

ALWRI PROGRAM OF WORK: WILDERNESS & LARGER SYSTEMS

Problem Selection and Justification: (extracted from the Leopold Institute's Program Charter)

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.