A Framework for Evaluating Proposals for Scientific Activities in Wilderness

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Abstract—This paper presents a structured framework for evaluating proposals for scientific activities in wilderness. Wilderness managers receive proposals for scientific activities ranging from unobtrusive inventorying of plants and animals to the use of chainsaws and helicopters for collecting information. Currently, there is no consistent process for evaluating proposals, resulting in confused and frustrated scientists and managers, as well as lost opportunities for gaining valuable information about a wilderness. The framework presented here is based on two premises: that both benefits and impacts are fully considered, and that communication between scientists and managers occurs at the beginning of the evaluation process.

Every year, managers in four different federal agencies receive hundreds of proposals for scientific activities to be conducted within designated wilderness. These proposals have included inventories of the plants and animals within a wilderness, marking amphibians and small mammals by toe-clipping and using radio collars on large mammals, removal of individual plants and animals for tissue analysis, and use of motorized equipment such as chainsaws or helicopters for collecting data and the installation of permanent plots and devices for recording data. Wilderness poses a unique set of opportunities and constraints on research (Butler and Roberts 1986, Franklin 1987, Greene and Franklin 1989), yet there is only vague legal and policy direction to guiding evaluation of proposed scientific activities. Each of the four wilderness agencies (USDA Forest Service, and the USDI Bureau of Land Management, National Park Service, and Fish and Wildlife Service) have their own evaluation procedures, and individual offices within an agency sometimes evaluate proposals in different ways. Further, evaluation procedures may not comprehensively consider the full range of ecological and social impacts. Inconsistent evaluation procedures leads to frustration and a lack of understanding between managers and scientists and, sometimes, the perception of arbitrary and capricious decisions in approving or denying proposals for scientific activities in wilderness.

The goal of this framework is to provide a systematic and comprehensive process for evaluating proposals to conduct scientific activities in wilderness. This framework is based largely on two premises. First, decisions to approve or deny scientific activities need to fully consider both the impacts and benefits of the proposed activity (Parsons and Graber 1991). Evaluating impacts and benefits is not an exact science, and making subjective judgments and their underlying assumptions explicit is a vital part of this framework. Second, communication between managers and scientists should occur at the beginning, rather than at the end, of the evaluation process. Improved up-front communication between managers and scientists increases the likelihood that (1) impacts from scientific activities on wilderness values will be reduced or mitigated, (2) managers will derive useful products from the proposed activities, (3) scientists will be given permission for their proposed activities, and (4) managers and scientists will have a better understanding of each others' concerns.

While no single evaluation process will work in every situation, especially in cases that have become contentious and politicized, a systematic evaluation process allows improved communication between managers and scientists and more defensible decisions.

Current Situation

Scientists and managers often fail to consider each other's context, needs and constraints. For example, scientists may not fully understand the philosophical basis of wilderness management and the impacts their activities may cause, and wilderness managers may not fully consider the potential benefits of a proposed activity to the broader system of natural areas nationwide (for example, Eichelberger and Sattler 1994). These different viewpoints, combined with the typically meager communication between scientists and managers, result in frustration and lost opportunities for both the advancement of science and wilderness protection (Peterson 1996).

Contributing to this lack of understanding and communication is inconsistency in how proposals for scientific activities are evaluated. Each of the four wilderness management agencies, and often administrative offices within these agencies, use different processes for evaluating proposals. Despite these differences, the following three screening questions, in various forms, are common to nearly all evaluation processes:

- Is the proposed activity necessary for the management of the area as wilderness?
- Is it necessary to conduct the proposed activity in wilderness?
- Will the proposed activity cause unacceptable impacts to the wilderness character?

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While these questions address valid concerns, they raise additional questions and problems. The first question is based on wording in the 1964 Wilderness Act which allows certain types of impacts if the activity is deemed "necessary to meet minimum requirements for the administration of the area for the purpose of this Act." However, the Wilderness Act does not define what these "minimum requirements" are or under what set of conditions they apply, leading to different interpretations by different people and different agencies.

The second question is largely based on the assumption that scientific activities are an intrusion and sometimes a threat to wilderness character, and if the activity could be conducted outside the wilderness, it should be. While it is a valid consideration, exclusive emphasis on minimizing impacts may restrict scientific activities unduly, leading to a lack of information about wilderness conditions and, possibly, adversarial relations between managers and scientists. These poor relationships may further stem the development of new and better information needed to protect wilderness and to plan for its future.

The last question poses the most difficult problem since all human activities cause impacts to wilderness, yet acceptability of the impact varies from one activity to another and from one situation to the next, often with little consistency or adequate definition. Acceptability can also change over time. For example, relatively pristine wilderness conditions are increasingly unique, and scientists believe ecological and social science activities within wilderness are of increasingly greater value beyond the boundaries of the wilderness. Many managers, however, are unwilling to accept impacts to an individual wilderness from scientific activities that provide only broad-scale, and more loosely defined, societal benefits.

Evaluation Framework

This framework is composed of three sequential filters: a Legal and Policy Filter, a Benefits and Impacts Filter and a Quality of Design Filter (fig. 1). The first filter helps determine if the proposed activity fits within the "minimum requirements" provision of the Wilderness Act and is compatible with other applicable legal, policy and planning documents for that wilderness. If the activity passes this filter, the second filter, composed of two stages, evaluates the relative benefits and impacts of the proposed activity. The first stage is a rapid assessment of benefits and impacts that classifies the proposed activity "approved to next filter," "denied" or "further evaluation needed." For proposed activities falling into the last class, the second stage is a comprehensive and in-depth evaluation of what the benefits of the activity are, who derives this benefit, what the ecological and social impacts are and whether these impacts can be prevented, minimized or mitigated. The third filter and last step in this process is to evaluate if the proposed activity is well-designed and capable of providing its intended outcome.

This framework includes all the elements that are necessary and sufficient to evaluate a proposed scientific activity. In some cases, this process will lead to quick decisions, while in other cases, the process will identify the need for

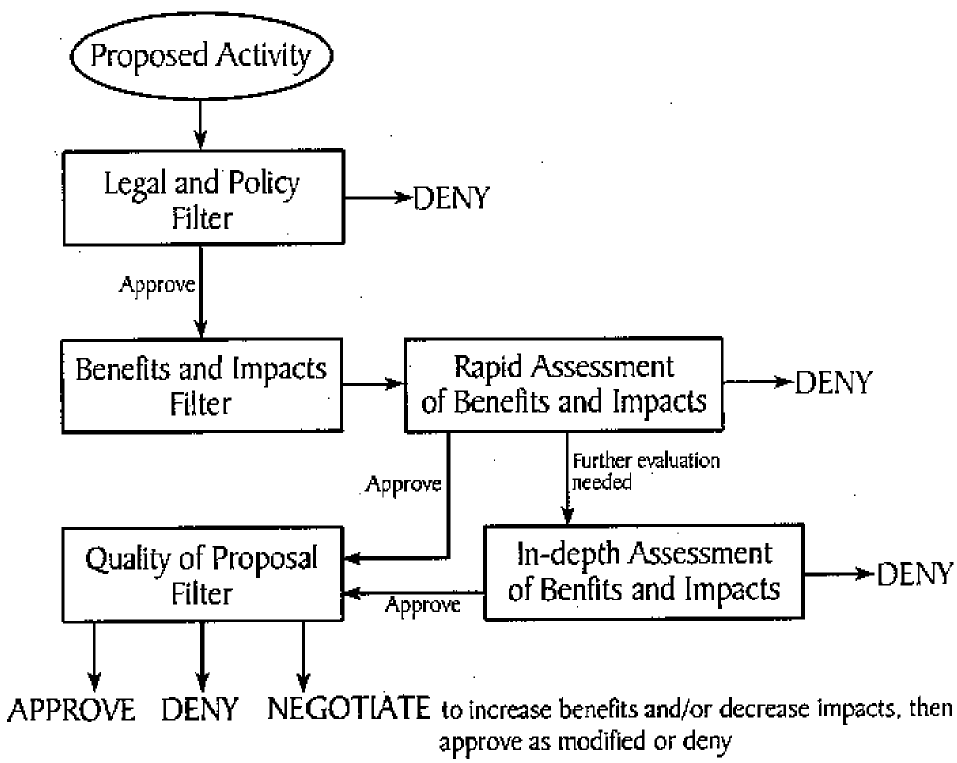

Figure 1—A systematic framework for evaluating proposals for scientific activities in wilderness.

a comprehensive evaluation that will take longer and be much more difficult. Subjective judgments are an integral part of evaluating proposed activities in many cases, especially in those needing a comprehensive evaluation of benefits and impacts. The proposed framework makes these judgments and their underlying assumptions more explicit, and allows their merits and limitations to be openly discussed. In addition, if a structured process is used to evaluate proposals, scientists and managers can discuss how the proposal will be evaluated *before* it is submitted. If scientists understand this process and that both benefits and impacts of their proposed activity will be rigorously evaluated, they will strive to minimize the impacts and maximize the benefits of their work. This structured process provides a sound basis for improved communication between managers and scientists, leading to scientific activities that may be tailored to maximize their benefits to wilderness and wilderness managers.

Legal and Policy Filter

Scientific activities that violate applicable laws and agency policies are not allowed in wilderness. In addition, most managers strive to fulfill the spirit of the Wilderness Act as well as the letter of the law. In some cases, however, the spirit of the law is obscured by ambiguous wording in both legislation and agency policy. For example, Section 4(c) of the Wilderness Act of 1964, "Prohibition of Certain Uses," reads in full:

> Except as specifically provided for in this Act, and subject to existing private rights, there shall be no commercial enterprise and no permanent road within any wilderness area designated by this Act and, *except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act* (including measures required in emergencies involving the health and safety of persons within the area), there shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation within any such area. [emphasis added]

In other words, *if* a proposed activity is "necessary" for the "minimum requirements for the administration of the area," *then* the typical prohibitions may be relaxed. The problem is that "necessary" and "minimum requirement" are nowhere defined in the Wilderness Act or in other wilderness legislation, leading to different definitions and criteria used by different people in different situations. Additional confusion is caused when different people interpret the phrase "for the purpose of this Act." Some consider the "purpose" of the Wilderness Act to protect and preserve wilderness for the enjoyment of present and future generations, which is primarily a recreation focus. Others consider this "purpose" to be much broader, to secure "the benefits of an enduring resource of wilderness," and these benefits are "recreational, scenic, scientific, educational, conservation, and historical use" (Sections 2(a) and 4(b), respectively, of the Wilderness Act of 1964). The broader view typically considers scientific activities to be an integral part of wilderness.

To help resolve these problems, the USDA Forest Service is developing guidelines for determining whether a proposed activity is the minimum required for administration of an area as wilderness. The Legal and Policy Filter shown in figure 2 is modified from the Forest Service's draft "Minimum Requirement Determination Guide" for the specific case of scientific activities. In this filter, the first three questions are used to determine if an activity must be approved. However, even if an activity is approved via any of these first three questions, negotiation may still be used to reduce and mitigate impacts. Proposed activities that pass to the fourth question require further evaluation based on eight additional questions that yield subjective "yes/no" answers. After these questions are answered, an individual determination is made about denying the activities because they fail to meet legal and policy standards, or approving them to be evaluated in the remaining two filters.

Benefits and Impacts Filter

If a proposed activity passes through the Legal and Policy Filter, the potential benefits and impacts of the activity are evaluated. Most of the processes currently used to evaluate proposals for scientific activities, especially within the Forest Service, largely focus on potential impacts and either ignore or underrate potential benefits. Focusing on impacts stems from the traditional view that scientific activities are primarily an intrusion in wilderness. This traditional view should be evaluated against the view that wilderness offers a unique opportunity to learn about the structure and functioning of both ecological and social systems in relatively pristine environments, and that this information may be of great value to wilderness managers, natural resource agencies and society at large.

This filter is composed of two stages. The first is a rapid assessment of benefits and impacts, yielding a quick decision about whether the proposed activity is denied, approved or further evaluation of impacts and benefits is needed. The second stage is an indepth evaluation of benefits and impacts. To understand how this filter and these two stages work, a brief description of benefits and impacts follows.

Benefits depend on who considers the information important and how it might eventually be used. In addition, these benefits may extend well beyond the boundary of the protected area. There are three relatively distinct groups that may derive benefits from proposed activities: (1) wilderness managers gaining information about the wilderness they manage; (2) regional and national-level managers and policymakers gaining information about several wildernesses or the entire National Wilderness Preservation System; and (3) society at large gaining information about relatively pristine ecological systems and the benefits people derive from these. Each of these users typically operates at a different spatial and temporal scale, and proposed activities are typically designed for one scale and therefore typically benefit one user more than another (fig. 3). For example, site-specific activities may provide knowledge about the flora or threatened and endangered species in one wilderness, but this information is of less importance to other wildernesses. Conversely, some activities, such as the Forest Health Monitoring program, are designed to collect a small amount of information from many wildernesses that, when summarized, provides critical information for national-level assessments.

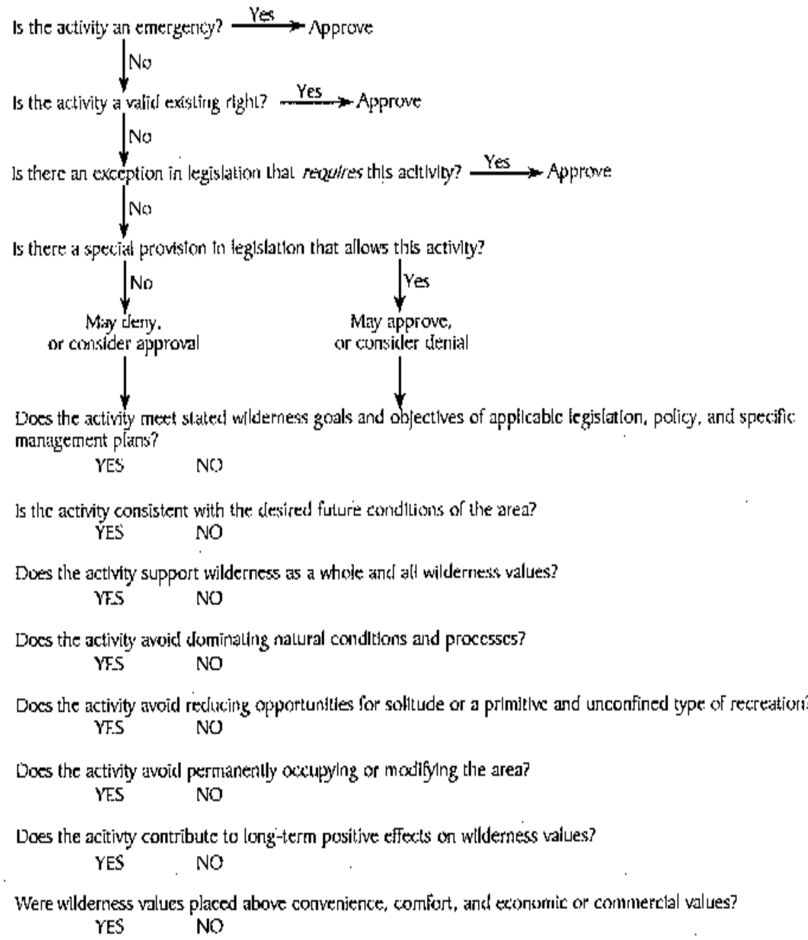

Figure 2—The Legal and Policy Filter. This filter is modified from the draft "Minimum Requirement Determination Guide" developed by the USDA Forest Service, 1999, used by permission. The first three questions yield direct "yes/no" answers that are used to determine if an activity must be approved. Even if an activity is approved via one of these three questions, negotiation may still be used to reduce and mitigate impacts. The fourth question about special provisions, and the remaining eight questions, yield subjective "yes/no" answers: a greater number of "yes" answers suggests approval of the activity while a greater number of "no" answers suggests denying the activity.

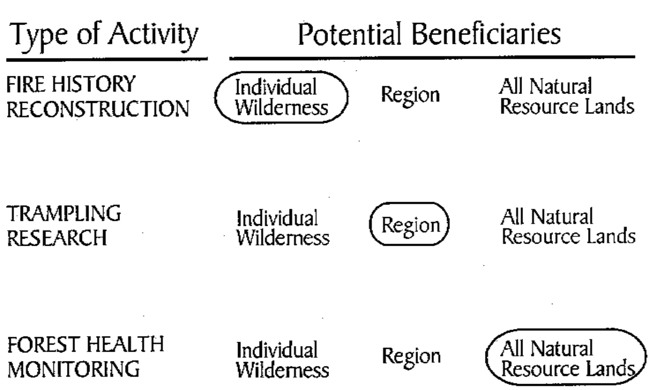

Figure 3—Diagrammatic view of the primary beneficiary (circled) of different types of scientific activities. While any given activity may benefit all of these different levels, an activity is usually designed to provide information primarily about one level, resulting in relatively greater benefits to this level.

Impacts may occur to both the ecological and social values of wilderness. Ecological impacts may include trampling plants, collecting specimens, disturbing soil, trapping and marking animals which are then released, or the use of exclosures or inclosures. Social impacts may include an increased number of encounters with scientists and their field crews, the sound and sight of motorized equipment or visual impacts from tags, markers and other equipment that affect a primitive wilderness experience. Social impacts also include philosophical concerns about a proposed activity that may, for example, set a precedent for violating the untrammeled character of a wilderness. For example, to some people, using helicopters to access remote locations for lake or vegetation monitoring, or for placing radio collars on threatened and endangered species such as wolverines, is a clear violation of the spirit and letter of the Wilderness Act.

Fundamental questions asked about all impacts include: (1) How big an area will be affected? (2) How intense will the impact(s) be? (3) How long will the impact(s) last? (4) Can the impact(s) be mitigated, both during the activity and after it is completed? In many, if not most cases, there will be no precise or hard information on impacts. Relying on subjective judgment is appropriate in such cases as long as these judgments and underlying assumptions are made explicit so their merits and detriments can be openly discussed and debated.

The first, rapid assessment stage of benefits and impacts is based on a simple two-way "benefits-impacts matrix" (fig. 4). The purpose of this matrix is to rapidly identify and approve proposed activities that provide large benefits with little impact and identify and deny those activities that offer little or no benefit but cause considerable impacts. Also, it is suggested that proposed activities which offer few or no direct benefits and cause little impact be readily approved (Graber 1988). Some may argue that the latter should be denied because they do not fulfill the necessary minimum requirements discussed earlier and that all unnecessary activities further trammel an area. In contrast, these activities are relatively benign, they may provide baseline information with unanticipated later usefulness, and they may fit under the "recreational, scenic, scientific, educational, conservation, and historical" uses described in the Wilderness Act of 1964.

The second, indepth evaluation stage is required because relatively few proposed activities will be readily approved or denied in the first, rapid assessment stage. Instead, many proposed activities will likely require indepth evaluation of the tradeoffs between potential benefits and impacts. Evaluating tradeoffs is as much art as science, and several different approaches may be taken. The approach described here first evaluates impacts in greater detail; these impacts are then compared to the benefits of the proposed activity. There are no objective, quantitative means for making this evaluation, and once the benefits and impacts are explicit, the decision-maker will need to make a subjective judgment about whether the benefits of the proposed activity outweigh the impacts, or vice versa.

Each proposed activity will probably have many different types of impacts, and it is crucial that all impacts are listed so they can be evaluated. A comprehensive evaluation needs to consider three broad types of impacts:

- Biophysical — impact to plants, animals, soil or ecological processes
- Recreational — impacts to solitude or opportunities for primitive recreation experiences
- Societal — impacts to the social purposes for which wilderness was created, including impacts to wildness or the untrammeled character of wilderness and the precedent an activity sets for wilderness nationwide

One way to evaluate impacts in greater detail is to array the amount of area affected against the intensity of the impact in a two-way "impacts matrix" and assign numerical categories to the different levels of overall impact (fig. 5). Specific data will usually not be available to evaluate an impact in this manner, so judgments are appropriate as long as the assumptions and constraints behind a judgment are made explicit. Each potential impact and its numerical score can then be listed together to provide a picture of the impacts from a proposed activity (figs. 6, 7 and 8). Listing all the potential biophysical, recreational, and societal impacts in this way should make apparent the specific impacts that are of greatest concern, allowing explicit discussions about accepting these impacts or how to minimize or mitigate them.

Quality of Design Filter

The outcome from the indepth evaluation of benefits and impacts is to either deny the proposed activity or to approve it to the last Quality of Design Filter. The purpose of this last filter is to ensure that the proposed work is adequately designed to meet its intended goals and objectives. It may be the most challenging for managers if they are not trained in scientific methods of research design, sampling theory and statistical analysis. Managers have four options to assess the quality of the proposed activity: (1) Review the design

IMPACTS \ BENEFITS	Few	Some	Many
Few	Approve	Approve	Approve
Some	??	??	Approve
Many	Deny	Deny	??

Figure 4—A *benefits-impacts matrix* used to rapidly assess proposed activities into one of three categories: "Approve" to the next Quality of Design Filter, "Deny," or proceed to an in-depth evaluation (denoted by "??"). The assignments shown here are merely to illustrate the process. The office or person doing this evaluation must develop their own assignment of "Approve," "Deny," and "??" into each box of this matrix.

INTENSITY OF IMPACT \ SIZE OF IMPACTED AREA	Small	Medium	Large
Small	1	2	3
Medium	2	3	4
High	3	4	5

Figure 5—An *in-depth impacts matrix* used in the evaluation of impacts by assigning numerical categories of overall impact. The numbers used here merely illustrate the process. The office or person doing this evaluation must develop their own assignment of numerical ratings into each box of this matrix.

TYPE OF IMPACT	AMOUNT OF IMPACT				
BIOPHYSICAL IMPACTS					
Sawcuts in living trees (small area, high intensity)	1	2	(3)	4	5
Trampling of vegetation (medium area, weak intensity)	1	(2)	3	4	5
Noise displacement of wildlife (medium area, medium intensity)	1	2	(3)	4	5
RECREATIONAL IMPACTS					
Sight of sawcut stumps (small area, high intensity)	1	2	(3)	4	5
Sight of chainsaws (small area, high intensity)	1	2	(3)	4	5
Noise of chainsaws (medium area, high intensity)	1	2	3	(4)	5
Encounters with field crews (medium area, weak intensity)	1	(2)	3	4	5
SOCIETAL IMPACTS					
Precendent of using chainsaws (large area, high intensity)	1	2	3	4	(5)

Figure 6—Example of an in-depth evaluation of the impacts from proposed *fire history reconstruction research* in a wilderness. This example is not exhaustive and only shows representative impacts within each of the three broad types of impacts. Parenthetical statements below each impact represent judgments of the amount of area affected and the intensity of impact. The circled numbers shown here reflect these judgments of impact based on the numerical categories shown in the in-depth impacts matrix (fig. 5). The judgments of impacts and numerical ratings shown here are only representative and do not reflect actual ratings.

TYPE OF IMPACT	AMOUNT OF IMPACT				
BIOPHYSICAL IMPACTS					
Trampling of vegetation (small area, high intensity)	1	2	(3)	4	5
Soil erosion (small area, high intensity)	1	2	(3)	4	5
RECREATIONAL IMPACTS					
Sight of trampling plots (small area, high intensity)	1	2	(3)	4	5
Encounters with field crews (medium area, weak intensity)	1	(2)	3	4	5
SOCIETAL IMPACTS					
Precendent of purposeful trampling (large area, high intensity)	1	2	3	4	(5)

Figure 7—Example of an in-depth evaluation of the impacts from proposed *trampling research* in a wilderness. This example is not exhaustive and only shows representative impacts within each of the three broad types of impacts. Parenthetical statements below each impact represent judgments of the amount of area affected and the intensity of impact. The circled numbers shown here reflect these judgments of impact based on the numerical categories shown in the in-depth impacts matrix (fig. 5). The judgments of impacts and numerical ratings shown here are only representative and do not reflect actual ratings.

TYPE OF IMPACT	AMOUNT OF IMPACT				
BIOPHYSICAL IMPACTS					
Trampling of vegetation (small area, weak intensity)	(1)	2	3	4	5
Driving nails in trees (small area, weak intensity)	(1)	2	3	4	5
RECREATIONAL IMPACTS					
Sight of permanent plot markers (small area, medium intensity)	1	(2)	3	4	5
Encounters with field crews (medium area, weak intensity)	1	(2)	3	4	5
SOCIETAL IMPACTS					
Precendent of national-level monitoring in wilderness (large area, medium intensity)	1	2	3	(4)	5

Figure 8—Example of an in-depth evaluation of the impacts from proposed *forest health monitoring* in a wilderness. This example is not exhaustive and only shows representative impacts within each of the three broad types of impacts. Parenthetical statements below each impact represent judgments of the amount of area affected and the intensity of impact. The circled numbers shown here reflect these judgments of impact based on the numerical categories shown in the in-depth impacts matrix (fig. 5). The judgments of impacts and numerical ratings shown here are only representative and do not reflect actual ratings.

quality of the proposal themselves; (2) ask their in-house science staff to review the proposal; (3) ask outside scientists for review; or (4) assume that the proposal is sufficiently well-designed that no review is needed. The drawbacks to the first three options are the staff time and funding needed to review proposals. While the fourth option may appear specious, some national-level cases such as the Forest Health Monitoring program are developed with rigorous standards and don't need to be reviewed for design quality.

The outcome from this Quality of Design Filter is to deny the proposed activity, approve it or negotiate with the proposer about how to maximize the benefits and how to reduce or mitigate impacts from the proposed activity.

Conclusions

This framework provides a process for systematically and comprehensively evaluating the benefits and impacts of proposals for scientific activities in wilderness. Fully considering the benefits and impacts of a proposed activity, and making all judgments and assumptions explicit, allows informed and defensible decisions. Furthermore, a systematic and comprehensive framework provides the basis for consistent and explicit communication between managers and scientists. Despite these advantages, this framework cannot be used "off-the-shelf." The managers of each wilderness will need to tailor and modify it to suite their particular administrative and philosophical context and constraints. This framework also points to the critical need for agencies to publish formal guidelines describing exactly how proposals for scientific activities will be evaluated.

Such guidelines provide the basis for explicit, up-front discussions between managers and scientists, leading to scientific activities tailored to reduce their impacts and increase their benefits to wilderness and wilderness managers.

Acknowledgments

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