RESEARCH WORK UNIT DESCRIPTION Ref: FSM 4070	1. Number RMRS-4901	2 . Station Rocky Mountain Research Station
	3. Unit Location Missoula, MT	

4. Research Work Unit Title
Aldo Leopold Wilderness Research Institute

5. Program Manager (Name and address)
David J. Parsons, U.S. Forest Service, 790 E. Beckwith Avenue, Missoula, Montana 59801

6. Area of Research Applicability	7. Estimated Duration
Regional, National, and International	10 years

8. Mission
Provide scientific leadership in developing and using the knowledge needed to sustain wilderness ecosystems and values

The following text supplements the section "Role of the Institute" in the 2005 Charter for the Aldo Leopold Wilderness Research Institute:

The role of the Aldo Leopold Wilderness Research Institute (ALWRI) is broadened to include coordination, facilitation and integration of the full breadth of wilderness relevant research carried out within the Science Programs of the Rocky Mountain Research Station. This expanded role is responsive to recommendations from the 2007 external peer review of Forest Service wilderness research, including expansion of the scope of what has traditionally been thought of as wilderness research, development of mechanisms to help scientists from all disciplines identify work relevant to wilderness, and better coordination, tracking, integration, and application of wilderness related research. This expanded role reflects the role for the Leopold Institute as a programmatic area that cross-cuts the 7 Science Programs in the restructured Rocky Mountain Research Station.

The expanded scope of wilderness research, as recommended by the 2007 peer review, recognizes three complementary components.

- Science for Wilderness: informing effective stewardship and management of wilderness
- Wilderness for Landscape Sustainability: improving understanding of the roles of protected lands to the ecological, economic, and social processes, services and integrity of larger landscapes
- Wilderness for Science: using wilderness as laboratories to understand the causes and consequences of environmental change, minimally confounded by other influences

Signature	Title	Date
Recommended: David J Parsons	Program Manager	11/24/2008
	WO SPA Lead	12/3/08
Robert L Dondrick	WO Staff Director	12/04/2008
Approved: D. Sam Foster	Station Director	12/11/2008
Concurred:	Deputy Chief for Research & Development	12/15/2008

The historic focus of the Aldo Leopold Wilderness Research Institute has been on research addressing the first component, Science for Wilderness, although increasingly, ALWRI scientists have also worked on the second component, Wilderness for Landscape Sustainability. The third component, Wilderness for Science, has become increasingly important to scientists interested in the study of global change. Although work by scientists in the Station's other Science Programs often has a high relevancy to one or more of the three identified components of an expanded wilderness research program, there has not been an effective way of recognizing, communicating or tracking that work as wilderness research.

The expanded role of the Leopold Institute utilizes the core group of wilderness specialists at the Institute to provide leadership for cross-program coordination, integration, reporting, and application of wilderness relevant research conducted throughout the Rocky Mountain Research Station. Full program accomplishment depends on cooperation with and work conducted within other disciplines and programs.

Under this strategy, ALWRI's role within RMRS is to:

1) Provide the Station's focus on Science for Wilderness, research that is primarily designed to improve the stewardship of wilderness.
2) Provide leadership, coordination and integration for research by Station scientists on all three areas of wilderness science. This includes engaging with the other RMRS Science Programs to help identify priorities as well as explicitly recognize the importance of or application to wilderness in study designs and outcomes.
3) Provide a clearinghouse for documentation of all wilderness-relevant research conducted by RMRS.
4) Provide coordination for the delivery and application of wilderness-relevant research to managers and other users.

The role of the other RMRS Science Programs is to:

1) Conduct wilderness-relevant research in any of the three areas of wilderness science as part of their overall research agenda.
2) Engage with ALWRI to assure appropriate documentation of wilderness-relevant studies, including progress and accomplishments.
3) Consult with ALWRI when developing research agendas, designing research studies and interpreting results relevant to wilderness.

The Rocky Mountain Research Station will apply this approach throughout the Interior West. If this approach proves effective, opportunities and support needed to expand it to include work conducted by Forest Service and other scientists across the country will be identified and pursued.

This expanded role for the Leopold Institute recognizes that wilderness science will be of enduring and critical importance to the Forest Service and RMRS.

The Aldo Leopold Wilderness Research Institute's program of research is consistent with the strategic direction of the Forest Service, Research and Development, and Rocky Mountain Research Station. Specifically, research results will provide information relevant to Forest Service strategic goals 1 (Restore, Sustain, and Enhance the Nation's Forests and Grasslands), 2 (Provide and Sustain Benefits to the American People), 3 (Conserve Open

Space), 4 (Sustain and Enhance Outdoor Recreational Opportunities), and 7 (Provide Science-based Applications and Tools for Sustainable Natural Resource Management) as well as many of the means and strategies identified in the 2008-2012 R&D Strategic Plan to address these goals. ALWRI activities also directly support all of the R&D Strategic Program Areas. Further, this research is important to all 6 focus areas in Rocky Mountain Research Station's strategic framework (Changing Ecosystems, Conflicting Values, Wildland Fire, Healthy Environments, Wildlife and Fish; and Communicating With our Stakeholders).

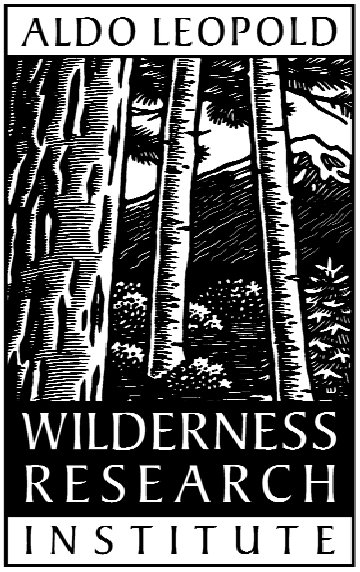
10. Approach to Problem Solution

The five Problem Areas, associated Elements and proposed studies and outcomes detailed in the 2005 ALWRI Program Charter remain unchanged. They will continue to provide the focus for activities carried out by Leopold Institute staff.

Location	Name	GS-Series	Position	Recreation	Relationships	Fire	Larger Systems	Science Delivery
Missoula	David Parsons	401	Director	0.2		0.2	0.1	
Missoula	David Cole	401	Research Geographer	1.0				
Missoula	Alan Watson	101	Research Social Scientist	0.1	0.8	0.1		
Missoula	Carol Miller	408	Research Ecologist			1.0		
Missoula	Peter Landres	408	Ecologist				0.2	0.8
Missoula	Anne Black	101	Social Scientist (Post-Doc)			0.8		0.2
Missoula	Vita Wright	401	Application Specialist			0.2		0.3
Missoula	Steve Corn	486	Research Zoologist (USGS)				1.0	
			Total FTE	1.3	0.8	2.3	1.3	1.3

PROGRAM CHARTER

ALDO LEOPOLD WILDERNESS RESEARCH INSTITUTE (RMRS – 4901)



USDA Forest Service
Rocky Mountain Research Station
Missoula, Montana

2005

The mission of the Aldo Leopold Wilderness Research Institute is to provide scientific leadership in developing and using the knowledge needed to sustain wilderness ecosystems and values.

CONTENTS

INTRODUCTION

The Aldo Leopold Wilderness Research Institute is dedicated to developing and applying the knowledge needed to improve the stewardship of wilderness, and other similarly protected areas, throughout the country. The Leopold Institute, which is administratively attached to the Rocky Mountain Research Station (RMRS) of the U.S. Forest Service (USFS), has strong programmatic ties to the management branch of the USFS as well as to the Department of the Interior's three wilderness management bureaus (Bureau of Land Management (BLM), Fish and Wildlife Service (FWS) and National Park Service (NPS) and primary science bureau (US Geological Survey (USGS)). Leopold Institute leadership is the responsibility of the Institute Director who reports to an Assistant Director for Research at RMRS in Fort Collins, Colorado. A USGS scientist on the Leopold Institute staff reports to the Director of the USGS's Northern Rocky Mountains Science Center in Bozeman, Montana.

This Program Charter builds from the Leopold Institute's 1993 enabling Charter and 1996 Strategic Plan, which together have provided direction during the formative years of the Institute. The Program Charter codifies roles, relationships, and activities that have developed at the Institute over the decade since its establishment and identifies a future program of work. It provides a guide for how we will serve as a catalyst to bring diverse groups of scientists and managers together and pursue various opportunities for the funding and staff support needed to address the scientific needs of wilderness stewardship. It is anticipated that the structure and direction outlined in this Program Charter will serve the Leopold Institute for the next ten years. The Program of Work, which identifies general problem areas and more specific studies to be addressed, will be revisited after five years.

The Leopold Institute is located in Forest Service facilities on the campus of The University of Montana in Missoula. This location facilitates collaboration with university scientists and students and the University's Wilderness Institute as well as with the interagency Arthur Carhart National Wilderness Training Center and Rocky Mountain Cooperative Ecosystems Studies Unit (CESU). The immediate Missoula area also serves as the location of six other RMRS research units, the headquarters of the USFS Northern Regional Office and the Lolo and Bitterroot National Forests, and numerous non-governmental organizations (NGO's) with wilderness interests.

Appendix I provides additional background on the history of the Leopold Institute, including its establishment, justification, and purpose. It also discusses the scope and context of wilderness in today's world.

STRATEGIC DIRECTION

Vision

The vision of the Aldo Leopold Wilderness Research Institute is to be the premier institution for wilderness stewardship research. We aspire to be the focal point for scientists and managers from different disciplines and backgrounds who seek to conduct, communicate and learn about science that addresses the challenges of wilderness stewardship, including the sustainability of wild ecosystems and relationships between people and wild lands.

Mission and Goals

In pursuit of our mission *to provide scientific leadership in developing and using the knowledge needed to sustain wilderness ecosystems and values*, the Leopold Institute seeks to accomplish the following goals:

1) develop the scientific knowledge and tools needed to protect and sustain wilderness and the ecological and social values derived from wilderness; and,

2) communicate and facilitate the application of this knowledge to the wilderness management agencies and other interested groups.

Role of the Institute

The Leopold Institute provides a focal point for scientists and managers from various disciplines and from across the country (and internationally) to work together to better understand and address the scientific needs for the proper stewardship of wilderness and similarly managed wild ecosystems. This differs from a traditional USFS Research Work Unit in that we bring together scientists from multiple disciplines (social and biophysical) to work across administrative boundaries on issues that address the needs of those agencies who manage wilderness. Partnerships and collaborations between scientists and managers as well as between agencies, universities, and NGO's are essential to our role as a focal point for development, discussion and debate about ideas related to the values and benefits of wilderness as well as the opportunities and challenges of wilderness stewardship. Our emphasis on wilderness stewardship research (knowledge that is needed to improve the stewardship of wilderness), as opposed to the full range of research that is, or might be, done in wilderness, provides a focus that is unique among research groups. In addition to providing science that serves as the basis for wilderness policy and management decisions, we help provide a context for much of the science relevant to wilderness that is developed by others. Our status as a federal Institute that receives support from multiple agencies and has strong working relationships with numerous universities and private organizations provides opportunities for leveraging funds and expertise in ways that, together with our administrative ties to the federal land base, provides a strong competitive advantage over the dispersed science expertise offered by more traditional science providers.

The Institute's role as a focal point for a broad range of research and critical thought related to the management and policy issues and challenges of wilderness stewardship, requires coordination and facilitation across the full range of ecological and social conditions and values that characterize wilderness ecosystems and their use. We strive to bring together the various natural and social science disciplines to provide multi- and inter-disciplinary approaches to vexing management issues. We further recognize that wilderness stewardship must be addressed in the context of the larger landscapes within which wilderness is located; including the larger ecological and social systems outside wilderness that influence the condition and stewardship of wilderness. This need to understand the relationships between wilderness and surrounding lands as well as between the public and public lands leads us beyond the historic focus of wilderness research on threats and management actions that occur largely within the wilderness boundary.

The Institute makes broad use of workshops, symposia, scientific exchanges, and other cooperative arrangements to encourage and facilitate dialogue and collaborative approaches (see appendix IV for examples of recent activities in organizing workshops and conferences). Lacking the staff and resources to address all the science needs of wilderness stewardship, we continue to explore and expand opportunities for adjunct and other affiliate type arrangements with scientists and managers from diverse disciplines and backgrounds that will further expand mutual learning opportunities and other benefits of shared interaction and experiences.

The Leopold Institute's programs emphasize both research and the delivery and application of research findings to policy and management issues. These activities are accomplished with in-house as well as collaborative and partnership programs.

Research: Leadership in the conduct, support, and facilitation of peer-reviewed, scientifically rigorous research forms the core of the Leopold Institute's activities. The Institute's research staff conducts, coordinates, and facilitates innovative research that improves basic understanding of wilderness resources and values. Our familiarity with the legal, policy and management issues related to wilderness assures that information produced is directly applicable and responsive to the current and future needs and priorities of wilderness managers. The scientific expertise of the Institute's staff is coordinated and leveraged with that of partner agencies, universities, and other entities to produce state-of-the-art knowledge about wilderness resources and the human uses and values associated with those resources. In addition to basic and applied research, the Institute produces practical syntheses, thought pieces, and decision support tools, such as monitoring protocols, models, and frameworks helping managers and policy-makers address difficult issues. These products are produced through in-house, cooperative, and contract studies.

The dissemination of findings through technical, peer-reviewed publications is fundamental to the research process. Research conducted and supported by the Leopold Institute is presented at meetings, conferences and workshops and is published in scientific journals, agency publications, and in symposia and workshop proceedings. In addition, scientists at the Institute facilitate dissemination of findings by serving as consultants, reviewers and editors for journals, members of management and scientific committees, as symposia and conference organizers and chairs, and on boards and committees of professional societies. These extramural activities reflect the professional stature of the Leopold Institute staff and are at a level beyond that

normally associated with doing and communicating research.

Science Delivery and Research Application: The delivery and application of science has been a priority of the Leopold Institute since its inception. In 1999, RMRS, BLM, and FWS funding enabled the Institute to hire a full time Research Application Specialist and begin development of a dedicated Research Application Program (RAP). The RAP complements the science delivery and application efforts of Institute scientists. The RAP tracks scientist delivery and application activities, and supplements them with additional efforts that promote access to and understanding of research results. RAP activities include development and management of the Institute's web site (http://leopold.wilderness.net), synthesizing and communicating information about research relevant to wilderness issues, identifying information gaps, and distributing information about research products. The RAP also strives to better understand barriers and develop improved approaches to the effective delivery and application of science. Research conducted directly through the Leopold Institute is given the highest priority in the RAP, followed by research that is pertinent to policy and management but conducted outside the Institute. Expanded coverage of research conducted by others in the wilderness research community is one of the Institute's highest priorities for new directions. The RAP's primary audiences are federal policy makers and managers with wilderness responsibilities. The RAP also distributes information to scientists, students, and members of the public, both nationally and internationally.

Collaboration and Partnerships: To accomplish its mission, the Leopold Institute depends on collaboration and partnerships with a wide variety of individuals and organizations. First and foremost, we work closely with the science and management staffs of the five federal agencies with wilderness responsibilities to identify information needs and priorities, develop and conduct research programs and projects, and apply research findings to management and policy issues. Collaboration and partnerships with federal wilderness managers are critical to the Institute's ability to be responsive to management needs. Institute scientists are frequent and active participants in a wide variety of management forums, including committees, workshops and training courses. Collaborations in planning, conducting, and applying research to management issues are especially strong with managers in the USFS and NPS. A close relationship also exists with the interagency Arthur Carhart National Wilderness Training Center which provides education and training for federal wilderness managers. The Leopold Institute provides information and services critical to many Carhart Center training programs.

Scientific collaboration with the many other scientists that conduct research that is either important to wilderness management or that uses wilderness as study sites is particularly important. For example, the USGS has stationed a research scientist at the Leopold Institute since 1996 and is interested in exploring opportunities for expanding that presence. The USGS scientist works with USFS scientists at the Institute to develop interagency priorities and programs as well as carry out research that addresses Department of the Interior information needs. Leopold Institute scientists also conduct cooperative research with USFS and USGS scientists located at research stations, in national parks, at universities, and in regional science centers (see Appendix III for full listing of recent collaborators). Partnerships with scientists at academic and private institutions also play a critical role in the Leopold Institute's success.

Collaborative research is carried out with a wide variety of university and NGO scientists (see Appendix III).

Cooperative activities at the Institute include exchange programs, support of visiting experts, sponsorship of lectures, workshops, and symposia, and staff involvement in professional activities and societies. The University of Montana's Wilderness Institute is a particularly valued partner in that it provides scholarly contributions to wilderness discussions as well as the services necessary to host the Institute's web site and web databases (as part of the larger wilderness information network (www.wilderness.net)). The interagency Northern Rockies Cooperative Ecosystems Studies Unit (CESU), which is also located on the University of Montana campus and which has identified wilderness as its driving theme, provides an additional forum for coordinating research priorities and activities as well as organizing cooperative programs to facilitate dialogue between wilderness managers and scientists. We also have important and productive collaborative relationships with such non-government organizations as the Wilderness Society's GIS Center, the National Science Foundation, the Fulbright Scholars Program, the National Outdoors Leadership School, the WILD Foundation, Leave No Trace, the Alaska Recreation and Tourism Association, and the native Village of Kotzebue in Alaska.

Coordination with other scientists working on wilderness issues, or simply working in wilderness, is important both to encourage others to fill needs that the Leopold Institute can't address and to assure that all available information relevant to wilderness stewardship is available to those who might need the information. Although Leopold Institute scientists and the RAP have attempted to maintain awareness of other ongoing wilderness related research, this is a large task and there are many disciplines for which it has proven impossible with existing resources. The role of expanding coordination with the broader universe of wilderness science is recognized as a high priority for future development. Discussions among the DOI partner agencies have identified this as a priority for their support. We will also develop a program of "adjunct" affiliations by which scientists and managers would develop formal relationships with the Leopold Institute through either a detail or as non-resident affiliates. The intent is to allow these affiliates to better understand wilderness research needs, the availability and relevance of available information, and, for scientists, to better relate the importance of their work to wilderness stewardship challenges. Discussions are underway with USFS, DOI and university staff regarding these opportunities.

Recognition of the special role that wilderness and similarly protected areas play in the ecological, economic, and social fabric of the global environment, together with what can be learned from the exchange of information about issues and experiences in other environments and cultures, has led us to look beyond national boundaries. Collaboration with scientists and managers in other countries is an increasingly important part of the Leopold Institute's programs.

Contributions of the Leopold Institute to Partner Agencies: Wilderness managers as well as scientists interested in research that benefits wilderness stewardship look to the Leopold Institute to provide leadership in setting the agenda for wilderness stewardship research. This includes the doing of research as well as the delivery and application of that research to managers and policy makers. In addition to the value of the research it conducts, coordinates and sponsors, the Leopold Institute is widely recognized for its contributions to the wilderness management

profession. The Institute provides leadership in scientific thought about wilderness and has played a major role in defining wilderness management as well as in articulating the understanding and information needed for the effective stewardship of wilderness. It has provided much of the intellectual and informational foundation for managing wilderness. These roles are demonstrated by the wide use throughout the federal wilderness management agencies of information, frameworks, and tools developed by the Institute. These include wilderness recreation planning frameworks (LAC and VERP), understanding of visitor experiences in low and high use areas, evaluation of wilderness management techniques and their effectiveness (e.g., development of the Leave No Trace curriculum), incorporation of wilderness fire management into larger fire and fuels management programs, and development of protocols for monitoring visitor use levels, campsite impacts, and aspects of wilderness character.

The expertise of Leopold Institute staff is widely recognized and regularly called upon by field managers, planners, and policy makers of the wilderness agencies as well as by international and non-government organizations. The pervasive influence of information and understanding developed by this small group of scientists and research application and other support staff is apparent from the contributions and use of their products in the standard text book on wilderness management as well as in management programs, agency planning documents, and interagency training courses offered through the Arthur Carhart National Wilderness Training Center on such topics as wilderness stewardship, management of visitor use, site restoration, and monitoring. Information provided by the Institute on its web site (http://leopold.wilderness.net) and through distribution of its publications is regularly used by field level wilderness managers as well as those interested in wilderness planning and policy. These contributions have, in part, resulted from the support provided for the Leopold Institute by the five federal wilderness agencies.

PROGRAM OF WORK

Problem Selection and Justification:

A wide variety of information is needed to assure effective wilderness stewardship and to understand the resources and values associated with wilderness. Particularly important to wilderness stewardship is an understanding of threats to wilderness values from diverse human activities, both internal and external to wilderness. Wilderness values are threatened by such activities and impacts as recreation use, fire management, grazing of domestic livestock, alien species, water projects, atmospheric pollutants, climatic change, and adjacent land use. The wilderness attributes affected by these threats include soil, vegetation, water, air, and animals, as well as cultural resources and human experiences. Although these individual threats and attributes are often studied in isolation, the cumulative effects are often synergistic rather than additive. They are best approached from an interdisciplinary perspective. Further, wilderness areas can best be understood as part of the larger social and ecological landscapes in which they exist (generally within matrices of non-wilderness lands). External threats to wilderness may be at least as important as internal threats and, conversely, wilderness has profound effects on neighboring lands and communities. In particular, an understanding of wilderness values can only come by adopting a large-scale perspective of the relationships between wilderness and the

social and ecological fabric within which it is embedded. In addition to threats, effective wilderness stewardship requires an understanding of the relationships that exist between people (both users and non-users) and lands managed for their wilderness values, including the effects of policies and practices on those relationships. Finally, wilderness stewardship must be approached with an understanding that environmental and social change are omnipresent influences that have and will continue to affect wilderness. Learning to manage wilderness in the face of constantly changing conditions will be a continual challenge. Science can help us understand the likely consequences of alternative future scenarios.

The programs and priorities of the Leopold Institute are shaped by our core values of high quality, credibility, integrity, and responsiveness, and by our strengths in working with managers and other scientists to identify and explore complex, long-term natural and social resource issues related to wilderness stewardship. Our knowledge of wilderness legislation and policy provides a context that facilitates our role as a catalyst for synergistic, interdisciplinary research that addresses the myriad of contentious issues that wilderness managers confront. Given the diverse array of important research topics and the small staff of Leopold Institute scientists, we have tried to maintain a broad vision regarding research needs, while of necessity identifying a few critical research priorities to focus on. We have carefully considered the numerous threats that need investigation, as well as the importance of understanding wilderness in the context of larger ecological and social systems. From this perspective, we have worked with wilderness managers from the USFS and other partner agencies to establish priorities based on the overall importance of the issue together with the likelihood that we can make an effective contribution to knowledge. In particular, we intend to focus on developing and communicating the kinds of scientific information that are responsive to the long-term needs of wilderness managers and that fill gaps that other scientists are not working on.

In selecting the broad problem areas identified in this Program Charter we considered the following criteria: 1) the priority of wilderness management research and application needs as identified by wilderness managers, 2) whether similar or related work is being conducted elsewhere, and 3) the match between research needs and the expertise of current Leopold Institute staff. Together, these criteria have led us to identify five principal problem areas that will provide the focus for the Leopold Institute's research and application efforts over the next five years. These problems, when taken together, constitute a program of work that addresses many of the most pressing challenges of 21st Century wilderness stewardship; ranging from an expansion of our historical focus on recreation use and impacts to emerging issues related to the larger landscape context within which wilderness is located. Emphases on relationships between the public and wilderness lands and the delivery and application of science recognize the importance of human dimensions in the effective stewardship of wilderness. The five Problems we have selected to focus on are:

- Inadequate understanding of recreation experiences and the impacts of recreation hamper efforts to preserve and protect wilderness resources and experiences.
- Improved information is needed on how relationships between people and lands protected for their wilderness values affect and are affected by management policies and actions.

- There is a need for improved information to guide the stewardship of fire as a natural process in wilderness while protecting social and ecological values inside and outside wilderness.
- There is a lack of adequate understanding of how wilderness stewardship is influenced by the location of wilderness within larger ecological and social systems that extend beyond wilderness boundaries.
- There is a need to improve the delivery and application of scientific knowledge and tools pertinent to wilderness stewardship.

These problem areas have been selected with the full recognition that there are many other important issues related to the understanding and management of wilderness that could and should form the basis for major research efforts. For example, wilderness, and similarly protected areas, play a critical role in landscape scale wildlife conservation; federal land managers are charged with the protection of air quality related values of Class I lands (including large wilderness areas); and wilderness provides some of the best places for understanding the complexities of natural ecosystems in the light of the effects of human induced climatic and land use changes. Yet, with over 17% of USFS lands (and over 52% of NPS lands) designated as wilderness, but only one small research program dedicated to wilderness related issues, it is clear that much of the needed wilderness research will need to be done by other research units (e.g., units focused on fire, wildlife, water, or air). Our role must be to fill the most significant information gaps that we can contribute to, while working to see that other needs are filled by coordinating with other experts to maximize the relevance of their work to wilderness.

Although our intent is to focus efforts on identified projects within the five problem areas, it must be recognized that limited base funding may influence what studies are actually conducted. Although we will actively pursue funds to support the proposed work, it is possible that the availability of project dollars will require some modification of priorities.

Problems and Approach to Problem Solution:

Problem 1. Inadequate understanding of recreation experiences and the impacts of recreation hamper efforts to preserve and protect wilderness resources and experiences.

Management of recreation has historically been the foremost focus of wilderness stewardship. Collectively, wilderness managers probably spend more time on recreation issues than on any other. They are confronted with the challenge of defining an appropriate balance between (1) providing access by visitors for the unique recreation opportunities that wilderness provides and (2) protecting biophysical, experiential and other values of wilderness and then implementing management programs to maintain this balance. Wilderness recreation use is increasing in many places, forcing managers to choose between restricting access, changing behaviors, increasing regulation, or accepting increased degradation of biophysical and/or experiential conditions. Each of these courses of action has different implications for wilderness resources and visitor experiences. The challenge of this assignment is elevated by recognition that recreation management objectives and strategies vary greatly across the National Wilderness Preservation System, with environmental, access, and use characteristics. Managers must decide on recreation

management strategies based on these characteristics. Some wilderness areas, however, remain extremely lightly used, though managers have little knowledge about the primary influences on recreation experiences there or how management should be implemented to protect those experiences. Intergenerational differences in knowledge of impacts, preferences or expectations for conditions encountered, and reaction to management strategies are relatively unexplored but of increasing importance.

Wilderness managers are encouraged to develop wilderness plans that clarify decisions about an appropriate balance between access, regulation and wilderness conditions. They are encouraged to develop specific management objectives (even indicators and standards), to monitor more systematically, and to develop comprehensive management programs that include education as well as regulation. Over the past few decades, wilderness recreation research has contributed substantially to the knowledge foundation for the development of recreation management objectives, monitoring programs, and effective management strategies. In particular, a substantial body of descriptive information about wilderness visitors and the biophysical and experiential impacts of visitors have been developed. But further work is needed. Basic, descriptive work must continue, as must research into relationships (e.g. between use levels, user behaviors, experiential and environmental variables and between experiential and resource impacts). Further research of an applied nature is also needed. We believe that we can make the most profound contribution by focusing our efforts on the following four topics.

Element 1a. Inadequate understanding of the basic dimensions of human experience in wilderness makes it difficult to establish appropriate management objectives and programs.

Wilderness managers are charged with the responsibility of managing wilderness such that opportunities for appropriate human experiences are protected. To effectively do this, we need to understand how wilderness management decisions (action and inaction) affect the nature of the human experience in wilderness. We need a better understanding of the basic dimensions of wilderness experiences, including opportunities for solitude, exhibition or development of primitive skills, unconfined travel and living, enjoyment of natural conditions, inspiration, challenge and reflection. The majority of past experiential research in wilderness has focused on crowding issues. We need to understand a broader array of human experiences in wilderness (particularly those that are relatively unique in wilderness) and the array of physical and social influences on these experiences. There has been a heavy reliance in the past on mail back surveys of wilderness visitors. This approach needs to be supplemented with other methods, both quantitative and qualitative, that provide greater insights into the nature of on-site wilderness experiences. Conflict between visitors with differing orientations detracts from the quality of experiences. To minimize this, we need a better understanding of conflict and ways it can be minimized. Wilderness planners and managers also need to consider the long-term and large-scale implications of their decisions. To do so, they need more information on displacement and substitutability. Displacement is the process whereby visitors change the location of their recreation in response to perceived adverse changes in condition or access. Substitutability refers to the ability to obtain similar benefits by recreating in different places.

These topics are important because wilderness planners have difficulty specifying objectives for human experiences in wilderness due to inadequate understanding of these experiences. In

addition, wilderness managers find it difficult to develop management strategies related to visitor experiences because there is little agreement on the range of experiences to be provided in wilderness or which experiences should be given highest priority. Wilderness planners and managers will benefit from this research through an improved ability to specify desired experiences and to implement management programs that are effective in providing opportunities for desired experiences. This research should also contribute conceptually to the advancement of the leisure sciences, by expanding our vocabulary for describing human experience and by increasing our insight into influences on experiences.

We propose to:

- Describe what visitors are experiencing in wilderness and how their experience varies (1) during the wilderness visit and over multiple visits, (2) between different types of visitors, (3) with visit characteristics (such as the experiences they are seeking on any particular trip), and (4) with setting attributes, such as use density, environmental characteristics, and management regime. This research will be conducted in wildernesses that vary in both user characteristics and ecoregion. Outcome: help managers specify objectives for experiences and devise management actions that promote opportunities for those experiences.

- Better understand conflict between recreation visitors and how conflicting values among visitors impact the realization of desired experiences. Outcome: development of approaches for managing conflict.

- Describe how visitor's use and experience of wilderness changes over their lifetime and in response to management actions by studying how recreationists use a system of wilderness and related lands to realize certain benefits. These use patterns should provide insight into the phenomena of displacement and substitutability, as well as understanding of how generational differences affect response to wilderness conditions. Outcome: improve perspectives on the large-scale (spatial and temporal) implications of wilderness recreation management decisions.

Element 1b. Inadequate understanding of recreational impacts makes it difficult to protect wilderness resources.

Wilderness recreation inevitably impacts biophysical resources. Site impacts are locally severe in most wildernesses and in many are increasing, both in extent and severity. There is general agreement that wilderness managers should not attempt to avoid recreation impact entirely, because the benefits would not exceed the costs of minimal access for recreation. Rather, managers must decide how much impact is acceptable. They should monitor impacts and develop strategies for keeping impacts to acceptable levels. The science of recreation disturbance ecology has been developing over the past few decades to assist wilderness managers in confronting this challenge. Substantial progress has been made in understanding the impacts of recreation on vegetation and certain attributes of soils, at the site level, as well as the short-term impacts of recreation on wildlife. However, we need a better understanding of below ground impacts of recreation, impacts on water, longer-term impacts on wildlife, and recreation impacts

at larger spatial scales. We need to complement extensive research in mountains with more research in other ecoregions, such as aridlands. The impacts of pack stock grazing on meadows are also poorly understood, given the prevalence of this use.

We need to increase our understanding of factors that influence the severity, extent and spatial pattern of impacts (primarily the amount, type, timing and location of use). We also need to translate this information into the curriculum presented in low-impact educational programs such as Leave-No-Trace. The primary beneficiaries of this research will be wilderness managers developing management programs to minimize recreation impacts or restore sites that have been damaged by recreation use. This research should also contribute conceptually to the advancement of the larger field of recreation ecology and its applications to recreation and tourism management outside wilderness. Given highly limited resources available for this work, our proposed program of work can only tackle a small portion of this research need.

We propose to:

- Further build fundamental ecological knowledge about the nature of recreation impacts, relationships between use and environmental attributes, and the severity, extent and spatial pattern of impact. Use this knowledge to develop potential management strategies and to predict the likely consequences of alternative strategies. Conduct this research in wildernesses that vary in both user characteristics and ecoregion. If possible, complement research on impacts to soil and vegetation with research on impacts to wildlife and water. Outcome: improved strategies for managing recreation use and resultant impacts.

- Identify trends in recreation impact by repeating surveys conducted in the past. Trends in places with substantially different environments, use patterns and management programs will be compared. Outcome: improved understanding of trends in wilderness conditions, as well as strategies for managing recreation use and resultant impacts.

- Close knowledge gaps related to low-impact practices, such as (1) the relative durability of different environments subjected to recreation use, (2) how to minimize harassment and disturbance of animals, (3) how to limit the adverse impacts of pack stock confinement and grazing, and (4) the nature and severity of recreation-related water pollution and how behaviors can reduce impacts. Outcome: development of practical techniques for reducing recreation impacts through behavioral change

Element 1c. Site restoration programs in wilderness are often ineffective, due to inadequate information.

Recreation has caused locally severe site impacts in most wildernesses. In many places, severely impacted sites have been closed to further use, either because the location or the severity of impact is considered inappropriate. Often, sites are simply closed and allowed to recover naturally. However, many of the damaged sites are in environments in which natural recovery rates are constrained by factors such as short growing seasons (e.g. alpine environments) or unpredictable or inadequate soil moisture (e.g. arid environments). In such places, unassisted

recovery is likely to require centuries, if it occurs at all. Increasingly, wilderness managers are expending substantial time and effort in attempts to accelerate natural recovery rates using assisted restoration techniques. Many of these restoration attempts have been unsuccessful and, in some cases, have exacerbated problems. Reasons for lack of success are poorly understood. Part of the problem is inadequate understanding of recreation impacts on belowground processes and on interactions between soil and plants (as discussed under element 1b). We lack a foundation of experimental work on alternative restoration techniques. Finally, we have no means of capturing the substantial experiential knowledge that exists among field practitioners. We need a better understanding of how impacts constrain recovery processes, as well as more assessments of the effectiveness of alternative restoration techniques. The primary beneficiaries of this research will be wilderness managers developing programs to restore sites that have been damaged by recreation use. This research should also contribute conceptually to the advancement of the larger field of restoration ecology and to applications outside wilderness.

We propose to:

- Identify the factors that limit natural recovery processes on damaged sites. Particular attention will be given to belowground conditions and processes and linkages between soil and vegetation. We will develop knowledge about the population biology, demography, and reproductive ecology of plant species used in restoration efforts. Outcome: suggest interventions that should increase the effectiveness of restorations.

- Evaluate the effectiveness of existing restoration techniques and adapt existing techniques to wilderness restoration. Existing restoration programs will be evaluated and experiments will be designed to isolate factors that influence success. These studies will be conducted in a variety of habitats. Outcome: our knowledge foundation about effective restoration techniques will be increased and made more accessible to practitioners.

Element 1d. Recreation planning and management is hampered by the lack of tools for assessing visitor distribution and flow in wilderness landscapes.

Understanding the spatio-temporal distribution of use is of fundamental importance to those who plan for and manage wilderness recreation use. The kind and amount of visitor use has profound effects on the quality of natural resources and visitor experiences in wilderness. Therefore, it is important to be able to monitor the flow of visitation, in space and over time, and predict how distributions are likely to change in response to both management actions and factors that are not subject to managerial control. Travel simulation models are useful tools for facilitating the planning and management of visitor use distribution in situations where monitoring and prediction of visitor flow is difficult. Simulation makes it possible to use easily collected measures (e.g., the number of people entering at particular trailheads) to monitor hard-to-measure indicators (e.g., number of encounters between groups on particular trails). Simulation modeling can help fine-tune existing management programs by allowing managers to experiment with different management actions (e.g. different entrance or trailhead quota schemes to identify a program of quotas that optimizes the tradeoff between amount of use and congestion). Work on wilderness travel simulation was conducted in the 1970s but, due to technical challenges, languished until recently. In the past few years, this work has been revived and now holds

renewed potential. These efforts need to be coordinated and focused so that they bring maximum utility to the wilderness recreation manager. Development of travel simulation models, to the point where they are readily available tools, should benefit wilderness planners and managers. They should also be useful in the broader context of park and transportation planning.

We propose to:

- Work collaboratively with developers of travel simulation models to maximize their utility to wilderness recreation managers. Outcome: a state-of-knowledge report that describes the current status of travel simulation modeling, illustrates varied applications of this tool, and facilitates the improvement and availability of this tool.

Problem 2: Improved information is needed on how relationships between people and lands protected for their wilderness values affect and are affected by management policies and actions.

The relationship between people and public lands influences response to management policies and practices. Wilderness management agencies are charged with making decisions that reflect the legislative intent of the Wilderness Act and subsequent legislation, but also are stewards of the relationship between the public and those public lands protected as wilderness. Most social science information used by wilderness managers has focused on indicators of threats to the quality of on-site recreational experiences. Measures of satisfaction, encounters with other visitors, perceived crowding, and other commonly used social science indicators imply a customer, or commodity, orientation towards the public. These measures suggest that the primary evaluations of how well public land managers are doing in their stewardship responsibilities are reflected through the quality of these transactions. Recent research has, however, suggested that these stewardship responsibilities may be further evaluated through examination of the relationship that is created, protected, or restored through wilderness management activities. This approach emphasizes relationships as a major influence on how the stakeholder public evaluates stewardship success. These stakeholders have opinions on how well the managing agencies reflect their values and how well they respond to knowledge about their needs. Stakeholders also vary in the level of commitment and attachment to these places and the activities that occur there, which influence their evaluation of management practices. The public has a range of perceptions about the collective social responsibility associated with providing opportunities to visit or receive other benefits from wilderness lands. Establishing baseline measures and monitoring of these indicators of the relationship between the public and wilderness lands can provide effective evaluation of many management activities, including protection of traditional relationships for indigenous people and enhancing and protecting relationships between the resource and both local and distant populations of stakeholders. They can also assist managers in making decisions that must weigh visitor and local community attitudes about policy against national legislation and policy direction.

Understanding the relationships between the public and wilderness is especially relevant for those who use wilderness for subsistence purposes or other traditional activities that preceded designation as wilderness. There is a need to better understand how management actions and off-

site influences affect these relationships and influence reactions to management actions. The definitions of wilderness contained in the 1964 Wilderness Act focus mostly on attributes of the place and recreation visits there, but there are many types of relationships and many complex and sometimes competing values arising from the set of attributes of wilderness prescribed in legislation. The 1980 Alaska National Interest Lands Conservation Act, for instance, introduced within our National Wilderness Preservation System the concepts of "inhabited wilderness" through continuation of subsistence and other traditional activities by rural residents and "wilderness recreation experiences" even for some areas not classified officially as wilderness, including those using motorized methods of access to get there. It is now apparent that planners have few resources available to guide them in establishing management objectives that address these types of relationship issues. We believe we can make significant contributions to this problem area by focusing research on the following three topics.

Element 2a. Lack of knowledge about contrasting values of wilderness for visitors and non-visitors, and local, rural and distant, urban stakeholders, and the range of threats to those values restricts establishment of objectives for protection or restoration of those relationships.

Wilderness in the United States was established as a system of areas, defined in the 1964 Wilderness Act as areas where the earth and its community of life are untrammeled by humans, where man himself is a visitor who does not remain. "Untrammeled" was included in this definition to mean "not subject to human controls and manipulations that hamper the free play of natural forces." We need to better understand the Euro-centric origin of this concept to more accurately contrast the dominant set of recreation values of visitors to the indigenous and local meanings of the landscapes we are calling wilderness. For example, although solitude has been studied extensively and is often described as the single greatest concern to protecting wilderness experiences in the U.S., continued research, and international collaboration are bringing us to a broader conceptualization of the human values and issues associated with wilderness protection.

For example, descendants of pioneers in the Western U.S. often have traditional and emotional ties to the wilderness landscape very different from those of newer migrants and from those of distant recreation visitors. Similarly, local, rural residents in Southern Appalachia may relate to a nearby wilderness primarily through the family cemetery it contains. Many indigenous people of North America believe that the complex interactions resulting from their relationship with the natural world enhance and preserve the ecosystem. Throughout time, people have managed the ecosystem to increase chances of human survival. However, when ecologists, land managers, and conservationists speak and write about threats to the natural environment they rarely address the potential loss to human cultures that can arise from changing these ancient relationships with the land. The concept of Traditional Ecological Knowledge (TEK) promotes 1) respect for nonhuman entities as individuals, 2) recognition of bonds between humans and nonhumans, including incorporation of nonhumans into ethical codes of behavior, 3) appreciation of the importance of local places, and 4) recognition of humans as part of the ecological system, rather than as separate from and defining the existence of that system. While TEK is the application of the evolving knowledge accumulated about the relationships between human and nonhuman forms, TEKW (Traditional Ecological Knowledge Wisdom) further acknowledges that there is also wisdom acquired through understanding and maintaining these relationships with a complex system. Improved understanding of the different orientations toward wilderness among

recreation visitors and non-visitors, and rural and non-rural stakeholders and identifying how management actions and social and environmental change are influencing those relationships will provide important input to inform dialogue between all stakeholders in decisions related to public lands protected for their wilderness values.

We propose studies to:

- Work cooperatively with indigenous and other rural groups to identify the range of attributes, threats, values and stakeholders associated with areas protected for wilderness values and how management actions threaten or protect those values. Outcome: improved ability to protect or restore traditional and evolving relationships with wilderness landscapes in planning and management decisions.

- Develop understanding of the attitudes indigenous and other rural people have towards the federal agencies' ability and intent to manage wilderness lands in a way that respects local values, and the things that influence those attitudes. Outcome: enhance collaborative planning by creating cross-cultural understanding and protection of the range of cultural values associated with wilderness landscapes.

Element 2b. Managers have little understanding of the sources of conflict between different demands and interests associated with wilderness, and how to determine the influences of management on these conflicts.

Whereas there has been substantial research on conflicts between different types of wilderness recreation visitors, there has been little study of conflicts between recreation and other uses of wilderness. For example, sport hunting, cattle grazing, scientific activities, and subsistence uses often occur within and adjacent to legally designated wilderness frequented by recreationists. In Alaska, indigenous and non-indigenous people actively engage in subsistence lifestyles, and these uses are often perceived in conflict with both recreation and ecological protection values of wilderness. The increasing pressure across the arctic north to develop energy resources and to attract ecotourism, while attempting to balance global needs, will have significant and unprecedented effects on wilderness values and overall biophysical integrity there. There is an acute need to understand the ways in which these forces constrain wilderness values, how they impact the "functionality" of wilderness socio-culturally and biophysically, and how these constraints can be mitigated so that reasonable rural economic progress is not blocked. We will try to better understand these types of conflicts and therefore understand how different groups may respond to attempts to manage some behavioral and attitudinal contributors to the conflict. The primary beneficiaries of this research will be future generations of people who visit, use, or otherwise benefit from wilderness resources.

We propose studies to:

- Determine the amount, causes and potential solutions to conflicts between different types of demand, such as between subsistence and recreation, hunting and non-hunting, local and distant visitor, agency and local community. Outcome: enhance the agencies'

abilities to establish and prioritize management actions with full understanding of the implications for various interest groups.

Element 2c. Managers need methods of measurement and frameworks for describing the various influences on relationships between the range of stakeholders and public lands and the role these relationships play in development of attitudes toward wilderness management actions.

Public land management agencies have been entrusted not only with stewardship of the land but also the public purposes legislatively mandated for that land. It is our belief that success of this stewardship is most likely when defined more by the development or fostering of a relationship between people and the place, and less by the matching of short-term outcomes with varying preferences. This reflects a recent trend in recreation research towards increased emphasis on meanings-based methodologies. Measuring the success of public lands management entails more than counting the number of satisfying experiences, if only because there are many factors beyond the control of managers that influence the achievement of those experiences. Research and management performance goals are becoming more focused on measuring the relationships between the public and wilderness and understanding communications, land management practices and collaborative planning procedures that influence these relationships. This research will benefit all stakeholders in wilderness and related wild lands through bringing focus to the influences of management actions on the relationship between the public and wilderness lands.

We propose studies to:

- Understand how public lands management techniques, visitor and local community characteristics, and collaborative planning techniques related to wild lands influences public trust. Outcome: increased effectiveness and efficiency of monitoring of public trust as a long-term evaluation of success of planning and management activities.

- Continue research to support application of "public purpose marketing," with focus on understanding the impacts of management activities on relationships between the public and public lands. Outcome: improved understanding of different segments of the public, facilitated targeting of information to the public, and public response to management policies, such as recreation fees, user control techniques and fire risk reduction actions.

Problem 3. There is a need for improved information to guide the stewardship of fire as a natural process in wilderness while protecting social and ecological values inside and outside wilderness.

Two fundamental goals of wilderness stewardship are to allow natural ecological processes to function without human interference and to preserve natural conditions. Natural disturbances are important ecological processes for perpetuating a wide variety of native species and the structure and function of wilderness ecosystems. To develop effective strategies for allowing natural disturbances to more freely function in wilderness, wilderness managers need to understand natural disturbance regimes, how human actions have altered these regimes, the effects of that

alteration, and the consequences of management options for reversing or mitigating these effects. Development of the Leopold Institute research program in this area has identified fire as the most important natural disturbance that wilderness managers need to understand in order to protect and preserve wilderness. Research in this problem area is primarily supported by funding from the National Fire Plan, but is supplemented by other project funding (e.g., Joint Fire Science Program, Bitterroot Ecosystem Management Research Project, etc.). Development and direction of this problem will depend, at least in part, on continued availability of funding and compatibility with the needs of these funding sources.

Wilderness fire managers and planners are faced with the challenge of restoring or maintaining the natural process of fire in wilderness while protecting a wide variety of other social and ecological values inside and outside of wilderness. Additional research in the ecological and social sciences is needed to understand when, how, and where the process of fire can best be maintained or restored. Fire suppression has been, and continues to be, the dominant fire management strategy in wilderness, as it is outside wilderness. In many areas, fire suppression has contributed to increasing hazardous fuel accumulations, increasing probability of extreme wildfire occurrence, and altered ecosystem structure and function; all results that run counter to wilderness management goals. In addition, fire suppression has helped to distort human perceptions of natural systems. The orientations toward wilderness fire management that are held by the public and government agencies need to shift away from fire suppression as the dominant fire management strategy and toward a stewardship of the process of fire that includes natural (i.e., wildland fire use) and prescribed fire. To support this shift, we need to understand 1) the natural role of fire in wilderness and how this role has been altered; 2) the options available for restoring fire as a natural process and the consequences of these actions on the wilderness environment; and 3) how social and institutional factors create and maintain a particular orientation toward wilderness fire management. This research will help managers and planners devise effective strategies for restoring and managing fire in wilderness. The need for a shift away from fire suppression as a dominant strategy and toward the use of wildland fire is increasingly being recognized outside wilderness and the knowledge gained will apply across the full spectrum of lands extending from wilderness outward to the wildland urban interface.

<u>Element 3a. An understanding of natural fire regimes and the extent and degree to which they have been altered is required for developing effective strategies for the stewardship of fire as a natural process.</u>

To establish realistic, sustainable, and scientifically defensible targets for management, we need a better understanding of the extent and degree to which natural fire regimes have been altered by human activities. Wilderness is the best laboratory we have for understanding the range of natural variability in fire frequency, size, severity and seasonality. Although scientists agree that the temporal and spatial variability of fires and fire effects are very important for ecosystem diversity and stability, methods have not yet emerged to effectively describe that heterogeneity. For example, descriptions of fire regimes typically only consider historical averages or mean conditions and therefore fail to capture ecologically important aspects of natural fire regimes. We need a better understanding of how characteristics of natural fire regimes vary in time and space because managers use these descriptions to

develop prescriptions and targets for management and they need to be able to plan for and incorporate this variability. An understanding of the inherent variability of natural fire regimes is also important for identifying the appropriate scales for the study and management of fire. Research has shown that different environmental factors influence fire regimes at different scales and we need an understanding of these factors and their related scales of influence. To identify where and what type of intervention may be necessary to achieve management goals, we need a better understanding of how fire regimes have been altered by a variety of agents of change, including: land management, fire suppression, land use change, other disturbances, and climate change. Primary beneficiaries of this research are fire and wilderness managers who seek to restore the natural process of fire to dynamic wildland ecosystems in the face of changing climate and vegetationconditions. The information on the degree and extent of alteration is important for policy-makers and agency leaders. Knowledge gained from wilderness about reference conditions and the natural range of variability will also help set management objectives for non-wilderness environments.

We propose to:

- Quantify and describe the variability in fire regimes at multiple spatial scales in the past and present. Outcome: identification of the appropriate scales for the study and management of natural fire regimes; sampling strategies and methods for describing and quantifying fire regimes at the spatial and temporal scales most relevant to management; identification of critical variables needed to model fire regimes at multiple scales.

- Determine how land management, fire suppression, land use change and climate have affected wildland ecosystems and their fire regimes. Outcome: evaluation of the relative influence of climate and fire suppression on past and present fire regimes; quantification of the effect of fire suppression on ecosystem conditions.

Element 3b. Fire managers and planners need to understand the options for restoring fire and the consequences of these actions on the wilderness environment.

Options for restoring the natural role of fire in wilderness vary among wildernesses. In some wildernesses, fire is already playing its natural role and maintenance of this role is best achieved through allowing lightning caused ignitions to burn. In other cases, systems have been altered to such a degree that allowing natural fire to burn would compromise wilderness values and therefore, prescribed fire may be a preferred option prior to allowing natural fire. And in still other cases, such as small wilderness areas, allowing natural ignitions to burn may never be feasible because of the potential for escaped fires and unacceptable risks to values. Before investing limited time and resources in developing and implementing strategies to restore and maintain the natural process of fire to wilderness, managers need to understand the likelihood of meeting their objectives through management actions and the consequences of these actions. The cumulative effects of fire and fuels management activities may not be readily apparent and can depend on how surrounding lands are managed.

Although the first order, immediate effects of fire on vegetation are well studied, other effects from fire are less well known. For example, fire management staff and wilderness managers need to know the extent to which fire management activities increase the likelihood of non-native plants becoming established in remote wilderness areas, and whether attempts to reduce suppression-accumulated fuels will exacerbate the spread of non-native plants. The current lack of information on the effects of fire on fish and aquatic wildlife is also a major impediment to developing and evaluating fire management strategies. This knowledge gap is particularly important as populations of several amphibian and salmonid species in the mountainous regions of the western U.S. are declining. Finally, to anticipate the long-term consequences of a particular management strategy, we need to better understand the cumulative effects of fire and fuels management activities, including the reciprocal interactions between fire regimes and patterns of vegetation and fuels across large landscapes. Through this research, we will evaluate the consequences of various options for managing and restoring fire in wilderness and adjacent lands. Beneficiaries of this research are fire managers, who need to anticipate the short- and long-term implications of their decisions, and planners, who need to develop strategies and set realistic objectives for managing fire.

We propose to:

- Investigate the long-term consequences of fire and fuels management strategies. We will use computer models to simulate the reciprocal interactions between fire and landscape pattern, project the long-term cumulative effects of fire and fire management, and assess the likelihood of meeting restoration objectives with wildland fire use. Outcome: quantification of the effect of altered fire regimes on landscape patterns of vegetation; recommended strategies for accomplishing fire management objectives; methods for tracking the cumulative effects of suppression.

- Improve understanding of the consequences of fire and fuels management activities on the establishment and spread of non-native, invasive plants in wilderness. Measure the effects of fire and fire management activities on the influx and spread of non-native invasive plants in wilderness, taking into account variables of physiography, extant vegetation, recent fire history and severity, and proximity to source pools of invasive plants. Outcome: guidelines for minimizing the effects of fire management activities on the establishment and spread of non-native invasive plants in wilderness.

- Improve understanding of the ecological consequences of fire in upland and riparian forests on stream communities and habitat conditions at multiple scales. We will document the range of biotic and abiotic responses to fires of varying intensities and attempt to determine if prescribed burning mimics the ecological function of fire in a watershed. Outcome: evaluation of the immediate and long-term effects of fire management activities on stream ecosystems; identification of opportunities to protect threatened and endangered species; quantification of the effects of prescription burning on stream communities and habitat conditions.

Element 3c. An understanding of how social and institutional factors influence the evaluation of tradeoffs by fire managers and members of the public is necessary to support the stewardship of fire as a natural process in wilderness.

Allowing lightning-caused fires to burn freely in wilderness is consistent with wilderness objectives and can impart many ecological benefits, but the potential for the fire to escape the wilderness boundary and threaten values outside of the wilderness often results in the decision to suppress. Because decisions about how to manage a wilderness fire are made within just a few hours following first report of a fire start, a full evaluation of the tradeoffs among these risks and benefits is difficult. Moreover, most existing decision-support tools focus attention on the short-term, negative consequences of fire. This concentration on the wilderness boundary, the time constraints on the decision process, and the focus on negative impacts of fire all combine to inhibit a comprehensive discussion of the trade-offs involved and ultimately reinforce an orientation towards suppression. To support wildland fire use, decision-support tools are needed to enable managers to weigh the benefits of fire against its risks, and these tools need to be used at multiple scales.

Achieving fire stewardship requires a restructuring of the decision process and a deeper understanding of the context within which decisions are made. We need to understand the individual, social, and organizational factors that support and maintain the existing orientation toward suppression and we need to determine what changes are necessary to accomplish a shift toward fire stewardship. This requires understanding the institutional factors that create barriers to fire use, developing methods to evaluate tradeoffs among risks and benefits, and developing methods to translate this understanding into changes in organizational behavior. In addition, this requires an understanding of how public attitudes, value orientations, anticipated outcomes, community norms, and knowledge influence the development of public views and trust in the agencies and fire and fuels management activities, and how individuals make personal tradeoffs when considering alternatives to fire suppression.

This research seeks to improve our capacity to help managers restore and maintain natural fire regimes in wilderness by providing: increased understanding of the barriers to fire use and methods for dismantling them, improved quality and consistency of decisions, and improved understanding of how to gauge and engage the public in wilderness fire management. Wilderness and fire planners and managers will benefit through an improved ability to engage themselves and the public in an evaluation of the short and long-term consequences of fire management, to anticipate public and organizational response to proposed management actions, and to protect both the ecological and human values affected by fire and fuels management.

We propose to:

- Determine the institutional, political, cultural, historical, and legal factors that influence fire management decisions when opportunities for restoring and maintaining the natural role of fire in wildland ecosystems become available. We will

determine and compare the factors leading to success (or lack of success) of wilderness fire programs. We will directly observe and collect data about the decision-making process for wildland fire use and suppression incidents. Outcome: identification and understanding of the primary barriers to wildland fire use.

- Increase understanding of the influence of public knowledge, value orientations, attitudes, community norms, and anticipated social and ecological outcomes on public decisions regarding fire and fuels management. We will identify and understand how specific influences such as trust in the agency, past experiences with fire, and attachment to place also affect the way the public views and responds to fire and fuels management activities. In particular, we will attempt to understand these influences in relation to public support or opposition towards wildland fire use. Outcome: improved understanding of human orientations towards wilderness fire management and how they vary; methods for monitoring public support of fire and fuels management.

- Develop and test methods for assessing tradeoffs among social and ecological values associated with fire and fuels management decisions. These methods will allow the positive outcomes of fire to be weighed against the risks from fire so that the effects of fire and fuels management on social and ecological values can be integrated into landscape planning tools. Outcome: procedures for integrating social and ecological outcomes of fire and fuels management into landscape planning activities; improved understanding of how social and ecological value tradeoffs affect management and public decisions regarding fire and fuels; improved ability to communicate about the social and ecological outcomes and tradeoffs related to fire and fuels management.

Problem 4: There is a lack of adequate understanding of how wilderness stewardship is influenced by the location of wilderness within larger ecological and social systems.

Over the past two decades a substantial body of research has shown that nearly every significant natural resource issue is embedded in the context of larger ecological and social systems. The ecological and social values of wilderness are affected by and affect ecological and social systems that extend beyond the wilderness boundary. For example, a small, heavily visited wilderness close to urban areas has a very different context than a large, remote, lightly visited wilderness. Because of its context, the small wilderness will likely have more incursions of non-native species, more air, water, and light pollution, diminished native wildlife, greater recreation impacts, more human conflicts, and more suppression of natural fire. Wilderness also affects the ecological and social context of a community, region, and the nation by providing such things as clean air, fresh water, wildlife habitat, and recreation that offer ecological, amenity, and commodity values. In all these examples, there is a strong interaction between ecological and social systems, oftentimes across multiple spatial and temporal scales, that ultimately affects wilderness, its stewardship, and its role in the surrounding landscape.

Most past wilderness research has focused at the site-level. Currently, there is very little empirical understanding on how the context of larger ecological and social systems affects

wilderness, or on the role wilderness plays in affecting lands and people outside wilderness. One of the primary challenges of this Problem is the vast range of ecological and social research topics operating across a variety of spatial, temporal, and human community scales. Because of this number and variety of topics, we must be selective in pursuing our future research directions. We believe that we can make the greatest contribution to improving wilderness stewardship and understanding the role of wilderness in the larger landscape by providing leadership in developing the following four topics.

Element 4a. The introduction, spread, and effects of non-native species threaten ecological and social values of wilderness.

Non-native species pose a serious, pervasive, and long-term threat to the ecological and social values of wilderness. Past research has established that non-native plants, animals, and pathogens, whether introduced intentionally or unintentionally, may irreversibly alter native species composition and ecosystem processes such as fire regimes and nutrient cycling. Research has also shown that non-native species may reduce the quality of wilderness recreation experiences. Wilderness specific research on non-native species is needed to improve understanding of the specific human and non-human vectors and environmental factors influencing the introduction and spread of non-native invasive species, especially in remote wilderness backcountry areas.

This research is important because by law wilderness is supposed to be as ecologically pristine as possible, thereby contributing conservation value to surrounding lands and to society. Non-native species have the potential for significantly altering many of the ecological and social values of wilderness. In addition, the large size and remoteness of many wilderness areas makes detection difficult, whereas wilderness restrictions make management of invasive species particularly challenging. This research will be of use in crafting wilderness management plans and in working with different partners, including outfitters and state fish and game agencies, to reduce the introduction and spread of non-native species in wilderness. This research should also contribute to the general understanding of interactions between disturbances (natural and anthropogenic), intentional and unintentional management actions, and the introduction and spread of non-native species.

We propose to:

- Identify the principal factors influencing the introduction and spread of non-native invasive plants within wilderness, focusing on recreation-caused disturbances and natural disturbances, how these disturbances interact, and their relationship to known sources of these plants. Outcome: description of the factors contributing to the introduction and spread of non-native invasive plants in wilderness.

- Develop spatially-explicit, empirically-based statistical models for predicting the occurrence of non-native invasive plants in wilderness to facilitate early detection and evaluation of potential effects and risks. Outcome: models to improve the detection and evaluation of potential risks from non-native invasive plants. Model results will suggest priorities for control and eradication of non-native invasive plants in wilderness.

- Investigate the effects of introducing (from hatcheries) and maintaining predacious nonnative fishes in wilderness lake ecosystems, including the effects on amphibians, invertebrates, and zooplankton. Outcome: information and predictive models on the threat of nonnative fishes to native species persistence in high elevation wilderness basins. (This work, which is currently conducted by a soft money funded post-doc will be phased out within the next year if new funds are not secured.)

Element 4b. Global change will alter the distributions of wildlife and their relationships to wilderness in ways that we need to understand.

Global change is a collection of processes occurring within large ecological contexts, from regional to global scales, but which affect wilderness and the species found in wilderness at local scales. Recent research suggests that climate change may be a more serious threat to biological diversity than previously realized, because the extent of potential habitats of many species will shrink as temperatures and precipitation change. Amphibians, being cold-blooded and having permeable skin that requires close ties to aquatic or moist habitats, are well suited for the study of the effects of climate change, and aspects of the life history of several species of amphibians already appear to have been affected by recent climate change. For example, several documented threats to amphibians may have climatic relationships, e.g., susceptibility to the pathogenic chytrid fungus may vary depending on temperature. Although amphibians have comparatively low diversity in high-elevation wilderness and backcountry areas of national parks and forests in the western United States, many of these species occupy important ecological niches. Knowledge about the status of amphibians in wilderness is important because a high proportion of western amphibian species have undergone recent declines, often in protected habitats.

Evaluating the effects of climate change often requires long-term data. The US Geological Survey's Amphibian Research and Monitoring Initiative (ARMI) includes monitoring to determine status and trends of amphibian species in the U.S. and to conduct research on causes of declines and effects of physical and biological stressors on amphibian populations. The USGS Research Zoologist at the Leopold Institute supervises the monitoring and research being conducted through ARMI in the Northern Rocky Mountains. The data will provide both direct evaluation of trends in amphibian abundance and distribution which may be related to climate change, and the context for generating hypotheses and conducting research on the effects of particular stressors. Data collected from wilderness allows researchers to minimize the effects of other stressors that are more prevalent in developed landscapes. The results will provide data to improve the precision of models that predict species' responses to climate change, which will benefit conservation science generally. Current models suffer from a lack of species-specific data. This monitoring and research will benefit park and wilderness managers directly by providing current information on the status of amphibians on their lands and predictions on expected changes. This work is entirely supported by the USGS.

We propose to:

- Monitor the status and trends of amphibians in the Rocky Mountains along the Continental Divide on a north to south transect incorporating the large national parks of the region. This provides the opportunity to track changes in status of amphibians over an extensive latitudinal gradient and compare these changes to gradients in climate and habitat. Outcome: data archived in a USGS-maintained national database of amphibian observation data; annual reports available at http://armi.usgs.gov; summaries of trends.

- Examine the relationships between amphibian life history and climatic variables likely to change during the next century. Outcome: predictive models of changes in distribution that may occur under various scenarios of climate change.

- Investigate the occurrence and effects of the pathogenic chytrid fungus among amphibians in the Rocky Mountains, including relationships to potential stressors such as climate change. Outcome: information on the threats to populations not yet thought to have been affected by chytrid infections.

Element 4c. There is a need to better understand the contribution of wilderness protection to water quality and quantity.

Wilderness and similarly managed lands protect watersheds vital for providing abundant, clean water. This water is essential for the economic well being of local and regional communities, maintains natural aquatic and terrestrial ecosystems, and provides opportunities for outdoor recreation. Yet, there is almost no information about the quantity and quality of water coming from the nation's wilderness areas, about the importance of hydrologic connectivity between wilderness and adjacent lands, or about who benefits from these protected watersheds and in what ways. Little is known about the values placed on wilderness watershed protection by the public, or on comparisons of the values of water quality and quantity within and outside of designated wilderness. Similarly, little is known about the effects of various management activities on these diverse values, or on the specific impacts to wilderness water from structures such as dams and diversions both inside and outside of the area. Beneficiaries of improved understanding of this topic will include land managers who must balance multiple values in making decisions about activities in protected watersheds. Full development of the identified studies will depend on a proposed watershed funding initiative, or other project level sources of funding.

We propose to:

- Describe the extent and number of watersheds wholly or partially protected by wilderness classification that provide water for off-site human uses. Outcome: description of the contribution of wilderness protection to society's needs for abundant clean water.

- Identify the economic, cultural or other social values that local residents and visitors place on water originating in or flowing through wilderness, and develop understanding of how these values are influenced by impoundments and other disturbances that pre-existed wilderness designation, or are being considered. Outcome: description of social

tradeoffs when making decisions about management activities in wilderness watersheds, including the repair and maintenance of pre-existing wilderness dams.

- Understand the influence of landscape modifications and management actions on the quality and quantity of water flowing from and into wilderness. Outcome: description of the influences of management actions and landscape modifications on the internal and external values of wilderness water.

Element 4d. Indicators and monitoring protocols are needed for assessing trends in ecological and social conditions in wilderness, threats to these conditions, and the value of wilderness to other lands.

To track changes into the future and provide feedback to managers that will improve stewardship decisions and actions, information is needed about the ecological and social conditions in wilderness and the threats to these conditions. In individual wilderness areas, threats are both internal (e.g., cattle grazing) and external (e.g., polluting industries). They can be activities (e.g., recreation use) or the indirect effects of activities (e.g., invasion of non-native species), and can also be management actions (e.g., fire suppression). Wilderness managers need monitoring data about the magnitude of these threats and their impacts to wilderness ecological and social conditions. For some threats, such as camping impacts to soil and vegetation or the impacts of crowding on solitude opportunities, research has developed and tested indicators that are widely used. For the majority of other threats, however, indicators have not been developed and the value of some currently used indicators has not been tested. Some information on ecological and social conditions in wilderness may be derived from national monitoring efforts, but research is also needed to maximize the value of these broad-scale monitoring efforts to the evaluation of conditions in local wilderness areas.

In addition to improving the stewardship of individual wilderness areas, wilderness program managers and policy makers need monitoring information to periodically review and improve agency wilderness policies at a national scale. The 1964 Wilderness Act mandates federal agencies to preserve "wilderness character," and a standard set of national core indicators of wilderness character are being developed. Consistent national scale monitoring both inside and outside wilderness would allow wilderness to be used as a benchmark to understand the effects of management actions on lands outside wilderness, allow assessment of potential threats to wilderness from adjacent lands, and improve understanding about the contribution of wilderness to the surrounding region. All of these monitoring efforts will be developed cooperatively with existing and planned agency monitoring and evaluation programs. The agencies can help ensure use of monitoring information through institutional support for these programs.

We propose to:

- Continue working cooperatively with agency managers to develop and test new, cost-effective indicators and monitoring protocols for assessing trends in wilderness character. Outcome: guidelines for monitoring trends in wilderness character.

- Develop and test new, cost-effective indicators to monitor ecological and social conditions that could be applied both within individual wildernesses and outside wilderness. Outcome: guidelines for monitoring and evaluating ecological and social conditions within wilderness, threats to wilderness from surrounding lands, and the role of wilderness in the surrounding landscape.

Problem 5. There is a need to improve the delivery and application of scientific knowledge and tools pertinent to wilderness stewardship.

The means of effectively incorporating scientific knowledge into federal land management planning and implementation efforts poses a challenge to both managers and researchers. Whereas scientists work to make their studies useful and available, it can be difficult to know exactly which managers need certain information, when they need it, what format is most useful, and what communication avenues are most effective. Managers also have limited time to search for research results, can be overwhelmed by a plethora of potentially relevant information, and have a variety of individual and organizational factors that influence how they learn about science, how they incorporate science into management, and how they communicate their needs for science. Facilitating the delivery and application of wilderness research can be especially challenging because wilderness management includes a broad range of ecological and social topics about which managers, policymakers, and the public must be knowledgeable, and many wilderness management problems require an in-depth understanding of interdependent resources. Additionally, wilderness information needs and communication networks vary among the four federal agencies that manage wilderness as well as other individuals and organizations interested in wilderness stewardship.

The Leopold Institute is dedicated to helping scientists and managers achieve effective delivery and application of scientific knowledge and tools. Delivery efforts of individual scientists usually focus on specific results and concepts developed by the Institute, often in response to requests by management units. Institute scientists do not have time to distribute and interpret all of the available relevant research, or provide information to all wilderness and other management audiences who might find it useful. Consequently, the Leopold Institute has developed a dedicated Research Application Program (RAP) to complement the efforts of individual scientists and to strategically investigate, plan, and implement approaches for the effective delivery and application of a broad array of wilderness related scientific information to a variety of management audiences. Since its inception in 2000, the RAP has summarized and synthesized research on a variety of ecological and social wilderness issues, developed an extensive web site, and begun investigating barriers to science delivery and research application. Barriers to the integration of science into policy and management include users not knowing what information is available or where to find it, cultural and communication differences between researchers and research users, and limited capacity to access, evaluate, and apply new research. In order to improve the effectiveness of science delivery and application efforts, the RAP will continue to investigate influences on the awareness, understanding, and use of science and to understand target wilderness management audiences across agencies, resource program areas, and administrative levels. Beneficiaries include managers who actively search for research as well as those who receive it through formal and informal communication avenues. Other

scientists and research application specialists will also benefit from a greater understanding of target management audiences and influences to the success of science delivery and application. Full development of this problem will depend on continued availability of funding from partner agencies and programs.

Element 5a. Facilitate access to scientific knowledge and tools by compiling, summarizing, and organizing scientific resources.

Managers can inform decisions with current and relevant scientific knowledge only if they can locate such information when they need it. The plethora of available research, much of which is published in journals or other outlets that managers may have difficulty in locating, often makes it challenging to find information relevant to specific management questions. In addition, managers frequently express concern that increasing workloads and lack of time to search for or read relevant information are significant barriers to locating scientific information. With limited time to wade through scientific publications, managers may not be aware of relevant research and how it fits into their management objectives. To date, we have developed searchable databases of Institute publications and projects; compiled and organized internal and external research in the *Linking Wilderness Research and Management* series of reading lists; and developed brief summaries of both completed and ongoing Institute research projects that direct readers to project objectives, management implications, and associated products. We propose to continue to compile, summarize, and organize research on a variety of topics important to wilderness management. By working directly with scientists, we can better articulate how individual studies fit within a broader context of wilderness research and assure that research application products are scientifically accurate.

We propose to:

- Maintain and expand the Leopold Institute web site to facilitate access to scientific resources relevant to wilderness stewardship. Outcome: those searching for information will be able to efficiently locate relevant scientific resources.

- Prepare and publish summaries and syntheses of scientific information on high priority wilderness management topics, and make them available through the Institute web site. Outcome: summaries of key wilderness issues will make it easier to determine what research has been done on a particular topic and to determine the relevance of specific publications; easy-to-read summaries will help determine whether to delve into related in-depth scientific publications.

- Develop searchable databases that compile information from a variety of sources, and make them available through the Institute web site. Expand existing databases to address additional issues and to include updated information. Outcome: increased awareness of available data and resources; increased communication among managers and researchers who use the databases and realize they are addressing common issues.

Element 5b. Improve awareness and understanding of scientific information through proactive delivery and communication.

Many people do not have time, and some do not have the skills, to search for scientific information. Unless we proactively deliver information research and research application products will only be useful to those who actively search for and find them. We plan to improve awareness and understanding of relevant science through actively communicating and distributing research and research application products. As a result, managers will be more likely to be aware of pertinent scientific information when they need it.

We propose to:

- Develop and maintain relationships with managers responsible for wilderness, with an emphasis on the national and regional program leaders in the four federal wilderness management agencies as well as agency representatives at the Arthur Carhart National Wilderness Training Center. Participate in meetings and conference calls to share information about new resources and ongoing scientific efforts relevant to wilderness stewardship. Outcome: new research findings and tools will be available to be incorporated into national wilderness training courses and materials; increased awareness of wilderness research findings.

- Use electronic media to distribute updates about new Leopold Institute research and application products. Outcome: managers will have an increased awareness of the Leopold Institute as a resource for scientific information and be aware of products soon after they are developed.

- Provide guidance to scientists interested in developing "technology transfer plans" to increase the rate of adoption of specific research products by target audiences. Outcome: increased awareness, understanding, and use of specific research products.

- Translate scientific findings to semi-popular formats for agency, web and other publications. Publish semi-popular articles or news briefs about wilderness research activities and products. Outcome: increased awareness of specific research and research application products; exposing casual readers to relevant research products may stimulate them to actively search for more information.

Element 5c. Investigate influences on and develop improved approaches for effective science delivery and application.

Research application and technology transfer efforts often are based on the assumption that making information accessible and increasing awareness will lead to the adoption and use of scientific resources. However, there are a variety of reasons why individual managers may not know about or use these resources. There is a wealth of knowledge in communication studies, organizational theory, decision theory, social psychology, adult learning, and other social disciplines that can provide insight into barriers that limit agency capacity to integrate science at both individual and organizational scales. This literature is dispersed throughout a variety of social science disciplines and has not been synthesized and integrated effectively to improve

science delivery and application. There are relatively few precedents, guides, or proven methods for improving the ability of managers to access and use scientific knowledge. As a result, science delivery approaches are often developed on an ad hoc basis without an overall understanding of the entire research application process, without addressing cultural and communication barriers between researchers and managers, or addressing organizational capacity. There has been little formal strategic effort in either the research or management communities to address fundamental barriers to effective science delivery or application. Strategic questions include: "What influences whether delivery translates into awareness and use? and "How can science can be delivered to increase the rate of adoption and achieve more effective application?" We propose to use knowledge from social science disciplines and empirical investigations to evaluate existing delivery and application approaches and develop strategies for improving the communication of available research results to target management audiences. While the focus will be wilderness research application, this effort will contribute to the understanding and assessment of a growing innovative effort within federal agencies to span boundaries between management and research.

We propose to:

- Explore the underlying technical and social mechanisms that influence how and when agency managers apply new scientific knowledge and approaches, with an emphasis on understanding target management audiences with wilderness responsibility. Improve understanding of how communication, organizational, decision, psychological, and adult learning theories apply to management audiences in different agencies and different resource program areas. Outcome: increased knowledge of barriers to the effective delivery and application of science; recommendations to help researchers, upper level managers, and research application specialists prioritize limited science delivery resources; increased effectiveness of science delivery and application efforts.

- Network with other research application and technology transfer specialists to identify, evaluate, and promote effective research application methods, tools and techniques. Outcome: increased efficiency and reduced redundancy in researching or trying new approaches, across units and across agencies; increased partnerships among federal research application and technology transfer specialists.

SUPPORT: STAFFING, FUNDING, FACILITIES

Although the Leopold Institute remains largely staffed and funded by Forest Service Research, its ultimate success as an interagency effort depends on the support provided by all the participating agencies. We continue to strive to fulfill the vision of a fully interagency program that focuses on the National Wilderness Preservation System and thus, our work is done in and is applicable to wilderness managed by all four federal wilderness management agencies. Liaison with the partner agencies is coordinated through a Washington DC based senior level interagency Wilderness Policy Council and a mid-level interagency wilderness coordinating group (Steering Committee) as well as interactions with intra-agency wilderness management

and science committees. The USGS provides a scientist and project support funds to focus on issues of particular interest to the DOI. USFS base funding to the Institute has been supplemented since 1994 by the BLM and since 1999 by the FWS. Project funding has been provided by individual field units or central offices of the partner agencies. This section provides further details related to staffing, funding and facilities, and discusses what is needed to assure the Leopold Institute remains a sustainable, interagency program.

Staffing:

Permanent staff at the Leopold Institute consists of the Institute Director, five Research Scientists, a Research Application Program Leader, a Biologist, and an office manager. These positions are all supported by USFS Research base funding except for two research scientists (one is a USFS scientist supported by National Fire Plan funding and the other is a USGS scientist) and the Research Application Program Leader (currently funded jointly by FS research, BLM and FWS). This staffing is supplemented, as funding allows, by post doc, term, temporary, and student appointments. All of these support positions are funded entirely by soft (project) funds. Much Leopold Institute sponsored research is accomplished through cooperative studies with collaborators from universities and other federal labs across the country.

<u>Staffing as of April, 2005:</u>

Permanent:

- Director, GS-15
- Research Geographer, GS-15 (Problem 1)
- Research Social Scientist, GS-15 (Problems 1 & 2)
- Research Ecologist, GS-14 (Problem 4) (identified to be abolished in FY06)
- Research Ecologist (National Fire Plan), GS-12 (Problem 3)
- Research Zoologist (USGS), GS-15 (Problem 4)
- Research Application Program Leader. GS-11
- Biologist, GS-9 (identified to be abolished in FY05)
- Support Services Specialist, GS-7

Post-Doc and Term (project funded):

- Post-Doc, Fire Ecologist, GS-12
- Term, GIS Analyst (fire), GS-11
- Term, Social Science Analyst, GS-9
- Term, Zoologist (USGS), GS-9
- Social Science Specialist, GS-7
- Forestry Technician (web support), GS-5

Demands for research in the areas of our permanent staff expertise are greater than we are able to be responsive to. Similarly, we do not have adequate staff to address the full suite of wilderness related research needs that have been identified by the partner agencies. With base funding inadequate to fully cover the salaries of the permanent staff, we have had to eliminate our once base funded permanent analyst position and are faced with the prospect of reducing

additional permanent staff if additional base funds are not secured. We are now dependent on project funds to provide the needed professional, technical and office staff to support the existing science and application efforts. The RAP staff is almost entirely soft money funded, the loss of which would place that important function, including maintenance of our web site, in jeopardy. Without these funds the salary of even the RAP Leader would be uncertain beyond 2005. These limitations emphasize the importance of cooperative and collaborative working arrangements with scientists from other organizations. Since they are largely dependent on new funding, priorities for new positions are addressed under the following section (Funding).

Funding:

Despite the original intent by the partner agencies to jointly develop and operate the Leopold Institute, base support continues to come primarily from USFS Research and Development appropriations. The Leopold Institute's 1996 Strategic Plan, developed with input from all the partner agencies, identified modest short-term staffing and funding targets for each of the agencies to more equitably share in support of the Institute's operating costs. These targets, which would have allowed a modest expansion of the scope and depth of the Research and RAP programs, have not been achieved. Coupled with the lack of significant increases in base funding since 1996 (FS support has increased by a total of less than 5% during the this time, to a FY2005 total of $875,000; BLM support has increased by $10,000 to a total of $60,000, and FWS support has held constant at $30,000), inflationary costs have seriously eroded the capacity of the Institute (see Appendix II for funding history). For example, whereas in 1996, base funding allowed $224,000 for use in research projects, by 2004 base funds were inadequate to cover operating expenses.

The erosion of the Institute's core USFS base funds has been accompanied by an increase of targeted funding that, while permitting a modest expansion of permanent science staff, requires that work be focused on addressing the needs of the funding source. Specifically, since 1996, there have been base increases from the USGS to cover the salary of a Research Zoologist to study declining amphibian populations, and from USFS Fire Plan funding to support a Research Ecologist to direct a significant program on wilderness fire. This latter funding has also provided support for other Institute staff who have shifted more of their focus to fire related issues (e.g., fire and alien species, social dimensions of fire management, and fire research application). The fact that Fire Plan funding, originally awarded as a permanent base increase, has decreased each year and is projected to decrease even more in the future further exacerbates the erosion of core base funding.

In addition to limiting expansion into new areas, the gradual erosion of core base funding has resulted in an increasing dependence on short-term, project-specific, soft funding. This trend has created several dilemmas that are expected to worsen in coming years. The perils of dependence on project funding include 1) the need to be responsive to specific needs of those with the funding, resulting in less control over what is studied; 2) difficulty in supporting the permanent positions required to develop expertise or establish relationships necessary to assure understanding of the policy and management context of wilderness science; 3) difficulties in planning ahead when funding sources are constantly changing; 4) pressure to produce short-term, often site-specific products, often at the expense of more broadly applicable findings; and 5)

increased costs of managing (tracking and reporting) multiple funding sources. Under a system dependent on soft funding individuals may survive, and even flourish; but institutional capacity is likely to decline, resulting in a loss of relevance, breadth and the ability to be proactive. We believe that many of the competitive advantages of government sponsored research programs are lost as they become more dependent on soft funding.

Priorities For New Support:

Should additional base funding become available, the first priority would be to provide support funds for the core programs of our permanent staff, including salary, office support, travel, and a minimal level of core project support. Priorities for additional permanent staff are as follows:

1) provide base funding to maintain the Research Ecologist position identified to be abolished in FY06.
2) place the Research Fire Ecologist and Research Application Program Leader on base funding.
3) create new position to cover the following basic program support needs:
   -web support, including content development
   -data base management, analysis and archiving
   -office and library assistance

If new funding is sufficient to consider expansion of existing programs to more fully address the needs identified by partners during development of this Charter, the following are our priorities:

4) new Research Scientist to address issues related to water and watersheds
5) new Research Wildlife Ecologist
6) new RAP program support position
7) new Research Social Scientist
8) new Atmospheric Scientist

These positions, some of which could be funded by the partner agencies, would allow us 1) to fully develop the Problems, Elements and studies as proposed in this Charter, and 2) expand into other important areas, including questions related to wildlife, air and water. This would also allow us to play a larger role in serving as a clearing-house for wilderness related science that is produced by others. It is clear that to significantly broaden our current scope would require a major increase in base funding. Should vacancies occur in the current staff needs and priorities will be re-examined, including the lost expertise created by the vacancy.

Facilities:

The Leopold Institute is housed in a 4,600 sq foot building on the campus of the University of Montana. The main lab, which along with the property it sits on, is owned by the Forest Service, is part of a four building complex referred to as the Missoula Forestry Science Laboratory of the Rocky Mountain Research Station. Recent expansion of project

staff due to Fire Plan funding has resulted in the placement of three post doc and term employees in a nearby modular building that is also part of the complex. All available space is fully used and at this time there is no location in which to place any additional staff should the opportunity arise.

Projections of additional staff (research, application, or support) that might be provided by program expansion or placement of staff by other agencies at the Institute, would require additional space. Funding is currently available (FY2004 and 2005) to begin planning for a joint building between RMRS, the Carhart Center, and the University of Montana. If construction funds are appropriated, this new building would replace the existing Forestry Sciences Laboratory complex, including the Leopold Institute's facility.

APPENDIX I. BACKGROUND

Authorization and History

The Leopold Institute was established in January 1993 through an enabling Charter signed by the Chief and Deputy Chief for Research of the USFS. It was formed from the Intermountain Research Station's Wilderness Management Research Work Unit that had provided national leadership in wilderness recreation research since its establishment in 1967. In recognition of the diverse array of wilderness stewardship challenges, the enabling Charter stated that the Leopold Institute was "to obtain and provide information necessary to sustain wilderness resources in an ecologically and socially sound manner for the present and future." The rationale for establishing the Institute included advantages of aggregating expertise from within and outside the agency, efficiency through partnerships and leveraging of funds, and continuity through development of long-term studies and data sets. The initial emphasis was to "address a full range of wilderness management issues," including recreation and non-recreation uses, physical, ecological, and social impacts on the wilderness resource, monitoring of the National Wilderness Preservation System (NWPS), and developing information useful for wilderness management and education. The Leopold Institute was to serve as a "model for integrated research and management to advance understanding of the social, cultural, and ecological significance of wilderness and wildlands." The Institute's work is thus applicable to Congressionally designated wilderness as well as other areas managed largely for their natural values throughout the United States and internationally. The 1993 enabling Charter continues to provide a foundation for the Institute's programs.

Initially, oversight of the Leopold Institute was assigned to the Washington Office (Staff Director for Forest Inventory, Economics and Recreation Research), with administrative support provided by the Intermountain Research Station in Ogden, Utah. In 1996, oversight responsibility was reassigned to the Intermountain Research Station, which was later merged into the Rocky Mountain Research Station.

In 1994, an Interagency Agreement (94-IA-052) signed by the Forest Service, Bureau of Land Management, Fish and Wildlife Service, National Park Service, and National Biological Survey (later to be incorporated into the USGS), recognized the value to the government and the public of cooperating in the development of "efficient and cost-effective research… opportunities." The IA specifically called for the agencies to cooperate in "the development and implementation of the Institute." It established the interagency Wilderness Steering Committee to "identify wilderness management research, training and education needs…and other high priority wilderness and wildland research topics." This committee has continued to work with the Leopold Institute to identify wilderness research priorities, provide liaison between the agencies, and pursue funding opportunities.

In 1999, the five federal agencies with wilderness responsibilities established the Interagency Wilderness Policy Council, composed of senior managers from each agency, to improve coordination and management of the NWPS. Among other responsibilities, the Wilderness Policy Council, which includes research representatives from the USFS and USGS, addresses issues related to science and its application to wilderness stewardship. The Leopold

Institute provides staff support to the Policy Council, including briefings and updates regarding activities and programs.

Interagency endorsement of the benefits of cooperative wilderness research was renewed in 2000 and 2005 Memorandum of Understandings (2005: 04-MU-11132424-243) that reiterated recognition of the benefits of the Leopold Institute to the wilderness programs of the five agencies. It also continued existence of the interagency Wilderness Steering Committee to provide "agency liaison, advocacy, and strategic planning" support to the Institute.

Tangible outcomes of the multi-agency support of the Leopold Institute include the 1996 assignment of a USGS scientist and support staff to the Institute as well as yearly funding support for the research and application programs from the BLM, beginning in 1994, and the FWS, beginning in 1999 (Appendix II). Support from the NPS has included funding for a number of specific research projects. This funding has been critical to the Institute's success.

In 1996, the Leopold Institute, in cooperation with the interagency Wilderness Steering Committee and Forest Service Research staff in Ogden and Washington D.C., developed a Strategic Plan to provide strategic and programmatic guidance to its operations. The Plan recognized the various meanings and values of wilderness, the context within which wilderness exists in today's world of changing environmental and societal conditions, and the challenges faced by a dedicated wilderness research unit in a time of government downsizing and limited fiscal resources. Development of the 1996 Strategic Plan involved a thorough review of issues related to wilderness policy and management, the need for science-informed decisions, and the most appropriate roles for the Leopold Institute. It outlined both the research and application components of Institute programs and identified the highest priority issues that would form the focus of initial efforts. The Strategic Plan and priority issues identified therein were based on input received from a wide cross section of scientists and representatives from the federal wilderness agencies and nongovernmental organizations.

The 1996 Strategic Plan was a strategic statement of what the Leopold Institute aims to be, what it proposes to do, how its programs will be accomplished, and what challenges must be faced in doing so. The Plan presents a model for interagency cooperation in the development and application of research information necessary to assure the long-term sustainability of wilderness resources and values. The 1996 Strategic Plan continues to provide guidance for the Institute's operations. It remains as applicable today as it was in 1996 as an overarching document explaining who we are and what we are about. Much of the background text from that document is used in this Program Charter. Other details, including discussion of the context within which the Leopold Institute's programs have been developed (a shrinking base of undeveloped land, increasing environmental threats, changing demographics and cultural diversity, and other relevant societal trends), as well as the Guiding Values and Principles, Unique Assets, Strategic Challenges, and Priority Issues that have guided us, can be found in the 1996 Strategic Plan (http://leopold.wilderness.net).

Scope, Context and Importance of Wilderness

Over 106 million acres of federal lands have been designated by the United States Congress as part of the National Wilderness Preservation System. Congress has mandated that these lands, which range from deserts to mountains and from swamps to arctic tundra, although managed by four different agencies (BLM, FWS, NPS and USFS), are to be managed as a single "system". Individual agency policies also mandate that significant additional acreage be managed to preserve its wilderness character (this includes lands that are managed as wilderness study areas, proposed wilderness, or for other similar purposes). The 1964 Wilderness Act and subsequent wilderness legislation identify wilderness as "an area where the earth and its community of life are untrammeled by man" and "retaining its primeval character and influence." The Wilderness Act further directs that wilderness be "protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; and, (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation….". Values related to both naturalness and wildness are central to the wilderness concept.

Wilderness is widely recognized as containing multiple values important to the American public. Wilderness includes many of the best remaining examples of relatively intact native ecosystems, providing natural laboratories from which we can better understand the effects of human activities. Wilderness protects public watersheds and provides biological reserves essential to the protection of rare species. It provides outstanding opportunities for recreation and serves as a source of inspiration to many. Wilderness also provides economic and subsistence values to local communities. The National Survey on Recreation and the Environment has documented strong public support for wilderness and the multiple roles it plays in today's world (see www.srs.fs.usda.gov/trends/Nsre/nsre2.html)

Given the mandate of protecting wilderness resources and values for future generations, the federal wilderness management agencies have often struggled with how best to translate legislative direction into policy and management practices. Rapid change in environmental, social, and technological conditions presents an immense challenge to manage wilderness in a way that protects natural ecosystems and processes, yet provides outstanding opportunities for recreation and other permitted uses. For example, the 1980 Alaska National Interest Lands Conservation Act poses particularly challenging directives to balance conservation interests in wilderness with the rights of local populations. Wilderness and similarly protected areas are increasingly vulnerable to influences from outside their boundaries and must be considered in a context that includes the matrix of surrounding lands. Wilderness exists as a part of larger ecological and social systems and must be managed in the context of those systems. Passive "protection" is no longer adequate to assure the sustainability of these most protected of areas. In many areas consideration must be given to need (and appropriateness) of restoration actions to reverse or mitigate the effects of human activities.

Wilderness stewardship requires that difficult decisions be made about how to manage human use, fire, invasive species, and wildlife; as well as the impacts of air pollution and water diversions. The threats to wilderness ecosystems and values are immense and management and

policy decisions are often contentious. It is critical that there be public understanding of decisions that affect local community, indigenous, and societal values. Science provides the basis for understanding the consequences of policy and management decisions.

A 2001 report prepared by the Pinchot Institute for Conservation, at the request of the federal wilderness agencies, analyzed the challenges of ensuring proper stewardship of the NWPS. In addition to emphasizing the management of wilderness as a "system," the Pinchot Report supported the importance of a multi-disciplinary approach to the vexing issues that face wilderness managers. It specifically recognized the value of the Leopold Institute in leveraging limited research funds and expertise and in bringing consistency to science-informed wilderness stewardship decisions. In 2003, the Wilderness Policy Council approved an action item based on the Pinchot Report: to bring the Leopold Institute "to an organizational, reporting, funding, and staffing level to ensure integrated interagency research and scholarship for providing the knowledge base for informed and enlightened wilderness stewardship."

The importance of wilderness and similarly protected wildlands to society are clearly recognized in the 2004 USDA Forest Service Strategic Plan as well as RMRS's 2003 Strategic Framework. The national goals of ecosystem health, benefits to people, and scientific and technical assistance, as well as the Station's focus areas of changing ecosystems, conflicting values, wildland fire, healthy environments, wildlife and fish habitats, and communicating with stakeholders are all directly supported by Leopold Institute programs and priorities. This Program Charter provides a primary mechanism for addressing key needs in each of these priority areas. It emphasizes the importance of quality, relevance and performance in all activities.

APPENDIX II: Funding History of the Leopold Institute

Since its inception in 1993, the Leopold Institute's base funding has been largely provided by Forest Service Research. Additional recurring funds have come from the BLM and FWS. Until relatively recently, this funding was supplemented only sporadically by project specific funds to carry out needed tasks or studies. For example, the NPS has provided between $30,000 and $40,000 each of the past three years to provide science support to park planning efforts in Alaska. Base funding from the USGS and the FS Fire Plan have been targeted to support specific needs and are unavailable for other priorities. In recent years base funding has not kept up with inflationary costs, and by FY 2004, base funds were inadequate to fully fund the Institute's permanent salaries. Targeted, project specific, soft funding has become essential to support the research activities of Institute scientists.

Base Funding History (in thousands of dollars, not corrected for inflation):

	FS Research	BLM	FWS	USGS*	Fire Plan	Total
1994	$768,000	$40,000				$808,000
1995	768,000	50,000				818,000
1996	834,000	50,000				884,000
1997	834,000	50,000		144,000		944,000
1998	834,000	50,000		180,000		987,000
1999	834,000	50,000	$25,000	106,000		985,000
2000	834,000	50,000	50,000	220,000		1,014,000
2001	887,000	60,000	30,000	227,000	$500,000	1,564,000
2002	887,000	60,000	40,000	284,000	407,000	1,489,000
2003	876,000	75,000	30,000	383,000	373,000	1,455,000
2004	892,000	60,000	30,000	275,000	347,000	1,434,000
2005	875,000	60,000	30,000	325,000	347,000	1,637,000

*USGS funds support the USGS staff assigned to the Institute as well as provide project funds for amphibian research and monitoring (Element 4b).

APPENDIX III: Key Collaborators

Federal, State, Local Government:
Bureau of Land Management
Fish and Wildlife Service
National Park Service
US Geological Survey
USFS, work units at RMRS, PNW, PSW, SRS; Bitterroot and Lewis & Clark National Forests
Joint Fire Sciences Program
Environmental Protection Agency
National Science Foundation
Montana Fish Wildlife & Parks
Alaska Department of Natural Resources
Alaska and California Departments of Fish & Game
Native Village of Kotzebue, Alaska
Parks Canada
South Africa Parks Board

University:
Cal Poly, San Luis Obispo
Clemson University
Colorado State University
Idaho State University
Montana State University
North Carolina State University
Oregon State University
Redlands University
Southern Illinois University
State University of New York
University of Alaska
University of Arizona
University of California, Berkeley, Santa Barbara
University of Idaho
University of Illinois
University of Minnesota
University of Montana
University of Nevada, Reno
University of Vermont
University of Washington
Utah State University
Virginia Tech University
West Virginia University

Private:
Wilderness Society
WILD Foundation
NOLS
Western Whitewater Association
Three Rivers Consulting
Partners in Amphibian and Reptile Conservation

APPENDIX IV. Staff Responsibilities by Problem and Element (Scientist, Post-Doc, RAP and Term positions included)

Problem 1 (Recreation)

1a. (Experiences): David Cole, Alan Watson, Neal Christensen, Katie Kneeshaw
1b. (Impacts): David Cole, David Parsons, Dave Spildie, Neal Christensen
1c. (Restoration): David Cole, Dave Spildie
1d. (Visitor Simulation): David Cole

Problem 2 (Relationships)

2a. (Trust): Alan Watson, Kari Gunderson*
2b. (Values): Alan Watson, Kari Gunderson*
2c. (Conflict): Alan Watson

Problem 3 (Fire)

3a. (Natural Regimes): Carol Miller, Brett Davis, Anne Black
3b. (Consequences): Carol Miller, Peter Landres, David Pilliod*, Anne Black, Brett Davis
3c. (Decisions): Carol Miller, Anne Black, Alan Watson, David Parsons, Katie Kneeshaw, Vita Wright

Problem 4 (Larger Systems)

4a. (Invasive Species): Peter Landres, David Pilliod*
4b. (Global Change): Steve Corn, David Pilliod*
4c. (Water): Alan Watson, Kari Gunderson*, Dave Spildie
4d. (Monitoring): Peter Landres, David Cole

Problem 5 (Science Delivery and Application)

5a. (Access): Vita Wright, Suzanne Lingle Schwartz
5b. (Awareness): Vita Wright, Suzanne Lingle Schwartz
5c. (Improving effectiveness): Vita Wright

* Kari Gunderson and David Pilliod have left the Institute but continue to work on portions of these projects.

Appendix V: Examples of Collaborative Activities: Leadership Roles in Conferences and Workshops

2005
-Chair, Science & Stewardship Symposium (Watson) and Members, Executive Committee (Parsons, Watson), 8th World Wilderness Congress, Anchorage, AK
-Organizing Committee, USFS Social Science Research Workshop (Cole)
-Co-Chair for Natural Resources, George Wright Society Biennial Conference on Parks, Protected Areas and Cultural Sites, Philadelphia, PA (Parsons)

2004
-Co-organized special session on Scaling Laws in Fire Regimes: Moving Landscape Fire History into the 21st Century; International Association for Landscape Ecology Symposium. Las Vegas, NV (Miller). Invited to be written us as special section in both *Ecosystems* and *Ecosystem Complexity*. Followup is also being considered for a NCEAS workshop proposal and a summary article in *Frontiers in Ecology and the Environment.*

-Organizer, session on Protecting and Restoring the Relationship Between Evolving Cultures and the Wilderness Landscape; International Congress on Arctic Social Sciences. Fairbanks, AK. (Watson)

-Co-organizer, workshop on Identifying Monitoring Indicators of the "Outstanding Opportunities" Element of Wilderness Character. Lubrecht Forest, MT (Landres)

2003
-Chair, George Wright Society Biennial Conference on Parks, Protected Areas and Cultural Sites, San Diego, CA (Parsons)

-Forest Service representative to Vth World Parks Congress and IUCN's World Commission on Protected Areas field seminar, Durban and the Drakensburg Mountains, South Africa (Parsons)

2002
-Co-organizer, workshop on Travel Simulation Modeling at Conference on Monitoring and Management of Visitor Flows in Recreational and Protected Areas. Vienna, Austria (Cole)

2001
- Organizer, Science and Stewardship Symposia, 7th World Wilderness Congress. Port Elizabeth, South Africa. (Watson) Resulted in *RMRS GTR*

-Co-organizer, workshop to develop an interagency process for evaluating proposals for scientific activities in wilderness, Seattle, WA (Landres)

-Organizer, workshop on Fire History in the Northern Rockies. Missoula, MT (Parsons)

2000

-Co-organizer, workshop on Use Density, Use Limits and Visitor Experiences. Lubrecht Forest, MT (Cole) Published as *RMRS GTR*

-Program Committee, National Conference on the Social Acceptability of Fuel Treatments on Western Public Lands Program Committee, Missoula, MT (Watson) Published as *RMRS GTR*.

-Organizers, workshop to identify wildland fire and fuels management information needs. Missoula, MT (Miller and Landres)

1999

-Co-Chairs and organizers, Wilderness Science in a Time of Change Conference. Missoula, MT (Cole, Parsons and Watson) Resulted in 5 volume Conference Proceedings.

-Organizer, symposium on Paradigms of Forest Restoration: Managing for Structure and Process. Ecological Society of America Meeting, Spokane, WA (Parsons)

1998

-Organizer, Science Symposia, 6th World Wilderness Congress. Bangalore, India (Watson) Resulted in *RMRS GTR*.

-Organizer, Naturalness and Natural Variability: Definitions, Concepts, and Strategies for Wilderness Management, at the Wilderness & Natural Areas in Eastern North America Conference. Gatlinburg, TN (Landres)

-Organizer, workshop on Effects of Fisheries Management on the Amphibians and other Biota of Wilderness Lakes. Kalispell, MT (Corn) Resulted in special issue of *Ecosystems.*

-Co-organizers, Society's Changing Attitudes Towards Wilderness: How Have Values Changed And Should These Changes Influence Management?, 7th International Symposium on Society and Resource Management. Columbia, MO (Watson and Landres)

-Coordinator, Public Response to Recreation Fees on Public Lands, International Symposium on Society and Resource Management, Columbia, MO (Watson)

-Coordinator, workshop on Limits of Acceptable Change. Lubrecht Forest, MT (Cole) Resulted in *RMRS GTR*

1997

-Organizer, symposium on Stewardship Across Boundaries, Society of Conservation Biology, Victoria, BC. (Landres)

1996

-Co-organizer, workshop on Uses and Limitations of Historical Variability Concepts. Georgetown Lake, MT (Parsons) Resulted in special section in *Ecological Applications*.