FOUR FOREST RESTORATION INITIATIVE LANDSCAPE STRATEGY

ECONOMICS AND UTILIZATION ANALYSIS

REPORT FROM THE FOUR FOREST RESTORATION INITIATIVE STAKEHOLDER GROUP TO THE USFS 4FRI PLANNING TEAM

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I. INTRODUCTION

In order to fulfill a collective desire to conduct landscape-level forest restoration, a group of stakeholders and the U.S. Forest Service created the Four Forest Restoration Initiative (4FRI) to address ponderosa pine forest restoration across 2.4 million acres on four National Forests in northern Arizona: the Apache-Sitgreaves, Coconino, Kaibab, and Tonto National Forests. The Landscape Strategy Working Group (LSWG), a sub-group of the 4FRI Stakeholder Group, was tasked to work with an integrated USFS team of specialists, the USFS 4FRI Team, to develop a comprehensive restoration strategy for the entire 4FRI area.

As part of the comprehensive restoration strategy, a subgroup of the LSWG was tasked with analyzing the economic and utilization issues associated with implementing 4FRI. This document, the Economic and Utilization Analysis of the 4FRI Landscape Strategy, analyzes the barriers that could undermine regional wood utilization opportunities; thereby limiting 4FRI's economic sustainability. Specifically, the document discusses challenges and potential solutions associated with maintaining a consistent and affordable wood supply and contracting requirements and obstacles. Additionally, it explores emerging opportunities for capturing the value of ecosystem services, which can be used to further support ecological restoration.

Implementation of the 4FRI should be ecologically and economically sustainable. Although these two distinct goals can be at odds, the 4FRI stakeholders believe they can work together to accomplish landscape-scale forest restoration in northern Arizona. Through the utilization of restoration byproducts by appropriately scaled industry, 4FRI aspires to implement ecologically sustainable restoration treatment in an economically sustainable manner.

Wood utilization provides one approach to offset treatment costs. However, the current state of the economy and the volatility of wood products markets suggest that we should consider other means to offset treatment costs. In addition to relying on industry investment, other funding possibilities include the monetization of ecosystem services, development of cost-share agreements, and if necessary, direct financing of treatment activities.

A. The Four Forest Restoration Initiative is Ecologically Sustainable

In 2007, the Arizona Forest Health Council created the Statewide Strategy for Restoring Arizona's forests, which described and emphasized the importance of ecological sustainability. The document urges that forests be managed in a way that sustains their natural composition, structure, and function in order to support the array of benefits people expect from them. It goes on to say that "management and uses of the forest should be 'sustainable'; they should not diminish the health and productivity of forests for future generations." (GFHC, 2007).

The Arizona Forest Health Council's emphasis on the importance of ecological sustainability is also consistent with the current management objectives of the U.S. Forest Service. Upon its establishment, the Forest Service was guided by the Organic Act of 1897, which mandated the agency to protect forest reserves for enhanced water flows and a continuous supply of timber for the citizens of the United States (Murphy et al. 2007; Loomis 2002). After World War II, demand increased for timber from public land and logging accelerated. In response to increased logging, citizens became concerned about the environmental impacts of timber extraction. During the 1960s and 70s Congress passed a host of environmental laws -- the Multiple-Use Sustained Yield Act, the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), and the National Forest Management Act (NFMA) -- which eventually guided the Forest Service to a management framework primarily focused on landscape-scale ecosystem health (Jones et al., 1995; de Steiguer, et al., 2005; Farnham et al., 1995; Jones and Taylor, 1995; Kennedy et al., 2001).

The forest conditions envisioned by the 4FRI will be ecologically sustainable and meet the management objectives of the State of Arizona and the U.S. Forest Service. The healthy, naturally functioning ponderosa pine forests restored by 4FRI will provide various benefits to the citizens of Arizona. For instance, restoring the forests using ecologically appropriate thinning and burning activities will contribute to:

- a significant reduction or elimination of the occurrence and cost of unnaturally large wildfires;
- the protection of watersheds from unnatural wildfire and subsequent soil loss, and the potential increase of water yield may be increased;
- the diversification of understory plant composition and the increase of vegetative abundance;
- the creation and management of habitat abundant and diverse wildlife species;
- the conservation and enhancement of user-friendly and aesthetically pleasing environments, creating increased recreation opportunities; and
- the potential improvement of overall air quality and sequestration of greater amounts of carbon in treated forests.

These types of benefits will create social, and in many cases, economic value for the members of communities surrounding the 4FRI area.

B. An Economically Sustainable Four Forest Restoration Initiative

The Statewide Strategy for Restoring Arizona's Forests also describes how restoration treatments can be economically sustainable using appropriately scaled industry. The Strategy provides a measure to determine the appropriate scale of industry to support sustainable forest management. It states that management action should focus on the restoration of forests as a first priority, and encourage business development based on restoration by-products. In other words, commercial development should be based on what is generated in terms of wood size and volume from ecologically driven forest management goals (GFHC, 2007). This philosophy is also reflected in the values of the Greater Flagstaff Forest Partnership (GFFP) and the White Mountain Natural Resources Working Group (WMNRWG), where their models for forest management seek to separate economic interests from project design and implementation to ensure that ecological objectives are not influenced by economic motivations (GFFP, 2003). The GFFP and WMNRWG are emphatic in their support of utilization and recognize that it is essential in order to achieve restoration goals, but that utilization should not drive forest management decisions. 4FRI will be implemented in a manner consistent with this philosophy.

II. COSTS OF IMPLEMENTATION

There are significant economic costs associated with implementing landscape scale forest restoration activities. The full cost accounting associated with treatments on federal land divide into two categories: (1) the administrative cost of preparation and (2) the operation costs attached to the contract.

A. Administrative Costs

Administrative costs to the Forest Service for treatment preparation include: project preparation, task order/contract administration, planning required under NEPA and NFMA, and project management. Recently, the Southwestern Region Restoration Task Group (2008) began compiling an itemized list of planning, preparation, and administration costs associated with forest restoration projects in Region 3 of the U.S. Forest Service. The Task Group's preliminary results indicate an approximate cost of $360 per acre in total costs (Table 1). The Group, however, offered suggestions to increase optimization and reduce costs to approximately $175 per acre (Bright, 2008). In the case of the White Mountain Stewardship contract, such costs are estimated to average $2.55 million per year, or roughly $300 per acre (Sitko and Hurteau, 2010).

Table 1. Preliminary analysis of the average administrative costs per acre for forest restoration projects implemented in Region 3 of the U.S. Forest Service (Southwestern Region Restoration Task Group, 2008).

Cost Category	Current Average Costs	Potential Costs with Full Optimization
Planning Costs	$65	$14.44 (NFMA) $41.19 (NEPA)
Preparation Costs	$200	$73.54
Administration Costs	$75 $20 (Monitoring)	$47.29
Total per acre	$360 / acre	$176.46 / acre

Although it may be difficult to significantly offset administrative costs with private dollars, it may be possible to qualify more acres for treatment for each dollar spent. For example, the structure of the White Mountain Stewardship Contract uses task orders to manage each project; this is a cheaper option than writing new contracts. In addition, if the proposed NEPA document can qualify 300,000 acres for mechanical treatment under the first 4FRI project, then environmental review costs per acre may decline as well.

B. <u>Operational Costs for Thinning</u>

Harvest costs vary significantly based on a variety of factors (Snider et al., 2006). Hjerpe and Kim (2008) validated this phenomenon across the four National Forests in the 4FRI area. The differences in cost can be attributed to factors including variation in forest structure, site-specific topographic characteristics, site-specific treatment prescriptions, harvest methods, and hauling distances. For example, treatments on the Apache-Sitgreaves generally require the removal of greater numbers of smaller-diameter trees, as compared to harvests on the Coconino and Kaibab National Forests. The increased time and effort required to harvest large numbers of small trees results in higher operational costs.

Expected cost variability across the 4FRI area makes it difficult to develop a single harvest cost for the entire 4FRI area. However, industry experience indicates an expected range of costs. Future Forests LLC's experience indicates that harvest costs for restoration treatments in the White Mountains of the Apache-Sitgreaves National Forests generally range between $1,100 and $1,300 per acre. On the Coconino and Kaibab National Forests, Arizona Forest Restoration Products estimates that harvest costs may range between $557 and $836 per acre (Table 2).

Although the aforementioned industry estimates are not the result of formal analyses, they are within the range of estimates derived from peer-reviewed studies. Lowell et al. (2008)

analyzed harvest costs associated with implementing fuel reduction treatments using two different harvesting systems – cut to length and whole tree operations - on four different sites in the Coconino National Forest. This study determined that harvest costs ranged from $893 to $1,553 per acre when harvesting wood for pallet lumber. However, when also processing wood for biomass, additional harvesting, handling, and chipping costs increased the per acre costs to $944 to $1,899. In the southwestern U.S. as a whole, Hjerpe et al. (2009) estimated that operational costs for restoration activities average between $300 and $700 per acre.

Table 2. Estimated range of harvest costs in northern Arizona during 2009, assuming restorative mechanical thinning yielding 6 to 12 ccf per acre, as compiled by Arizona Forest Restoration Products Inc.

Cost Category	**Range of Operational Costs($/ac)**	
	Low	**High**
Mobilization (moving of equipment and operators)	$10	$15
Cutting (mechanized)	$148	$223
Skidding (mechanized)	$112	$168
Delimbing (mechanized)	$91	$137
Loading (mechanized)	$72	$107
Slash pilling (mechanized)	$33	$50
Roads maintenance	$13	$19
Overhead	$78	$117
Total	$557	$836

C. Operational Costs for Prescribed Burning

The average total costs for prescribed burning in Region 3 of the U.S. Forest Service are estimated to be approximately $200 per acre within the wildland-urban interface (WUI) and $100 - $150 per acre outside the WUI. These total costs include the cost of writing burn plans, conducting prep work, cutting hand lines, and conducting the actual burning and monitoring (Irwin, 2010).

III. CHALLENGES TO TREATMENT IMPLEMENTATION AND WOOD UTILIZATION

The current harvest and utilization capacity in the 4FRI region is inadequate to accomplish the 4FRI's ecological restoration goals. In addition, it is unlikely that Congress or the Administration will want or be able to increase the Forest Service budget to subsidize forest treatments beyond current levels. In order to move forward at the pace and scale envisioned by the 4FRI, forest treatments must be implemented with minimal cost to the federal government. Therefore, it is critical that the Forest Service reduce its administrative preparation costs and the private sector invest in harvest operations and innovative manufacturing infrastructure for small-diameter wood, which will help offset treatment costs.

Historically, the wood products industry paid the Forest Service for the value of large trees that were harvested from national forests and processed into dimensional lumber and other valuable wood products. Past forest management and fire suppression, however, have created a forest structure that is dominated by small-diameter trees and biomass that have relatively low economic value. In addition, resistance to cutting trees over 16 inches has led to fewer treatments that include large trees that can help offset forest management costs (Larson and Mirth, 2001). These forest conditions, along with a soft housing market and a currently weak economy, create challenges that must be overcome to successfully engage industries that are capable of supporting 4FRI efforts.

The desire to mechanically harvest at least 50,000 acres per year over the next twenty to thirty years in the 4FRI area provides a platform for different business models, from small-scale to large-scale operations. Each business model has different needs and requires different approaches for stimulating investment and sustaining operations. In this section we discuss many of the issues that present challenges to northern Arizona's existing wood products industry and the development of new businesses. Where appropriate, this section also presents potential solutions to these challenges, recognizing that there are multiple ways to solve the utilization challenge.

A. <u>Ability to Profitably Utilize Large Volumes of Small-Diameter Wood</u>

Challenge 1 – Production of economically viable products using small diameter wood

In order to generate revenue from the byproducts removed during restoration-based thinning operations, private industry must be able to convert small-diameter wood to economically viable products. If revenue can be generated, the merchantable value of this small-diameter wood, and potentially even slash, should be used to offset treatment implementation costs.

Potential Solutions

Fortunately, there are existing and potential new uses for small-diameter wood in the region, and there is interest in developing additional processing capacity. For instance, wood products already derived from the White Mountain Stewardship Project include pellets, pallets, molding, furniture and small lumber, biomass-to-energy production, livestock bedding and soil fertilizers (Sitko and Hurteau, 2010). Additionally, Larson (2001) identified oriented strand board (OSB) as an excellent end-use product that is capable of absorbing large volumes of wood, as well as plywood, fiberboard, particleboard and roundwood products. Others have expressed interest in developing facilities to produce finger-jointed and edge-glued panels, cupboard doors, and other finished products, as well as briquettes for sale in the international energy market.

In June 2009, the U.S. Forest Service's Southwestern Regional Office issued a Sources Sought notice for industry to gauge the level of interest from private companies in the 4FRI. Responses to this notice were received from 41 entities. Although numerous responses were from non-industry entities or consultants offering a variety of services, respondents also included individuals and representatives from various potential businesses, including biofuels and electricity generation companies, logging companies, and pellet producers. Unfortunately, industry investments are largely theoretical until a contract is actually awarded. However, 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.

Challenge 2– Sustaining private infrastructure requires favorable market conditions.

The recession that began in 2008 has depressed market conditions for wood products in the Southwest. Construction and housing has been one of the hardest hit sectors of the economy; however, over half a million privately owned new houses are still being built every year in the United States, with a quarter of those housing starts in the Southwest (U.S. Census Bureau and U.S. Department of Housing and Urban Development, 2010). Although this is only one third of the number of housing starts that occurred at the peak of the housing "bubble," these construction projects still create a steady demand for dimensional lumber, engineered wood, and molding. Most other small-diameter wood products that are not directly tied to the housing markets, including pallets, furniture, and finished products, have been affected by the recession to a lesser degree.

The energy markets that utilize small-diameter wood products remain uncertain. Biomass, which is estimated to make up over 40% of the wood supply from the White Mountain Stewardship Contract, has been used for electrical generation and pellet fuel production.

Potential Solutions

Federal and state policies have the potential to exert significant influence on the markets for wood products. For instance, by 2025, Arizona's Renewable Energy Standard and Tariff Plan will require regulated electric utilities to generate 15% of their energy from renewable resources, including biomass. If the Arizona Corporation Commission were to increase the stringency of Arizona's existing renewable energy standard or if the U.S. Congress were to pass legislation implementing a federal renewable energy standard, increased demand for biomass-generated electricity and thermal energy would radically change the market. Of course, for such a market shift to affect 4FRI-related activities, legislation should (1) define biomass-generated electricity and thermal energy as a "renewable energy" (2) provide a definition of biomass that is inclusive of products harvested from federal lands during forest restoration activities, and (3) recognize the carbon benefits associated with biomass-generated electricity and thermal energy, as compared to fossil fuel-fired sources.

There are numerous other state legislative and policy changes that could improve market conditions for Arizona's wood products industry and thereby support 4FRI implementation. The 4FRI stakeholder group plans to work with Arizona's Governor's Forest Health Advisory Council to advance policies that (1) encourage or require the State to purchase wood products that are manufactured from wood harvested in Arizona, (2) generally and specifically support the use of Arizona-grown, ponderosa pine-derived products (e.g., modify building codes to allow for the use of pine lumber), and (3) develop financial incentive programs that support Arizona's existing and future wood products industry.

B. Infrastructure and Accessibility

Challenge - Uneven harvest, milling, and manufacturing capacity

Existing harvest, milling, and manufacturing capacity is uneven across the 4FRI area. The White Mountain Stewardship Contract stimulated the establishment of a diversity of products and processing facilities. In fact, businesses in the White Mountains would like to increase the acres treated to 15,000 to 20,000 acres per year in order to meet demand for some products; however, the federal government is only contractually obligated to provide a fixed contract price on 5,000 acres per year. In order to increase the acres treated, the contractors would need to increase their own efficiency, find better markets, or more public money to pay for the work. Regardless, it is vital that 4FRI utilize and integrate with these existing operations and infrastructure.

Current infrastructure on the west end of the Mogollon Rim is more limited; however, the first landscape analysis area for the 4FRI is located on the Westside of the Mogollon Rim, which should help stimulate investment in that area.

Potential Solutions

Existing infrastructure that is capable of utilizing sufficient quantities of restoration byproducts and supporting 4FRI's restoration efforts should be sustained and supported. Given the challenges and cost of developing new infrastructure, in certain situations, it may be more cost effective to directly support and maintain existing infrastructure by subsidizing treatments. This direct federal investment in forest restoration activities can be justified by examining the ecological and economic value of restored forests and the avoided costs of fire suppression, natural resource damage and loss, and other variables.

Where infrastructure capable of supporting forest restoration does not exist, or where exiting industry is struggling, actions should be taken that support a favorable investment climate. The Forest Service can encourage investment by configuring contracts and structuring task orders to ensure wood supply and economically viable harvest regimes over time periods that are long enough to recover costs and provide a return on investment. Additionally, the government can share the risk of investment by creating and enabling financial incentive programs, such as competitive grant programs or loan guarantees. Various types of tax incentives (i.e., grants and credits) can also be used to reduce costs and spur investment.

C. <u>Predictability of NEPA-Ready Wood Supply</u>

Challenge - Wood supply can be unpredictable

Predictability of wood supply from federal land is a key issue to investors. Decreasing wood supply from federal land during the late 1980s and 1990s contributed to the closing of wood-based industries in the Southwest. Over the past ten years, commercial interests nationally have shifted to the Southeast where private lands supply a significant portion of wood required to meet demand.

Two factors influence the flow of wood from federal land: (1) the capacity of the federal government to complete administrative tasks and (2) disruptions due to legal challenges. Presently, the 4FRI's four forests prepare less than 10,000 acres for mechanical treatments annually. This will need to increase to 50,000 acres per year to achieve the vision of the 4FRI. However, declining federal budgets in combination with loss of expertise due to retirements will challenge the ability of the Forest Service to complete the legally mandated administrative tasks required to do mechanical treatments. Additionally, many of the forest management efforts that are administratively planned in the Southwest regularly face legal challenges. The pace of administrative planning for harvest activities and subsequent challenges of those plans create delays that diminish private sector interest in federal forests for a dependable wood supply.

Potential Solutions

To ensure a predictable wood supply, the 4FRI will collaboratively plan management in order to build stakeholder support. The goal is to create a plan that is broadly supported, thereby lowering the risk of administrative and legal challenges.

The NEPA documents will unfold at a large scale to achieve administrative efficiency, improve cumulative effects analysis, and improve the strategic timing and placement of treatments.

The Forest Service and Congress will need to invest in the recruitment and training of sufficient personnel to accelerate administrative planning and deliver 50,000 acres of mechanical treatments per year.

D. <u>Contracting Considerations and Challenges</u>

Challenge - Contracting Requirements

The contracting instrument chosen to implement treatments will influence private investment and business sustainability across the 4FRI geography. In order to sustain or attract business the contract instrument should be flexible and include:

a) The ability to perform ecological restoration

The contracting instrument must provide the flexibility and means to accomplish the ecological restoration goals of the 4FRI. The contract structure should facilitate uneven-aged management by providing the ability to harvest trees across all diameter classes. Additionally, the contract should enable additional restoration activities where appropriate, such as riparian area restoration, weed management, and slash management. Finally, the contract should be flexible enough to allow for adjustments that improve restoration treatment activities, such as slash management, in response to changing markets. For instance, contractors should be able to pile and burn slash when it has no merchantable value or, when a viable biomass market exists, remove slash from the site for biomass utilization.

b) Long-term contract duration

Because significant investment from private industry will be required to accomplish the 4FRI's ecological restoration goals, private industry will require a long-term commitment of wood supply from the Forest Service in order to achieve an adequate return on their investment. Depending on the amount of actual investment, industry may require up to a twenty-year commitment in order to obtain a sufficient return.

c) Guaranteed annual acres

In order to ensure adequate return on their investments, industry will also require a firm commitment regarding the amount of available wood volume. Industry understands that such a commitment may only be available in terms of guaranteed treatable acres. Such a commitment should provide industry with adequate certainty to invest in the 4FRI.

d) Exchange of goods for services

The contract mechanism must allow the Forest Service to exchange restoration byproducts (i.e., round wood and slash) for contractor services. Offset value must be assigned to all byproducts that have actual merchantable value in accessible and viable markets. In order to achieve maximum economic efficiency and account for dynamic wood product markets, the contract mechanism must allow for regular redeterminations of the merchantable value of all restoration byproducts based on accessible and viable markets.

2. Stewardship Contract Challenges

The four national forests in the 4FRI area use a variety of contracting instruments to accomplish mechanical harvests. Although the stakeholder group is not recommending a specific contracting approach, several factors, including the requirements discussed above, indicate that stewardship contracts may provide the means for accomplishing the goals of the 4FRI. Stewardship contracts offer flexibility and efficiency and are designed to support restoration and forest health as the primary management goal. Where timber has value, timber sales can be imbedded within the stewardship contract, goods for services can be procured, and the agency can commit to a ten year guarantee of wood supply. From an agency efficiency standpoint, stewardship contracts can be configured to function with task orders, thereby reducing administrative costs. Finally, they allow the Forest Service to retain receipts for additional restoration work on the forest.

There are two significant challenges associated with using stewardship contracts to accomplish the 4FRI's goals: (1) stewardship contracts have a statutory 10-year limit on contract duration and (2) stewardship contracts generally require a cancellation ceiling. Additionally, the Forest Service's authority to execute Stewardship Contracts is scheduled to expire in 2013 and uncertainty remains regarding a legislative extension.

a) 10-Year Limit on Contract Duration

Because wood supply from federal land has been unreliable since the mid-1990s, and because the cost of capitalization of new infrastructure is expensive, some investors and businesses will need more than 10 years of guaranteed supply in order to commit to developing new facilities. In order to attract large business investment, solutions are needed to provide assurances of wood supply for longer than 10 years while enabling adaptive management and adjustment to changing market conditions.

Efforts to overcome this challenge raise the following questions:

- Can the Forest Service develop and implement a long-term strategy to sequence/phase contract issuance, within the confines of its stewardship contracting authority, to provide a contract commitment to industry that is greater than 10 years?
- Can the Forest Service immediately follow issuance of a 10-year stewardship contract with a second, prospective stewardship contract?
- Are there other options for extending the term of a stewardship contract?
- Is a statutory extension of the stewardship contract term limit feasible?

b) Cancellation Ceiling

The cancellation ceiling for a Stewardship Contract is authorized under the Federal Acquisition Regulations (FAR). It is the amount an agency obligates at the inception of a multiyear contract to protect the contractor's investment and the government's interest in case the government later cancels the contract. Due to the scale of financial investment required from industry to accomplish 4FRI, the amount of the cancellation ceiling required by industry and the Forest Service may be significant.

Efforts to overcome this challenge raise the following questions:

- Can the Forest Service waive or negotiate the amount of the cancellation ceiling requirement for contracts that require significant investment in new infrastructure?
- Are funds available at the department or agency level to support the cancellation ceiling? Could such funds be guaranteed for the necessary length of time?
- Are there alternative mechanisms that would allow the Forest Service to comply with stewardship contracting cancellation ceiling requirements without creating undue financial burdens for the department, agency, or contracting entity?

3. Contract Timing, Size, and Distribution

The number of contracts, their size, and their distribution will influence the types and location of businesses in the region. Presently the majority of treated acres in the region are on the Apache-Sitgreaves National Forests under the White Mountain Stewardship contract. Under that contract, treatments of at least 5,000 acres per year will occur through 2014. Acreage from the first, large-scale 4FRI Environmental Impact Statement (EIS) is anticipated to become available for treatment after the Forest Service's Record of Decision, which is expected by April 30, 2012. This EIS is expected to produce approximately 30,000 acres per year for treatment. In order to meet the annual 4FRI goal of 50,000 acres per year, an additional 20,000 acres per year will needed.

It is assumed that a second, large-scale 4FRI EIS will eventually provide the additional 20,000 acres per year that are needed to achieve the 4FRI's 50,000 acre per year goal. Until that time, however, other restoration projects on the four forests are needed. We anticipate that NEPA-ready shelf stock, including the White Mountain Stewardship contract, will be used to fill the 20,000 acre gap. The stakeholders believe that the additional 20,000 acres per year should be geographically distributed in order to support restoration efforts and businesses throughout the 4FRI region. This is particularly important to the businesses associated with White Mountain Stewardship Contract as they transition into acres identified under the 4FRI's large-scale EISs.

The size of the first contract or contracts offered in 2011, as well as future contracts, will influence business development on the Westside of the Mogollon Rim. A single contract may be required to attract large business that can potentially use the significant volume of wood anticipated from 30,000 acres per year.

E. <u>Planning and Implementing Treatments</u>

In order to implement thinning operations across one million acres over 20 years, treatments should be designed and sequenced in a manner that, among other ecological and social considerations, allows the wood products industry to be economically viable.

Wood product manufacturers and processors need a consistent wood supply volume in order to maintain operations. Unfortunately, the structural variability of forests in the 4FRI area, the ecological prioritization of specific treatment areas, and varying degrees of treatment intensity are likely to create ebbs and flows in wood supplies for wood-product manufacturers and processers. Thus, in order to mitigate wood supply inconsistencies, the Forest Service should release enough task orders at a given point in time to allow operators to sequence harvest activities in order to balance wood yields at an operationally sufficient level. Typically, based on the size of most expected facilities' wood-storage yards, average wood yields need to be balanced on a quarterly to semi-annual basis.

The structural variability of forests in the 4FRI area and the widespread geographic distribution of treatment units will create a mix of high-cost and low-cost, or more profitable and less profitable, harvest sites. Contractors, however, will not be able to pick and choose treatment sites based on profitability; rather, they will be required to conduct operations at many sites with varying degrees of economic value. In order to ensure that contractors are able to conduct operations viably across all sites, profitable and unprofitable, the Forest Service should release enough task orders at a given point in time so operators can sequence operations to balance economic variables.

The profitability of individual treatment areas is determined by examining the operational costs of treatments versus the value and amount of the wood removed from the site. Generally, operational costs for individual sites can be placed into three categories: (1) cost of mobilization, (2) loaded costs, and (3) haul costs. The cost of mobilization is the cost associated with moving harvesting equipment from one site to another and workers from their home base to the site on a daily basis. For a given site, the cost of mobilization will be dependent on the site's location relative to the location of the previously treated site (i.e., how far harvesting equipment must be moved), and its general geographical remoteness (i.e., the distance of workers daily commute). Loaded costs are incurred through cutting, skidding, delimbing, piling slash, and loading stems on truck trailers at the landing. For a particular site, loaded costs are primarily affected by the average volume and number of individual trees harvested (the larger and fewer the trees, the less costs incurred), the average skidding distance, and the site's topography. Haul costs are the costs associated with transporting wood from the landing to the manufacturing or processing facility. Haul costs are directly proportional to the distance between the harvest site and the manufacturing or processing facility, but is also affected by the quality of road traveled. Ultimately, hauling time is more a factor than hauling distance.

The operational costs of treatments for a particular site is mitigated by the amount and value of wood removed from the site. For instance, a contractor may be willing to incur a greater cost of mobilization if the site the contractor is moving to yields large amounts of valuable wood. Similarly, a contractor may be willing to haul wood a greater distance if the contractor can obtain greater value for the wood that is hauled. However, ecological restoration will include sites with low value wood that may not offset operational costs. Therefore, treatments should be sequenced or configured to enable contractors to offset their overall operational costs across all sites with the total value of wood harvested from all sites. Because individual contracts may require treatments across tens of thousands of acres over ten- to twenty- year periods, treatments should be sequenced in a manner that allows an individual contractor to balance its overall costs and revenues on a quarterly to semi-annual basis.

IV. **ECONOMIC BENEFITS OF A RESTORED FOREST**

A. <u>Wood Utilization</u>

The harvest and utilization of forest byproducts from restoration can produce significant economic benefits for local and regional economies. An analysis of the wood supply from 4FRI's potential management area concluded that, as of 2006, forest thinning could result in a wood supply increase of 850 million to over one billion cubic feet, from tree boles alone, and between 8 and 9.5 million green tons from branches and other tree crown biomass (Hampton et al., 2008). Over time these values will change as individual trees grow or die and entire stands succumb to varying levels of forest disturbance. Although the vast majority of the wood supply in the area is available on the national forests, the 2006 study analyzed the available wood supply on the 6% of the area that is non-federal land. The appropriate and complete utilization of this wood will not only help offset project implementation costs, but will create and retain jobs and economic opportunities in surrounding communities.

Some of the businesses necessary for removing and utilizing this wood already exist in the region. As of 2005, the US Forest Service determined that wood harvested from the Apache-Sitgreaves, Coconino, Kaibab, and Tonto National Forests supported a total of approximately 357 jobs and was responsible for generating over $7.5 million in income for the surrounding communities (Winter and Watson, 2005). Since the Forest Service analysis in 2005, work under the White Mountain Stewardship Contract has provided for the removal and utilization of ~48,000 ccf per year and treatment of between 5,000-10,000 acres per year (average is 7,500 acres). Current industry and market capacity on the White Mountains could increase in the next several years up to ~20,000 acres of treatment per year.

Even with potential increased capacity, however, the region's existing wood products industry is not robust enough to utilize the amount of wood that would be harvested by 4FRI's mechanical thinning treatments. If current utilization rates are extrapolated over the next twenty years, it is estimated that the region's existing industry could only process and utilize roughly 15-25% of the wood supply potentially available from 4FRI activities (Winter and Watson, 2005). The influx of such a massive wood supply could attract new, large industrial users, bolstering the region's existing wood products industry and economy.

The implementation of 4FRI's mechanical treatments and associated regional wood market expansion will affect a wide range of economic activities. Direct benefits include creating jobs in the logging and wood products industry. Existing sources of data, including estimates from industry business plans and from economic assessments from the White Mountains, indicate that, in combination with current work taking place in the region, the implementation of additional mechanical thinning treatments over 30,000 acres could support almost 600 private sector jobs (Hjerpe and Gunderson, 2007).

According to a study by Kim (2010), mechanically thinning 1.7 million acres will generate more than $1.3 billion in output and almost 15,000 job-years, or 740 jobs per year, over twenty years, while mechanically thinning approximately 1 million acres would generate more than $786 million dollars and almost 9,000 job-years, or over 400 jobs per year, over twenty years. Importantly, these estimates include the indirect economic effects from businesses that sell their products and services outside of the region, but do not include the additional temporary jobs associated with construction and reconstruction of the region's wood products utilization infrastructure, which could boost the northern Arizona economy for a period of 18-24 months.

To get a complete picture of the economic impact associated with market expansion and infrastructure development from 4FRI, construction and reconstruction-related jobs can be considered. A case study conducted by the W. A. Franke College of Business at Northern Arizona University analyzed the economic effects of Arizona Forest Restoration Products Inc.'s (AZFRP's) plans to invest $375 million dollars in the construction and operation of oriented strand board facility in Winslow, AZ (Hjerpe and Gunderson, 2007). The project's economic impacts on the regional economy were estimated based on employment and output data provided by AZFRP and Input-Output (I-O) modeling, along with the economic modeling software IMPLAN. The analysis estimated that the construction and initial operations of the facility would generate approximately $244 million dollars in economic output and over 1,000 jobs. After initial startup, it projected that the annual impact of the operating facility to be $170 million dollars in total output and 589 jobs. These estimates are an example of the economic impact that could generated from just one of many facilities that could be developed to support 4FRI.

B. Ecosystem Services

The goods and services provided by a healthy, naturally functioning, restored forest will also produce economic benefits for the region surrounding the 4FRI area. The economic benefits from ecosystem services may be realized through economic cost savings and added values that occur as a direct result of restoration treatments, or enhanced ecosystem services may be monetized and used to help offset the cost implementing restoration treatments. Direct economic benefits from ecosystem services can be realized through wildfire cost savings, improved watershed health, and enhanced recreational opportunities, which will increase revenue and reduce costs in the economies of surrounding communities. Additionally, ecosystem services, including enhanced carbon sequestration, habitat creation and preservation, and improved watershed health, may be used to create payments that assist the US Forest Service or its contractors in offsetting treatment costs. "When fully incorporated into a comprehensive land-management accounting system, these values can provide avenues for recouping treatment costs and recognition for the full suite of economic benefits associated with ponderosa pine restoration projects". (Hjerpe et al., 2009)

1. Wildfire Cost Savings

Communities and agencies in the 4FRI area will reap the direct economic benefits of avoiding wildfires. Every year, the cost of wildfire suppression impacts federal, state and local governments. In 2007, fire suppression activities on all wildfires across the country cost the federal government nearly $1.8 billion (Large Wildfire Cost Panel, 2008). Although staggering, these direct fire suppression costs account for only a fraction of the total economic costs associated with unnatural wildfires.

To fully calculate the costs associated with unnatural wildfires, the impacts to watersheds, ecosystems, infrastructure, businesses, individuals, and the local and national economy must be included. "Specifically, these costs include property losses (insured and uninsured), postfire impacts (such as flooding and erosion), air and water quality damages, healthcare costs, injuries and fatalities, lost revenues (to residents evacuated by the fire, and to local businesses), infrastructure shutdowns (such as highways, airports, and railroads), and a host of ecosystem service costs that may extend into the distant future" (WFLC, 2010). When all damage is considered, the true costs of wildfire become astronomical and are shown to be 2 to 30 times greater than the fire suppression costs that are usually reported (WFLC, 2010).

An examination of the 2002 Rodeo-Chedeski (R-C) fire provides a stark example of the *total* costs attributable to unnaturally large and severe wildfires. The R-C fire, the largest known wildfire in Arizona history, burned almost 463,000 acres and resulted in over $308 million in total calculable costs, including direct costs for suppression activities, property loss, and post-fire rehabilitation, as well as indirect costs associated with loss of sales tax revenue and job losses. (WFLC, 2010). Importantly, the $308 million estimated cost of the R-C fire does not include the economic losses associated with the long-term destruction of the forest's timber and recreational resources, the effects of lost infrastructure, damage to ecosystem resources and wildlife habitat, and impacts on community physical and mental health (WFLC, 2010).

By conducting ecologically appropriate thinning and burning, the occurrence and cost of unnaturally large wildfires can be greatly reduced or even eliminated. Simulations have found that the acres burned and associated costs are exponentially reduced in treated areas as compared to non-treated areas (Omi et al., 1999). Indeed, considering only wildfire suppression and rehabilitation costs, Snider et al. (2006) determined that these avoided costs justify spending $238–601 per acre for fuel-reduction treatments in the southwest, and Mason et al. (2006) determined positive net benefits of fuel removal treatments to be between $606 and $1,402 per acre. Considering these results and the *total* costs of unnaturally large wildfires, the expected economic benefit from reducing wildfire management costs as a result of the 4FRI would be significant.

2. Wildlife, biodiversity and related recreational activities

The presence of abundant and diverse wildlife, aesthetically pleasing forests, and a user-friendly environment exert a significant effect on the local economies surrounding national forests. Forests attract recreational and wildlife-related (i.e., hunting, fishing, and wildlife viewing) visits to the Kaibab, Coconino, Tonto, and Apache-Sitgreaves National Forests. These visits bring revenue to local communities through the purchase of gasoline, lodging, equipment, and other services that create jobs and significantly benefit the region's economy. In 2005, the US Forest Service determined that recreational and wildlife-related visits in these four national forests supported a total of almost 6,600 community jobs and were responsible for generating over $182 million in income for the surrounding communities (Winter and Watson, 2005).

Recreation in national forests plays an important role in the regional economy and benefits from forest management. Using available survey data collected in New Mexico during the summer of 2001, Starbucks et al. (2006) analyzed the effect of fuels management on forest recreation demand and its associated impact on the regional economy. Starbucks et al. (2006) found that fuel-reduction treatments had a positive effect on forest recreation uses. "Forests that are thinned are attractive to hikers and mountain bikers and tend to experience more trips for those activities than areas with dense growth and significant quantities of downed trees" (Starbucks et al., 2006). As a result, Starbucks et al. (2006) determined that recreational use increases due to fuel reduction treatments on national forests lead to "a one-time increase of $7.75 million in output, $3.5 million in earnings, and an increase of 186 jobs for New Mexico."

The benefits associated with creating, preserving, or restoring wildlife habitat could be monetized in the future to help offset treatment costs. Currently, the U.S. has seven active biodiversity offset and compensation programs and three in development, which produce total payments of $1.5-$2.4 billion annually (Madsen et al., 2010). These programs are voluntary and regulatory-based market tools that provide direct and indirect payments for habitat enhancement and mitigation efforts. As they currently exist, no U.S. programs allow for the monetization of the habitat values enhanced by 4FRI activities; however, these programs and their markets are in constant flux and may eventually enable the monetization of this benefit.

3. Water Quality and Quantity

Approximately 40 percent of surface and subsurface water in Arizona originates on its National Forests *(*Apache-Sitgreaves National Forests, 2009; Tonto National Forest, 2005). As populations continue to increase and greater demand is placed on Arizona's limited water resources, the management and protection of the State's National Forests' watershed integrity will become more and more important.

Increased demand and several years of below-average precipitation have led to periodic decreases in Arizona's water supply (Tonto National Forest, 2005). For instance, as of 2005, water consumption in the two watersheds closest to the Tonto National Forest, the Verde and

Salt River Systems, were at 90% and 95% of capacity, respectively. In the Apache-Sitgreaves National Forests, projected growth rates in Apache and Navajo Counties and southern Arizona will make the forest's role in protecting it watersheds even more vital (Apache-Sitgreaves National Forests, 2009). Although overall groundwater supply within the Coconino National Forest remains generally static to slightly declining, increasing demand from the City of Flagstaff and Coconino and Yavapai counties pose a risk to groundwater supply and those plants and animals that rely on it for their survival (Coconino National Forest, 2008). Overall, Arizona suffers from inadequate water availability, which could eventually constrain population growth and limit agricultural and industrial activities.

Conducting ecologically appropriate thinning and burning on the State's National Forests, however, can increase water yield and protect watersheds from unnatural fire and subsequent soil loss. Numerous studies worldwide demonstrate that reducing forest cover increases water yield (Elliot et al., 2010). More specifically, in northern Arizona's ponderosa pine forests, studies demonstrate that initial water yields can be expected to increase by 15 to 40% when forest basal areas are reduced by 30% to 100% (Baker, 2003). Although these gains in water yield typically disappear several years following treatment, the gains could potentially be sustained by using fire as a tool to manage understory vegetation (AFRTG, 2010).

Furthermore, Arizona can benefit from the increased water yields caused by fuel-reduction treatments, such as thinning and prescribed burning, without sacrificing its water quality. Although restoration treatments can potentially affect water quality, implementation of best management practices can effectively minimize or eliminate deleterious water quality effects. (Elliot et al., 2010). The improved availability of clean water from sustainably implemented forest management treatments will benefit the wildlife that live in and around the State's precious riparian areas, the recreational users of the State's rivers and lakes, Arizona farmers that produce crops on over one million acres of cropland, the ranchers that require clean drinking water for their livestock, and the over 6 million people living in Arizona that require clean drinking water every day.

The values associated with increased water quality and yield can create economic benefits for communities surrounding the 4FRI area, and potentially help offset treatment costs. Increased water yields and improved water quality will reduce costs associated with transporting, treating, or developing new and existing water supplies. Additionally, potential payments from individuals or companies that benefit from the improved water supply can be used to offset a portion of restoration treatment costs. Typically, water users pay for the services of capturing, treating, and delivering water, but not the ecosystem services that produce the water. By attaching an economic value to these natural processes and services, water districts and municipalities can access a new source of revenue to support needed watershed protection. Santa Fe, NM has proposed the Santa Fe Municipal Watershed Restoration Project, which would collect payments from water users to fund the maintenance of forest restoration activities as an insurance policy against future threats to the municipal water supply, including wildfire (Greenwalt and McGrath, 2009).

4. Carbon Sequestration

Concern about increased concentrations of carbon dioxide and other greenhouses gases in the atmosphere has prompted the U.S. Congress to propose various iterations of climate change legislation. A majority of the climate change bills include a greenhouse gas cap-and-trade program (ACES, H.R. 2454, 2009). Cap-and-trade programs will limit the amount of carbon dioxide that certain entities, such as coal-fired power plants, are allowed to emit, but would also allow those entities to exceed their emission limits if they purchased additional emission allowances or “carbon credits” to offset their pollution. Under most cap-and-trade programs, carbon credits can be generated by “carbon offset projects,” including certain forest management projects that sequester carbon dioxide from the atmosphere. If the Congress eventually passes cap-and-trade legislation and industry is forced to operate in a carbon-constrained environment, the carbon credits produced by carbon offset projects could become a very valuable commodity.

Forest thinning and burning in southwestern ponderosa pine forests may potentially generate carbon credits. Although forest fuel-reduction treatments are generally considered to cause a reduction in forest carbon stocks, these activities may actually reduce carbon emissions over the long-term in fire prone areas (Hurteau and North, 2010). Because untreated forests in fire-prone areas are likely to burn at high intensities and combust biomass completely, the overall carbon eventually released from untreated stands during a wildfire may be several times greater than the carbon released from treated stands during thinning and burning operations. Dore et al. (2010) determined that intensely burned ponderosa pine forests contained 42% lower total ecosystem carbon 10 years after burning than undisturbed forests, while thinned ponderosa pine forests had only 18% lower total ecosystem carbon than undisturbed forests. Thus, carbon credits could be generated in an amount equal to the difference between the amount of carbon released during fuel-reduction treatments, and that potentially released from that same untreated forest during a wildfire. The carbon credits generated from such forest management operations would not only provide greenhouse gas emitters with necessary emission allowances, but would also provide the wood products industry with a valuable means for offsetting its costs.

Without the development of a federal cap-and-trade program, a market could still exist for carbon credits generated through 4FRI activities. There is a robust voluntary carbon market in the US that experienced $143.4 million worth of transactions in 2009 (Kossoy and Ambrosi, 2010). Although no voluntary carbon registry currently has a protocol that would allow 4FRI-related activities to generate carbon credits, at least two registries are exploring the possibility.

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