The year 1964 was a landmark 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, more protection even 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 to be made available to be enjoyed by the public, as long as recreation use did not adversely affect the values for which the area was designated. But 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 new and unique set of management objectives. Uncertainty about exactly what those objectives were and how to achieve them was a problem. Wilderness areas were not created in a vacuum. Prior to 1964, there were administratively designated wilderness and primitive areas, open and available for recreation use. Through the 1950s and particularly through the 1960s, wilderness recreation – mostly backpacking and horse travel – increased greatly. Heavy use in some places resulted in significant impact on the environment – eroded trails, compacted campsites, piles of litter, human waste problems and more. Increasing use also meant that popular destinations were often crowded and less likely to offer the outstanding opportunities for solitude that wilderness was 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 and in a sign of how different those times were, in 1966 the Senate appropriations committee asked the Forest Service to develop a proposal for a wilderness management research unit, within the research branch of the Forest Service (Klade 2006). Responding to this request, the Intermountain Forest and Range Experiment Station developed a 13-page proposal for a wilderness research program. The proposal documented the challenges to wilderness management, specific research questions that need to be addressed and the fact that there has been little relevant research to date. It laid out a 4-pronged research 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. The proposal asked for an annual allocation of $300,000 to finance an interdisciplinary team of scientists and support staff to focus initially on the first three research prongs. The research was to be conducted at the new Forestry Sciences Laboratory, located on the University of Montana campus, in Missoula, Montana—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 in Missoula. However, only $75,000 was appropriated (Lucas 1972). The first leader of the research project was Bob Lucas, who was transferred from the Lake States Forest Experiment Station in St. Paul, Minnesota. Lucas was a geographer who had been leader of a recreation research project there since 1961. He had conducted pioneering research on visitors to the Boundary Waters Canoe Area, a large tract of wilderness land in northern Minnesota. His initial tasks were to develop a problem analysis to

---

The impacts associated with recreational use of wilderness are a primary concern of wilderness managers. In response to serious impacts, many wilderness areas limit group size and prohibit camping immediately adjacent to lakes.
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. Lucas had met Stankey

The Wilderness Management Research Unit was the first research institution in the United States
to focus intensively on wilderness management issues. 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, it is helpful to divide the unit’s tenure into three
different time periods. In the decade from 1967-1977, Bob Lucas and
George Stankey were the sole scientists in the unit. Both social
scientists, in-house research during this period was highly focused on wilderness visitors. In the
subsequent decade--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 was
project leader. He was joined by Alan Watson, who Bob Lucas hired in 1987. Alan was interested in a
range of 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.

Lucas and Stankey: 1967-1977

Prior to the 1990s, the research conducted by Forest Service scientists was largely guided by
Research Work Unit Descriptions and problem analyses. These sought to identify high priority topics, and
associated specific projects, that the research unit would focus on for five-year periods. In 1967, Bob
Lucas developed the first such program of work. As befits the fact that wilderness science was a brand
new field of inquiry, the initial emphasis was on descriptive studies and development of and improvement
in research techniques. Given that there were only two scientists—both social scientists—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” (Lucas 1972). 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. In addition, support was provided for a study of fire history in the Bob
Marshall Wilderness, as well as work on methods for projecting wilderness use and for estimating the
costs of wilderness land classification.

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. One of George Stankey’s earliest papers was “Myths in wilderness
decision-making” (Stankey 1971). As Lucas (1972) 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.” Even the most basic and descriptive information
went a long ways towards making management more science-informed.
Bob Lucas’ earliest personal research sought to refine methods for accurately estimating recreation use in wilderness-type areas. 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 (Lucas et al. 1971). 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 was after comparable data on the users of all these areas, regarding activity patterns, visitor characteristics and preferences for management, facilities and use situations. The profile of visitors that emerged was fairly consistent across areas, though there was some variation related to the character of each area (Lucas 1980). Since these original surveys, similar visitor surveys—often using questions first developed by Lucas—have been conducted in wilderness 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.

One finding of the baseline survey was that use distribution on trails and at campsites is very uneven. Consequently, 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 one’s aren’t. Lucas found that such an effort was not likely 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 (Lucas 1981). 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 (Lucas and Schechter 1977). 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 a good 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 basis for his dissertation. 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 (Stankey 1973). The ambitious aims of the study were to better understand the nature of high quality wilderness experiences, what characteristics of use influence experience quality and how one might manage for quality experiences. Extending the early work of Lucas on the perceptions of Boundary Waters Canoe Area visitors, Stankey studied visitors to four areas—the Bob Marshall Wilderness in Montana, the Bridger Wilderness in Wyoming, the High Uintas Wilderness in Utah and the Boundary Waters Canoe Area in Minnesota. 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 where there were few encounters with others, in an environment where man’s evidence was minimal and where it was possible to camp far from others.
In the study, 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 (e.g. Vaske et al. 1986, Manning 2012). Importantly, Stankey found that other characteristics of the groups encountered affected satisfaction more than the number of groups encountered. From the perspective of what we know today, this might seem obvious, but at the time this finding ran counter to the wide 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 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.

Stankey extended this research in the early 1970s by studying visitors to wilderness areas that differed greatly in level of use: the lightly-used Spanish Peaks Primitive Area in Montana and the more heavily-used Desolation Wilderness in California. The socio-economic characteristics of visitors were

George Stankey found evidence that satisfaction declines as visitors encounter more other groups, with the decline being more extreme when the groups encountered were on horseback.
similar between the two areas, as were their general concepts of appropriate and desirable use and conditions in wilderness. However, in the more heavily-used wilderness, visitors were more tolerant of heavy use and more accepting of regulation (Stankey 1980). The two other empirical studies Stankey undertook in the early 1970s were (1) a study of Selway-Bitterroot Wilderness visitors regarding their attitudes toward wilderness fire policy (Stankey 1976) and (2) a study of visitor acceptance of use rationing in two popular southern California wildernesses (Stankey 1979).

The wilderness visitor research of Lucas and Stankey was supplemented by several studies of ecological impacts of recreation in wilderness conducted by University 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 (Helgath 1975). Sid Frissell developed a campsite condition monitoring technique (Frissell 1978) and applied it to all the campsites at popular destinations in the Spanish Peaks Primitive Area (Frissell 1973). Both of these studies innovated techniques that have been subsequently 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 acknowledge who first discovered it.

As important as their empirical research were Lucas’ and Stankey’s conceptual contributions to wilderness management and their close cooperative work with other scientists and wilderness managers. 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. Lucas (1973), for example, laid out a framework for wilderness management that provided an organizational foundation for the field, identified a series of management principles and presciently identified a number of issues that remain problematic today, including the need for multiple types of roadless areas, an issue Cole (2011) returned to decades later. Stankey did important conceptual work on carrying capacity, working collaboratively with Sid Frissell. Their concepts were ultimately employed in development of the highly-influential Limits of Acceptable Change planning process (Frissell and Stankey 1972). He also collaborated with
John Baden, a political scientist at Utah State University, on a description of alternative techniques for rationing use, including an insightful assessment of their pros and cons (Stankey and Baden 1977).

The publication of the textbook *Wilderness Management* (Hendee et al. 1978), in collaboration with fellow Forest Service scientist John Hendee, is a fitting culmination of the Wilderness Management Research Unit’s first decade. The comprehensiveness and helpfulness 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.

The textbook, *Wilderness Management*, coauthored with John Hendee in 1978, represented the culmination of knowledge developed, organized and applied during the first decade of the Wilderness Management Research Unit.

Social and Ecological Science: 1978-1987

In 1978, funding for the Wilderness Management Research Unit was doubled. This allowed the unit to expand. David Cole was hired to increase the capacity of the unit 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 to 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.

During this period, Bob Lucas continued his empirical research on improving use measurement techniques, finding that self-issued permits provided better use data than trailhead registers (Lucas and Kovalicky 1981). He oversaw research that Margaret Petersen conducted, demonstrating that trail registration compliance could be increased by locating registers up the trail and including a sign with reasons for registering (Petersen 1985). 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 (Lucas 1985). He followed up on earlier work of Petersen (1980) on trends in wilderness visitor use with the first in depth discussion of trends in wilderness visitors and visitation, concluding that the rate of increase in wilderness visitation has slowed and use of many areas, particular in national parks, has declined (Lucas 1989). His final data-based report used the 1982 Bob Marshall visitor data to explore factors that influence visitors’ choice of trailheads and campsites. Not surprisingly, he found that good fishing and hunting opportunities top the long list of factors that influence trail choice, that campsites are rejected more often because of their location than their condition, and that hikers, horse users and hunters differ sharply in the effect of campsite condition on campsite choice (Lucas 1990).

With expansion of the unit, more of Lucas’ time went into administrative tasks. He spent considerable amounts of time working in Colorado with a group developing a state-of-the-art wilderness management plan for the Maroon Bells-Snowmass Wilderness and planning for the first wilderness science conference, held in Fort Collins, Colorado in 1985. Finally, he wrote and spoke about his concern for the increased use of regulation in wilderness management and its effect on freedom and spontaneity (Lucas 1982).

By this time, George Stankey had largely shifted away from empirical science, although he did collaborate in two cooperative studies that extended earlier work. In 1978, he collaborated with Joe Roggenbuck, from Virginia Tech, to study visitors to southern Appalachian wildernesses, exploring
issues comparable to those he had explored in the early 1970s in western wildernesses (Roggenbuck et al. 1979). He also collaborated with Steve McCool, from the University of Montana, to reexamine the attitudes of Selway-Bitterroot Wilderness visitors toward fire management. They found that, between 1971 and 1982, visitors became more knowledgeable about fire and were much more likely to support allowing some fires to burn in wilderness (McCool and Stankey 1986). Requests for Stankey’s time and expertise came from around the world and, during this period, he took two years of leave and spent them in Australia, teaching classes and working with the New South Wales National Parks & Wildlife Service.

When in Missoula, much of Stankey’s effort went into work on two planning frameworks that proved to be highly influential. With Roger Clark, he expanded on the long-established notion of the value of diversity in recreation experience to operationalize the framework referred to as the Recreation Opportunity Spectrum (Clark and Stankey 1979), a framework also being worked on by Bev Driver and Perry Brown. Along with Sid Frissell, David Cole, Bob Lucas, Randy Washburne and Margaret Peterson, he also worked to operationalize a process for dealing with the issue of recreational carrying capacity—a process that came to be known as Limits of Acceptable Change (LAC) (Stankey et al. 1985).

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 all the factors they needed to consider when grappling with the issue; they wanted a step-by-step process. Developing and applying such a process seemed like 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 of the scientists were involved, working to develop and publish the framework, conduct empirical studies of visitors and impacts, and work with managers to develop the LAC plan for the Bob Marshall Wilderness Complex. Moreover, 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” (Klade 2006: 109).

Randy Washburne was hired primarily to work on two surveys. One involved extending the baseline surveys of wilderness visitors that Bob Lucas had conducted in Montana to other parts of the country. The second involved working with George Stankey to study visitors across a wide array of dispersed recreation settings. Ultimately, both required levels of funding that proved impossible to secure. Instead, Randy conducted the first survey of the management practices of all wildernesses in the system (Washburne and Cole 1983) and, in 1982, decided to pursue his passion for boats, attending wooden boat building school and becoming an ocean kayaking guru in Seattle.
The addition of David Cole, in 1978, allowed the unit to balance its work on wilderness visitors with work on ecological impacts. Bob Lucas’ original intent was to make Cole’s position a permanent one. However, in meetings with some wilderness managers, his certainty regarding the need for ecological impact work was shaken by managers who thought they already knew enough to deal effectively with impact issues. So a temporary position was created. In hindsight, this was unfortunate. By the time it became clear that impact work was a critical need, funding had declined, making it impossible to make the position permanent. Nevertheless, Cole’s temporary assignment lasted from 1978 to 1982 and he was able to maintain an office with the unit and obtain cooperative research funds, as an independent scientist with Systems for Environmental Management, until 1987, when funding improved and he was permanently hired.

Cole’s initial assignment was to develop a program of work on recreation impacts in wilderness, based on a survey of existing knowledge in the literature. By 1978, a number of relevant studies had been conducted, but few researchers had ever 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 his first products was an annotated bibliography of more than 300 previous studies (Cole and Schreiner 1981). Synthesis of this information and its organization into a coherent field of recreation ecology followed, most notably in a state-of-knowledge review (Cole 1987a), the first textbook on recreation ecology, *Wildland Recreation: Ecology and Management* (Hammitt and Cole 1987) and a number of book chapters, including one in the second edition of the text, *Wilderness Management* (Cole 1990). Parallel to the early work of Bob Lucas on improving use
measurement techniques, Cole developed monitoring techniques for campsites and trails in wilderness (Cole 1983, Cole 1989a). Using these techniques, he documented trends in impact, in some cases over periods up to 32 years (Cole 2013).

In a manner similar to what Stankey had done for visitor experiences, Cole identified the use factors that influence the nature and magnitude of ecological impact: amount, type, timing, location and geographic distribution. He then 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 and also studied rates of recovery in places where recreation use was curtailed. Many of the most 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 and less effect (Cole 1982). He found that impact almost always occurs rapidly; recovery rates are more variable but almost always are slower than rates of impact (Cole and Ranz 1983). He found that the vegetation in forests was often more fragile than that in meadows, even at high elevations (Cole 1987b). 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. Implications of this research, along with relevant social research was summarized in a “trouble-shooting guide” for managers regarding the pros and cons of alternative strategies and tactics for dealing with common recreation management problems (Cole et al. 1987).

Funding levels during this period were sufficient to support a diverse array of cooperative research projects. In addition to Cole’s work, several other ecological impact studies were completed. Cathy Ream (1980) compiled a bibliography of recreation impacts on wildlife. Ken Temple studied decomposition of human waste buried in “cat-holes,” finding that it did not decompose rapidly, as visitors were being told (Temple et al. 1982).

Studies of packstock grazing impacts were initiated in the Lee Metcalf Wilderness, Montana (Olson-Rutz et al. 1996). In several studies of visitor perceptions of ecological impact, findings indicated that managers and visitors perceive impacts very differently and that the acceptability of impact varies with both magnitude of impact and the attribute that was impacted (Shelby and Harris 1985, Martin et al. 1989). Extending Lucas’ early work on use redistribution, Krumpe and Brown (1982) found visitor use could be shifted somewhat by providing visitors with information before their trip. Finally, Bill Hammitt (1982) explored what visitors are seeking when they say they are seeking solitude, concluding that there are several cognitive dimensions of wilderness solitude, among which the notion of privacy is particularly important.

**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. In the late 1980s, the emphasis of the research unit had shifted substantially toward visitor education. The two primary problem statements for the unit were (1) “provide knowledge of visitor behavior and the impacts it causes in various settings that will enable managers to make the content of visitor education programs more effective” and (2) “provide a better understanding of key audiences and communication methods to help managers more effectively change undesirable visitor use patterns and behavior through education.” 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 was to be new emphasis on understanding visitor conflict and on trends in visitors and impacts. The effectiveness of management techniques was to be 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, in 1992, Peter Landres was hired to increase the capacity of the unit to work on ecological issues other than recreation.

For a long time, Bob Lucas had been interested in information and education as an alternative to regulation. 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, along with other agency employees and academics. 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 proceeded to collect hundreds of brochures, pamphlets, articles and other examples of recommended low impact practices, from all the management agencies around the country. He compared them to each other, finding that 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 (Cole 1989b), 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 (Hampton and Cole 1988). Subsequently, a video version of *Soft Paths* was produced, containing the first version of Leave-No-Trace principles, principles that have since spread round the world, being found, for example, on hang tags on recreational equipment. Interagency brochures were produced, training sessions were held, and ultimately a non-profit organization, Leave-No-Trace, Inc. 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. Working with the Appalachian Mountain Club, a handbook on alternative methods of communicating with the public regarding LNT practices was produced (Douchette and Cole 1993). With project funding, Manfredo (1992) edited a book that applied social psychological theory to the issue of effective communication. It articulated the various routes to persuasion that exist, how difficult persuasion is, and how unlikely it is that simply giving people information will result in substantial behavioral change. Several empirical studies were also conducted. Braithwaite and McCool (1989), at the University of Montana, studied beliefs and social influences on visitor behavior in grizzly bear country finding, among other things, that the most important and reliable source of information was wilderness rangers. David Cole collaborated with Steve McCool and Tim Hammond 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. Consequently, hikers exposed to eight messages could not identify any more of the agency-recommended practices than
those exposed to only two messages (Cole et al. 1997). In a subsequent experiment, Cole (1998) found that simply asking people to take the time to read messages—in a banner above the messages—doubled the length of time they attended to the messages.

With the addition of Alan Watson, in-house empirical social science research increased dramatically. Moreover, with the retirement of Bob Lucas, there were 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 1989 study of visitors to three wildernesses in the South: Caney Creek in Arkansas, Cohutta in Georgia and Upland Island in Texas (Watson et al. 1992). Besides collecting baseline survey information on visitors to wildernesses in a region and in ecosystem types that had not been studied before, a major focus of the study was to provide scientific input to the selection of indicators and standards, as part of the LAC process. To do so, 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 (Roggenbuck et al. 1993). Regarding standards for acceptable wilderness conditions, there was broad agreement across wilderness areas. However, there was little shared agreement on appropriate conditions within each wilderness, suggesting the value of managing different zones within wilderness to different standards. It also suggests caution in using visitor opinions to set standards as “the
task of making a numerical judgement regarding acceptable social encounter levels may be too abstract or hypothetical to result in a meaningful standard” (Williams et al. 1992a: 755).

Data from these studies were also used to refine methods and concepts, both visitors’ emotional and symbolic attachment to place and the wilderness concept (Williams et al. 1992b) and visitors’ past wilderness experience (Watson and Niccolucci 1992). Watson et al. (1991) used a controlled laboratory setting to further examine past wilderness experience—in this case its influence on site choice. These studies advanced the field both methodologically and conceptually; many findings were counter to established theory and suggested shortcomings in established methods and approaches.

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 horse users and hikers, with hikers being more bothered by meeting horse groups than other hikers (Stankey 1982). Watson et al. (1993, 1994) sought to explore the nature of this conflict in more detail. They employed 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. They also examined the extent to which four potential determinants of conflict (definition of place, specialization level, focus of trip/expectations and lifestyle tolerance) predicted degree of conflict. They learned a lot particularly 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” (Watson et al. 1993: 32).
Watson and Cole collaborated on several projects. To complement handbooks on monitoring campsites and trails, a handbook on use estimation was produced (Watson et al. 2000). 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 (Cole et al. 1995). Analysis of trends showed that characteristics of the people who visit wilderness changed more consistently than the types 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. Watson utilized data from Desolation—where permits are required—to explore characteristics of people who entered the Desolation Wilderness without a permit (Watson 1993). He used data from the Boundary Waters to explore solitude opportunities there (Watson 1995).

The final collaborative project, which also involved Troy Hall from Virginia Tech, 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, social 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 in other wilderness areas. 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 (Cole et al. 1997). Study findings were highly influential in the development of a new wilderness recreation management strategy for the Forest Service—one that embraced the oft-lauded approach of internal zoning (Oye 2001)—as well as in wilderness planning in the Pacific Northwest, at wildernesses such as Mt. Hood and Alpine Lakes.

Alan Watson also oversaw a varied program of extramural research. With Tim Love, he studied effects of a large fire in the Bob Marshall Wilderness on visitors’ choice of where to go (Love and Watson 1992). He worked with Bo Shelby and Troy Hall at Oregon State on methods for monitoring encounters (Watson et al. 1998a). He worked with Dale Blahna at Utah State University on llama users and sources of potential conflict (Watson et al. 1998b) and with Bill Hammitt and Scott Shafer from Clemson to explore influences on the quality of wilderness experiences and how to operationalize the privacy, primitiveness and unconfinement concepts in the Wilderness Act (Shafer and Hammitt 1995a,b). He worked with Mike Manfredo at Colorado State University on norm focus theory, with Tommy Swearingen to apply ethical and moral reasoning to explaining normative violations of low-impact...
behaviors, with Steve Hollenhorst at West Virginia University on measuring solitude achievement and
with Bob Muth at University of Massachusetts to develop a problem analysis of conflict between
recreation, subsistence and commercial users in Alaska wilderness.

David Cole’s personal research during this period was largely focused on trend studies and on
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 (Cole 1991). Campsites—once they have been repeatedly used—also tend to be
relatively stable over time (Cole et al. 1992). Campsite impact during the 1970s and 1980s often increased
greatly, but more from the proliferation of new campsites than the deterioration of existing ones (Cole
1993). 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, a Scottish ecologist who
had pioneered experimental studies of recreation impact in the 1960s. They developed a standardized
method for conducting trampling experiments that would facilitate the comparability of trampling
experiments, studies that were increasingly common around the world (Cole and Bayfield 1993). These
methods were applied to 18 vegetation types, in Washington, Montana, Colorado, New Hampshire and
North Carolina. Camping impacts were also explored experimentally by directing people to camp on
previously-unused sites in varied vegetation types (Cole 1995c). Results showed that vegetation types
growing in close proximity to each other can vary at least 30-fold in durability (Cole 1995a). The ability
to resist being damaged by trampling was often negatively correlated with the ability to recover from
damage (Cole 1995b), and it was possible to predict the resistance and resilience of vegetation by
examining plant morphological characteristics. These results added to knowledge about where managers
should locate facilities and what visitors should be told—in Leave-No-Trace messages—about more durable routes over which to travel and camp.

Interest in finding practical means of limiting impact by concentrating use led Cole—with the help of unit biologist Dave Spildie—to evaluate the effectiveness of such a management program in a subalpine lake basin in the Selway-Bitterroot Wilderness, in Idaho. Rangers attempted to concentrate use and impact by designating campsites, separating stock and hiking camps, providing highlines for horses and actively revegetating impacted areas. Although the time and resources devoted to this program were substantial, disturbed area in the basin was reduced by 37% in just five years, suggesting the potential of such a program to limit impact (Spildie et al. 2000).

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 (1994) developed a tool—the threats matrix—to clarify the breadth of threats to wilderness that were of concern and the variety of wilderness values at risk. He also worked to identify scientists who could contribute new types of expertise to wilderness management. He worked with Mitch McClaran on issues related to meadow management and packstock grazing (McClaran and Cole 1993). 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 (Knight and Gutzwiller 1995). He supported empirical work on the effects of human intrusion on birds (Gutzwiller et al. 1994).
The hiring of ecologist Peter Landres, in 1992, also reflected this interest in expanding the array of issues the unit could explore by expanding its skill set. Much of Landres’s 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 (Cole and Landres 1996) and a chapter on indirect threats of recreation to wildlife (Cole and Landres 1995). He funded extramural research by Dan Pletscher of the University of Montana on packstock impacts to birds and small mammals in the Bob Marshall Wilderness and by Chuck Hawkins of Utah State University on the effects of exotic fish introductions in the High Uintas Wilderness. He collaborated with Rick Schneider to work on developing a process for quantifying the effects of disturbance on landscape patterns in the Bob Marshall Wilderness and to compare historical patterns to current patterns. He began several studies in the Anaconda-Pintlar Wilderness to assess the ability of digital elevation models to predict vegetation type and landscape patterns and the potential of GIS technology to improve wilderness management (Landres et al. 2001). He focused particularly on monitoring (Landres 1995), working in the near-term with Wayne Minshall of Idaho State University on a manual for monitoring wilderness stream ecosystems (Davis et al. 2001) and ultimately on wilderness character monitoring (Landres 2006).

Peter Landres was hired in 1992 to expand the ecological capacity of the unit. Much of his work focused on wilderness monitoring.
From Wilderness Management Research Unit to Aldo Leopold Wilderness Research Institute

In April 1990, Jim Bradley, staffer for Congressman Bruce Vento told David Cole that Vento was going to introduce a Forest Service Wilderness Management Act, to address concerns about agencies not giving wilderness management the attention it deserved. He noted that the Act would call for creation of an interagency Aldo Leopold Wilderness Research Institute, to be located in or near Missoula, Montana. Indeed the bill was introduced in Congress in 1992, though it was not enacted. This led Forest Service Research to propose administratively creating such an institute. The primary individuals working to make the proposal a reality were Keith Evans, Assistant Director of the Intermountain Research Station and David Cole’s supervisor and Alan Ewert, head of recreation research for the Forest Service, in Washington DC. Both felt that this was an opportunity to gain additional funding and resources for wilderness research, particularly by making the institute interagency. The Institute, they decided, could be created by assimilating the Wilderness Management Research Unit, its personnel and resources, and then seeking to attract additional resources to expand the program from there. Questions were raised about whether the Institute should stay in Missoula, about whether it should be administratively housed in recreation research, given the desire to expand non-recreational research and whether it should remain within the Intermountain Research Station. Should it be housed in the Forest Service, if it is to be interagency? Some of these questions continue to haunt the Institute. Nevertheless, in 1993, the Institute was dedicated and 26 years after it was created, the Wilderness Management Research Unit ceased to exist.

The Aldo Leopold Wilderness Management Institute, created in 1993, was initially staffed by members of the Wilderness Management Research unit.
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 planning. 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.
Literature Cited


Cole, David N. 1987b. Effects of three seasons of experimental trampling on five montane forest communities and a grassland in western Montana, USA. Biological Conservation 40:219-244.


Lucas, Robert C. 1972. Forest Service wilderness research—the problem, research to date, and needed research. Unpublished paper on file at USDA For. Serv., Aldo Leopold Wilderness Research Institute, Missoula MT.


