They Left A Trace

A History of the Wilderness Management Research Unit

BY DAVID N. COLE

A wilderness visitor registers at a wilderness trailhead to receive a mailback questionnaire—part of Bob Lucas' early 1970s baseline study of wilderness visitors in Montana.

Passing a law in 1964 establishing wilderness areas within the National Forest System did not mean that the U.S. Forest Service immediately understood how to manage these areas. To do that required research to understand these areas and how they were being used.

The year 1964 was a landmark one for important legislation in the United States. Among the bills passed that year was the Wilderness Act, which created a new category of public lands. Lands designated as wilderness were to be afforded the highest level of protection, even more protection than national parks and wildlife refuges. Like parks and refuges they were to be preserved in their natural condition, but above all, they were to be managed to protect their "wilderness character." Like parks and refuges they were available for public enjoyment, as long as recreation did not adversely affect the values for which the area was designated. They were to be used and enjoyed "as wilderness." What did it mean to be charged with protecting wilderness character and managing for uniquely wilderness experiences? And how should one go about doing that?

The new land designation "wilderness" gave federal land managers a unique set of management objectives. Uncertainty about what those objectives were and how to achieve them was a problem. Prior to 1964, there were administratively designated wildernesses, open and available for recreation use. Through the 1950s and particularly the 1960s, wilderness recreation increased greatly. Heavy use resulted in significant impact on the environment (such as eroded trails, compacted campsites, piles of litter, and human waste problems).

Increasing use meant popular destinations were often crowded and less likely to offer the outstanding opportunities for solitude that wilderness was expected to provide. Increasing use and impact was a cause for concern, with little clarity about the nature or seriousness of the problem and uncertainty about what to do about it.

In response to this situation, in 1966, the Senate Appropriations Committee asked the U.S. Forest

PHOTOS FOR THIS ARTICLE COURTESY OF THE AUTHOR

Service to develop a proposal for a wilderness management research unit, within the Research Branch of the agency.[1] Responding to this request, the Intermountain Forest and Range Experiment Station developed a thirteen-page proposal that documented the challenge of wilderness management and specific research questions that needed to be addressed. It laid out a program focused on: 1) the wilderness visitor, 2) plant and animal ecology in wilderness, 3) wildlife species in wilderness, and 4) insect, fire, and disease control in wilderness.

It asked for an annual allocation of $300,000 and proposed that the research be conducted at the new Forestry Sciences Laboratory, located on the University of Montana campus in Missoula—an ideal location given its proximity to 7.3 million acres of existing or proposed wilderness.

Much of the proposal was accepted. In 1967, the new wilderness management research unit was established there. However, only $75,000 was appropriated.[2] The Forest Service appointed Bob Lucas the first project leader and transferred him from the Lake States Forest Experiment Station in St. Paul, Minnesota. Lucas, a geographer, had conducted pioneering research on visitors to the Boundary Waters Canoe Area, a large tract of wilderness in northern Minnesota. His initial tasks were to develop a problem analysis to guide the new unit's research program and to hire an additional scientist. For the latter, he selected George Stankey, a doctoral student in geography from Michigan State University.

The Wilderness Management Research Unit was the first research institution in the United States to focus intensively on the subject. It remained the only research institution in the world to work exclusively on wilderness for decades, as interest in wilderness exploded around the world and wilderness acreage in the United States increased from 9.1 million acres in 1964 to more than 100 million acres today. As such, its influence around the world has been profound, arguably more influential than any other Forest Service research program of its size. The unit produced much of the pioneering and seminal research in the field, collaborated with and often funded other wilderness researchers. It defined much of the research agenda for the burgeoning wilderness management field and provided much of the raw material for training successive generations of wilderness scientists and managers.

To describe the work and influence of this pioneering research unit, I divide the unit's tenure into three time periods. From 1967–1977, Bob Lucas and George Stankey were the sole scientists in the unit. Both social scientists, in-house research during this period focused on wilderness visitors. From 1978–1987, budgets increased briefly. David Cole, Randy Washburne, and Margaret Peterson joined the unit and the research agenda expanded. Randy Washburne, Margaret Peterson, and George Stankey left the unit in 1982, 1984, and 1987, respectively, and Bob Lucas retired in 1988. During the final period, from 1988–1993, the research agenda expanded further. David Cole became project leader. He was joined by Alan Watson, whom Bob Lucas hired in 1987. Alan was interested in social science issues beyond recreation visitors. Peter Landres was hired in 1992 to explore a broader range of ecological issues in wilderness. In 1993, the unit morphed into the Aldo Leopold Wilderness Research Institute.

THE LUCAS AND STANKEY PERIOD, 1967–1977

As befits the fact that wilderness science was a brand-new field of inquiry, the initial emphasis of the unit was on descriptive studies and development of and improvement in research techniques. Because there were only two scientists—both social scientists, at that—the emphasis was on "visitor studies, use patterns, visitor characteristics, attitudes concerning wilderness, its use and management, and, particularly on the esthetic or social carrying capacity of wilderness and on management to match use to capacity."[3] The emphasis on visitor studies and social carrying capacity was retained throughout the 1970s, but was increasingly supplemented by research on the ecological impacts of visitors.

Much of the early work of the unit was so simple and basic as to appear—from the perspective of today—to be commonsense. But the unit's research results were new knowledge and, in many cases, counter to prevailing notions. As Lucas noted, "Experienced administrative officers working with the same Wilderness sometimes disagree as to whether the area's main use season is summer or fall, whether half or one-fifth of the visitors hike, how long they stay, where they go, and their estimates as to the level of use may vary by a hundred percent or more."[4] Even the most basic and descriptive information went a long way towards making management more science-informed.

Bob Lucas' earliest personal research sought to refine methods for estimating recreation use in wilderness. He found that use estimates from trail registers were inaccurate but could be adjusted using correction factors obtained by either observing or using automatic cameras to estimate the proportion of different user types that failed to register. Some kinds of visitors—horsemen, hunters, day-users, and teenagers—are less likely to register.[5] Much of Lucas' empirical work in the early 1970s focused on a "baseline survey" of summer and fall visitors to wilderness and backcountry areas in Montana. He sought comparable data on users of these areas, regarding activity patterns, visitor characteristics, and preferences for management, facilities,

and use situations. Since these original surveys, similar visitor surveys—often using questions first developed by Lucas—have been conducted in wilderness areas and parks around the world, resulting in an ever-improving understanding of wilderness visitors and an increased ability to monitor and understand trends over time.[6]

One finding of the baseline survey was that use distribution on trails and at campsites is very uneven. Certain places are much more crowded and heavily impacted than other places. This led to a study of the degree to which users might distribute themselves more equitably if they were given information about which trails are crowded and which ones aren't. Lucas found that such an effort was unlikely to be effective unless visitors have information in the planning stages of their trip and unless information on more than just use levels is provided.[7] This interest in use distribution and how it might change over time or be altered through management led Lucas to cooperate with scientists from Resources for the Future, Inc., to develop a simulation model of wilderness visitor flows.[8] With this tool, managers could simulate the effects of policies under consideration, such as limiting use at most trailheads, building a new trail or the effect of an increase in amount of use. Without having to actually try out the change, managers could get an idea of what the resulting use pattern would be, what would happen to the number of encounters between parties and how crowded camping areas would be.

In 1969, George Stankey did the fieldwork for his first research project. The resulting report on visitor perceptions of wilderness recreation carrying capacity proved to be highly insightful and influential—for its conceptualization of the issue, its methodology, and its empirical results.[9] The study aimed to understand the nature of high-quality wilderness experiences, what characteristics of use influence experience quality, and how to manage for quality experiences. Extending the work of Lucas on perceptions of Boundary Waters Canoe Area visitors, Stankey studied visitors to the Bob Marshall Wilderness in Montana, the Bridger Wilderness in Wyoming, the High Uintas Wilderness in Utah, and the Boundary Waters Canoe Area. Recognizing that there are many different ideas about what constitutes a wilderness experience, Stankey reasoned that experience quality should be judged—not by the average visitor—but by those he called "purists," those visitors whose personal definitions of what is and is not desirable in wilderness most closely match the legal framework provided by the Wilderness Act. These visitors defined a high-quality wilderness experience as one with few encounters with others, in an environment where human evidence was minimal, and where it was possible to camp far from others.

The unit produced much of the pioneering and seminal research in the field, collaborated with and often funded other wilderness researchers.

Stankey asked visitors how they would feel about encountering an increasingly large number of other groups, in this way relating satisfaction with one's experience to level of use. He referred to widely shared preferences as norms—both regarding the number of encounters with other groups and appropriate methods of travel and group size. Hundreds of subsequent visitor studies have taken a similar approach—often referred to as a normative approach.[10] Stankey found that other characteristics of the groups encountered affected satisfaction more than the number of groups encountered. This finding ran counter to the perception that defining carrying capacity was the key to management and capacity was all about the number of visitors. Stankey found that, in addition to the amount of use, visitor satisfaction was affected by method of travel, group size, and where encounters occurred. He then described a range of management actions, including restricting the number of users, that might be taken to manage wilderness within its capacity and provided data on visitor opinions about the desirability of these actions.

The wilderness visitor research of Lucas and Stankey was supplemented by several studies of ecological impacts of recreation in wilderness conducted by University of Montana cooperators. Sheila Helgath studied trail deterioration in the Selway-Bitterroot Wilderness in Idaho, finding that most trail segments were stable, though a few deteriorate rapidly, and that deterioration rates are determined more by location, design, and maintenance than by the amount of use they receive.[11] Sid Frissell developed a campsite condition monitoring technique and applied it to campsites at popular destinations in the Spanish Peaks Primitive Area.[12] Both of these studies innovated techniques that have subsequently been used in scores of other areas and that continue to be used today. They also discovered new knowledge that is so fundamental that few modern recreation ecologists know who first discovered it.

As important as their empirical research was, Lucas' and Stankey's conceptual contributions to wilderness management and their close cooperative work with other

scientists and wilderness managers exceeded that. The result was a much larger and more closely-knit wilderness community than would normally have been possible given the meager investment made in the research unit. The publication of the textbook *Wilderness Management*, in collaboration with fellow Forest Service scientist John Hendee, is a fitting culmination of the unit's first decade.[13] The comprehensiveness of the book reflects Lucas' and Stankey's work organizing the field of wilderness management, developing concepts and principles as well as their empirical research. It is strengthened by the time they spent with wilderness managers and working within the larger community of wilderness scientists they helped nurture and foster. Although the first edition of the book was written when the field was barely a decade old, it is currently in its fourth edition, and 40 years later much of the book remains as originally written.

SOCIAL AND ECOLOGICAL SCIENCE: 1978–1987

In 1978, funding for the Wilderness Management Research Unit doubled. David Cole was hired to increase the unit's capacity to work on ecological impacts in wilderness. Randy Washburne was hired to develop support for and work on several ambitious survey projects. There were also more funds available to support cooperative research on a wider array of wilderness issues. In 1980, Margaret Peterson joined the unit to assist in technology transfer and work as a junior scientist. The primary research themes of an updated work unit description were visitor studies, ecological impacts of recreation, and improving wilderness management systems. Based on the prestige they developed over the preceding decade, requests for Lucas' and Stankey's time increased greatly. The wilderness concept was spreading around the world. As the only research institution in the world devoted exclusively to wilderness management, international requests for guidance and visits increased along with similar domestic requests.

Bob Lucas, the foremost pioneer of wilderness science, worked from the unit's beginning in 1967 until his retirement in 1988. George Stankey, seen washing up in camp during fieldwork in 1969, served in the unit from 1969 until 1987.

During this period, much of Bob Lucas' time went into administrative tasks. However, he continued empirical research on use measurement techniques, finding that self-issued permits provided better data than trailhead registers.[14] In 1982, he repeated the survey of Bob Marshall Wilderness visitors first conducted in 1970, providing the first systematic information on trends in wilderness visitors and visits.[15] He developed the first in-depth discussion of trends in wilderness visitation, concluding that the rate of increase in wilderness visitation had slowed and use of many areas, particular in national parks, had declined.[16] He also wrote and spoke about his concern for increased regulation in wilderness and its effect on freedom and spontaneity.[17]

By this time, George Stankey had largely shifted away from empirical science. Requests for his expertise came from around the world and, during this period, he spent two years in Australia, teaching classes and working with the New South Wales National Parks and Wildlife Service. When in Missoula, much of Stankey's effort went into two planning frameworks that proved to be highly influential. With Roger Clark, he expanded on the notion of the value of diversity in recreation experience to operationalize the framework referred to as the Recreation Opportunity Spectrum.[18] Along with Sid Frissell, David Cole, Bob Lucas, Randy Washburne, and Margaret Peterson, he worked to operationalize a process for dealing with recreational carrying capacity—a process that came to be known as Limits of Acceptable Change (LAC).[19]

With the wilderness concept spreading around the world, requests from abroad for guidance and visits increased along with similar domestic requests.

The genesis of this project was a request, in 1979, from Tom Kovalicky, deputy supervisor of the Flathead National Forest, to work with managers of the Bob Marshall Wilderness on some sort of demonstration of innovative wilderness management. At the same time, the research unit was being barraged with requests for help in dealing with carrying capacity. Managers sought something more than a list of factors to consider when grappling with the issue; they wanted a step-by-step process. Developing and applying such a process seemed a good idea for the demonstration project. The project took six years to complete and represented the largest outlay of time and resources in the history of the unit. All the scientists were involved, working to develop and publish the framework, conduct empirical studies of visitors and impacts, and work with managers on the LAC plan for the Bob Marshall Wilderness Complex.

Following development of the framework, years were spent training agency personnel in its application. The LAC framework proved to be highly influential, providing the conceptual basis for a series of similar frameworks developed for other applications and around the world. Bob Lucas stated that by turning "what had long been referred to as carrying capacity into a practical management tool," development of LAC was the research unit's "major accomplishment."[20]

The addition of David Cole, there on temporary assignment, in 1978, allowed the unit to balance its work on wilderness visitors with work on ecological impacts. Cole's initial assignment was to develop a program of work on recreation impacts in wilderness, based on a survey of existing literature. By 1978, a number of relevant studies had been conducted, but few researchers had conducted more than one study. Existing knowledge, therefore, was disparate and unorganized; it was not cumulative and seldom applied to wilderness management problems. One of Cole's first products was an annotated bibliography of more than 300 previous studies.[21] Synthesis of this information and its organization into a coherent field of recreation ecology followed, most notably in a state-of-knowledge review, the first textbook on recreation ecology, *Wildland Recreation: Ecology and Management*, and a number of book chapters, including one in the second edition of *Wilderness Management*.[22] Parallel to the early work of Bob Lucas on improving use measurement techniques, Cole developed monitoring techniques for campsites and trails in wilderness. Using these techniques, he documented trends in impact, in some cases over periods of up to 32 years.[23]

In a manner similar to Stankey's work on visitor experiences, Cole identified the use factors that influence the nature and magnitude of ecological impact: amount, type, timing, location, and geographic distribution. He systematically studied the influence of each of these factors in a variety of environmental settings across the country, using a combination of experimental techniques and examination of existing recreation sites. Most of this work was conducted on campsites, but he also worked on trails. He studied the disturbance process and the rate at which impact occurred, using experimental application of trampling and camping in previously undisturbed environments. He

studied rates of recovery in places where recreation use was curtailed. Many of the fundamental principles of recreation ecology emerged from this work. Cole found that the relationship between amount of use and impact is generally curvilinear; a little use causes substantial impact, with higher levels of use having less effect.[24] Vegetation in forests was often more fragile than that in meadows, even at high elevations.[25] He emphasized the management implications of these studies, pointing out how results were often counter to prevailing wisdom. Impacts are usually minimized by concentrating rather than dispersing use. Resting and rotating sites—allowing them to recover—is usually a futile strategy. Recreation impacts may be more unsightly in meadows than in forests, but meadows are generally not more fragile.

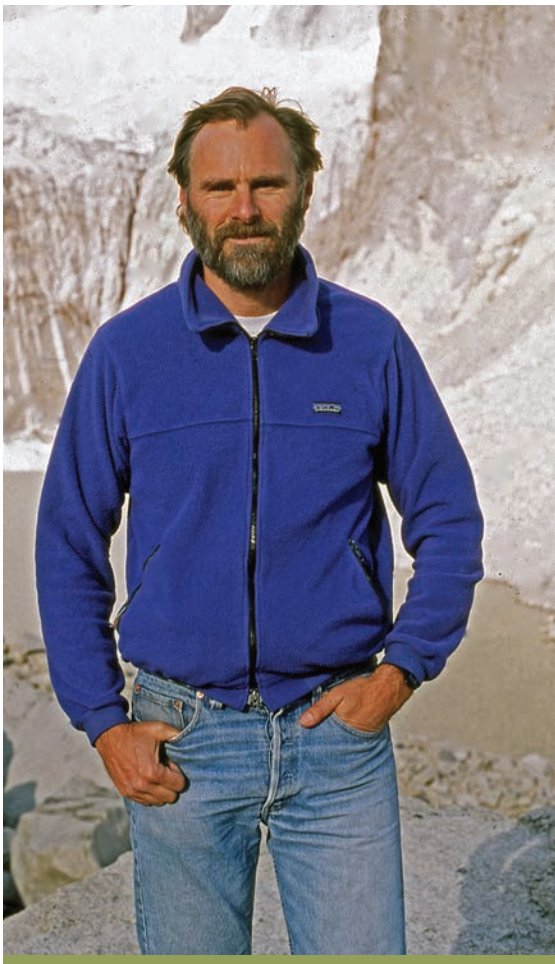
BEYOND WILDERNESS RECREATION: 1988–1993

In 1987, George Stankey resigned from the Forest Service, returning to Australia to teach. Funding was sufficient to hire David Cole into a permanent position and to hire Alan Watson into George Stankey's position as a social scientist. Bob Lucas retired in 1988 and David Cole was appointed project leader. For a long time, Bob Lucas had been interested in information and education as an alternative to regulation. So, in the mid-1980s, the unit began to devote substantial resources to low-impact education—improving the accuracy of message content and increasing the effectiveness of communication channels. Much of this was spurred by a trip organized by the National Outdoor Leadership School (NOLS) in 1985 that Bob Lucas and David Cole attended. On that trip, NOLS and the Forest Service agreed to collaborate to improve the content of low-impact educational messages and assure that they were consistent with science, a project that David Cole undertook. He collected brochures, pamphlets, articles, and other examples of recommended low-impact practices, from management agencies around the country. He compared them to each other, finding they were frequently contradictory. He evaluated them in the light of existing research and distilled them into a consistent set of science-based messages. This work was summarized in a handbook on low-impact practices, a revision of the *NOLS Conservation Practices*, and *Soft Paths*, the first book-length treatment of what came to be called Leave No Trace (LNT) practices.[26] Subsequently, a video version of *Soft Paths* was produced, containing the first version of Leave No Trace principles—principles that have since spread around the world. Interagency brochures were produced, training sessions were held, and ultimately a nonprofit organization, Leave No Trace Center for Outdoor Ethics, was created to further this work.

Work on communication methods was more limited, and much of it was conducted by cooperators with funding from the research unit. David Cole collaborated with Steve McCool and Tim Hammond from the University of Montana to assess the effectiveness of posting LNT messages on trailhead bulletin boards. They found that as the number of messages increased, the attention devoted to each message declined, as did the ability to retain message content: hikers exposed to eight messages could not identify any more of the agency-recommended practices than those exposed to only two messages.[27]

Around 1990, after the departure of Bob Lucas and with the hiring of Alan Watson, research emphases shifted again. Basic research on ecological impacts and experiential quality and the factors that influence them was to continue, but there would be new emphasis on understanding visitor conflict and on trends in visitors and impacts. The effectiveness of management techniques was evaluated, particularly in places that receive concentrated use and, given widespread interest in the LAC process, research was to be conducted on appropriate indicators and standards and cost-effective techniques for monitoring them. Given the latter emphasis item, Peter Landres was hired in 1992 to increase the unit's capacity to work on ecological issues other than recreation.

With the addition of Watson, in-house empirical social science research increased dramatically.



David Cole and other researchers shared their expertise with park managers around the world. Cole's work sites included Torres del Paine National Park in Chile.

Margaret Petersen is shown measuring vegetation cover on campsites in the Bob Marshall Wilderness in the early 1980s.

Moreover, Lucas' retirement freed up substantial funds for extramural research. Perhaps after two decades, the era of pioneering research was over, but this was a period of substantial research output by the unit. The first empirical study Watson undertook, in cooperation with Joe Roggenbuck and Dan Williams from Virginia Tech, was a study of visitors to three wilderness areas in the South: Caney Creek in Arkansas, Cohutta in Georgia, and Upland Island in Texas. Besides collecting baseline information on visitors to wildernesses in a region and in ecosystem types that had never been studied, a major objective was to provide scientific input to the selection of indicators and standards, as part of the LAC process. Visitors were asked their opinions regarding which attributes of wilderness have the most impact on their experience. Littering and damage to trees in campsites, noise, and seeing wildlife were found to be very important influences on wilderness experiences. Less important were the number of encounters with other people, though campsite encounters were more important than trail encounters.[28]

In 1990, Watson started field studies of conflict between horse users and hikers in the John Muir and Sequoia-Kings Canyon Wildernesses in California and the Charles Deam Wilderness in Indiana. Twenty years earlier, George Stankey had found conflict between the two groups, with hikers being more bothered by meeting horse groups than other hikers.[29] Watson explored this conflict in more detail, employing multiple measures of conflict, evaluations of whether encounters were disliked, as well as evaluations of whether one's experience goals were interfered with due to encounters. He also examined the extent to which four potential determinants of conflict (definition of place, specialization level, focus of trip/expectations, and lifestyle tolerance) predicted the degree of conflict, learning a lot about what predisposes visitors to experiencing conflict. Most fundamentally, hikers who dislike meeting horses in wilderness believe that horses are inappropriate in wilderness. They "also are not as likely to accord high status to horse users, have stronger relationships with the wilderness, and place more value on the opportunities for solitude than those who do not dislike horses."[30]

Watson and Cole collaborated on several projects. To extend the work on visitor trends begun by Lucas, in 1990 and 1991 visitor surveys were repeated in three wilderness areas that had initially been studied between 1969 and 1978; the Boundary Waters Canoe Area in Minnesota, Desolation Wilderness in California, and Shining Rock Wilderness in North Carolina. Analysis of trends showed that characteristics of the people who visit wilderness changed more consistently than the type of trip they take, their evaluations of conditions, or their preferences for conditions and management. In particular, visitors were older, more highly educated, more likely to be female, and to have visited other wildernesses.[31]

The final collaborative project was a study of high-use destination areas a short distance from trailheads and close to large urban areas. Such places are generally highly crowded and impacted; they continue to have

the same problems and concerns that first surfaced in the 1960s and spurred creation of the Wilderness Management Research Unit. Similar to the LAC project earlier, a major goal of the project was to bring both ecological and social science to bear on these issues, seeking increased insight into how to manage such places. Work was conducted in six lake basins in the Alpine Lakes, Mount Jefferson, and Three Sisters Wildernesses in Washington and Oregon. Recreation impacts on system trails, user-created trails, campsites, and lakeshores were quantified, as were encounters between groups, during the day and in the evening, on the trail and at the destination. Exit interviews were conducted with visitors to explore who they were, what they encountered, their responses to what they encountered, and their management preferences.

Not surprisingly, encounter rates in these destination areas were extremely high, clearly exceeding what most visitors preferred. Ecological impacts were also substantial, although generally not higher than has been reported elsewhere. Most visitors expected to have numerous encounters and were not bothered by their experience. They noticed impacts and reported that impacts detracted from their experience. Few visitors supported reducing use levels—the most effective means of reducing encounters—but were highly supportive of site management approaches to limiting impact.[32] Study findings influenced a new wilderness recreation management strategy developed by the Forest Service—one that embraced the oft-lauded approach of internal zoning—as well as wilderness planning in the Pacific Northwest, at wildernesses such as Mt. Hood and Alpine Lakes.[33]

Cole's personal research focused on trend studies and further exploring the relationship between amount of use and amount of impact, in environments that vary in their durability. Studies indicated that trails were generally stable, although some segments are prone to rapid deterioration.[34] Most campsites—once they have been repeatedly used—are also relatively stable.[35] Campsite impact during the 1970s and 1980s often increased greatly, but more from the proliferation of new campsites than the deterioration of existing ones.[36] This work had important implications both for wilderness management and Leave No Trace practices. In popular places, it is important to concentrate use on a few established sites that rangers keep as small, clean, and attractive as possible. In little-used places, use should be dispersed, places where incipient impact is apparent should be avoided, and rangers should try to eliminate evidence of use and impact.

To extend experimental methodologies, Cole worked with Neil Bayfield, the Scottish ecologist who pioneered experimental studies of recreation impact in the 1960s. They developed a standardized method for conducting trampling experiments to facilitate the comparability of trampling experiments, studies that were increasingly common around the world.[37] These methods were applied to 18 vegetation types, in Washington, Montana, Colorado, New Hampshire, and North Carolina. Results showed that vegetation types growing in close proximity to each other can vary at least thirty-fold in durability. The ability to resist being damaged by trampling was often negatively correlated with the ability to recover from damage, and it was possible to predict the resistance and resilience of vegetation by examining plant morphological characteristics.[38] These results added to knowledge about where managers should locate facilities and what

Encounter rates in these destination areas were extremely high, clearly exceeding what most visitors preferred. Ecological impacts were also substantial, although generally not higher than has been reported elsewhere.

In 1988, Alan Watson was hired to continue the social science agenda of Lucas and Stankey. He broadened the array of social science issues that were studied.

visitors should be told, in Leave No Trace messages, about more durable routes over which to travel and camp.

A quarter century after establishment of the Wilderness Management Research Unit, the program still did not have sufficient funding to work on the array of research needs identified in the 1966 proposal to Congress. Cole worked to identify scientists who could contribute new types of expertise to wilderness management. For example, he recruited and funded Rick Knight at Colorado State University to synthesize knowledge about recreation impacts on wildlife, resulting in the first book on the topic.[39] The hiring of ecologist Peter Landres, in 1992, also reflected this interest in expanding the array of issues the unit could explore. Much of Landres' time during the final year the research unit existed was devoted to developing a research agenda for ecological work beyond recreation. He collaborated with David Cole on a further elaboration of threats to wilderness ecosystems[40] and ultimately focused his work on monitoring.[41]

In 1992, Congressman Bruce Vento (D-MN), concerned that agencies were not giving wilderness management the attention it deserved, introduced a bill called the Forest Service Wilderness Management Act in Congress. Among other things, the act called for creation of an interagency research entity, what would become the Aldo Leopold Wilderness Research Institute, to be located in or near Missoula, Montana. Although the bill was never enacted, the Forest Service's Research branch leadership decided to administratively create such an institute by assimilating the Wilderness Management Research Unit, its personnel and resources, and then seeking to attract additional resources to expand the program. In 1993, the institute was dedicated, and 26 years after it was created, the Wilderness Management Research Unit ceased to exist.

LEGACY

Although it only existed for 26 years and usually had a staff of only two or three scientists, the legacy of the Wilderness Management Research Unit is profound. Staff scientists organized and gave structure to two fledgling disciplines—wilderness science and recreation ecology. They developed and refined sampling protocols and research methods for both these fields, protocols and methods that have been repeated in hundreds of subsequent studies. They coauthored the first textbooks in these fields as well as the first book devoted exclusively to Leave No Trace practices. The science being done moved from basic observation, description, and organization to ever more sophisticated theory and hypothesis testing. With collaborators they developed two of the most important recreation planning frameworks, the Recreation Opportunity Spectrum and Limits of Acceptable Change. The arc of the unit's contributions to knowledge can be traced from the pioneering work of two social scientists, to the seminal recreation ecology work of the unit's second decade, to the increasingly diverse and productive agenda that was taken on in the final years and is being carried on by the Aldo Leopold Wilderness Research Institute.

As important as their contributions to knowledge was their attention to building and nurturing a collegial and vibrant network of wilderness scientists and managers. Staff scientists mentored young scientists, provided funding for research projects, collaborated with others, organized and attended conferences and workshops, and interacted frequently with field managers and rangers all over the country. They attended and gave talks at international wilderness conferences, expanding the collaborative network further. Most of the first few generations of wilderness scientists and recreation ecologists worked with, were funded by, or otherwise collaborated with unit scientists, leaving them profoundly influenced

by those interactions. The ultimate legacy of the Wilderness Management Research Unit is this network of scientists and managers working on wilderness issues, made wiser and more informed by the work that was done by this small group of scientists.

David N. Cole served with the Aldo Leopold Wilderness Research Institute from 1978 until his retirement in 2013. As Emeritus Scientist, he continues contributing to wilderness science. *This article is reprinted from the April 2019 issue of the* International Journal of Wilderness *and can be accessed at www.ijw.org.*

NOTES

1. Richard J. Klade, *Building a Research Legacy: The Intermountain Station: 1911–1997* (Ft. Collins, CO: USDA Forest Service, 2006), RMRS-GTR-184, 109.
2. Robert C. Lucas, "Forest Service Wilderness Research: The Problem, Research to Date, and Needed Research" (unpublished manuscript, January 1972), 8.
3. Lucas, "Forest Service Wilderness Research," 8.
4. Lucas, "Forest Service Wilderness Research," 12.
5. Robert C. Lucas, Hans T. Schreuder, and George A. James, *Wilderness Use Estimation: A Pilot Test of Sampling Procedures on the Mission Mountains Primitive Area*, INT-RP-109 (Ogden, UT: USDA Forest Service, 1971).
6. Robert C. Lucas, *Use Patterns and Visitor Characteristics, Attitudes, and Preferences in Nine Wilderness and Other Roadless Areas*, INT-RP-253 (Ogden, UT: USDA Forest Service, 1980).
7. Robert C. Lucas, *Redistributing Wilderness Use Through Information Supplied to Visitors*, INT-RP-277 (Ogden, UT: USDA Forest Service, 1981).
8. See, for example, Robert C. Lucas and Mordechai Shechter, "A Recreational Visitor Travel Simulation Model as an Aid to Management Planning," *Simulation and Games* 8 (1977): 375–84.
9. George H. Stankey, *Visitor Perception of Wilderness Recreation Carrying Capacity*, INT-RP-142 (Ogden, UT: USDA Forest Service, 1973).
10. See, for example, Jerry Vaske et al., "Backcountry Encounter Norms: Theory, Method, and Empirical Evidence," *Journal of Leisure Research* 18 (1986): 137–53.
11. Sheila F. Helgath, *Trail Deterioration in the Selway-Bitterroot Wilderness*, INT-RN-193 (Ogden, UT: USDA Forest Service, 1975).
12. Sidney S. Frissell, "Judging Recreation Impacts on Wilderness Campsites," *Journal of Forestry* 76 (1978): 481–83.
13. John C. Hendee, George H. Stankey, and Robert C. Lucas, *Wilderness Management* (Washington, DC: U.S. Government Printing Office, 1978).
14. Robert C. Lucas and Thomas J. Kovalicky, *Self-issued Wilderness Permits as a Use Measurement System*, INT-RP-270 (Ogden, UT: USDA Forest Service, 1981).
15. Robert C. Lucas, *Visitor Characteristics, Attitudes, and Use Patterns in the Bob Marshall Wilderness Complex, 1970-82*, INT-RP-345 (Ogden, UT: USDA Forest Service, 1985).
16. Robert C. Lucas, "A Look at Wilderness Use and Users in Transition," *Natural Resources Journal* 29 (1989): 41–55.
17. Robert C. Lucas, "Recreation Regulations—When Are They Needed?" *Journal of Forestry* 80 (1982): 148–51.
18. Roger N. Clark and George H. Stankey, *The Recreation Opportunity Spectrum: A Framework for Planning, Management, and Research*, PNW-GTR-98 (Portland, OR: USDA Forest Service, 1979).
19. George H. Stankey et al., *The Limits of Acceptable Change (LAC) System for Wilderness Planning*, INT-GTR-176 (Ogden, UT: USDA Forest Service, 1985).
20. Klade, *Building a Research Legacy*, 109.
21. David N. Cole and Edward G. Schreiner, *Impacts of Backcountry Recreation: Site Management and Rehabilitation—An Annotated Bibliography*, INT-GTR-121 (Ogden, UT: USDA Forest Service, 1981).
22. See David N. Cole, "Research on Soil and Vegetation in Wilderness: A State-of-Knowledge Review," in *Proceedings, National Wilderness Research Conference: Issues, State-of-Knowledge, Future Directions*, INT-GTR-220 (Ogden, UT: USDA Forest Service, 1987), 135–77; and William E. Hammitt and David N. Cole, *Wildland Recreation: Ecology and Management* (New York: John Wiley, 1998).
23. David N. Cole, *Changing Conditions on Wilderness Campsites: Seven Case Studies of Trends Over 13 to 32 Years*, RMRS-GTR-300 (Ft. Collins, CO: USDA Forest Service, 2013).
24. David N. Cole, *Wilderness Campsite Impacts: Effect of Amount of Use*, INT-RP-284 (Ogden, UT: USDA Forest Service, 1982).
25. David N. Cole, "Effects of Three Seasons of Experimental Trampling on Five Montane Forest Communities and a Grassland in Western Montana, USA," *Biological Conservation* 40 (1987): 219–44.
26. Bruce Hampton and David N. Cole, *Soft Paths: How to Enjoy the Wilderness Without Harming It* (Mechanicsburg, PA: Stackpole Books, 1988).
27. David N. Cole, Timothy P. Hammond, and Stephen F. McCool, "Information Quantity and Communication Effectiveness: Low Impact Messages on Wilderness Trailside Bulletin Boards," *Leisure Sciences* 19 (1997): 59–72.
28. Joseph W. Roggenbuck, Daniel R. Williams and Alan E. Watson, "Defining Acceptable Conditions in Wilderness," *Environmental Management* 17 (1993): 187–97.
29. Stankey, *Perception of Carrying Capacity*.
30. Alan E. Watson, Michael J. Niccolucci, and Daniel R. Williams, *Hikers and Recreational Stock Users: Predicting and Managing Recreation Conflicts in Three Wildernesses*, INT-RP-468 (Ogden, UT: USDA Forest Service, 1993), 32.
31. David N. Cole, Alan E. Watson, and Joseph W. Roggenbuck, *Trends in Wilderness Visitors and Visits: Boundary Waters Canoe Area, Shining Rock, and Desolation Wildernesses*, INT-RP-483 (Ogden, UT: USDA Forest Service, 1995).
32. David N. Cole et al. *High-use Destinations in Wilderness: Social and Biophysical Impacts, Visitor Responses, and Management Options*, INT-RP-496 (Ogden, UT: USDA Forest Service, 1997).
33. Garry Oye, "A New Wilderness Recreation Strategy for National Forest Wilderness," *International Journal of Wilderness* 7 (2001): 15–16.
34. David N. Cole, *Changes on Trails in the Selway-Bitterroot Wilderness, Montana, 1978–89*, INT-RP-450 (Ogden, UT: USDA Forest Service, 1991).
35. David N. Cole and Troy E. Hall, *Trends in Campsite Condition: Eagle Cap Wilderness, Bob Marshall Wilderness, and Grand Canyon National Park*, INT-RP-453 (Ogden, UT: USDA Forest Service, 1992).
36. David N. Cole, *Campsites in Three Western Wildernesses: Proliferation and Changes in Condition Over 12 to 16 Years*, INT-RP-463 (Ogden, UT: USDA Forest Service, 1993).
37. David N. Cole and Neil G. Bayfield, "Recreational Trampling of Vegetation: Standard Experimental Procedures," *Biological Conservation* 63 (1993): 209–15.
38. David N. Cole, "Experimental Trampling of Vegetation. II. Predictors of Resistance and Resilience," *Journal of Applied Ecology* 32 (1995): 215–24.
39. Richard L. Knight and Kevin G. Gutzwiller, *Wildlife and Recreationists: Coexistence Through Management and Research* (Washington, DC: Island Press, 1995).
40. David N. Cole and Peter B. Landres, "Threats to Wilderness Ecosystems: Impacts and Research Needs," *Ecological Applications* 6 (1996): 168–84.
41. Peter B. Landres, "The Role of Ecological Monitoring in Managing Wilderness," *TRENDS* 32 (1995): 10–13.