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MOUNT LOGAN WILDERNESS REFERENCE CONDITION AND SOCIAL PREFERENCES FOR ECOLOGICAL RESTORATION

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ABSTRACT

MOUNT LOGAN WILDERNESS REFERENCE CONDITION AND SOCIAL PREFERENCES FOR ECOLOGICAL RESTORATION

Marcy A. DeMillion

Changes in the Mount Logan Wilderness Area since Euro-American settlement have severely impacted the ponderosa pine forest. These human-induced changes include fire exclusion, logging, and grazing. The wilderness, which was once open and park-like, has become a dense forest with a lack of herbaceous material, creating a fuel structure conducive to catastrophic fires.

The first step in restoration of the wilderness is to determine a ecological reference condition. The reference condition was determined by the number of presettlement trees, stumps, and snags per hectare, as well as fire scar analysis. The reference condition was determined for forest structure in 1870, the time of Euro-American settlement and consequent fire regime disruption.

A social survey then gauged ecological wilderness restoration treatment preferences among the Bureau of Land Management defined "local" populations. The residents were asked about their underlying beliefs about the outcome of three ecological treatments. Residents were divided into three groups those with a positive, negative, or

neutral attitude toward the use of mechanical, non-mechanical, and prescribed fire wilderness restoration treatments. The beliefs and attitudes of these three groups were compared.

The results from the social survey showed that 75% of the residents supported a mechanical treatment, 54% of the residents supported a non-mechanical treatment, and 55% of the residents supported a prescribed fire treatment. We recommend to the Bureau of Land Management and Northern Arizona University that all three treatments be used in restoring the Mount Logan Wilderness Area. A mechanical treatment would thin doghair thickets, while non-mechanical equipment would reduce forest fuels around old-growth trees, and prescribed fire would restore the forest conditions by reintroducing a historical fire regime.

The most useful portion of my social research for managers was in the determination of underlying beliefs held toward each treatment method. For example, the belief that prescribed fire would burn out of control was held by all three groups (positive, negative, and neutral) and this outcome was bad. Underlying beliefs are important to consider because beliefs can be changed through the use of education. Potentially, a person with a negative belief can be persuaded to adopt a positive or neutral belief as they become educated about treatment methods. Through the use of both ecological and social research, wilderness restoration can be more successful by using socially acceptable treatment methods. The more the public is involved in choosing a restoration method, the more they will feel a sense of ownership of public lands.

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PREFACE

This thesis is in manuscript format. The manuscript chapters include Chapter 4 "*Changes in Southwestern ponderosa pine forest structure in the Mount Logan Wilderness Area*"; Chapter 5 " *Local Communities Attitudes Towards Ecological Restoration Treatments: Mount Logan Wilderness Case Study*"; Chapter 6 "*Determining socially acceptable restoration treatments while considering a Euro-American reference condition for Mount Logan Wilderness*". Chapter 4 will be a manuscript completed with Wally Covington, Amy Waltz, and Pete Fulé. Chapter 5 will be submitted to the Journal of Natural Resources with Marty Lee and Chapter 6 will be submitted to the International Journal of Wilderness with Wally Covington and Marty Lee. These manuscript chapters contain information that is contained within other chapters resulting in redundancy.

CHAPTER 1: INTRODUCTION

Wilderness Act of 1964, Sec. 2 (c); Public Law 88-577

"A wilderness... is hereby recognized as an area where earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. Wilderness is defined in this act as an area of undeveloped Federal land retaining its primeval character... which is protected and managed so as to preserve its natural conditions which 1) generally appear to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable...and 4) may contain ecological, geological, or other features of scientific, educational, scenic, or historical value."

Wilderness Threatened

Only 6% of federal lands are protected as wilderness areas (Cole and Landres 1996). Before the turn of the century, the goal of Euro-American settlement was to "tame wild areas" (Nash 1982), and areas not tamed (mostly because of natural barriers or poor access) often became Congressionally designated wilderness. Since the passage of the Wilderness Act of 1964, society has become increasingly aware that our wilderness ecosystems are in danger.

According to the Wilderness Act of 1964, "*wilderness is a place where the imprint of man's work is substantially unnoticeable*"; but today's forest structure in many wilderness areas does not represent an area which has been left to nature. Anthropogenic changes have created both large accumulations of forest fuel with the potential to promote catastrophic crown fires (Arno et al. 1995, Sackett et al. 1996) and unnaturally

dense forest stands which can lead to unnaturally intense insect and disease attacks (Arno and Brown 1988, Kolb et al. 1994, Covington and Moore 1994a,).

In particular, wilderness areas comprised of primarily ponderosa pine are on a collision course with time. Today wilderness areas and nature reserves dominated by ponderosa pine often have higher tree densities and fuel loads than lands outside their boundaries (Covington et al. 1994).

Mount Logan Wilderness Area: Changes since Euro-American Settlement

The Mount Logan Wilderness Area is located within Mohave County in northern Arizona and boarders Grand Canyon National Park. Since the time of Euro-American settlement, the Mount Logan area has changed drastically. The first European settlers of the southwestern United States encountered open and park-like forests dominated by ponderosa pine (Cooper 1960, Covington and Moore 1994a, Swetnam and Baisan 1996). In some situations, Native Americans helped to perpetuate these open landscapes by setting fire to the vegetation (Kay 1995).

Prior to Euro-American settlement, the uneven aged forest with old-growth (yellow bark) ponderosa pine trees (White 1985) had an abundance of native grasses. Low intensity fires, either human-ignited or caused by lightning, were frequent. Therefore, today's forest structure of dense poles and doghair thickets would not have occurred if fires which historically burned every two to twelve years had kept pine populations in check (Cooper 1960, Swetnam 1990, Covington and Moore 1994a). These current dense stands provide fuel ladders and landscape-scale fuel continuity that

often support large catastrophic crown fires (Arno et al. 1995) which did not occur prior to Euro-American settlement.

Fire exclusion is not the only disruption that changed the forest structure after Euro-American settlement. Livestock grazing and logging also contributed to our current forest situation. Grazing removed most of the herbaceous composition which helped the establishment of dense pine stands (Cooper 1960, Covington and Moore 1994a) while logging removed the largest old-growth ponderosa pine trees. This management practice created an even-aged forest structure.

Anthropogenic changes since Euro-American settlement have reduced tree growth, increased fuel loads, increased canopy closure, increased potential for large fires, and decreased wildlife habitat for those species dependent on native herbaceous vegetation (Covington and Moore 1994a). Of the anthropogenic changes that occurred, fire is the key natural disturbance that has controlled species distributions and population viability of habitat types across the landscape (Cole and Landres 1996).

Wilderness and the Social Component

The term wilderness management seems to be an oxymoron. To control wilderness does not allow natural process to operate freely. In today's modern technological age, however, wilderness areas must be managed in order to sustain, preserve, and protect them. This is especially important since wilderness areas can be as small as 5,000 acres. Management will help to prevent degradation from over use to restore natural conditions and to emulate natural processes. Management practices in wilderness require input from both the public and federal land management agencies to

identify goals and objectives (Won Sop Shin and Jaakson 1997). Management is important since it helps to identify guidelines for the physical, biological, and social component for wilderness (Hendee et al. 1990).

Social research and surveys have helped managers make wilderness decisions based on public comments. One survey conducted in Colorado concluded that the most important reasons for wilderness is for their biophysical resources and the knowledge that wilderness areas will exist for future generations (Hass et al. 1986). Public input to a decision making process on restoration treatments can be complex. For example, Cortner et al. (1984) concluded that attitudes of Tucson residents toward prescribed burning (one type of restoration treatment) were correlated with education levels. Taylor and Daniel (1984) concluded that informing survey participants about prescribed burning changed responses to more positive attitudes on the use of fire as a management tool. A further study by Taylor et al. (1986) indicated that the more well educated public was tolerant of prescribed fire. Therefore, it may be that more education on restoration will allow the public to make more informed decisions about restoration. To provide answers to this and other wilderness restoration questions, it is important to conduct social research studies of public attitudes, behaviors, and perceptions prior to implementing restoration treatments.

My social research approach is built on the Theory of Reasoned Action (Ajzen and Fishbein 1980). Among the most relevant applications of this theory are two studies pertaining to prescribed burning (Manfredo et al. 1990, Bright et al. 1993). Both studies compared positive and negative attitudes held by survey respondents about prescribed burning. The application of this theory in my research will determine resident attitudes

and perceptions about restoration treatments specific to the Mount Logan Wilderness Area. The use of the theory and my research will help managers focus educational message on underlying beliefs that respondents hold toward wildernedss ecological restoration.

Objectives for Social Research

The two objectives for my research are: 1) to determine the ecological changes in Mount Logan Wilderness Area since the time of Euro-American settlement, and 2) to determine local residents' attitudes toward their underlying beliefs about specific restoration treatments. The literature that follows first focuses on the changes in Mount Logan Wilderness since Euro-American settlement.

CHAPTER 2: WILDERNESS LITERATURE REVIEW

WILDERNESS ECOSYSTEM MANAGEMENT, ECOLOGY, POLICY AND RESTORATION

Introduction

First is a discussion of wilderness ecosystem management followed by a discussion on restoration ecology including: 1) forest structure, 2) fire's ecological role, and 3) specific restoration treatments. Then follows a discussion on wilderness management and policy including: 1) history of wilderness management, 2) the Wilderness Act of 1964, 3) conducting scientific research considering wilderness policies and BLM (Bureau of Land Management) guidelines, and 4) wilderness management. The final section of the literature review contains information on implementation of wilderness restoration.

Numerous studies have been conducted to determine the ecological restoration reference conditions for ponderosa pine (*Pinus ponderosa*) forests (Covington and Moore 1994b; Fulé and Covington 1994; Covington et al. 1994; Fulé and Covington 1996; Sackett et al. 1996, and Fulé et al. 1997). Although these studies concerned restoration, reference conditions and treatments, none of them focused on designated wilderness areas.

My ecological research analyzed the reference conditions and changes in stand structure after settlement of the Mount Logan Wilderness. The ecological portion of my

research on wilderness restoration addressed three questions: 1) What is the forest structure and historical fire regime for the Mount Logan Wilderness Area, 2) What is the date of Euro-American settlement, and 3) What are possible wilderness restoration treatments in the context of wilderness management and policy?

Wilderness Ecosystem Management

Wilderness areas are vital for both ecological and human values. Wilderness ecosystems provide habitats for species, in some cases endangered and threatened species (Noss 1991a). Wilderness areas sometimes contain genetic diversity found specifically in that area, one reason why wilderness should be sustained, restored, and integrated into general land use planning (Salwasser 1990). Wilderness areas are sometimes referred to as "protected islands". These areas usually have an intact roadless forest core that can harbor plants and animals that may otherwise become threatened or endangered. Noss (1991b) believes that areas without roads are the key to wilderness integrity.

Although wilderness is important for humanity, it is not necessary for sustaining life; however some wilderness enthusiasts believe that wilderness is vital to their sense of spiritual being. Rather, wilderness values for most humans are more spiritual than utilitarian. Some people believe wilderness is a place to escape the realities of today's modern technological world. Salwasser (1990) suggests that management of wilderness should integrate human needs with biological diversity. This is a delicate balance since human needs, most commonly in the form of recreation, are the most known and managed threat to the wilderness (Cole and Landres 1996).

Because designated wilderness areas are less impacted by modern day improvements, they are particularly valuable for examining ecological reference conditions. The first step in ecological restoration is determining if there is ecosystem damage; an ecosystem which will not regain its integrity without restoration activity within 20 to 50 years (Jackson et al. 1995). Wilderness area settings provide a baseline of conditions that are generally protected against human development (Stankey 1987), but this does not imply that humans have not been altering the ecosystem. To compensate for anthropogenic disturbances (grazing, logging, and fire exclusion since the time of Euro-American settlement) and to create more pristine wilderness conditions, managers may have to actively manipulate wilderness (Cole 1996).

To understand current wilderness conditions, more information is needed on the threats to the ecosystem (Cole and Landres 1996). According to Landres (1995), monitoring and inventorying can improve wilderness conditions in four ways, by 1) establishing a baseline condition, 2) determining when a significant change occurred (such as fire exclusion), 3) identifying the cause of the change, and 4) challenging scientists and managers to gain an understanding of natural systems and consequences of management actions. My ecological research on Mount Logan Wilderness involved establishing a baseline condition and determining the changes that have occurred over the last 130 years.

Restoration Ecology

Forest Structure

Today's forest structure in the Mount Logan Wilderness Area consists of overcrowded stands with dense thickets produced by years of fire exclusion. These forest conditions are unlike those seen by the first Euro-American settlers. Forest managers and conservationists alike are concerned that fire exclusion is having an increasingly negative impact on biotic diversity and on ecosystem sustainability (Covington et al. 1994, and Minnich et al. 1995). Severe crown fires (or the lack of natural fires) are affecting the ecosystem structure and biodiversity because they alter the availability of habitats in space and time (Swetnam 1993). This is occurring within and outside wilderness boundaries. Frequent, low intensity fire plays an important, natural role in the ponderosa pine wilderness ecosystems. For example, Brown et al. (1994) conducted a study in the Selway-Bitterroot Wilderness and concluded that during the presettlement time period in the ponderosa pine type, fires burned three times more often than they do today. Without low intensity surface fires, stand structure and composition of forests can change drastically.

Ponderosa pine forests, prior to Euro-American settlement were more open and park-like (Cooper 1960, White 1985, Covington and Moore 1994a, Fiedler et al. 1996). Today, park-like conditions are rare because forest density and fuel loading have increased substantially since fire regime disruption (Covington and Moore 1994b and Fulé and Covington 1994). Heavy livestock grazing, logging, and fire exclusion have

brought about substantial changes in tree density, cover, and age distribution since Euro-American settlement (Covington and Moore 1994b).

Prior to Euro-American settlement in the 1870s, fires occurred every 2 to 20 years for southwestern ponderosa pine (Cooper 1960, Kilgore 1975, Covington and Moore 1994a, and Covington et al. 1994). Cooper (1960) provides an historical account of how settlers, explorers, and members of the military described southwestern ponderosa pine forests during their expeditions and travels. These historical accounts describe different forest conditions (more open and park-like) than those seen today, since fire has been excluded by a combination of active fire suppression and overgrazing.

After 50 to 70 years of fire exclusion (in concert with climatic fluctuations and grazing), both foresters and ecologists began to notice accelerating ecological degradation (Leopold 1937). Degradation included increased stand densities and forest fuels, which contributed to a decline in herbaceous plant communities. Increased fuels caused tree mortality from above and below ground heating when fires do occur (Sackett et al. 1996). Additionally, increased forest fuels created the potential for catastrophic forest fires.

Comparisons of forest structure in the American Southwest and Mexico showed considerable differences in fire regime. Fulé and Covington (1996) conducted studies in Mexico's Sierra Madre Occidental, which has had relatively little fire regime disruption compared to the American Southwest. The remoteness of the northern Sierra Madre allowed the region to retain a more natural state (Felger and Dahl 1995), resembling what the pine ecosystems may have looked like in the United States prior to Euro-American settlement.

Another important factor for understanding changes in forest structure is climatic fluctuations. Climatic conditions can lead to frequent fires which regulate the forest structure (Swetnam and Betancourt 1990). In the Southwest, tree growth corresponds to climatic conditions (Pearson 1950), and starting in the early 1900s, wetter and warmer trends provided conditions for ponderosa pine establishment (Savage et al. 1996). Generally, the less precipitation in a given year, the more likely that a fire would start. In the Southwest during La Niña years there is less precipitation, which increases the possibility of fires (Swetnam and Betancourt 1990). Recently, during El Niño years (1991 through 1993) there was more precipitation and fewer fires occurring in Arizona and New Mexico (Swetnam and Biasan 1996). Thus, although, Euro-American settlement is the principal cause of increase in southwestern ponderosa pine densities, fluctuations in climate control the temporal pattern (e.g. lags) of pine population irruption's (Mast et al. 1999).

Fire: Its Ecological Role

Prescribed fire is one way to help restore forests to their presettlement conditions. Wilderness purists may not support the use of prescribed fire, but will support naturally ignited fires, started with a stochastic event such as lightning. Naturally caused wildfire is less predictable and prescribed burning may be necessary in some wilderness areas to restore the structure and function of forests (Murry 1996).

Prescribed burning can be used to maintain or reintroduce natural conditions into an area (BLM manual 8560 .35 (3) 1983) including the reduction of unnatural buildup of fuels, which helps to decrease the likelihood of a catastrophic wildfire (Parsons et al.

1986). Prescribed fire has also been used to improve the health of the ranges and forests, creating more forage for livestock (Babbitt 1995). The exclusion of fire will increase stand densities creating the potential for stand replacing crown fires. Without fires, pines will establish in open areas, herbaceous understory will decrease, and habitat for both livestock grazing and some wildlife will decline (Covington et al. 1994).

Restoring fire to its role in ecosystem dynamics will help perpetuate wilderness areas (Agee 1974). Wilderness areas and nature reserves often have higher tree densities and greater risk for crown fires than outside these areas (Covington et al. 1994). One solution for this problem is to reintroduce natural disturbances in order to restore areas to presettlement conditions where the habitat structure can support wildfires (Noss 1991b). Continuing to exclude fire from small natural areas and wilderness areas circumvents natural processes and can eventually lead to severe and uncontrollable wildfires (Arno and Brown 1988).

Recently, there has been more support for prescribed burning than in the past (see social literature review). This is evident in the Forest Service and other land management agencies' adoption of the idea that fire should play a natural role in wilderness management (Kilgore 1984). Fire management programs have expanded rapidly in national parks and in designated Forest Service wilderness areas. Both the Forest Service and the National Park Service revised their fire policies in the late 1970s. The Forest Service adopted guidelines for prescribed and naturally ignited fire (Davis 1979), while the National Park Service had what came to be known as a "let it burn" policy.

The National Park Service had a more aggressive fire policy allowing both intentional prescribed and prescribed natural fires to burn (Parsons and Botti 1996). This

policy came under heavy attack by some members of the public during the Yellowstone fires in 1988 as fires threatened homes and livelihoods and fire suppression costs were estimated at 145 million dollars (Arno and Brown 1988). This caused the National Park Service to review its "let it burn" policy and place restrictions on when a fire should be allowed to burn (Wakimoto 1990). For example, Wakimoto (1990) suggested that forest fuels need to be reduced prior to allowing a fire to burn. Since the National Park Service instituted the first prescribed natural fire programs (Parsons and Botti 1996), other agencies followed suit, including the BLM and the United States Fish and Wildlife Service (Kilgore 1984).

The first approved BLM wilderness management plan that allowed prescribed fire was for the Mount Logan Wilderness (Parsons and Landres 1998). The BLM manual 8560 .35 section 2, (1983) recognizes that exclusion of lightning-caused fire can significantly affect the ecology of the area. The manual also refers to fire management plans that should address the issue of natural and prescribed fires. Although Mount Logan has a wilderness fire plan which has allowed the BLM to initiate prescribed fires, naturally ignited fires have never been allowed to burn (Parsons and Landres 1998, Moore, personal communication 1998). Naturally ignited fires may not have occurred because managers realized that often these types of ignitions are difficult to control.

The public does not always support the reintroduction of fire. After a fire, most visitors' immediate response is a feeling of loss for the site, even though they believe that dense vegetation can impede their recreation experience (Mackay 1987). Due to years of Forest Service campaigning with "Smoky the Bear," some visitors still perceive fire as having intrusively negative effects on the ecosystem. Visitors may not be able to

distinguish between a human-caused fire due to carelessness during a hot and dry burning season and a managed prescribed fire to restore the forest structure.

Human activities such as recreation, mining, livestock grazing, logging, and an array of other activities have altered natural conditions in wilderness areas; therefore restoration techniques need to be considered (Cole 1996). Fire, one of these techniques, is important for various ecological reasons, but simple reintroduction of prescribed fire into ponderosa pine ecosystems may not be sufficient to restore the natural functions of the ecosystem (Fiedler et al. 1996). Prescribed fire alone cannot restore the park-like structure of a presettlement forest (Bonnicksen and Stone 1985, Sackett et al. 1996, Covington et al. 1997). Even within wilderness, other restoration techniques will be needed to restore the forest structure.

Specific Restoration Treatments

A variety of restoration approaches have been examined in western forests. In northern Arizona, a study was conducted at the Gus Pearson Natural Area (Covington et al. 1997), using partial and complete restoration methods. Partial restoration methods involved thinning, while complete restoration included thinning, mechanically raking, removing duff from the site, and prescribed burning (Covington et al. 1997). Researchers concluded that a combination of methods was necessary to restore the ecosystem.

Within the Mount Trumbull Ecosystem Restoration Project, operational restoration treatments are being tested. These treatments included thinning, mechanical raking, and prescribed burning (NAU annual report 1996). Treatment methods for Mount Trumbull are similar to the Gus Pearson Natural Area (discussed above) except at Gus

Pearson duff was hauled off site and mown grass fuel was added (Covington et al. 1997) as a part of an intensive restoration research treatment.

To restore the structure and composition of a Sierran Conifer ecosystem, Bonnicksen and Stone (1985) suggested what they considered to be the three most cost-effective treatments. These treatments included mechanical manipulation, prescribed burning, and a combination of both methods. I will also examine the use of mechanical manipulation and prescribed burning.

Wilderness Policy and Management

Decisions regarding Arizona BLM wilderness restoration will be based on the Wilderness Act of 1964, BLM manual 8560, Handbook 8560-1, BLM manual 8561 (individual wilderness management plans), and the Arizona Wilderness Act of 1984. These legislative acts set precedents for managing wilderness as an enduring resource.

History of Wilderness Management

Early supporters of wilderness and wild areas included John Muir, Aldo Leopold, Arthur Carhart, Robert Marshall, among others. These conservationists were concerned that there would not be preservation of large areas for future generations. The first large area designated for preservation and enjoyment of the public was Yellowstone National Park in 1872 with other park areas to follow. These areas were designated as parks; but it was common to build improvements and facilities within them. Conservationists like John Muir fought against economic development within national parks and developed a

more purist sense of wild areas. This philosophy led to the designation of the Forest Service wilderness areas where development was minimized.

Aldo Leopold, a well known Forest Service employee, realized that areas in Arizona and New Mexico were quickly becoming developed. He recommended that the Forest Service designate undeveloped and wild land areas over 5,000 acres as wilderness (Hendee et al. 1990). Because of Leopold's recommendation to the Forest Service in 1924, the Gila Wilderness Reserve was designated in New Mexico. After designation of Forest Service areas, the BLM was the last land management agency to designate and manage wilderness areas.

The BLM did not have wilderness responsibilities until the passage of the Federal Land Policy and Management Act (FLPMA, Public Law 94-579 1976). Previous to FLPMA, the BLM managed only primitive and natural areas. FLPMA required the BLM to inventory all areas over 5,000 acres that would qualify under Wilderness Act of 1964 (Public Law 94-579 1976). The BLM was given four years after the passage of FLPMA to conclude their studies and report the findings to the Secretary of the Interior. Within many states which the BLM manages public lands, however, there is still debate about what areas to designate as wilderness.

Wilderness Act of 1964

The passage of the Wilderness Act of 1964 was a long awaited victory for many environmental groups and citizens of the United States. With the introduction of 65 bills, and the convening of 18 hearings, the Wilderness Act of 1964 took eight years for Congress to pass (Hendee et al. 1990). The Wilderness Act enabled land management

agencies, including the Forest Service, National Park Service, Fish and Wildlife Service, and later the BLM, to preserve numerous areas (the majority over 5,000 acres). However, researchers such as Dobson et al. (1997) believe that habitat conversion on degraded land is creating a biological diversity crisis. Therefore, more wilderness areas need to be designated, especially in large tracts.

The Wilderness Act of 1964 in section 2c defined wilderness as, "A place where man's work is substantially unnoticeable and where man is a visitor who does not remain." Section 2a of the act identifies wilderness character as potentially containing ecological, geological, and other features of scientific, educational, scenic or historical value. For the act to be passed by Congress, provisions had to be made for special uses. Special provisions are discussed in section 4d of the Wilderness Act of 1964. These provisions include what is necessary to control fire, insects, and diseases' as well as provisions for multiple uses.

Grazing was the topic of special provisions that the Wilderness Act of 1964 allowed. In section 4d (4) (2), as it provides for the continuation of grazing in areas where it was established prior to the passage of the act. Further clarification on grazing in wilderness appeared in the Forest Service Roadless Area Review and Evaluation Impact Statement in 1979. This impact statement clarified that there would be no curtailments of grazing in wilderness and grazing would not be "phased out". Livestock numbers would continue at the same levels as they were previous to the wilderness designation. Furthermore, an increase in stocking numbers could occur as long as the wilderness resource was not adversely impacted.

Conducting Scientific Research While Considering the Arizona Wilderness Act of 1984 and BLM Wilderness Guidelines

The Mount Logan Wilderness Area was established on August 28, 1984, as part of the Arizona Wilderness Act (Public Law 98-406). This law established eight wilderness areas for the BLM Arizona Strip Field Office, as well as numerous other Forest Service and BLM wilderness areas throughout the state. The BLM manages Mount Logan Wilderness in accordance with the Wilderness Act of 1964, BLM manual 8560 (1983), BLM manual 8561 (1984), BLM handbook 8560-1 (1988), Arizona Wilderness Act of 1984, and the Arizona Strip Resource Management Plan (1990).

BLM manual 8560 (1983) addresses research in BLM wilderness areas. Wilderness areas can provide researchers with scientific information on the natural environment and ecosystems. Scientific information is also necessary to understand natural processes at work in wilderness areas (Stankey 1987), and without this information, restoration of wilderness would be unlikely to occur. Prior to scientific research in wilderness, scientists must follow guidelines designed to minimize wilderness impacts (Stankey 1987).

Research methods used within wilderness should be conducted in a manner compatible with wilderness management. Researchers must apply to BLM in writing about the specifics of the scientific research, and permission may be granted if the research is important to the understanding of wilderness (BLM manual 8560, .18b 1983). Research projects are encouraged as long as they "further the management of scientific, educational, historical, and conservation purposes" of the wilderness area (BLM manual

8560, .18a 1983). In general, research should be conducted without the use of motorized equipment (BLM manual 8560, .18d 1983).

BLM handbook 8560-1 (1988) further addresses the use of motorized equipment and mechanical transportation in wilderness. Request for approval of motorized equipment and mechanical transportation must include a clear description of the project, an analysis of alternatives, the time involved, and a clear statement of the type of equipment to be used (BLM 8560-1, section 4c (1) 1988). The regulations outlined above mandate that managers must preserve the wilderness character for future generations.

Wilderness Management

Wilderness management is defined by Hendee et al. (1990) as the management of human uses and influences to preserve naturalness and solitude. Managers generally subscribe to one of two types of wilderness philosophies, having either an anthropocentric or biocentric view. The anthropocentric view embodies maximizing human gain from the wilderness resource, while the biocentric view preserves wilderness areas in their natural conditions with less emphasis on human needs (Hendee et al. 1990). Both philosophies should be utilized to make wilderness management decisions (Hendee et al. 1990). The Wilderness Act of 1964 contains both anthropocentric and biocentric values. From some points of view, the biocentric values are more important. For example, Aldo Leopold asserts in Sand County Almanac (1949), that management is right when it preserves the biotic community and is wrong when it does not.

Implementing Wilderness Restoration

The ponderosa pine forests in the Mount Logan Wilderness Area will serve as a natural laboratory for testing adaptive ecosystem restoration methods in wilderness areas (Taylor 1996). Adaptive ecosystem management involves using monitoring and evaluation feedback in order to guide management decisions (Kaufmann et al. 1994)

The primary goal for wilderness restoration is to re-establish native integrity to the area (Landres 1996). Simple remedies for wilderness areas, such as a laissez-faire approach to preserving areas without management, will not achieve ecological sustainability (Murry 1996). The lack of management in wilderness and park areas has created unnatural forest conditions resulting from human intervention. These altered forest conditions include reduced herbaceous production, changes in ecosystem structure, fewer old trees and more younger trees, and heavy accumulation of forest fuels (Covington et al. 1994).

Human influences on natural processes are substantial throughout most wilderness areas. Human impact creates the need for wilderness restoration (Murry 1996). Concerns for overcutting of old-growth trees has led some environmental groups and scientists to argue against using mechanical treatments for restoration of ecosystem health (Covington et al. 1994). Wilderness restoration treatments may include mechanically removing unnaturally dense trees, prescribed burning, and raking of accumulated fuels to protect old trees. These methods may conflict with the public's perception of wilderness and with traditional methods of wilderness management.

Wilderness managers such as Roger Taylor, Arizona Strip BLM District Manager, as well as other land managers, are starting to discuss wilderness restoration (Taylor

1996). In some respects, wilderness managers have the most opportunity to practice ecosystem management (Murry 1996). As part of the Mount Trumbull Ecosystem Restoration Project, spot treatments are being established to examine mechanical thinning for potential use in wilderness restoration (Taylor 1996). Currently, restoration decisions are being made for public lands adjacent to wilderness, however in wilderness there are many legal constraints that can make wilderness restoration difficult to implement. Restoration of wilderness will depend on the way wilderness managers interpret the various legislative and policy guidelines.

Some groups may perceive general restoration as an attempt by land management agencies to harvest timber and cut old-growth trees. Timber sales are perceived as causing the loss of important aesthetic and spiritual values and as threats to the survival of ecosystems (McDaniels 1990). Wilderness restoration will be conducted for reasons other than economic harvesting, as old growth and large diameter trees will be left intact. Some wilderness restoration treatments will likely be more acceptable to the public than others. For example it seems likely that acceptance of wilderness restoration treatments for the Mount Logan Wilderness Area by both the general public and the BLM might occur in this order: 1) prescribed burning, 2) mechanically raking around old growth, 3) spot thinning and raking around old growth.

There will be differences in opinion over how to proceed with wilderness restoration. Disagreements in values often lead to arguments about facts, the possible consequences associated with management, and the lack of management actions (McDaniels 1990). Because of this, it may be time that lawmakers reassess the relationship between the Wilderness Act of 1964 and the current ecological status of the

nation's wilderness areas (Murry 1996). To restore wilderness areas, wilderness managers, scientists, and society will have to work together in the decision making process.

Conclusion

The research conducted within the Mount Logan Wilderness will provide managers with more information about an ecological reference condition. "Preserving wilderness conditions requires an understanding of ecological systems we "don't possess" (Landres 1995). My research is one step in understanding the Mount Logan Wilderness ecosystem.

The results of my ecological wilderness research, including ecological reference conditions, the date of Euro-American settlement, and possible wilderness restoration treatments will enable the Arizona Strip BLM and researchers to make more informed wilderness management and research decisions. These decisions are not only important in identifying treatments for the Mount Logan Wilderness Area, but also vital to the development of wilderness restoration approaches and to the future of wilderness sustainability.

SOCIAL RESEARCH

Introduction

This chapter provides a foundation for my social research. This literature review supports the premise that wilderness researchers and managers must find out what activities the public is willing to accept in wilderness (Taylor and Mutch 1986). First I discuss the theory of reasoned action, the basis of my research. Next is a discussion of literature that focuses on attitudinal studies that are based on the theory of reasoned action. These studies include public attitudes and perceptions of fire in forest and wild land areas, attitudes regarding wolf reintroduction, and ecological restoration. Next are a discussion of variables that can affect research, followed by an examination of research on public to attitudes and knowledge toward fire. Last, is a discussion of literature on public support for wilderness.

Theory of Reasoned Action

There are many underlying theories available for conducting attitudinal based social research. I chose the theory of reasoned action (TRA) because past studies have employed this theory in examining the use of prescribed fire in forest and wilderness settings. These studies of attitudes were conducted in the late 1980s and early 1990s after the Yellowstone and Yosemite National Park fires. During this time, there was a

heightened social awareness about the potential for catastrophic fires. Other attitude studies in various professions have used the TRA, including one study on the social aspects of ecological restoration in the Chicago area (Barro and Bright 1998).

Development of the Theory of Reasoned Action

The TRA was first introduced by Martin Fishbein in 1967 and later tested by Ajzen and Fishbein in 1980. They sought to explain the cognitive structure underlying a belief towards an attitude (Ajzen and Fishbein 1980, Fishbein and Manfredo 1992). The name of the theory was derived from a reasoning process wherein, people consider their action prior to performing a behavior (Ajzen and Fishbein 1980). The theory measures people's attitudes, behavioral beliefs, outcome evaluations, normative beliefs, subjective norms, and motivation to comply. Because I wanted to measure people's attitudes and beliefs to correlate their response with a positive, negative, or neutral attitude, I chose not to measure their normative beliefs, subjective norms and motivations to comply. I felt that managers would not benefit from this additional information, as they could not change respondents salient referents, which were developed over a lifetime and involved uncontrollable factors such as background and peer attitudes. Therefore, this analysis would not help managers decide how to educate or change peoples attitudes. My ultimate goal was to link attitudes with beliefs and beliefs with outcomes.

An attitude is a tendency to act toward or against some environmental factor (Mueller 1986). When the independent beliefs for each attitude are considered together rather than as separate variables, they can better account for an attitude (Bruvold 1973). Individual characteristics such as age, gender, education, employment status, and

knowledge of a particular subject can influence beliefs (Chaiken and Stangor 1987). Each underlying belief helps to define an attitude which is classified as either positive or negative (Bruvold 1973, Fishbein and Ajzen 1975, Manfredo et al. 1990, Bright et al. 1993, Pate et al. 1996, and Barro and Bright 1998).

In general, the TRA uses highly reliable measures of attitudes and beliefs (Fishbein and Ajzen 1975), and is based on correlation between the attitudes and beliefs (Pate et al. 1996). To measure the correlation between the attitudes and beliefs, the TRA uses a belief and an attitude index. The belief index is formulated from two questions that measure the strength of the beliefs and belief outcomes. The attitude index is the summation that a restoration treatment is good or bad with how it is perceived as either beneficial or harmful.

Data on public attitudes is useful to managers in two ways: 1) it provides survey information about support and public knowledge for a project and 2) it helps managers establish goals or objectives for a program (Heberlein 1989). However, two limitations of the theory include the validity of measuring an attitude and predicting why people responded in a certain way. In some cases, people may respond with the most socially desirable answer (Mueller 1986), and factors such as prior knowledge, personal involvement, and credibility can also affect the way a person responds to questions.

Research Based on the Theory of Reasoned Action

There is much research on the TRA in various professions, including health, consumer products, and resource management. In resource management, the TRA was used to examine the public's attitudes and underlying beliefs regarding prescribed fire.

Bright et al. (1993) conducted a study in Yellowstone National Park, where the TRA was used to determine the public perception of prescribed (controlled) burn policy among park visitors. The researchers designed their study to determine if people who held positive attitudes about prescribed fire could be persuaded with information to adopt a more negative attitude toward prescribed fire, and if people with a negative attitude exposed to information could adopt a more positive attitude. Their results concluded that respondents who originally held a positive attitude became more negative, but negative attitudes did not become more positive. The researchers attributed this to two facts: 1) participants may not have given credibility to the information source, and 2) it is more difficult to change people's negative attitudes by presenting an opposing view.

Another study using the TRA was conducted regarding both regional and national attitudes toward a prescribed fire policy in Yellowstone National Park (Manfredo et al. 1990). Participants were separated into two groups, those who held positive and those who held a negative attitude towards prescribed fire. In the regional survey, 55 % of the population supported controlled burning, while in the national survey, 48 % supported the policy (Manfredo et al. 1990). The survey measured ten beliefs regarding a prescribed fire policy outcome (i.e., should natural events such as fire occur, does prescribed burning save money by avoiding a catastrophic fire, and other knowledge questions on how fires affect the ecosystem). Both groups agreed that prescribed burning destroys scenery (which has important recreation implications). The researchers concluded that as people's knowledge about prescribed fire increased, so did their support for fire techniques (Manfredo et al. 1990). The authors suggested ways to educate the public on a prescribed fire policy.

Barro and Bright (1998) examined the attitudes of local residents towards ecological restoration in and around the Chicago area using the TRA. The researchers asked questions targeting the participant's beliefs about management techniques and restoration. Belief questions that focused on management techniques included the use of cutting, burning, and the use of herbicides. Belief questions that focused on restoration included the idea that an area can be restored to Euro-American settlement, the belief that restoration is good, and if it is a wise use of tax dollars.

Barrow and Bright (1998) found that 90% of the respondents in the Chicago area had a positive attitude toward ecological restoration and 80% of the participants who had a positive attitude towards ecological restoration held a high positive attitude towards restoring natural areas. The researchers concluded that this might have been the case because the respondents surveyed had heard of ecological restoration through various media sources such as the newspaper and the daily news.

Four of the belief questions from Barro and Bright (1998) seem particularly relevant to my research topic. The first question asked if restoring natural areas to pre-settlement conditions would create healthy ecosystems within the Chicago metropolitan area. Most of the respondents, 75% agreed with that statement while 12% disagreed, and 13% were undecided. The second belief question asked if restoring natural presettlement conditions by cutting or burning would result in areas looking unattractive; 50% agreed, 24% disagreed, 22% were undecided. Even though there was a high positive attitude toward ecological restoration, over half of the participants disapproved of manipulation to restore an area. The third belief question asked if restoring areas to presettlement conditions would be a wise use of public tax dollars; 35% disagreed, 16% were

undecided, and 49% agreed. The final belief question asked if the participants agreed that the areas in and around Chicago could not be restored to a pre Euro-American settlement condition; 78% agreed, 15% disagreed, 7% were undecided. Most participants believed that restoration could not fully depict an area like it was seen by the first Euro-American settlers. This result suggests that the public thinks that restoration to a presettlement condition is not realistic.

Barro and Bright (1998) concluded that there is a better chance of implementing ecological restoration locally rather than trying to implement restoration around a city. The BLM has implemented ecological restoration on a local level. This is attributed to BLM and Northern Arizona University scientists collaborating with local and regional populations to accomplish a restoration goal.

The last TRA study discussed is research conducted by Pate et al. (1996). This study focused on determining residents' attitudes and underlying beliefs towards wolf (*Canis lupus*) reintroduction. The groups of residents included general Colorado residents, Colorado residents east of the continental divide, and Colorado residents west of the continental divide.

The results of Pate et al. (1996) showed differences in attitudes toward wolf reintroduction between the east-and west-slope residents. East-slope residents had a more positive attitude than did west-slope residents toward a wolf re-introduction. West slope residents with negative attitudes disagreed that a wolf reintroduction would keep deer and elk populations in balance, preserve the wolf as a wildlife species, while they more strongly agreed that a wolf reintroduction would result in wolf attacks on humans (Pate et al. 1996). Pate et al. (1996) found a note worthy non-response bias. In the

follow-up contact with those who did not respond to their survey they concluded that non-respondents were less likely to vote in favor of a wolf reintroduction, but held a more neutral feeling about a wolf reintroduction.

Variables that Potentially Affect Attitudes

In some cases, variables such as level of education and income are more important than respondents' residence (urban or rural). In a study on urban and rural differences, Arcury and Christianson (1993), concluded that education and income seemed to make a more significant difference on environmental education than a participant's urban or rural residence. So, it may be important to focus on a participant's level of education and income as variables affecting attitudes.

Another factor that may be important to consider that can affect attitudes is group affiliation. For example, members of an off-highway vehicle group are more likely to support motorized recreation, whereas non-motorized groups often support non-mechanical recreation. Community residents often affiliate themselves with a group and prefer either motorized recreation or non-motorized recreation depending on the rural versus the urban community setting (my personal observation as a BLM recreation planner).

Brunson and Shelby (1992) surveyed frequent forest visitors in Oregon to rate their preference for silvicultural methods. Most of the respondents judged the old-growth stands the most acceptable with partial cutting and traditional clearcuts least acceptable. The researchers concluded that frequent forest visitors were more familiar with commercial timber harvesting which may have influenced their preference for

silvicultural methods. The more direct experience the respondent has with an attitude object (such as restoration), the more they will support the attitude object (Bruvold 1973, Chaiken and Stangor 1987, Fazio 1982). In other words, people with positive attitudes toward a restoration treatment may be more familiar with that treatment method.

Public Attitudes and Knowledge of Prescribed Fire and Fire Policies

Taylor and Daniel (1982) surveyed Tucson residents about their perceptions concerning prescribed fire and its effect on the landscape. Participants who received informational brochures on the effects of prescribed burning had a greater tolerance for fire than participants who were not sent the brochure. The authors found that 81% of the participants who were informed about prescribed fire supported its use, while only 54% of the non-informed participants supported it. In general, respondents preferred prescribed fire burned areas to more heavily burned areas. In fact, recreation users preferred prescribed burn areas over unburned areas to recreate in five years after a burn (Taylor and Daniel 1982).

Another survey conducted by Taylor and Daniel (1984) examined the impacts of prescribed fire on scenic beauty. This study focused on the attitudes of Tucson, Arizona residents. Respondents were shown photographs of three different landscapes including an unburned, a lightly burned, and a severely burned area. The results showed that respondents believed that light fire improved visual impacts, while severe fire detracted from scenic beauty (Taylor and Daniel 1984). They also concluded that when the respondent received education on prescribed fire their tolerance for fire in ponderosa pine increased.

Educational efforts are increasing the Tucson public positive perception of fire in wilderness. Taylor and Mutch (1986) conducted a literature review on this subject. Their article discussed a balance that must occur in wilderness management between what is legal, what is ecologically appropriate, and what is publicly accepted. The authors after conducting both chi-square and multivariate analysis did not believe that demographics between the studies they reviewed are good predictors of overall attitudes toward fire in wilderness.

A study conducted by Stankey (1976) examined attitudes of wilderness visitors toward a wilderness fire policy. He observed that the more knowledge a person has about fire in wilderness, the greater the support that this person will have for allowing a wilderness area to burn. The less knowledge a person has, the more they will favor complete suppression.

Recent surveys conducted in Tucson, Arizona show an increase in support for the use of prescribed fire. Cortner et al. (1984) showed that 57% of their surveyed population of Tucson, Arizona, residents agreed that fire should be used as a management tool to clear brush and debris. At the same time, Taylor and Daniel (1984) showed that 90% of the surveyed population of Tucson, Arizona, agreed that fire should periodically burn underbrush and debris. Therefore, it seems to be a belief among Tucson, Arizona, residents that prescribed fire can help decrease forest fuels.

Various studies have examined education and attitudes toward the use of fire. Stankey (1976) found that education provided by the agencies would increase public support for a change in wilderness fire policy allowing more fires to burn in the wilderness. Cortner et al. (1984) surveyed Tucson, Arizona residents and found a

correlation between educational programs and support for prescribed burning. For example, of the participants who had heard of prescribed fire, 80% approved of its use. Public education seems to be a common way to increase public attitudes toward fire, restoration, and the environment. The task of educating the public about ecology and the environment is an enormous undertaking which has a critical outcome (Maloney and Ward 1973).

Public Support for Wilderness

Public support is vital in the management of wilderness areas. It is important to develop ways of incorporating public values about wilderness into public participation and political processes (Henning 1987). Public values about a wilderness area can be affected by the location of the wilderness, expectation of use for the wilderness area, and a person's attitude toward wilderness purism. A high wilderness purism attitude is characterized by high expectations for wilderness use, wilderness sensitivity, wilderness knowledge, and personal concern and involvement in wilderness issues (Won Shop Shin and Jaakson 1997).

One study that measured support for wilderness was conducted by Shindler et al. (1993). This study compared residents of the state of Oregon to the United States population. These authors found that 46% of Oregon residents supported adding more wilderness designations compared to 73% of the national sample. Another survey, examining public support for adding more wilderness, was conducted among eleven counties in ten states from all over the United States (Rudzitis and Johansen 1991). The criteria for surveying the counties included a growth rate from 29% to 104% between

1970 and 1985. Most of these counties contained wilderness, including Coconino County in northern Arizona where my study site lies. Results from Rudzitis and Johansen (1991) concluded that 49% of Coconino County residents wanted more wilderness designation, compared to 73% of a national sample. Additionally, 90% of the residents believed that wilderness was important for their county. Attitudes about wilderness and scenic areas are important and seem to differ on county, regional, and national levels.

Conclusion

To restore the Mount Logan Wilderness, researchers and managers need to understand public attitudes and support for wilderness treatments. This chapter focused on literature from one type of wilderness treatment (prescribed fire), as no research has yet examined public attitudes toward other wilderness ecological treatment methods.

Studies that focus on the theory of reasoned action give invaluable insight into how to design and implement a survey using that theory. The literature discussed on public attitudes toward wilderness and fire provides a basic understanding of how people feel about two politically charged issues.

My social research will address three questions: 1) What are local resident attitudes toward three treatment methods, 2) What are the most socially acceptable restoration treatment, 3) What are the underlying beliefs that affect each attitude and, 4) What beliefs can managers target to create more positive attitudes.

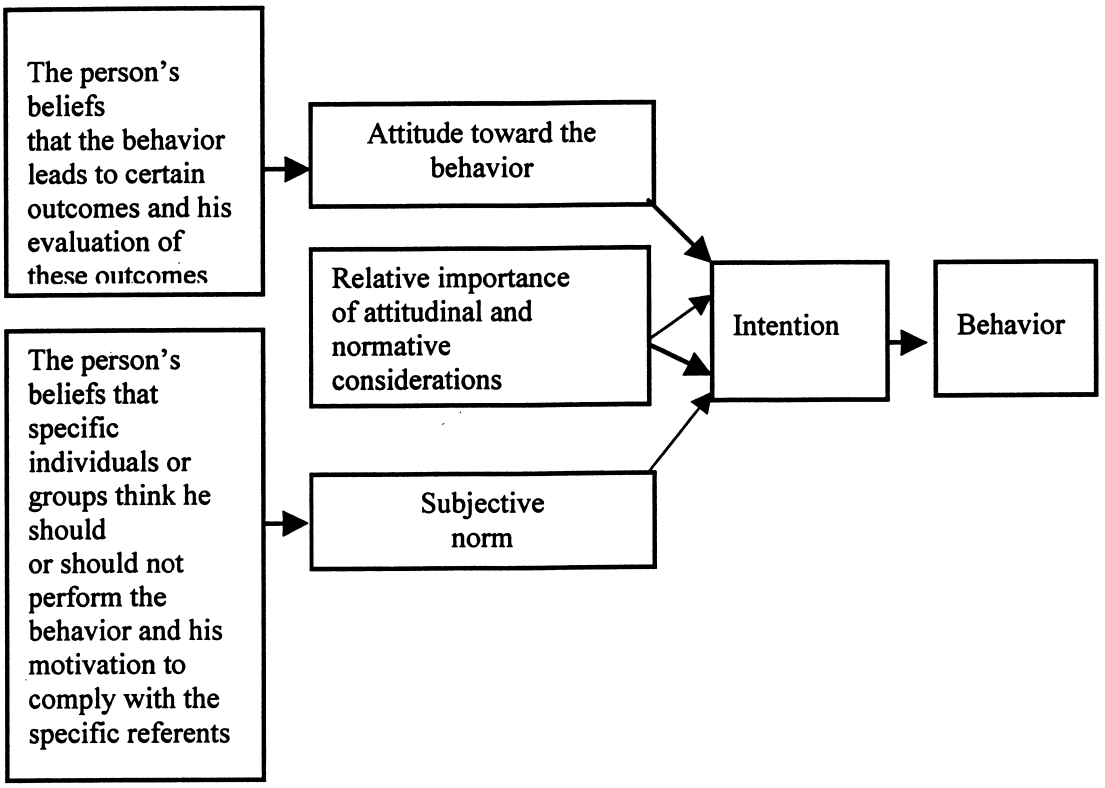


Figure 1. Theory of Reasoned Action Model

Factors determining a person's behavior. From Ajzen, I. and Fishbein, M. (1980) Understanding Attitudes and Predicting Social Behavior. Prentice Hall, New Jersey, p. 8. Arrows indicate the direction of influence.

CHAPTER 3: METHODS

Location of Study Area

The Mount Logan Wilderness Area is located north of the Colorado River adjacent to Grand Canyon National Park, and is considered a part of the Colorado Plateau within Mohave County (Figure 2). Visiting the wilderness requires driving between 31 and 43 kilometers on dirt roads, depending on whether the wilderness is accessed from Utah or Arizona. Direct access to the wilderness interior is provided by one cherry-stemmed wilderness boundary road along a 2.7-kilometer road corridor on the southeast portion of the boundary.

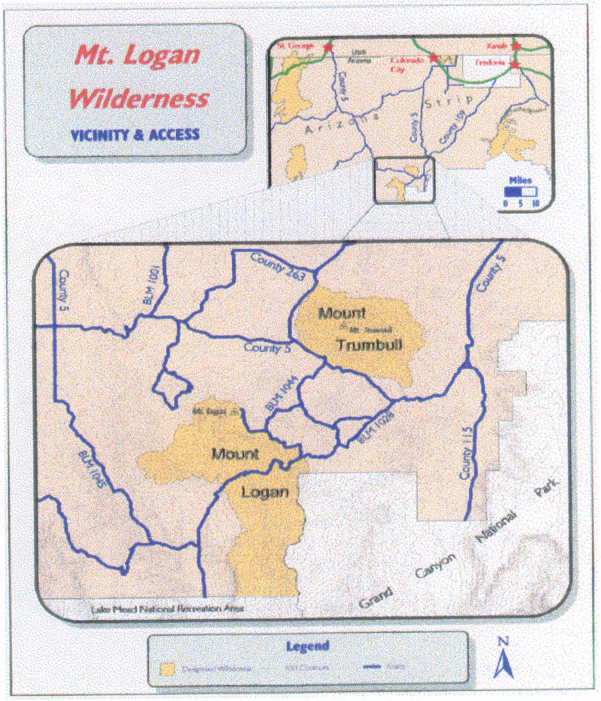


Figure 2. Mount Logan Wilderness Vicinity Map.

Mount Logan is one of eight wilderness areas located on the Arizona Strip, Bureau of Land Management (BLM). Adjacent National Park Service managed areas include Lake Mead National Recreation Area and Grand Canyon National Park, which together encompass an additional 300,651 hectares of proposed wilderness (USDI Wilderness Management Plan 1990). The Mount Logan Wilderness study area (Figure 3) is contained within the Mount Trumbull Resource Conservation Area (RCA), which encompasses 143,707 hectares. Originally this RCA was designated because of timber, wildlife, recreation and wilderness resources. Guidance for management of the RCA is outlined in the Arizona Strip Resource Management Plan 1990. The legal description of the Mount Logan Wilderness Area is Townships 33, 34, North, Ranges 8, 9 West, of the Gila and Salt River Meridian.

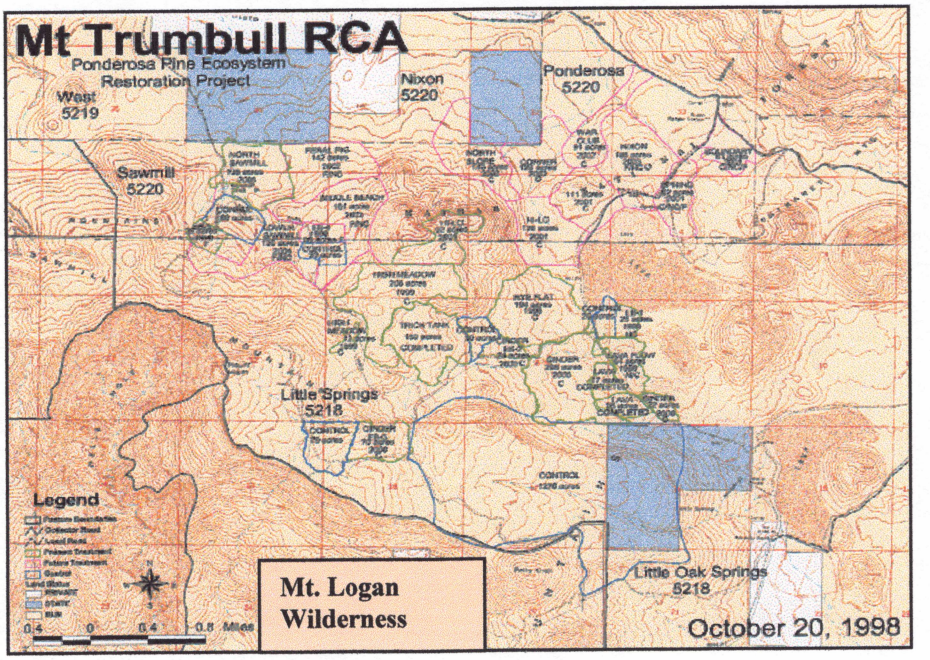


Figure 3. Mt. Logan Wilderness is situated within the Mt. Trumbull Resource Conservation Area.

The elevation of Mount Logan Wilderness is 734 meters with a mountainous climate. Mount Logan experiences four seasons with most of the precipitation occurring in the spring and summer months. Inclement weather in the winter and spring can make access difficult to impossible. The two dominant soil types for the Mount Logan Wilderness include Siesta cobbly clay loam and Wukoki Variant--Lomaki Cold Variant. Siesta cobbly clay loam soil is on slopes 1-45% while gravely loam soil is present on slopes of 15-60% (USDI Wilderness Plan 1990).

Mount Logan Wilderness Area encompasses 5,909 hectare, with 85 hectares of vegetation patches consisting of oak (*Quercus gambelii*), locust (*Robinia neomexicanus*), and manzanita (*Arctostaphylos platphylla and pungens*) (USDI Wilderness Plan 1990). The dominant species is ponderosa pine (*Pinus ponderosa*) with some quaking aspen (*Populus tremuloides*) and Gamble oak (*Quercus gambeli*) occurring in the area.

Wildlife species are diverse in the Mount Trumbull RCA. Two important game species include mule deer (*Odocoileus hemionus*) and merriam turkey's *(Meleagris gallopavo merriami Nelson*). The highest success ratio for turkey hunting in Arizona occurs in the Mount Logan area (USDI Wilderness Plan 1990). Currently, there are no listed threatened or endangered species within the area.

The multiple use land patterns for Mount Logan Wilderness includes grazing on a seasonal rotating basis, recreation, cultural/historical resources, and no active mining claims. Recreation in Mount Logan Wilderness usually consists of day use with activities including picnicking, hunting, and hiking. Management of recreational opportunities for the Mount Logan Wilderness are guided by the Recreation Opportunity Spectrum (ROS).

Using the ROS, the BLM recreation planners and managers created three trails and one interpretive site within the RCA, including Mount Trumbull, Mount Logan, Temple Trails, and the Blake Sawmill interpretive site. The Mount Trumbull Trail, is 1.2 kilometers long with an estimated visitation of 517 people per year; while the Mount Logan Lookout Trail (less than a mile long) receives an estimated visitation of 189 people per year (Folks, personal communication 1998). The 113 kilometer long Temple Trail was designated as a historical trail and is currently being re-designed to enhance visitor enjoyment. The Blake Sawmill interpretive site was constructed by the cultural specialist and recreation planner, who involved local residents to provide historical interpretation of sawmill ruins that operated within the RCA around 1870, and provided timber for the construction of the St. George Temple.

History of Mount Logan Wilderness Area

Humans have occupied the Mount Logan area since 2600 B.C. with the Anasazi culture beginning about 1 A.D. (USDI Wilderness Plan 1990). Little information is known specifically about the Arizona Strip prehistory except for a few sites that have been studied and recorded. The research from the recorded sites, based on the presence of distinguishable ceramics and architecture, has shown that the area was mostly occupied by the Anasazi (Altschul and Fairley 1989). From studies throughout the region, archaeologists concluded that the Anasazi culture diminished by 1150 A.D., as this culture either migrated to the east into the Kayenta area or they became part of other Native American tribes (Altschul and Fairley 1989). Although little is known about the prehistory of Mount Logan area, Native American groups have cultural ties to the area.

These Native American tribes include but may not be limited to the Hopi, Paiute, and Navajo. The tribe within the closest proximity to Mount Logan Wilderness Area is the Southern Paiute. Some of the prehistory impacts are unknown and will not be taken into account while determining reference conditions prior to Euro-American settlement.

The first Euro-Americans to visit the Mount Logan area were John Wesley Powell, Mormon settlers, and the United States Geological Survey. John Wesley Powell visited the area in 1870, in search of lost members of his river expedition (UDSI Wilderness Plan 1990). Shortly after John Wesley Powell's expedition, Mount Logan was discovered and noted for its timber resources.

According to local ranchers and descendants of Mormon settlers on the Arizona Strip, portable sawmills were constructed in various locations around 1874 in what is now the Mount Logan Wilderness Area. Most sawmills ceased operation after completion of the St. George Temple in Utah, as the paving of roads made other areas in the region more accessible for timber harvesting. The ruins of these sawmills are still evident today.

The Forest Service first managed the Mount Logan area from 1923 to 1974. During this period, timber sales occurred within the Mount Logan area. In 1974, the land was transferred from the Forest Service to the BLM. After the transfer, and prior to the Arizona Wilderness Act of 1984, BLM conducted a thinning to decrease the amount of trees-per-hectare in the area. Slash left from this thinning is still evident within the wilderness area and has contributed to the build-up of hazardous fuels. This fuel accumulation is addressed in the Mount Logan Fire Management Plan of 1977, which is

currently being revised. The BLM is actively reducing these fuel loads in Mount Logan Wilderness with prescribed burning occurring each year.

Ecological Methods and Materials

The methods used to gather data on the ecological reference condition and current versus presettlement forest density was designed and implemented with the help of Northern Arizona University, Forestry Ecology Laboratory. Although I helped to collect the ecological field data, Amy Waltz and Peter Fulé conducted the laboratory analysis.

To determine the reference condition, ecological data was collected from Mount Logan Wilderness Area on thirty-four, 50x20 meter (.01 hectare) fixed plots. The plots were located on a systematic 300 meter grid system within areas of ponderosa pine. These methods were previously tested within the Mount Trumbull restoration project.

The plots were permanently marked as long-term monitoring sites with rebar stakes and rock cairns at the origin and at four outer corners. Each plot was divided into four quadrants (Q1-Q4) for data sampling purposes, with 50 meter sides parallel to the slope azimuth to maximize sampling of variability due to the elevational gradient (Figure 4). For each plot, a presettlement tree was tagged with the distance and bearing recorded to the plot origin.

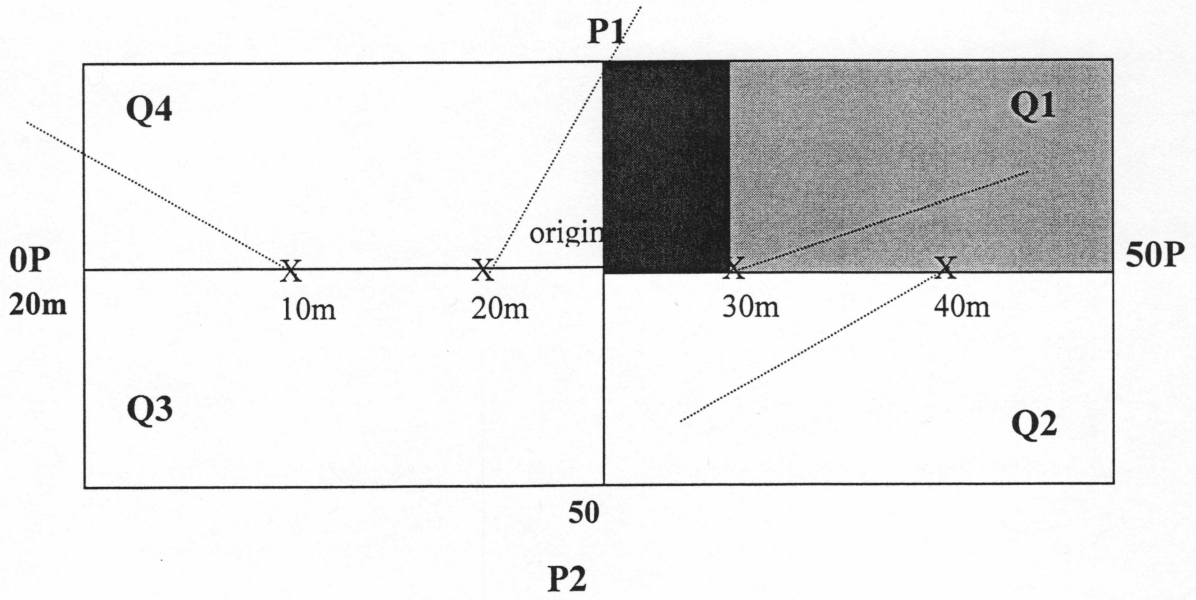


Figure 4. Ecosystem Monitoring Plot Map including the four quadrants. Fuel measurements were made along the centerline of the plot every 10 meters as depicted by the dashed lines. Each plot was established to serve as a permanent monitoring system for future re-measurement.

Data Collection

The data collection was divided into five sections including: 1) overstory trees, 2) poled-sized trees, 3) tree seedlings, 4) herbaceous and brush layer, and 5) canopy cover. Overstory trees greater than 15 cm diameter at breast height were permanently tagged. Data was collected on tree species at breast height (4.5 ft). Data collection consisted of the following: condition class, crown code, damage code (noticeable damage was recorded varying from lightning strikes to beetle infestations), field call of presettlement versus postsettlement trees, tree cores, and snag cavities. The field determination of a presettlement tree was based on the diameter of the tree at breast height (dbh) in addition to the color of the tree bark. More accurate determination of presettlement tree status was made in the laboratory, after dendrochronological analysis determined the pith date. In

addition, tree cores were taken at stump height on all field-determined live presettlement trees and on ten percent of postsettlement trees. The condition class data classified trees as: live, declining, recent snag, loose bark snag, clean snag, broken above dbh, broken below dbh, dead and down, cut stump, and stump hole. The crown codes included: dominant, co-dominant, intermediate, and subcanopy field observances.

Pole-sized trees (between 2.5 to 14.9 at dbh) were permanently tagged on a 10x25 area within quadrant 1. Data collected on the pole-sized trees included species, dbh, condition class, height, and presettlement/postsettlement class with the same methods as mentioned for the overstory trees. As with the collection of the overstory data, all presettlement trees and ten percent of all postsettlement trees were cored at stump height. One additional measurement for pole trees included the height of the tree to the nearest meter.

On each plot, tree seedlings were tallied by species, condition, and height on a small area (5x10 m). Dead and down fuel loadings were also collected by size class (tons/acre of woody fuels by time-lag fuel moisture size classes: 0-1/4 inch, 1/4-1 inch, 1-3 inches, and 3+ inches in sound wood). For duff and litter, fuel depths were collected at ten points along four 50 foot planar transects in each plot (total 200 feet). Each transect was determined by collecting the fuel depths from random directions on 10 m, 20 m, 30 m, and 40 m points along the O P to 50 P centerline.

Herbaceous and brush layer data was collected along the 50 meter sides of the plot. At every 30 centimeters along the 50 meter transect, herbaceous species, height, and substrate were recorded. There were a total of 166 points per transect and 332 points per plot. In addition, if the plots were located in a shrubby area, such as sage, a belt

transect was created by widening the herbaceous transect to 50 m x 1 m area. Within this transect, all shrubs, along with living and dead material were tallied by maturity state.

Canopy cover was collected using the point intercept method every 30 centimeters along the two 50 meter transects. As with the herbaceous and brush data, there were a total of 166 points per transect and 332 points per plot to measure the presence or absence of tree canopy. For each plot, eight photopoints were established.

Presettlement tree information was vital in determining the reference condition (previous to Euro-American settlement) for Mount Logan Wilderness Area. The reference condition was determined by analysis of age structure and composition.

In addition to identifying the structure of the presettlement forest, fire history data was collected to determine the fire frequency. Samples from cat-faces (fire-scarred wood) were surfaced and analyzed. This data determined the date of fire exclusion as 1870 which coincides as intersecting lines of evidence with the settlement of the Mount Logan area.

Limitations

The ecological field data collection was limited to the overstory reconstruction. Herbaceous materials were difficult to reconstruct from current conditions because little evidence remains of previous herbaceous communities. Quantitative data (such as historical records) was also difficult to locate. Historical records are limited to a few explorers like John Wesley Powell and the United States Geological Survey (USGS) team who traveled though the area prior to 1882. The field descriptions from the USGS are general about the Mount Logan area.

For the studies in the Mount Logan area, climate changes since Euro-American settlement may not have been taken into consideration. Climate affects germination, as conditions have to be favorable for tree establishment (Savage et al. 1996). According to Swetnam and Betancourt (1990) the fire scar record is unreliable for the 20th century.

Social Methods and Materials

Five communities were selected for the resident survey based on their proximity to Mount Logan Wilderness Area and their traditional involvement in land use planning with the Arizona Strip Field Office. Participants were selected from both urban and rural communities. The goal was to sample 500 residents from an urban area (St. George, Utah) and 500 residents from rural areas (Hurricane and Kanab in Utah, Fredonia and Colorado City in Arizona). A list of randomly selected names, addresses, and phone numbers was obtained from a professional sampling firm.

Data Collection

Data was collected in two stages. Stage one included a preliminary telephone survey conducted in the spring of 1998. The purpose of this survey was to identify the advantages and disadvantages of three restoration treatments: mechanical, non-mechanical, and prescribed burning. Thirty residents from each sample (urban and rural) were contacted and asked open-ended questions about each treatment. For the mechanical and prescribed fire treatment, the most consistent nine responses were identified, and for the non-mechanical treatment the most consistent eight responses were compiled. These responses were used in developing the mail questionnaire.

Mail Questionnaire

The mail questionnaire was the primary data collection instrument and was completed in the summer of 1998. The questionnaire was designed and the mailing was prepared at Northern Arizona University in the College of Ecosystem Science and Management. Due to budget constraints, however, the questionnaires were postmarked and mailed from the Arizona Strip Field Office in St. George, Utah. The envelopes and enclosed information clearly identified Northern Arizona University as the entity conducting this research. The return envelopes were sent directly back to the university for data collection and analysis.

The questionnaire was designed to ask one attitude question about each ecological wilderness restoration treatment and two questions about the beliefs that were determined in the preliminary telephone survey. Demographic questions, knowledge of ecological restoration, and knowledge of the study site were asked.

Our standard method of mailings followed Dillman (1978) methods. This included four mailings to selected participants: 1) a personally signed cover letter along with a survey, 2) a reminder/thank-you postcard sent one week after the initial mailing, 3) a cover letter and replacement questionnaire sent only to non-respondents three weeks after the initial mailing, and 4) a cover letter and a survey delivered by certified mail sent to non-respondents seven weeks after the initial mailing. Surveys were returned for three months after the initial mailing. To increase our response rate, an incentive was included during the final mailing, which included a fifty-dollar book gift certificate. I was unable to positively determine if the incentive increased the response rate, but since there was a

duplication of returns from the second and third mailing I suspect that this could be attributed to the incentive. My sample size decreased from 1,000 to 738, since 262 surveys were undeliverable. Of the remaining 738 questionnaires, 408 were returned, bringing the overall response rate to 55%.

To determine the reasons that respondents did not return the questionnaire, 27 randomly selected non-respondents from each sample were contacted during October of 1998. The four most common reasons for a non-response were: 1) did not have time, 2) did not know the study area, 3) the survey was slanted/unfair, and 4) did not want to.

Data Analysis

I chose to use SPSS software version 8.0 for all statistical analysis. The analysis was divided into two phases. In the first phase, descriptive statistics were computed to provide a profile of respondents and their attitudes for mechanical, non-mechanical, and prescribed fire ecological wilderness restoration treatments. Additionally, chi-squared was used to compare several variables that affected the attitudes. In the second phase, a reliability analysis (Chronbach's alpha) was computed for the questions to produce the attitude index. Correlations were then conducted for the attitudes, beliefs, and the belief evaluation index. The third phase consisted of dividing respondents into groups based on whether they had a positive, negative, or neutral attitude toward each wilderness treatment, then comparing them on multiple variables using an analysis of variance and post hoc statistical tests.

Limitations

This social research examined many variables within one study. Respondents may have been confused on some questions because they were asked about three restoration treatments as opposed to one. The topic of restoration in general may also have been unfamiliar to respondents (even though many had heard of the concept of ecological restoration), and respondents may not have known how they truly felt about restoration treatments in wilderness. Therefore, a survey focusing on these issues separately may be useful to compare with results from this survey.

Conclusion

Wilderness areas contain information that contributes to the understanding of natural processes and can improve management of wilderness areas (Cole and Landres 1996). Both ecological and social data are important to consider when trying to restore the Mount Logan Wilderness Area. Once this information is collected, managers will have more information to proceed with wilderness management.

To implement successful wilderness restoration, an ecological reference condition must be established as a guideline, and information on local residents' attitudes and beliefs must be considered to determine what the public is willing to accept as wilderness restoration treatments. If managers use both ecological and social data to restore the Mount Logan Wilderness, restoration is more likely to become a realistic goal.

CHAPTER 4: RESULTS FROM THE ECOLOGICAL DATA

CHANGES IN SOUTHWESTERN PONDEROSA PINE FOREST STRUCTURE IN THE MOUNT LOGAN WILDERNESS AREA

Abstract

The Mount Logan Wilderness Area was chosen as the wilderness study site because its location is fairly accessible and is within close proximity to the ongoing Mount Trumbull ecological restoration study area. To establish an ecosystem restoration reference condition, a total of 34 ecosystem monitoring plots were established between 1995 and 1997. The plots were located on basalt and cinder soils and included thinned and unthinned areas. Depending on the soil type and past management practices, the tree density per plot differed. Thinned and unthinned plots differ the most in the density of trees/hectare. Unthinned basalt plots contained 2,725 ponderosa pine (*Pinus ponderosa)* trees/hectare with a total of 2,790 trees/hectare. Thinned plots contained 704 ponderosa pine (*Pinus ponderosa*) trees/hectare with a total of 801 trees/hectare(Waltz and Fulé, unpublished report 1998). Along with measuring tree density, fire scars were collected from 32 trees within the wilderness. The date of fire exclusion was determined as 1870, the time of Euro-American settlement.

The 1964 Wilderness Act states that wilderness areas should "allow natural processes to operate freely", but anthropogenic disturbances have altered the Mount

Logan Wilderness Area, creating the need for forest restoration. It is time to change the trajectory of this wilderness area to one consistent with pre-settlement conditions.

Introduction

Before the turn of the century, the goal of settlement was to tame "wild" areas. Often the areas that were not tamed became wilderness by legal definitions. According to the Wilderness Act of 1964, "wilderness is a place where the imprint of man's work is substantially unnoticeable", however today's forest regime does not depict an area which has been left to nature. Out of 726 million acres of public lands in the United States only 104 million acres are wilderness. Over half of the wilderness acreage is located in the State of Alaska, leaving only 6% of federal lands in the lower 48 states protected.

Wilderness areas in the southwestern ponderosa pine type have changed dramatically since the time of Euro-American settlement. Euro-American settlement is defined as a period in which fire suppression, livestock grazing, and logging has contributed to changes in forest structure (Covington et al. 1994, Covington and Moore 1994b, Swetnam and Baisan 1996, Fiedler et al. 1996, Covington et al. 1997). Prior to Euro-American settlement, natural disturbance regimes such as frequent and low-intensity fires (occur every two to twenty years) and competition from herbaceous vegetation kept ponderosa pine forests open and park-like. Today, wilderness areas and nature reserves in the southwestern ponderosa pine type often have higher tree densities than land outside their boundaries (Covington et al. 1994). To restore the natural ecosystem process, fire would help the perpetuation of wilderness areas (Agee 1974).

Fire is a key natural disturbance regime and fire suppression has altered species distributions and population viability of habitat types across landscapes (Cole and Landres 1996). Over 100 years of fire exclusion has played a role in the unnatural buildup of litter, duff, and dense dog-hair thickets. These dense stands provide fuel ladders that cause crown fires (Arno et. al 1995). Today's large stand replacing fires in the southwestern ponderosa pine type, often thought of as catastrophic, were uncommon prior to Euro-American settlement (Cooper 1960).

Wilderness is an important place for forest restoration. Wilderness ecosystems because of their size may be able to support large mammal species and greater numbers of viable plant and animal species than outside wilderness. Usually, wilderness areas are roadless and remote areas that provide an unmodified landscape for scientific research (Noss 1991a). Restoration is necessary to assure the long-term viability of wilderness, and to be effective, restoration needs to be on the scale of millions of hectares (Noss 1991b). Numerous studies conducted in southwestern ponderosa pine (Cooper 1960, White 1985, Covington and Moore 1994a, Covington and Moore 1994b, Sackett et al. 1996, Covington et al. 1997) relate to concern for restoration, reference conditions and treatments, but none of them focused on wilderness. This research project concentrates on the Mount Logan Wilderness area.

Study Site

The Mount Logan Wilderness study site is located on the Arizona Strip Bureau of Land Management in Arizona. Vehicular access is possible only from the north because steep remote portions of Grand Canyon National Park and Lake Mead National

Recreation Area provide natural barriers. St. George, Utah, Fredonia and Colorado City, Arizona are the nearest city locations. Direct access to the wilderness interior is provided by one cherry stemmed road along a 2.7 kilometer road corridor. The Utah access requires driving 43.4 kilometers on dirt roads while the Arizona access requires 31 kilometers of dirt roads. Inclement weather in the winter and spring often make access difficult or impossible.

The dominant tree species in Mount Logan Wilderness is ponderosa pine with some Quaking aspen (*Populus tremuloides*) and Gambel Oak (*Quercus gambelii*). Other species present include Utah juniper (*Juniperus osteosperma*), pinyon (*Pinus edulis*) and Mexican locust (*Robinia neomexicana*) (Waltz and Fulé, unpublished report 1998). In the ponderosa pine type, a total of 34 plots were established between 1995 and 1997.

Adjacent to Mount Logan Wilderness (in the Mount Trumbull restoration project site) a total of 216 plots were established between 1995 and 1998. In addition to the plots, five experimental blocks each comprised of 16-40 hectares were established for controlled testing of ecosystem restoration treatments.

The Mount Logan Wilderness study area ranges in elevation from 2,079 meters to the highest area in the study of 2,295 meters (Waltz and Fulé, unpublished report 1998). The Mount Logan area has four distinct seasons with most of the precipitation occurring during the winter snowfall and the summer monsoons (June through September). Soils consists of Siesta cobbly clay loam (1-45% slopes) and cinder soils of Wukoki Variant--Lomaki Cold Variant complex (15-60% slopes) (USDI Wilderness Plan 1990).

Management of the Mount Logan area began with the Forest Service from 1923 to1974, thereafter it was transferred to the Bureau of Land Management (BLM). When

BLM first acquired the Mount Logan area, they thinned portions of the dense forest leaving slash, which is still evident today. The BLM is actively reducing these fuel loads by using prescribed fire within the wilderness.

Multiple use within the Mount Logan Wilderness includes grazing, which was prevalent after Euro-American settlement and which existed prior to the 1984 Arizona Wilderness bill (which designated Mount Logan as a wilderness area). Grazing is permitted on a seasonal rotational basis but currently no other forms of multiple use occurs. Multiple use can also occur in one private inholding in the northeast portion of the wilderness consisting of 16 hectares.

Methods

Measurements included overstory structure, herbaceous cover, canopy cover, fire scar samples, forest floor and woody debris. Plot specifications and measurements were adapted from the National Park Service Western region's fire-monitoring handbook (USDI NPS 1992). Plots measured 50 by 20 meters and were located on a systematic 300-meter grid. Grid points were located in the field by pace and compass, or by taping and compass, while all other plots were from map reference points such as roads or section corners (Waltz and Fulé, unpublished report 1998). The wilderness was surveyed for suitable plots containing more than 10% ponderosa pine cover based on presettlement trees, snags, stumps, or logs. In mixed stands, ponderosa pines had to be the dominant tree. When a gridpoint was located in an unsuitable location, points 50 meters away (N, S, E, W) of the grid point were checked for suitability. Within the wilderness only two

plots were found unsuitable because less than 10% of the plot consisted of ponderosa pine.

To measure for the contemporary forest overstory structure, trees were mapped, tagged, and analyzed on each plot. Trees > 15 cm dbh (diameter at breast height, 4.5 ft) were measured on the entire plot (1000 m^2). In quadrant one, measurements included pole-sized trees between 2.5cm and15 cm dbh, along with tree seedlings < 2.5 cm. Tree data collected included: dbh, crown position (dominant, co-dominant, intermediate or sub-canopy), tree damage, and condition class.

Presettlement trees were ponderosa pines with yellow bark or a dbh > 37.5 cm along with oak, juniper, and pinyon trees with a dbh > 17 cm. All field-estimated presettlement trees and 10% of all post-settlement live trees were cored and later analyzed in the laboratory to determine if the trees were of pre or post-settlement origin. To acquire information on herbaceous composition, transects were recorded along the two outer 50-m sides of each plot. Every 30 cm, plant species, species height and substrate (e.g., soil, litter, and rock) were recorded for a total of 332 points per plot. Canopy cover was also recorded at each of the 332 points along the herbaceous transects. Forest floor and woody debris were measured along four 50-ft planar intersect transects (Brown et al. 1982) in random directions every 10 m. Woody debris was recorded by size/timelag classes: 1, 10, 100, and 1,000-hour (sound and rotten) fuels. Litter and duff were measured every five feet along the centerline of each plot.

Starting at the centerline of the plot, eight photographic points were identified to capture the basic characteristics of the plot. The last measurement was from the plot origin to the closest presettlement tree (reference tree). This tree was tagged with the

distance and bearing to the plot origin. This was necessary because only rebar markers were left in place, as we tried to minimize our research impact in the wilderness.

The wilderness was checked for catfaces (fire-scarred trees) including living trees, snags, and downed logs across the study site. Partial or full cross sections through the fire scars were collected with a chain saw. In the laboratory, the fire-scarred samples were mounted, surfaced, and crossdated. A master chronology was constructed by combining ring series (Stokes and Smiley 1996) from both wilderness and non-wilderness plots. Ring widths of all samples were measured, dated, and checked with the COFECHA program (Grissino-Mayer and Holmes 1993). Fire scars were dated to the year and season (either spring or summer) of occurrence, depending on the position of the fire lesion within the annual ring (Waltz and Fulé, unpublished report 1998). Fire history data, as revealed by fire-related injuries often found in the growth rings of trees, was analyzed using the FHX2 software (Grissino-Mayer 1995).

Results and Discussion

Presettlement Forest Structure

Presettlement density for cinder soils averaged 74 trees/hectare while unthinned basalt soils averaged 103 trees/hectare and thinned basalt averaged 86 trees/hectare (Table 1). Ponderosa pine was the dominant tree species on all plots with the most density occurring on the unthinned and thinned basalt soils. Gambel oak, the second most common species was more prominent on cinder versus basalt soils. Overall, presettlement densities were higher on the basalt versus the cinder soils.

Contemporary Forest Structure

Approximately 90% of trees in both soil types were ponderosa pine, 7% were Gambel oak, and 3% were other species. Differences in tree density were observed between the two soil types, including the basalt and cinder soils and the thinned and unthinned plots. The basalt soils averaged 2,790 trees/hectare while the cinder soil averaged 696 trees/hectare (Table 2). Cinder soils had the least trees/hectare, while unthinned basalt soils contained the greatest density. The unthinnd basalt plots contained 2,790 trees/hectare with 2,725 ponderosa pine trees/hectare (Table 3).

The thinned basalt plots contained 801 trees/hectare with 704 ponderosa pine trees (Table 3). The thinned basalt plots had the least variable trees/hectare since the thinning treatment created a more uniform overstory structure. The thinned plots increased the growth of residual trees and allowed some recovery in basal area. This stand management did improve tree growth, but it did not radically help herbaceous plant growth, since stands were still dense after the thinning. These dense conditions have increased the likelihood of tree mortality due to insect outbreaks (especially bark beetle outbreaks) and the risk of severe wildfires (Kolb et al. 1994).

Fire History

A total of 200 fire scars were dated from 32 sample trees within the wilderness. The earliest fire date occurred in 1632 and the latest in 1996. The fire sample plots were separated into three areas: Logan, Petty Knoll, and Slide Mountain (Table 4). The mean fire interval (MFI) for both Mount Logan and Petty Knoll was five years while MFI for

Slide Mountain was seven years. The date of fire exclusion was determined as 1870, the same date as Euro-American settlement.

Contemporary Herbaceous Composition and Density

The mean substrate cover for the herbaceous transect consisted of 8% plant material, 18-20% mineral soil, wood, rock or duff, and 70% litter. Of the 8% plant cover, 2% of the plants were sagebrush (*Artemisia tridentata*). Canopy cover averaged 53% on all wilderness plots.

Native plant species were predominant in the understory but several species of the most frequent taxonomic groups were exotics (*Bromus tectorum, Poa pratensis, Verbascum thapsus and some species of Agropyron*). Comparing substrate cover by soil type produced different results. The cinder soil had 16% plant cover while the basalt soil had 7% plant cover (Waltz and Fulé, unpublished report 1998).

Management Implications

The 1964 Wilderness Act states that wilderness areas should "allow natural processes to operate freely." For over 100 years anthropogenic disturbances such as fire have altered the Mount Logan Wilderness forest structure. This situation has created a management dilemma because by law wilderness areas are to be unmodified by human disturbance. Today's forest stands whose canopy closures are higher than in presettlement times, are susceptible to crown fire, low tree vigor, and mortality from drought, insects, and diseases (Covington and Moore 1994a). Only a few living presettlement trees per hectare remain in the Mount Logan Wilderness and many appear

to have reduced vigor, underscoring the need for rapid intervention to save the remaining old-growth trees, even in the absence of catastrophic fire (Waltz and Fulé, unpublished report 1998).

To reverse the effects of anthropogenic disturbance and to re-create more pristine conditions, managers will have to actively manipulate wilderness ecosystems (Cole 1996). Simply reintroducing fire to restore wilderness stands will not be enough to restore natural conditions. Both restoration of ecosystem structure and reintroduction of fire are necessary for restoring rates of decomposition, nutrient cycling, and net primary production to natural, presettlement levels (Covington et al. 1997).

Treatment plots could be tested outside wilderness before embarking on wilderness restoration. Integrating past studies, simulation modeling, and management experiments should ensure that wildland management issues in the ponderosa pine type are addressed in a more coherent and ecologically sound manner (Covington and Moore 1994a).

Conclusion

Disagreements about wilderness values often lead to arguments about facts, the possible consequences associated with management, and the lack of management actions (McDaniels 1990). It may be time for lawmakers to reassess the relationship between the 1964 Wilderness Act and the current ecological status of the nation's wilderness (Murry 1996). Our results show a dramatic increase in tree density, a decline in herbaceous composition, an increase in canopy cover, and a decline in frequent low-intensity fires. These changes have all occurred at the time of Euro-American settlement in the late 1800's and the present.

In order to address the changes in forest structure common throughout the Southwest, restoration treatments are being conducted outside wilderness areas. Treatments consist of raking the forest floor accumulation away from presettlement trees (Covington et al. 1997), thinning, and using prescribed fire. The response of these treatment areas will help direct restoration efforts in Mount Logan Wilderness.

By using adaptive management, treatment procedures will be incorporated into wilderness treatments. While discussing wilderness restoration, however, the legal constraints of wilderness management must be realized. Wilderness areas have changed dramatically over time; therefore it may be time to change the trajectory of these areas to one consistent with presettlement conditions. One suggested compromise is for wilderness restoration to occur either generally or on a case-by-case basis (Cole 1996). Society will have a large role in deciding the future management of our wilderness areas. Therefore, education should be used to inform the public of the consequences of not restoring our wilderness areas. By using the best possible science along with attitudinal social surveys, managers can determine how to approach restoring wilderness areas to preserve the delicate balance of wilderness integrity.

Table 1. Presettlement (1870) trees/hectare by soil and management type (from Waltz and Fulé, unpublished report 1998)

Soil Type	Trees/hectare
Cinder	74
Unthinned basalt	103
Thinned basalt	86

Table 2. Tree Density (trees/hectare) in 1997 on Basalt Versus Cinder Soils. (From Waltz and Fulé, unpublished report 1998)

	Basalt Plots, n = 11		Cinder Plots, n = 11	
Species	Mean	S.E.	Mean	S.E.
Ponderosa pine	2725.2	709.52	475.6	150.49
Gambel oak	42.8	29.60	157.0	106.47
Utah juniper	13.7	5.62	17.5	9.61
Pinyon pine	8.2	7.27	14.8	8.27
New Mexican Locust	0	0	31.4	21.08
Total	2789.9	699.63	696.3	178.91

Table 3. Tree Density (trees/hectare) in 1997 on Unthinned Versus Thinned Plots. (From Waltz and Fulé, unpublished report 1998)

	Unthinned Plots, n = 11		Thinned Plots, n = 12	
Species	Mean	S.E.	Mean	S.E.
Ponderosa pine	2725.2	709.52	703.5	75.99
Gambel oak	42.8	29.60	85.3	57.09
Utah juniper	13.7	5.62	7.5	5.00
Pinyon pine	8.2	7.27	0	0
New Mexican Locust	0	0	3.4	3.35
Total	2789.9	699.63	801.3	64.60

Table 4. Summary of Fire History Data. (From Waltz and Fulé, unpublished report 1998)

Site	Number of samples	Number of fire scars	Beginning year	Ending year	Length of fire history (years)	Fire regime disruption date
Logan	14	78	1632	1996	365	1879
Petty Knoll	8	70	1670	1996	326	1869
Slide Mountain	10	52	1684	1996	312	1871

***Beginning year is the first fire year with adequate sample depth (at least 3 recording trees).**

CHAPTER 5: RESULTS FOR SOCIAL RESERCH

LOCAL COMMUNITIES ATTITUDES TOWARD ECOLOGICAL RESTORATION TREATMENTS: MOUNT LOGAN WILDERNESS CASE STUDY

Abstract

Changes have been occurring in southwestern ponderosa pine (*Pinus ponderosa*) since Euro-American settlers introduced livestock grazing, logging, and fire exclusion. Managers and scientists working together have determined that Mount Logan Wilderness Area is in desperate need of forest restoration as these changes have created the potential for catastrophic wildfires.

Our goal was to determine for the Arizona Strip, Bureau of Land Management, what types of ecological wilderness restoration treatments local residents would support. To accomplish this, we developed a mail-back questionnaire to determine the attitudes and underlying beliefs of local residents toward the use of three wilderness treatments including a non-mechanical, prescribed fire, and mechanical treatment to aid in restoring the Mount Logan Wilderness Area.

Each attitude and underlying belief was identified and categorized into a positive, negative, or neutral attitude. The results concluded that the most positive attitude existed for using mechanical methods while less positive attitudes existed for the non-mechanical

and prescribed fire treatments. Information about attitudes is important to managers, so they can develop educational materials to help change resident beliefs.

Introduction

Wilderness areas may not be as pristine as society envisioned when the Wilderness Act of 1964 was passed. In fact, wilderness areas in ponderosa pine, left to their own devices have created suitable conditions for high intensity forest fires. We have a small window of opportunity, perhaps between 15 to 30 years, to restore ponderosa pine forest conditions before these areas are lost forever (Covington et al. 1994).

Changes in natural processes have been occurring in the southwestern ponderosa pine wilderness areas since Euro-American settlers introduced livestock grazing, logging, and fire exclusion (Covington et al. 1994, Covington and Moore 1994b). The exclusion of fire is the largest known threat to these wilderness areas (Cole and Landres 1996). To compensate for anthropogenic disturbances such as fire exclusion, managers will have to decide if they want pristine wilderness conditions (by restoring the area) or if they want unnaturally dense forests conditions which remain unmanipulated (Cole 1996). We argue that restoration is necessary before forest conditions worsen resulting in the complete loss of wilderness resources. For restoration activities to succeed, however, public support is needed, particularly among those who live near areas where restoration activities occur.

This article focuses on the attitudes and beliefs that residents of local communities hold toward Mount Logan Wilderness ecological restoration treatments. Five communities within close proximity to the proposed treatment site were surveyed on their

attitudes toward restoration treatments in Mount Logan Wilderness Area. The wilderness is located in northern Arizona, managed by the Arizona Strip Field Office of the Bureau of Land Management (BLM), and is adjacent to Grand Canyon National Park. The BLM defined local communities as, any community that had been involved with land use planning and within close proximity to the wilderness area. Communities surveyed are located in both Utah and Arizona. In Utah the communities included St. George, Kanab, and Hurricane, while in Arizona the communities included Fredonia and Colorado City. We divided the communities into urban and rural samples. The single urban community consisted of St. George, Utah, while the other communities constituted the rural sample.

The three purposes of this research were to:1) explore local resident attitudes toward three potential wilderness restoration treatments, including mechanical, non-mechanical, and prescribed fire, 2) identify the salient beliefs and underlying attitudes that residents hold toward wilderness restoration, and 3) use these findings to recommend ways that managers can influence public attitudes through the use of education.

Relevant Research

Research has been published on public knowledge and perceptions of using prescribed fire as a management tool (Stankey 1976, Bass et al. 1983, Cortner 1984, Taylor and Mutch 1986, Taylor and Daniel 1984, Taylor et al. 1986, Parsons and Landres 1998), while a few studies focused on public attitudes toward prescribed fire (Manfredo et al. 1990, Bright et al. 1993). The Manfredo et al. 1990 results showed that 55% of the regional sample of Montana and Wyoming residents supported prescribed fire while 48% of the national sample supported prescribed fire. The Bright et al. 1993 study examined

how educational materials may affect respondents' attitudes. None of the studies examine public attitudes toward the use of mechanical and non-mechanical restoration methods such as thinning and harvesting pertaining to wilderness restoration.

The research most relevant to our study of wilderness ecological restoration treatments was research conducted by Barro and Bright (1998) of Chicago residents' beliefs about ecological restoration. They discovered that residents had an overall positive attitude toward ecological restoration in and around the Chicago area. These authors attributed these results to the fact that residents held a positive attitude toward the environment.

Theory and Methods

We used a portion of the theory of reasoned action (TRA) as our underlying framework to identify public attitudes and salient beliefs about ecological restoration treatments. The theory measures people's attitudes, behavioral beliefs, outcome evaluations, normative beliefs, subjective norms, and motivation to comply. We wanted to measure people's attitudes and underlying salient beliefs so we chose not to measure their normative beliefs, subjective norms and motivations to comply. The salient beliefs are comprised of the overall attitude a respondent holds toward wilderness restoration treatments and each attitude is classified as either positive or negative (Fishbein and Ajzen 1975, Manfredo et al. 1990, Bright et al. 1993, Pate et al. 1996). Our ultimate goal was to link attitudes with beliefs and beliefs with outcomes. According to Herberlein (1989), attitude data is very useful to managers in two ways: 1) it provides survey

information about support and public knowledge for a project, and 2) it helps managers establish goals and objectives.

Data Gathering

A mail-back questionnaire contained questions designed to assess residents' attitudes and underlying beliefs toward three types of wilderness restoration treatments. The beliefs were obtained from a preliminary elicitation survey administered by telephone to a sample of 60 urban and rural residents. A similar elicitation survey had been successfully used in other attitude studies (Manfredo et al. 1990, Bright et al. 1993, and Pate et al. 1996). The telephone survey identified the seven to nine most commonly mentioned beliefs regarding each treatment, which was then included in the mail back questionnaire. Other questions on the survey asked about the residents' knowledge and participation in ecological restoration activities, along with selected demographic variables.

The mail-back questionnaire was sent to a random sample of residents living near the Mount Logan Wilderness Area. A list of 1,000 names and addresses was obtained from a professional sampling firm. The names were divided into rural and urban samples, because we speculated that the attitudes and beliefs of these two groups might differ. Mail-back questionnaires were sent to 500 residents of St. George, Utah (urban sample) with another 500 questionnaires sent to residents of two rural communities in Utah (Kanab and Hurricane) and two rural communities in Arizona (Fredonia and Colorado City).

The mail back questionnaire was administered using methods suggested by Dillman (1978) and included an original and three follow-up mailings. An incentive was used during the last mailing to encourage participation. Excluding undeliverable questionnaires, a total of 408 questionnaires were returned for a 55 percent response rate. After the questionnaires were returned, we contacted by phone 27 non-respondents in both the urban and rural samples and asked the reason that they did not return the questionnaire. The four most common reasons were: 1) did not have time, 2) did not know the area, 3) survey was slanted/unfair, and 4) did not want to. The urban and rural responses were compared and no significant differences were found among them.

Measuring Attitudes and Beliefs

To measure resident attitudes toward the three restoration treatments, residents were asked to rank two statements. The first was "*Using (the treatment method) to restore the Mount Logan Wilderness to a more natural condition is extremely good (+3) to extremely bad (-3), or neutral (0).*" The second statement was, "*Using (the treatment method) to restore the Mount Logan Wilderness to a more natural condition is extremely beneficial (+3) to extremely harmful (-3), or neutral (0).*" Respondents answered these two questions using a seven-point scale. The two questions were then used to create an attitude index by adding the responses and calculating an average. To measure resident beliefs, the product of two questions on the same scale as the attitudes, were calculated to form a belief index.

Analysis

SPSS version 8.0 was used for all analysis (SPSS Inc. 1997). In the first phase of the analysis, descriptive statistics were used to determine the residents' overall support for the three treatments and their knowledge of and participation in ecological restoration. In phase two, differences between attitudes and beliefs about ecological treatments between residents of urban and rural communities were examined. Finding no significant differences, we combined the urban and rural samples and each treatment was examined individually. In phase three, each treatment was divided into three groups: those with a positive, negative, or neutral attitude toward the treatment. These three groups were compared for different variables to determine the basis for the attitudes. Finally, we used Chi-square, an analysis of variance, a post hoc test, and Crobach's alpha to determine significant differences, among the three attitude groups for each type of treatment.

Results and Discussion

Attitudes Toward Ecological Wilderness Restoration

Resident attitudes toward three ecological wilderness restoration treatments including a non-mechanical, prescribed fire and mechanical treatment were measured. The non-mechanical treatment was defined as any activity that involved a living power source, for example the use of a handsaw, hand rake, or horses. The prescribed fire treatment was defined as the use of intentionally ignited and controlled fires. The mechanical treatment was defined as any activity where machines are used to cut and/or

transport personnel or material. Examples include the use of chainsaws, motorized equipment, and vehicles with wheels or tracks.

Resident attitudes toward using a non-mechanical and prescribed fire treatment were similar. Attitudes toward a non-mechanical treatment were 54% positive, 32% negative, and 14% neutral. Residents thought that using non-mechanical treatments was slightly good (51%) and slightly beneficial (57%). These two percentages (which are actually two questions) made up the attitude index, which had an internal consistency of 0.87 using Cronbach's alpha.

Resident attitudes toward prescribed fire were 55% positive, 33% negative, and 13% neutral. Residents thought that using prescribed fire was slightly good (50%) and somewhat beneficial (40%). These two questions formed the prescribed fire attitude index that had an internal consistency of 0.93 using Cronbach's alpha.

The results of the prescribed fire treatment attitudes are similar to a study conducted by Manfredo et al. (1990). These researchers compared a regional sample of Wyoming and Montana residents with a national sample of resident attitudes toward prescribed fire policies. Manfredo et al. (1990) who also used the theory of reasoned action examined beliefs and attitudes. Their results found similar salient beliefs toward prescribed fire such as, "fire will burn out of control and destroy scenery but will result in removing dead vegetation".

The strongest resident support for any restoration treatment was for the use of a mechanical treatment to restore the Mount Logan Wilderness. Residents were 74% positive, 15% negative, and 11% neutral. Respondents thought that using a mechanical treatment was quite good (71%) and quite beneficial (74%). The mechanical treatment

attitude index had an internal consistency of 0.90 using Cronbach's alpha. This treatment may have stronger support because residents may have had a direct experience with mechanical methods. Research on attitudes has shown that the more familiar people are with the attitude object (mechanical methods in this case), the more supportive they are toward that object (Bruvold 1973, Chaiken and Stangor 1987, Fazio 1982). In other words, people more familiar with mechanical restoration methods may have more positive attitudes toward that treatment.

Beliefs About Wilderness Ecological Restoration Treatments

A second purpose of this research was to identify the beliefs that underlie residents' attitudes toward three types of ecological restoration treatments. We looked at each treatment separately, dividing residents into one of three attitude groups: positive, negative, or neutral. We then compared these groups on the belief statements identified from the telephone survey, as well as over other selected variables. We will first discuss non-mechanical treatments followed by prescribed fire and mechanical treatments.

Non-Mechanical Treatments

Respondents showed support for non-mechanical treatments, but did not show strong positive or negative attitudes toward this treatment. The attitude index result showed slightly over 50% of the residents with a positive attitude. Residents with positive attitudes agreed that a non-mechanical treatment would result in "good" outcomes, (restore the wilderness naturally, create less damage than a mechanical treatment, create less noise than a mechanical treatment, and create less pollution than a

mechanical treatment, but would be hard work) (Table 1). The neutral group agreed with these outcomes with the exception of (hard work) as they agreed that a non-mechanical treatment would result in a "bad" outcome (would be hard work).

The residents with negative attitudes disliked non-mechanical treatments and felt that their use would result in a "bad" outcome (restoring the wilderness in a natural way); respondents with negative and neutral attitudes agreed it would result in a "bad" outcome (would be hard work). The negative group agreed that a non-mechanical treatment would result in some "good" outcomes when compared to a mechanical treatment (would be less damaging, create less noise, and create less air pollution). All three groups agreed that a non-mechanical treatment would result in "good" outcomes when compared to a mechanical treatment involving noise, damage, and air pollution.

Prescribed Fire Treatments

Residents were not strongly positive or negative in their support for prescribed fire, as the attitude was just over 50% positive. Respondents with positive and neutral attitudes agreed that a prescribed fire treatment results in "good" outcomes (naturally restores the wilderness, encourages tree growth, is healthy for the wilderness, reduces pests and diseases), but disagreed that it would result in "bad" outcomes, (fires burning out of control, creating air pollution, destroying valuable timber resources, and negatively affecting scenic beauty) (Table 2).

Residents with negative attitudes agreed that prescribed fire would result in "good" outcomes (decrease debris on the forest floor and decrease pests and diseases), but also agreed that it would result in some "bad" outcomes (fires burning out of control,

creating air pollution, destroying valuable timber resources, and negatively affecting scenic beauty). The neutral group had a similar agreement in "bad" outcomes except for (fires burning out of control). The neutral group disagreed that fires would (burn out of control) but still thought that a fire burning out of control was a "bad" outcome. The negative group disagreed that prescribed fire would result in some "good" outcomes, (naturally restoring the wilderness, being healthy for the wilderness, and encouraging tree growth). All three groups agreed that prescribed fire results in some "good" outcomes, (decreases debris on the forest floor and decreases pests and diseases).

Mechanical Treatments

The mechanical treatments had the strongest resident support among the three wilderness restoration treatments surveyed. The mechanical treatment positive and negative attitude groups differed significantly while the neutral group generally agreed with the negative group on "bad" outcomes. The respondents with a positive attitude agreed that mechanical treatments result in "good" outcomes, (gets the job done quickly, makes it easy to do the work, is an efficient use of time, makes use of modern technology, and creates new roads) (Table 3). Respondents with neutral attitudes agreed with these "good" outcomes with the exception of (creating new roads), as this group believed that this is a "bad" outcome. The positive attitude group agreed that a mechanical treatment would result in "bad" outcomes, (would be noisy and disturb wildlife), but they disagreed that a mechanical treatment would create "bad" outcomes, (cause negative impacts to the wilderness, and cause air pollution).

The negative attitude group agreed that a mechanical treatment would result in a "good" outcome, (would be an efficient use of time), and agreed since it was the negative group that a mechanical treatment would result in a "bad" outcome, (would make it easier to do the work, get the job done quickly, make use of modern technology, but would be noisy, disturb wildlife, cause negative impacts to the wilderness, cause air pollution, and create new roads). This group did not generally disagree with any beliefs.

The neutral attitude group agreed that a mechanical treatment would result in "bad" outcomes (would be noisy, disturb wildlife, cause negative impacts to the wilderness, cause air pollution, and create new roads). All three attitude groups agreed that a mechanical treatment would result in a "good" outcome (would be an efficient use of time), and agreed it would result in "bad" outcomes (would be noisy and disturb wildlife).

Overall Sample Profile

We found only a few demographic variables that showed a significant relationship with attitudes. The variables we selected to focus on were gender, participation in an ecological restoration project, knowledge of ecological restoration, and familiarity with the study site (Mount Logan Wilderness). Analysis using descriptive statistics was used to describe each of these variables. Although we randomly sampled the communities, the respondents were 72% male. Using a chi-squared test, a significant difference was found between the residents' gender and attitudes toward the three treatments. Males held a more negative attitude toward the use of non-mechanical treatments while females held a more positive attitude. When asked about mechanical treatments, however, males held a

more positive attitude while females held a more negative attitude. The same number of males as females held a positive and neutral attitude toward the prescribed fire treatment.

Eleven percent of the residents had participated in an ecological restoration project. Participation in a restoration project was found significant for attitudes toward a mechanical treatment. While participation in an ecological restoration project was low, knowledge of ecological restoration was high. For the sample, 79% of the respondents had heard of the concept of ecological restoration. The positive group had the most knowledge toward ecological restoration, while the negative and neutral group had the least amount of knowledge. Knowledge of ecological restoration was found to be significant and may have influenced residents' attitudes toward a prescribed fire treatment.

Additionally, 56% of the residents were familiar with the site. Familiarity with the study site was found to be significant and may have influenced the residents' attitudes toward prescribed fire. Sixty-three percent of the respondents had visited the study site at least once. Visiting the site was found to be significant and may have influenced the residents' attitudes toward a non-mechanical and prescribed fire treatment.

Management Implications

According to the theory of reasoned action, residents have beliefs that underlay their attitudes and level of support for ecological wilderness restoration treatments. Education may be the key to changing beliefs that can affect the attitude. Bright et al. (1993) found that by educating respondents on beliefs toward prescribed fire (using facts about prescribed fire getting out of control and destroying natural settings), the

respondents' attitudes toward burning changed. If educating people about certain beliefs can change respondents' attitudes, then our results will help managers target beliefs that can be changed to increase positive attitudes toward ecological restoration treatments in wilderness.

To increase positive attitudes toward a non-mechanical treatment four beliefs could be targeted. Education about beliefs including: restoring the wilderness naturally, creating less damage (impacts), creating less noise and creating less air pollution than a mechanical treatment could affect the respondents' overall positive attitudes toward this treatment.

To increase positive attitudes toward a prescribed fire treatment, educational efforts could focus on two beliefs: the probability that a prescribed fire would burn out of control, and the likelihood that a fire would destroy valuable timber resources. To increase positive attitudes toward a mechanical treatment, educational efforts could focus on two beliefs: air pollution and impacts that a mechanical treatment would create in the wilderness.

Conclusion

Ecological restoration of wilderness is necessary to maintain wilderness integrity. Overly simple remedies for wilderness will not achieve ecological sustainability (Murry 1996). Managers armed with information about public attitudes toward wilderness restoration treatments can propose the most socially acceptable and ecologically sound wilderness treatments. With information about public attitudes, managers can decide if

they want to attempt to change the community's underlying beliefs toward wilderness restoration treatments.

Attitudes differed for the three wilderness restoration treatments. Communities surveyed had the most positive attitude toward mechanical activities, while the attitudes toward non-mechanical and prescribed fire treatments were similar. A lower positive attitude toward non-mechanical and prescribed fire may be due to respondents having less knowledge about these two treatments. They may not have had direct experience with the attitude object, which can produce a lower positive attitude (Bruvold 1973 and Fazio 1982). If respondents had a direct and positive experience with mechanical treatments, this could account for the overall positive attitude.

Our research showed that attitudes toward mechanical treatments are more positive than other treatment methods. A positive experience with a mechanical treatment may have been prevalent among respondents, since historically some of the communities surveyed are resource extraction-based economies. A larger population survey may produce different results.

Future Research

This social research examined many variables within one study. Respondents may have been confused on some questions, because they were asked about three restoration treatments as opposed to one. The topic of restoration in general may also have been unfamiliar to respondents, even though many had heard of the concept of ecological restoration, and respondents may not have known how they truly felt about restoration treatments in wilderness. Therefore, a survey focusing on these issues separately may be useful to compare with our results.

Table 1. Beliefs about the Outcome of Non-Mechanical Methods to Restore Mount Logan Wilderness Area.

	Attitudes			
Response to outcomes	**Positive**	**Negative**	**Neutral**	**Post hoc**
Attitude	4.00	-2.80	0.00	1>3>2*
Naturally restores Wilderness				
Agree-disagree	1.65	-.79	.46	1>3>2*
Good-bad	1.83	-.31	.48	1>3>2*
Less damaging than mechanical treatment				
Agree-disagree	1.71	-.32	.61	1>3>2*
Good-bad	2.16	.68	1.43	1>3>2*
Make less noise than a mechanical treatment				
Agree-disagree	1.95	.54	1.32	1>3>2*
Good-bad	1.60	.14	.73	1>2>3*
Make less pollution than a mechanical treatment				
Agree-disagree	1.89	.27	1.14	1>3>2*
Good-bad	1.83	.34	1.05	1>3>2*
Would be hard work				
Agree-disagree	2.05	2.40	2.13	no s.d.
Good-bad	.49	-1.07	-.39	1>3>2*
Would be expensive				
Agree-disagree	1.23	1.75	1.54	no s.d
Good-bad	-.92	-1.10	-.83	no s.d.
Would be time consuming				
Agree-disagree	1.97	2.40	2.12	no s.d.
Good-bad	-.92	-1.10	-.83	no s.d.

*difference is significant at $p \leq .01$

This table presents the means of attitudes toward the outcome of using non-mechanical methods to restore the Mount Logan Wilderness Area. Respondents were asked if they thought that this treatment was good or bad, and beneficial or harmful. The attitude scale ranges from -9 to + 9. The belief scale ranged from +3 = extremely good and extremely beneficial, +2 = quite good and quite beneficial, +1= slightly good and slightly beneficial, 0 = neutral, -1 = slightly bad and slightly harmful, -2 = quite bad and quite harmful, -3 = extremely bad and extremely harmful.

A positive value indicates a good and beneficial belief while a negative value indicates a bad and harmful belief.

Table 2. Beliefs About the Outcome of Prescribed Fire to the Restore Mount Logan Wilderness Area.

	Attitudes			
Response to beliefs	**Positive**	**Negative**	**Neutral**	**Post hoc**
Attitude	3.67	-4.04	0.00	1>3>2*
Restore Wilderness naturally				
Agree-disagree	1.85	-1.12	.55	1>3>2*
Good-bad	1.55	.89	.88	1>2,3*
Would encourage tree growth				
Agree-disagree	1.95	-.42	.82	1>3>2*
Good-bad	2.34	1.83	2.02	1,3>2,3*
Would be healthy for wilderness				
Agree-disagree	1.96	-.95	.52	1>3>2*
Good-bad	2.38	1.87	1.82	1>3,2*
Would reduce pests and disease				
Agree-disagree	1.99	.06	.80	1>3>2*
Good-bad	2.53	1.76	1.92	1>2,3*
Reduce debris on the forest floor				
Agree-disagree	2.10	.63	1.26	1>3>2*
Good-bad	1.99	1.05	1.32	1>2,3*
Allow prescribed fire to burn out of control				
Agree-disagree	-.62	.98	-.10	2>1,3*
Good-bad	-1.83	-2.59	-1.86	1,3>2*
Would create air pollution				
Agree-disagree	.36	2.00	1.22	2>3>1*
Good-bad	-1.15	-2.06	-1.37	1,3>2*
Destroy valuable timber resources				
Agree-disagree	.13	1.88	1.04	2>3>1*
Good-bad	-1.43	-2.30	-1.48	1,3>2*
Negative affect on scenic beauty				
Agree-disagree	.33	1.81	.98	2>3>1**
Good-bad	-1.28	-2.31	-1.38	3,1>2*

*difference is significant at $p \leq .01$, **difference is significant at $p \leq .05$

This table presents the means of attitudes toward the outcome of using prescribed fire to restore Mount Logan Wilderness Area. Respondents were asked if they thought that this treatment was good or bad, and beneficial or harmful. The attitude scale ranged from -9 to +9. The belief scale ranged from +3 = extremely good and extremely beneficial, +2 = quite good and quite beneficial, +1= slightly good and slightly beneficial, 0 = neutral, -1 = slightly bad and slightly harmful, -2 = quite bad and quite harmful, -3 = extremely bad and extremely harmful. A positive value indicates a good and beneficial belief while a negative value indicates a bad and harmful belief.

Table 3. Beliefs About the Outcome of Mechanical Use to Restore the Mount Logan Wilderness Area.

Attitudes

Response to Outcomes	Positive	Negative	Neutral	Post hoc
Attitude	4.04	-3.77	0.00	1>3>2*
Get job done quickly				
Agree-disagree	2.41	.69	1.41	1>3>2*
Good-bad	2.03	-.34	.53	1>3>2*
Make it easy to do work				
Agree-disagree	2.43	.90	1.83	1>3>2*
Good-bad	2.09	-.21	.87	1>3>2*
Efficient use of time				
Agree-disagree	2.44	.008	1.38	1>3>2*
Good-bad	2.49	1.03	1.15	1>3,2*
Make use of technology				
Agree-disagree	2.39	.48	1.48	1>3>2*
Good-bad	2.26	-.87	.68	1>3>2*
Neg. impacts to Wilderness				
Agree-disagree	-.47	1.92	.33	2>3>1**
Good-bad	-.99	-2.26	-1.38	1,3>2*
Would cause air pollution				
Agree-disagree	-.37	1.46	.005	2>1,3*
Good-bad	-.84	-2.13	-1.25	1,3>2*
Would disturb wildlife				
Agree-disagree	.33	2.0	1.00	2>3>1**
Good-bad	-.78	-2.34	-1.29	1>3>2**
Would create new roads				
Agree-disagree	1.17	1.48	.83	no s.d.
Good-bad	.61	-1.48	-.22	1>3>2*
Would be noisy				
Agree-disagree	1.04	2.02	1.15	2>1,3*
Good-bad	-.38	-.80	-.35	no s.d.

*difference is significant at $p \leq .01$, **difference is significant at $p \leq .05$

This table presents the means of attitudes toward the outcome of using mechanical methods to restore Mount Logan Wilderness Area. Respondents were asked if they thought that this treatment was good or bad, and beneficial or harmful. The attitude scale ranged from -9 to + 9. The belief scale ranged from +3 = extremely good and extremely beneficial, +2 = quite good and quite beneficial, +1= slightly good and slightly beneficial, 0 = neutral, -1 = slightly bad and slightly harmful, -2 = quite bad and quite harmful, -3 = extremely bad and extremely harmful. A positive value indicates a good and beneficial belief while a negative value indicates a bad and harmful belief.

CHAPTER 6: RESULTS OF THE ECOLOGICAL AND SOCIAL DATA

ECOLOGICAL RESTORATION OF THE MOUNT LOGAN WILDERNESS: A SOCIAL AND ECOLOGICAL ANALYSIS

Abstract

Euro-American impacts of grazing, logging, and fire exclusion have created unnaturally dense forest conditions that are not sustainable. Restoration of the Mount Logan Wilderness will require the application of both ecological and social data. Ecological data established a reference condition of 1870, a time previous to Euro-American settlement. This date was established by collecting data on 34 ecosystem-monitoring plots within the Mount Logan Wilderness Area. From information collected on each plot and from fire scar data, the difference in fire regime and tree densities between current forest conditions and presettlement were determined. Present conditions consist of 1,410 trees/hectare (571 trees/acre), while presettlement conditions consisted of 88 trees/hectare (36 trees/acre). This fifteen-fold increase in tree density underscores the need for ecological restoration treatments in Mount Logan Wilderness.

The ecological data was vital to establishing a reference condition prior to conducting a survey to determine the most socially acceptable wilderness restoration methods. The three types of wilderness restoration treatments surveyed included the use of mechanical, non-mechanical, and prescribed fire.

Introduction

Euro-American settlement has disrupted natural processes, and wilderness areas may be less pristine then society envisioned when the Wilderness Act of 1964 was passed. This act states, "wilderness is protected and managed to preserve its natural conditions which have been affected by the forces of nature, with the imprint of man's work substantially unnoticeable" (Wilderness Act of 1964). European settlement substantially altered natural conditions and we argue that restoring wilderness forest structure in the Mount Logan Wilderness Area will require restoration treatments based on a firm foundation of ecological and social research.

Euro-American settlers affected the Mount Logan Wilderness, located within the southwestern ponderosa pine (*Pinus ponderosa)* type, by introducing grazing, logging, and fire exclusion. These impacts have created unnaturally dense forests of ponderosa pines with reduced herbaceous production. These dense forest conditions are not sustainable over time, because these conditions have created an environment conducive to unnatural outbreaks of insects and diseases and, perhaps more importantly, high intensity, often-catastrophic crown fires (Cooper 1960, Covington and Moore 1994a, and Covington et al. 1994). In fact, according to Kolb et al. (1994) today's southwestern ponderosa pine forests do not meet any reasonable definition of a healthy forest.

Prior to Euro-American settlement, southwestern ponderosa pine forests exhibited a more open park-like appearance (Cooper 1960, Covington et al. 1994, Covington and Moore 1994b). Today, this park-like appearance is not evident even in the Mount Logan Wilderness, located in northern Arizona adjacent to Grand Canyon National Park and managed by the Arizona Strip Field Office of the Bureau of Land Management (BLM).

Changes that have occurred since Euro-American settlement challenge managers and scientists to find methods to restore wilderness areas. The purpose of this paper is to address the following three questions:

1. What is the ecological reference condition for Mount Logan Wilderness?
2. What is the present versus presettlement density and fire regime in the Mount Logan Wilderness?
3. What are the most socially acceptable restoration treatment methods to restore Mount Logan Wilderness?

Determining Reference Conditions

The first question, the ecological reference condition for Mount Logan Wilderness, was determined as 1870, the date of Euro-American settlement. To determine the reference conditions, data was collected on thirty-four, 50x20 meter (.1 hectare) plots located on the 310-hectare study area. Data collected between 1995 and 1997 included overstory measurements and fire scar samples. The two soil types evident were basalt Siesta very cobbly loam found on 23 plots and cinder soils of Wukoki Variant--Lomaki Cold Variant complex found on 11 plots (USDI Wilderness Management 1990). Within the basalt soil, 12 plots were heavily thinned in 1974 (USDI Wilderness Management Plan 1990); while 11 basalt plots were unthinned areas (Waltz and Fulé, unpublished report 1998). Results we discuss combine both soil types including thinned and unthinned plots.

The sampling design was based on the National Park Service's Fire Monitoring Protocol (USDI NPS 1992, Reeberg 1995). Overstory data collected on each plot included tree measurements on live trees, stumps, snags, and downed trees. Increment cores were collected from live trees or yellow bark (White 1984) with a diameter > 37.5 dbh (diameter at breast height), and from 10% of postsettlement trees. Additionally, fire scar cross sections were collected from 32 trees. The fire scar analysis for Weibull median probability interval (WMPI) showed that presettlement fires occurred on the average every five years, and that widespread fires stopped after settlement (Waltz and Fulé, unpublished report 1998). This analysis provided an overstory reconstruction and a chronological fire history, as the results depicted intersecting lines of evidence between tree samples and fire scars. This information helped to confirm the date of fire disruption (1870), and this date coincides with the historical accounts of Euro-American settlement of the area (Altschul and Fairley 1989).

Present Versus Presettlement Forest Density

The second question, present versus presettlement forest density for developing ecological restoration treatments, is important because tree density affects many aspects of the wilderness ecosystem. Tree density has increased the potential for catastrophic crown fires and has reduced and changed the herbaceous composition. The results (n=34 plots) for present and presettlement overstory structure were determined from measuring live presettlement trees, stumps, snags, and downed trees. If the tree was a stump, snag or a downed tree then the year of death was estimated using tree growth models (Fulé et al. 1997). The results (Table 1) showed that present forest conditions consist of a high

density of trees with a mean of 1,410 trees/hectare (571 trees/acre). Presettlement structure consisted of 88 tress/hectare (36 trees/acre) for both soil types. The presettlement trees density for Mount Logan Wilderness is similar to other studies conducted in southwestern ponderosa pine (Covington and Moore 1994a, and Covington and Moore 1994b) (Table 2). The fifteen-fold increase in tree density underscores the need for ecological restoration treatments in the Mount Logan Wilderness.

Socially Acceptable Restoration Treatments

To answer question three, what is the most socially acceptable restoration treatment method to restore the wilderness, a survey of local residents was conducted. The Bureau of Land Management defined local communities as any community that has been involved with land use planning and within close proximity to the wilderness area. Communities surveyed were located in both Utah and Arizona. In Utah the communities included St. George, Kanab, and Hurricane, while in Arizona the communities included Fredonia and Colorado City. The criteria selected by BLM for including a community included close proximity to the wilderness, and community involvement in land use planning. According to the Arizona Strip Field manager, knowledge of public attitudes towards Mount Logan Wilderness restoration treatments is vital information prior to conducting restoration treatments (Taylor 1996).

To determine socially acceptable restoration treatment methods, our research focused on identifying local residents' attitudes and beliefs about wilderness restoration specifically three treatments mechanical, non-mechanical, and prescribed fire. These methods raise different concerns and beliefs about treatment impacts. Other studies have

focused on the public's knowledge, perception, and attitudes toward the use of fire in wilderness (Stankey 1976, Bass et al. 1983, Cortner et al. 1984, Taylor and Mutch 1986, Taylor et al. 1986, Manfredo et al. 1990, Bright et al. 1993, and Parsons and Landres 1998); however, this literature did not focus on wilderness restoration treatment attitudes and underlying beliefs towards mechanical and non-mechanical methods.

Research methods included a preliminary elicitation telephone survey followed by a mail-back questionnaire conducted in the spring and summer of 1998. The preliminary elicitation survey determined resident beliefs, which according to the theory of reasoned action, form the basis of attitudes (Ajzen and Fishbein 1980). The elicitation survey determined the underlying beliefs by asking residents what they felt were the advantages and disadvantages of each of the treatments. Then the most common seven to nine beliefs were used to design the mail-back questionnaire.

The mail back questionnaire was initially mailed to 1,000 local residents. Of the 738 deliverable questionnaires, a total of 408 questionnaires were returned for an overall response rate of 55 percent. Survey methods similar to Dillman's (1978) were followed which included an initial mailing, a postcard reminder, two follow-up mailings, and a certified mailing. During the certified mailing, an incentive was added to increase the response rate. Because some respondents mailed in duplicate questionnaires, we inferred that the incentive was effective. These mail-back questionnaires provided information useful for determining which treatments were the most socially acceptable.

Beliefs and Attitudes About Restoration Treatments

To determine residents' overall attitude toward each treatment, two questions were asked using a seven-point scale. These ranged from extremely good (+3) to extremely bad (-3) and extremely beneficial (+3) to extremely harmful (-3). Responses to these questions were combined to form an attitude index (Table 3). For each treatment residents with positive, negative and neutral attitudes were compared using an analysis of variance (ANOVA). Post hoc statistical tests were used to determine whether differences were significant (Table 4).

Of the three restoration treatments we examined, local residents showed the strongest support for mechanical treatment. The mechanical treatment index results showed that 74% of the respondents had a positive attitude, whereas 15% were negative and 11% were neutral. The mechanical treatment index showed an internal consistency with Cronbach's alpha equal to 0.90.

Residents' positive attitudes toward mechanical treatments could be attributed to respondents having direct experiences with mechanical treatments (Fazio 1982), as historically the communities were based on extraction-based economies. A larger population survey may produce different results. The underlying negative beliefs that residents hold for mechanical treatments include negatively impact the wilderness, create new roads, disturb wildlife, and cause pollution (Table 4).

Beliefs that residents held toward a non-mechanical method include the use of expensive techniques and hard work (Table 5). Local residents' attitudes towards non-mechanical treatments included 54% positive, 32% negative, and 14% neutral. This showed an internal consistency with Crobach's alpha equal to 0.87. Both the non-

mechanical and prescribed fire treatments elicited slightly over 50% positive responses. We concluded that residents are generally supportive of these two treatment methods.

Negative beliefs residents held toward using prescribed fire include allowing a fire to burn out of control, destroying valuable timber resources, negatively impacting scenic beauty, and harming wildlife (Table 6). The attitude index results for prescribed fire were 55% positive, 33% negative, and 13% neutral, with an internal consistency with Cronbach's alpha equal to 0.93.

Management Implications

The Mount Logan Wilderness area is far from the forest conditions that Euro-American settlers would have seen. Fire regime disruption which occurred in 1870, the time of Euro-American settlement, have created forest structure changes of increased tree densities creating conditions suitable for catastrophic fires. These structural changes have created an unhealthy forest that is not sustainable over time, therefore, restoration of Mount Logan Wilderness is necessary before forest conditions worsen. Both ecological and social data is necessary to implement ecological wilderness restoration.

If managers want to increase positive support for wilderness restoration treatments, underlying beliefs need to be targeted through the use of education. With non-mechanical and prescribed fire treatments, beliefs may be easier to change than those toward a mechanical treatment. Mechanical treatment beliefs are already quite positive but an increase in positive support is possible.

Bright et al. (1993) found that educating respondents on beliefs toward prescribed fire changed their attitude. If this is true for the communities we surveyed, then our

results can help managers target beliefs that can increase positive attitudes towards ecological restoration treatments in wilderness.

To increase positive attitudes for non-mechanical treatments, four underlying beliefs could be targeted, including restoring the wilderness naturally, creating less damage (impacts), creating less noise, and creating less air pollution than a mechanical treatment. To increase positive attitudes towards prescribed fire treatments, two underlying beliefs could be targeted: the likelihood that a prescribed fire will burn out of control and the likelihood that a fire would destroy valuable timber resources.

Conclusion

Unhealthy forest conditions result from anthropogenic disturbances that inhibit natural wilderness processes. Euro-American impacts and subsequent forest changes in wilderness have created conditions inconsistent with wilderness goals. These conditions are unsustainable and conducive to unnaturally intense and often catastrophic forest fires. Such catastrophic fires would not only destroy wilderness values, but also cause the loss of vital information that is necessary to establish ecological reference conditions essential for wilderness management.

Our results can help managers bridge the gap between a strictly ecological proposal for restoration of the Mount Logan Wilderness to one that is socially acceptable among local residents. According to Cole (1996) managers need to decide if wilderness should be left unmanipulated or be restored to more natural conditions. To restore wilderness a combination of ecological principles (to determine an ecological reference

condition) and accompanying social research (to determine the social preferences towards restoration treatments) will help ensure the success of wilderness restoration.

Table 1. Changes in Wilderness Tree Density Representing Present and Presettlement (1870) Trees/hectare (n=34)

Species	1870	1997
Ponderosa pine	58.8	1,283.8
Gambel oak	22.4	94.7
Utah juniper	6.2	12.7
Pinyon pine	.29	7.44
New Mexican locust	0.0	11.35
Total	87.6	1,409.99

This table includes two soil types of basalt and cinder along with unthinned and thinned plots. Dramatic increases since 1870 are found among all each tree species.

Table 2. Changes in Tree Density Since Euro-American Settlement for Various Studies in Southwestern Ponderosa Pine Forests.

Study Area	(n)	Presettlement Trees/hectare	(n)	Year	Trees/hectare
North Kaibab[a] (limestone)	36	138.1	30	1994	1,686.4
Bar-M-Canyon[a] (volcanic)	70	56.3	8	1994	2,101.9
Gus Pearson[b] (basalt and volcanic)	15	56.3	15	1992	3,097.00
Mt. Logan Wilderness (cinder and basalt thinnned and unthinned)	34	87.59	34	1997	1,409.99

[a] Covington and Moore 1994b.
[b] Covington et al. 1997.
The year indicates the reconstruction year.

Table 3. Attitudes Towards a Mechanical Treatment.

Attitude toward treatment	Positive	Negative	Neutral
Mechanical			
Attitude Index	74%	15%	11%
Good/bad	53%	17%	13%
Beneficial/harmful	74%	17%	9%
Non-Mechanical			
Attitude Index	54%	32%	14%
Good/bad	51%	35%	14%
Beneficial/harmful	43%	14%	29%
Prescribed fire			
Attitude Index	54%	33%	13%
Good/bad	51%	34%	15%
Beneficial/harmful	57%	29%	14%

The mechanical treatment had the most positive attitude of all three treatments.

Table 4. Beliefs About the Outcome of Mechanical Use to Restore the Mount Logan Wilderness Area.

	Attitudes			
Response to outcomes	**Positive**	**Negative**	**Neutral**	**Post hoc**
Get job done quickly				
Agree-disagree	2.41	.69	1.41	1>3>2*
Good-bad	2.03	-.34	.53	1>3>2*
Make it easy to do work				
Agree-disagree	2.43	.90	1.83	1>3>2*
Good-bad	2.09	-.21	.87	1>3>2*
Efficient use of time				
Agree-disagree	2.44	.008	1.38	1>3>2*
Good-bad	2.49	1.03	1.15	1>3,2*
Make use of technology				
Agree-disagree	2.39	.48	1.48	1>3>2*
Good-bad	2.26	-.87	.68	1>3>2*
Neg. impacts to Wilderness				
Agree-disagree	-.47	1.92	.33	2>3>1**
Good-bad	-.99	-2.26	-1.38	1,3>2*
Would cause air pollution				
Agree-disagree	-.37	1.46	.005	2>1,3*
Good-bad	-.84	-2.13	-1.25	1,3>2*
Would disturb wildlife				
Agree-disagree	.33	2.0	1.00	2>3>1**
Good-bad	-.78	-2.34	-1.29	1>3>2**
Would create new roads				
Agree-disagree	1.17	1.48	.83	no s.d.
Good-bad	.61	-1.48	-.22	1>3>2*
Would be noisy				
Agree-disagree	1.04	2.02	1.15	2>1,3*
Good-bad	-.38	-.80	-.35	no s.d.

*difference is significant at $p \leq .01$, **difference is significant at $p \leq .05$

This table presents the means of attitudes toward the outcome of using mechanical methods to restore Mount Logan Wilderness Area. Respondents were asked if they thought that this treatment was good or bad, and beneficial or harmful. The attitude ranged from -9 to +9. The belief scale ranged from +3 = extremely good and extremely beneficial, +2 = quite good and quite beneficial, +1= slightly good and slightly beneficial, 0 = neutral, -3 = extremely bad and extremely harmful, -2 = quite bad and quite harmful, -1 = slightly bad and slightly harmful. A positive value indicates a good and beneficial belief while a negative value indicates a bad and harmful belief.

Table 5. Beliefs about the Outcome of Non-Mechanical Methods to Restore Mount Logan Wilderness Area.

	Attitudes			
Response to outcomes	Positive	Negative	Neutral	Post hoc
Naturally restores Wilderness				
Agree-disagree	1.65	-.79	.46	1>3>2*
Good-bad	1.83	-.31	.48	1>3>2*
Less damaging than mechanical treatment				
Agree-disagree	1.71	-.32	.61	1>3>2*
Good-bad	2.16	.68	1.43	1>3>2*
Make less noise than a mechanical treatment				
Agree-disagree	1.95	.54	1.32	1>3>2*
Good-bad	1.60	.14	.73	1>2>3*
Make less pollution than a mechanical treatment				
Agree-disagree	1.89	.27	1.14	1>3>2*
Good-bad	1.83	.34	1.05	1>3>2*
Would be hard work				
Agree-disagree	2.05	2.40	2.13	no s.d.
Good-bad	.49	-1.07	-.39	1>3>2*
Would be expensive				
Agree-disagree	1.23	1.75	1.54	no s.d
Good-bad	-.92	-1.10	-.83	no s.d.
Would be time consuming				
Agree-disagree	1.97	2.40	2.12	no s.d.
Good-bad	-.92	-1.10	-.83	no s.d.

*difference is significant at $p \leq .01$

This table presents the means of attitudes toward the outcome of using non-mechanical methods to restore the Mount Logan Wilderness Area. Respondents were asked if they thought that this treatment was good or bad, and beneficial or harmful. The attitude scale ranged from -9 to +9. The belief scale ranged from +3 = extremely good and extremely beneficial, +2 = quite good and quite beneficial, +1= slightly good and slightly beneficial, 0 = neutral, -3 = extremely bad and extremely harmful, -2 = quite bad and quite harmful, -1 = slightly bad and slightly harmful.

A positive value indicates a good and beneficial belief while a negative value indicates a bad and harmful belief.

Table 6. Beliefs About the Outcome of Prescribed Fire to the Restore Mount Logan Wilderness Area.

	Attitudes			
Response to beliefs	**Positive**	**Negative**	**Neutral**	**Post hoc**
Restore Wilderness naturally				
Agree-disagree	1.85	-1.12	.55	1>3>2*
Good-bad	1.55	.89	.88	1>2,3*
Would encourage tree growth				
Agree-disagree	1.95	-.42	.82	1>3>2*
Good-bad	2.34	1.83	2.02	1,3>2,3*
Would be healthy for wilderness				
Agree-disagree	1.96	-.95	.52	1>3>2*
Good-bad	2.38	1.87	1.82	1>3,2*
Would reduce pests and disease				
Agree-disagree	1.99	.06	.80	1>3>2*
Good-bad	2.53	1.76	1.92	1>2,3*
Reduce debris on the forest floor				
Agree-disagree	2.10	.63	1.26	1>3>2*
Good-bad	1.99	1.05	1.32	1>2,3*
Allow prescribed fire to burn out of control				
Agree-disagree	-.62	.98	-.10	2>1,3*
Good-bad	-1.83	-2.59	-1.86	1,3>2*
Would create air pollution				
Agree-disagree	.36	2.00	1.22	2>3>1*
Good-bad	-1.15	-2.06	-1.37	1,3>2*
Destroy valuable timber resources				
Agree-disagree	.13	1.88	1.04	2>3>1*
Good-bad	-1.43	-2.30	-1.48	1,3>2*
Negative affect on scenic beauty				
Agree-disagree	.33	1.81	.98	2>3>1**
Good-bad	-1.28	-2.31	-1.38	3,1>2*

*difference is significant at $p \leq .01$, **difference is significant at $p \leq .05$

This table presents the means of attitudes toward the outcome of using prescribed fire to restore Mount Logan Wilderness Area. Respondents were asked if they thought that this treatment was good or bad, and beneficial or harmful. The attitude scale ranged from -9 to +9. The belief scale ranged from +3 = extremely good and extremely beneficial, +2 = quite good and quite beneficial, +1= slightly good and slightly beneficial, 0 = neutral, -3 = extremely bad and extremely harmful, -2 = quite bad and quite harmful, -1 = slightly bad and slightly harmful. A positive value indicates a good and beneficial belief while a negative value indicates a bad and harmful belief.

CHAPTER 7: CONCLUSION AND MANAGEMENT IMPLICATIONS

The purpose of this thesis research was twofold. The ecological objective was to determine the reference condition and forest changes that occurred in the Mount Logan Wilderness since Euro-American settlement. The social objective was to determine local residents' attitudes and underlying beliefs about three types of wilderness restoration treatments. The results of both the ecological and the social data will help guide managers in restoring the Mount Logan Wilderness.

Forest conditions in Mount Logan Wilderness are declining and will continue to degrade until ecological restoration treatments are initiated. Conditions are now suitable for large catastrophic fires, and such fires would prove seriously detrimental to the ultimate goal of restoring the wilderness to a pre Euro-American reference condition. My ecological research determined the reference condition for the Mount Logan Wilderness to be the time of Euro-American settlement (1870). Restoration to this reference condition should be performed as soon as possible, before the forest structure changes so drastically that the ecosystem can no longer properly function and wilderness integrity is lost.

My social research determined attitudes and underlying beliefs that residents hold toward three restoration treatments: mechanical, non-mechanical, and prescribed fire. The questionnaire clearly shows that a mechanical method is the most preferred of the three treatments: 75% of the residents supported mechanical, 54% supported non-mechanical,

and 55% supported prescribed fire. Managers can use the results to help target less-positive beliefs through the use of education.

Our recommendation to the Bureau of Land Management is that all three treatments be used in restoring the Mount Logan Wilderness Area. A mechanical treatment alone will not restore the forest structure without the concurrent use of the other methods, since mechanical treatments thin doghair thickets, non-mechanical equipment reduces forest fuels around old-growth trees, and prescribed fire restores the forest by reintroducing a historical fire regime.

Euro-American impacts and subsequent forest changes in Mount Logan Wilderness have created conditions inconsistent with wilderness goals. By using the best possible science in combination with ecological and attitudinal research, managers can determine how to approach the restoration of wilderness areas to re-establish and preserve the delicate balance of wilderness integrity.

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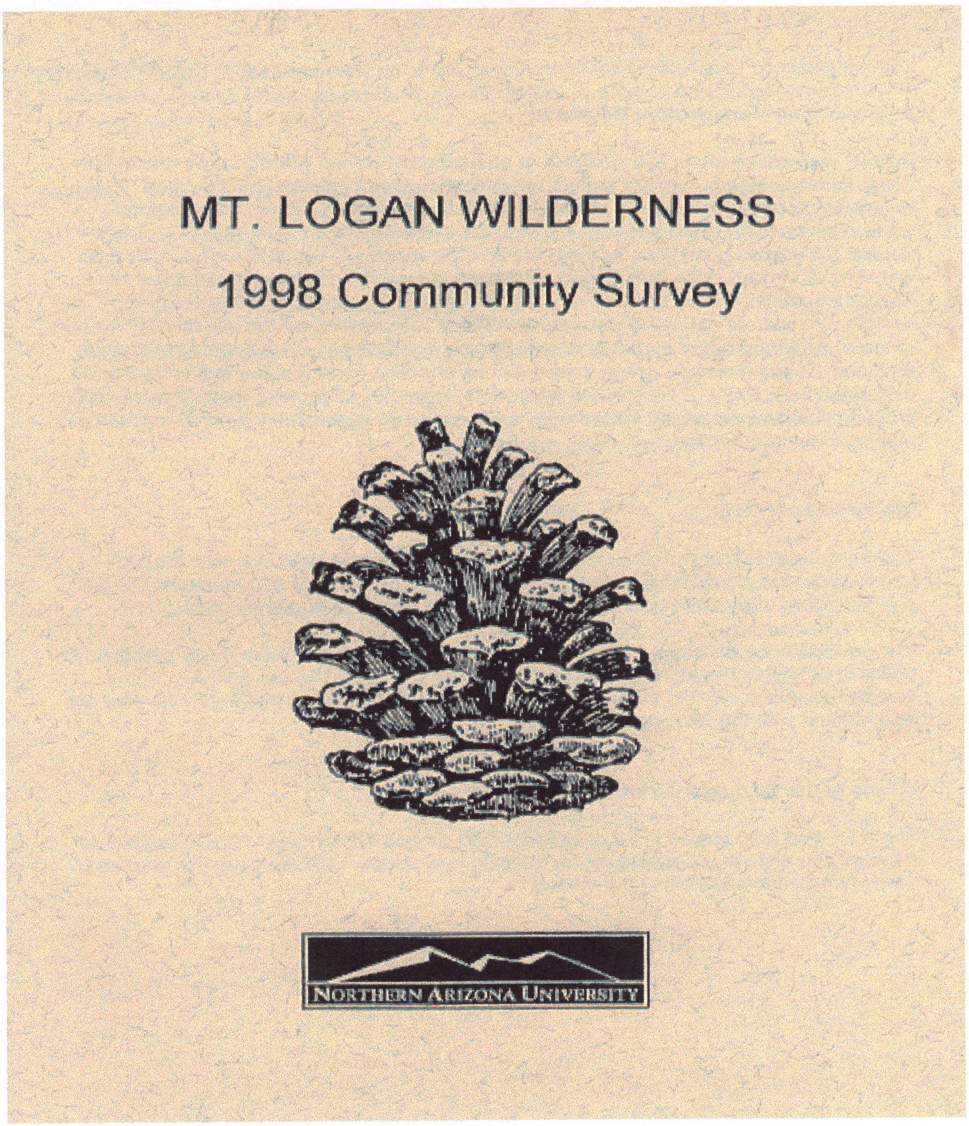
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APPENDIX A

MT. LOGAN WILDERNESS QUESTIONAIRE

The following pages depict the actual pages of the questionnaire sent to local residents.





A Wilderness Management Dilemma:

By law, wilderness areas are intended to be unspoiled places where nature rules and where humans visit but do not live and where evidence of modern, mechanized civilization is generally absent. However, this can present a problem when natural wilderness conditions have been hindered or impaired by human activities. We define natural wilderness conditions as what the first European settlers to the Mt. Logan area would have viewed upon their arrival. Because the wilderness has been altered since European settlement, particularly as a result of fire suppression, projects are being designed to restore natural wilderness conditions. Depending on the situation, a variety of tools, equipment, and methods may be legally considered for wilderness restoration projects. These tools can range from the most primitive hand tool to mechanized and motorized equipment. This creates a dilemma: How can wilderness managers design projects that restore natural wilderness conditions while at the same time try to reduce or minimize human impacts.

We Need Your Help:

The purpose of this survey is to find out how people like you, who live near the Mt. Logan Wilderness and Mt. Trumbull feel about some of the tools that managers could use to restore wilderness conditions while trying to minimize human impacts.

We would like you to answer the following questions even if you have never personally heard of or visited the Mt. Logan Wilderness. It is important that we gain a comprehensive opinion of all the residents who live in the area, including those who are less familiar with the Mt. Logan Wilderness.

Where is the Mt. Logan Wilderness?

The enclosed map shows the location of the Mt. Logan Wilderness. Keep this area in mind as you answer the questions on the following pages. Please keep the map as a thank-you for participating in the survey.

Q3. Using mechanical activities to restore the Mt. Logan Wilderness to a more natural condition would:

⇒ **get the job done quickly.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

⇒ **make it easy to do the work.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

⇒ **be an efficient use of time.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

⇒ **make use of modern technology.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

⇒ **be noisy.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

⇒ **cause negative impacts to the Wilderness.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

⇒ **cause air pollution.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

Q3. Con't. Using mechanical activities to restore the Mt. Logan Wilderness to a more natural condition would:

⇒ **disturb wildlife.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

⇒ **create new roads.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

Q4. Getting the Mt. Logan Wilderness restoration job done quickly is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Q5. Making the Mt. Logan Wilderness restoration job easy is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Q6. Doing the Mt. Logan Wilderness restoration job efficiently is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Q7. Using modern technology to restore the Mt. Logan Wilderness is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Q8. Creating noise in the Mt. Logan Wilderness is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Q9. Causing negative impacts to the Mt. Logan Wilderness is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Q10. Causing air pollution in the Mt. Logan Wilderness is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Q11. Disturbing wildlife in the Mt. Logan Wilderness is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Q12. Creating roads in the Mt. Logan Wilderness is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Non-Mechanical Activities

Next we would like to ask you about a second potential type of restoration activity in the Mt. Logan Wilderness. Non-mechanical activities are defined as any activity that involves a living power source such as a horse or a human. Examples of these activities include using handsaws, hand rakes, or horses.

Q13. Using non-mechanical activities to restore the Mt. Logan Wilderness to a more natural condition is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

BENEFICIAL _____:_____:_____:_____:_____:_____:_____ HARMFUL
extremely quite slightly neither slightly quite extremely

Q14. Using non-mechanical activities to restore the Mt. Logan Wilderness to a more natural condition would:

⇒ **be a natural way to restore the Wilderness.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

Q14. Con't. Using non-mechanical activities to restore the Mt. Logan Wilderness to a more natural condition would:

⇒ **be less damaging to the environment than would mechanical activities.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

⇒ **make less noise than mechanical activities.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

⇒ **result in less pollution than mechanical activities.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

⇒ **be expensive.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

⇒ **be time consuming.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

⇒ **be hard work.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

⇒ **result in negative impacts caused by using horses.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

Q15. Restoring the Mt. Logan Wilderness naturally is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Q16. Causing less damage in the Mt. Logan Wilderness is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Q17. Making less noise in the Mt. Logan Wilderness is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Q18. Not polluting the air in the Mt. Logan Wilderness is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Q19. Using expensive activities to restore the Mt. Logan Wilderness is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Q20: Using time consuming activities to restore the Mt. Logan Wilderness is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Q21. Using activities that require hard work to restore the Mt. Logan Wilderness is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Q22. The negative impacts that may result from using horses in the Mt. Logan Wilderness are:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

A

Prescribed Fire

The third and final potential restoration activity is prescribed burning or controlled fire. Prescribed fire is defined as the use of intentionally ignited and controlled fires.

Q23. Using prescribed fire to restore the Mt. Logan Wilderness to a more natural condition is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

BENEFICIAL _____:_____:_____:_____:_____:_____:_____ HARMFUL
extremely quite slightly neither slightly quite extremely

Q24. Using prescribed fire to restore the Mt. Logan Wilderness to a more natural condition would:

⇒ **restore the Wilderness in a natural way.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

⇒ **encourage tree growth.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

⇒ **be healthy for the Wilderness.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

⇒ **reduce the occurrence of pests and disease.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

⇒ **reduce debris on the forest floor.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

Q24. Con't. Using prescribed fire to restore the Mt. Logan Wilderness to a more natural condition would:

⇒ **allow a prescribed fire to burn out of control.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

⇒ **harm wildlife.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

⇒ **create air pollution.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

⇒ **destroy valuable timber resources.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

⇒ **have a negative impact on scenic beauty.**

AGREE _____:_____:_____:_____:_____:_____:_____ DISAGREE
extremely quite slightly neither slightly quite extremely

Q25. Restoring the Mt. Logan Wilderness in a natural way is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Q26. Encouraging tree growth in the Mt. Logan Wilderness is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Q27. Creating a healthier Mt. Logan Wilderness environment is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Q28. Reducing the occurrence of pests and disease in the Mt. Logan Wilderness is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Q29. Reducing debris on the forest floor in the Mt. Logan Wilderness is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Q30. Allowing a prescribed fire to get out of control in the Mt. Logan Wilderness is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Q31. Creating air pollution in the Mt. Logan Wilderness is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Q32. Destroying valuable timber resources in the Mt. Logan Wilderness is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Q33. Negatively impacting scenic beauty in the Mt. Logan Wilderness is:

GOOD _____:_____:_____:_____:_____:_____:_____ BAD
extremely quite slightly neither slightly quite extremely

Section III. General Information

These last questions will help us know more about those who participated in our survey.

Q34. In what community do you currently live? _____

Q35. How many years have you lived in that community? _____ years

Q36. What is your present situation? (check all that apply)

____ employed
____ unemployed
____ homemaker
____ retired
____ student
____ other (please explain) _____

Q37. Are you a member of any of the groups listed below? (check all that apply)

____ an Arizona off highway vehicle group
____ a Utah off highway vehicle group
____ a resource advisory committee
____ an environmental group → Which one(s) _____
____ other (please explain) _____

Q38. What is your highest level of education? (check one)

____ eighth grade or less
____ some high school
____ graduated high school or completed a GED
____ some college
____ graduated college
____ some graduate school
____ completed graduate school

Q39. In what year were you born? 19 _____

Q40. What is your gender? (check one) male _____ female _____

Q41. Have you ever heard of the concept "ecological restoration?" (check one)

____ no
____ yes → (If yes) How would you rate your understanding of the concept? (check one)

____ I have heard of it but I don't really know what it means
____ I have a vague understanding of what it means
____ I am fairly knowledgeable about the concept
____ I am very knowledgeable about the concept

Q42. How would you prefer to receive information on ecological restoration in the Mt. Logan Wilderness? (check all that apply)

____ a brochure
____ a flier
____ a video tape
____ from a web site
____ an on site tour
____ a public meeting
____ other (please explain) _____

____ I would prefer not to receive information on ecological restoration in the Mt. Logan Wilderness.

Q43. Have you ever participated in an ecological restoration project? (check one)

____ no
____ yes → (If yes) When and where did you participate?_____

_____

Q44. Would you like to learn more about how you could participate in a future ecological restoration project? (check one)

____ no
____ yes → (If yes) We will send you information on how you could get involved.

Is there anything else you would like to tell managers about Mt. Logan Wilderness restoration? (explain below)

Thank you for your time. Please return the questionnaire in the postage-paid envelope provided.