49 stock outfitters, 27 backpacking outfitters and 18 canoeing/kayaking outfitters. Outfitters and their clients share the same system of campsites that private parties use; they are not assigned areas or sites in which they can operate, and there is currently no limit on the number of trips an individual outfitter can take. Only 30% and 75% of campsites may be reserved in advance by commercial nonstock and stock outfitters, respectively. About 12%, 27% and 89% of overnight use is currently comprised of commercially led backpacking, boating and stock parties, respectively.

Overnight use is managed through a system of backcountry permits. Backcountry staff at 12 locations throughout the park work in conjunction with the Central Backcountry Office to dispense up-to-date information about trail and campsite conditions and special restrictions designed to minimize public safety hazards and resource conflicts. The park has implemented a computerized network for backcountry permitting, including the opportunity (since 1996) for the general public to make advanced reservations for backcountry campsites. Park rangers, in cooperation with trail crew staff and others, are responsible for the supervision of trails, campsite maintenance and evaluations, law enforcement and resource protection patrols, outfitter evaluations, monitoring visitor use, mitigating resource impacts,

recommending any additional needed corrective action and other resource management activities.

Assessing Yellowstone's Science-Based Management Efforts

The goal of this paper is to assess how Yellowstone's wilderness managers incorporate science into management and how we allocate our science resources. We based this assessment on three criteria for allocating wilderness management resources proposed by Cole (1997): 1) Preciousness: More resources ought to be allocated to areas that are more precious, defined as areas that are the most undisturbed or undeveloped; 2) Vulnerability: More resources ought to be allocated to areas that are likely to degrade further; and 3) Responsiveness to Management: More resources ought to be allocated to areas that are likely to respond positively to good management. Using these criteria, we assessed our current and proposed science-based program in five subject areas: 1) campsite inventories; 2) a program of monitoring grazing at stock sites; 3) the spread of exotic organisms by recreational users; 4) impacts of recreational users on wildlife; and 5) impacts on visitor experience. We focused on these areas because we are either allocating significant resources toward them or because significant concerns have been raised about them by visitors and park staff.

Campsite Inventories

Like many park and wilderness managers, we have invested much of our inventory and monitoring capital in campsite inventories. We completed two separate inventories. A Code-A-Site inventory was completed in 1979, but the key was lost and the data rendered unusable. A much more intensive inventory was completed from 1989-92. We inventoried 226 (75%) of our designated campsites by locating eight transects, radiating from the campsite center to measure the edge of bare ground and trampled vegetation; establishing a photopoint and taking a series of photos; and measuring the amount of and distance to firewood, the number of damaged trees and social trails and the distance to water and the main trail. The draft Backcountry Management Plan called for monitoring these sites every five years.

Campsite inventories have become a standard way for managers throughout the National Park System to monitor visitor impacts on wilderness resources. In a 1993 survey, Marion and others (1993) found that nearly 40% of parks that participated in the survey used campsite monitoring to evaluate visitor impacts. This compared to fewer than 10% of parks that used trail impacts, wildlife impacts, water quality or visitor experience. It was interesting to note that Marion and others (1993) found that although more National Park Service managers were concerned about trail impacts than campsite impacts (50% to 36% respectively), more managers monitored campsites than trails (nearly 39% to 9%).

In Yellowstone, we chose to put effort into campsite inventories for valid reasons. Managers are concerned about impacts at campsites because, as Cole (1982) pointed out, "In many areas, the most severe impacts occur on campsites

where use is highly concentrated, both spatially and temporally.” Campsite impacts are very evident, and wilderness rangers spend a lot of time working at campsites. Perhaps most important, though, is that a campsite inventory is easy to do because the scientists have left a well-worn trail. Techniques have been developed through research and have been widely distributed to managers (Marion 1991, Cole 1983, Cole 1989). Where scientists lead, managers will follow, or try to follow. Scientists that leave the best trail will be followed most closely.

But is this a productive use of scarce resources? These campsites do not meet the criterion of preciousness; by definition, they are some of the most developed, thus the least precious, backcountry areas. These areas are also some of the least vulnerable. Research indicates that most impact occurs rapidly at low levels of use (Marion and Cole 1996). When Yellowstone moved to a designated campsite management regime in 1973, sites were selected primarily from existing campsites. Most of Yellowstone’s designated campsites have been in use for over 30 years, and site use varies from six to more than 400 visitor use nights each year. These sites are not changing rapidly, if at all. Finally, these campsites respond slowly to management action. We have had some limited success with restricting wood fires, limiting the number of people allowed per night at sites and revegetating site margins. But these management actions tend to reduce sites from being highly impacted to being only moderately impacted. Based on this assessment, we ought to shift emphasis away from campsite monitoring toward more productive activities.

Stocksite Grazing Monitoring

The use of packstock presents special challenges to managers. McClaran and Cole (1993) state:

Even low levels of packstock use can cause substantial impacts. Compared to impacts caused by backpackers, packstock impacts to trails and campsites are more severe, and packstock impacts to grazing areas have no corollary to backpackers’ impacts.

Yellowstone managers became concerned enough about backcountry stock grazing impacts to begin developing a system for monitoring such impacts in 1984, when stock use was beginning to increase in Yellowstone; stock grazing practices led to overuse in close proximity to campsites and little or no use in the far reaches of grazing meadows. Managers began to search for a grazing monitoring system that was simple to use, easy to explain and accurate. We searched through the range science literature and, after a couple of false starts, borrowed the grazed loop method from the Forest Service for estimating range utilization (USDA Forest Service 1977). By 1994, we had established stock use night limits, based on monitoring results, at all of our (approximately 50) popular stock sites.

Here, too, we must ask ourselves: Is this monitoring system a productive use of scarce resources? These areas do not meet the criterion of preciousness; again, they are some of the most developed, thus the least precious, backcountry areas. Stock sites are vulnerable to grazing impact. Heavy grazing can lead to changes in species composition and reduce biomass production, plant size and seed output

(Briske 1991, McClaran and Cole 1993). Preliminary inventories (Sauer 1989, Whipple pers. commun.) indicate that Yellowstone stock-site meadows are, with a few exceptions, still comprised of native vegetation; thus, they are still important to maintain. Finally, these sites have responded to management action. Managers have used the results of stock-site monitoring to limit use and educate stock-site users about grazing management. Advanced reservations are limited based on the results of several years’ of monitoring at each stock site.

During the field season, wilderness rangers can adjust use levels based on monitoring results (results are influenced by weather and stock handling). As stock users have come to understand the monitoring system, they have changed the way they handle horses, grazing the farther reaches of stock meadows to conserve user days. In one example, utilization in the meadow adjacent to Soldier’s Corral, a campsite on the Gardner River, was reduced from almost 70% to 20%, maintaining consistent use levels but dispersing use, after the monitoring system was installed. Based on this assessment, we ought to continue conducting stock-site monitoring; however, it should probably not be expanded much beyond the present scope since impacts are not likely to spread to more precious areas.

Exotic Species

At least 180 nonnative plant species have been found in Yellowstone (Olliff and others, in press). Wilderness managers have conducted a few sporadic surveys for exotic plants and concluded that weeds listed as noxious in the tri-state area (Idaho, Montana and Wyoming) are primarily restricted to roadsides and developed areas.

Of more concern in recent years is the discovery of two exotic organisms that pose significant threats to native fish and aquatic ecosystems: *Myxobolus cerebralis*, the parasite that causes whirling disease, and the New Zealand mudsnail (*Potamopyrgus antipodarum*).

M. cerebralis is a parasite native to Eurasia that was introduced into North America in the 1950s. It penetrates the head and spinal cartilage of fingerling trout, causing fish to swim erratically and have difficulty feeding and avoiding predators. The disease can cause high rates of mortality in young-of-the-year fish. When an infected fish dies, thousands of parasite spores are released into the water (Whirling Disease Foundation 1999). So far, severe damage has been documented in wild rainbow trout populations. For example, in the Madison River in Montana, whirling disease caused a 77% decrease in the rainbow trout population in each mile of the severely infected sections (Whirling Disease Foundation 1999). *M. cerebralis* was discovered in Yellowstone Lake in 1998. Fisheries managers are concerned that Yellowstone cutthroat trout may be highly susceptible to whirling disease. Yellowstone Lake is the last refuge of the native Yellowstone cutthroat trout; 91% of the remaining range is located in Yellowstone National Park, mostly in Yellowstone Lake and the Yellowstone River (Varley and Schullery 1995). Coupled with the discovery of exotic lake trout in Yellowstone Lake in 1994, whirling disease may pose a significant threat to the Yellowstone cutthroat trout.

The New Zealand mudsnail was discovered in the Snake River south of Yellowstone in 1985 (Gangloff and others

1998). Since 1987, it has been discovered in four widespread localities in the U.S: the Middle Snake, Idaho; Lake Ontario; the Snake River from American Falls to the Thousand Springs area; and the Madison River. It has recently been discovered in Yellowstone, in the Firehole River, the Gardner River and the Snake River near South Entrance. Specimens can survive out of water for several hours. If kept in damp surroundings (such as wading boot tread or a Velcro strap), the snail's terrestrial survival time increases markedly (Gangloff and others 1998). Ecological impacts include competition with native species and changes in community biodiversity and ecosystem function. The mud snail seems to be a poor food source for secondary consumers such as fishes and terrestrial animals such as birds. In Yellowstone, one fisheries manager has observed that the occurrence of New Zealand mudsnail seems to be correlated with areas where people typically swim (Mahony, personal communication).

Should wilderness managers spend more resources monitoring exotic species? These species have high potential to spread off-site and invade the most pristine, undeveloped areas—those that fit the very definition of preciousness. The pristine waters that these species invade are definitely vulnerable. Finally, do these exotic species respond to management action? Without further research and monitoring, that is unclear. But because these species invade the most pristine, vulnerable areas, we ought to step up our inventory and monitoring efforts for exotic plant species, as well as aquatic exotics. Scientists need to help us by increasing research on how exotic organisms are spread, which will help us identify areas in which to concentrate both inventories and management efforts such as regulations on human use. Keeping up with research on exotic species may be a stretch for many wilderness managers since the results are typically reported outside the “wilderness science” literature.

Recreation Effects on Wildlife

It is well-documented that nonhunting recreation can have negative impacts on wildlife (Aune 1981, Hammitt and Cole 1987, Cassirer and others 1992, Knight and Gutzwiller 1995, Olliff and others 1999). A lot of research has been done; however, when a manager needs to make decision about a certain type of use, the information is often confusing, conflicting, counter-intuitive or unapplicable. Research conducted in one area or habitat or on one species is often hard to extrapolate. Managers have a difficult time applying the research to site-specific decisions. For example, in the draft Backcountry Management Plan, Yellowstone wilderness managers proposed an increase in dispersed camping (camping in nondesignated sites), but the U. S. Fish and Wildlife Service expressed concern that the effects on threatened grizzly bears would be unacceptable (U. S. Fish and Wildlife Service 1994). Unfortunately, most of the research related to human effects on grizzly bears has been focused on roads and developments rather than on dispersed activities such as backcountry camping.

Should wilderness managers spend more capital monitoring recreational effects on wildlife? Wildlife are among the most precious wilderness resources. In a recent survey, 82% of the respondents rated wildlife as extremely important; in fact, it was rated much higher than any other wilderness

resource (Littlejohn 1996). Like exotic species, impacts to wildlife can migrate off-site to become a landscape-scale issue. Are wildlife vulnerable? Yes, and wildlife that inhabit the most pristine areas may be most likely to be affected since they have less chance to habituate to human activity (Aune 1981, Cassirer and others 1992). Finally, do wildlife species respond to management action? It is likely that restricting human use to designated trails and campsites, or away from some areas altogether, can help protect wildlife from human influence. It is easy to conclude that more effort needs to be expended to determine the effects of visitors on wildlife and to determine appropriate management responses, but it is difficult to determine where managers should focus their effort. We seek scientists' help in understanding the effects of visitors on wildlife. But this is difficult, time-consuming work. It must be accomplished species by species, habitat by habitat and considering a broad array of recreational activities. Again, keeping up with such research may be a stretch for many wilderness managers since the results are typically reported outside the “wilderness science” literature in a wide spectrum of wildlife, bird and fish-related scientific forums.

Based on the previous four examples, we believe that on the continuum of site-specific to landscape-scale impacts, wilderness managers have focused more on site-specific impacts. We need to refocus on landscape-scale impacts, and we need scientists to give us the techniques to do this. Wilderness managers currently need to look outside of the “wilderness science” literature to obtain information on landscape-scale impacts.

Visitor Experience Surveys

The National Park Service has not, to our knowledge, conducted any visitor attitude studies directed at backcountry users in Yellowstone. We hear from visitors in letters, comments and other ways. Last year, as a group of Yellowstone managers were hiking out of Slough Creek, we came across a place where someone had thrown rocks and logs down on the wagon road that leads to the Silvertip Ranch, a private facility located outside the park but accessed through Yellowstone. They were obviously angry, and they were making a statement. The section of road was so steep that it would have been impossible for a wagon to pass.

While working on the Backcountry Management Plan, we did not commission or try to conduct any visitor experience surveys. We focused our monitoring on counting the number of visitors leaving trailheads, the number of overnight visitors in the backcountry and otherwise monitoring resource impacts. During the public comment period, however, we found that most of the controversial issues were driven by visitor attitudes: conflicts between stock users and hikers, controversy over whether to have designated campsites or dispersed camping, whether to have wooden or metal directional signs and whether to have more or fewer orange trail markers (or none at all).

Since the draft Backcountry Management Plan was completed, one survey has been conducted independent of the National Park Service on visitor perceptions of backcountry llama packing (Blahna and others 1995). Wilderness managers have written a proposal, with Dr. Alan Watson,

Aldo Leopold Wilderness Research Center, to conduct a visitor survey at Slough Creek. However, social science research in the backcountry has never been a high enough park priority to fund.

Why haven't we done a better job of conducting visitor surveys? A lot of science has been conducted in this area, although not in Yellowstone or many other NPS areas (Marion and others 1993). Some reasons likely include: 1) Many managers have a strong background in biological sciences, not in social sciences. So visitor surveys are foreign to us; we tend to focus more on resource impacts. 2) Visitor surveys can be expensive and limited by government regulations. 3) Unlike campsite inventories, surveys do not have step-by-step instructions for managers to do it themselves. 4) Data analysis is difficult—at least, it is perceived to be difficult. 5) Managers may either think they know what is best or, since they have a lot of contact with visitors, they know what visitors want (or should want).

Should wilderness managers spend more capital monitoring visitor attitudes? The concept of visitor experience does not seem to fit the area-based definition of preciousness. However, we might argue that our visitors, and the support they provide for wilderness, are our most precious resource. Are visitors' experiences vulnerable, and do they respond to management? Yes, perhaps more than any other resource. Management actions, such as requiring permits, erecting signs, designating campsites and maintaining trails, may have a disproportionate effect on visitors' perception of their visit. On the continuum of impacts-to-resource to impacts-to-visitors, wilderness managers have focused more on impacts to resources. We conclude here that more effort should be focused on surveying visitor experience and attitudes and helping managers understand options for managing visitors.

Cumulative Impacts

Assessing cumulative impacts is an issue we did not assess against Cole's criteria, but it is critical for park managers. During Section 7 consultation for the Backcountry Management Plan, the U.S. Fish and Wildlife Service (1994) commented, "Due to the fact that recreational and other demands are and can only be expected to increase, cumulative impacts to the grizzly bear remain a concern and an issue that needs to be addressed." This sentiment can be extended to all resources and to the visitor experience.

Cumulative impacts are especially critical when assessing requests for new uses or proposals to dramatically change existing uses. Traditional knowledge of recreational impacts and methods for measuring recreational impacts do little to inform the debate on whether or not to allow many of these new uses. A cumulative impacts assessment lends itself to assessing landscape-scale changes. How will new activities, or major changes to existing activities, add to the total impact from all recreational activities?

This is difficult work. First, it is very difficult to know how a new use will grow. If the park managers that allowed the first 200 snowmobiles into Yellowstone in the 1960s were told that the park is now visited by over 170,000 snowmobilers each winter, they would surely be amazed. Second, the amount of data and the complexity of the

modeling involved in a realistic Cumulative Effects Model (CEM) are staggering. The Grizzly Bear CEM team has been working on the CEM for over 18 years. While it is a good start, managers still do not incorporate it into most decision-making and it has limited application to a wider range of management. To be applied to a wider variety of species, the model coefficients would have to be developed for each individual species. Managers need to refocus efforts to assess cumulative effects; however, scientists must first develop usable, accurate models.

Conclusions

Managers are under a lot of constraints from court orders (Yellowstone managers are being guided by federal judges on bison management, wolf management, winter use management and thermophile management), pressure from politicians, pressure from special interest groups and the tyranny of history. Having access to good, applicable science helps to reduce these constraints. Wilderness managers need to do a better job of searching out relevant science and applying our efforts to the most important problems. In some areas, the science is missing or needs to be more fully developed. If managers can integrate science into decisions on wilderness management in a responsible way, people will more readily accept, and actually support, decisions.

Specifically, we propose four observations based on our experience. First, where scientists lead, managers will follow, or try to follow. Scientists that leave the best trail will be followed most closely. Second, on the continuum of site-specific to landscape-scale impacts (impacts that migrate off-site), wilderness managers have focused on site-specific impacts. We need to focus more on landscape-scale impacts, and we need scientists to give us the techniques to do this. Wilderness managers currently need to look outside of the "wilderness science" literature to obtain information on most landscape-scale impacts. Third, wilderness managers have focused more on impacts to resources than on impacts to visitors. We need to refocus more of our efforts on assessing impacts to visitors. Fourth, managers need to refocus efforts to assess cumulative effects; however, scientists must first develop usable, accurate models.

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