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# PERSPECTIVES ON THE HISTORY OF WILDERNESS RESEARCH

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## ABSTRACT

*Wilderness management-oriented research was almost nonexistent before 1960. About then, recognition of the need for research knowledge to support management and protection of wilderness resulted in studies by Federal, private, and university scientists. Early research was exploratory, largely descriptive, and somewhat naive, but it was an exciting period. By the late 1960's research efforts matured and became more theoretical and interdisciplinary. The size of the wilderness research effort grew through about 1978 and has since declined. Early research stressed physical-biological studies of recreation impacts, but the emphasis quickly shifted to visitor studies. Carrying capacity was a major focus. The limits of acceptable change system was developed to deal with the carrying capacity issue. To maximize the contribution of a smaller research effort to protection of the large wilderness system, five recommendations are made.*

## INTRODUCTION

I have been deeply involved in wilderness research since the late 1950's, and I think that gives me the privilege of presenting a somewhat personal, impressionistic view of the history of wilderness research. I hope this will help us all see where we have come from and be of some value to us in dealing with future challenges.

I will cover three main topics: first, the chronology of wilderness management research, including general trends and research institutional developments; second, trends in the size of the research effort; third, major research themes or topics studied so far. In other words, we will cover the "when," the "how much," and the "what." It is not my intention to present a thorough literature review, to discuss specific results of research, or to list all the persons who have contributed. The nine state-of-the-art review papers at this conference do that much better and in detail. This paper may help set the stage for those reviews, which describe what we have learned and what important questions need answers. I will also briefly review the application of research to wilderness management.

Wilderness research is of two different types—"in wilderness" and "about wilderness." The first, "in wilderness" research, uses wilderness as a setting or laboratory for a variety of research, most of it in the biological and earth sciences. It is not directly focused on wilderness management issues. Most of it can be described as relatively basic research, and can be traced back at least as far as Lewis and Clark and Audubon. John Muir did some of this type of research on glaciation in the Sierra Nevada range. Preserving opportuni-

ties for this type of research is one of the important values of wilderness and one of the explicit purposes listed in the Wilderness Act (Public Law 88-5771).

The second type of research, "about wilderness," is focused on wilderness management issues, and is relatively applied. It seeks to provide managers with improved knowledge for making effective decisions to protect and preserve the wilderness character of areas in the National Wilderness Preservation System, as they are required to do by the Wilderness Act. Such research also seems related to one purpose of wilderness areas listed in the Act, "the gathering and dissemination of information regarding their use and enjoyment as wilderness." This research deals with topics such as wilderness fire management, control of visitor impacts, wilderness recreation experiences, and visitor management.

This paper will concentrate on the management-oriented, "about wilderness," research. There are borderline cases. The distinction between the two types of research is not always clear, and more of the "in wilderness" research could contribute to management if researchers would highlight management implications of their studies when appropriate. I will aim to err on the inclusive side. Some research conducted outside wilderness, and some done outside the United States, is relevant to management of wilderness and examples will be discussed without pretending to be exhaustive. "Wilderness" will be used in a rather broad, generic sense, not limited strictly to American wilderness classified under the Wilderness Act, although that is the primary focus.

## PRE-WILDERNESS ACT BEGINNINGS

Formal wilderness designations did not exist before 1924 when the Gila Wilderness was established by the Forest Service. There have been national parks since 1872 when Yellowstone was designated, but without any specific wilderness direction (Nash 1978). Wilderness preservation in a national park was first mentioned in the act establishing Everglades National Park in 1934. There seems to have been no research and almost no recognition of the need for research to support wilderness management at first. In fact, except for developing and maintaining trail systems, usually more for administration and fire protection than visitor use, there was little management of wilderness.

Bob Marshall, the prime mover behind development of the National Forest wilderness program in the 1930's, was one of the first to recognize that establishing wilderness was not the only issue: management also was necessary. He commented on overused campsites and the need for visitor education in what we would now call minimum impact camping in 1933 (Nash 1978). In 1937,

Marshall requested a University of California professor (who was also president of the Sierra Club) to form a committee of scientists to advise the Forest Service on wilderness management, which might have served a purpose similar to research. Another of the early recognitions of issues needing study was by Lowell Sumner of the National Park Service who expressed concern about the impacts of recreational use in 1936 and raised the question of recreational carrying capacity in 1942 (Nash 1978).

There were only a few scattered wilderness research studies before 1960. George Wright and his colleagues in the National Park Service began wildlife research in the late 1920's, and a fauna series was published. Wright and others (1933) dealt with general wildlife relationships in national parks. Others covered individual or related species, for example, Adolph Murie's "The Wolves of Mount McKinley" (1944). Outside wilderness, but of some relevance, was research on the effects of visitor trampling on vegetation. Probably the first was work by H. L. Meinicke in the redwoods in 1928. In the 1930's, trampling studies were conducted in Great Britain by Bates (1935), among others. A 1954 Ph.D. dissertation by James Gilligan analyzed the evolution of Forest Service wilderness policy in detail, and may even have contributed to introduction of the first wilderness bill in 1956.

In the late 1950's, interest in outdoor recreation, and recreation research in general, grew rapidly. Recreation use was growing fast, even explosively in the view of many. Developed recreation facilities, many of which had been built in the 1930's by the Civilian Conservation Corps, were aging and deteriorating. Because of these conditions, the National Park Service launched "Mission 66" in 1956, a 10-year capital investment program to renovate, replace, and expand buildings, campgrounds, and other facilities. The Forest Service followed suit with the similar "Operation Outdoors" the next year.

Both of these major recreation investment programs were launched with no recreation research knowledge base at all. Resource inventories and visitor desires both were handled on a best-guess basis. Perhaps because some policymakers were uneasy about the knowledge gap, the Forest Service commissioned Samuel Dana, Dean Emeritus of the University of Michigan School of Natural Resources, to prepare a problem analysis for research in forest recreation (Dana 1957). This was the result of a recommendation by a U.S. Department of Agriculture Forest Research Advisory Committee, on which Dana also served, that research on forest recreation be stressed. Dana was not a recreation research specialist; nobody was then. However, he wrote a perceptive report. Some of his terminology differs from current jargon, but his analysis is not badly dated even now.

About the same time, Marion Clawson of Resources for the Future, one of the pioneers of recreation research, published "Statistics on Outdoor Recreation" (Clawson 1958). This publication brought together scattered data, primarily on recreational use, for State and Federal lands for the first time. Increasing use was documented, and this captured the interest of a number of people. Clawson also published his influential travel-

cost method for measuring recreation demand and value (1959). This and a number of popular articles by such a respected scientist helped build support for research on outdoor recreation.

Also in the 1950's, the very first studies of wilderness visitors and their motives and opinions were done in Minnesota's Boundary Waters Canoe Area by University of Minnesota sociologists (Stone and Taves 1956).

The Sierra Club's Sixth Biennial Wilderness Conference in 1959 addressed "The Meaning of Wilderness to Science" (Brower 1960). As the title suggests, many of the papers dealt with the value of wilderness as a research laboratory, a point made by Aldo Leopold in 1941, but there was recognition in several papers of the need for ecological research to help deal with growing problems of recreational use pressures. Research on visitors was mentioned only briefly in the conferees' discussion relating to one paper.

In 1958, the Outdoor Recreation Resources Review Commission (ORRRC) was established by Congress. This was a major program and reflected the growing public interest in outdoor recreation and the need for an information base for informed decisions. The commission's main summary report in 1962 was accompanied by 27 special study volumes-about 1 foot on the bookshelf. The stimulating effect on interest in outdoor recreation and research produced by this mass of data and analysis at the time is hard to imagine now. There was so little previous scientific literature that these 27 volumes increased available information at least severalfold.

ORRRC Report No. 3 (ORRRC 1962) focused on wilderness. It was prepared by the University of California Berkeley Wildland Research Center, directed by James Gilligan, author of the wilderness policy dissertation discussed before. One of the longer reports, it included historical and policy analysis and data from visitor surveys in three wilderness-type areas. Again, it loomed large in the near vacuum that existed at that time.

## **THE ACT AND NEW RESEARCH PROGRAMS**

Various wilderness bills, 65 in all, were debated in Congress from 1956 to 1964, when the Wilderness Act finally passed. ORRRC Report No. 3, the wilderness volume, recommended passage of a wilderness act. I do not know if that recommendation is related to the odd fact that the wilderness volume alone among the 27 special study reports had to be printed with contributed private funds.

The Wilderness Act does not refer to research explicitly, although the reference previously cited to "gathering and dissemination of information regarding their use and enjoyment as wilderness" can be read as implying research. On the other hand, it probably could be read as implying preparation of brochures on how to visit a wilderness. I have not found anything that clarifies the intent of Congress. Scientific, educational, and historical use are among the authorized uses of wilderness. The first two, at least, are consistent with research. (The meaning of "historical use" is unclear to

me, but it could include historical research, as well as viewing historic sites.) I could not find anything in the legislative history that refers to research to support management, although there is testimony about the value of wilderness as a research laboratory—the type of research I have dubbed “in wilderness.” Clearly, however, if managers are to meet the challenge of the Wilderness Act to administer wilderness for “use and enjoyment of the American people,” to “leave them unimpaired for future use and enjoyment as wilderness,” “provide for the protection of these areas,” and “the preservation of their wilderness character” some support from research appears to be implied.

In 1959-60, while the Wilderness Act was about half-way through its debate, the Forest Service began its recreation research program (Camp 1984). This was the first tangible recognition of the need for a continuing research program oriented to recreation management issues.

None of the research units at different locations in eight forest experiment stations had wilderness management specifically as a mission at this time, although this was a major part of the early research program at the Pacific Northwest Forest and Range Experiment Station in Portland, OR, where the first research unit was entitled “Wilderness Dynamics.” The first wilderness use measurement research (Wenger 1964), and some visitor survey research. (Burch and Wenger 1967) were done by this unit. Several other units did some research on wilderness problems in the early years: the North Central Forest Experiment Station (then called Lake States) began with research on use/user characteristics as related to carrying capacity in the Boundary Waters Canoe Area (Lucas 1964), and followed up with fire history (Heinselman 1973) and ecosystem classification studies (Ohmann 1971). The carrying capacity concept presented by Alan Wagar (1964) of the Intermountain Forest and Range Experiment Station was not limited to wilderness but was particularly applicable there. The Northeastern Station began studies of vegetation impacts from heavy use (Ketchledge and Leonard 1970) and visitor attitudes about heavy use in backcountry (Echelberger and others 1974). Thus, wilderness research by the Forest Service began before passage of the Wilderness Act.

The Forest Service also began outdoor recreation cooperative units at five universities in the early 1960's (Camp 1984). These usually consisted of one Forest Service scientist placed in a natural resource or forestry school to stimulate interest (especially by faculty and graduate students), to provide professional leadership in outdoor recreation, and to help train future outdoor recreation managers. The units were modeled somewhat after the Fish and Wildlife Service's cooperative research units. Financial support for university research projects was channeled through these recreation co-op units, some of it wilderness related. Most of the Forest Service scientists did some teaching and student advising. The intent was to fill a near vacuum of recreation expertise in natural resource faculties and to accelerate development of such skills. The Forest Service also foresaw a need for a large number of employees with professional

training in outdoor recreation that they felt would not be met without a special program.

At this time, the National Park Service research program was primarily conducted by scientists assigned to individual parks. Most of it seems to have been quite applied, serving largely as staff work for the park line officers. Unfortunately, much was unpublished, and other scientists were seldom able to build on the work. A large part was wildlife research for management decisions and information for interpretation. Some was natural history, geological, historical, or prehistorical research.

This period of the early 1960's was a time of excitement associated with new beginnings, idealism, and a certain amount of naivete. Outdoor recreation grew in recognition as an important program, although there was still some insecurity about the respectability of studying a noncommodity output that was not generally viewed as a necessity of life. Researchers had high hopes of providing solid answers to basic, usually rather simple questions, such as “what do people want?“, “how much use is too much?“, and so on. It really was great fun!

Many disciplines were involved: social sciences, biological sciences, and forestry, which was primarily biological in orientation within a professional management program. There was a considerable amount of trial and error, not a great deal of coordination, and some scattering of efforts that was probably inevitable in the newness of the effort, and perhaps necessary to start the development of concepts and structure for research. At this early stage, there were no journals focused on outdoor recreation research. This contributed to the limited coordination and scattering of efforts, especially with so many disciplines involved.

By the late 1960's or early 1970's, the early research efforts evolved and matured into what seems to me to have been a stronger, more coordinated and coherent program. The simplicity and naivete were replaced with more recognition of the complexity of the issues and the elusiveness of simple, easy answers, magic numbers, and the like. Recreation managers were also becoming more professional and knowledgeable. This resulted in more productive interaction between managers and researchers.

The National Park Service began to play a more prominent role in wilderness research in this period. The first permanent, full-time research sociologist, Neil Cheek, joined the Park Service in 1968. In 1970 the first of the cooperative park studies units (CPSU) was established at the University of Washington (Agee and others 1982-1983), led by Don Field. The number of these research units has grown to 35, and about 15 have a resident Park Service scientist. These are located in all parts of the country, but are most common in the West.

The CPSU's have similarities to the Forest Service cooperative units beyond the name, but major differences as well. The Forest Service units were meant to serve the temporary needs of the universities, and when those needs were met by the late 1960's, as the universities developed their own expertise, the units were phased out. In contrast, the Park Service CPSU's primary function is to meet the research needs of the national parks

(Agee and others 1982-1983). Teaching and extension are also outputs from the CPSU's, but research to meet the needs of individual national parks and general problems of groups of parks is uppermost. Research is done not only by National Park Service scientists but also cooperatively by university scientists with appropriate skills and interests. Some has involved cooperation with Forest Service researchers, and this has led to research on regional recreation systems, cutting across agency boundaries, in Alaska, for example (Clark and others 1982). Some of this research relates directly to wilderness; for example, a series of visitor studies in Alaska (Womble and others 1978). Systems for handling backcountry permit data were also developed (Field and others 1977).

In 1967 the first and only research unit with wilderness management as its sole mission was established by the Forest Service in Missoula, MT, as part of the research program of the Intermountain Forest and Range Experiment Station. It was staffed by George Stankey and I, and later, for a time, by Randy Washburne, David Cole, and Margaret Petersen. The major focus has been visitor management research, including descriptive surveys, social carrying capacity studies, use measurement methods, redistribution of use through information, use and encounter simulation models, and management systems, such as the Recreation Opportunity Spectrum and Limits of Acceptable Change. Ecological impact research was begun in 1978 when David Cole joined the unit on a temporary appointment and has continued through cooperative research after his appointment ended. This research program is reviewed in Lucas and others (1985).

There was also some wilderness research by other Forest Service recreation research units, as part of their research program missions, although none was directly focused on wilderness. At the Rocky Mountain Station, Bev Driver's work on experience preferences or motivations, *some* of it in cooperation with Perry Brown and others at Colorado State University, was applied to wilderness visitors in Colorado and Wyoming (Brown and Haas 1980), and to an integrated management planning pilot project for the Maroon Bells-Snowmass Wilderness in Colorado. At the Northeastern Forest Experiment Station, Ray Leonard studied recreational impacts on soils (Leonard and Plumley 1979a) and capacity concepts (Leonard 1976), and Skip Echelberger and George Moeller did wilderness visitor surveys (Echelberger and Moeller 1977). At the North Central Station, Dave Lime and cooperator George Peterson did further research in the Boundary Waters Canoe Area on use patterns (Lime 1972), visitor expectations and preferences (Peterson 1974), use estimation (Lime and Lorence 1974), and simulation models. Dorothy Anderson studied displacement-succession (Anderson 1980). George James at the Southeastern Station included wilderness in a continuing program of recreational use measurement research (James 1971). At the Pacific Northwest Station, John Hendee and Roger Clark did wilderness-related research, including a study of visitor characteristics and attitudes in three Washington and Oregon wildernesses (Hendee and others 1968), littering behavior in wilder-

ness (Muth and Clark 1978), and surveys of southeast Alaskan recreationists (Clark and others 1982).

The Park Service wilderness-related research concentrated on natural sciences-botany, zoology, ecology-while Forest Service research focused on recreation use (Butler and Roberts, this proceedings).

Resources for the Future continued to be active in recreation and wilderness research, particularly opportunity costs of development of natural areas (Krutilla and Cicchetti 1972) and wilderness use simulation (Shechter and Lucas 1978).

Conservation organizations also contributed to early research. The Appalachian Mountain Club established a research department and began study of social and ecological problems (for example, Taylor and Mackoy 1980). The Sierra Club sponsored a group of studies on recreation impacts in the Sierra Nevadas in the early 1970's (Stanley and others 1979).

Strong university research involvement developed at a number of places. At risk of offending someone by omission, wilderness-related research comes to mind at such universities as Colorado State, Washington, Michigan, Virginia Polytechnic, Utah State, Minnesota, Vermont, Oregon State, Texas A&M, Idaho, Montana, and Montana State. Most of this research activity centered around forestry and natural resource schools, but it also involved park and recreation departments, and geography, psychology, sociology, economics, botany, and zoology. A wide variety of topics related to wilderness have been studied. Publications have appeared in many different journals and other outlets, but it is my impression that social science or visitor studies have predominated strongly, with fire and visitor impacts well behind.

The first recreation research journals appeared. None focused on wilderness, but they included wilderness research. First was the *Journal of Leisure Research* in 1969, then *Leisure Sciences* in 1977. Several new journals with a biological, environmental, conservation emphasis also appeared in this period, although none of them provided as much of a forum for wilderness-related research as the two essentially social science journals. In 1981, *Pacific Park Science*, published by the National Park Service, went national and became *Park Science*. At present, its focus is on national park management and most contributors are National Park Service employees. This leaves a gap: there is no journal aimed at wilderness managers. The *Journal of Forestry*, particularly, and the *Journal of Soil and Water Conservation* have been the primary outlets for articles written for wilderness managers.

## SIZE OF RESEARCH EFFORT

The wilderness-related research effort began from scratch about 1960. I will use Forest Service recreation research as a handy example because it was the first separate, discrete program; it has a readily identifiable budget; and has involved a substantial amount of research on wilderness topics over the years. Growth from 1960 through the middle 1970's was rapid and fairly steady, increasing about ninefold in budgets (fig. 1) and with a smaller but substantial growth in staff. Then,

in 1978, the recreation research program doubled, and urban forestry research was initiated and added to the recreation research program. The budget peaked in 1979 at about 83.3 million. After this one brief, euphoric burst of growth, it has been all downhill, although irregularly, declining about 40 percent from 1979 to 1985. Staffs have declined only slightly, and, as a result, operating budgets for field research and cooperative studies with university scientists have plummeted.

The Forest Service wilderness management research unit began in 1967 in Missoula, MT. The changes in its size have followed a path similar to that for recreation research in general—fairly steady growth through 1977, then nearly a doubling in 1978 to a high of \$310,000, followed by a decline of about 45 percent (fig. 1). Staff grew from two to five and now is back down to two. All budget figures are in nominal dollars. Adjustments for inflation diminish earlier growth and accentuate later declines. Using constant 1982 dollars (GNP price deflator), the budget grew 61 percent from 1968 to 1977, grew 64 percent from 1977 to 1978, and declined 57 percent from 1978 to 1985.

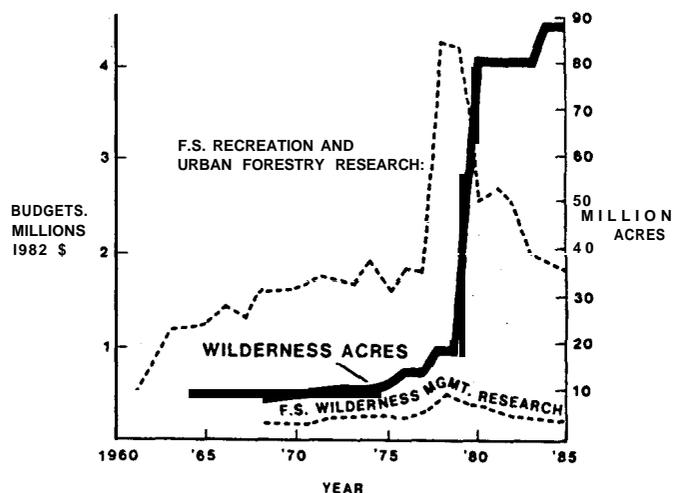


Figure 1.—Trends in size of the National Wilderness Preservation System and budgets for related Forest Service research.

The National Park Service research program in the parks and at the cooperative park studies units grew in the 1970's and has been relatively stable since then. The Cooperative Park Studies Units contract for over \$1 million of research per year, on the average (Agee and others 1982-1983).

Research budgets for the national parks apparently have fared better in recent years than those in the Forest Service. One might speculate that this reflects the close link to park management needs contrasted to the more independent role played by Forest Service research.

University wilderness research is too widespread and diverse to be tallied and quantified. However, it probably followed somewhat the same pattern of growth until the late 1970's and decline since then, less extremely than Forest Service wilderness research. Numbers of professors involved in wilderness research, amount of

faculty time, and numbers of graduate students also first grew, then leveled off, and declined. Contract and grant sources and funds for cooperative research that support much of the university wilderness research all grew and now have been declining for 5 years or more.

It seems only reasonable to presume that the production of new knowledge, solution of important problems, and technology transfer from researchers to managers reflect in general the resources devoted to wilderness-related research, and therefore these also rose and then declined.

In sharp contrast to the recent decline in wilderness research, the size of the wilderness system has grown greatly, from 9 million acres in 1964 when the Wilderness Act passed, to over 88 million acres early in 1985 (fig. 1). Assuming total expenditures by all agencies and universities for wilderness-related research are five times the budget of the Forest Service wilderness management research unit, about \$0.09 (1982 dollars) was spent per acre of wilderness in the late 1960's. In 1985, about \$0.01 per acre of wilderness is being invested in research for wilderness management and protection. By my estimate, commercial timberland research amounts to \$0.50 or more per acre. I do not believe the relative values at stake, the difficulties of management, or the adequacy of existing knowledge for timberland management compared to wilderness protection justify this wide disparity. Managing wilderness to do an acceptable job of protecting it and producing benefits for society will require a larger research effort.

## MAJOR RESEARCH THEMES

I will divide the discussion of research themes into two periods, the early period from about 1960 through the early 1970's, and the late period from the early 1970's to 1985. (Because the lag between research and publication varies widely, some of the studies I call "early" have publication dates past the early 1970's.)

### The Early Period

In general, the earliest outdoor recreation research was exploratory. There was considerable uncertainty about what the problems really were and what research approaches were appropriate. Concepts and theories were absent from most of the studies, implicit in some, and explicit and formal in only a few.

As was appropriate at this early stage, much of the research was largely descriptive, providing reliable information about wilderness recreation characteristics, patterns, and effects. However, it is unfair to describe most of this research as "mere description" or "purely descriptive." From the first, many of the studies went beyond description to analyze relationships and offer explanations. Basic descriptions also were an essential foundation, I think, to the more specialized, sophisticated research that followed.

**Physical and Biological Research.** -Biophysical research on ecological processes and visitor impacts began early, and was stressed more than visitor research initially. Most of the first impact research was conducted at developed recreation sites, mainly camp

grounds and picnic areas, rather than wilderness (for example, LaPage 1962). This served to develop techniques and concepts that were applied later to wilderness settings.

Soon research in backcountry dispersed recreation settings, including wilderness, began to address wilderness management topics more directly. Much of it dealt with impacts, mainly to vegetation, and with the role of natural fire in wilderness ecosystems.

Early impact research made limited use of range management science for principles and approaches to studying vegetative disturbance. There was a little research on the effects of grazing by recreational stock (Sharsmith 1959), but campsite conditions were the main focus of impact research, with trail conditions receiving somewhat less attention. Most studies were mainly attempts to document impacts in a systematic, accurate way (see the annotations of studies in Cole and Schreiner 1981). A few attempted to relate impacts to site conditions such as forest versus meadow and degree of closure of forest canopy (Schreiner and Moorhead 1976), and even fewer dealt with amount of use (Fassell and Duncan 1965). Most of the campsite studies were based on measurement of conditions on already existing sites. One exception was a study of newly created campsites in the Boundary Waters Canoe Area (Merriam and Smith 1974). Vegetation impacts were the main concern, with lesser attention to soil compaction. There were also several studies that applied experimental trampling to vegetation (Bell and Bliss 1973). Research on trail erosion almost always dealt with conditions on existing trails. One of the earliest trail erosion studies was conducted in the Adirondack Mountains of New York by Ketchledge and Leonard (1970). A review of research on the ecological effects of outdoor recreation by Speight (1973) summarizes much of the early period impact research. Almost 200 publications were reviewed from Britain, western Europe, and North America.

Many ecological and impact topics received very little attention in the early period. Impacts of recreational use on water quality were only rarely studied (Barton 1969). Recreational impacts on wildlife, other than the direct effects of hunting and fishing, were almost unstudied. There was a large amount of general wildlife research, some of it conducted in wilderness. This research dealt with issues such as home ranges, movement, feeding behavior, reproduction rates, and so on, much of which is relevant to perpetuation of natural populations. This research contributes at least generally to wilderness management decisions. Examples include research on moosewolf relationships on Isle Royale (Mech 1966); mountain lions in the Idaho Primitive Area (Homocker 1969); and grizzly bears in Yellowstone National Park (Craighead and others 1974). Studies of recovery of vegetation from the effects of recreational use were largely missing during this early stage, as was research on air quality.

Some research on plant succession was done in the early period. Very early research examined succession in mountain meadows in California (Sharsmith 1959). Most of this early research focused on plant succession in relation to natural fire. Fire history studies were fairly

common near the end of the early period, including Sequoia-Kings Canyon National Park in California (Kilgore 1973); the Selway-Bitterroot Wilderness in Idaho (Habeck 1972); Glacier National Park, MT (Habeck 1968); Yellowstone National Park, WY (Houston 1973); Everglades National Park, FL (Robertson 1962); and the Boundary Waters Canoe Area, MN (Heinselman 1973). Research on fire's natural role resulted in the rapid evolution of agency policy toward restoration of natural fire in wilderness. To date, this probably is the most conspicuous example of the application of research results to wilderness management.

Physical-biological research on wilderness impacts and ecological processes in the early period was concentrated in the mountain landscapes of the West, including western Canada, and in northern Minnesota. There were a few studies in New England, most by Ray Leonard, and, later, in the Southeast. (Other research was conducted overseas, in Great Britain, western Europe, and Japan.) There was almost no research in deserts, grasslands, or river corridors at this time.

Almost all studies were one-time descriptions; longer term trend studies were very scarce.

**Social Research.** -Social research on visitor use patterns, attitudes, activities, and demographic characteristics began in the early period, with attitudes receiving particular emphasis. Visitor surveys were fairly common, although the scientists carrying them out had to contend with difficult sampling and data collection problems (Lucas and Oltman 1971): users were widely dispersed, relatively few, and highly variable in number, all resulting in high sampling costs, small samples, and large variances. For example, the wilderness report by ORRRC (1962) described their attempts to survey visitors to seven wildernesses, but they obtained samples large enough to analyze in only three areas. The potential for interference with visitors' wilderness experiences also limited some approaches to collecting information.

Most of the wilderness visitor surveys were more than purely descriptive "census reports." Data were analyzed in terms of types of use and characteristics of visitors, as well as attitudes, such as Hendee's "wilderness purism" scale (Hendee and others 1968). The surveys helped clarify the nature of wilderness recreation, and indicated the limited truth of a number of common misconceptions about wilderness use and users (Stankey 1971).

Early visitor surveys provided a general picture of wilderness visitors (Lucas 1964; Hendee and others 1968; Murray 1974). Visitor characteristics tended to be similar in many wildernesses, but activities and behavior were more variable and site specific. The most distinguishing characteristic of wilderness visitors in every study was high education levels.

Use measurement methods received considerable research emphasis during this early time. Much of this research was done by Jim James from the Forest Service Southeastern Forest Experiment Station (James 1971). Reasonably accurate, cost-effective, practical techniques for measuring wilderness recreational use were needed to provide data that are basic both to skilled professional management and to many types of research. Most of the research dealt with systems for calculating

use estimates based on trail register data or various types of traffic counters. Computerized systems for summarizing wilderness permit information were developed (Elsner 1972; Frayer and Butts 1974; Field and others 1977).

The wilderness use measurement research was a part of a more general effort to develop recreation use measurement systems, including systems for developed sites of various kinds. Usable methods were developed for campgrounds in particular, and incorporated into widely used handbooks. This did not happen for wilderness use estimation, which was more difficult and expensive, for much the same reasons mentioned in connection with visitor surveys. The problem was potentially solvable to a greater degree than many other wilderness research topics, but it did not receive enough effort long enough to finish the job and produce completed technology for transfer to managers. James retired and research to develop an integrated wilderness use measurement program was dropped shortly after.

Carrying capacity was one of the major themes of research in the early period. Research focused on concepts or approaches to carrying capacity (Wagar 1964; Lime and Stankey 1971; Frissell and Stankey 1972). Very early physical-biological capacity was emphasized, but social carrying capacity quickly replaced it as the main thrust of research, with stress on investigations of the solitude dimension of wilderness experiences and visitor standards for solitude (Lucas 1964; Stankey 1973). The important role of the human dimensions of wilderness management is another research output adopted by managers, gradually but widely. This concept is so generally accepted now that its origin in research is no longer recognized.

The social carrying capacity studies laid down many principles that later research confirmed. Results indicated that satisfactions depend on more than use level, particularly on type, frequency, and location of encounters. It was recognized early that capacity had to be related to management objectives.

There was some early emphasis on economic research; most focused on outdoor recreation in general, but some related to wilderness. Much of this early economic research is discussed in Clawson and Knetsch (1966). Part was concerned with general economic values. Another part dealt with demand, travel cost models to estimate demand for and value of individual areas, gravity models, and intervening opportunity analyses to attempt to explain and predict use of specific areas, and economic impacts on local regions.

There were other topics addressed by a study or two: for example, Nash's classic work on the intellectual history of wilderness, first in *Forest History* (1963), then in a major book (1982—with the first edition published in 1967), or Hughes' (1965) study of wilderness land allocation.

Early social research, like physical-biological research, also was concentrated in the West and the Boundary Waters Canoe Area-Quetico Park region. There was a little in New England and eastern Canada. There was considerable social recreation research in Canada, some of it wilderness related; for example, see the wilderness bibliography by Herrick (1974).

Little or no early research was conducted on wilderness visitor education/information programs (although there was a little in nonwilderness situations). No general population studies were related to wilderness: all the studies were based on samples of current on-site visitors. There were no trend studies; all of the visitor research was based on one-time surveys.

## The Late Period

After the early 1970's, wilderness studies became more narrowly focused and more scientifically rigorous. There was more conscious effort to develop theories, concepts, and models. Samples were better designed and multivariate statistics were used more in analysis.

As many different disciplines were involved as before, but there was at least a little more communication and collaboration and less "go it alone" research. Communication was enhanced by the new journals (*Journal of Leisure Research, Leisure Sciences, Environment and Behavior, Environmental Conservation, Journal of Environmental Education, Park Science*, and so on), and more review bibliographies. Conferences and symposia focused on wilderness also furthered collaboration. Conferences included wilderness management meetings in Seattle in 1973 and at the University of Idaho in 1983, a wildlands recreation impact conference in Seattle in 1978, conferences on wilderness in the East held in Knoxville in 1980 and Nacodoches, TX, in 1985, a wilderness fire symposium in Missoula in 1983, and World Wilderness Congresses in 1977, 1980, and 1984 in South Africa, Australia, and Scotland. Other conferences were not focused just on wilderness but included many wilderness concerns; for example, the wildland recreation conference in Banff National Park (Canada) in 1978, river recreation conferences in Minneapolis in 1977 and Baton Rouge in 1984, the trends symposia in Durham, NH, in 1980 and Myrtle Beach, SC, in 1985, and conferences on scientific research in the national parks held in New Orleans in 1976 and San Francisco in 1979.

Biophysical research on impacts and ecological processes continued, but the balance between visitor studies and biophysical research shifted in the early period toward visitor studies. The view that visitor research should receive higher priority was widely adopted. Reasons included the belief that less was known about visitors in comparison to biophysical processes, change affecting visitors was more rapid, potential consequences were more serious, and that wilderness management is largely people management. All these were probably true at the time, but the pendulum, in my view (and I am a social scientist), swung too far away from research on interactions between visitors and soils, vegetation, water, and wildlife, particularly, and has stayed away too long. Except for natural fire research, there were too few biophysical scientists and too little wilderness-related research in most of this period to achieve a "critical mass." Unlike social researchers, there were few biophysical scientists deeply involved in wilderness research and few careers devoted to it.

**Physical and Biological Research.** Campsite impacts received major emphasis in biophysical research

in this period, as they did earlier. Research revealed the complexity of the impact process and its management. The relatively minor role of total amount of use in determining impacts became clearer (Marion and Merriam 1985; Cole 1982). Campsite condition rating systems were developed. One by Frissell (1978) was widely used, as was the monitoring approach developed by Cole (1983a). Sometimes the two systems were combined, and occasionally integrated into the Code-a-site campsite inventory data management system (Hendee and others 1976).

There was considerable research on trail conditions. It became clear that heavy use was not the main cause of trail deterioration. Location, design, maintenance, and type of use were more important (Helgath 1975, for example). Monitoring techniques for trails were developed (Leonard and Whitney 1977; Cole 1983b). Application of research to trail management has lagged, in large part due to the decline in major trail work as wilderness management budgets have dropped.

Other research dealt with vegetation recovery and rehabilitation of campsites particularly, and trails to a lesser extent. An annotated bibliography by Cole and Schreiner (1981) indicates the scope of this research.

Impacts of recreational use on wildlife, primarily disturbance and indirect effects on habitat rather than hunting or fishing, received some attention in the later period, as documented in an annotated bibliography by Ream (1980), but knowledge gaps for this topic remain severe. There also was a continuation of *more* general, basic wildlife studies, usually of individual species (such as eagles, grizzly bears, wolves), much of it by National Park Service scientists and cooperators.

Some water quality research was conducted in this period, as is apparent from the studies reviewed by Christensen and others (1979). There also were several studies of human sanitation under wilderness conditions (Leonard and Plumley 1979b; Temple and others 1980, 1982).

Only very recently has there been any research on air quality as it affects wilderness; for example, research on the effect of air pollution on vegetation and water chemistry in progress in the Wind River Range, WY, and current studies of visibility changes as they affect visitors in Grand Canyon and Mesa Verde National Parks. A workshop addressed changes in air quality affecting the Flat Tops Wilderness in Colorado (Fox and others 1982) and Malm (1983) described the basic processes affecting visibility in relation to national parks. Rowe and Chestnut (1983) edited a series of papers on air quality in national parks and wilderness.

Fire research was emphasized in the later period, with accumulating knowledge on fuels, fire behavior, fire histories, and growing managerial experience in applying policies that helped permit fire more nearly to play its, natural role in many wildernesses. Knowledge about wilderness fire was summarized in a major conference in Missoula in 1983, documenting major advances. Both the Forest Service and Park Service, as well as university scientists, were active in research on fire in this period.

There was still not much research on basic ecological processes (see the paper by Franklin in these proceedings). The overall knowledge base from impact research and more basic ecological research was still fairly weak and did not provide an adequate foundation for many recommended minimum impact visitor use practices suggested by managers and sometimes incorporated in regulations.

**Social Research-** Social research shifted its focus more than biophysical research in the later period and also increased more. Visitor surveys became less common than earlier, and research related to development of use measurement methods diminished, with the problem still not quite solved. Objectives for measuring back-country use and the advantages and disadvantages of the available technology were summarized by Leonard and others (1980). Social carrying capacity research grew, and intensive questioning of earlier formulations occurred (Graefe and others 1984). Earlier research had shown strong negative evaluations of increasing contact with other parties (Stankey 1973), but some later research showed little or no association of contacts and satisfaction, especially on rivers. A synthesis is emerging, drawing on ideas present, at least implicitly, in the earlier research (Stankey and McCool 1984). This approach takes into account individual variation in visitor motives, recognizes that seeking solitude is one of a number of motives, and views satisfaction as a complex concept, difficult to measure, and influenced positively and negatively by many factors in addition to number of encounters.

The issue behind all research activity concerned with carrying capacity was the question originally phrased as "How much use is too much?" Much carrying capacity research aspired to determine a maximum amount of use, without much success. Application lagged. But the basic question has gradually, over more than 10 years, been redefined and a solution proposed. The redefined question is "What sort of conditions resulting from use are acceptable?" It includes a concern for both biophysical and social conditions—in other words, for both visitor impacts and experiences. The related question of how to manage for capacity also shifted from a narrow focus on limiting or redistributing use to a broader array of management actions affecting visitor behavior as well as numbers and distributions.

The proposed solution is management within limits of acceptable change, or the LAC approach (Stankey and others 1985). With the clear vision of hindsight, LAC now seems so obvious to me, so practical and feasible, that it is hard to comprehend why it took so long for us to grasp it, especially since the basic ideas had been in the literature since the early 1970's (Frissell and Stankey 1972) and even before. Of course, many developments look simple in retrospect, and turning the basic idea into a coherent, sequential management system founded on research knowledge was a complex challenge. The LAC approach integrates social and ecological concerns, which has not been common. LAC may provide a vehicle for further collaboration and integration of social and biological research. Current applications of LAC (Stankey and others 1984) may indicate unforeseen prob-

lems and the need for further development, but this system seems to have the potential to become another major example of successful technology transfer.

Related to the concern for managing for carrying capacity, several simulation models of wilderness recreational use were developed in this period. One model relates number of groups entering at various access points to resulting use in travel zones. The numbers of campsites in each zone were compared to simulated use to establish entry point quotas that would not result in use exceeding campsite capacity (Peterson and others 1977). This model was developed for the Boundary Waters Canoe Area Wilderness and applied there. Another model simulates use levels and various types of encounters among visitors for specific locations (Shechter and Lucas 1978). It was applied by managers in California to develop use limits with minimal restriction of use and in Colorado to develop encounter standards and to select sites for use monitoring, and in teaching wilderness management (Manning and Potter 1984).

Benefits and values were studied more in this period, particularly in social-psychological terms. Attitude scales were constructed to measure a wide variety of motives or preferred outcomes, and were applied to many participants in a diverse range of activities in varied settings, including wilderness (for example, Brown and Haas 1980). General study of attitudes about wildlife and wildlife values also had some relevance to wilderness (Kellert 1976).

Economic analysis of values continued. Some of it focused specifically on wilderness (Walsh 1982, for example), some of it dealt with recreation and wildland values in general (Peterson and Randall 1984, for example). Opportunity costs of allocating forest land to wilderness were studied in southwestern Montana, where they were low, and western Oregon, where they were high (Campbell and Countryman 1981).

Some research explored means of changing problem behaviors, particularly littering, by using incentives or appeals, and part of this research has been applied to wilderness visitors (Muth and Clark 1978). Some related research tested the effect of various types of information on wilderness visitors' choices of when and where to visit (Lime and Lucas 1977; Lucas 1981; Krumpke and Brown 1982) and where to camp (Roggenbuck and Berrier 1982; Echelberger and others 1983). Information campaigns designed to cause wilderness visitors to adopt other minimum impact practices have scarcely been studied, however, despite the large amount of effort managers are putting into minimum impact education.

Trends have received little research attention (Lucas 1985 reviews the few trend studies done, and the National Park Service CPSU scientists are repeating some of the Alaska visitor surveys). Projections have been studied even less (Jungst and Countryman 1982).

## RESEARCH APPLICATIONS

Wilderness managers have benefited substantially from a productive relationship with research. Some contributions are distinct and readily identified, others are

more general concepts that have been widely adopted and whose roots in research are no longer obvious.

Among the more distinct research outputs are: wilderness fire management programs; campsite inventory systems; trail register systems; computerized use-data summary programs; general approaches to use measurement; equitable use-rationing systems; the basis for party size limits; simulation models used to ration use; advantages of education approaches (high visitor education levels and commitment to wilderness); use of information to redistribute use; the limits of acceptable change system; recognition of the ineffectiveness of campsite closure as a rehabilitation technique; identifying location, design, and maintenance of trails, rather than amount of use, as the keys to controlling deterioration; and many site-specific results.

Some of the broader, more general research concepts that now are part of the overall approach to wilderness management are that experiences are the major output of management, that diversity in experiences is essential, that visitor conflict is an important problem, that visitor displacement can occur, that wilderness management is largely visitor management that objectives are critical to wilderness management, that wilderness use is very unevenly distributed geographically and over time, that nonregulatory management fits visitors' goals well, much of the concept of minimum impact use, recognition that carrying capacity involves social as well as ecological factors, the fact that most resource impacts result from light use, and the role of many factors besides amount of use in producing impacts.

Research contributions to wilderness management are presented in more depth in the book *Wilderness Management* (Hendee and others 1978).

The professional ski of wilderness managers has matured and grown over the last 20 years, with researchers' work contributing to this process. Managers' attitudes have also changed, for the better I feel. I recall early management meetings at which a major topic of discussion was the validity of wilderness as a land classification and expressions of frustration that "business as usual" could not prevail in wilderness. It has been a long time since I have heard those tunes. Acceptance of wilderness, commitment to its preservation, and serious concerns about how to manage it effectively are the rule at present wilderness workshops. And the general concepts listed above are widely understood by wilderness managers today.

## CONCLUSIONS

The wilderness system is large and growing (fig. 1). There are many new wilderness managers as a result of additions to the system. In 1964, only 55 National Forests had any wilderness: now 128 do. Eighty-two percent of all National Forests have to face the challenge of managing wilderness. More national park, wildlife refuge, and BLM managers have wilderness responsibilities, and almost surely more will in the future. Many of the people now managing wilderness have no previous experience in this demanding type of management, and no training. Most wildernesses are totally unstudied, and

some whole types of wilderness and kinds of wilderness users are virtually unstudied; for example, desert wilderness, or snow-season visitors.

A strong knowledge base is essential to protect and manage the over 88 million acres of established wilderness. Society has a large investment in the wilderness system, and has forgone many other uses of the land. Will skilled professional management enable society to obtain a return, in the form of preservation of wilderness conditions and opportunities for high-quality wilderness experiences, that will make this large investment worthwhile? Can management provide adequate returns to society with the present level of knowledge? The research whose history has been reviewed can help. We have come a long way in research-based knowledge for wilderness management since the early 1960s. But there is a great deal left to learn. Furthermore, the management problems themselves evolve and change. Results of three surveys of wilderness managers over a 5-year period hint at such changes (Godin and Leonard 1979; Bury and Fish 1980; Washburne and Cole 1983).

Limited management budgets make it more critical that management be highly effective and sharply focused on important problems. This seems to require improved knowledge of wilderness resources, natural processes, visitor and external impacts, visitor desires and behavior, and the effect of management actions.

However, less wilderness research is being done now. Support has diminished for 5 or 6 years. Agency research and support for university and consultant research are down. New sources of support need to be developed. The Wilderness Research Foundation, which will be introduced at this conference today, may help fill this need. I hope so, but other funding sources will be essential.

There are barriers to wilderness research besides shrinking budgets; Most are not new, but some are becoming more serious. The Federal Paperwork Reduction Act, administered by the Office of Management and Budget, deals with the important problem of government reporting requirements that constitute a heavy burden for businesses and local governments. All collection of information by Federal Government employees or by anyone who is federally supported must be reviewed and approved by the Office of Management and Budget. Technical review of questionnaires and research design to assure quality control is certainly desirable. However, the application of lengthy, formal approval procedures to small-scale, voluntary questionnaires used in wilderness visitor studies impedes effective research in response to managers' needs. Planning lead time now exceeds 1 year as a result of requirements for advance listing in annual information collection budgets and the typical drawn-out process of review. Even the term "respondent burden" seems of questionable appropriateness for voluntary questionnaires. Many recent surveys have used mail questionnaires, and 80 to 90 percent rates of return are usual. Visitors are answering questions about something important to them, and most of them welcome the opportunity to express themselves. Seriously hampering research in order to protect people who seldom feel imposed upon seems unfortunate.

Some wildernesses have dropped permit requirements and others have abandoned trail registers. The reasons for these changes are unclear. Shrinking budgets, failure to use permit or register data effectively for management and thus assignment of low priority to collecting the data, and a desire to not obligate visitors unless truly necessary are all partial reasons for this retreat. These may be justified decisions, but they result in the loss of basic data on use and users that can impede both visitor and impact research.

Sometimes agency policies can make basic ecological research more difficult (Franklin, this proceedings) or hamper fire history research (Kilgore, this proceedings). It appears that less research is conducted in National Forest wilderness than in national park backcountry and wilderness (Butler and Roberts, this proceedings).

In this situation, I think there are five things members of the wilderness research community need to do:

1. Select high-priority problems to study. We will have to leave most problems unstudied, but clearly these should be problems of lesser importance.

As I have indicated earlier in the paper, I think wilderness managers will need more research on the impact process in a variety of settings. They need research on the effectiveness of various minimum impact practices in different situations. They need research to guide wilderness fire programs, especially manager-ignited fires. They need to have research finish the job of developing use measurement systems. They need help from research in applying the Limits of Acceptable Change system, and research to plug some remaining gaps (Lucas and Stankey 1985). Research needs to evaluate and develop nonregulatory visitor management techniques, especially education-persuasion. Trends need to be identified, including displacement of visitors by changing conditions. Finally, research needs to better cover the wide range of conditions and uses in the expanded wilderness system now established.

2. Do rigorous, high-quality research, to learn as much as possible from reduced amounts of research.

3. Collaborate and communicate with other researchers, with wilderness managers, and with concerned publics. This can help focus efforts on the most important issues and improve the quality of studies. It can also facilitate application of research to wilderness management. A good example of collaboration between university, Forest Service, and private consulting firm scientists, managers, and the public in the development of the Limits of Acceptable Change system and its application to the Bob Marshall Wilderness is described in this proceedings (McCool, and others).

4. Strive for comparability and additivity to achieve a more integrated, cohesive research effort. I think at least one large, unified wilderness research program would facilitate integration, but if this fails to develop, scientists will need to work harder at cooperation. That, of course, is a major goal of this conference. If more studies could use common units of measure, comparable data classifications, and so on, one study could build on another more than has happened in the past. This could also facilitate study of trends.

5. Finally, strive for better days, so research can contribute to the management and preservation of wilderness. There is too much at stake for wilderness research to be neglected.

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