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Wilderness Research and Management in the Sierra Nevada National Parks

Jan W. van Wagtendonk and David J. Parsons

The concept of managing wilderness had its beginning in the Sierra Nevada of California in 1890 when Sequoia and Yosemite National Parks were established. Expansion of Sequoia in 1926 and establishment of Kings Canyon National Park in 1940 reinforced the importance of wilderness. Management has evolved from army troops patrolling for trespassers to the sophisticated use of computers and the application of scientific data in decision making. The success of the efforts to manage these spectacular areas has been largely dependent on the availability of data from long-term research studies.

The Sierra Nevada form a chain of mountains stretching over 300 km along the eastern edge of California. Elevations range from near sea level on the western slope to nearly 4,000 m at the crest. Yosemite National Park lies in the central Sierra Nevada, whereas Sequoia and Kings Canyon National Parks occupy the southern end of the range. The wilderness areas in the parks are characterized by rugged glaciated mountains incised by steep river canyons. The vegetation consists of dense conifer forests, interspersed with open expanses of granite and alpine meadows above tree line.

For many years after the establishment of the parks, users of the wilderness were few. The remote high-elevation backcountry was accessible only by foot or on horseback. Interest in the environment and the availability of lightweight backpacking equipment during the 1960s and early 1970s led to

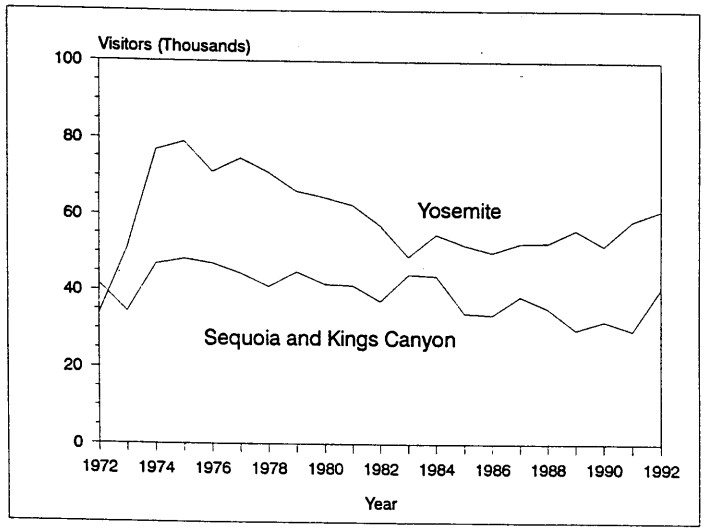

Figure 13.1 Recorded visitors in wilderness and backcountry areas of Yosemite, Sequoia, and Kings Canyon National Parks, 1972–1992.

dramatically increased use (van Wagtendonk 1981; Parsons 1983). By 1975 wilderness use had reached a peak when both Yosemite and Sequoia/Kings Canyon recorded more than 200,000 visitor nights each (Fig. 13.1). Since that time, wilderness use has decreased, leveling off at about 10% below those peak levels.

The legislative mandates establishing Sequoia and Yosemite National Parks state that they will be managed to "provide for preservation from injury of all timber, mineral deposits, natural curiosities, or wonders within said reservation, and their retention in their natural condition." Preservation of wilderness values was specifically mentioned as the primary purpose for establishing Kings Canyon National Park.

In 1984 the California Wilderness Act set aside 95% of Yosemite and 85% of Sequoia/Kings Canyon as parts of the National Wilderness Preservation System. Additional backcountry areas in each park that were not designated by the act are managed as de facto wilderness. The act described wilderness areas as lands that retain their primeval character and that must be managed to preserve their natural conditions. House Report 98-582 accompanying the act required the National Park Service (NPS) to monitor and assess impacts in areas within and adjacent to the wilderness.

NPS policies state that the conditions and long-term trends of wilderness resources will be monitored to identify the needs for and results of management actions (National Park Service 1988). Monitoring programs are required not only to assess physical and biological resources, but also to identify impacts of human activities on wilderness resources and experiences. Research is recognized as one of the statutory purposes of wilderness and is permitted as long as resource values are preserved (Graber 1988; Parsons and Graber 1991).

The wilderness management programs in the Sierra Nevada parks have largely been based on findings from research conducted by park scientists. From the earliest observations to modern computer simulations, research results have been applied to solve a diversity of issues from overgrazing to overused campsites.

Research and Monitoring Program

Muir (1894) was the first to record resource impacts in the Sierra Nevada when he described the effects of sheep grazing on mountain meadows. Qualitative assessments of wilderness conditions were also available in Sierra Club base-camp trip logs from the early 1900s. Scientific record keeping did not begin until the 1930s and, as was often the case, was initiated only after park managers believed that excessive impacts were occurring.

Early Studies

Scientific collection of wilderness impact data began in Sequoia National Park during the 1930s. Backcountry use in the Sierra Nevada was unrestricted during these early years; visitors could go wherever and do whatever they wanted. Park managers responded by sending out investigators to collect data on the impacts and make recommendations.

Sumner (1936, 1942) inventoried meadows in Sequoia and Yosemite National Parks and noted overgrazing and trampling by recreational stock as the most common forms of direct impact. More insidious were the indirect impacts associated with increased access through roads and trails. As access improved, more visitors came to the mountains. Soon additional facilities were developed to accommodate the visitors. These visitors widened trails,

trampled meadows, denuded campsites, and left trash throughout the backcountry.

Sumner (1947, 1948) repeated his studies a few years later and found no improvement in meadow and trail conditions. Armstrong (1942) also studied grazing impacts in meadows in Kings Canyon National Park but concluded that they would recover if stock were managed carefully. Black (1952) and Rutter and Black (1953) addressed grazing, camping, trails, and stock impacts in Sequoia/Kings Canyon. They were guardedly optimistic about the prospects for recovery but recommended aggressive management. These reports resulted in an increased emphasis on wilderness management. Grazing was restricted in some areas, and ranger patrols were established to inform and regulate visitors.

As a result of visual observations of the effects of overgrazing, Sharsmith (1959, 1961) conducted studies of meadows in all three parks. He concluded that the meadows were in serious decline and that restrictions on use would have to be enforced. Thede et al. (1963) and Briggs (1965) completed exhaustive reviews of previous studies and conducted extensive field surveys of the backcountry areas of the parks. Their reports formed the basis for managing those areas. Grazing capacities were established, and use was managed with permits and adjusted annually with data from grazing reports. As a result, impacts associated with stock use were reduced for a period of time.

Meanwhile, impacts by the visitors themselves were locally concentrated at campsites and along trails, streams, and lakeshores (Parsons and DeBenedetti 1979). The threat of wildfires from campfires set in flammable areas or left to burn unattended was a serious concern. The collection of fuel stripped trees of all dead wood, especially at high-elevation sites. Humans were also affecting wildlife species by stocking and taking fish, trapping furbearers, and preempting bighorn-sheep range. Based on data that researchers collected on these impacts, campfire permits were issued to contact visitors and gather information on the amount and distribution of use. Unfortunately, no system for analyzing the data was instituted.

Current Research Programs

The great influx of backcountry visitors in the late 1960s and early 1970s prompted a series of new inventories and research studies. Holmes (1972), as part of a larger study of carrying capacities for the Yosemite backcountry,

inventoried every trail and campsite in the park for human-caused impacts. For the first time, quantitative data were available for future comparisons. The realization that wilderness impacts far exceeded acceptable limits led to the decision to control visitor use. Based on research recommendations, managers in Yosemite decided in 1973 to restrict the number of people camping in a particular travel zone in the backcountry.

Park managers started a comprehensive research program to refine the numbers used for the zone limits. Harvey et al. (1972) conducted a study of wilderness impacts due to trampling by humans and stock and to fuel collection. This study was the first in the Sierra Nevada to scientifically document the relative trampling impacts of humans and horses.

Social impact studies were also underway in Sequoia/Kings Canyon (Kantola 1975) and Yosemite (Lee 1977; Absher and Lee 1981) to determine the effect visitors were having on each others' experience. These researchers interviewed visitors about their attitudes toward crowding, resource impacts, and satisfaction. They also observed the same visitors in the backcountry under varying social and environmental conditions. The conclusion was that wilderness enjoyment was affected more by human behavior and resource condition than by measures of crowding, such as total number of people encountered. These studies lent credence to the management decision to control use through more general restrictions, such as trailhead quotas or zone limits, rather than limit total use.

To better understand aquatic impacts, Silverman and Erman (1979) studied water quality in heavily used lakes in Kings Canyon National Park and found little adverse effect. However, Taylor and Erman (1979, 1980) found elevated levels of benthic plants and invertebrates in the same lakes. As a result of these studies, park managers began to remove campsites within 30.5 m of water.

Increasing use of the wilderness areas resulted in more frequent contacts between humans and black bears. These contacts are recorded as incidents if they result in a personal injury or property damage. Keay and van Wagtendonk (1983) found a positive linear relationship between use levels and bear incidents. Based on their results, park managers provided information about where incidents might occur using maps in visitor centers. Brochures and interpretive programs were also used to inform visitors how they might avoid incidents. Although these efforts resulted in an early decline in incidents, sub-

sequent bear-proofing of front-country campgrounds has exacerbated the backcountry problem.

Visitor-use impact studies in Kings Canyon National Park (Parsons 1983) found that use levels and ecological impacts could be lessened by a variety of management restrictions. Parsons and DeBenedetti (1979) and Stohlgren and Parsons (1986) documented extremely slow recovery when heavily used campsites around alpine lakes in Sequoia National Park were closed to visitor use. This information led to the recognition that reducing use levels or using short-term closures were of limited value in allowing recovery. Studies at Bullfrog Lake, however, showed that campsites do recover in forested areas (Parsons and DeBenedetti 1979).

The value of campsite impact data as a basis for management decisions and future reevaluations of impacts was evident. Parsons and McLeod (1980) described field methods for assessing those impacts. Park managers used data from campsite impact studies to derive wilderness use capacities (Parsons et al. 1981). Parsons (1986) also used these data to determine that one-night camping limits and wood-fire bans were effective means of controlling impacts. As a result, park managers permanently closed some areas and restricted camping to one night only in others.

The studies in Yosemite were complementary to those in Sequoia National Park, although the former concentrated on the means for determining and implementing use limits. Van Wagtendonk (1979a) conceived a wilderness carrying-capacity model based on ecological, physical, human, and managerial components. He applied this model by analyzing wilderness resources, including ecological fragility and social density (van Wagtendonk 1986). Parsons (1986) combined the model with campsite data to determine and implement capacities for Sequoia.

Van Wagtendonk (1979b) used a computerized wilderness-simulation model to predict visitor movements based on travel times and existing use patterns. He and another researcher determined the travel times used by the model (van Wagtendonk and Benedict 1980a). Because computers were a new tool for managing wilderness, rangers in Yosemite were initially skeptical of the model. After they compared the results to their own field experience, however, they acknowledged the usefulness of the model and accepted the limits recommended by the researchers.

The use of wilderness permits to monitor and limit visitor use in the three parks began in 1972. Because use limits rely on accurate permit data, van Wagtendonk and Benedict (1980b) studied permit compliance and validity in Yosemite, and Parsons et al. (1982) compiled similar data for Sequoia/Kings Canyon. The methods for converting permit data into travel patterns were developed by van Wagtendonk (1978). Although the researchers found that limits affected the spatial and temporal distributions of use patterns, they did not affect the total amount of use (van Wagtendonk 1981). Park managers used this information to adjust use limits.

Limits were just the first step in developing a management system that would maximize visitor freedom in accordance with wilderness resource goals. The quota program was developed in Yosemite to translate zone carrying capacities and travel patterns into trailhead quotas (van Wagtendonk and Coho 1986). Park managers implemented quotas by issuing permits for only a specified number of people for each trailhead each day. Placing controls at the entry points allowed visitors to go where they wanted and stay as long as they wanted. Because trailhead quotas are relatively simple to understand and to implement, managers embraced them with little hesitancy.

Trailhead quotas are now in effect in the wilderness areas of all three parks, as well as in the adjoining Forest Service wilderness areas (van Wagtendonk et al. 1990, 1992). When supplemented with site-specific restrictions, such as one-night-only campsites or area closures, the quotas have proven to be both effective and popular. Whether enforcing use limits and trailhead quotas results in fewer impacts is still an unanswered question, however. Subsequent monitoring of resource conditions is important to determine the effectiveness of these management actions.

Monitoring Programs

Once the management systems were in place, it became necessary to monitor results and make refinements. Visitor use has been monitored through mandatory wilderness permits since 1972. Rangers check permits throughout the wilderness and record the number of people they encounter in each area each day. Data from the permits have been useful for chronicling temporal and spatial trends as well as for limiting use. Similar data are used in Sequoia/Kings Canyon to track and regulate the amount and distribution of recrea-

tional stock use. Park managers make adjustments each year based on the monitoring results.

Long-term monitoring of trail and campsite impacts has also proven to be useful for detecting change. Sydoriak (1986) implemented a comprehensive inventory and monitoring system for trail and campsite impacts in Yosemite. This system followed much of the earlier effort and allowed comparisons to be made. A computerized database allows access to the data and is used to direct mitigation programs (Stohlgren 1988). Monitoring of campsites will continue in Sequoia/Kings Canyon on a periodic basis (Parsons and Stohlgren 1987). Park managers annually review the data and adjust quotas upward or downward.

Management of the backcountry meadows has been a particular source of controversy in Sequoia/Kings Canyon. Reviews of meadow conditions (Ratliff 1985) and the history of pack-stock use and management (DeBenedetti and Parsons 1979, 1983; McClaren 1989), together with a recent inventory of all park meadows (Neumann 1990), have provided a basis for the development of an ecologically sensitive, meadow–and–stock-use management program. Park managers are using research data on the effects of different quantities and timing of herbage removal in different meadow types (Stohlgren et al. 1989) to revise standards for evaluating the impacts of stock on meadows. The management program includes systematic monitoring to evaluate meadow conditions and the trend in those conditions. Annual grazing programs, including opening dates and total allowable use, are based on the monitoring results.

Major Issues and Challenges

The history of wilderness use in the Sierra Nevada highlights the major management issues: impacts from grazing and limitations on visitors. Several decisions based on monitoring and research data have resulted in specific management actions.

Various areas have been closed to camping or grazing. The Bullfrog Lake area in Kings Canyon National Park was closed as early as 1960 (Parsons and DeBenedetti 1979). Subsequently, all areas within 6.4 km of Yosemite Valley and Tuolumne Meadows in Yosemite National Park were closed to camping. Some meadows in all three parks have been permanently closed to

grazing, whereas others cannot be grazed during the early season until the soil dries enough to withstand stock use.

In Sequoia/Kings Canyon, managers have banned fires in areas with limited firewood, have established designated campsites, and have restricted camping to one or two nights in some areas to reduce impacts (Parsons 1983). In Yosemite, wood fires are prohibited above an elevation limit, and camping in designated sites is required in one limited area. Wilderness permits for overnight use were instituted in 1972 in all three parks and became mandatory the next year. Travel-zone limits were used to control use in Yosemite in 1973. Trailhead quotas based on campsite impacts were instituted in Sequoia/Kings Canyon in 1975. Quotas based on zone limits were implemented in Yosemite in 1977.

For many years, stock use has been largely restricted to maintained trails, although some historical unmaintained routes continue to be permitted. Recent restrictions include closing some areas and trails, prohibiting loose herding in all but the most dangerous situations, and not allowing stock to be tied to trees. Closures of meadows to grazing have been based on periodic monitoring and analysis of meadow conditions as well as qualitative judgments. Several meadows have been closed recently in Sequoia/Kings Canyon to preserve examples of pristine, untrampled meadow vegetation as a baseline for future comparisons.

Before 1972 there were no restrictions on party size. Then a party limit of 25 was enforced, whereas the number of allowable stock varied. Based on an analysis of wilderness permit data, managers of the Sierra Nevada parks and forests have recently limited party size to 15 and the number of stock to 25 (van Wagtendonk et al. 1992). Public comments on the decision were requested and were overwhelmingly in support of the reductions, although some groups vociferously opposed the decision.

The management actions have been unchallenged, except for the closure of certain areas to stock use and the increase from 20 to 25 head of stock in Sequoia/Kings Canyon. Stock users object to any closure as long as park managers lack quantitative standards derived from long-term data on ecosystem changes. On the other hand, hikers have argued that stock have far greater impact than humans and should be eliminated from the wilderness entirely. Both groups are requesting that managers of Sequoia and Kings Canyon write an Environmental Impact Statement before adopting a new

wilderness management plan. The plan would increase the network of trails maintained for stock use and raise the stock limits from 20 to 25 animals per group.

The Role of Monitoring and Long-term Research

Both research and monitoring have played pivotal roles in the management of wilderness in the Sierra Nevada national parks. Scientific research that built upon previously recorded data was instrumental in determining how issues were perceived, approached, resolved, and followed. Without scientifically based information, it would have been impossible to make informed decisions. Because the data had been collected over a long period and supported the decisions, the decisions were more acceptable to the managers and the public. Although it would be difficult to assess the cost of not having valid data, the fact that only one decision has been contested attests to their value.

Much of the research and monitoring that was done in the Sierra Nevada was progressive for its time and addressed major problems in wilderness management. New emphases, such as the U.S. Forest Service program to limit acceptable changes, are based on measurable objectives, which must be determined by public involvement and policy reviews. Monitoring must be focused on issues that trigger management actions to ensure that objective wilderness conditions are maintained. Research and monitoring will play pivotal roles in the evaluation and refinement of management objectives. The feedback loop between management and research, if employed in a process of adaptive management, would sustain a process of program refinement.

Scientific data from long-term research and monitoring programs will become more important as a growing population, air pollution, and habitat fragmentation place increasing pressures on the preservation of wilderness ecosystems. We Americans can no longer think of these areas in isolation from the human environments that surround and affect them. We can speak of the Sierra Nevada ecosystems as specific entities, but we must realize that they are also part of the larger global ecosystem.

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