Wilderness for Science: Pros and Cons of Using Wilderness Areas for Biological Research

Diana L. Six
Paul Alaback
Robert A. Winfree
Della Snyder
Anne Hagele

Abstract—Research is one of the intended purposes of wilderness. The Wilderness Act states that "wilderness may contain ecological, geological, or other features of scientific, educational, scenic, or historical value." This session specifically focuses on the pros and cons of conducting research in wilderness.

Research is one of the intended purposes of wilderness. The Wilderness Act states that "wilderness may contain ecological, geological, or other features of scientific, educational, scenic, or historical value." This session specifically focuses on the pros and cons of conducting research in wilderness. Therefore, I thought it might be helpful to present, at the beginning, the general criteria that must usually be met if a research project is to be conducted in wilderness. These criteria are:

1. The intended research activities are otherwise allowable under federal laws and regulations.
2. There are no alternatives to conducting the research in a wilderness area.
3. The project will not adversely affect physical or biological resources, ecosystem processes, or aesthetic values of an area or for a duration greater than necessary to meet research objectives.
4. The project will not interfere with recreational, scenic or conservation purposes of the wilderness over a broad area or long duration.

I think most of us agree that wilderness areas provide an invaluable resource for researchers in many of the sciences, not just the biological sciences. The benefits of working in wilderness are innumerable; for some studies, wilderness provides the only appropriate setting available. For instance, studies looking at natural processes are especially suited to wilderness settings. Indeed, studies looking at long-term natural processes would, in many cases, be impossible to conduct outside of the wilderness context.

For example, my research focuses on bark beetles. Bark beetles are little insects about 2-6 mm long, depending on the species. Some species kill trees, and they do this with such gusto and vigor that they are considered our most important forest pest. Bark beetles are usually present in the forest in very low numbers, often confined to single tree populations or small clusters of attacked trees widely scattered across the landscape. Under certain conditions, they can develop large outbreaks that kill thousands of trees. These outbreaks quite obviously can have great impacts on succession, fire patterns, wildlife and just about everything existing within the affected area and its immediate surroundings. However, besides being viewed as a pest because they compete with us for timber, increase fuel loading and affect aesthetics by killing trees, they are also an integral and necessary part of our forest ecosystems. They are a natural disturbance agent that our forests have coevolved with and a major force determining successional patterns and ecosystem dynamics.

A lot of research has been conducted over the decades on how to manage bark beetles to avoid timber losses. However, very little is known about their population dynamics and their role in ecosystem dynamics. Studies in managed areas are difficult. Silvicultural and pest management of stands greatly alter beetle population dynamics and disrupt long term field experiments and observations. To properly study bark beetle population dynamics, one must work in unmanaged areas of substantial size for relatively long periods of time. These requirements eliminate most, if not all, national forests, state, and private lands where beetles are usually managed as soon as populations begin to expand. Wilderness remains the only appropriate location for such studies. The point I would like to emphasize is that, in many cases, wilderness areas provide critical outdoor laboratories, and sometimes, the only laboratory.

On the other hand, while wilderness areas provide desirable and often optimal conditions for many studies, some studies are not at all appropriate. Given that wilderness is described in the Wilderness Act as an area untrammeled by humans, some studies are immediately and correctly excluded because of their highly disruptive or manipulative natures. However, for studies involving less disruptive experimentation or observation, working within the confines of legal and ethical restrictions can sometimes be

In: McCool, Stephen F.; Cole, David N.; Borrie, William T.; O'Loughlin, Jennifer, comps. 2000. Wilderness science in a time of change conference—Volume 3: Wilderness as a place for scientific inquiry; 1999 May 23-27; Missoula, MT. Proceedings RMRS-P-15-VOL-3. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Diana L. Six is Assistant Professor of Integrated Forest Entomology/Pathology, School of Forestry, University of Montana, Missoula MT 59812 U.S.A. Paul Alaback is Associate Professor of Forest Ecology, School of Forestry, University of Montana, Missoula MT 59812 U.S.A. Robert A. Winfree is Senior Scientist; Della Snyder and Anne Hagele are Research Assistants, Grand Canyon National Park, AZ U.S.A.

difficult. Restrictions constraining research are often not clearly stated or evenly applied. This situation is not easily remedied because the constraining factors may not lend themselves to precise definition or consistent applicability, especially because research projects are likely to require evaluation on a case by case basis. In addition, many researchers often avoid working in wilderness because the permitting process can be intimidating and/or frustrating. The need is apparent for clear, consistent and understandable policies on research in wilderness.

The purpose behind organizing this dialogue session was to bring together researchers, managers and other interested parties to discuss the positive and negative aspects of doing research in wilderness areas. The session began with short presentations by panelists and concluded with open discussion on how benefits to researchers and to wilderness areas may be increased through appropriate research, as well as on how to alleviate some of the negative aspects of conducting wilderness research.

Panelists

Why Do Ecological Research in Wilderness? Paul Alaback

The Scientific Opportunity—As ecology moves toward providing increasingly more useful information for improving natural resource policy and a more rigorous basis for management, it is increasingly impelled to tackle more complex and multidimensional questions. Since ecosystems are so complex and little understood, we cannot at this time, or any time in the foreseeable future, capture the full array of historic and contemporary ecological influences on ecosystems across a range of scales, in either the laboratory or a computer model. We need to have nature as our laboratory.

This complexity is our greatest challenge. Since the temperate forests I have studied are composed of species of great antiquity which have adapted to a broad range of climatic and natural disturbance-induced stress, mostly before the advent of humanity, it is key to understand how ecosystems work in a “natural” physical landscape and climatic regime. This is our essential scientific framework, which provides a critical context for most questions of human alteration of these patterns and functions.

While some wilderness areas suffer from varying degrees of global to regional-scale human impacts, they still hold more promise for studies hoping to unravel clear cause-effect ecological relationships than for studies that use ecosystems which have been variously affected by both known and unknown human influences. One particular category of ecological inquiry absolutely requires wilderness landscapes: landscape ecology. One of the key objectives of landscape ecology is to understand the influence of ecological factors that vary over a range of scales on ecological structures and processes. Wilderness areas are, by definition, the only places where such studies could be done without additional complications of human disruption of landscape structure and function.

I would like to also point out that some philosophers, historians and policy makers have tended to over generalize the extent of global human alteration of wilderness ecosystems and in so doing underestimating the value of wilderness as a scientific resource. The wilderness ecosystems that I have studied include some of the most pristine and least impacted by humans on Earth. For example Admiralty Island in Southeast Alaska is a wilderness area nearly 400,000 ha, which aside from a small portion of coastline on the north side, is a complete and intact ecosystem completely surrounded by a generous buffer of cold ocean. No significant alteration of disturbance regimes has occurred and all the key large and wide-ranging mammal and bird species that occurred 2,000 years or more ago, such as grizzly bears, and bald eagles continue to have healthy thriving populations.

In such unaltered wilderness areas scientists can understand clearly what factors affect ecological processes across a range of scales up to hundreds of thousands of hectares. Some wilderness reserves in Chile and Argentina also offer similar opportunities to ecological scientists. Many sites also occur in boreal, polar and even in some tropical ecosystems. Even when there has been some human-induced disturbance in these ecosystems the disturbance tends to be better defined and more conducive to study than in unprotected areas. An example would be old roads and clearcuts and the opportunity they afford for understanding long-term patterns of ecosystem recovery without complications of firewood cutting, salvage logging, human use of logging roads etc. which often compromise these studies in unprotected areas.

So what’s the problem?—So why aren’t these large pristine wilderness areas key centers of ecological research, as would be assumed given the above reasoning and the direction given in the Wilderness Act especially in the National Antiquities Act (affecting Admiralty Island, Escalante and Misty Fjords National Monuments in particular)? The examples cited above have had only a modest history of research use.

1. It is very expensive to conduct research in these remote regions. These coastal wildernesses are accessible only by boat or airplane, and weather frequently prevents safe travel over much of the year. None are close to major universities, so travel even to the general vicinity of these wilderness areas is expensive.
2. Wilderness areas generally do not represent either a broad range or a random sample of ecosystems within a region so they cannot be used as appropriate study sites for some studies without producing a biased or limited result. This is particularly true in interior mountainous regions, where wilderness generally represents only high-elevation sites; in coastal and high latitude areas, this may be less problematical.
3. Research that requires equipment or delicate electronics is very difficult because of the lack of control of climatic factors and generally nonexistent facilities for such research within wilderness.
4. It is difficult to travel efficiently within these large and rugged wilderness areas, leading to studies with small and not well distributed samples sites, compromising statistical rigor and inference.
5. Despite general legislative support and encouragement for research, there are often administrative barriers, varying from more involved permission procedures to restrictions in travel, use of equipment, establishment of

permanent plots, sampling restrictions and even location of campsites and timing of research activity.

6. There is often a lack of good communication and understanding between managers and scientists, leading to unnecessary amplification of the above problems.

For examples, some of my colleagues have been told they needed to establish campsites that were not visible to tour ships that traveled through study fjords, significantly compromising field efficiency. In some cases, plots could not be randomly located because of considerations of potential dispersed recreational use. Restrictions on tree or plot markers have made plot relocation difficult and reduced scientific precision for long-term studies. In some cases, environmental activists removed all plot markers from ecological studies in wilderness areas, leaving notes for the researchers in which they detailed their objections to how these markers compromised their wilderness experience.

Solutions—There many possible ways of mitigating problems associated with field ecological research in wilderness areas. As technology advances, some of these issues have become less important. For example, many landscape studies can effectively utilize remote sensing technologies, reducing requirements for extensive field plot sampling. Computer technologies also offer opportunities to reduce the visibility or even remove the necessity of having plot markers. These technologies may also reduce study costs by increasing field sampling efficiency.

If wilderness management agencies and nongovernment organizations (NGO's) that need more scientific information about wilderness areas developed more broadly based and well-funded grant programs, a larger base of scientists might be recruited to conduct wilderness studies. This program could aid communication between managers and scientists at the same time. For example, in British Columbia, NGO's successfully attracted a broad range of scientists internationally at minimal cost, simply by helping with logistical support and using existing scientific information networks to advertise the scientific values of their areas. In Alaska, a foundation is being organized to accomplish a similar goal for Admiralty Island. Key to these efforts is the establishment of a combined manager/scientists committee to set goals and determine evaluation criteria for proposed research projects.

Scientific use of wilderness areas is very different from recreational use. Wilderness managers sometimes focus their attention primarily on recreational issues in wilderness areas. Promotion of scientific use of wilderness may require some very different management philosophies. There is a need for careful evaluation of policies and procedures regulating scientific use of wilderness areas to see how management goals of resource protection and enhancement of visit or uses can be balanced against potential benefits or the need for scientific study of these unique areas. The dilemma is that these few protected areas in world, generally less than 6% of terrestrial ecosystems, are the best or even only places for both answering certain scientific questions and engaging in certain kinds of recreation and resource protection. Of course, determining the best ways to achieve all these management goals should itself benefit from more research in wilderness. So the resolution of these problems should be of potential benefit to all wilderness users and managers, not just scientists.

Designation and protection of additional areas, with regard to wilderness as a scientific resource, could also play a major role in promoting scientific utilization of wilderness. For example, when the French Pete additions to the Three Sisters Wilderness in Oregon were approved, the scientific value of this wilderness was enhanced vastly beyond the mere addition of land area. Now the wilderness includes productive low-elevation secondary forest and riparian ecosystems, in addition to the previously protected high-elevation forests, lakes and meadows that buffer this addition. Recent additions of protected land in the Tongass National Forest also have had generally greater scientific value than the original wilderness system in the area, including broad geographic representation of pristine old-growth riparian forests, for example, which are key to many local and even global questions of biodiversity conservation.

Management of wilderness landscapes, including the surrounding matrix, also has a key affect on the usefulness of wilderness as a resource for science. Resolution of boundary issues in highly fragmented wilderness areas, for example, will be of great benefit, both for resource protection and for the value of the wilderness as a scientific resource since it will greatly amplify the ecological integrity of smaller wilderness areas. In this case, the solution may not require the politically difficult and costly allocation of resources to land acquisition but could include promoting more compatible management of surrounding areas. For example, open-pit mining, ski areas or motorized and intensive recreation development on wilderness boundaries reduce the effective size of wilderness ecosystems. Selective logging or other intermediate levels of resource development activities could actually expand the effective wilderness for many ecological functions and processes.

There should be ample opportunities to enhance scientific understanding of wilderness without unduly compromising recreational opportunities and resource protection. Increased recognition and need for scientific information about wilderness, both for general understanding of ecology and to help improve management of wilderness, combined with better communication between managers and scientists, should help encourage more research in wilderness and also aid in its implementation in policy and management.

Wilderness Science Issues at Grand Canyon National Park

Robert A. Winfree, Della Snyder, and Anne Hagele

More than 90% of the Grand Canyon is managed as wilderness. Each year, the Park's research office handles about 150 permit applications for about 80 new or continuing studies. We start with the assumption that scientific inquiry is appropriate and beneficial for resource management. However, because of the high demand for access to this Park (five million visitors per year), and the need to manage for appropriate levels of use, permits are required for scientific studies, specimen collecting, camping, boating, caving and aircraft use.

We provide prospective researchers with a package of information fo r planning their work at Grand Canyon. The package explains the information needed for evaluating a proposal, identifies areas with special restrictions and out-lines standard permit conditions.

The first step in proposal review is to determine if all the required information has been provided. Frequently, proposals lack detail on the specific methods to be employed, the means of reaching the study site or the specific location of the study site. Consequently, permit office staff spend a fair amount of time fleshing out the details with applicants.

Once we have a complete proposal, we evaluate it for potential impacts to natural, cultural and recreational resources, including social values such as solitude and natural quiet. Eleven factors are considered in this part of the proposal evaluation, including: means of access, use of mechanized or motorized equipment, magnitude and duration of effects, frequency of disturbance, group size, safety, cost/benefit considerations, scheduling, significance and urgency of the study and location.

Each factor is represented by a column in the Wilderness Impact Matrix (table 1), and each column is divided into blocks. Blocks are arranged in descending order, with the most complex and controversial activities at the top of the table. The reviewer selects the block(s) in each column that best describe the proposal. The columns are further subdivided with a line. Studies involving activities "above the line" frequently have substantial issues that need to be resolved. We then work with the researcher to consider alternatives to lower the overall impact. An important point about this process is that all 11 factors are considered significant, and most of them are interrelated.

If potential impacts are identified, the evaluation shifts to considerations of alternatives through a minimum requirement analysis. The following questions are asked:

- Is the information really needed? We rely on peer review and resource management plans to determine the importance of the proposed work.
- Can the information be collected outside of the wilderness? This is feasible for some work along the wilderness perimeter and for research that is not site-dependent.
- Can the magnitude, duration and frequency of biophysical impacts be minimized, and can the social impacts be reduced?

- through alternative scheduling of activities when visitors are not present in the area,
- through erasing evidence of the activity by restoring the study site to its original appearance,
- through alternative equipment or research designs that use less intrusive methods to complete the objectives.

Finally, the proposed alternatives are re-examined to determine if they are likely to significantly compromise other important factors. Has safety or statistical confidence been reduced? Have costs or difficulty increased to a point where current work may not be completed, or where future work may not even be proposed?

Depending on the specific study objectives, a low-intensity approach may serve the purpose, or it may not work at all. However, consideration of alternatives, combined with the flexibility to select the most appropriate alternative enables information collection to proceed with minimal resource impact and minimal disturbance to visitors. We believe that it should not be necessary to compromise scientific inquiry or wilderness preservation, as long as scientists and resource managers are willing to work cooperatively toward common goals. The evaluation of research proposals, using the methods described above, are a process to accomplish these ends.

Dialogue Session Discussion

Discussion began with a comment that wilderness managers often tend to place the recreational values of wilderness above those of research. It was felt that research should also play an important role and that research has the potential to provide considerable benefits to wilderness areas. Several members of the audience felt that the benefits of research are not often considered by managers. These perceptions may, in part, stem from an approach by many managers to focus mostly, or completely, on the problems associated with the research, rather than the potential benefits. It was felt that focusing on research as a problem rather than as a positive factor that can benefit wilderness has led to a devaluation of science and an attitude that research in wilderness must be hidden, that the public should not be aware of its presence. It was suggested that the focus should shift from trying to hide science to showcasing it. As part of this showcasing, scientists conducting research in wilderness could develop interpretive literature or displays of their projects for visitor centers to describe how their project increased our knowledge of wilderness.

A related comment was that wilderness areas are some of our most biologically important areas, but also, those that we know the least about. By encouraging research, not discouraging it, we can learn more about wilderness, and in so doing, increase our understanding of its needs and management and aid in its protection.

Several members of the audience stated that increased communication between scientists and management would be a good way to tackle many problems associated with conducting research in wilderness. Early communication (pre-application rather than post-application) was seen as a way to increase management's understanding of the value of the research and to develop good working partnerships.

Other concerns voiced by audience members were: discrepancies among agencies and regions in how research applications are reviewed, lack of staffing to handle large numbers of applications and frequent changes in managerial staff, resulting in inconsistencies in the administration of projects.

Table 1—Wilderness Impact Matrix. **Permit No:**

Means of Access[1]	Mechanized/Motor Equip.[2]	Magnitude of effects	Duration of Effects	Frequency of Disturbance	Field Crew	Safety	Cost/Benefit Factors	Scheduling	Significance & Urgency	Location
☐ Helicopter	☐ 2-cycle combustion engines (e.g., generators, pumps, saw drill)	☐ Potential regional or greater effect (e.g., species introduction).	☐ Permanent modification of park resources or adjacent areas (e.g., construction of a permanent study platform, field laboratory, or quarters; alteration of nonrenewable resources, excavation of archaeological or paleontological	☐ Continuous or near continuous activity (e.g., permanent field laboratory).	☐ Multiple group encampments or very large groups (e.g., 12 or more persons).	☐ High perceived risk to project personnel, visitors, or park staff from proposed activities. Training, safety gear, and other reasonable precautions do not appear sufficient to mitigate risk.	☐ Cost of NPS requirements associated with the proposed activities will make completion of the primary study objective infeasible.	☐ Timing of access is critical, and may be spur-of-the-moment. Essential data can only be collected within a short window of time. (e.g., studies of short term or unpredictable phenomena, floods, migrations, fire, seismic activity).	☐ Proposed activity is deemed inappropriate for NPS areas (permit will be denied).	☐ Activities proposed for restricted-access locations identified in the Superintendent's Compendium.
☐ Fixed wing aircraft	☐ 4-cycle combustion engines (e.g., generators, pumps)	☐ Potential effects extend over a broad area within or adjacent to the park unit (e.g., fire, river manipulation, extensive aircraft use).	☐ Long-term impacts (6 months to several years) to renewable resources (e.g., tree damage, population manipulation, excavation in recent sediments above mean high water).	☐ Frequent, long term activities (seasonal en-campments).	☐ Large group encampment (e.g., 7-11 persons).	☐ Participation of essential personnel will not be possible under existing safety or logistical stipulations. Other qualified personnel are not available (i.e., can't complete primary study objective given	☐ Permit stipulations are expected to increase cost to the point that meeting the secondary objectives will not be achieved.	☐ Study has specific seasonality and site visits must be made during pre-established time frames (e.g., migratory wildlife, plant or animal reproduction, seasonal growth, seasonal visitation).	☐ Importance of study, or the need for conducting the study within an NPS area, is not supported by the proposal (permitting decision will be postponed pending major proposal revision).	☐ Activities under consideration are planned for portions of the park that are managed as Wilderness areas.
☐ Off-road motorized vehicle (e.g., truck, auto, ATV, snowmobile).	☐ Solar, battery, wind, current, and human powered mechanical devices.	☐ Potential effects confined to multiple small areas (e.g., multiple, small sampling plots and excavations).	☐ Seasonal impact (2-6 months, e.g., removal of seasonal plant growth, disturbance of beach deposits).	☐ Multiple overnight site visits.	☐ Small group encampment (2-6 individuals).	☐ Participation of preferred, but nonessential personnel may be limited by safety or logistical considerations, inaccessibility of site, or personal capabilities (e.g., technical rock climbing, hike out from river). Other qualified individuals can be available to complete task.	☐ Permit stipulations will increase costs to the point that other, equally important, studies will be negatively affected.	☐ Study objectives can be met at any time of year subject to convenient scheduling of personnel, equipment, access, funding, etc (i.e., work is not seasonal, resources re relatively stable, e.g., geologic strata, archaeology, paleontology, forest history).	☐ Significance of study and need for conducting activities in protected NPS areas is letters of recommendation from the investigator's institution and colleagues, but is not sup- ported by qualified independ-ent peer reviews (permitting decision may depend on a compelling justification by principal investigator or authority if there is any potential for resource impacts or interference with visitors).	☐ No activities planned in NPS wilderness areas.
☐ No mechanized devices.	☐ Probable effects confined to a single study site, which will be restored and is out of public view.		☐ Extended impact (obvious to casual observers for 2-4 weeks).	☐ Multiple daytime site visits (e.g., repetitive surveys, data collection).	☐ Single individual.	☐ Broad participation of study team may be possible, but will require development of additional skills, special training or certification, guide services, special supplies or equipment (e.g., backpack, river trip, winter camping).	☐ Permit stipulations have no lasting significant effect on ability to complete the study, or on institutional capabilities.	☐ Study objectives have a high probability of being met through opportunistic sampling (e.g., river guide monitoring of beach sites, participation on river trips on a space-available	☐ Significance of study and value to the park unit is clearly recognized by qualified independent peer reviews and by park management.	
☐ Sport or utility watercraft (i.e., frequent upriver travel) during motorized season (Dec 16-Sept 15).		☐ Probable effects will be hard to detect without prior knowledge (e.g., limited sampling of loose geologic materials, seasonal plant growth, water, or air).	☐ Short term impact (1 day to 2 weeks, e.g., surface water dye studies, overnight field excursion).	☐ Single overnight site visit.	☐ No additional personnel placed on site, activities concurrent with approved site visits for other studies.	☐ Participation of study team is not limited by safety, logistical considerations or permit stipulations.	☐ Proposed alternatives are expected to reduce total project costs.		☐ Broad recognition for the importance of the study exists at park, regional, and national/internation al level. Data are deemed important to Solving	
☐ Motorized, quiet watercraft (4-cycle engines required) launching during motorized season, Dec 16-Sept 15, principally downriver travel.		☐ No physical site impacts anticipated (e.g., photography, sound or climate monitoring).	☐ Instantaneous disturbance (e.g., seismic survey blast).	☐ Single daytime site visit.	☐ No site visit.				☐ Need for studies on this topic is documented in the park's current Resource Management Plan.	
☐ Non-motorized wheeled vehicles (e.g., bike, wagon) only above the canyon rim.			☐ No apparent impact.	☐ No site visit (e.g., high altitude remote sensing).						
☐ Oar powered watercraft (e.g., raft, dory, kayak).										
☐ Approved pack animals (e.g., mule, horse)										
☐ Human powered (e.g., day hike, backpack, ski, climb).										

[1]Use restrictions apply to all forms of access except day hikes and public roads.

[2]Use of quietest available technology is required.

NOTE:>>Each column of this table represents one set of ranking criteria (e.g., significance, safety, effects on park resources, etc.). Proposals that match descriptions at the top of the column are frequently complex and controversial. Activities above the dark line require evaluation of alternatives. Some may require lengthy impact assessments and negotiations prior to a permit decision. Decision making is simpler for proposals matching descriptions near the bottom of a column.