



SOUTHWEST FIRE INITIATIVE FINAL REPORT DECEMBER 31, 2005

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EXECUTIVE SUMMARY

The Ecological Restoration Institute at Northern Arizona University used the Fiscal Year 2001 funds to design, implement and test scientifically credible ecological restoration treatments designed to reduce hazardous fuels while simultaneously restoring the ecological and economic integrity of frequent fire landscapes. The approach we used integrated the best research-based evidence with the practical experience of natural resource management professionals and the values of stakeholders. These treatments are the first replicated ponderosa pine restoration treatments at a landscape scale.

There is reason for optimism. Since 2000, unprecedented public and private attention has been focused on solving wildfire and forest health problems.

Restoration of fire-adapted landscapes is supported through new policies, additional funding, and solid public support. Those engaged in forest restoration are applying lessons learned from previous management and have an expanding base of new, rigorous knowledge from which to act. In addition, restoration benefits from active collaboration through public and private partnerships. The groundwork has been laid to proceed with dispatch to restore forested landscapes and avoid future unnatural forest catastrophes.

This Executive Summary, in combination with the materials included in notebooks 1-4, are the final report for the \$8.8 million provided to the Ecological Restoration Institute (ERI) at Northern Arizona University (NAU) and its partners in 2001. The authorization was provided in the Department of Interior and Related Agencies Conference Report 106-914. In report language Congress established four main goals for the ERI:

1. research, develop, monitor and apply practical, scientifically valid restoration-based fuels reduction treatments;
2. develop an approach to evaluate restoration-based fuels reduction treatments on a landscape or operational scale;
3. develop options and markets for the utilization of small diameter wood and other by-products; and,
4. transfer information to land managers, communities and stakeholders who ultimately determine the treatments and rate of progress for fire risk reduction.

The activities performed by the ERI in cooperation with many partners met the expectations established by Congress while simultaneously contributing to progress in later policy directives, including the 10-Year Comprehensive Strategy developed by the Western Governors' Association, the National Fire Plan, the Healthy Forest Restoration Act, and the Southwest Forest Health and Wildfire Prevention Act. The knowledge created through this effort was transferred to land managers and stakeholders through 27 field trips, 82 presentations and 81 publications designed for nonacademic audiences. The scientific evidence supporting our work was published in a total of 36 peer-reviewed publications.

The Ecological Restoration Institute is not only grateful for this funding but also appreciates the unique, on-going partnership we share with the Bureau of Land Management, Arizona Strip District at the Grand Canyon-Parashant National Monument. This partnership, begun in 1995, anticipated calls for understanding restoration treatments at the landscape scale and enabled the largest landscape-scale restoration experiment to be implemented in the Southwest. This unparalleled project produced new knowledge of restoration challenges and outcomes. We look forward to continuing this relationship as we work together in the ongoing monitoring and evaluation of treatment effects, while expanding our scope to discover new ways to restore pinyon-juniper ecosystems and related grasslands.

This funding prompted many new discoveries and action on the ground. These discoveries span a wide spectrum of disciplines from bio-physical to social science. Restoration requires the integration of many forms of knowledge in a practical hands-on approach. The diversity of information in this report reflects that fact. Such an interdisciplinary approach has resulted in a broad range of advances, including, for example: the link between treatment design and fire behavior, the economic benefits of treatments and wildfire avoidance, ecosystem health changes resulting from removal of hazardous fuels, the relationship between wildlife and restoration, and especially the expanded public acceptance of, and support for, restoration treatments.

PROJECT HIGHLIGHTS

The following section highlights some of the key findings that respond to the request by Congress in the FY 2001 report language (see page 12).

Item One directed the ERI to ***“research, develop, monitor, and conduct fuels treatments in partnership with all Federal, Tribal, State, and private landowners to demonstrate the feasibility of restoration-based fuels treatments on a community level.”*** The ERI in collaboration with partners such as the Arizona Game and Fish Department, have created a body of knowledge that analyzes important facets of restoration treatment design and provides the scientific information needed for restoration of forests at the landscape scale. The 2001 funding enabled fuel reduction treatments to be implemented by the Coconino National Forest, Arizona State Lands Department and rural workforce development in Coconino County.

Important discoveries from this work include:

Wildlife

A common concern among wildlife biologists is that forest thinning associated with restoration activities may negatively impact wildlife, wildlife habitat and native biodiversity. The wildlife monitoring conducted with these funds at the largest restoration experiment in the Southwest (Grand Canyon-Parashant National Monument), demonstrates that short-term responses to restoration are positive for the majority of the studied species. This work covers 9 field seasons, an extended period compared to most wildlife research. These results have helped reduce concern about negative impacts of restoration and have in fact mobilized many in the wildlife community to advocate for comprehensive forest restoration—particularly when the alternative is the risk of catastrophic fire. There are many important findings from this work that contribute to a critically important knowledge base that can inform treatment design and improve social acceptance.

Mule Deer (*Odocoileus hemionus*) benefit from restoration treatments

To improve understanding of mule deer landscape habitat selection and home ranges in restoration treated forests, thirteen female mule deer were outfitted with GPS collars to monitor movements. One collared deer died in winter 2005, but this collar was retrieved. Of the remaining twelve collars, eight were retrieved in September and October. **Preliminary results suggest that mule deer are spending almost all of their time in treated habitats at night, but are splitting their time equally between treated and untreated habitats during the day, perhaps because of improved forage quality and abundance in restored sites.**

Tassel-eared squirrel (*Sciurus aberti*) populations decline, as would be expected

Surveys for tassel-eared squirrel feeding sign on 10 plots in treated ($n = 5$) and untreated ($n = 5$) forests. Feeding sign surveys provided an estimate of population density. The data revealed higher densities of squirrels on untreated than on treated plots. When compared with pre-treatment data collected in 1997 – 1999, the data show that squirrel densities across the study area have declined overall, but they have declined more steeply in treated areas. **A preference for untreated sites, where trees are more abundant is consistent with squirrel habitat preferences.** A significant drought during the study period is the likely explanation for the overall population decline.

Northern Goshawks (*Accipiter gentilis*) breeding pairs nested in both treated and untreated areas

Two breeding pairs of northern goshawks were observed in 2005. One pair nested on a plot thinned in 2004. The other nested in the control plot. Both pairs successfully fledged two young.

Butterflies increased on treated areas—but not for the reasons one might expect

Few ecosystem restoration studies evaluate whether arthropods are important components of ecosystem recovery. We tested the hypothesis that ponderosa pine restoration treatments would increase adult butterfly species diversity (richness) and abundance as a direct result of increased understory diversity and abundance. To examine mechanisms that potentially affect adult butterfly distribution, we quantified host plant frequency, nectar plant abundance, and insolation (light intensity) in restoration treatment and control forests. This study comprised the first invertebrate monitoring in ponderosa pine forest restoration treatments in the U.S. Southwest. Three patterns emerged: (1) butterfly species richness and abundance were 2 and 3 times greater, respectively, in restoration treatment units than in paired control forests 1 year after treatment, and 1.5 and 3.5 times greater, respectively, 2 years after treatment. Ordination of control and treatment sampling units using butterfly assemblages showed significant separation of control and restoration treatment units after restoration treatment; (2) host plant and nectar plant species richness showed little difference between treated and control forests even 2 years after treatment; and (3) insolation (light intensity) was significantly greater in treated forests after restoration. **We suggest that changes in the butterfly assemblage may occur due to light intensity effects before plant community changes occur or can be detected. Butterfly assemblage differences will have additional cascading effects on the ecosystem as prey for higher trophic levels and through plant interactions including herbivory and pollination.**

Fire Behavior and Treatments: It matters what you do

Minimal Intervention Does Not Work

Restoration treatments were tested on the South Rim (ponderosa pine) and North Rim (mixed conifer) of Grand Canyon National Park, in never-harvested forests where the historical frequent surface regime was interrupted in the late 19th century. Treatments were designed for “minimal impact” by limiting the size of trees to be thinned and minimizing mechanical equipment. Treatments included (1) thinning of very small trees (diameter \leq 12.7 cm, or five inches) and prescribed fire, (2) thinning of small trees located close to large, old trees and prescribed fire, (3) prescribed fire only, and (4) control. The treatments removed or killed many small trees but led to relatively minor basal area reduction. **The effects of thinning only very small trees plus burning were nearly indistinguishable from burning alone. All the treated units were left with modest gain in resistance to severe wildfires, but in conditions still far removed from pre-fire-exclusion conditions.**

Meaningful Reductions in Fire Behavior Requires Substantial Thinning

Three treatments designed to initiate the process of restoring the surface fire and open forest structure of a southwestern ponderosa pine/Gambel oak forest were compared on the Kaibab National Forest along the Grand Canyon’s South Rim. The potential for intense fire behavior under dry, windy conditions was reduced in all three treatments, but the full restoration treatment was much less susceptible to crownfire. Crownfire susceptibility of the burn only treatment was only slightly reduced, while the minimal thin treatment was intermediate.

Ecosystem Health and Prescription Design

Determining Pre-settlement Conditions and Developing Techniques for Implementing Prescriptions

Long-term permanent plots are essential to detect and quantify vegetation changes over long time periods and to provide a context for interpreting plant community changes, especially for evaluating various factors such as fire exclusion, shading, overgrazing, etc. From 2001-2004 the oldest known permanent plots in the southwestern forests were relocated, remeasured and analyzed. We compared forest structure at plot establishment (1909-1914) and present, examined methods of reconstructing tree size and stand structure, and examined functional changes (biomass, nutrient pools, crown fire hazard) associated with presettlement, postsettlement, and contemporary conditions. This work demonstrated that:

1. Remnant tree structures (live trees, snags, logs, stumps) provide a valid template for the design of restoration treatments in the semiarid Southwest. Their presence can help guide where to retain trees and remove trees and where to encourage grass openings. This is important for re-establishing the spatial distribution of trees that will restore landscape patterns and more natural ecological function such as low-intensity fire. The research also developed a more precise method of reconstructing historical tree diameters;
2. The remeasured historical plots indicate that stand density (trees $>$ greater than or equal to 3.6 inches diameter at breast height) increased six-fold, basal area increased more than three-fold, and diameter distributions shifted towards smaller size classes since plot establishment. Stand structure (especially tree size and density) and composition on

ponderosa pine plots in Arizona are drastically different from those in New Mexico, with plots in Arizona having larger and fewer trees on average;

3. Information from the historical plots is broadly representative of the ecosystem units in which they occur. Results indicate that tree density, diameter distributions, and regeneration patterns vary drastically over time depending on the parent material and site history.

Restoration prescriptions can lead to long-lasting increases in key ecological processes that sustain these ecosystems.

Restoration treatments increased soil temperatures and microbial activity, soil nitrogen availability (the most limiting plant nutrient in these ecosystems), and ponderosa pine litter decomposition and nutrient release. Treatments had relatively little effect on soil water content. These responses were sustained 7 years after treatment, suggesting that treatments have longer benefits than previously thought.

Genetics can vary within grass species based on the source. This is of concern when considering seeding with non-local seed source following treatments or fire.

The data shows that all the species investigated in this study had differences in at least one of the traits analyzed. Height was significantly different in all species and germination and leaf morphology were significantly different in most species. Genetic variation was found in all four species. Conservation of the genetic integrity of the ecosystem where native seed is used may require the use of seed transfer guidelines for these species. Seed transfer zones for trees could be good surrogates for seed transfer of these grass species.

Revegetation following unnatural, severe crown fire in Arizona and New Mexico was found to follow two paths: 1) establishment of unnaturally dense ponderosa pine stands vulnerable to further crown fire, and 2) establishment of non-forested, grass or shrub communities.

This is a very important finding because it shows that across both AZ and NM, severe fires can lead to extended—perhaps permanent—change from ponderosa to shrub/grass vegetation or to “hyperdense” conditions, thickets of trees that will support future unnatural crown fires and/or insect and disease outbreaks. Severely burned sites following either pattern did not recover to natural conditions. This finding underscores the importance of intervention in the form of restoration treatments to reduce the loss of forests.

Tree densities have more than doubled in pinyon-juniper woodlands on Anderson Mesa in Northern Arizona since Euro-American settlement on three soil types.

Pinyon-juniper associations and stand conditions vary depending upon soil type. Restoration prescriptions must be site specific. A one-size-fits-all approach would reduce the range of variability present in the woodlands and savannas even at the scale of this study.

Thinking and Acting at the Landscape Scale:

Action number two described in report language directed the ERI to: ***conduct an adaptive ecosystem analysis of ponderosa pine and related forests as a prototype for larger ecosystem analyses, and to fill the gaps between project or district/forest level analyses and regional analyses to support future operational scale treatment.***

To meet the goal established by Congress the ForestERA landscape assessment approach was

developed. The ForestERA approach uses a geographic information system to support a collaborative process which provides participants the best available science in a map-based format. It is designed to assist land managers and stakeholders who seek to implement treatments in the context of greater ecosystems (areas of several million acres, which include human communities as components of the landscape ecosystem).

ForestERA has been used to help managers and stakeholders identify and prioritize forest restoration treatments for over 4 million acres along the Mogollon Rim in Arizona. It is also being used in Northern New Mexico to advance planning over multiple public and private jurisdictions (private, state, BLM and Forest Service lands). Equally important, the data layers are informing project level action at the district level in the Forest Service and have been used by communities to prepare Community Wildfire Protection Plans.

Single species management at the stand level fails to protect species, restore forests and conserve the broad suite of biological diversity present at the ecosystem level. A new way of thinking is needed to conserve species.

During the summer of 2004, noted Conservation Biologist Dr. Reed Noss collaborated with the Ecological Restoration Institute on two workshops designed to identify the intersection between conservation biology and ecological restoration approaches to landscape conservation. The first workshop was held in July of 2004. Participation was limited to a small group of internationally recognized conservation biologists. The several day workshop included discussions and a review of forest restoration treatments in and around Flagstaff. The second workshop was held in October of 2004 for a broader group of interested stakeholders and provided a forum to discuss the workshop findings in July.

The overarching recommendation is that conservation biologists and restoration ecologists, particularly those engaged in conservation planning and ecological restoration planning, have much to gain through collaboration. Key recommendations include:

- Restoration should be understood as a process of guiding and managing an ecosystem along a trajectory of recovery of its natural structure, function, and composition.
- Planning on a regional scale offers opportunities to integrate and reconcile multiple objectives (e.g., biodiversity conservation and restoration of ecosystem health) that cannot easily be addressed on a stand or site scale. Thus, conservation planning must be actively coordinated with restoration planning on a regional scale.
- A variety of restoration treatments should be used to “spread the risk” of failure of any one approach. Managers should not implement the same treatment everywhere, even within the same landscape and forest type. A “one size fits all” approach to forest restoration is clearly inappropriate.
- Active adaptive management is the most sensible approach to restoration and management of southwestern ponderosa pine ecosystems, but only if pursued rigorously with a valid experimental design and the testing of multiple, often competing hypotheses.
- Restoration should pay most attention to the slowest variables, i.e., those that take the longest to recover and (perhaps) respond to treatment, such as old growth and associated species.

- Protected areas should not automatically be excluded from active management. After initial treatments and road closures, some large areas can potentially become self-managing in the future by permitting natural fires to burn. Some areas may be capable of self-management without prior treatments.
- Management regimes that favor the restoration and retention of natural herbaceous cover should be favored over those that promote reduced cover or richness of native herbaceous plants. Special care needs to be taken, especially in protected areas, to prevent the introduction and spread of exotic and invasive species.
- Because forest types and forest landscapes vary considerably in ecosystem structure, function, and composition, restorationists working in dry ponderosa pine ecosystems need to be cautious not to extrapolate their recommendations beyond their system. They should also make clear to policy makers and land managers that practices for the restoration of ponderosa pine should not be extrapolated uncritically to other systems.

The Challenge of No Markets and Therefore No Utilization

The third action requested by Congress was to “*develop options and recommendations for developing markets for by-products of fuels treatment activities.*” The ERI worked closely with the Greater Flagstaff Forests Partnership to identify why utilization wasn’t occurring and what needed to change to catalyze private market and actions.

Lack of confidence in a reliable supply of wood from federal lands and the desire to see investment risk shared between the public and private sector are key issues confounding utilization of small diameter wood.

Funding from the FY 2001 appropriation allowed the Greater Flagstaff Forests Partnership to identify two barriers to wood utilization. Fundamentally, private investors are reluctant to invest in the capitalization of utilization facilities because of a fear of an interrupted supply of wood from federal land. A private sector entrepreneur must be able to demonstrate to private investors or banks that they can pay off loans within a specified period of time. Lacking certainty about wood supply, entrepreneurs want the public sector to share investment risk.

Since initiation of this project several significant changes have occurred to address investor concerns. The Forest Service has a large number of acres in Northern Arizona cleared through the NEPA process and recognizes the importance of this action to motivate utilization by the private sector. In addition, the sky-rocketing costs of oil and natural gas have stimulated interest in wood as a source for the production of biomass based energy. Across northern Arizona private sector interest has increased to a critical point.

Can we afford not to implement restoration-based hazardous fuel reduction/thinning treatment?

A number of recent studies have asked the question: How much are fuel reduction treatments going to cost and can society afford to pay for restoration? These studies examined the economics of implementing treatments. In general, these studies find it difficult to justify treatment expenditures based on the value of the wood fiber removed. These analyses suggest that restoration must be considered an investment, and would need to be justified by the marginal benefits/value provided by a healthy ecosystem. A study funded with FY 2001 dollars probed

the question of whether or not it is possible that policy-makers have been asking the wrong question when it comes to the analyzing the cost and benefits of treatments.

The ever-increasing cost of *not* doing restoration-based fuel treatments suggests an approach for determining the level of investment that bypasses the limitations of marginal economic analysis. One can set a conservative lower bound on the amount to be invested by setting fuel treatment funding at least equal to the direct costs, such as fire suppression, that are *avoided* by investing—in other words, each dollar invested in restoration-based fuel treatment saves at least a dollar in suppression.

The analysis showed that it is worth spending from \$205/acre to \$538/acre just to avoid suppression costs related to a catastrophic fire. If other values are added to the analysis, such as avoidance of property damage, loss of commercial timber, recreation, endangered species values and drinking water, the amount of money that is economically rational to spend on restoration to avoid catastrophic fire increases. It demonstrates that investing more money in fire suppression than in restoration and prevention is an irrational economic choice.

The Public and Land Management Community Supports Restoration

Congress recognized that public and land management agency support is required for restoration to occur at the landscape scale. To achieve this understanding the ERI was directed to: ***“hold community workshops to design suitable treatments, training and information transfer to land managers, and information development and transfer to inform the public and land managers about ecologically based treatments.”***

Over the last five years the ERI has conducted over two hundred presentations, workshops, reports and field trips to improve understanding of the importance of forest restoration. Among the wide variety of public and land manager education tools we have developed are: short working papers that distill scientific findings into short guidance documents for land managers engaged in treatments; workshops designed to help practitioners understand and implement science-based treatments; community technical assistance to build understanding about the ecological and economic benefits of restoration; and numerous fact sheets, consultations and other technology transfer events designed to build support and understanding.

The public supports land managers and thinning

With FY 2001 funding, we sought to understand public values, perceptions, and preferences with regard to forest restoration. Results indicate that the Forest Service has earned a high level of trust from the general public. Interviewees expressed expectations for having their voices heard on a range of management and policy issues, with noted interest in being more informed and involved in specific management decisions. When asked questions about techniques used to manage the forest, there was wide-spread support for mechanical thinning, prescribed fire, and reducing the right to appeal environmental decisions. Overall, the public appears to have a sound understanding of the natural role of fire in southwestern forests, with most residents believing fire can have beneficial effects on forest ecosystems.

Citizens, land managers and policy makers have made great strides towards solving the problems created by degraded forest health. Many acres of land still require treatment. The scientific

knowledge to treat acres effectively exists and the societal will to do so is strong. The integrated, comprehensive work resulting from this funding contributes new knowledge to improve treatments and reinforces the need to act now. The ERI will continue to help land managers and stakeholders use this knowledge for the benefit of forest ecosystems and the human communities that depend on them.

INTRODUCTION

Early in the 20th century scientists became concerned about degradation of the ponderosa pine forests of the Southwest. The catastrophic fire season of 2000 focused critical national attention on the wildfire problem, led to significant funding increases in fire suppression and fire abatement activities in the urban/wildland interface, and inspired an increased commitment to solving the problem. However, the most cost-effective approach to solving the threat of catastrophic wildfire to communities and forests requires fixing the underlying problem of declining forest health. The Ecological Restoration Institute (ERI) is an advocate of science-based forest restoration treatments that reduce the threat of unnatural wildfire by restoring the forest to a healthier condition.

WHY THE ECOLOGICAL RESTORATION INSTITUTE AT NORTHERN ARIZONA UNIVERSITY?

In 1994, Dr. Wally Covington and colleagues published a scholarly paper predicting that fire seasons would become longer and that the size and intensity of fires would increase. During that time Arizona Senator Jon Kyl and then-Secretary of the Interior Bruce Babbitt became concerned about the potential fire danger, the conflict and economic upset created by degraded forests, and the general trend of forest decline. In 1995, the first federal support began for the Ecological Restoration Institute to implement a network of unique experiments to develop and test landscape-scale forest treatments, to restore forest health, reduce the risk of wildfire, and enhance natural resource values.

The work of the Ecological Restoration Institute is unique because we use an adaptive ecosystem management approach based on collaboration with land managers and stakeholders to research, develop, and apply treatments for landscape-scale fuel reduction and ecosystem restoration. Simultaneously we probe for better understanding of how we can improve treatments based on operational experience and new scientific information—in other words, learning by doing. In sum, the need for this type of mission-oriented, applied knowledge development, synthesis and transfer is widely acknowledged and desperately needed; however, it is not fundable through existing competitive grants and contracts programs.

In 2004 Congress passed “The Southwest Forest Health and Wildfire Prevention Act (PL 108-317).” The legislation authorizes ecological restoration institutes in Arizona, Colorado and New Mexico, and formally designates the Ecological Restoration Institute at NAU as the institute for Arizona. This new authorization is an acknowledgement by Congress of the importance of the institutes and their integrated, interdisciplinary and applied approach to solving the forest health crisis. The significance of the new model was reinforced by the Governors of Arizona, New Mexico and Colorado through the signing of a charter at the annual meeting of the Western Governors’ Association in June of 2005. The charter provides a framework for the states, universities and institutes to work together to ensure the successful implementation of the federal legislation and to ensure that the partnership creates a multi-jurisdictional synergy to maximize efficiency and service to all land managers and stakeholders who develop and implement treatments.

REQUESTS FROM CONGRESS

Fiscal Year 2001 funding was provided to the Ecological Restoration Institute, Northern Arizona University, in the Department of Interior and Related Agencies Conference Report 106-914. The language reads:

Within the amounts provided for wildland-urban treatments, \$8,800,000 is to be made available to the Ecological Restoration Institute (ERI) of Northern Arizona University, through a cooperative agreement with the Bureau of Land Management, to support new and existing ecologically based forest restoration activities in ponderosa pine forests. The managers' goal is to develop a scientifically-based model that will promote restoration of the ecological health of forests in the Southwest, while reducing the threat of wildfire to forest communities. Under this agreement, the managers expect that ERI will:

- 1. research, develop, monitor, and conduct fuels treatments in partnership with all Federal, Tribal, State, and private landowners to demonstrate the feasibility of restoration-based fuels treatments on a community level;*
- 2. conduct an adaptive ecosystem analysis of ponderosa pine and related forests as a prototype for larger ecosystem analyses, and to fill the gaps between project or district/forest level analyses and regional analyses to support future operational scale treatments;*
- 3. develop options and recommendations for developing markets for by-products of fuels treatment activities;*
- 4. hold community workshops to design suitable treatments, training and information transfer to land managers, and information development and transfer to inform the public and land managers about ecologically-based treatments.*

Recognizing the importance of cooperative agreements, the managers request that the Bureau place a priority on timely negotiation and implementation of this agreement to ensure the prompt availability of funding pursuant to it, and that the Bureau conduct negotiations at the national level. The agreement shall not include funding for facilities or capital equipment like buildings and vehicles.

A cooperative agreement for transfer of the funds was completed between the Bureau of Land Management and ERI/NAU in April of 2001. The agreement included eight task orders outlining specific deliverables. Three additional task orders were developed for the three federal agencies that received direct transfers of the federal funds (Bureau of Land Management-Arizona Strip Field Office, Grand Canyon National Park, and Coconino National Forest). The ERI/NAU assumed no responsibility for the deliverables of the three federal agencies because the ERI had no financial control. However, in the positive spirit of cooperation associated with this project the ERI collaborated with all three agencies.

All accounts have been expended and no funds remain from this appropriation. The contract instrument covered five years with a deadline of September 30, 2005.

Five of the task orders representing \$2.2 million were committed to local and state partners implementing the Flagstaff wildland/urban interface treatments, subcontractors (e.g. the Greater Flagstaff Forests Partnership), or federal agencies (Bureau of Land Management, Coconino National Forest, and Grand Canyon National Park). Four task orders included \$2.0 million for ongoing ERI operations and \$1.0 million for ERI research including Mount Trumbull. Finally, two task orders included \$3.5 million to fund research by cooperators outside the ERI to answer questions related to the development of socially acceptable and scientifically valid forest restoration treatments. In keeping with standard university protocols, the funding to cooperators was managed on a cost reimbursable basis to assure performance and accountability. Many of these projects required several field seasons to complete; consequently the pace of expenditure reflects this timeline.

This agreement received active oversight. First, the Bureau of Land Management reviewed and approved all expenditures under the cooperative agreement. Second, Northern Arizona University managed the contracts and disbursements to ensure that all federal and state procedures were met and that the expenditures conformed to the deliverables stated in the task orders. Third, ERI staff remained involved with the subcontractors to provide oversight and direction. Finally, as a result of the size of the grant, Northern Arizona University completed a full internal audit of the federal funds to guarantee proper management.

INTRODUCTION TO THE DELIVERABLES AND TASK ORDERS

The following pages summarize the tasks and deliverables associated with the federal appropriation. The “Purpose” for each task is a direct quote from the task order and therefore appears in the future tense. Where publications, summaries, videos or other products are identified we have tried to provide them in the notebooks accompanying the final report. Some activities do not yield written reports, especially actions such as field trips, consultations with community stakeholders and presentations. In those cases the time and place of the activity are listed.

The majority of work was accomplished during the first three years of the funding. During the last year it was possible to initiate several small, related projects that were consistent with the original task order.

PROGRESS BY TASK ORDER

TASK ORDER A: BLM TASK ORDER 4 TREATMENTS AND ACTIVITIES BY PARTNERS

PURPOSE: To provide resources to federal, state, tribal, local, and non-governmental partners to support and treat areas in need of ecologically based forest restoration. This includes areas in and around the Flagstaff, AZ urban-wildland interface, other “Urban Wildland Interface Communities within the vicinity of federal lands that are at high risk from wildfire” as published in the Federal Register on January 4, 2001, and areas of significant biological importance. The objectives are to reduce the threat of wildfire in the wildland-urban interface and areas of significant biological importance while applying fuel reduction and restoration treatments.

SUMMARY:

- **All deliverables completed**
- Collaboration and coordination through the Greater Flagstaff Forests Partnership led to more acres completed than anticipated. A total of 3,172 acres (716 acres over the amount committed) were treated with funding under this task order
- Research results based on the activities in this task order have been delivered in 15 presentations
- Completed slash-pile and grassland research at the Flagstaff Arboretum contributes to solving important Congressional concerns regarding invasive exotics in post-burn rehabilitation and the development of native seed sources for pre-fire and post-fire restoration
- Jobs creation- 6 FTE and 22 part-time positions from laborers to professionals
- Training of young adults to create a qualified labor pool for restoration and thinning
- Education for primary, secondary, and post-secondary education; outreach to improve treatment development to accommodate wildlife
- Technical assistance to fire fighters in 5 western states
- 7 communities in the Southwest have been served
- Leveraged nonfederal funds-\$163,292

DELIVERABLES:

1. A report every nine months demonstrating progress towards the goals established with each partner including a summary of treatment activity.
 - First report completed January 31, 2002
 - Interim report June 20, 2002
 - Second report completed September 30, 2002
 - Third report completed June 30, 2003
 - Fourth report completed March 31, 2004
 - **Final report December 31, 2005**

2. As a part of the annual report a summary of lessons learned relevant to creating a multi-jurisdictional coordinated effort to treat the wildland-urban interface.
 - Many important lessons have been learned that can improve implementation on the local level. Completed January 31, 2002, revised September 30, 2002, second revision June 30, 2003, final revision March 31, 2004-**Provided in Appendix titled “Task Order A: BLM Task Order 1”**
3. NAU will coordinate with the partners to achieve the following goals. The acreage targets are in parentheses.

FLAGSTAFF FIRE DEPARTMENT

Planning (1250 acres), thinning (1350 acres), and burning (650 acres) to reduce the threat of fire throughout greater Flagstaff on private land. Information transfer to other fire departments and community members. –**Specific information provided in Appendix titled “Task Order A: BLM Task Order 1”**

- Planning (1250 acres)-**Completed**
- Thinning (1350 acres)-**Completed**
- Burning (650 acres)- **Completed**
- Presentations to other fire fighters and communities -**9 Completed**
- Assistance to communities in Arizona, Colorado, South Dakota, Colorado, Wyoming- **5**
- 2500 total contacts providing information or assistance since April 2001
- Leveraged nonfederal funds- \$85,000
- Job creation- 3 FTE, 4 Part-time
- **Contract completed**

COCONINO COUNTY

Establish two crews, 8 people each (a six-month and a three-month crew), and support the work of three other county crews to reduce fire hazard on 256 acres of state, county, and private land (supported crews treated additional acres), restored meadow and grassland habitat in the urban-wildland interface, and assisted in ecological surveys and assessments. Training prepared crews for other resource management job opportunities. –**Specific information provided in Appendix titled “Task Order A: BLM Task Order 1”**

Acres treated (256)- **858 Completed**

- Crew members hired (12)- 16
- Training sessions (12)- 11
- New projects (15)- 12
- Existing crews supported (3)- 5
- Leveraged nonfederal funds- \$25,000
- Job creation- 16 Part-time, 1 FTE
- **Contract completed; acreage goals exceeded**

ARBORETUM

Task order included: research on post-burn slash pile restoration; grassland restoration; development of education materials and activities for public education. The Arboretum contacted Steve Caicco at BLM to collaborate on the propagation of local native plants. –**Specific information provided in Appendix titled “Task Order A: BLM Task Order 1”**

Eighty slash pile experimental plots were installed; 60 slash piles were burned, 20 were left as controls to determine the impact of pile size and burning on diversity and abundance of native, rare, and exotic understory species. Final conclusions are included in the Seymour Master’s Thesis included in the attached notebooks.

- September and October 2002, 450 students from 17 classes in 8 different schools
- Brochures to enlist schools to participate in ecological restoration and education printed (500)- **Completed**
- Distribution to 17 schools (100 brochures)- **Completed**
- Schools scheduled for participation (15)- **Completed**
- 4 age-specific curricula developed for restoration program- **Completed**
- Grassland and native plant propagation research- **Completed**
- Steve Caicco from the BLM contacted
- Job creation- 1 FTE, 1 Part-time
- Lay publication explaining restoration techniques, costs, and benefits, written November 15th, 2002, published by December 15, 2002- **Completed**
- 15 schools by March 2002- **Completed**
- Interpretive displays: Forest Restoration-**Completed**, Grassland Restoration, Interactive display explaining restoration-**Completed**
- Target number of participants in educational program: 250 students, 15 teachers, and 300 citizens: From June through September 16, 2002, 206 students from 5 schools and the Museum of Northern Arizona, and 11 teachers participated in restoration activities. 24% were minorities (primarily Native American). Direct participation from organizations such as Americorps, Youth Conservation Corps, ROTC, and Flagstaff Parks and Recreation numbered 121. Adult individuals participating in restoration through public programs, workshops, and seminars, numbered 160. In addition, The Arboretum’s week long 2002 summer teacher’s workshop focused on restoration ecology for educators
- **Contract Completed**

ARIZONA GAME AND FISH

Task order included research and coordination activities to address wildlife issues. Wildlife concerns are often used during the environmental review process to stop restoration activities. Addressing these issues is critical for moving treatments to an operational scale. This funding assisted Arizona Game and Fish, a chronically under-funded agency, to build capacity and participated in the design of wildlife and biodiversity-compatible treatments. –**Specific information provided in Appendix titled “Task Order A: BLM Task Order 1”**

- Implementation of research (4)- **6 Completed**. Continuation of Mt. Trumbull Forest Restoration/Wildlife Project, continuation of tassel-eared squirrel habitat relationships study, initiation of oak snag monitoring of restored areas on U.S. Naval Observatory, initiation of forest structure relationships to Goshawk, initiation of snag inventory on

pre-restored forests on Camp Navajo, initiation of biological surveys on Camp Navajo to be used as pre-treatment comparisons

- Outreach meetings (15)- **29 Completed**
- Presentations of results (6)- **6 Completed**
- Scientific papers (6)- **3 published, 4 in review, 4 in preparation**
- Deliverables exceeded in most categories, remaining 2001 funds were combined with FY'02 funds to produce a synthesis of what is known about ecological restoration and the relationship to wildlife conservation
- Research proposals to enhance research (4)- **9 submitted**
- Environmental assessments (4)- **2 completed but no others were requested**; however, Arizona Game and Fish commented on several projects that were forest related and coordinated through the AGFD Habitat Branch
- Job creation- 1 FTE
- **Contract Completed**

ARIZONA STATE LANDS DEPARTMENT

Activities included: hiring one prison crew, crew coordinator, and officer to accomplish planning, thinning, and slash disposal (including burning) on 200 private and state-owned acres.

–Specific information provided in Appendix titled “Task Order A: BLM Task Order 1”

- Thinning (200 acres)- **314 acres completed**
- Leveraged nonfederal funds- (state and private) **\$53,292**
- Job creation- 1 Part-time
- **Contract completed, acreage goal exceeded**

**TASK ORDER B:
BLM TASK ORDER 2
RESEARCH, TREATMENT DEVELOPMENT, MONITORING AND IMPLEMENTATION**

Purpose: The ERI will continue research, development, application, and monitoring of ecologically based forest hazard fuels reduction treatments. This work will be targeted toward the wildland-urban interface and critical habitat/valuable highlands in cooperation with federal partners, Native American communities, and forest communities in Arizona and New Mexico.

SUMMARY:

- **Deliverable #1-Mogollon Rim Fire/Fuels Research. Treatments Completed.** This project contributed new knowledge relevant to regional responses to restoration treatment and fuel reduction, and contributed to expanding treatments to an operational scale. **Highlights include: Demonstration plots established in the Apache-Sitgreaves National Forest and surrounding communities; hazardous fuel reduction using restoration-based treatments near Flagstaff, Arizona; and the testing of restoration-based fuel reduction treatments designed to protect old growth.**
- **Deliverable #2- Native American Fire Initiative. Completed.** This project served the needs of Fire Plan implementation by providing technical assistance to a Native American community in designing treatments to accomplish community protection and ecosystem restoration. It also increased information transfer between tribes, and contributed new information about unnatural wildfire behavior and the design of strategic fuel breaks. **Highlights include: hazardous fuels reduction treatments to protect four Kaibab-Paiute villages; implementation of a strategically placed 100-acre fire break; research to predict future fire tracks and outreach and education to other tribes.** Funding provided through this task order has supported 6 part-time resource technicians on the Kaibab-Paiute Reservation (two employees returned to the reservation to do this work). Two have moved into full time positions with the Tribe
- **Deliverable #3- Quantifying Forest Reference Conditions for Ecological Restoration- Completed.** This project remeasured research plots established in the early 20th Century to establish the structure and composition of pre-settlement forests. This study informs the design restoration treatments that seek to emulate historic conditions – **Highlights include: publication and presentation –Specific information provided in Appendix titled “Task Order B: BLM Task Order 2”**
- **Deliverable #4-Thinning and restoration treatments at Grand Canyon National Park. Completed.** This project helped inform fuels treatments for the Park’s urban interface (e.g., North Rim developed area) and forces important consideration of appropriate fuels reduction and restoration treatments within a national park. **Highlights include: two publications —Specific information provided in Appendix titled “Task Order B: BLM Task Order 2”**
- **Deliverable #5- Landscape Fuels and Fire: The San Francisco Peaks- Phase I completed.** This project advanced knowledge of the role of fire in Southwest mixed conifer forests, advances technology for large landscape planning and treatment design, and contributes to ongoing management efforts in Flagstaff wildland/urban interface.

Highlights include: Completion of two M.S. theses –Specific information provided in Appendix titled “Task Order B: BLM Task Order 2”

- **Deliverable #6- Fire and Grazing Effects on Semi-Arid Grasslands Associated with Ponderosa Pine Forests. Completed.** Grass productivity and range condition in ponderosa pine forests are critical to future management and introduction of natural fire. This work contributed important information for utilization of forest and range resources. **Highlights include: two publications, five in progress and six presentations; a collaborative process that engaged researchers, agencies and ranchers in developing a mutual understanding of grassland restoration and management –Specific information provided in Appendix titled “Task Order B: BLM Task Order 2”**
- **Deliverable #7- Southwest Fire Initiative. Completed.** The body of research conducted under this deliverable contributes to the development, monitoring, and implementation of fuels treatments to demonstrate the feasibility of restoration-based fuel treatments on a community level. 25 independent research projects funded by this deliverable are complete. Two additional projects were funded by unanticipated remaining dollars. **Highlights Include: Numerous publications –Specific information provided in Appendix titled “Task Order B: BLM Task Order 2”**

DELIVERABLES:

The ERI/NAU will provide the Assistance Representative with the following deliverables—annual report on each of the following research/development/application initiatives:

1. Mogollon Rim fire/fuels including: Centennial Forest (formerly Deliverable 1) and Camp Navajo restoration (Formerly Deliverable 7)
 - This deliverable included the following activities:
 - Implementation and monitoring of treatments in the Apache Sitgreaves National Forest;
 - Implementation of treatments in the Centennial Forest, Coconino National Forest that accomplish fuel reduction and community protection; and,
 - Implementation of restoration treatments to protect and restore old growth in the Centennial Forest. The original task order included activity at the Arizona National Guard Depot at Camp Navajo in Bellemont, Arizona. Due to insurmountable procedural obstacles at the Camp Navajo facility, the project site was changed to an adjacent area in Northern Arizona University’s Centennial Forest to complete work on the old-growth project.
 - a. Objectives of the Apache-Sitgreaves site included:
 1. Design and implement an ecological restoration and fuels treatment project on approximately 160 acres in collaboration with Forest Service managers and community partners,
 2. Measure and evaluate pretreatment conditions of forest vegetation and fuels,
 3. Monitor and measure treatment characteristics. This project provides site-specific treatment information to managers and community partners in and adjacent to the Apache-Sitgreaves National Forest and contributes data to the long-term regional network of restoration sites.
 - Environmental analysis completed. Project was offered for bid as a stewardship contract through Apache-Sitgreaves National Forest.

- Design and implement an ecological restoration and fuels treatment project on approximately 160 acres in collaboration with Forest Service managers and community partners on the Mogollon Rim, Arizona- **Completed**, site is near Springerville, Arizona
 - Pretreatment conditions of forest vegetation and fuels were measured in summer 2002;
 - This project contributes information for restoration treatment design for the Apache-Sitgreaves National Forest and associated communities, contributes new knowledge relevant to regional responses to restoration treatment and fuel reduction, and contributes to expanding treatments to an operational scale
- b. Specific objectives for Centennial Forest restoration were to identify and inventory “old growth” areas on the Centennial Forest and implement forest restoration treatments on at least 4 replicated 100-acre experimental sites. These treatments were designed to be an appropriate experimental extension of the Stand Treatment Impacts on Forest Health (STIFH) experimental protocol www.for.nau.edu/forhlth. In addition to the 4 old-growth restoration areas, fuels reduction treatments were applied on an additional 200 acres in the Arboretum and West Project Treatment areas on the Centennial Forest. These treatments were high-priority fuels reduction activities designed to significantly reduce fire risk to the Arboretum at Flagstaff and the new Westwood Estates Development. These fuels reduction projects were designed to provide raw materials for the Coconino Rural Environment Corps proposed Rural Wood Products Enterprise Initiative. Activities address the “research, develop, monitor, and conduct fuels treatments” objectives established by the Bureau of Land Management.
- Thinning **completed on 200 acres** (Fisher Unit) and in on the remaining **200 acres (Rock Unit)**
 - Thinning to accomplish fuels reduction (200 acres)- **Completed** 200 acres at Arboretum site. Costs and acreage at Arboretum were higher (20 acres more) than anticipated therefore thinning did not proceed on West Project
 - Forest restoration treatments in old growth (400 acres)- Thinning contracts have been established - **Completed**
 - Some of the medium logs were used by the Indigenous Community Enterprises program to build affordable hogans for the Navajo tribe- **Completed**
 - Surveys of Mexican spotted owls, goshawks, snags, large logs, yellow pine, and noxious weeds- **Completed**
 - Provides economic benefit to Native American communities.
- c. Objectives of the old-growth protection of the Centennial Forest include:
1. Ecosystem restoration of a demonstration area (76 acres),
 2. Intensive research on 4 experimental blocks (70 acres), and
 3. Prescribed burning of Old Growth Area (29 acres). Total research/application project cover 175 acres.
- Funds were used to conduct research on the 400-acre old-growth treatment sites described under #1, above. The experiment tests ecological restoration treatments (thinning and burning) vs. control. The experimental techniques

are comparable to those applied in the Mogollon Rim project (#3, above) to permit wider inferences to be drawn from the result - **Completed**

- All pre-treatment measurements (200 plots)- **Completed**
- This site is used for cooperative studies with other researchers and provides easy access for forest restoration field trips and educational activities
- The 400-acre experiment provides information for forest management in the Flagstaff urban interface to the Forest Service and university researchers.

2. Native American Fire Initiative

Objectives were:

- a. **Community Fire Protection:** Develop predictive models to identify potential fire tracks leading to 4 Kaibab Paiute villages, apply fire protection treatments for 40 homes or structures on the Kaibab Paiute Reservation, and fire protection treatments on 100 acres of potential fire tracks leading to Kaibab Paiute villages.
 - Predictive model developed, tested and validated using the Moccasin Fire- **Completed**
 - Initiated treatments in two villages representing 40 homes during the summer of 2002- **Completed**
 - Two more villages were treated in cooperation with the BIA in the summer of 2003-**Completed**
 - Work on 100-acre track progressed slowly. The original site was changed and 20 acres were completed in the summer of 2002. The location, identified by the tribe, provides a strategic break for fire coming into the town-**Completed**
- b. **Fire research:** Develop baseline ecological data on the 1,565- acre Moccasin Fire (which burned in the summer of 2000), data-based assessments of wildfire threat to houses, structures, and cultural sites in pinyon and juniper woodlands adjacent to villages, investigate viability of seeds and the distribution of mycorrhizal associations in soils, determine potential economic losses from wildfire for houses, structures, cultural sites, wildlife, and habitats affected by wildfire on the Kaibab Paiute Reservation, conduct a feasibility study for potential development of “value added” woodlands thinning products.
 - Baseline ecological data collection on the 1,565-acre Moccasin Mountain Fire-**Completed**. The tribe has asked the ERI to work collaboratively on re-vegetation of the Moccasin Fire site
 - Assessment of wildfire threat to structures and cultural sites- **Completed**
 - Data collection for the viability of seeds and the distribution of mycorrhizal associations in the soils - **Completed**
 - Economic assessment of potential losses from wildfire on the Kaibab Paiute Reservation- Planned for spring 2002- Canceled
 - Feasibility study for potential development of “value added” woodlands thinning products. Analyzed using pinyon-juniper wood chips for firewood. Logs using this study are scheduled to go into production in the fall of 2002- **Completed**
- c. **Outreach:** Collaborate with the Kaibab Reservation community to design a community based communication initiative to inform local community members about the Kaibab Wildfire Protection and Natural Resources Restoration Model, assist spokespersons from

the Kaibab Reservation community to communicate ideas and applications of the Kaibab Wildfire Protection Model to additional native communities where wildfire protection around homes and villages is needed and desired, establish an academic and research partnership between the Ecological Restoration Institute at NAU and the Department of Biological Sciences and the Environmental Sciences and Education Program at the University of North Texas. This collaborative partnership a) began a student exchange partnership for undergraduate and graduate students in natural resource careers between NAU and UNT and b) expanded current research collaboration through the exchange and sharing of research efforts in northern Arizona and southern Utah. Native students were identified, encouraged, and supported in seeking degree programs in forestry and natural resource careers.

- Communication networks and schedules to provide local community members with information regarding the Kaibab Wildfire Protection and Natural Resources Restoration Model-**Completed**. These networks have assisted tribal officers in communicating the model to additional communities. Tribal representatives from across the state met on the Kaibab-Paiute reservation in November, 2002 to learn about the model and community-based decision-making
- Academic and research partnership between the Ecological Restoration Institute at NAU and the Department of Biological Sciences at the University of North Texas-**Completed** The first report submitted to the tribe illustrates the fire prediction model-**Completed**
- Funding provided under this task order supported 3 part time resource technicians in 2002. A total of six people have been supported, and two have moved on to full-time professional employment with the tribe
- **Native American students were recruited**
- **Final deliverables provided in Appendix titled “Task Order B: BLM Task Order 2”**

This project served the needs of Fire Plan implementation by providing technical assistance to a Native American community in designing treatments to accomplish community protection and ecosystem restoration. It also increased information transfer between tribes, and contributes new information about unnatural wildfire behavior and the design of strategic fuel breaks

3. Quantifying Forest Reference Conditions for Ecological Restoration: The Woolsey Plots
The goal of this project was to analyze changes in forest structure, composition, and function over a 90-year period using a subset of historical permanent plots established in the early 1900s in ponderosa pine and mixed conifer forest types of Arizona and New Mexico. Specific objectives of this research project were to:
 - a. Re-measure a subset of the permanent plots established between 1909-1914 so as to achieve an adequate sample size, and thus be able to analyze this unique data source.
 - b. Determine changes in forest composition and structure (tree species, density, size, and age) in southwestern forests from early 1900s until the present time.

- c. Reconstruct forest structure for each plot at its establishment date using dendrochronological techniques. Compare the reconstructed (modeled) structure to the historical (actual) data to determine the accuracy and limitations of our reconstruction technique(s).
- d. Determine the date of initiation of fire exclusion for the plots and reconstruct forest structure at this date (circa 1870-1890), showing forest composition and structural conditions at the time of disruption of the long-term frequent-fire regime. Compare species composition, tree densities, and size distributions to 1909-1914 and contemporary conditions.
- e. Use the Forest Vegetation Simulator (FVS; Teck et al. 1996) or another stand simulation model to determine and link stand structural changes with functional changes (tree biomass, carbon and nitrogen storage, herbaceous production, fire susceptibility) on these plots from the time of fire regime disruption (circa 1870-1890) and initial plot establishment (1909-1914) until the present. Also, project future conditions based on alternative management scenarios.

Analysis of historical datasets and data from present-day re-measurements help quantify ecological changes that have occurred on these plots. Further, these data allow evaluation of forest reconstruction modeling techniques, which in turn provides a more precise understanding of presettlement conditions. Restoring forest health requires understanding forest structure, processes, and functions prior to Euro-American settlement. This information is essential for developing restoration-based fuel treatments.

- Remeasurement of three historical forest plots established in 1909-1913-**Completed**
- Relocation of additional historical plots-**Completed**
- Analysis and development of reconstruction model-**Completed**
- Field samples processed-**Completed**
- Data analysis for overstory and understory plot measurements-**Completed**
- Presentation of research results at national conference (Ecological Society of America, Tucson, AZ, August 2002)-**Completed**
- **Final deliverables provided in Appendix titled “Task Order B: BLM Task Order 2”**

4. Fire and Fuels Treatments: Grand Canyon National Park

Objectives were to:

- a. Measure effects of three forest restoration treatments on two experimental blocks in Grand Canyon National Park (GCNP), covering 120 acres,
- b. Provide technical assistance in restoration and fuels treatment in support of urban interface hazard reduction in GCNP, and
- c. Assess landscape fire behavior and fire hazard across high-elevation GCNP forest ecosystems.
 - The ERI has provided technical assistance to the park to prepare the environmental assessment for the experiment
 - The environmental assessment and record of decision for the 120-acre treatment area was completed by Grand Canyon National Park in 2002. This was a major accomplishment
 - Tree thinning on both rims –**Completed**

- South Rim burned with prescription fire –**Completed**
- North Rim burned with wildland use fire –**Completed**
- Continued research and analysis of landscape fire behavior and fire hazard across high-elevation GCHP forest ecosystems- **Completed (2 publications resulted)**
- This experiment was important to inform fuels treatments for the Park’s urban interface (e.g., North Rim developed area) and forces important consideration of appropriate fuels reduction and restoration treatments within a national park
- **Final deliverables provided in Appendix titled “Task Order B: BLM Task Order 2”**

5. Landscape Fuels and Fire: San Francisco Peaks

Objectives were to:

- a. Compare and evaluate the effectiveness and suitability of Landsat Enhanced Thematic Mapper and Ikonos multispectral satellite imagery to develop overstory vegetation and forest fuels maps over an elevational gradient, and
- b. Assess landscape fire behavior and fire hazard across this high-elevation forest ecosystem. The project area encompassed the southern portion of the San Francisco Peaks, which are located approximately 12 km north of Flagstaff, Arizona. Landsat Thematic Mapper imagery has been used extensively for vegetation mapping projects but has not been used to develop vegetation maps to the level of detail attempted in this project for mixed-conifer areas in the Southwest. Ikonos imagery has only been available for approximately a year and its suitability for detailed vegetation mapping has not yet been reported in the literature. The results from this project help guide Coconino National Forest and Greater Flagstaff Forests Partnership fuel and fire management and technology transfer for interface treatments.
 - Field work initiated in 2001 and was completed in 2002; data analysis is completed
 - Two related M.S. theses – **Completed**
 - Research has been expanded to include testing plant-soil-mycorrhizal fungi interactions
 - Multispectral satellite imagery will be purchased in 2002, **Completed**
 - Fuel maps were used for landscape fire behavior modeling and will support ongoing forest simulation modeling—**Completed**
 - This project advances knowledge of the role of fire in Southwest mixed conifer forests, advances technology for large landscape planning and treatment design, and contributes to ongoing management efforts in Flagstaff wildland/urban interface
 - **Final deliverables provided in Appendix titled “Task Order B: BLM Task Order 2”**

6. Fire and Grazing Effects on Semi-arid Grasslands Associated with Southwestern Ponderosa Pine Forests—Landscape Analysis

Objectives were to:

- a. Address the feasibility of restoration-based fuels treatments in the grasslands of ponderosa pine forests with 2 primary emphases:
 1. measure responses of plant biodiversity to various treatments of fire and grazing, and link these responses to measures of ecosystem function; and
 2. conduct a thorough analysis of collaborative land management teams as a means to

accomplishing ecosystem restoration and management,

- analyze biodiversity and productivity in the grasslands associated with ponderosa pine forests. The focus was on measuring plant diversity and productivity along disturbance gradients at plot and landscape-scales.
- study a range of restoration options through which fire and grazing treatments may help achieve diverse objectives including, but not limited to, wildlife enhancement, soil and water conservation, beef production, cultural preservation, and aesthetic value.
- Transfer the knowledge generated from this work to both scientific and public audiences via publications in a wide range of outlets, and through diverse educational activities, including workshops and on-the-ground training. This project explored the role of collaborative land management teams in transferring information from academic research to management agencies, landowners, and the public.

Understanding grass productivity and range condition in ponderosa pine forests are critical to future management and introduction of natural fire. This work contributes important information for utilization of forest resources.

Project Objective #1 (addresses Congressional Objective #1)

We met and exceeded the goals within this objective through experiments that quantified plant diversity responses to fire and grazing. Potential ecosystem consequences have been outlined in the final report. These experiments identified specific management actions that affect fuel loads. Based on an extensive literature review of methods to evaluate the effectiveness of collaborative teams in accomplishing ecosystem restoration and management, as well as a series of interviews with current collaborative land management team members, we have finalized a framework based on indicators of ecosystem health. This framework, developed for local rangelands, provides an objective tool to assess the effectiveness of collaborative management.

Project Objective #2 (addresses Congressional Objective #2)

We met this objective and measurements of ecological responses to treatments of fire and grazing suggest resilience in these high-elevation, semi-arid grasslands. Interactive effects were documented. Specific grazing practices were shown to increase fuel load while other practices lessened fuel load. These results suggest alternative strategies for restoration of fire in Ponderosa pine ecosystems.

Project Objective #3 (addresses Congressional Objective #3)

We met and exceeded the goals of this objective. We have integrated social and ecological data to identify management options based on the parameters defined by our ecosystem health framework. Stakeholder interviews in combination with ecological research have been used to conceptualize the socio-ecological system and identify plausible restoration actions. This research has identified trade-offs in ecological and social values that are specific to management actions.

Project Objective #4 (addresses Congressional Objective #4)

We met and exceeded the goals outlined by this objective through the transfer of knowledge to others via numerous conferences, and at least 20 meetings with agencies, land-owners and collaborative management teams. In addition we have published 2 articles, and we are in the process of completing at least 5 more articles. A key component of the ecosystem health framework that we have developed is multi-party monitoring which makes information more transparent, facilitate communication, and increase mutual learning.

7. Fire/Fuels/Restoration Cooperative Studies

Cooperative projects between NAU and other researchers contribute to the development, monitoring, and implementation of fuels treatments to demonstrate the feasibility of restoration-based fuel treatments on a community level. Invited experts in restoration ecology and community-based fuel treatments developed a detailed set of critical questions in a facilitated workshop in February 2001. Questions were organized into the following two categories:

a. Socioeconomic issues

Socioeconomic themes were:

1. Social uses and values associated with forest restoration,
2. Utilization and flow of restoration by-products,
3. Costs, benefits, and public policy,
4. Health and human safety, and
5. Institutions and partnerships.

b. Biophysical issues

Biophysical themes were:

1. Site-specific restoration treatments and effects,
2. Planning and conducting landscape-scale restoration,
3. Special ecological features in the urban/wildland interface. Cooperative study proposals were invited from NAU faculty and collaborators to address these questions.
 - Twenty-four applied research projects were funded in 2001 addressing the themes identified in the collaborative workshop. Disciplines represented in the cooperative studies include forestry, geography, engineering, education, chemistry, environmental science, and biology. All researchers will be required to report their findings to practitioners and land managers
 - All researchers participated in the Southwest Fire Initiative Conference in April 2002 and April 2003
 - Over 63 presentations and 9 publications have resulted from the 24 research projects
 - A progress report was submitted June 20, 2002 and updated June 2003
 - Research funds for an economic analysis were redirected to analyze the cost of no action versus restoration of forests to avoid unnatural fire. The results were reported at the Western Governors' Forest Health Summit in June 2003
 - Unanticipated funds remaining in this account were used to accomplish two additional questions: First, from a conservation biology perspective, what are the most critical landscape elements for long-term viability of the greater ecosystem? What sorts of restoration-based treatments are appropriate to afford some level of protection to those elements, either by implementing restoration based fuel breaks or by implementing restoration treatments within them? Second, will fund additional

data collection on wildlife responses to restoration at the BLM Mt. Trumbull landscape scale restoration site. – **Completed**

- **Final deliverables provided in Appendix titled “Task Order B: BLM Task Order 2”**

8. ERI Support

Objectives were to maintain the operations of the research, outreach, administrative, and management component of the ERI. Work included the overall management of this and other task orders. Coordination of work, scope, and implementation of restoration research efforts was supported both on the ground and through outreach efforts such as community meetings, workshops, and other forums. Administrative support provided oversight to the budget expenditures for this and other task orders.

- **Final deliverables provided in Appendix titled “Task Order B: BLM Task Order 2”**

**TASK ORDER C:
BLM TASK ORDER 5
LANDSCAPE ASSESSMENT**

PURPOSE:

The Ecological Restoration Institute (ERI) will contract with the Laboratory of Applied Ecology, Northern Arizona University (NAU) to perform a landscape analysis of ponderosa pine forests across northern Arizona. This effort will involve extensive data acquisition and quality assessment, creation of an integrated database that is fully incorporated into a geographic information system (GIS), and the development of analytical tools that will bring state-of-the-art capabilities to forest planning and restoration efforts throughout this geographic region. The project will produce a comprehensive report detailing the landscape assessment, and it will make available to all stakeholders the database and analytical tools developed in conducting this assessment, except where distribution is limited or prohibited by statute.

SUMMARY:

- This project developed a new approach for evaluating proposed restoration treatments on a landscape-scale
- Project objectives, deliverables, and time line were extended in order to capture new opportunities for implementing the ForestERA Project in the real world landscape assessment focusing on the Western Mogollon Plateau (see deliverables section, below)
- Project implementation has successfully recruited and retained the participation of land managers, public-interest groups, community leaders (the target audience for this project) and other stakeholders
- Job creation- 3 FTE, 4 Part-time
- Data collection and analysis **completed**
- An independent Science Advisory Committee was established, with representatives from academia, federal agencies, and the non-profit sector
- First review by the Science Advisory Committee occurred in June 2002
- ForestERA questionnaires were given to ForestERA stakeholders throughout October 2002. Results have been used to guide Phase II of the ForestERA work plan
- Collaborations with local, state and federal agencies, university researchers, and non-profit groups expanded on the science and policy elements of the project. These collaborations included: Western Governor's Association, Office of the Governor of Arizona, USDA Forest Service, DOI Bureau of Land Management, Arizona Department of Game and Fish, Grand Canyon Forest Partnership, Gila County Board of Supervisors, Colorado State University, Grand Canyon Trust, Center for Biodiversity, Wilderness Society, Forest Trust, and others
- A 3-day workshop, involving 50 stakeholders, successfully operationalized ForestERA data and analytical tools in an effort to prioritize areas for management attention in the context of a landscape-scale restoration assessment
- A "Virtual Workshop" utilized state-of-the-art web approaches to engage participants in a time-efficient follow-up to the initial face-to-face workshop
- The ForestERA Project has completed "foundation data layers" detailing forest characteristics over the 2-million-acre Western Mogollon Plateau planning area,

including vegetation composition and three descriptors of forest structure. These data, the best available for the region, are now available to all stakeholders and potential users. The layers may be downloaded from the ForestERA web page (URL:

www.forestera.nau.edu)

- The project developed several new tools for modeling forest restoration treatments that implement, in a digital planning environment, various combinations of thinning and/or prescribed fire, at the landscape-scale
- Numerous presentations and workshop-based technology transfer efforts were carried out in conjunction with community, county, state, and federal partners
- Efforts to streamline scientific tools and provide a user-friendly interface for tested ForestERA tools advanced substantially during the performance period

DELIVERABLES:

1. ERI and the contractor will convene a planning workshop with technical representatives of the stakeholders to identify their individual and collective needs from this landscape assessment, for the purpose of specifying in greater scientific and technical detail the deliverables from this project. The result from this workshop will be a brief technical report that will serve as the basis for assessing project completion. The contractor will incorporate the primary points from this report into an expanded work plan, which shall be distributed, with the workshop report, to all stakeholders.
 - ForestERA assessed the needs of regional collaborators through personal interviews, collaborator survey sheets, and a collaborator planning workshop- **Completed**
 - Planning workshop- Completed in November 2001, following presentations/discussions at one national and one regional gathering of agency personnel and fire and resource managers- **Completed**
 - Stakeholder meetings- 12 meetings with individual stakeholders
 - Stakeholder survey- **Completed**
 - Results compiled in an updated Project Plan were distributed broadly at the end of January 2002- **Completed**
 - Information transfer - Comprehensive ForestERA Project website established to expand distribution of new information and progress on landscape analysis (supplements ongoing meetings with collaborators and stakeholders). URL: www.forestera.nau.edu
 - Project Plan and updates of key subprojects have been distributed to all interested parties, and over the ForestERA Project comprehensive website - **Completed**
 - In early 2004 this deliverable was appended to include the convening and support of a 3-part planning workshop focusing on the Western Mogollon Plateau Adaptive Landscape Assessment, convened by the Regional Forester and the Governor of Arizona. Reports for both this Assessment and the original ForestERA Project Plan will be completed by August 31, 2004 - **Completed**
 - Initial workshop completed in February; 2nd workshop – a “virtual workshop” in March 2004; third workshop scheduled for May 2004 - **Completed**
 - Communications with all stakeholders, including regular updates and invitations for participation in all project efforts, continue via email and web-based discussions - **Completed**

- Results and reports from workshops, data development, spatial analyses, and map creation are compiled in an updated Project Web Site that is accessible to all stakeholders 24/7 URL: www.forestera.nau.edu
 - Multiple manuscripts are being submitted to scientific journals. Manuscripts will be made available on the ForestERA Web Site as they are accepted for publication – **Completed**
 - **Final deliverables provided in Appendix titled “Task Order C: BLM Task Order 5”**
2. The contractor will work with scientists, agencies, and others to develop a data dictionary listing available spatial data for the study region. This will be updated throughout the life of the project.
- Available data identified
 - Comprehensive inventory of relevant data sources **compiled**
 - Project focused on key spatial data layers
 - Metadata was developed for all entries in the ForestERA data dictionary
 - Data dictionary is continually updated
 - Collaborations and data-sharing agreements have been established with federal agencies, perhaps most importantly with the Forest Service’s Forest Inventory and Analysis program
 - Data Dictionary was developed for the WMPALA Adaptive Landscape Assessment was produced and distributed to stakeholders in hard copy and digitally, via the ForestERA web site
 - WMPALA data dictionary - **Completed**
 - MOU with the Forest Inventory Analysis (FIA), USDA Forest Service, was signed and implemented, permitting cooperative work to integrate best-available data with ForestERA tools
 - **Final deliverables provided in Appendix titled “Task Order C: BLM Task Order 5”**
3. The contractor will acquire and assess for quality those data that are deemed to be most appropriate for the landscape analysis. These data will be incorporated into a GIS database.
- Work pending final examination of stakeholder analysis and data inventory
 - Previous ongoing research and discussions with experts was incorporated into this step
 - Available data was reviewed, and a subset deemed relevant and scientifically credible was incorporated into ForestERA data archives
 - Production of primary forest data layers was **completed**, involving integration of extensive ground data with satellite- and aircraft-based remotely sensed information
 - Initial analytical tools were developed and tested
 - New data from many sources, including USDA, DOI, State of Arizona, The Nature Conservancy, and various counties and communities were acquired, reviewed, and incorporated into the ForestERA database
 - New data were developed using innovative, interactive tools to capture local knowledge, recent changes, and historical information relevant to landscape analysis

- **Final deliverables provided in Appendix titled “Task Order C: BLM Task Order 5”**
4. The contractor will prepare a comprehensive report of the results of the landscape analysis, including a) text explaining the objectives, questions, hypotheses, methods, results, conclusions, and interpretations of the assessment; b) map-based graphical presentations of key results and conclusions; c) data-based deliverables that will illustrate and support the above; and d) a graphics-based, dynamic presentation of project results, suitable for informed, non-technical audiences.
- The preliminary (“Phase I”) was completed in September 2002 and was appended to the September 30, 2002 Southwest Fire Initiative Progress Report
 - Reports from the WMPALA process – **Completed**
 - **Final deliverables provided in Appendix titled “Task Order C: BLM Task Order 5”**
5. The contractor will make available to ERI and all stakeholders the complete database developed through this project, and will assist ERI and all stakeholders in making these data fully accessible for continuing research and forest management efforts throughout the study region.
- Broad distribution of data and analytical tools occurred during Phase II of the ForestERA Project (Oct. 2002 – Dec. 2003)
 - Broad distribution of data and analytical tools has occurred, with products distributed as soon as they became available over the ForestERA Web Site. Additional distribution efforts, via CD, are available upon request
 - Currently, foundational data are available for free download through the project website
 - Extensive efforts have succeeded in making available to ERI and to a broad community of stakeholders, all data and analytical tools produced by the ForestERA landscape assessment efforts
 - **Final deliverables provided in Appendix titled “Task Order C: BLM Task Order 5”**

**TASK ORDER D:
BLM TASK ORDER 6
GREATER FLAGSTAFF FORESTS PARTNERSHIP
(FORMERLY THE GRAND CANYON FORESTS FOUNDATION)
WOOD UTILIZATION**

PURPOSE: Funding was provided to the nonprofit, 501C3 Grand Canyon Forests Foundation so that the Greater Flagstaff Forests Partnership (the community-based partnership associated with the Foundation) can pursue market-based solutions for the utilization of small-diameter wood and continue to advance the work of the “Flagstaff Model.” (The Greater Flagstaff Forests Partnership and the Grand Canyon Forests Foundation have merged into the Greater Flagstaff Forests Partnership-GFFP).

Presently, the cost of thinning and restoration of degraded forests is subsidized by the federal government because the small-diameter wood resulting from the thinning is unmerchantable. The objective is to create markets for small-diameter wood that will pay for the thinning needed to reduce the threat of wildfire in the wildland-urban interface.

The “Flagstaff Model” of community-based forest restoration has received national attention as a strategy for accomplishing socially acceptable and scientifically based forest restoration. The objective is to continue advancing and developing treatments to meet the ten-year goal of treating 100,000 acres in the wildland-urban interface.

SUMMARY:

- Technology to use small-diameter wood has been identified
- Remaining challenges for utilization and economic development include creating a continuous and coordinated supply of material and investor’s desire to share risk.
- Biomass Energy Utilization Study **completed**
- Planning for the projects managed by the Partnership are **completed**, two projects, including the 1,700-acre Fort Valley project (Phase I of the total 9,100-acre project) were delayed due to drought and fire, forest closures, and lack of markets for small diameter timber
- Through competitive RFP grant program of GFFP, 6 grant proposals were evaluated and awards were made. \$195,000 in Enterprise Development Funds to 2 small businesses utilizing small diameter materials: \$100,000 to Total Timber, a new start-up company, to develop a bulk firewood processing and distribution operation; and \$95,000 to Indigenous Community Ventures to purchase a Wood Mizer mill to create dimension lumber out of small diameter wood for inclusion in their hogan construction projects
- Leveraged Funds- **\$15,000**
- Job creation- 1 FTE maintained, 1 Part Time (potential for generating many more jobs through small-diameter wood utilization)

DELIVERABLES:

1. Developing Economic Options for Utilization of Small-Diameter Wood

- Review of all pertinent studies, determine existing wood flow (forest to market) throughout the region- **Completed**
- Identify new, industry-established technologies that are appropriate for the GFFP- **Completed**
- Hired a new position in the Partnership to carry on the marketing and utilization work- **Completed**
- Contribute to building market and utilization options- **Completed**
- Biomass energy utilization study- **Final report delivered November 2002**; meetings with AZ Corp. Commission on biomass issues initiated early 2003 and ongoing; final report on “promotion” phase/task accepted **February 2004**
- Development of one or more marketing and/or utilization enterprises - Ongoing
 - Wood testing of the "emerging technologies" profiled in the *Utilization Study* (Mater Report) using Fort Valley ponderosa pine was conducted in cooperation with private business throughout Spring 2002. Conversations with these companies continue about investing and locating in Northern Arizona
 - As an immediate "next step" to the *Utilization Study*, the Partnership conducted "Small Diameter Wood Sawmill Site Assessments" in three locations across N. AZ: Williams, Winslow and Eagar, all locations were where previous sawmills were located and where current efforts are being made to reestablish the sites as small wood utilization cluster locations. This sawmill site information, along with the small- diameter test run sawmill report (Kinzua Mill, Pilot Rock, OR) from the logs used for the "emerging technologies" testing has been distributed to economic and community development officials and private forest industry consultants throughout northern Arizona. This information has then been distributed to interested sawmill companies and other investors with very favorable responses
 - Partnership staff continues to work closely with local and regional economic development officials and private forest industry consultants to attract and recruit various wood products industries to Northern Arizona
 - CROP (Coordinated Resource Offering Protocol) initiated July 2003; draft report submitted December 2003 & presentation made to GFFP January 2004; **final report April 2004**
 - Draft mobile MicroMill feasibility assessment report submitted February 2004
- Successful launch of one or more marketing and/or utilization enterprises in partnership with private and other public interests that are helping to move all of the small diameter wood generated by the GFFP projects as well as other fuels reduction projects regionally
 - Perkins Timber Harvesting's (PTH) new scrag mill near Williams is a direct result of Partnership participation; the Partnership's coordinator provided networking and contact information for a company in Idaho, originally intending to move their large log mill to Eagar. That company eventually sold PTH the small log scrag mill. PTH will be producing rail ties
 - With GFFP assistance and input, Perkins Timber Harvesting, in partnership with the City of Williams, received a US Forest Service 2002 EAP grant for a firewood operation for bulk firewood processing and distribution (both local and regional (CA) markets)

- Through the competitive RFP grant program of GFFP, evaluated 6 proposals and then awarded \$195,000 in Enterprise Development Funds to 2 small businesses utilizing small diameter material: \$100,000 to Total Timber, a new start-up company, to develop a bulk firewood processing and distribution operation; and \$95,000 to Indigenous Community Ventures to purchase a Wood Mizer mill to create dimension lumber out of small diameter wood for inclusion in their hogan construction projects
- **Final deliverables provided in Appendix titled “Task Order D: BLM Task Order 6”**

2. Implementing the Flagstaff Model/Greater Flagstaff Forests Partnership Core Support

a. Project Planning

- Renegotiated Cooperative Agreement with USDA Forest Service into MOU with Coconino National Forest in summer/fall 2003
- Airport Project- Cancelled due to land swap
- Arboretum- **Completed**
- Woody Ridge- ”Proposed Action” approved May 2003; “Environmental Assessment” and “Preferred Alternative” released early 2004; **“Decision” released March 2004**
- Elden project area-**Project completed early 2003**
- Mountaineer – Planning initiated February 2004
- Complete development of a standardized format for restoration plans, this includes:
 - Standardized Restoration Plan Outline- “Standardized Restoration Project Planning Template”- **Completed**
 - Monitoring Protocols- GFFP’s Multi-Party Monitoring Plan **completed Spring 2002**
 - Adaptive Feedback- Detailed in the document “Guide to the GFFP” and reiterated in the completed Multi-Party Monitoring Plan
 - Operational / Implementation standards- The Partnership adheres to Forest Service Best Management Practices, as well as actively monitors on-the-ground effects of in-woods operations with the sale administrator
 - Imperiled Species Mitigation- The Partnership follows all NFMA and ESA regulations in planning and implementing restoration projects
 - **Final deliverables provided in Appendix titled “Task Order D: BLM Task Order 6”**

b. Project Implementation

- Fort Valley Phase One (1700 acres)-All thinning treatments **completed**
- Phase II recommendations provided to FS; marking to begin summer 2004
- Elden Interface project-**Completed**
- Arboretum project- **Completed**
- Kachina Project Implementation Project approved - **Completed**
- **Final deliverables provided in Appendix titled “Task Order D: BLM Task Order 6”**

c. Science, Research, and Monitoring

- Design of a multiparty monitoring and evaluation system for Fort Valley- **Completed**, though the implementation of the Multi-party Monitoring Plan was held up by the lengthy forest closure during the summer of 2002 and the lack of a USFS Liaison for the Partnership. The departure of the former liaison effectively put a halt to the Partnership's formal Multi-party Monitoring Plan, although numerous other monitoring and research activities are occurring within and by the Partnership. The Multi-party Monitoring Team began monitoring activities in Fall 2002
- Annual presentation and synthesis of research findings to the Partnership- Research Reference Guide- **Completed**
- 2nd Edition completed and distributed; 3rd edition in production
- Participation in science conference hosted by the Ecological Restoration Institute on current knowledge in the field of restoration held in April 2002- **Completed**
- Negotiating separate Forest Service MOU with RMRS, PNWRS, SRS & FPL
- **Final deliverables provided in Appendix titled “Task Order D: BLM Task Order 6”**

d. Public Involvement

- Second Annual Forest Festival 2001-**Completed**
- Third Annual Forest Festival 2002- **Completed**
- Fourth Annual Forest Festival 2003 - **Completed**
- Significant media coverage of progress of GFFP-Consistent coverage in local newspaper and media; National Public Radio produced a story about the GFFP small wood utilization efforts in September 2002; extensive coverage also in 2003
- Public involvement in the work of GCFP through volunteer field programs- completed and ongoing through cooperation with the Grand Canyon Trust's new Volunteer Program. This program's major area of emphasis is forest restoration activities, particularly within the GFFP's Fort Valley Ecosystem Restoration Project. The latest in-field volunteer activity occurred August 24, 2003 (Chimney Springs restoration in Fort Valley)
- Initiated a collaborative Community Wildfire Protection Plan under HFRA- **Completed**
- **Final deliverables provided in Appendix titled “Task Order D: BLM Task Order 6”**

TASK ORDER E
BLM TASK ORDER 3
ERI OUTREACH AND EDUCATION

PURPOSE: The ERI will conduct workshops, organize conferences, expand community outreach, and develop communication tools to share the results of the adaptive management and research/monitoring efforts of forest restoration activities.

SUMMARY:

- Goals for outreach events, meetings with land management professionals and field trips to educate the media, public, and interested stakeholders-**Exceeded**
- Goals for educating land managers and professionals involved with thinning and restoration-**Exceeded**
- Goals for outreach to community leaders-**Completed**
- Goals for conflict resolution presentation and workshops-**Exceeded**
- Publications to translate science to the public and land managers- **Ongoing**
- Thirteen Southwest communities actively served through ERI technology transfer
- Congressional testimony delivered four times in the summer of 2002, and once in 2003
Numerous requests for information by both Democratic and Republican Members of the House and Senate fulfilled

DELIVERABLES:

1. The ERI initiated open forum discussions with the community through a number of events under the category of community workshops. The ERI facilitated and participated in these activities:
 - a. The “State of the Forest” event
 - **Completed**, April 2001/Repeated, April 2002
 - b. “Fort Valley Day” (historic tours and open house review of urban interface treatment areas)
 - **Completed**, April 2001
 - c. “Lone Tree Restoration Field Trip”
 - **Completed**, April 2001
 - d. “Hogans--a new market for small diameter trees”
 - **Completed**, April 2001
 - e. “Forest Health and Restoration Teacher Workshop”
 - **Completed**, April 2001
 - f. “Forest Education Open House”
 - **Completed**, April 2001
 - g. Two (2) Town Forums
 - **Completed**, Parks Community Forum, July 4, 2001
 - **Completed**, Flagstaff Town Forum, April 26, 2003
 - h. Six (6) meetings with community leaders

- Community capacity-building workshop, *Ecological Monitoring for Forest Restoration*, held in Albuquerque, New Mexico, September 16, 2002
 - Community capacity-building workshop, *Forest Restoration and Rehabilitation Field Tour: Opportunities for Youth*, Taos and Los Alamos, New Mexico 9/26-9/27
 - Community capacity-building workshop, *Ecological Restoration and the New Communion With Nature* Flagstaff, Arizona 6/6/02-6/8/02
 - Community capacity-building workshop, *Nature, Work, and Community*, Flagstaff, Arizona 7/18/03-7/20/03
 - **Final deliverables provided in Appendix titled “Task Order E: BLM Task Order 3”**
- Three conference sessions on conflict resolution and community building-**Completed**
 - *Fighting Words: Rhetoric and Values in Ecological Restoration Conflicts*, 9th International Symposium on Society and Resource Management, 6/2-5, 2002
 - *Restoration and Rhetoric: Language and Values in Restoration Conflicts*, presented at the Ecological Society of America/Society for Ecological Restoration, Tucson, Arizona, August 9, 2002
 - *Building Forest Restoration Businesses and Practices*, Durango, Colorado 12/1-12/3/2002
 - Financial support to jump-start communities
 - Parks, Arizona
 - Technical Assistance provided by the ERI to 13 communities in the Southwest region
5. A steady diet of research project information and emerging scientific findings will be delivered to the community. This will be achieved through video news releases (marketed to regional television stations), a tabloid publication to be inserted into the daily paper, a publication reporting research findings, the planning of a 30-60 minute documentary on ecological restoration, and radio spots produced under the program name of "Earth Notes."
- a. Video news releases (several videos have been sent to Mike Haske):
 - Mixed-conifer research/llamas, **June 2001**
 - Leupp School Hogan project (Navajo Reservation), **June 2001**
 - Small-diameter construct for Hogans, **November 2001**
 - Prison crews assist homeowners with restoration, **August 2001**
 - CNN special on fire, **July 2002**- ERI provided people, video footage and story development
 - American Frontiers visit to Coconino National Forest-Partnership with National Geographic, BLM, Forest Service and National Park Service, **August 2002**
 - b. Tabloid for community
 - Completed and released in **April 2002**
 - c. Publications
 - 8 scientific publications and many in press January 30, 2002- Seven additional scientific papers published or in press by September 30, 2002

- 12 scientific presentations by January, 30, 2002- Nineteen additional presentations made by September 30, 2002
 - Invited testimony by Wally Covington: Senate Resources Committee 7/16/02; Senator Kyl hearing in Phoenix 8/20/02; House Resources Committee 9/5/02; Field Hearing, House Resources Subcommittee on Forest and Forest Health, Show Low, AZ 9/28/02
 - Requests for information from Congressional members provided. Congressional members include: Congressmen DeFazio, Hayworth, Shadegg and Flake. Senators include: Kyl, Feinstein, Bingaman and McCain
 - Four management notes oriented to practitioners-**Exceeded**
 - *Restoring the Uinkaret Mountains: Operational Lessons and Management Practices* July, 2002
 - *Understory Plant Community Restoration in the Uinkaret Mountains*, July 2002
 - *Protecting Old Growth Trees from Prescribed Fire*, November 2002
 - *Fire Risk Reduction using Restoration Treatments for Homeowners in the Wildland Urban Interface*, December 2002
 - *Fuels Treatments and Forest Restoration: An Analysis of Benefits*, May 2003
 - *Limiting Damage to Forest Soils During Restoration*, August 2003
 - *Fire Risk Reduction using Restoration Treatments for Homeowners in the Wildland Urban Interface*, December 2002
 - **Final deliverables provided in Appendix titled “Task Order E: BLM Task Order 3”**
 - Trumbull Brochure-January 2002 -**Completed**
 - 7 Newsletters to land management organizations, media, key political leaders and students: summer 2001, fall-winter 2001, spring 2002, summer 2002, fall and winter 2002, **spring 2003, and summer 2003- Completed**
 - **Final deliverables provided in Appendix titled “Task Order E: BLM Task Order 3”**
- d. 30-60 Minute Documentary
- “Sacred Balance” is a four-hour television series produced by the Canadian Broadcasting Company (CBC) and Public Broadcasting Station (PBS) with input from the ERI. The program sets out to explore the belief that once we reclaim our ancient understanding of the intimate, indissoluble connection between ourselves and the planet, we will change the way we act toward it- **Completed**, release dates for the four episodes: October 13, October 14, October 20 and October 21, 2002
 - 5-7 minute video to promote forest ecology, awareness of natural processes, an understanding of unhealthy forest conditions, and forest restoration projects- **Completed**
 - 10 radio spots called, “Earth Notes” reaching a listening audience of 50,000 people-**Completed**
- e. A report every nine months demonstrating progress towards the outreach and education goals, listing training, workshop, town meeting, and conference activities.

- January 31, 2002, September 30, 2002, June 30, 2003, final report December 31, 2005- **Completed**

**TASK ORDER F:
BLM TASK ORDER 2
TRAINING**

PURPOSE: By September 30, 2001, the ERI will assist the BLM with the development of a training module for interdisciplinary resource professionals. BLM will provide the leadership as far as setting the times, length of the module, and participants in the development. The modules will cover the fundamentals of conservation biology and ecological restoration necessary to design landscape-level restoration activities. Overall coordination and presentation of the workshop remains the responsibility of the BLM.

SUMMARY:

- The ERI is actively collaborating with the Bureau of Land Management, National Park Service, and United States Forest Service to develop training that will increase the knowledge and technical skill of land managers to develop ecological restoration treatments - **Ongoing**
- First intensive one-week fire ecology and restoration workshop was held in April 2003 in Flagstaff, Arizona

DELIVERABLES:

A report every nine months demonstrating progress towards the goals established with the BLM on training module design and implementation. Collaborating with the agencies on training did not proceed as planned. Initially we focused on working with the agencies to help design or augment existing training programs. However, we felt more training was needed than provided in a single presentation. In April 2003 the ERI conducted a Fire Ecology and Ecological Restoration at Northern Arizona University for land managers. In addition we continue to work with several tribes to design and implement a workshop structured to meet their needs.

- ERI staff met with the BLM several times to collaborate on national training and a national introductory session. The ERI worked collaboratively with the BLM on a workshop held in Flagstaff, Arizona in fall 2003 and then completed a second training workshop during September of 2004
- The ERI is worked with Mark Phillips of the BLM National Training Center to develop a biodiversity course entitled “Collaborative Ecosystem Assessment and Conservation.” The work of the ERI has been **completed** unless the NTC wants additional help in the development of the lesson plans
- The ERI worked with Don Washco of the BLM National Training Center to help develop a new course to supplement or replace “Technical Fire Management.” This work is ongoing and is a collaborative effort between the ERI, Northern Arizona University School of Forestry, and the National Training Center
- A training course for fire managers, natural resource managers, and cultural resource managers scheduled for November 2002 and organized by the National Park Service was cancelled. The Ecological Restoration Institute was involved in the planning and teaching of part of the course.

- The ERI worked with the National Advanced Resource Technology Center to develop collaborative training opportunities-**Ongoing**
- Report on progress-Completed, January 31, 2002, September 30, 2002, June 30, 2003, March 31, 2004, **and December 31, 2005**
- **Final deliverables provided in Appendix titled “Task Order F: BLM Task Order 4”**

TASK ORDER G
BLM TASK ORDER 5
MOUNT TRUMBULL

PURPOSE:

The ERI will conduct research/monitoring at Mt. Trumbull, in collaboration with BLM's Arizona Strip Field Office. Funding/in-kind contributions by ERI toward completion of this work will not be used to cover field operations.

SUMMARY:

- Research and monitoring designed to understand and develop landscape-scale or operational scale treatment continues at the largest research site in the Southwest
- Findings from this research are incorporated into treatment planning and environmental review throughout the Southwest
- This project produced more 6 publications in 2001, and more than 10 presentations in 2002-2003
- This project expands knowledge on the effects of large landscape treatments on certain wildlife species

DELIVERABLES:

1. ERI/NAU will provide the Assistance Representative with the following deliverable—Annual Report on each of the following research/monitoring initiatives:
 - a. PERMANENT PLOTS. Remeasurement of all treated permanent plots across the Mt. Trumbull landscape (anticipate total of 200 plots by FY02). All variables (tree, shrub, and herbaceous composition and structure, fuels, canopy cover, photos) were measured 1 and 5 years after treatment; herbaceous response will be measured each year.
 - Measurements of the permanent plots - **Completed**
 - The network of permanent plots at Mt. Trumbull comprises the basic monitoring system for the largest landscape-scale ecological restoration experiment in the Southwest. A total of 23 plot re-measurements were carried out in 2001 (the total of “200 plots” in the project description was a typographical error), several of these for the fourth or fifth time. The three oldest treatment plots were re-measured in 2002
 - Herbaceous and canopy cover measurements, and photo documentation was completed on 3 treated plots in 2003
 - Approximately 110 research plots, both control and treated, were remeasured during the summer of 2003. Photos were taken at the original photo points. The oldest of these plots date back to the initiation of ecological restoration activity at Mt. Trumbull in 1995-**Completed**
 - **Final deliverables provided in Appendix titled “Task Order G: BLM Task Order 7”**

- b. **EXPERIMENTAL BLOCKS** for controlled testing of the effects of ecosystem restoration manipulations are an important component of the landscape-scale sampling at Mt. Trumbull. The experimental blocks were established at a series of five controlled study sites. Each block consists of a nominal 80-acre area divided into two similar units. Treatments—(1) ecosystem restoration and (2) control—were randomly assigned to each unit. All pre-treatment data, including vegetation, small mammal, soil seed bank, butterfly community, and edge effect, were collected in 1998. Treatments on blocks 1-4 were completed in the winter of 1999/2000. Block 5 was treated by 2001. Herbaceous response in all blocks were remeasured (200 permanent plots) every year.
- Post-treatment measurements were completed in 2000, 2001, and 2002 on all plots in experimental blocks 1-4 (total of 180 permanent plots). We will re-measure EB5 when treatment is complete. A series of publications aimed at scientific and general audiences are in progress
 - All plant specimens that were collected in 2001 and 2002 have been identified
 - Completion of one peer-reviewed publication
 - **Final deliverables provided in Appendix titled “Task Order G: BLM Task Order 7”**
- c. **HIGH-INTENSITY FIRE STUDY.** Stand-replacing fires are increasingly common in ponderosa pine forests due to the high tree densities and heavy fuels accumulated over a century or more of fire exclusion. What kind of ecosystem structures and habitats appear following high-intensity fire? Can these fires recreate conditions similar to presettlement forest patterns, or do different ecosystem structures emerge? To answer these questions, this study focused on measuring ecosystem structure (trees, shrubs, grasses, forbs, dead biomass) in sites burned with high-intensity fire, reconstructing pre-burn conditions where possible, and comparing present and forecast conditions over the burned area. Two severe wildfires at Mt. Trumbull were sampled in 1996, the Lava fire (approximately 20 acres) and the Logan fire (approximately 150 acres), paired with a complementary study of a high-intensity 1996 wildfire at the Michilía study site in Durango, Mexico.
- All wildfire sites at Mount Trumbull were re-measured in 2002 to determine patterns of successional change
 - Fire hazard analysis- **Completed**
- d. **FIRE ECOLOGY MODELING.** Frequent, low-intensity fire regimes are characteristic of ponderosa pine throughout its range, but specific knowledge of the characteristics of presettlement fire patterns at Mt. Trumbull are important to guide the re-introduction of fire and to permit future evaluation of the restored fire disturbance regime. Sampling for fire history reconstruction based on dendrochronological measurement of fire-scarred trees, stumps, and logs has been completed at Mt. Trumbull to estimate the frequency and seasonality of presettlement fire as well as determining the date of fire exclusion and developing a record of any postsettlement fires. These data will be used in fire behavior models to examine (1) historic landscape fire regime, (2) changes in fuel structures and fire behavior between 1870 (presettlement), 1995 (pretreatment), and 2000 (post treatment). This analysis addresses the effects of restoration on large-scale fire events.

- The data collected on the treated and controlled landscapes have been checked and the data layers have been prepared for the Farsite and Flammap analysis.
 - M.S. thesis completed (Roccaforte, 2005); two manuscripts in preparation.
 - **Final deliverables provided in Appendix titled “Task Order G: BLM Task Order 7”**
- e. LEPIDOPTERAN RESPONSE. Butterflies may be potential indicators of arthropod communities, bird communities, and even forest health. Because of this, we monitored butterflies (abundance, composition, life stages) in the Mt. Trumbull ecosystem area across the experimental blocks and larger landscape. In addition to the sampling at Mt. Trumbull, we monitored butterfly populations in remnant areas that might represent forests of presettlement time. These include isolated plateaus of the North Rim of Grand Canyon National Park, including Fire Point, Powell Plateau, and Rainbow Plateau.
- Butterfly abundance and species richness were found to be higher in restored sites compared to control sites. These differences appear to be related to increased sunlight in the thinned stands. Results from this study are included in a doctoral dissertation (2001) and two manuscripts that were submitted for peer-reviewed publication in 2002
 - Completion of one peer-reviewed publication
 - **Final deliverables provided in Appendix titled “Task Order G: BLM Task Order 7”**
- f. SMALL MAMMAL COMMUNITIES AND HANTAVIRUS RESULTS of 1998 blood sampling revealed that hantavirus was most prevalent in brush mice (*Peromyscus boylii*; 17.3%), less prevalent in pinyon mice (*P. truei*; 10.4%), and least prevalent in deer mice (*P. maniculatus*; 4.7%). We found more antibody-positive male brush mice than females. We did not detect significant differences in the sex ratios of antibody-positive pinyon mice and deer mice. Our findings regarding brush mice were consistent with previous studies. However, blood-sampling results from pinyon mice and deer mice may indicate inconsistencies with other findings. Measurement and analysis of initial responses will continue in FY01-02. Small mammal responses will be analyzed both in terms of community response in years 1, 2, and 3 years after treatment, as well as detailed study of habitat use (logs, branches, shrubs, etc.) by radio-tagged mice.
- **Fieldwork was completed for this study in 2001.** Small mammal communities were measured and hantavirus infection levels assessed. Behavior of radio-tagged mice was measured in one of the experimental sites. Habitat use was measured.
 - Data presented in M.S. thesis - **Completed**
 - **Final deliverables provided in Appendix titled “Task Order G: BLM Task Order 7”**

**TASK ORDER H1:
BLM TASK ORDER 8
DIRECT FEDERAL TRANSFER
GRAND CANYON NATIONAL PARK**

PURPOSE:

The purpose of this task order is to provide resources to the Grand Canyon National Park. Dense areas of untreated forest surround the Park's North Rim and South Rim village communities, with few roads for safe evacuation in the event of fire. This problem was clearly demonstrated during summer 2000, when a 13,000-acre wildfire separated residents of the North Rim village from their principal evacuation route. The purpose of this task order is to provide resources to Grand Canyon National Park to implement and test forest thinning and restoration in dense forests in close proximity to visitor activity to reduce the threat of unnatural wildfire.

SUMMARY:

- Environmental review **completed**
- Thinning on 80 acres-**Completed 2002**
- Burning on 120 acres- **Completed**

DELIVERABLES:

1. By September 30, 2001. Public meetings to provide information and receive comment from interested public about proposed treatments. Timing to follow public release of the environmental assessment.
 - The *Environmental Assessment and Assessment of Effect for Research on Wildfire Hazard Reduction in Ponderosa Pine Ecosystems at Grand Canyon National Park* was released for public review and comment on April 22, 2002. Public meetings to provide information and receive comment were held in Grand Canyon, AZ (May 7, 2002), Flagstaff, AZ (May 8, 2002) and Kanab, UT (May 9, 2002). Public comment was generally neutral to favorable, with several people who formerly opposed the project speaking in favor of the current plan. Following review and analysis of public comment, the National Park Service issued a Finding of No Significant Impact (FONSI) for the project on August 1, 2002. Intermountain Regional Director Karen Wade approved the FONSI based on the environmental assessment/assessment of effect (AE/AEF) recommended by Grand Canyon National Park Superintendent Joseph F. Alston
2. During summer 2001 and/or 2002. Necessary pre-treatment compliance surveys were conducted for special status species, especially Mexican spotted owl and northern goshawk, and for other sensitive resources in treatment area.
 - The experimental sites were surveyed for Mexican spotted owl (MSO) and northern goshawk in 2001 and 2002. No nests of either species were found within proposed treatment areas. Informal consultation was initiated with the US Fish and Wildlife Service (USFWS) during April 2002. However, on April 4, 2002 a single male MSO call was detected at the Grandview site. Subsequent surveys on April 20, April 23,

April 24, and April 25 failed to detect MSO calls within proposed treatment areas. Following further informal consultation, the Superintendent sent a letter to the USFWS in which he agreed not to begin treatments on the South Rim until after the MSO breeding season, after September 15, 2002. The USFWS concurred on June 17, 2002 with a written determination of "may affect, but not likely to adversely affect" for MSO and California condor

3. By September 30, 2001 or September 30, 2002. Thinning of two 40-acre blocks, timing contingent on compliance, contracting, and logistical details.
 - Following release of the FONSI, Grand Canyon National Park contracted with the Northern Arizona Conservation Corps to carry out thinning treatments on the North and South Rim. North Rim thinning treatments began September 4, 2002 and took 9-12 weeks to complete. South Rim treatments began in fall 2002 after the North Rim treatments were completed. **South Rim treatments were completed**
4. By September 30, 2002. Prescribed burning of two 60-acre blocks, to be scheduled during the fall season following thinning, contingent to regulatory requirements and appropriate burning conditions.
 - Fire restrictions were implemented in Grand Canyon National Park on May 18, 2002 due to unprecedented drought and extreme fire danger conditions. While the restrictions have since been lifted, several planned burns were delayed. Thinned trees are being piled and scattered for burning on the North Rim. **Burning is completed.**

**TASK ORDER H2:
DIRECT FEDERAL TRANSFER
COCONINO NATIONAL FOREST**

PURPOSE: To provide financial resources to the Coconino National Forest for forest restoration and thinning treatments in the wildland-urban interface around Flagstaff, Arizona. The objectives are to reduce the threat of wildfire in the wildland-urban interface using thinning and restoration treatments and to further demonstrate to the community ecologically based restoration actions.

SUMMARY:

- **890 acres were planned for thinning during summer of 2002, due to project changes 920 acres were treated for a net gain of 30 acres**
 - 200 acres thinning completed on the Skunk Fuels Reduction Project during summer of 2002
 - 720 acres of thinning awarded and under contract for the A1 Ecosystem Management Project September 2002- Completed
- 7,000 acres were approved for treatment in Kachina Village following the successful completion of NEPA requirements.
- Surveys for environmental review documents were completed on 30,000 acres
- Job creation- 3 Part-time
- 20-acre meadow restored, using fencing created by restoration thinning

DELIVERABLES:

1. Complete NEPA-EIS for 7,000 acres of treatments at Kachina Village/Mountaineer by March 31, 2002
 - Draft EIS completed in August, 2002
 - Completed EIS by December, 2002
 - **Completed**
2. Restore 20 acres of meadow, install pole fence, and obliterate ½ mile of road
 - **Completed**, using volunteer labor and poles purchased from local business
3. Riparian Project: restore 5 acres of spring
 - **Completed**
4. A1-Thinning: Complete 90 acres of thinning and piling in the wildland/urban interface
 - Goal changed to 720 acres. **Completed**
5. Airport Implementation: 830 acres of thinning and slash piling in wildland/urban interface to be completed by September 30, 2002
 - The airport project was **cancelled** due to a land exchange
 - Treatment acreage was transferred to 200 acres at the Skunk Project Area and to A-1 Mountain, #4 above
 - 200 acres at Skunk Project- **Completed**

6. Woody Ridge Out-year: Biological, archeological, fuels, road, and recreation inventory to be completed by September 30, 2001 for future NEPA projects
 - 30,000 acres **completed** in October, 2001

TASK ORDER I
BLM TASK ORDER 10
DIRECT FEDERAL TRANSFER
BUREAU OF LAND MANAGEMENT- ARIZONA STRIP DISTRICT FIELD OFFICE

PURPOSE: to provide resources to the BLM/Arizona Strip District Field Office that will facilitate continued ecological restoration research.

SUMMARY:

- 295 acres of thinning at Nixon Springs-**Completed**
- Partial funding transferred to support ongoing research on wildlife conducted by the Arizona Department of Game and Fish

DELIVERABLES:

1. Complete thinning at Nixon Springs by March 31, 2002.
 - **Completed**
2. Reimburse the operation account impacted by funding transferred from the account to Arizona Game and Fish for research conducted during FY'2001.
 - **Completed**

CONCLUSION

Work funded by this cooperative agreement is complete and all FY'01 funds have been exhausted. The activities listed in this progress report support the four Congressional goals established for the Ecological Restoration Institute in the fiscal year 2001 Department of Interior and Related Agencies Conference Report 106-914.

The program of work approved and supported by the BLM has enabled the ERI and our many partners to advance the goals of the National Fire Plan and the Western Governors' Association "10 Year Comprehensive Strategy". This work contributes to:

1. Agency efforts to design and implement comprehensive forest restoration treatments;
2. Community collaborative forestry efforts designed to engage local citizens in managing public resources;
3. Develop private business and investment that will assist in the utilization and removal of small diameter wood;
4. Develop landscape-scale assessment tool that will help land managers and communities identify and coordinate treatments that will protect important natural resource values throughout the forest.

The severe fire seasons of 2000, 2002 and now 2003 provide the incontrovertible evidence that the integrated work of the ERI is critically needed at a rapid pace and at a large scale. The ERI will continue to bring solid, practical and understandable science to land managers, communities, decision-makers and stakeholders at the local, state, regional and national level. Public and Congressional awareness of the problem of degraded forest health and unnatural wildfire has never been greater. Fortunately, there is a solution. The ERI is grateful to have the human and financial resources needed to help the federal agencies design, implement and achieve that solution.