Landscape Strategy for the 4 Forest Restoration Initiative

Overview: The 4 Forest Restoration Initiative (4FRI) is a collaborative, landscape-scale restoration effort across 2.4 million acres of ponderosa pine forest on National Forest System lands in northern Arizona. Working collaboratively with 4FRI stakeholders, the U.S. Forest Service (USFS) has developed this landscape strategy to guide future 4FRI planning and to accompany a 4FRI proposal for funding under the Collaborative Forest Landscape Restoration Program. This strategy is substantially complete and will be finalized in late 2010. The finalized landscape strategy will provide a framework that contributes information, analysis outputs, and guidance for a landscape-scale, multi-faceted restoration program. This strategy provides an overview of the effort and the need for active ecological restoration. Priority areas for future restoration activities are identified, along with an overview of how the 4FRI incorporates best available science and a strategy for engaging appropriately-scaled wood products industries. Additional information needs and analytical steps needed to finalize this strategy are discussed herein. This document is not a decision document, but, rather, is meant to be a synthesis of data that identifies existing landscape conditions and establishes a programmatic context for subsequent decision-making processes under the 4FRI.

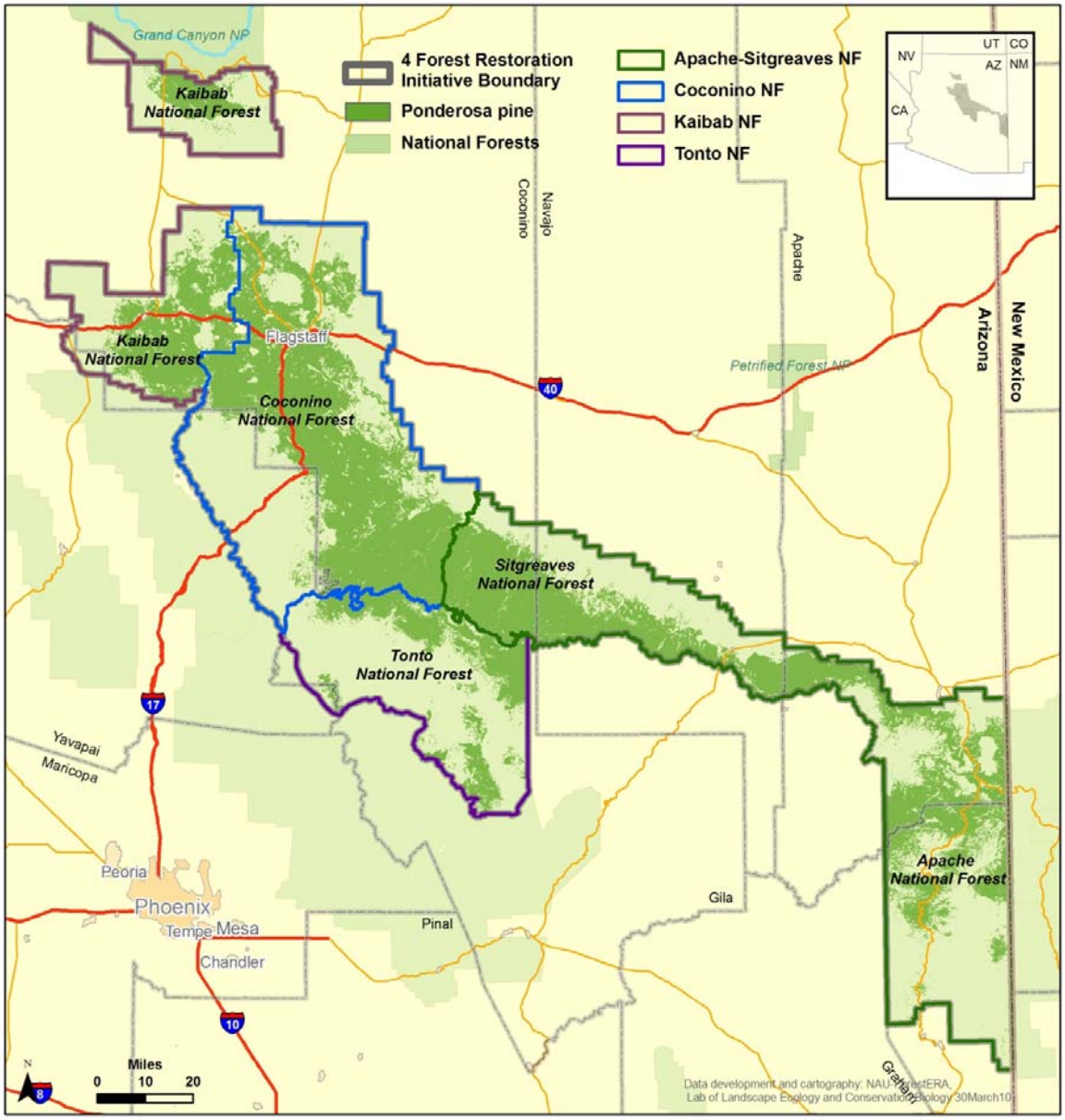
I. Introduction

Ponderosa pine forests stretch almost continuously from the south rim of the Grand Canyon in north-central Arizona, across the vast Mogollon Rim to the White Mountains of eastern Arizona. Forests across this expanse surround and support communities, and provide invaluable wildlife habitat, recreational resources, and ecosystem services, ranging from clean water supply to carbon storage. Unfortunately, these forests have been degraded by unsustainable historical land uses and are threatened by unnaturally severe fire and climate change. There is an urgent need to restore northern Arizona's ponderosa pine forest ecosystems to reestablish ecosystem resiliency, restore beneficial natural fire regimes, sustain native biodiversity, and protect communities from unnaturally severe fires.

In order to fulfill a collective desire to move forward rapidly to implementation of accelerated, landscape-scale forest restoration, a group of stakeholders and the Forest Service created the 4FRI to address ponderosa pine forest restoration on the four National Forests in northern Arizona: the Apache-

Sitgreaves, Coconino, Kaibab, and Tonto National Forests.[1] Figure 1 illustrates the scale of the 4FRI, which covers 2.4 million acres of ponderosa pine forest, the vast majority (94%) of which exists on contiguous National Forest System lands.[2]

Figure 1. Map of the 4FRI area showing the ponderosa pine belt that stretches across the four northern Arizona National Forests.



[1] See Appendix A for a list of stakeholders involved in the 4FRI.

[2] This area was identified in the *Analysis of Small-Diameter Wood Supply in Northern Arizona* (Hampton et al. 2008). The 4FRI landscape strategy covers all 2.4 million acres of the ponderosa pine belt in northern Arizona.

The 4FRI is an outgrowth of nearly a decade of collaborative efforts and analyses focused on accelerating forest restoration in northern Arizona. Prominent among these collaborative efforts have been those of the Natural Resources Working Group in the White Mountains of eastern Arizona, the Greater Flagstaff Forests Partnership in the Western Mogollon Rim area, and the Arizona Governor's Forest Health Councils. The central theme of these activities has been the broadly-recognized need to accelerate forest restoration and to shift restoration and management efforts from a short term, project-by-project basis to an integrated, landscape-scale program. After years of gridlock, resulting from intense disagreement over the direction of forest management, there is now an opportunity as a result of this collaborative work to move forward with accelerated, landscape-scale restoration at an unprecedented pace and scale. The current social support for landscape-scale restoration in northern Arizona presents an historic opportunity that should be recognized and acted upon immediately. The 4FRI's primary objective is to assure that the science-based and socially-acceptable agreements forged over the past several years result in implementation of long-term, landscape-scale forest restoration as soon as possible.

The overarching goals of the 4FRI are to undertake landscape-scale restoration that will support:

- resilient and diverse forest ecosystem structures, processes, and functions (including heterogeneous forest structures in terms of the age, size, and spacing of vegetation);
- enhanced biodiversity conservation at multiple spatial scales;
- reduce unsustainable densities of post-settlement trees and enhance forest resilience so that low-intensity, frequent fire and other natural processes can operate to the fullest extent possible;
- thriving communities in forested landscapes that pose little threat of destructive wildfire;
- forest restoration treatments with limited negative impacts to wildlife, soils, aquatic systems, and other ecological processes;
- maintenance of water quality and improvements to watershed conditions;
- the maintenance and development of old growth trees;
- use of best available science, monitoring, and adaptive management to inform decision-making, and;
- appropriately-scaled, sustainable, forest products industries that strengthen local economies, while conserving natural resources and aesthetic values (a key premise of the 4FRI is that landscape-scale restoration will only be possible with the support of wood products enterprises

that create value for harvested material such that the costs of restoration are offset substantially, allowing restoration to move forward more rapidly over larger areas).

Specific implementation goals of the 4FRI are to:

- promote restoration and reduce hazardous fuels through mechanical thinning of up to 50,000 acres per year across the four forests (up from a current rate of ~17,000 acres per year);
- allow for reestablishment of frequent, low-severity fire as a key process in this ecosystem, including increased use of prescribed fire following mechanical thinning and increased management of wildland fires for restoration objectives, and;
- engage new industry such that all, or nearly all, of the cost of removal of material is covered by the value of the products removed.

II. Ecological Need for Active Restoration

Ponderosa pine ecosystems in the 4FRI area were shaped through time by a variety of natural processes, including frequent, low-intensity surface fires, episodic regeneration, insect infestations, and regional climate events such as droughts. These processes contributed to heterogeneous forest spatial patterns at local and landscape scales with pattern shifts through time within a natural range of variability (Allen et al. 2002). Since European settlement, pervasive changes have homogenized the structure and altered the natural processes of these forest ecosystems. Livestock grazing, through the removal of fine fuels, and fire suppression have promoted unnaturally dense stands of small trees. Logging has decreased the number of old and large trees. Old growth ponderosa pine forests have become rare, and meadows have shrunk due to tree encroachment. A primary driver of these ecological changes has been the absence of frequent, low-intensity fire.

Current conditions inhibit the survival and recruitment of large trees through competition and threaten the maintenance of ecological systems by fueling increasingly extensive crown fires. In the 4FRI area, fires are at risk of burning at a severity, frequency, and scale outside the natural range of variability (Swetnam and Betancourt 1998, Westerling et al. 2006). High-intensity crown fires can alter successional trajectories of post-burn vegetation, creating entirely different communities than those existing before such events (Savage and Mast 2005, Kuenzi et al. 2008). Landscape scars that are created by total canopy destruction may persist as grasslands, shrublands, or small tree thickets for

decades to centuries. In severe post-fire habitats, invasive plant, animal, and pathogen species have an increased competitive advantage (Sheley and Petroff 1999). The aftermath of such fires includes short term amplification of erosion and flooding. An increase in number, size, and severity of stand-replacing fires has affected and continues to threaten both human and ecological communities. If the current trajectories of anthropogenically-driven change continue, serious ecological damage to ponderosa pine ecosystems within the 4FRI will accumulate and, with global climate change, likely accelerate.

Overall levels of biodiversity have also been diminished as a result of these pervasive ecological changes. The development of dense, closed-canopy overstory conditions has substantially reduced or eliminated understory production and species richness and has altered ecosystem and hydrologic function across northern Arizona. Historically, fire-based disturbance regimes created patchy, structurally heterogeneous forest structure with multi-aged stands dominated by old trees interspersed with regenerating trees and grassy openings (Covington and Moore 1994, Allen et al. 2002, Fulé et al. 2001). Openings are now fewer, smaller, and fragmented patches with decreased rates of litter decomposition and increased fuels accumulation (Sabo et al. 2008). Wildlife, fish, and native plant habitats are threatened by decreased habitat resiliency, a loss of structural heterogeneity, and habitat loss due to uncharacteristic disturbance events. Following high-severity fire, riparian and aquatic habitats are also at risk from excessive erosion pulses, loss of riparian vegetation, and lower water yields (Baker 1990, Cain et al. 1997). Nutrient cycling dynamics also have been disrupted. Future climate patterns are predicted to put fish and wildlife habitats at further risk.

A Strategy for Active Ecological Restoration

The goal of the 4FRI is to achieve ecological restoration across the ~2.4 million acres of contiguous ponderosa pine forest on National Forest System lands in northern Arizona. Restoration can be defined as a suite of intentional actions that initiate or accelerate ecosystem recovery with respect to health (functional processes), integrity (composition & structure), and sustainability (resilience & resistance to disturbance). Restoration attempts to return an ecosystem to its historic trajectory, although a restored ecosystem may not necessarily recover its former state since contemporary constraints and conditions can cause it to develop along an altered trajectory. The overall goal of 4FRI treatments is to reset ecosystem trends towards a natural range of variability and to reestablish natural processes, particularly the presence of frequent, low-intensity fire.

4FRI treatments will be designed to:

- facilitate the reestablishment of a multi-scale mosaic of age and structural classes and reduce hazardous fuels through mechanical thinning on up to 50,000 acres annually across the four forests;
- increase the use of prescribed fire following thinning treatments, and;
- set the stage for increased management of wildland fires to meet restoration objectives.

More specifically, mechanical thinning treatments will retain pre-settlement trees, retain post-settlement trees as needed to establish a range of desired forest conditions, and thin and remove hazardous fuels in order to allow for the reintroduction of increased levels of low-intensity, frequent fire. Together, these activities will work together to approximate the natural range of conditions in southwestern ponderosa pine forests (Long and Smith 2000).

Treatments will be designed in order to create heterogeneity in forest composition and structure and will be designed to achieve a range of post treatment conditions with regard to vegetation structure and composition to effectively reduce fire danger, improve wildlife habitat and overall levels of biodiversity, and improve forest ecosystem resiliency in the long term (Covington et al. 2001; Omi and Martinson 2004). Successful restoration will allow low-severity fire to easily and inexpensively shape forest conditions in the future – and this, in turn, will reduce the need for future maintenance thinning.

Direction for maintenance and recruitment of old-growth

Current US Forest Service Inventory and Analysis (FIA) plots in the ponderosa pine forest type of the 4FRI area (n = 277) show an average of >550 trees per acre (tpa) and an estimated 88% of trees <12" diameter at breast height (dbh). These data indicate that the 4FRI landscape is dominated by high densities of small-diameter trees and relatively closed canopy structure. Areas of high tree density and canopy closure are more susceptible to fire, drought, and insect and disease infestations. Because of their age, old growth trees are hard to replace, and current rates of treatments to restore ponderosa pine are not keeping pace with the risks to old growth. Comparisons of FIA and historical forest inventory data (Woolsey 1912) suggest that there are relatively few old or large diameter trees, large snags, or large logs. Comparisons of historical and contemporary data can be problematic (Bell et al. 2009), however the number of existing large trees are at the low end of historical estimates.

Landscape level treatments in the 4FRI area will reduce the risk to existing old growth from wildfire, insect and disease, and drought, and set the stage for successful recruitment of future old growth by reducing tree densities. The 4FRI collaborative group has clearly articulated that no old-growth trees should be removed as part of the 4FRI effort. Given the threats to old-growth trees and the recruitment of new old-growth trees, the Forest Service has no intention to include old-growth tree removal as part of 4FRI projects in the future. Additionally, guidance for old growth is provided in the Land Management Plan for each Forest in the 4FRI area. All Forest Land Management Plans in the Southwestern Region were amended in 1996 to update guidance for old growth, as well as for Mexican spotted owls and northern goshawks. The guidance describes structural attributes for old growth by vegetation type as well as the minimum percentage of old growth required across the landscape.

Direction for road establishment, decommissioning, maintenance, and rehabilitation

No permanent roads will be constructed under the 4FRI. Construction of temporary roads and upgrades, road maintenance and rehabilitation, and relocation of existing roads will occur as needed for implementation and where it benefits resources. Projects will be designed to minimize the need for and impact of temporary roads. USFS staff are conducting comprehensive evaluations of transportation systems as part of travel management planning across the four forests, and travel management plans will likely be completed starting in 2011. 4FRI planning will coordinate closely with these teams and plan for decommissioning of roads in accordance with opportunities identified in travel management plans. 4FRI project planning and contracting will require additional travel analysis to identify needs and opportunities for road maintenance, decommissioning, and associated costs.

III. Assessment and Planning

Planning under the 4FRI has three primary objectives: 1) forest ecosystem restoration across the 2.4 million-acre 4FRI area; 2) protection of communities from uncharacteristically severe wildland fire; and 3) the successful engagement of sustainable wood products industries to support local economies and make accelerated, landscape-scale restoration economically-viable. 4FRI planning builds upon a vast amount of collaborative work that has already been completed to identify values-at-risk, priority areas for forest management activities, and the potential for wood products availability as a result of restoration activities. Future 4FRI planning will continue to be done collaboratively with stakeholders.

Landscape Assessments in Northern Arizona

For over eight years, beginning with the Western *Mogollon Plateau Adaptive Landscape Assessment* (Sisk et al. 2004), stakeholders have donated thousands of hours to efforts sponsored by the USFS and led by the Forest Ecosystem Restoration Analysis (ForestERA) group at Northern Arizona University. These assessments also included the *White Mountains Landscape Assessment* (Abrams et al. 2005), the *Analysis of Wood Supply in Northern Arizona* (Hampton et al 2008), and the *Kaibab Forest Health Focus* (Sisk et al 2009). Figure 2 includes a map of the areas covered by these prior assessments. These efforts brought together individuals and groups, including resource managers, natural and social scientists, elected officials, environmental groups, and the engaged public to address the challenges of forest restoration in the 4FRI area. These previous landscapes assessments were based on high-resolution spatial data describing forest composition and structure. Such data layers are central to the modeling of fire risk and hazard (e.g., Scott and Burgan 2005; Finney et al. 2007), wildlife habitat quality (e.g., Prather et al. 2007), and other information needs at large spatial extents.

Stakeholders worked together in workshops to prioritize areas, via data overlays, scenario comparisons, and the examination of predicted effects of alternative approaches to forest management. Each process resulted in the prioritization of areas for restoration treatments, formulation of management recommendations for major topic areas, such as watersheds, wildlife and fire management, and development of detailed and spatially explicit guidance for ecological restoration, conservation, and appropriate uses of small-diameter timber across large forested landscapes.

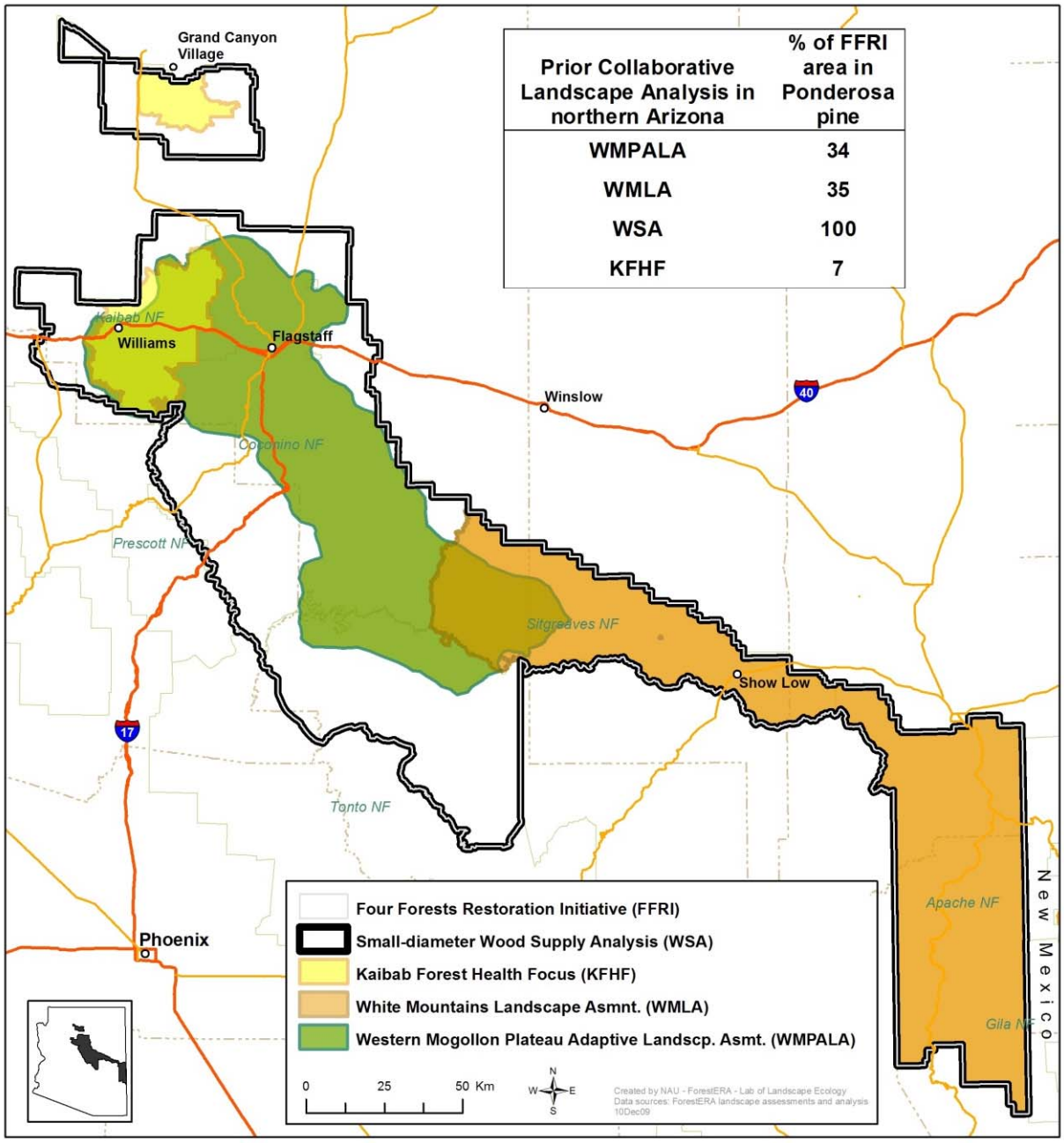


Figure 2. Map of prior landscape assessments and wood supply analysis locations in northern Arizona. These efforts provide a basis for the collaborative, science-based work proposed for the 4FRI.

As an example, Figure 3 illustrates a synthesis of priorities from the *Western Mogollon Plateau Landscape Assessment* (left panel), along with a map showing the level of agreement on those priorities among four groups of stakeholders working in parallel (right panel). Figure 4 illustrates priority areas for the entire 4FRI area, based on the *White Mountains* and *Western Mogollon Plateau Landscape*

Assessments, along with several of the data layers (representing different values-at-risk) that were used to support the prioritization process.

These priorities, recommendations, and related map-based results are the products of diverse, informed stakeholders working with the support of the USFS and utilizing the best available science. The resultant priority maps identify areas in greatest need of management attention. These priority areas will inform future planning under the 4FRI and serve as a starting place for identifying priority areas for treatment as part of the first large-scale 4FRI project.

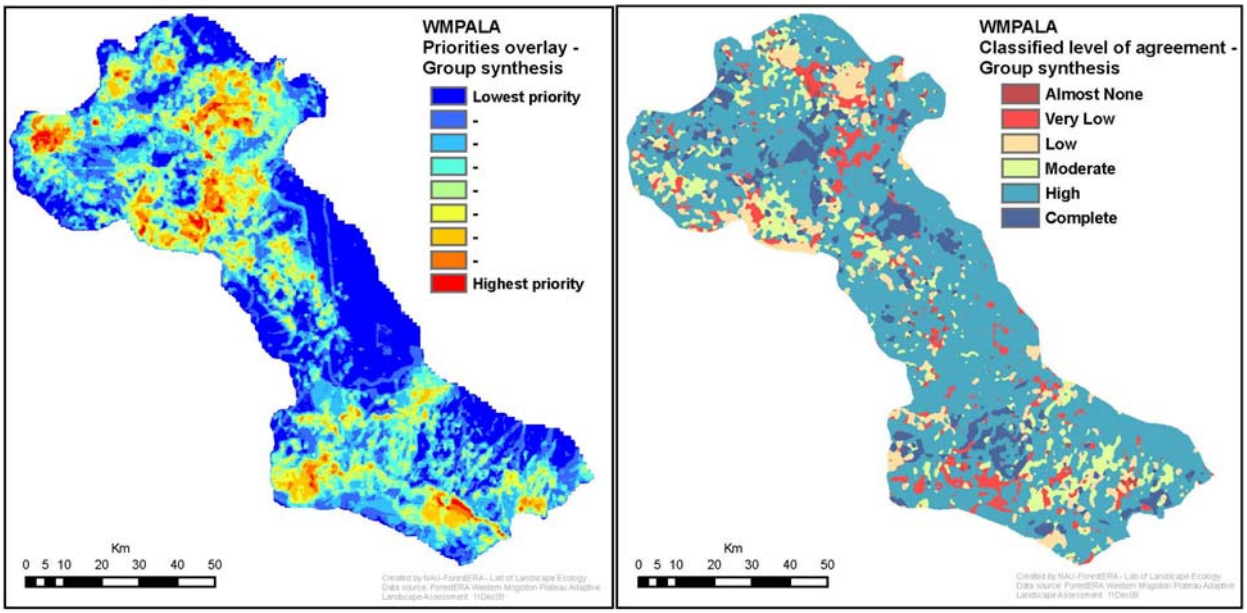


Figure 3. Combined prioritization derived from the results of four working groups—part of the 2004 Western Mogollon Plateau Adaptive Landscape Assessment. Panel on right illustrates the level of agreement among groups for all locations across the study area.

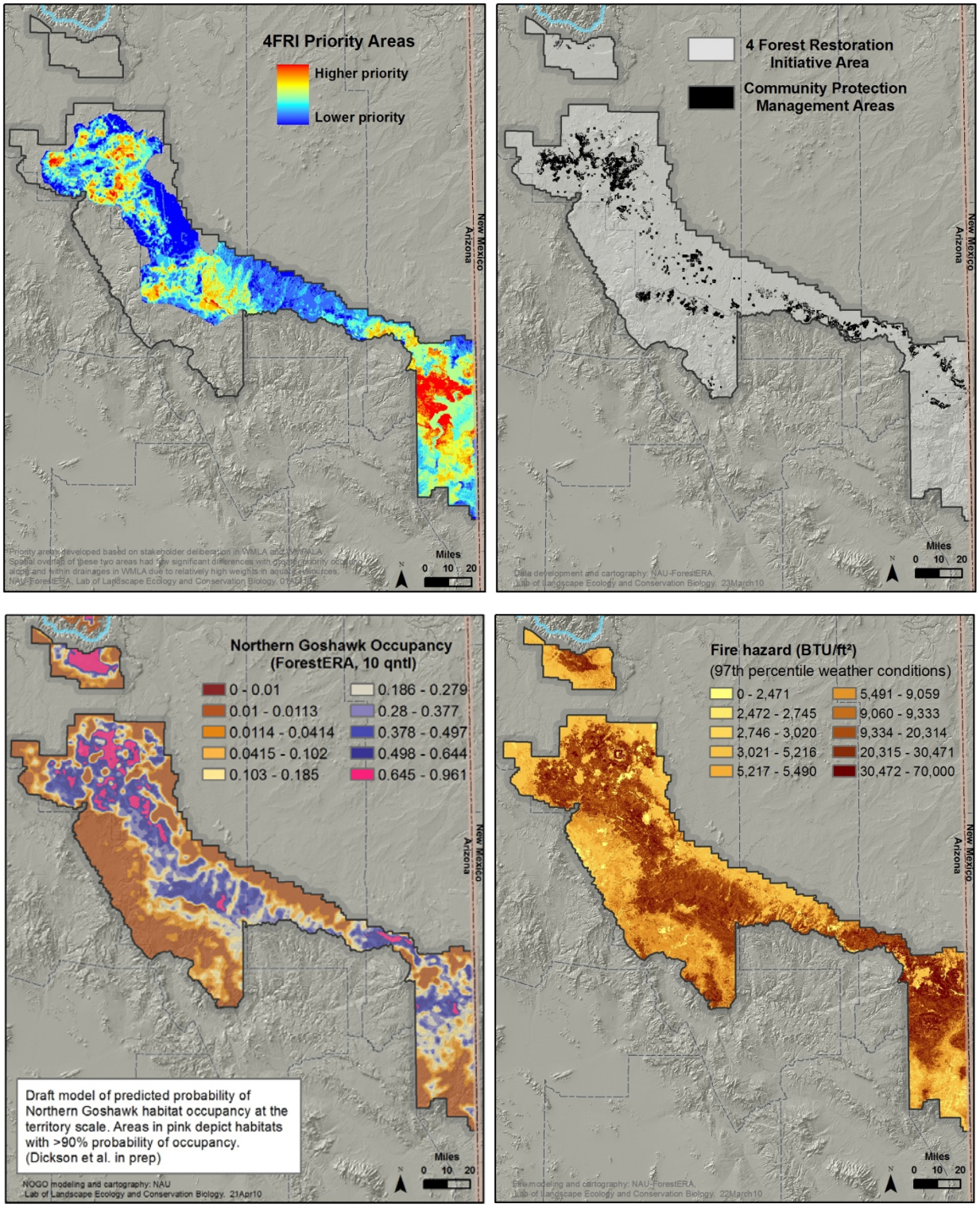


Figure 4. Priority areas for the 4FRI landscape (map in upper left) were identified through the White Mountains and Western Mogollon Plateau Landscape Assessments. These Landscape Assessments utilized map-based data representing values and risks (other three maps). These data layers were overlaid, along with other data layers, to identify priority areas for management attention.

The results of the *Kaibab Forest Health Focus* from 2009 provide a sense of how these priority areas can be scaled down to more site-specific planning. Figures 5 and 6 show the results of that work. A similar process that builds upon priority areas from this study will be utilized in planning for 4FRI project areas.

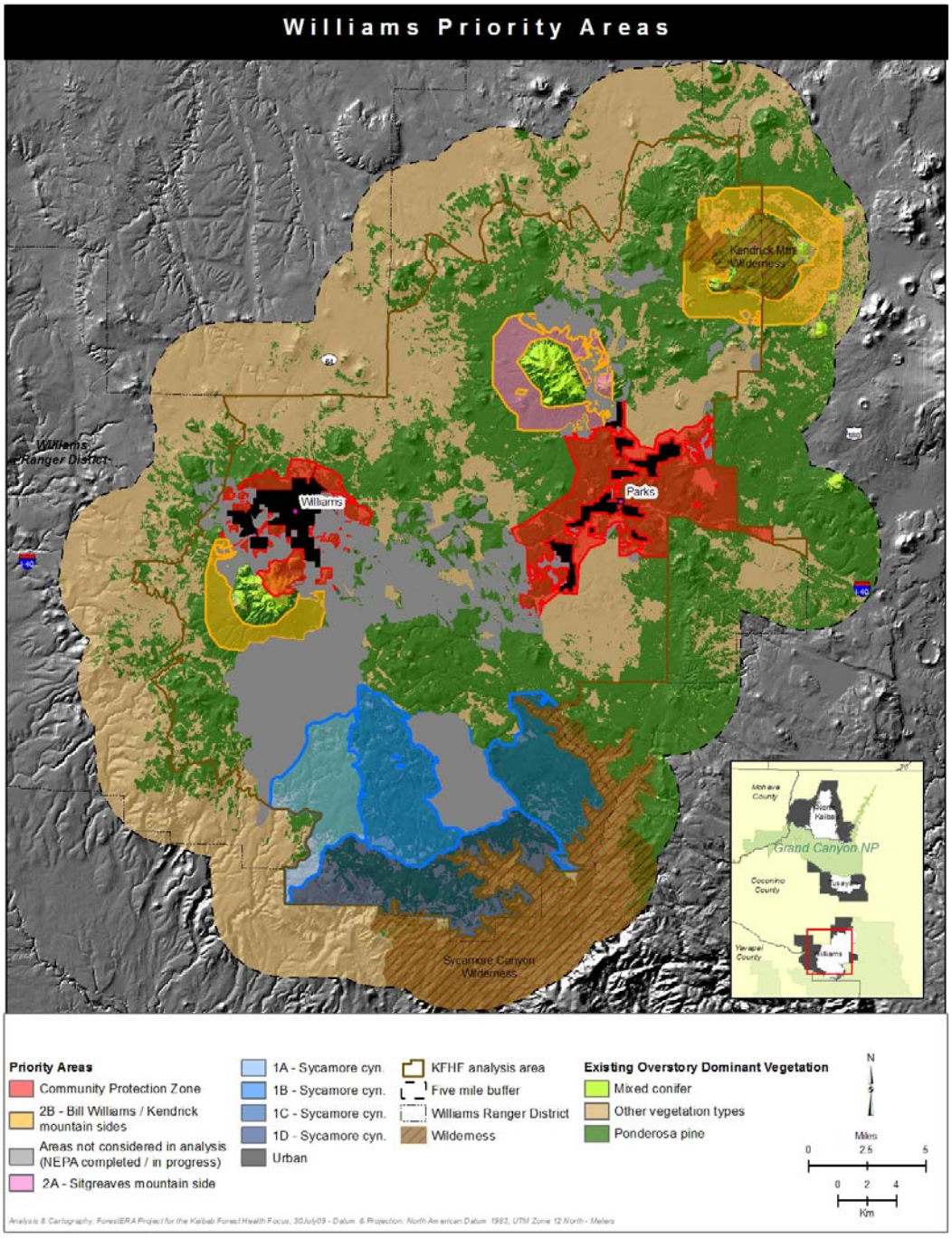


Figure 5. Priorities for management attention on the Williams District of the Kaibab National Forest, as part of the 2009 *Kaibab Forest Health Focus*.

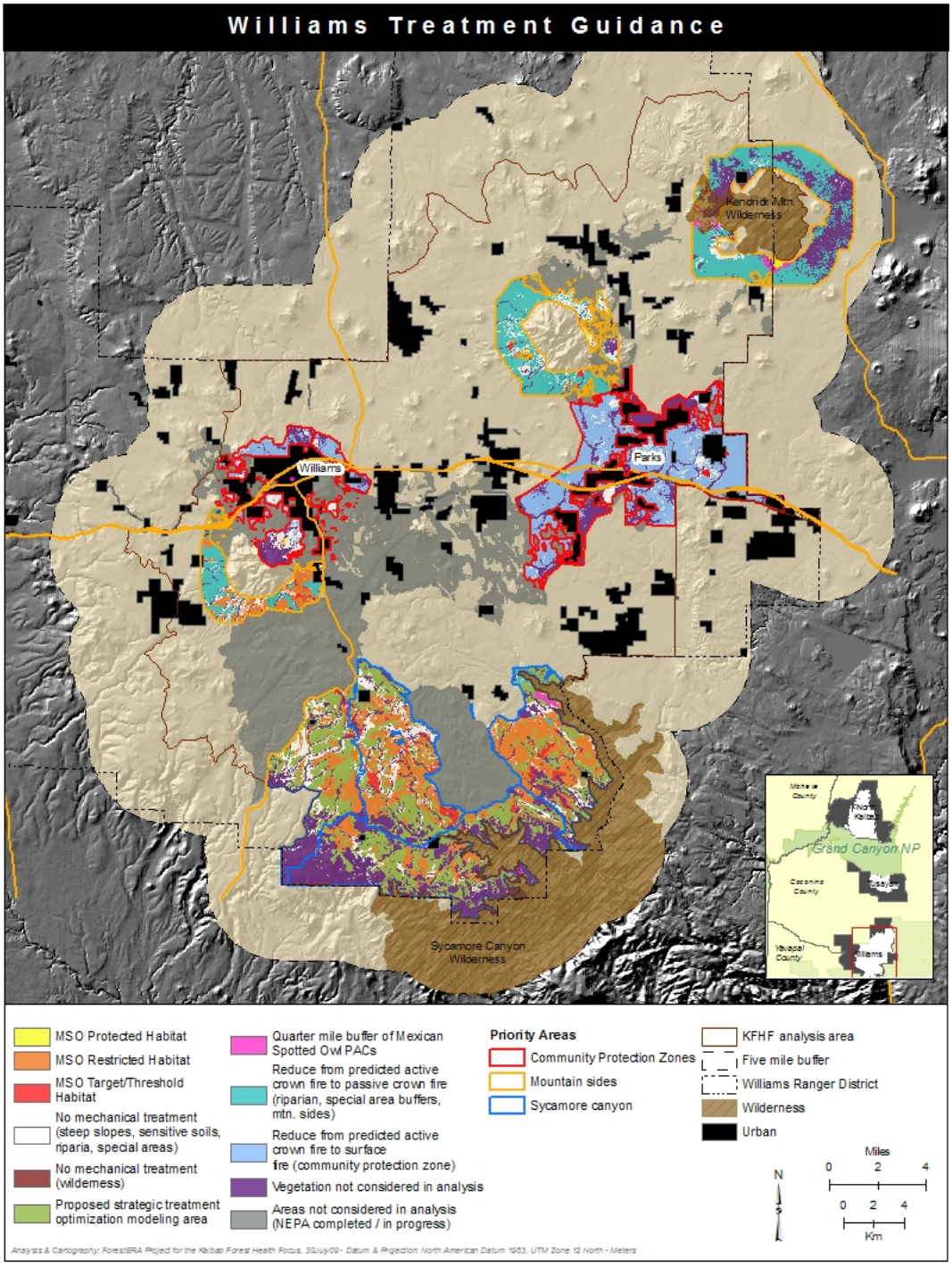


Figure 6. Management guidance, developed by stakeholders for the Williams District, a product of the 2009 *Kaibab Forest Health Focus*.

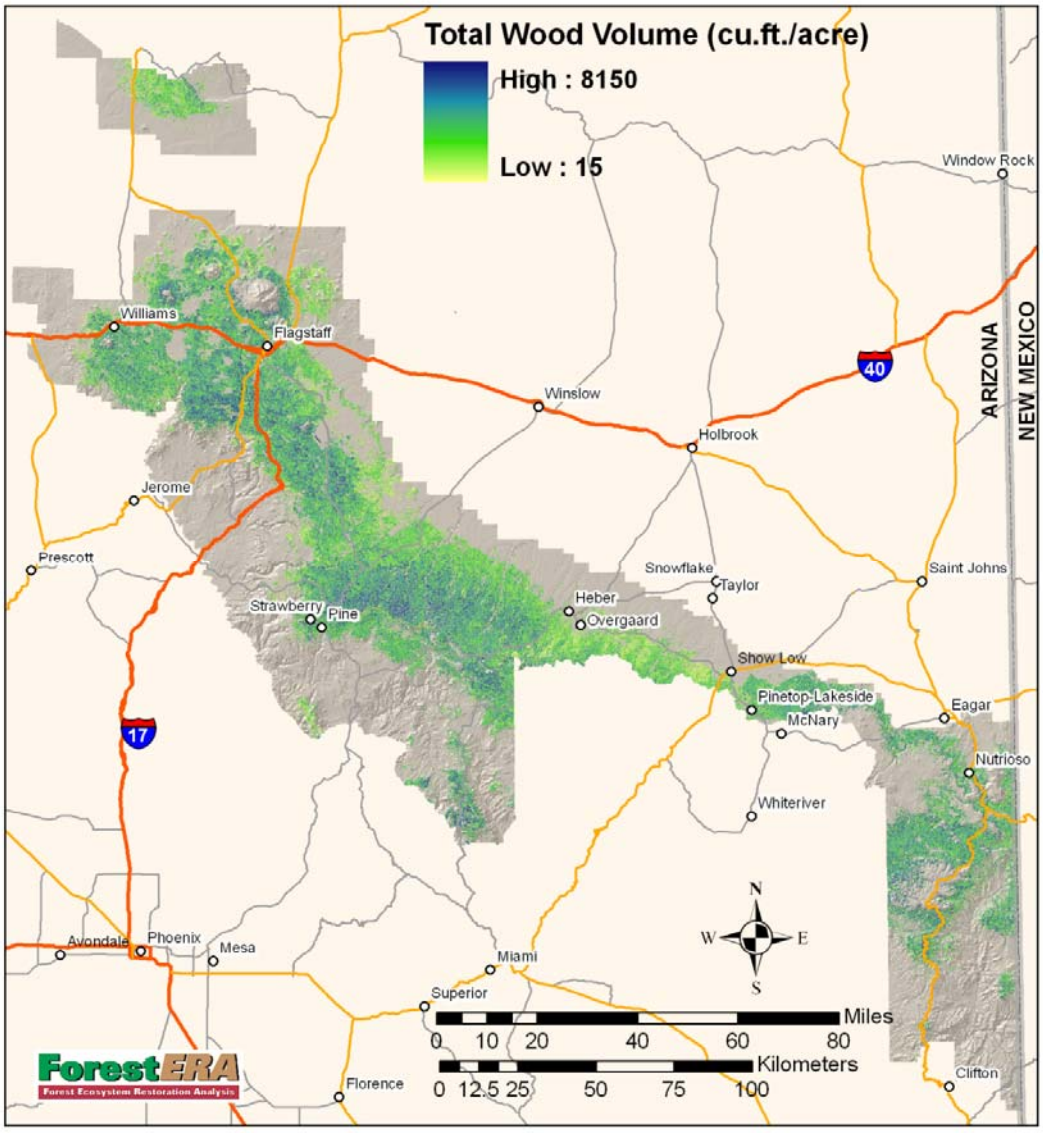
The other key assessment that provides a critical foundation for the 4FRI is the *Analysis of Small-Diameter Wood Supply in Northern Arizona* (Hampton et al. 2008) (henceforth, the *Wood Supply Study*). This project focused on identifying the wood volume that might be made commercially available

through the implementation of a comprehensive restoration plan covering the 4FRI area, 94% of which is on National Forest System lands. The origins of this work began with the formulation of the *Statewide Strategy for Restoring Arizona's Forests* (Governor's Forest Health Councils 2007) in which 4FRI stakeholders expressed interest in undertaking an effort that would quantify the amount of wood potentially available to industry as a result of implementation of landscape-scale restoration. The Regional Forester for the Southwestern Region decided to fund the *Wood Supply Study* to be conducted by Northern Arizona University's ForestERA Project and to be guided by the involvement and input of stakeholders and local communities.

Using advanced techniques for spatial analysis, wood supply estimates were divided into three size classes based on diameter: < 5", 5-16", and >16". No explicit "diameter cap" was used in this analysis, but examining wood supply by size classes allowed the group to address concerns about large tree retention and harvest. Overall, agreements regarding "supply" were predicated upon an agreement that no harvest would go forward that was not in accordance with the broader societal goals of forest restoration, fire management, wildlife conservation, and other values. The analysis considered wood supply available on both USFS and non-USFS lands in the study area. The *Wood Supply Study* demonstrated strong and broad social agreement regarding the supply of wood products that could be expected under a paradigm of restoration of fire-adapted forest ecosystems. Because the objective of this project was to estimate the volume of wood available through broadly agreed-upon forest treatments, it did not specify the locations where particular treatments should be carried out.

The study area included 2.4 million acres of the ponderosa pine-dominated ecosystem along the Mogollon Rim and White Mountains, with the exception of the White Mountain-Apache tribal forest. In the study, stakeholders identified a number of management areas with associated treatment guidance. These areas include community protection management areas, Mexican spotted owl (MSO) restricted habitat, municipal watersheds, aquatic species watersheds, and wildlands. Stakeholders identified some aspects of post-treatment target conditions, which vary for the different management areas, in order to predict wood supply availability. They also determined that treatments should not be considered in wilderness and previously designated inventoried roadless areas, on steep slopes (>40%), in northern goshawk nest areas, or on soils with mechanized treatment limitations. This guidance will be carried forward as input into future 4FRI planning efforts.

Figure 7. Map of estimated wood volume from small-diameter trees from the Wood Supply Study.

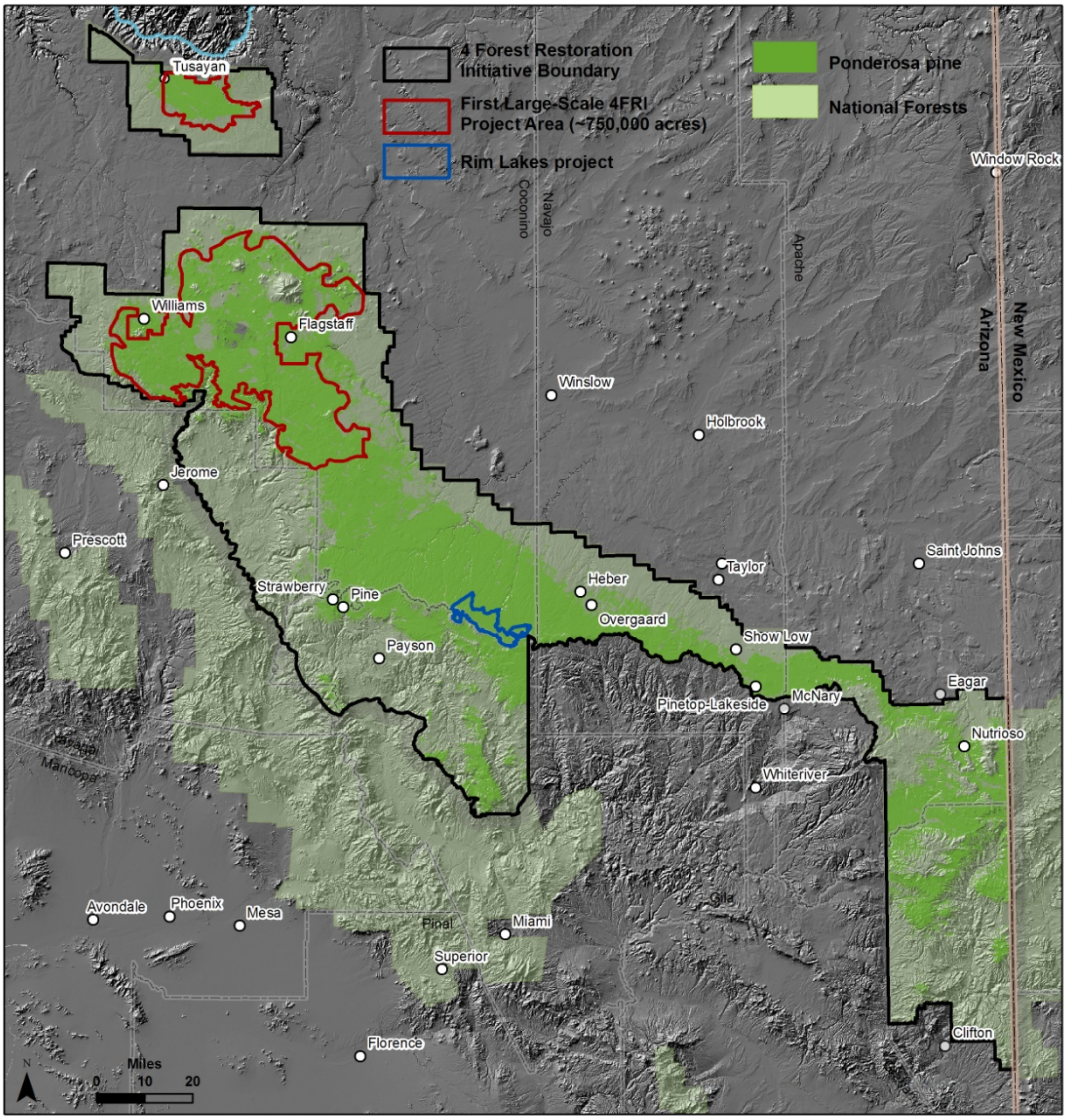


Treatment Prioritization in Future Planning

Several factors will drive the prioritization of areas for treatment under the 4FRI. Treatments on National Forest System land have been and will continue to be prioritized in areas of highest fire danger and where the threat of fire immediately threatens communities. In areas further from communities, dynamic fire modeling may be used to strategically place treatments to optimize the effects of thinning treatments on predicted fire behavior and to allow for increased use of fire to meet restoration objectives. Previous assessments have identified additional priority areas, based on the protection of key habitat components, water quality, and other values, in need of restoration and management

attention. These priority areas, such as those in Figures 4 and 5, will be utilized as a foundation for future project planning. Figure 8 shows the first large-scale project area, which can be overlaid with maps of priority areas to serve as an initial spatial assessment of where treatments may be prioritized in future 4FRI planning. Priority areas may be revised based on the final landscape strategy, which will be completed in 2010, and during project planning and the project-level decision-making process, including NEPA analysis. The first 4FRI project is expected to cover approximately 750,000 acres. The project is expected to be located on the Coconino and Kaibab National Forests, with treatments prioritized in areas in greatest need of restoration and where conditions pose a threat of severe wildland fires.

Figure 8. The first large 4FRI project area (shown below in red) will cover parts of the Coconino and Kaibab National Forests.



The final 4FRI landscape strategy will be developed collaboratively and will characterize:

- updated existing conditions across the 2.4 million-acre 4FRI landscape;
- a finalized set of desired post-treatment conditions;
- a completed restoration strategy to prioritize and sequence projects and treatments within project areas, and;
- frameworks for conducting monitoring.

This landscape strategy will provide a consistent and strategic approach to restoration across the ponderosa pine ecosystem in northern Arizona and also a program of work with a predictable and strategically-located supply of wood products in order to facilitate industry involvement at commensurate scales. Efforts will be made to plan on a scale that matches the scale of potential contracts, capitalize on planning and analytical efficiencies that may be realized from planning at landscape scales, and consider how factors related to administrative capacity may relate to successful planning and implementation. Planning also will be conducted such that project boundaries and designs reflect relevant ecological structures and processes. The 4FRI landscape strategy will be finalized in late 2010 and will guide all new projects planned under this initiative.

Collaborative Planning

Future 4FRI planning will build upon the vast amount of collaborative stakeholder work that has gone into the past assessments done across the 4FRI landscape. This work has facilitated the development of an unprecedented level of trust and agreement among stakeholders about the nature and extent of activities to take place under a paradigm of large-scale and accelerated restoration on USFS lands. 4FRI stakeholders have provided the USFS with a document, *The Path Forward,* which outlines their zone of agreement regarding the vision, principles, and sideboards to guide the 4FRI.[3] The document represents an unprecedented level of social consensus regarding the direction of forest restoration in the 4FRI area and is meant to guide future 4FRI planning and implementation. Because *The Path Forward* advocates for USFS management decisions, the USFS cannot sign on to *The Path Forward* without its own separate decision-making process. Nonetheless, the USFS recognizes the importance placed on the document's

[3] *The Path Forward* is attached as Appendix B to provide an indication of the vast amount of collaborative work that has already taken place in order to provide strong social support to guide the 4FRI; this document is not meant to represent the USFS's perspective nor any USFS decisions.

principles and sideboards and accepts these as input representing important stakeholder values, interests, and perspectives.

Management areas identified in the *Wood Supply Study* and their associated treatment parameters will also be considered and refined as the 4FRI develops its final landscape strategy and a proposed action for the first large-scale 4FRI project. The USFS and 4FRI stakeholders recognize that the *Wood Supply Study* was not spatially explicit and that treatment parameters were not intended to be prescriptive, but, rather, to provide a basis for estimating wood supply volumes. Developing a proposed action will require drilling down recommendations from that analysis to identify where and how treatments will be applied on the landscape. Additional detail will be necessary to guide the nature of treatments, and the final 4FRI landscape strategy and planning documents will consider additional parameters that may better describe target conditions on the 4FRI landscape.

Future planning under the 4FRI, along with the development of the final landscape strategy, will continue to occur collaboratively with input from stakeholders. At present, stakeholders have formed a landscape strategy working group to inform the development of the final 4FRI landscape strategy. Additional detail about collaborative involvement of 4FRI stakeholders can be found in the 4FRI proposal for funding under the Collaborative Forest Landscape Restoration Program.

IV. Use of Best Available Science

Foundational Science

The 4FRI effort benefits from a long and rich history of forest science in northern Arizona, beginning with the establishment of Fort Valley Experimental Forest in 1908, the oldest experimental forest in the National Forest system (Olberding and Moore 2008). Researchers established large permanent plots in 1909 to track forest structure near Flagstaff and nearly 100 other permanent plots were established to document understory conditions. Recently, scientists relocated these plots and have determined the magnitude and direction of changes that have occurred over the last century (Moore et al. 2004). The pioneering work of Aldo Leopold (1924), Harold Weaver (1951), and Charles Cooper (1960) set the stage for evaluating fire's prominent role in ponderosa pine forests. Dendrochronology was invented in Flagstaff and research from the Tree-Ring Laboratory at the University of Arizona and laboratories at Northern Arizona University (NAU) have described frequent surface-fire regimes. Fires recurred every 2-

10 years in ponderosa pine forests prior to Euro-American settlement, when an abrupt reduction or cessation of fires occurred. An experimental program to evaluate fire effects began when USDA Rocky Mountain Research Station (RMRS) scientists established long-term interval burning experiments in the Fort Valley Experimental Forest (Olberding and Moore 2008). Wally Covington and others at NAU Ecological Restoration Institute (ERI) followed this research with long-term experiments evaluating thinning and burning effects on trees, herbaceous plants, and soils (Covington and Moore 1994, Covington et al. 1997). Recent research has scaled up from plot level to landscape level data analysis through the use of remote sensing data to understand and model forest structure across large landscapes. The Forest Ecosystem Restoration Analysis team (ForestERA) at NAU has developed landscape-scale models to inform project-level restoration planning. This vast amount of forest ecosystem research conducted by RMRS, NAU, the University of Arizona Tree-Ring Laboratory, and other agency and non-governmental organization researchers makes the ponderosa pine forests of the Southwest one of the best-studied ecosystems in the world. Given the depth of understanding of how forest ecosystems function and the inherent capacity to model and evaluate treatment effects at a landscape scale, the 4FRI collaborative is well-positioned to use and develop the best available science.

Fire severity and size have increased after over a century of fire exclusion (Swetnam and Betancourt 1998, Westerling et al. 2006), and there is an increasing risk that future fires will be uncharacteristically large and severe if Southwest ponderosa pine landscapes are not managed on a restoration trajectory. Effects of fire and forest restoration on wildlife resources have been increasingly studied in frequent fire ecosystems. The RMRS initiated a Birds in Burns monitoring network across 7 states, including study locations within the 4FRI area, monitoring avian response to prescribed and wildland fires (Saab et al. 2007). Effects of wildland fire, prescribed fire, forest thinning, and other restoration-related stand conditions have been evaluated for an increasing list of resident species including birds, (Pilliod et al. 2006, Wightman and Germaine 2006, Hurteau et al. 2008, Bagne and Finch 2009a) small mammals, (Rabe et al. 1998, Kyle and Block 2000, Converse et al. 2006, Pilliod et al. 2006, Chambers and Doucett 2008, Bagne and Finch 2009b, Kalies et al. 2010), and associated habitat features within ponderosa pine forests (Ganey 1999, Griffis-Kyle and Beier 2003, Ganey and Vojta 2004, Chambers and Mast 2005, George et al. 2006, Mast and Chambers 2006, Passovoy and Fulé 2006). This body of research adds to the ecological foundation supporting the 4FRI.

Monitoring and Adaptive Management Strategy

The 4FRI planning effort allows an efficiency of scale by addressing project planning across the majority of the largest ponderosa pine belt in the world. The 4FRI will undertake a cohesive program including planning, monitoring, and adaptive management. Monitoring will begin prior to implementation and continue for 15 years after project completion. Collaborative monitoring for this effort, led by a 4FRI Science and Monitoring Working Group involving stakeholders and the Forest Service, will be multi-party and multi-scale. A collaborative, science-driven, monitoring and adaptive management strategy is currently being developed to address both project effectiveness and long-term ecological questions through systematic, applied, and question-driven science. Results of such efforts will be used to inform ongoing planning and implementation of the 4FRI project and to refine efforts to meet landscape-scale forest restoration goals, as part of an adaptive management approach.

4FRI stakeholders bring to this effort substantial technical expertise and capacity. The group includes representatives from the ERI and ForestERA at NAU, RMRS, Arizona Game and Fish Department, US Fish and Wildlife Service, and US Forest Service. In addition, 4FRI stakeholders from the Arizona Forest Restoration Products, Center for Biological Diversity, Grand Canyon Trust, Greater Flagstaff Forests Partnership (GFFP), The Nature Conservancy, and municipal, county, and state governments, offer wide-ranging experience with regional and local issues. This diverse group will allow the 4FRI to monitor ecological, economic, and social results of landscape restoration. The existing scientific foundation will facilitate a critical assessment of information needs to ensure that relevant and informative project and monitoring questions are addressed by the 4FRI. These stakeholders already have experience designing restoration and monitoring projects with the White Mountains Stewardship Contract and the GFFP. Past projects include: an effectiveness monitoring project for Flagstaff-area fuels reduction treatments through a grant from the National Forest Foundation (2005); *Greater-Flagstaff Omnibus Surveys* to assess social attitudes and perceptions regarding forest health issues and the effectiveness of forest management (2006 and 2007); and 5- and 10-year summary evaluations describing lessons learned from the White Mountains and GFFP.

Treatments will be designed to meet science-based restoration goals, including: risk reduction of uncharacteristic wildfire; re-establishment of natural fire regimes; retention of large trees and protection and enhancement of old growth; enhancement of fish and wildlife habitat, including species listed under the Endangered Species Act; maintenance or improvement of water quality and watershed

function; control of invasive and exotic species; and effectiveness of road and trail rehabilitation. Monitoring will be designed to track whether projects promote recovery of resilience and adaptive capacity within this fire-dependent ecosystem. Projects will be measured in terms of: reductions in uncharacteristic wildfire risk at watershed scales; increases in area suitable for managed fire; achievement of specific measures of ecological and watershed health; improvement of fish and wildlife habitat; and determination of how these changes develop through time. Efforts will be designed to provide information on whether post-treatment vegetation meets project goals and objectives (implementation monitoring) and whether project goals and objectives are achieving ecological restoration (effectiveness monitoring). Social monitoring will include existing baseline data and post-treatment measures to track public perceptions and attitudes as well as effectiveness of outreach and education programs associated with the 4FRI. Economic monitoring will assess utilization of wood products and track how industry development and economic stimuli affect planning and implementation costs. A scientific advisory process will provide independent science-based evaluations of monitoring questions to assist in determining whether the indicators, metrics, and study design will meet the ecological, social and economic goals of the 4FRI.

V. Wood Products Utilization as Part of the 4FRI

Historically, the wood products industry in northern Arizona was based on large-tree logging for timber and small tree/pre-commercial thinning for pulp. In the mid-1980's to the mid-1990's major sawmills closed in Flagstaff, Eagar, and Payson, and small sawmills closed or curtailed production. Ongoing restoration work on National Forest lands provided large volumes of wood, but the majority was too small to be merchantable for conventional industries. At present, few large logs are removed, but significant volumes of small diameter material must be removed to restore forest ecosystems and for the safety of forest communities. At present, most forest restoration operations have been based on goods-for-services contracts requiring large payments by the Forest Service in exchange for restoration work performed. The White Mountain Stewardship Contract has revitalized several operations in the Eastern Mogollon Rim country, resulting in the rebuilding of industry capacity to utilize forest restoration byproducts from approximately 20,000 acres in the White Mountains. In order to accelerate the pace and scale of future restoration work, while allowing for significant reductions to the cost of restoration work (significantly decreased payments for acres treated), it will be critical to attract

appropriately-scaled, high-efficiency operations that can utilize small-diameter material and produce a high-value product.

Potential for Wood Products Utilization

In 2008, the *Analysis of Small Diameter Woody Supply in Northern Arizona (Wood Supply Study)* (Hampton et al. 2008) was completed and filled a key information need by identifying the amount of wood and biomass that could be available to the wood products industry as a function of socially-acceptable, landscape-scale forest restoration efforts across northern Arizona. This analysis offers a snapshot in time (year 2006) of wood volumes across the study area and the range of wood byproducts that could potentially be harvested with broad stakeholder support. The analysis estimates a range of 850 million to 1 billion cubic feet of wood byproducts from tree boles alone (defined as the tree's main stem, from the ground to top of tree) and 8 million to 9.5 million green tons from branches and other tree crown biomass. The majority of the volume considered available for removal is in the 5-16" diameter class. The amount of potential wood byproducts from restoration treatments and small-diameter trees identified through this analysis far exceeds market demand associated with existing industries. Based on the analysis, there is enough small-diameter material available to offer an additional 30,000 acres of treatment for 20 years. The results of this study will be used by the 4FRI to provide a more predictable supply of wood and biomass to existing industry and to develop multi-year forest stewardship contracts that have the potential to attract new industrial users accessing new and expanded markets. Several business plans have been advanced by interested industry partners that suggest there is a serious possibility to engage new industry on this scale and at significantly reduced costs to the government.

Industry Interest/Engagement

Within the 4FRI area, a variety of wood products industries currently exist and various potential new utilization proposals have been advanced, ranging from micro-industries to larger-scale industries, with the economic capability to offset the costs of restoration treatment on tens of thousands of acres per year. Numerous entities have expressed interest in the project, including Arizona Forest Restoration Products, the Northern Arizona Wood Products Association, Forest Energy Corporation, and Pioneer Association. In June 2009, the USFS Southwestern Regional Office issued a Sources Sought notice for industry to gauge the level of interest from private companies in this initiative. Responses to this notice were received from a variety of different contractors and companies, ranging from biofuel and

electricity generation companies to loggers and pellet producers, that could utilize material from the 4FRI. Although no contract has yet been issued and industry investments are largely theoretical at this stage, this broad and varied interest suggests a high potential for establishment of new industry and significant new job creation in northern Arizona through this effort.

In order to engage industries in larger landscape-scale restoration across the region, stakeholders also have systematically created conditions under which appropriately-scaled industries could profitably invest in the infrastructure needed to implement landscape-scale restoration. Steps towards this end have included *Wood Supply Study,* identification of potential economic benefits, outreach to appropriately-scaled industries, and the collaborative work that has created an unprecedented level of stakeholder trust and agreement regarding the direction and scale of forest restoration in the 4FRI area. These steps will help to ensure that an appropriately-scaled and restoration-supportive industry may sustainably and efficiently utilize restoration byproducts, while realizing economic benefits.

In order to support successful wood products utilization industries, during the design phase of a new 4FRI contract, several key factors will be considered:

- Provision of a large enough wood supply over a long enough time-period to attract a sustainable wood products industry;
- Industry provision of markets for the excess wood from restoration treatments;
- Creation of enough market value from the wood products to eventually reduce the costs of treatments considerably.

The USFS will assign minimum values to small diameter sawtimber (9-11.9" DBH) and roundwood (5-8.9" DBH) and allow for rate adjustment as industry matures. The agency and industry will need to identify incentives to treat additional acres when per acre costs are reduced.

VI. Conclusion

A confluence of factors has set the stage for successful, accelerated forest restoration in Northern Arizona. The level of social agreement, clear ecological need for active restoration, prime opportunity for expanded industry, and history of collaborative, science-based planning efforts provide an unmistakable opportunity to undertake an ambitious, innovative, and unprecedented program of ecological restoration in northern Arizona.

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VIII. Appendix A: Organizations Involved in the 4FRI

- Arizona Forest Restoration Products
- Arizona Game and Fish Department
- Arizona State Forestry Division
- Arizona Eastern Counties Association
- Center for Biological Diversity
- Coconino County Board of Supervisors
- Coconino Natural Resources Conservation District
- Coconino Rural Environment Corps
- Ecological Restoration Institute
- Flagstaff Fire Department
- Forest Energy Corp.
- Gila County
- Graham County
- Grand Canyon Trust
- Greater Flagstaff Forest Partnership
- Greenlee County
- Northern Arizona Wood Products Association
- Natural Resources Working Group
- The Nature Conservancy
- Navajo County
- Northern AZ Logging Association
- Northern Arizona University Forest Ecosystem Restoration Analysis (ForestERA)
- Pioneer Association
- Rocky Mountain Elk Foundation
- Sierra Club
- Southwest Sustainable Forests Partnership
- USDA Forest Service Rocky Mountain Research Station
- USDA Forest Service
- US Fish and Wildlife Service

IX. Appendix B: *The Path Forward*

THE PATH FORWARD

I. VISION

Our visionwithin the Four Forests Restoration Initiative essentially mirrors that outlined in the *Statewide Strategy for Restoring Arizona's Forests*. We expect that landscape-scale restoration across the Mogollon Rim will support healthy, diverse stands, supporting abundant populations of native plants and animals; thriving communities in forested landscapes that pose little threat of destructive wildfire; and sustainable forest industries that strengthen local economies while conserving natural resources and aesthetic values.

II. To Achieve the Vision

In striving to achieve this vision across the Mogollon Rim, we recognize the critically important ecological, economic, and social contexts within which landscape-scale restoration necessarily occurs. First and foremost, we recognize that comprehensive ecological restoration needs and priorities should guide landscape-scale forest management. Second, we recognize that sustainable restoration economies can and should be developed and enhanced so that restoration can proceed more efficiently, and so that rural communities can benefit from such action. A critical step toward creating economies requires a longer-term (e.g. 10 to 20 years) assurance of wood and biomass supply to appropriately-scaled industries such that necessary economic infrastructure investments can be made. Third, we believe that sustained investment in collaboration can build agreement and trust and minimize controversy surrounding forest management, thus allowing ambitious landscape-scale restoration to proceed with maximum efficiency and effectiveness without sacrificing quality of work.

In order to implement ecologically, economically, and socially viable landscape-scale forest restoration across the Mogollon Rim, additional capital investment will be necessary at the local, state, and federal levels. Beyond investing additional resources, we will need to use existing resources with maximum efficiency. We can do so by: 1) integrating restoration, fire management, and community protection planning at the landscape scale; 2) adopting land use policies that support rather than hinder landscape-scale restoration; 3) strategically prioritizing and placing restoration treatments; 4) safely employing prescribed fire and Wildland Fire Use; 5) employing adaptive management supported by the best available science; 6) identifying sustainable cost offset opportunities through wood and biomass utilization.

Landscape-scale forest restoration across the Mogollon Rim will be a new endeavor for northern Arizona's citizens, and create significant ecological change across hundreds of thousands of acres. As such, it is imperative that we proceed ambitiously, but cautiously; that we maximize our opportunities to systematically learn our way through the process; and, that we proceed with confidence tempered with humility.

III. Ecological Goals for Ponderosa Pine Forest Ecosystems

Arizona's forests and the ecological processes that sustain them span landscapes. The *Analysis of Small Diameter Wood Supply in Northern Arizona* identified the need as well as the priorities for restoration within a large, landscape context. Identification of ecological goals and the charting of progress toward reaching those goals must also occur within a similarly large landscape context. At this scale, goals for restoring forest ecosystem health and protecting communities must be dynamic, comprehensive, and integrated. It is important to understand that restoration at this scale is characterized by uncertainty. Therefore, a diversity of restoration strategies that fit local ecological, social, political, and economic circumstances are needed. A "one-size-fits-all" approach is not appropriate, and an open, transparent, collaborative process is essential to the success of those restoration strategies.

The following ecological goals are a synthesis of the Arizona Governor's Forest Health Council's *Statewide Strategy for Restoring Arizona's Forests*, *Guiding Principles for Forest Restoration and Community Protection*, *Guiding Principles for Wildlife Habitat,* as well as the National Forest Service Manual Directive Chapter 2020: *Ecological Restoration and Resilience*:

1. Protect and restore ecosystem structures, processes and functions
2. Conserve and enhance biological diversity at multiple spatial scales (from the stand to the landscape)
3. Integrate conservation and recovery of listed, rare, and declining species into the planning and implementation of restoration treatments
4. Use historic range of variability, current conditions, and potential effects of climate change in planning of restoration treatments
5. Reduce unsustainable densities of post-settlement trees and enhance forest resilience so that low-intensity, frequent fire and other natural processes can operate to the fullest extent possible
6. Retain sufficient trees of all size and age classes to assure development of natural stand dynamics.
7. Reintroduce low-intensity, frequent fire as the primary natural process maintaining forest structure and function
8. Minimize potential negative impacts of restoration treatments to wildlife, residual vegetation, soils, aquatic systems, and other ecological and biological values
9. Strive for structural diversity in the attributes of the tree component (e.g., density, size, and spacing), the size and distribution of forested patches and openings, and the associated shrubs and understory vegetation to create diverse conditions most beneficial to wildlife and most resilient to widespread habitat loss
10. No old growth trees (predating Euro-American settlement or currently exhibiting old growth structural characteristics) shall be cut
11. Use the best available science, current and desired conditions, climate change projections, and human uses to plan restoration treatments
12. Employ adaptive management, monitoring, and evaluation with a clearly defined feedback mechanism into all ecological restoration decisions and activities

IV. Building a Science-Based, Collaborative and Adaptive Infrastructure for Accelerated Restoration

Landscape-scale restoration as described in this document will require significant commitment to science, learning, and adaptation as the effort initiates and proceeds. Prior to on-the-ground landscape-scale restoration occurring, significant resources and collective effort must be directed towards designing landscape-scale planning, monitoring, research, and adaptive management mechanisms that support highly efficient and effective program implementation.

Adaptive management is defined as a systematic approach for improving resource management by learning from management outcomes. An adaptive approach to landscape-scale forest restoration involves: 1) identifying existing conditions through pre-treatment monitoring and inventory, 2) developing explicit restoration objectives, 3) exploring alternative approaches to meet restoration objectives, 4) developing monitoring objectives that are tied to restoration objectives, 5) predicting outcomes of alternatives based on current knowledge, 6) implementing one or more alternatives, 7) monitoring effects, and 8) adjusting restoration actions if/as needed to meet objectives. [cite]

Adaptive management mechanisms should be designed to maximize the generation and incorporation of best available science during all stages of NEPA and NFMA planning that is likely to occur at the scale of the Four Forests Restoration area (approximately 2.4 million acres), as well as nested large landscape scales (e.g., 500,000 – 1 million acres), and project implementation scales (e.g., 100,000 acres). They should be used to establish desired future conditions, develop implementation strategies, and measure progress through rigorous monitoring. Funding mechanisms to support pre- and post-treatment monitoring need to be identified at the earliest stages possible.

As landscape-scale restoration proceeds, science-informed collaboration will be absolutely essential. The opportunity for formal collaboration will be necessary through all stages and at all scales of planning, implementation, monitoring. It will be especially important in the process of formalizing and integrating lessons learned into future projects. This process will also be used to navigate difficult discussions, and build agreement necessary to move forward. At 5-year intervals, a formal and comprehensive adaptive management review will be conducted to review progress and build on successes.

While certain elements of the adaptive management and collaboration infrastructure for supporting landscape-scale restoration currently exist in northern Arizona, significant re-investment will be required to bolster capacity over the next 20 years. Stakeholders will work collaboratively with the Forests over the coming months and years to ensure that this capacity (in addition to other capacity needs) is met by securing necessary public and private investments. Just as we look to the novel partnership between the Forests, industries, and stakeholders to accelerate unprecedented restoration, we should be looking at that same novel partnership to design and implement an unprecedented adaptive management approach.

V. Sideboards for Accelerated Restoration

Embarking on a 20-year initiative to restore northern Arizona's ponderosa pine forests at the landscape scale requires substantial up-front commitment, investment, and assurance of direction. Recognizing that we will learn our way through the process of accelerating landscape-scale restoration, such an initiative also requires a formal collaborative process that allows research results, monitoring, adaptive management, and lessons learned through the process of implementing landscape-scale restoration to be incorporated into an evolving set of project design parameters. The following sideboards are meant to strike a balance between up-front assurance regarding restoration direction across the region, and flexibility allowing continued learning and adaptation through the process of landscape-scale restoration. These sideboards are meant to be an initial reflection of social agreement, and an opportunity for continued analysis, refinement, and translation through subsequent planning and design efforts. Sideboards have been designed to allow landscape-scale restoration to occur across the entire Four Forest Restoration Area for at least 20 years. Adaptations of sideboards can occur at any time. Modifications will be spatially explicit and based on a science-informed, collaborative

process that is agreement based, as defined in the 4FRI Charter. As part of the 5-year comprehensive adaptive management review, sideboards will be evaluated.

1. Landscape-scale restoration of ponderosa pine forests in northern Arizona should be designed to restore and maintain watershed health and function, conserve and enhance the diversity of native species and their habitats, retain mature and old growth trees, and facilitate the reestablishment of natural fire regimes at landscape scales.

2. Landscape-scale restoration efforts should employ a combination of strategically-placed mechanical thinning, prescribed burning, road obliteration, exotic species management, hand thinning, recreation management and Wildland Fire Use techniques to meet – at the broadest possible scales – restoration, socio-economic, community protection, and fire management goals

3. Landscape-scale restoration should be guided by collaborative planning, implementation, monitoring, and adaptive management. These efforts should build on existing collaboratively developed documents such as the Arizona Governor's Forest Health Council's *Statewide Strategy for Restoring Arizona's Forests*, *Guiding Principles for Forest Restoration and Community Protection*, *Guiding Principles for Wildlife Habitat, Guiding Principles for a New Economy based on Forest Restoration,* the *Analysis of Small Diameter Wood Supply in Northern Arizona,* and approved community wildfire protection plans.

4. Landscape-scale restoration efforts should adopt and make full use of rigorous science, including research, monitoring, and adaptive management that enhances our understanding about their ecological, social, and economic implications.

5. These efforts should support and be supported by a diverse, multi-scale, restoration economy that is ecologically and economically sustainable and has the capacity to create jobs, provide revenue to rural economies, and significantly offset the costs of planning, implementation, and monitoring of landscape-scale restoration;

6. Comprehensive ponderosa pine forest restoration efforts should include up to 1 million acres of mechanical thinning over the next 20 years. Such thinning efforts should be accelerated from an annual rate of less than 15,000 acres to a rate of up to approximately 50,000 acres per year (on average, over the next 20 years).

7. Landscape-scale restoration efforts should use elements of the consensus scenario developed in the *Analysis of Small Diameter Wood Supply in Northern Arizona* as sideboards for landscape-scale restoration across the Four Forest Restoration area. These sideboards include:
    - Landscape management area designations
    - Desired post-treatment conditions (basal area, stem density, and canopy cover)
    - Percentage of landscape management areas to be mechanically thinned
    - The goal of no net increase in roads.

    It is important to note that the Wood Supply Analysis was not intended to be a prescriptive, comprehensive restoration plan. For example, desired post-treatment conditions such as spatial and structural heterogeneity were not defined due to time and modeling limitations and will need to be developed. We will also need to clarify the application of desired post-treatment conditions at landscape and site-specific scales in light of existing conditions. The ecological, social, and economic effects of applying the consensus scenario from the Wood Supply Analysis should be examined during the development of the Proposed Action and site-specific NEPA analysis.

8. No old growth trees (predating Euro-American settlement) shall be cut.

9. The group has agreed to a large tree retention strategy that is not based on a strict diameter cap. Large trees in the ponderosa pine forest type, defined by the socio-political process as those greater than 16" diameter at breast height (>16" dbh), shall be retained throughout the 4FRI landscape except as described below. Large trees may be cut/removed: 1) as necessary to meet community protection and public safety goals within the Community Protection Management Areas identified in the *Analysis of Small Diameter Wood Supply in Northern Arizona*; or 2) when best available science and stakeholder agreement (as defined in the 4FRI Charter) identify sites where ecological restoration and biodiversity objectives cannot otherwise be met – specifically wet meadows, seeps, springs, riparian areas, encroached grasslands, aspen groves or oak stands, within-stand openings, and heavily stocked stands with high basal area generated by a preponderance of large, young trees. As part of broader research efforts, the ecological and social aspects of this large tree retention strategy coupled with limited site-specific removal needs will be examined during the development of the Proposed Action and the site-specific NEPA analysis and through stakeholder-guided research.

10. In order to improve planning and treatment efficiencies, ecological benefits, and socio-economic benefits, and to distribute those efficiencies and benefits as broadly as possible, initial sideboards should be used to guide forest restoration across the Four Forests Restoration Area.