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The Evolution of Wilderness Social Science and Future Research to Protect Experiences, Resources, and Societal Benefits

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The historic Wilderness Act celebrated its 50th anniversary in 2014, and wilderness social science shared a similar legacy. As paradoxical as it might seem, humans are an important part of wilderness, helping to define the very concept and representing an important component of wilderness use and management. Much of the past five decades of wilderness-related social science has focused on recreational use, documenting the impacts of recreation on wilderness resources and the quality of the wilderness experience, exploring application of the concept of recreational carrying capacity to wilderness, and developing planning and management frameworks for balancing the inherent tension between wilderness use and protecting the quality of wilderness resources and the experience of visiting wilderness. The Limits of Acceptable Change and related planning frameworks, including formulation of recreation-related indicators and standards, continues to help guide wilderness management today. Other programs of social science research have developed protocols for measuring and monitoring wilderness recreation, defined the root causes of conflict among wilderness users and identified management approaches to minimize this conflict, explored the appropriate and acceptable use of fees for wilderness use, and identified a growing suite of wilderness values. All of these programs of research and others that could not be included in this review article have helped guide wilderness management and policy. However, social science research has evolved as a function of changes in both wilderness and society. This evolution continues through a focus on public attitudes toward adaptation to climate change, public attitudes toward restoration in wilderness to correct past human intervention, appropriate use of technology in wilderness, and issues related to the relevance of wilderness in light of changes in society and use of public lands. This article tells the story of these changes in issues and the relationship between wilderness and the American people.

Keywords: recreation, climate change, restoration, ecosystem services

The word "wilderness" conjures up romantic images of pristine nature untouched by humans; the Wilderness Act of 1964 defines wilderness as "untrammeled by man." But, in fact, humans are an important part of wilderness, defining the very word and concept of wilderness (Nash 2015). Wilderness management has focused largely on managing human use of wilderness to control impacts. Consequently, social science has contributed substantially to the growing understanding of the human values placed on nature, especially those that are wilderness dependent (i.e., uniquely received from wilderness). Passage of the Wilderness Act was the beginning of a modern period of social science about wilderness use and users that has been responsive to managers' and the public's needs for knowledge. This article describes an early focus of wilderness social science on recreation use and its management. Although this is still an important topic, research has contributed also to an understanding of general societal attitudes toward wilderness, which extend well beyond recreation values. Current wilderness social science has evolved even farther to contribute knowledge on public attitudes toward adaptation practices to address climate change issues, attitudes toward restoration to correct past human influences, the role of technology in wilderness experiences, and the future relevance of wilderness to a changing society and environment.

Wilderness Recreation

We acknowledge that it was not possible to address every social sciences topic related to wilderness in this article. Part of the challenge is that, particularly in the early years of wilderness research, wilderness social science was inextricably part of recreation research; therefore, methods and theories were advanced in a coordinated manner, not solely within separate disci-

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plines. Similarly, the topic of wilderness values benefited from other values research in economics, recreation, and environmental philosophy. As wilderness issues were defined more broadly over time, wilderness social science also became inextricably intertwined with other fields of study. However, it is our hope that the topics included in this review will adequately demonstrate our primary purpose: assisting the reader in understanding how change in the environment, people, and policy has driven and will continue to drive change in wilderness social science approaches, methods, and importance into the future.

Wilderness social science in the United States has evolved from an emphasis on recreation management research in the 1960s and 1970s to an emphasis on the broader social science issues of the 21st century, but in important ways we are still drawn to some of the fundamental human use and related policy issues of the early years. For example, a seemingly revolutionary stewardship idea from Hendee and Lucas (1973) to enhance communication with wilderness visitors and more accurately monitor user numbers, knowledge, and travel intentions through mandatory permits for wilderness use had an intuitive appeal. Early research on these topics suggested that mandatory permits might be the best way to control many environmental and social impacts and rationing use through limiting the number of permits offered a possibility to protect wilderness characteristics at a time when use of the National Wilderness Preservation System (NWPS) was growing rapidly. On the other hand, Behan's (1974) response suggesting that such practices were a manifestation of a police state wilderness in which managers could exercise such big brother restraints on wilderness enthusiasts raised valid questions about the appropriateness of such obtrusive management measures in places managed to protect attributes of freedom and wildness. Behan's suggestion of civil disobedience to protect the wilderness experience from authoritarian mismanagement fit the times and was a beckoning call to young scientists. We have still not fully solved this issue; however, we have learned to better identify and explore these types of dilemmas and acknowledge that wilderness is not necessarily the same thing to all people at all places, despite the establishment of a legal definition of wilderness in the Wilderness Act of 1964 (Watson 2004).

Recreation Carrying Capacity of Wilderness

The US Department of Agriculture (USDA) Forest Service invested heavily in a program of social science to support wilderness management decisionmaking beginning in the 1960s, a program that continues to this day and that built the foundation for much of what we know about wilderness recreation. This team of scientists, representing a number of social science disciplines, included Bill Burch, Roger Clark, Bev Driver, John Hendee, Will LaPage, Dave Lime, Bob Lucas, Elwood Shaffer, George Stankey, and Al Wagar along with a cadre of academics at research universities around the country. The social science literature on wilderness is full of their citations, and we still rely on their original, thoughtful, and remarkably productive program of social science applied to wilderness. This literature tells the story of the emergence and importance of social science to our understanding of wilderness. An early example of the recognition of the role of social science in wilderness research is found in the preface of Wagar's (1964, preface) influential monograph on the carrying capacity of "wild lands":

> The study reported here was initiated with the view that the carrying capacity of recreation lands could be determined primarily in terms of ecology and the deterioration of areas. However, it soon became obvious that the resource-oriented point of view must be augmented by consideration of human values.

Wilderness social science has largely focused on the provision in the Wilderness Act that wilderness should provide "outstanding opportunities for solitude" (e.g., Stankey 1973, Williams et al. 1992, Roggenbuck et al. 1993, Watson 1995a). But how many visitors were too many? The implication of this research was that managers could (and perhaps should) consider controlling use levels or distribution so that visitors would not feel unacceptably crowded in wilderness.

Carrying capacity has been a longstanding research and management issue in wilderness. Studies by Wagar (1964) and Lucas (1964a, 1964b, 1964c) are emblematic of the earliest wilderness recreation research. Recreational carrying capacity of wilderness has been generically defined as the amount and type of recreation use that can be accommodated without unacceptable impacts to wilderness resources or the quality of the wilderness experience (Manning 2007). Recent analyses have suggested that this foundational issue—the degree to which wilderness can be both used and preserved—is still a wilderness management challenge, although both natural and social science research reports have contributed theory, methods, and findings to its resolution (Graefe et al. 2011, Manning 2011, Whittaker et al. 2011, Marion 2015).

Research on wilderness recreation carrying capacity led to the concept of "limits of acceptable change" (Frissell and Stankey 1972, Stankey 1973). The Limits of Acceptable Change (Stankey et al. 1985) wilderness planning process was introduced as a way to systematically address recreation carrying capacity in wilderness through a focus on how recreation use threatened specific attributes of the wilderness environment (social and biophysical) and how much change was acceptable. With increasing wilderness use, some change to natural/cultural resources

Management and Policy Implications

The US Congress established the National Wilderness Preservation System in 1964, and it has steadily grown from about 9 million acres to nearly 110 million acres today. Congress also allocated funds for creation of a wilderness research program in 1967 to support management and policy decisionmaking. Wilderness science has provided data to support management decisions and management frameworks to accomplish resource and experience protection through use limits, education, zoning and fees, and other means. In the future, wilderness social science will respond to new challenges with provision of information to support decisions about intervention to adapt to climate change influences, restoration of conditions affected by previous human activities, management of changes in technology and new uses that may threaten wilderness experiences, the relevance of wilderness to an increasingly diverse and urban population, and exploration of the vulnerability of ecosystem services and associated benefits flowing from wilderness due to changes in climate, policy, and land use. New topics that have emerged will require adjustment of the federally funded research program and stimulation of academic research and training programs that are responsive to the needs for knowledge identified.

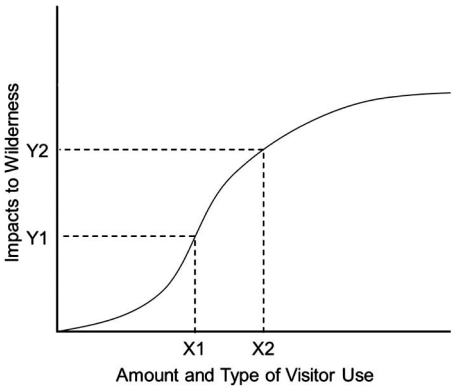

Figure 1. Hypothetical relationship between amount and type of visitor use and impacts to wilderness resources and the quality of the wilderness experience.

and the quality of the wilderness experience is inevitable, but sooner or later the amount or type of change may become unacceptable. But what determines the limits of acceptable change? In Figure 1, a hypothetical relationship between visitor use of wilderness and the resulting impacts is shown. This relationship suggests that increasing recreation use causes increasing impacts such as damage to fragile soils and vegetation and to wilderness experiences in the form of crowding and conflicting uses. However, from this relationship it is not clear at what point these impacts are unacceptable and what part of the impacts is attributable to the number of visitors versus visitor behavior or other aspects of use of the resource. In Figure 1, X1 and X2 represent alternative levels of visitor use that result in corresponding levels of impact as defined by points Y1 and Y2, respectively. But which of these points—Y1 or Y2 or some other point along the vertical axis—represents the maximum amount of impact that is acceptable? The typical steepness of these curves might also have implications for selecting a managerially acceptable point; most impacts increase at a rapid rate at lower levels of use.

The scientific and professional literature suggests that answers to this foundational question of recreation carrying capacity can be derived through formulation of management objectives and associated indicators and standards (Frissell and Stankey 1972, Lucas and Stankey 1974, Lime 1979, Stankey et al. 1985, Stankey and Manning 1986, Manning 2007). This approach to wilderness recreation management requires defining the resource and experience attributes to be protected. Broad management objectives and general narrative statements defining desirable conditions can then be made operational through more specific empirical indicators and standards.

Indicators and Standards for Wilderness Recreation

Indicators are measurable, manageable variables reflecting the essence or meaning of management objectives (Stankey et al. 1985, Manning 2011); they are quantifiable proxies of management objectives and should be stated specifically enough to make monitoring easily prescribed (Watson et al. 1998). Indicators typically are selected to represent threats to the resource or social environment. *Standards* define the maximum departure from pristine indicator conditions that are allowed to occur due to the presence of these threats (i.e., the limits of acceptable change). The concepts and approach of the Limits of Acceptable Change greatly influenced wilderness planning and management approaches, was quickly incorporated into the USDA Forest Service handbook, and generated a National Park Service initiative (US Department of Interior National Park Service 1997, Manning 2001, 2007) to develop and implement a similar indicator-based planning and management system. Marion (2015) describes a recent movement among federal agencies to be more consistent across application of these indicator-based planning systems.

Research to define indicators and set standards has involved both qualitative and quantitative research methods. Qualitative approaches, as well as in situ place-based methods, to understanding experiences and identifying threats and contributions to wilderness experiences (cf., Patterson et al. 1998, Watson and Roggenbuck 1998, Glaspell et al. 2003, Watson et al. 2007) have been used in a number of studies. These studies have asked visitors to define important elements of the wilderness experience and the things that threaten or facilitate them. For instance, at Juniper Prairie Wilderness in Florida (Patterson et al. 1998, Borrie and Roggenbuck 1998), management was focusing on numbers of intergroup encounters as the primary indicator of wilderness character without a full understanding of how these encounters (or other possible indicators) influenced visitor-defined experiences (e.g., way-finding, challenge, and immersion in nature). Research here greatly expanded understanding of how management policies, commercial activities, visitor behaviors, and numbers of visitors affected a range of experience outcomes. This research was in contrast to many previous studies that either focused narrowly on the experiences believed to be prescribed by legislation (primarily solitude), on the experiences investigated in studies at other places (primarily solitude), or on a single aspect of the setting, such as crowding and its effect on trip satisfaction.

More than half of the NWPS is located in Alaska, and this provided a new challenge and opportunity to identify indicators of the wilderness experience in a different context. Wilderness research, beyond some simple replications of recreation preference studies, was nearly nonexistent in arctic and subarctic North America until after 2000. Studies at several wilderness areas in this region have provided new insights into contributing and threatening influences on visitor experiences at large, remote northern locations. This research also led to expanded efforts to generate indicators for nonrecreation users. For example, studies of indigenous people have expanded wilderness planning models to incorporate understanding of influences on their experiences and how they can be protected (Kluwe and Krumpe 2003, Whiting 2004, Christensen et al. 2007, Watson et al. 2011). This program of research continues and is occurring at a growing number of places with new contributions to solving conflicts, addressing underrepresented population perceptions, and expanding understanding of the tradeoffs involved in wilderness stewardship decisions.

Setting standards for indicators conventionally involved collecting survey data to explore visitor evaluations of a range of wilderness conditions. Social norms, one approach, can be illustrated graphically, as shown in Figure 2. This graph plots average acceptability ratings for encountering increasing numbers of visitor groups along trails. Data for this type of analysis might be derived from a survey of wilderness hikers. The line plotted in this illustration is sometimes called an "encounter" or "contact preference" curve (when applied to crowding-related variables) or might be called an "impact acceptability" curve more generally or simply a "norm curve."

Norm curves, as illustrated in Figure 2, have several potentially important applications. First, all points along the curve above the neutral line of the evaluation scale, the point on the vertical axis where aggregate evaluation ratings fall from the acceptable into the unacceptable range, define

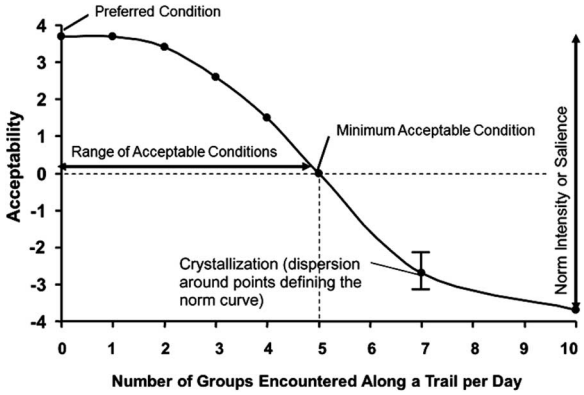

Figure 2. Hypothetical social norm curve for the acceptability of a range of wilderness groups seen on trails per day.

the range of conditions acceptable to a majority of visitors. All of the conditions represented in this range are judged to meet some level of acceptability by most respondents. The optimum condition is defined by the highest point on the norm curve. This is the condition that, absent other considerations, received the highest rating of acceptability. The minimum acceptable condition is defined as the point at which the norm curve crosses the neutral point of the evaluation scale. Norm intensity, the strength of respondents' feelings about the importance of a potential indicator, is suggested by the distance of the norm curve above or below the neutral line of the evaluation scale. The greater this distance, the more strongly respondents feel about the indicator being measured. High measures of norm intensity suggest that a variable may be a good indicator because respondents feel it is important in defining the quality of the wilderness experience. Crystallization of the norm concerns the amount of agreement or consensus about the norm. It is usually calculated by standard deviations or other measures of variance around the points that describe the norm curve. The less variance or dispersion of data around those points, the more consensus there is about social norms.

Research has measured normative standards for a variety of recreation-related indicators that address the resource and experiential components of wilderness and related recreation opportunities, and this information has been compiled in several sources (Manning 2011 and the National Park Service website[1]). In these studies, most respondents are able to report norms for most indicators included in the study (e.g., encounters with others, resource impact levels, and use densities) and normative standards are typically reported most often and are most highly crystallized in wilderness or backcountry areas.

Impact standards have also been elicited using a social judgment theory approach (Petty and Cacioppo 1981). Inherent in social judgment theory is the assumption that people order stimuli relative to an internal reference point or norm which is developed through social interaction and relevant experiences with the judgment domain. In addition to being well established in social psychology, the social judgment rating approach has several positive attributes. First, it allows ratings along a continuous scale (as opposed to categories sometimes used in some surveys), providing greater specificity of judgments. Second, the procedure allows respondents to indicate a most preferred or ideal position on an attitude continuum, as well as a range of acceptable conditions and another range of unacceptable conditions. Third, the approach recognizes that respondents may be unsure or noncommittal with respect to a judgment (Williams et al. 1992). In this approach, input to standards is derived from visitor indications of these ranges of acceptable and unacceptable levels on key indicators. One may easily determine what proportion of visitors consider a potential standard as acceptable. Movement along a graph of these results can illustrate the tradeoff between the standard level and proportion of visitors considering this level acceptable. Preferred values are not averaged, and there is no assumption that a visitor accepts levels below the preferred value. The relationship between preferred levels and acceptable levels is very clear.

Recreation Use Monitoring

Statistically sound estimates of wilderness visitation are a necessary ingredient for national, regional, and area-level planning and management for the NWPS. Yet, none of the management agencies had a system for specifically estimating wilderness use levels or trends before the Forest Service's development of the National Visitor Use Monitoring (NVUM) Program in the 1990s. The NVUM methodology samples visitation across a number of visitor activities and settings (Zarnoch et al. 2011). Visits where all or a portion of visitors' time was spent in wilderness are identified separately for each national forest where NVUM is applied.

Before NVUM, data on visits to national forests were developed independently by each ranger district using whatever methodology district personnel preferred. Inconsistent methods and application of methods and other problems, such as nonresponse and sample selection bias, assured that the district level estimates would not be valid when aggregated upward to region and national levels. Tested and revised numerous times, NVUM was implemented across the National Forest System in 2000. The NVUM methodology has since been reevaluated and modified to reduce variability and thus increase the accuracy of the estimates. The NVUM samples visitors at the wilderness area and other recreation site levels and from these site-level samples estimates visitation at the forest, regional, and national levels. Although the primary objective of NVUM is estimating recreation visitation, it also provides a profile of visitor demographics (e.g., age, gender, and income level), satisfaction with the visit, and local economic spending. In that NVUM provides the only estimates specifically for federal wilderness visitation, the resulting data have been used as the primary basis for NWPS systemwide visitation estimates, future trend forecasts, and net economic value (e.g., Bowker et al. 2005).

More intensive monitoring of use and users to understand trends or specific issues at specific wilderness sites is still an important wilderness social science effort with roots in the 1960s. Forest Service scientists (e.g., James 1967) initiated efforts to address manager needs to estimate recreation use to all dispersed outdoor recreation sites and eventually with specific applications to wilderness (Lucas et al. 1971). Based on this program of research, a manual was developed to help managers identify use monitoring objectives, the type of monitoring system that could provide this information, technology and sampling considerations,

and data analysis methods (Watson et al. 2000).

Recreation Conflict in Wilderness

Early descriptive studies of outdoor recreation in wilderness often found substantial conflict among participants in different recreation activities. Canoeists in the Boundary Waters Canoe Area, in Minnesota, for example, were found to be relatively tolerant of meeting other canoeists but to dislike meeting motorboaters (Lucas 1964b, 1964c). Similarly, hikers in several western wilderness areas were found to be more tolerant of meeting backpackers than stock users (Stankey 1973, 1980, Watson et al. 1993). Research has continued to identify and study many types of conflict in outdoor recreation, and conflict appears to be expanding as demand for outdoor recreation continues to grow, as technology and innovation contribute to development of new recreation equipment and activities, and as contemporary lifestyles become increasingly diverse (Devall and Harry 1981, Owens 1985, Hendricks 1995, Watson 1995b, 2012). A distinct finding is the common asymmetric or one-way nature of such conflict as described between motorboaters and canoeists above (Watson et al. 1994).

An initial theoretical model of conflict focused on its potential origins (Jacob and Schreyer 1980). Conflict was defined as goal interference attributed to another's behavior, a definition based on expectancy and discrepancy theory. Expectancy theory suggests that human behavior, including outdoor recreation, is goal oriented: people participate in recreation activities because they expect to achieve certain goals. Discrepancy theory defines dissatisfaction in outdoor recreation as the difference between desired and achieved goals. Conflict is a special application of discrepancy theory for which dissatisfaction is attributed to another individual's or group's behavior. In this way, conflict tends to be differentiated from crowding or sheer competition for resources.

A second theoretical model of conflict is generally referred to as "social values" (Vaske et al. 1995a, 1995b, 2007, Ewert et al. 1999). In this model, conflict is understood to arise from fundamentally different beliefs, values, and norms held by alternative types of recreationists. It is interesting to note that this type of conflict can occur even when there is no contact between potentially conflicting user groups; such user groups object to the presence or behavior of the other group based on philosophical grounds. For example, canoeists could be in conflict with motorboaters, even when they do not encounter one another, simply because they feel motorboat use is an inappropriate recreation activity in wilderness. In fact, motorboat use in wilderness is allowed in only a very few locations through legislative special provisions.

Research suggests several insights for managing conflict. In particular, these insights are based on an understanding of conflict as something more than simple competition for recreation opportunities or even incompatibility among recreation activities. Perceived conceptions of conflict as goal interference attributed to others or a clash of social values suggest that conflict among groups is often the manifestation of underlying functional causes. Therefore, management action may not be effective if it does not address these underlying causes.

Zoning or separation of conflicting recreation activities is probably the most common management approach to conflict. Research suggests that where direct or interpersonal conflict is present, zoning may be an effective management strategy. Educational programs may also be an effective management approach to conflict that is based on direct or interpersonal sources, and education may be effective where conflict is related to indirect causes such as alternative social values. Educational programs can be effective in two ways. First, they can help establish a basic etiquette, code of conduct, or other behavioral norms that might lessen both direct and indirect conflict. Second, they can help address indirect or social values-related conflict by increasing tolerance of recreation visitors for other types of groups and activities, perhaps by explaining the reasons behind certain behaviors that might be viewed as objectionable and by emphasizing similarities that are shared by recreation groups and activities (Ivy et al. 1992). Most other conflict management solutions, such as management interventions to influence directional flow of travel (e.g., everyone moves in a clockwise direction through a trail system), set activity restrictions (e.g., set fines for conflicting behaviors), or manage timing of conflicting uses (temporal zoning), are aimed at only direct or interpersonal conflict sources. Only elimination of one use or the other can completely eliminate conflict, and this, of course has serious implications for the group eliminated.

Recreation Fees

Another indication of how societal change can influence wilderness social science was the response of managers and scientists to the Recreation Fee Demonstration Program introduced in 1996. Congress voted to allow the federal agencies to collect more user fees for public land access, with the intent of keeping more receipts for local use. There was great uncertainty about where to charge fees, how much to charge and how to evaluate the effect on visitor experiences. Many felt that wilderness users were possibly the most threatened by new user fees, but they could also benefit substantially from more sustainable methods of raising funds to accomplish wilderness stewardship (Watson 2001).

There was a flurry of research at the time of initiation of these fees, much of it broad to include wilderness but not focused solely on wilderness, to understand how wilderness use fees might be different from other recreation use fees (Watson and Herath 1999, Williams et al. 1999), consider tradeoffs in setting prices for wilderness access (Richer and Christensen 1999), and distinguish between day user and overnight user attitudes toward wilderness fees (Vogt and Williams 1999). Generally, research found that wilderness visitors are less supportive of wilderness fees than of fees for more developed recreation, that setting fees for wilderness is complex due to social justice and difficult to describe costs of production issues, and that wilderness visitors generally express more support for fees for restoring or maintaining conditions than somehow "improving" them.

Recent searches have found there to have been very little if any more current fee research connected to wilderness. Occasionally (cf. Dvorak et al. 2012), a few questions are asked about fees paid for wilderness access, but normally research is very focused on how to improve methods of fee collection, the appropriateness of a fee level, and other technical aspects of implementation.

Wilderness Values

Whereas most of the recreation research has occurred with wilderness visitors or potential visitors, research on wilderness values extended across the US population. Public attitudes toward wilderness protection and indications of public support for designating more federal land as wilderness have been important social science topics. This research informs legislators, land management

agencies, designation advocates, and other stakeholders about public support for wilderness. Early writings often supported the concept of wilderness, but lacked empirical evidence for the value(s) of preserving natural lands. Until the early 1960s, little research was conducted to evaluate public sentiment toward protecting wilderness. One study that highlighted two broad classes of wilderness values, recreation and indirect values, was commissioned by the Outdoor Recreation Resources Review Commission (ORRRC) (1962). Indirect values were defined to include conservation ethics, scientific uses, and the wilderness idea. The "wilderness idea" established the roots of the concept of existence value: wilderness is valuable to society because it is there and has been designated for protection from development and exploitation.

Pioneering scientists tackled research on the economic value of recreation (cf. Clawson 1959). As this line of research progressed, there was realization that the total recreation value to society could be estimated, and these projections could be used to estimate societal recreation value in future years. Scientists attempted to estimate the per acre value of wilderness and to provide a framework for considering allocation of additional public land to wilderness status. An ORRRC recreation demand study of wilderness visitors found that among the 21 benefits of wilderness visits asked about, the highest values were to observe natural beauty, to get away from the sights and sounds of civilization, and to escape work pressures.

A variety of studies have been done to further illuminate the values attributed to wilderness protection, beyond those of onsite recreation experiences. In part, this advancement sprang from the work of natural resource economists who suggested that onsite recreation visit values captured only a part of the total value of wilderness (Krutilla and Fisher 1985). The idea that the societal value of wilderness is multidimensional has been widely accepted. For example, research has expanded the definition of wilderness values referred to by ORRRC and by other early values researchers as indirect values to include option, existence, and bequest values (Walsh and Loomis 1989).

A survey of Colorado residents applied a 13-item wilderness values scale (Haas et al. 1986). The most highly supported values were protection of water quality, wildlife habitat, and air quality. Next were bequest (future generations) and option (future own use) values. Following these values were the values of seeing wilderness as a contemporary recreation opportunity and scenic beauty.

A larger, national survey, the National Survey on Recreation and the Environment (NSRE), was developed and administered in 1995 to the US population of individuals 16 years or older. The survey asked about awareness of the NWPS, whether there was adequate acreage protected, and the importance of various benefits or values. Findings indicated broad public support for wilderness protection, mainly for its ecological, environmental quality, and offsite values (Cordell et al. 1998). This earlier survey was followed by a replication of the values scale in 2000 (Cordell et al. 2003). The public in 2000 placed the greatest importance on ecosystem services, existence value, recreation, and future use options. Findings built on earlier scientists' work to add dimensions to the total value of wilderness. Throughout this expansion, however, recreation use of wilderness has remained a chief focus of both managers and many researchers.

The 2003 NSRE included an added module of wilderness questions that increased the breadth of possible values. An outcome of this research was to identify the underlying importance of demographic strata in explaining variations in public evaluation of wilderness benefits. This observation was followed by further exploration of wilderness values data to identify demographics at play (Johnson et al. 2005). This research revealed that wilderness is valued similarly across the diversity of the US population, including immigrants, non-whites, females, and different socioeconomic strata.

Further analysis revealed two especially strong nature protection values: 90% of Americans indicated that protection of air quality and water quality were extremely important (Cordell et al. 2008). Protecting wildlife habitat, having wilderness for future generations (bequest value), protecting rare plant and animal species, and preserving unique plants and animals were very to extremely important to more than 80% of the sample. Overall, there were no value differences between urban and rural residents. Somewhat fewer in the West placed high importance on water quality and more people in the South put high importance on scenic beauty and spiritual inspiration. The percentages of Americans assigning very high importance to the 13 basic wilderness values have generally increased or remained constant.

Wilderness Social Science: Today and into the Future

Wilderness social science has changed to address new topics and issues, often adopting new research methods. The number of scientists has also increased substantially. The carrying capacity concept and Limits of Acceptable Change framework and related indicator and standard-based approaches continue to offer conceptual and empirical frameworks for informed wilderness management. However, one pioneering Forest Service scientist indicated surprise at the expanded range of current wilderness research topics.

> It was just a few of us researching a small number of questions we thought would be answered in a few years. Today you are studying issues we didn't even think about back then. (Robert C. Lucas, retired USDA Forest Service, pers. comm., Sept. 8, 2008)

Replication of past recreation research to address changing uses and users is still productive, has led to refinement of wilderness management, and continues to contribute to wilderness protection today.

It is easy now to look back and see how a changing society, a threatened environment, and changes in public policy have demanded more from social science and how this has led to widespread benefits. Science has contributed substantially to developing knowledge about wilderness recreation use and users, their impacts on the resource and each other, indicators and standards of wilderness recreation, role of recreation fees, sources of conflict and potential conflict management solutions, and understanding changes in public support for wilderness. But new wilderness-related topics have emerged, and this means that more and better social science research will be needed.

Climate Change Social Science

Of course, there is a great deal of contemporary concern and uncertainty about climate change. Moreover, there is increasing recognition of the value of wilderness as a baseline of relatively undisturbed landscapes, and, therefore, wilderness will be subject to more intensive natural science research to understand the impact of climate change. This presents a number of potentially challenging issues: there are new demands on wilderness for installation of ecological measurement devices, more human

activity in wilderness to support ecological monitoring in remote locations, and more pressure for wilderness managers to review proposals for achieving the scientific values of wilderness (Carver et al. 2014). All of these issues can benefit from social science research. Important questions are also emerging about public attitudes toward the appropriateness of human intervention in wilderness to adapt to climate change influences. In a recent survey of managers of federal agencies, well over half of respondents agreed they need information on public attitudes toward intervention to adapt to climate change influences (Ghimire et al. 2015). Although managers must comply with Wilderness Act guidance and policy interpretations, many managers agree that understanding public perceptions of appropriateness of intervention in wilderness to adapt to climate change influences may help them make decisions about intervention and about how to explain either intervention or nonintervention decisions. Decisions about whether to provide water improvements due to changes in hydrologic features or weather patterns, whether to introduce new genetic material more resistant to drought and disease in a changing climate, and whether to assist in migration of plants or animals may be easier to make outside of wilderness. The initial research on this topic among wilderness visitors found strong opposition to these practices in wilderness (Watson et al. 2015).

Wilderness Restoration Social Science

Along with changes in climate have come increased concerns about efforts to restore the effects of past human intervention in wilderness ecosystems. In a 2014 survey of wilderness managers, the second highest information need described was public attitudes toward ecological restoration (e.g., fire, vegetation, and wildlife) activities (Ghimire et al. 2015). Over half of all managers surveyed considered the information available on this topic to be not adequate or only somewhat adequate.

Miller and Aplet (2015) suggest that most studies of the relationship between fire and humans have focused on the built environment, where humans and fire most frequently interact. Scientists have worked only a small amount in the past to understand public opinion about fire management and fire restoration in wilderness ecosystems (e.g., McCool and Stankey 1986). After the large western fires of 1988 and 2000, however, there has been renewed interest, but limited funding, in understanding a variety of wildland fire issues relevant to wilderness management. Shortly after the 1988 fires in the Greater Yellowstone Ecosystem, research helped uncover differences in public support levels between the public in the region of the fire and a national sample (Manfredo et al. 1990). Those who lived in the region of the fires were more supportive of restoration and more knowledgeable about the role of fire in nature. An additional topic explored in wilderness fire social science includes public attitudes toward management-ignited fire in wilderness. For example, support was found for management-ignited fires and no difference between justifying those fires for ecological restoration or protecting adjacent land resources by reducing hazardous fuels inside wilderness (Knotek et al. 2008). With climate and land use change forcing agencies to proactively address fire restoration issues, recent studies, such as working to understand recreation visitors' preferences for managing recreation with the inevitable increase in wildfires (Ryan et al. 2008), trust in managing agencies and their wildfire objectives (Liljeblad et al. 2009), and support for decisions in high-risk situations (Knotek 2006) are likely to become higher priorities in wildland fire management organizations (Miller and Aplet 2015).

The Role of Technology in Wilderness Experiences

The relationship between wilderness and technology is complex. In the 1960s and 1970s, advancements in equipment technology (e.g., lighter packs and freeze-dried food) made it easier for people to access wilderness, leading to increased use with all its accompanying benefits and challenges. In the 1990s, global positioning systems (GPS) technology had a similar effect. Today, wilderness visitors may carry satellite phones and/or personal locator beacons, making communication with the outside world instantaneous and reliable. Researchers and managers are just beginning to examine visitor attitudes toward such technology (Pope and Martin 2011): how visitors use such technology in wilderness (Martin and Blackwell 2012); how such technology might affect use levels and the spatial distribution of use and impacts (e.g., more inexperienced people visiting wilderness because they feel safer and increased use of remote areas and cross-country routes); whether such technology could influence visitor behaviors in wilderness (e.g., increased risk-taking) (Martin and Pope 2012); how such technology might both increase the frequency of search and rescue efforts, but potentially also make such efforts easier; and how the use of such technology might affect visitor experiences, including the experiences of other visitors who might be exposed to it. In addition, advanced technology such as Google Trekker and UAVs (unmanned aerial vehicles [drones]) that can record and quickly disseminate high-quality photography, when combined with advanced digital trip planning tools, also have the potential to attract, increase, and redistribute use and potentially lead to an overreliance on such technology relative to route-finding and risk-taking. On the other hand, all of these technologies also have the potential to increase support for wilderness, through both direct use and indirect appreciation. As always, technology is a two-edged sword, one that managers and researchers often struggle to keep up with. Clearly, more research on this topic will be warranted.

Expanded Relevance of Wilderness

In addition to creating more opportunities for a more diverse public to visit the wilderness to receive the set of benefits so desired by politically influential activists in the 1960s, our responsibility may be to promote awareness and commitment to protection of areas with wilderness characteristics for values other than use. Public wilderness values research certainly has suggested that these are increasingly the values for which society supports wilderness protection. The relevance of wilderness in the future may flow increasingly from environmental well-being and wilderness may be the ultimate cultural symbol of our commitment to environmental well-being. Our knowledge has changed about the functions and services provided by protected lands and water, and this knowledge may suggest the need to weight the contribution of environmental well-being to that of human well-being more than in the past (Watson 2013). Research that is focused on the flow of ecological services is useful by creating understanding of the value of protecting biodiversity, carbon storage reservoirs, and sources of high-quality water for offsite benefits. In the Millennium Ecosystem Assessment (2005), the link between ecosystem services and human well-being is described as contributing to security; material for livelihoods, food,

Figure 3. A young girl fishing in the Boundary Waters Canoe Area Wilderness within the Superior National Forest in northeastern Minnesota. Photo courtesy of the Aldo Leopold Wilderness Research Institute.

and shelter; healthy environment, water, and air; social cohesion; and freedom of choice to do what an individual values doing. These are values received broadly across society, not just to those driven to and capable of outdoor recreation participation.

Today, someone can engage in assuring the protection of wilderness attributes through showing commitment to ecosystem services provided by these areas. The decision to engage in carbon, biodiversity, or water ecosystem markets today may be the equivalent of identity expression through wilderness visits of the 1960s and even of the 1990s. Zinn and Graefe (2007) found evidence that more educated, more urban, younger adults were expressing increasingly strong protection-oriented environmental values. The implications for research suggest an increased need to more accurately describe exactly what ecosystem services benefits are provided by protected nature, who in society benefits from these services and protection of attributes that give rise to these services, how to model the effects of natural or anthropogenic disturbance on flow of these services, how to protect the flow of benefits once they leave (if they do) collectively held lands and water, and how adaptive planning may help preserve the flow of historically important or crucially life-sustaining benefits. Research to contribute to greater understanding of the values protection brings to current and future populations is in high demand and has immediate application potential (Cordell et al. 2015).

As society changes in its relationship with wilderness, we are anticipating all of society to pay more attention to benefits accumulating from wilderness protection. Clean water, wildlife corridors for movement, air sheds, filtration of groundwater, cultural practices, and recreation will all only become more important to us as a society (Figure 3). But will wilderness protection become less controversial in the political arena? Will the NWPS continue to expand in the United States? Will new interpretations of the values of wilderness be widely accepted as we continue to move away from a limited perception of the value of wilderness as a playground and more toward recognition of wilderness as part of our identity, part of our necessary lifeline to support human life on earth, and a demonstration of our ethic toward nature and future generations? These are some of the challenges wilderness social science will face in the coming decades.

Endnote

1. Also see usercapacity.nps.gov.

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