Wilderness Management Dilemmas: Fertile Ground for Wilderness Management Research

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Abstract—Increasingly, wilderness managers must choose between the objective of wildness ("untrammeled" wilderness) and the objectives of naturalness and solitude. This dilemma has surfaced with awareness of the pervasiveness of human influence in wilderness and that regulation is often the only way to maintain outstanding opportunities for solitude. Should we trammel wilderness to compensate for unnatural effects of human activity or, to avoid trammeling wilderness, should we allow conditions to become increasingly unnatural? Should we restrict access and behavior to preserve opportunities for solitude, knowing this will exacerbate supply/demand problems and deny visitors a sense of freedom and spontaneity? This paper discusses this dilemma and opportunities for research in support of different objectives.

The goals of wilderness management are to keep wilderness wild and "untrammeled" while preserving natural ecosystems and opportunities for high quality experiences, characterized by solitude, primitiveness and lack of confinement. When working toward these goals, managers have frequently turned to science for help. Science can often help management by identifying potential problems and useful approaches, by evaluating the effectiveness of alternative approaches and by describing the pros and cons of alternative courses of action. However, science is less helpful in deciding between alternative management objectives when fundamental goals are in conflict. Ideally, applied science—like management—should be conducted within the context of objectives that have already been clearly defined by society.

As scientific understanding has progressed, recognition of the magnitude and complexity of information needed to support wilderness management has grown. We have learned recently that we must confront dilemmas in wilderness management that were not envisioned or at least underappreciated at the time the Wilderness Act was passed. A half-century ago, it was generally assumed that undisturbed ecosystems were static, in balance and would remain so if left untouched. Today, we understand that undisturbed ecosystems change continuously, idiosyncratically and unpredictably (Botkin 1990). This suggests that management should allow wilderness ecosystems to continue to change in these ways, without being fettered by human influence or human intention.

We have also discovered that human activities have had global effects, that even the most remote portions of wilderness have been and are being altered by human activity. Many different human activities, most of them outside the control of wilderness managers, threaten wilderness conditions. We have learned that the cumulative effects of these multiple threats are often synergistic rather than additive, and they affect all components of wilderness ecosystems and all levels of biological organization (Cole and Landres 1996). The more science advances, the more intractable conflicts and dilemmas appear to be and the more inadequate current scientific understanding seems as a support for wilderness management.

Wilderness management is made especially difficult by the fact that few of the human activities that alter wilderness ecosystems are internal uses readily subject to managerial control. Recreation and grazing by domestic livestock are probably the two most common internal uses of wilderness that are both substantial threats and subject to managerial control. Even for these uses, managers' discretion to limit use to preserve wilderness conditions is constrained by political interests. Where uses are subject to control, research is needed on the effects of these activities and their significance. Efficient monitoring protocols need to be developed, and potential management strategies need to be identified and evaluated.

Recreation impacts on vegetation and soil have been well-studied and provide a good example of the value of science to management (Leung and Marion, this proceedings). Managers understand most of the primary impacts on trails and campsites, where recreation use concentrates, and have an enlightened perspective on the significance of these impacts. They have considerable information about factors that influence the magnitude and extent of impacts, which allows them to evaluate the pros and cons of alternative management strategies. The effectiveness of various management techniques have been evaluated, and efficient monitoring protocols have been developed (Cole 1989). Perhaps the most glaring information gap involves recreation impacts to soil biota and the biotic-abiotic interface, a gap which severely constrains efforts to restore damaged recreation sites (Zabinski and Gannon 1997).

Recreation impacts on animals and water have also been frequently studied, but these studies have not provided as firm a support for management (Hammitt and Cole 1998, Knight and Gutzwiller 1995, Liddle 1997). Impacts have

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often been identified, but results are often contradictory, and perspectives on the significance of impacts are poorly developed. Efficient monitoring protocols are lacking, and few potential management strategies have been advanced or evaluated.

Domestic livestock grazing has also been studied intensively but usually in situations that are only partially applicable to wilderness (McClaran, this proceedings). More research is needed to improve our understanding of how natural ecosystems have changed in response to domestic livestock grazing and how to develop grazing practices that are more compatible with the goals of wilderness than the goal of maximizing sustainable animal production.

We have also learned over the past 50 years that the desire to use wilderness is ever increasing. The experience Aldo Leopold appreciated, a two-week horse-packing trip without seeing anyone else, is now rare. Today, most wilderness visitors may be day-trippers, and encounters with many other groups is the norm (Watson, this proceedings). The social sciences have advanced our understanding on such important topics as wilderness solitude, unconfined use, use encounter standards and other attributes of wilderness experiences. However, this research has also uncovered unexpected complexities.

Progress has been substantial in the development and application of alternative management techniques (Manning and Lime, this proceedings). The use of permits, zoning of use and party size standards are fairly well established and effectively used by managers. The use patterns and characteristics of users are understood (Cole and others 1995). Areas needing more research involve the solitude and privacy needs and preferences of wilderness users, and the functions that solitude serves (Hammitt and Rutlin 1995). The functional process of how use encounters affect solitude and privacy in wilderness is not well understood. Thirty years of norms research have been quite successful in advancing scientific knowledge concerning visitor preferences and evaluations of encounters. However, some consider these evaluations to be "norms" (Shelby and Heberlein 1986; Shelby and Vaske 1991), while other researchers question the existence of norms for encounters among wilderness visitors (Roggenbuck and others 1991). This argument has critical implications for management application. Are these evaluations of how visitors think they would respond to different numbers of encounters, or are they well-thought-out prescriptive statements of how many encounters ought to be allowed (as norm terminology suggests), offered with full cognizance of the tradeoffs involved in any decision? This controversy is not the fault of normative research, but rather, the reward of an extended period of research that has uncovered the complexities of this topic.

Despite considerable progress along some avenues of wilderness management research, many challenges remain. The more profound challenges to ecological science and management, we believe, involve impacts that cannot be minimized through on-site management of the uses which cause those impacts. How, for example, should managers respond to the effects of acid deposition resulting from regional pollutants (Tonnessen, this proceedings)? How should they respond to the widespread invasion of exotic pathogens that decimate native populations? How should they respond to the regional absence of top-level predators or frequent fires? How should they respond to anthropogenic climate change?

The prevalence of impacts caused by human agents that cannot be controlled by wilderness managers raises a profound dilemma that is only now being clearly recognized. Should we emphasize naturalness or wildness in the management of wilderness ecosystems? The challenge to social science is how to reconcile demand for access to wilderness and the desire to keep wilderness experiences unconfined, with the fact that many attributes of the ideal wilderness experience, with its emphasis on solitude, deteriorate as use levels increase. Should we emphasize solitude or wildness in the management of use in wilderness?

The Dilemma of Naturalness, Solitude, and Wildness

The Wilderness Act of 1964 mandated preservation of natural conditions and opportunities for solitude. The concepts of naturalness and solitude have been defined in many different ways. In wilderness, objectives usually stress minimizing the influence of modern technological society and maintaining relatively uncrowded conditions. The Wilderness Act also stated that wilderness was to be "untrammeled by man"and a place for an "unconfined type of recreation". "Untrammeled" is an unfamiliar word that is often misread as untrampled, and even more frequently misinterpreted as implying undisturbed or uninfluenced conditions. A trammel is a net for birds or fish or a shackle used to make horses amble. Synonymous with unconfined and unrestrained, an untrammeled wilderness is one that is wild, self-organizing and autonomous (Turner 1996), not manipulated or directed by humans for any purpose. In this paper, we use the more common word "wild" to denote the freedom from human control that is a desirable attribute of both wilderness ecosystems and wilderness experiences.

At the time the Wilderness Act was passed, it was probably assumed that keeping wilderness wild would keep wilderness natural and *vice versa*. However, now that we better understand the ubiquity of ecosystem change and human disturbance, we know this is not the case. We have learned that we cannot have wilderness that is truly wild or natura—let alone have wilderness that is simultaneously wild and natural. Management must emphasize either wildness or naturalness. It must either intentionally manipulate wilderness to compensate for the unnatural effects of human activity or, to avoid exerting human control, it must allow conditions to become increasingly unnatural (Graber 1995).

The same is true for wildness and solitude. Management cannot have wild use (unrestricted and unconfined) and provide outstanding opportunities for solitude where demand for access to wilderness is high and supply is limited. Use restrictions, permits, and even trail/campsite construction constrain (trammel) the use patterns of wilderness users. Unrestricted, uninfluenced and unmanipulated use often results in lost opportunities for solitude and other important attributes of the wilderness experience. Manipulation of wilderness to keep experiences solitary takes away the wildness of wilderness experiences as it does the wildness of wilderness environments. Only in very low use areas and/or wilderness areas with very difficult and limited

access can wildness be maintained along with outstanding opportunities for solitude.

In choosing between the lesser of these two evils, science has less to offer than a careful evaluation of societal values. Valuable attributes will be lost with any choice of action or with inaction. As has been argued elsewhere, aggregate value might be optimized with a compromise in which wildness is pursued to a high degree on some wilderness lands, and naturalness is pursued to a high degree on others (Cole 1996; 1997). The contribution of science to this decision should be to clarify the costs and benefits of alternative choices.

To date, science has contributed substantially to understanding the benefits of pursuing naturalness and the costs of a "hands-off" management policy that emphasizes preserving wildness. For example, extensive research has been conducted on historic fire regimes and stand structure, invariably leading to conclusions that fire suppression policies have had adverse impacts (Agee, this volume). This has promulgated recent attempts to restore historic fire frequencies, even where this necessitates intentional management ignitions. Recent research has shown that fire suppression in conjunction with invasion of an exotic fungus, white pine blister rust (*Cronartium ribicola*), is decimating populations of whitebark pine (*Pinus albicaulis*) in the northern Rocky Mountains. Restoration of more natural conditions will require such manipulative actions as management ignitions and genetic intervention to develop rust-resistant trees (Kendall and Schirokauer 1997). In the wilderness social science literature, there has been a similar emphasis on the importance of solitude, visitors evaluations (or norms) for encounters, and management actions needed to maintain solitude (Manning and Lime, this proceedings).

In contrast, the benefits of not manipulating wilderness lands and wilderness experiences and the costs of manipulation and regulation have not received serious scientific scrutiny. This is unfortunate because the managers who must decide between options are left with an unbalanced scientific perspective on costs and benefits. A partial explanation for this inequity, applicable to the ecological sciences, is the difficulty of studying the potential adverse outcomes of extensive ecosystem manipulation or loss of wildness. There is no reference for comparison analogous to historic conditions or uninfluenced ecosystems. Another explanation of this inequity is the predominant worldview of ecological science, with its emphasis on the value of natural systems and its faith in the competence of ecological understanding as a foundation for ecological manipulation. In the tradition of all Western science, most ecologists believe in the value of and their ability to control and manipulate systems for human purposes, in this case the restoration of more natural conditions in wilderness. Similar explanations might pertain to the surfeit of social science research on the benefits of unconstrained experiences and the costs of regulation.

Clearly, science needs to provide a better understanding of how human activities are causing wilderness ecosystems to diverge from the trajectories they would take in the absence of modern technological society. Perspectives on the costs of these divergences (loss of biological diversity, loss of scientific information, etc.) need to be sharpened. Science also should continue to study the erosion of solitude opportunities in wilderness and the costs involved. However, a more critical need at the present time—when actions are being taken that will decide the degree of naturalness, solitude opportunity and wildness of the future wilderness system—may be more scientific input on the value of preserving a high degree of wildness on at least some wilderness lands. This might lead to more enlightened and balanced decisions about the future emphasis of management in wilderness.

The relative importance of various types of scientific information will be greatly influenced by the extent to which naturalness and solitude are emphasized as wilderness management goals, at the expense of wildness. The pursuit of naturalness and solitude will require extensive manipulation of ecosystems and users. Ecological restoration, as well as solitude restoration, will take on greater importance. Because it is closely allied with the notions of ecological and social engineering, this approach implies a much higher degree of precision in defining management objectives, monitoring wilderness conditions and implementing management prescriptions than the pursuit of wildness. It places much greater demands on the quantity, reliability and sophistication of scientific information than does management for wildness.

Research to Support Managing for Naturalness

Substantial scientific knowledge is needed to restore the naturalness of wilderness ecosystems with any degree of precision. Studies of past and present ecological conditions must be undertaken to assess the extent to which current conditions deviate from a natural state. Science needs to contribute to a better understanding of the impacts of many different human activities on various ecological components and at different spatial and temporal scales (Cole and Landres 1996). Managers need to define targets, both for restorative manipulations and for future ecosystems (Bonnicksen and Stone 1985). Historic conditions, particularly the concept of historic range of variability, have been advanced as a tool for defining targets (Morgan and others 1994). The general notion is that, where naturalness is a goal, current conditions ought to lie within the range of conditions that existed in the past. For some ecosystem components, such as fire frequencies or long-lived tree species, relatively precise estimates of historic conditions are possible (Swetnam 1993). For components that are short-lived or for processes that leave little trace, information about historic conditions is less adequate. If this research is to be useful, several important philosophical issues about how to define naturalness need to be resolved (Anderson 1991, Haydon 1997). What time period should be used as a reference for "natural" conditions? Should aboriginal humans be considered part of the natural landscape?

Management prescriptions need to be developed that are capable of realigning existing conditions with those that would exist in a natural state. Probably the foremost ecosystem management challenge in most wilderness areas is the restoration of more natural fire processes. Considerable research effort, some of it reported at this conference, is

going into restoring native forest stand structure through management ignitions and, in some cases, mechanical removal of vegetation (Agee, this proceedings). Considerable research is being undertaken to find effective means of eradicating alien species and restoring native biotic components in ecosystems heavily infested with invasive species (Randall, this proceedings). Water bodies in many wildernesses have been highly altered by such diverse actions as regulation of upstream flows, pollution, acid deposition and the introduction of alien fisheries. The success of any restoration will largely depend on our understanding of how systems have changed in response to human activity and on the development of practical techniques for reversing those changes.

Once restorations are undertaken, ecosystem conditions need to be monitored in order to assess the effectiveness of prescriptions and to refine future management targets. At the current time, wilderness monitoring is virtually nonexistent. Considerable research needs to focus on developing effective monitoring protocols and this must be accompanied by an effort to obtain political support for the resources to adequately monitor wilderness lands (Landres and others 1994).

Can science provide the foundation needed to rigorously approach natural conditions in wilderness? There are several reasons for concern. The historic range of conditions might be appropriate for defining present targets for ecosystem conditions. However, what we have learned about natural ecosystems suggests that the future state of a natural system will be very different from the present state and not a predictable extension of recent ecosystem trajectories. Ecosystem manipulation and ecological restoration practices (for example, natural fire regimes) allow natural processes to be reintroduced in wilderness on the basis of past records, but there is no guarantee that these processes will produce an end-state similar to the past nor that they will play the same ecological role they did in the past. Climatic conditions and other determinants make these processes vary in unpredictable ways over time.

0nce wilderness systems have been extensively manipulated, they can no longer provide independent information about "natural" ecosystem manipulations. Historic conditions will increasingly become the only undisturbed reference conditions available for developing targets. It seems inevitable that we will tend to consider a future ecosystem trajectory that lies within the bounds of historic variation in conditions to be natural and one that goes beyond those bounds to be unnatural. This tendency would lead to future management prescriptions that push systems toward their past state, regardless of the trajectory of natural change. If all wilderness ecosystems have been manipulated, there will be no way to know whether our actions are pushing systems toward or farther away from a natural state.

Another concern is that manipulative prescriptions may effectively restore one ecosystem component but not another. For example, management ignitions during times of low fire danger are a possible prescription for restoring natural fire frequencies and tree stand structures. However, fires set during seasons when they would not naturally burn may cause unnatural changes to forest soils or to forest components other than dominant tree species. In attempting to restore naturalness, we may inadvertently promote the protection of dominant ecosystem components—long-lived, well-studied, charismatic elements—at the expense of other ecosystem components.

One type of restoration may make it more difficult to achieve a different restoration goal. For example, attempts to restore fire may increase vulnerability to invasions by alien plants (Cole and Landres 1996). Finally, attempts to restore ecosystem processes in a localized area might thwart efforts to conserve biological diversity at larger spatial scales. For example, in response to the establishment of alien salt-cedar (*Tamarix chinensis*) riparian vegetation along the dam-regulated Colorado River in Grand Canyon, several rare riparian birds, such as Bell's vireo (*Vireo bellii*) have expanded their range (Johnson and Carothers 1987). Attempts to eradicate alien salt-cedar or to restore pre-dam flow regimes would further endanger the survival of these species in the region.

Research to Support Managing for Solitude

Recreational carrying capacity, acceptable use encounters and solitude are issues that have been studied extensively in wilderness research. Beginning with the early thoughtful analysis by Wagar (1964) and 35 years of empirical research by agency and university scientists, much effort has been devoted to understanding the influence of use levels and encounters on wilderness experiences and solitude opportunities (Shelby and Heberlein 1986).

This relatively long and rich history of use level and solitude research has evolved in many directions, concentrating on various dependent measures. For example, use levels and encounters have been thought to influence satisfaction, density, crowding and solitude. In recent years, perceived crowding and normative explanations have been dominant. As summarized by Heberlein (1977), recreation researchers have used normative kinds of approaches in at least three ways. First, various researchers have developed measures of wilderness purism, aimed at identifying particular subgroups of wilderness users who share more sensitive beliefs about wilderness resources and solitude experiences. Second, normative perspectives have been used to explain the phenomenon of asymmetrical antipathy that exists between different types of wilderness users (for example, campers and horse packers). A third way that norms have been used is in the development of contact preference curves and encounter preference standards. A contact preference standard is "a normative construct based on shared beliefs about the appropriate number and type of encounters for a particular setting. The standard establishes an acceptable level for the number of encounters, and capacity can be specified if use level or some other management parameter affects encounters" (Shelby and Heberlein 1986).

Various normative approaches have been taken by wilderness researchers in trying to understand the relationship between wilderness solitude and use levels or encounters. Early research was able to determine encounter preference curves and standards for user reaction to various suggested levels of use. For example, canoeists were asked their reaction to seeing 1,2,3,5,7,9,15,20 and 25 other canoeists, inner-tubers or anglers. Encounter preference curves were developed from

these data to describe canoeist norms for contacts with other canoeists, inner-tubers and anglers. However, these encounter preference curves were based on researcher-suggested use levels and user preference responses, rather than actual response to field encounters.

Most recent research has evaluated visitor tolerance for optimum contact levels, essentially a measure of maximum preferred contacts. Visitors are asked to give their highest tolerable contact level (Shelby and Heberlein 1986). Tolerance standards have been derived for various use parameters and in various levels of wilderness settings. In addition to asking recreation users for the maximum level of encounters/contacts they will tolerate, users have been asked for the use level that would be most acceptable (the ideal). Based on descriptive measures of central tendency (such as mode or median) and dispersion (standard deviation) of visitor tolerance responses, normative standards and curves of use have been developed for wilderness management.

Tolerance/acceptability curves and standards are useful for investigating recreation user reaction to use levels, and they offer a means of formulating management standards of tolerable and acceptable use levels; but these standards still involve a preference rather than actual reaction to use levels. Some researchers have criticized the procedure because it forces respondents to formulate tolerance standards when, in fact, they may not care about use encounters and thus have not formulated valid tolerable and acceptable limits of use (Roggenbuck and Williams 1994).

A current question in use encounter, use norms and solitude research in wilderness is to what degree encounter norms actually exist among wilderness users, and if they do exist, what influence actual encounters on-site have on wilderness solitude and associated experiences. For example, fewer than half of New River whitewater rafters had norms about appropriate encounter levels for most types of experiences (Roggenbuck and others 1991). Many said encounters made no difference, or that they made a difference but could not give an encounter number. For those who had norms, consensus was not strong. Patterson and Hammitt (1990) found similar results when they examined the influence of actual encounter levels on solitude experiences. Although 83% of backcountry backpackers reported encountering more parties than their acceptable norms, only 34% of the backpackers reported that the number of encounters detracted from their solitude experience.

Controversy among social scientists continued at this conference over the validity of encounter norms as indicator standards for manipulating solitude opportunities in wilderness. While there are different schools of scientific thought on this topic, one thing is certain. Solitude is an important aspect of wilderness management, use encounters have to be involved, and it is the responsibility of wilderness scientists to develop more sophisticated research in order to validly support managing for solitude in wilderness ecosystems.

Research to Support Managing for Wildness

Managing for a high degree of wildness does not require nearly as much science as managing for naturalness or solitude. Managing for wildness would preclude options for extensive manipulation of wilderness ecosystems or of wilderness users. Localized, intensively impacted sites, such as recreation sites, former roads, old mines or localized alien infestations, could be restored without substantially jeopardizing the wildness of most wilderness. For these types of impact, it is relatively easy to identify appropriate target conditions because disturbed sites can be compared with adjacent, undisturbed sites. There is no need to use historic conditions as a reference. Consequently, concerns about the tendency to manage for a static state are reduced.

It may be more challenging to develop management prescriptions for localized disturbances than for extensive disturbances because localized disturbances are usually more intense. Consider, for example, the difference in intensity of impact between a forest subjected to fire suppression and a compacted campsite or mine tailings full of heavy metals. The forest has experienced some structural and compositional change, but every aspect of the structure, composition and function of the campsite and mine tailings has been radically altered. Advances in the science of restoration ecology would make a substantial contribution to the success of efforts to restore localized impacts. Failed localized restorations—while costly in terms of resources expended—would not be as costly to wilderness values as failed extensive restorations because most wilderness would remain unmanipulated and wild, regardless of the success of prescriptions.

It may also be possible to restrict use and behaviors in some portions of wilderness while still managing for wildness. For example, research data indicate that intensively impacted sites and areas of concentrated use where solitude opportunities are in jeopardy typically comprise less than two percent of wilderness ecosystem acreage (Hammitt and Cole 1998). With behavioral restrictions, large numbers of people could continue to visit these popular locations, leaving the rest of the wilderness relatively unused. If use of these low-use places increases, it might be necessary to restrict access to them (Cole 1997), but wildness could be maintained by minimizing the use of behavioral restrictions once one gains access.

When wildness is the primary goal of wilderness management, the same types of scientific understanding are needed as when naturalness and solitude are the primary goals. It is still important to understand the influence of human agents of change and their significance and to monitor wilderness conditions in relation to management objectives. However, science in support of maintaining wildness need not be as precise, comprehensive or sophisticated as science in support of maintaining naturalness and solitude, because there is less emphasis on the prescription of target conditions and restorative manipulations. Moreover, scientific inadequacy is much less costly where management emphasizes wildness.

Conclusions

Wilderness management, with its goals of preserving natural conditions and solitude opportunities while avoiding intentional human control, is arguably the most challenging task confronting land managers. To succeed, the

quantity and quality of scientific knowledge need to be increased dramatically. We need better information about the influences of a wide range of human activities, from recreation and grazing to fire, pollution and the influence of adjacent land practices. The more rigorously we pursue the protection and restoration of natural conditions and solitude opportunities in wilderness, the greater the demands on science. The most prudent course of action might be to (1) work to increase the resources allocated for wilderness research and (2) temper our zeal for pursuing naturalness, solitude and manipulation inside wilderness with a healthy skepticism about the adequacies of our knowledge and abilities. Wilderness stewardship is a delicate balance between the paralysis that can come from too little faith in existing scientific knowledge and the excessive engineering of wilderness that can come from too much faith in science.

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