Anchor Forests

Sustainable Forest Ecosystems through Cross-Boundary, Landscape-Scale Collaborative Management

Task Assessments

Prepared for:

The Intertribal Timber Council
1112 NE 21st Avenue, Suite 4
Portland, OR 97232

March, 2016

Anchor Forests

Sustainable Forest Ecosystems through Cross-Boundary, Landscape-Scale Collaborative Management

Task Assessments

Prepared for:

The Intertribal Timber Council
1112 NE 21st Avenue, Suite 4
Portland, OR 97232

March, 2016

Prepared by:
Mark Corrao[1], Vincent Corrao[2], and Tera King[3]

Northwest Management, Inc.
Moscow, ID – Deer Park, WA – Helena, MT
www.TheNMIway.com

The Full Report on the Anchor Forests Pilot Project Assessment consists of eight parts: (1) an Executive Summary that encapsulates key findings and recommendations from the assessment, (2) a Final Report that summarizes the findings and recommendations specific to the six individual tasks, and (3) a Task Analysis Report that contains the detailed results for each of the six individual tasks.

In addition, four (4) short Anchor Forest videos have been produced to facilitate communication of the concepts and exemplify the value of balanced social/cultural, economic and ecologic forest ecosystem management. The Anchor Forest documents can be obtained from the Intertribal Timber Council office listed below. The final reports and videos are also available on-line at: www.ITCnet.org.

Intertribal Timber Council
1112 NE 21st Avenue, Suite 4
Portland, OR 97232-2114
(503) 282-4296

Anchor Forests — People, Place, Community, Environment and Economy

[1] Mark Corrao, Ph.D., P.H., CPESC: Certified Professional Hydrologist, Northwest Management, Inc., Moscow, ID
[2] Vincent Corrao: Certified Professional Forester, Northwest Management, Inc., Moscow, ID
[3] Tera King, MBA: Certified Professional Forester and Arborist, Northwest Management, Inc., Moscow, ID

Acknowledgments

The Anchor Forest Oversight Committee and coordinating team gratefully acknowledges the tribes who participated in this assessment. Special thanks go to the members of the Anchor Forest Oversight Committee who helped guide and direct the team of coordinators and consultants through analysis and final recommendations. We are indebted to the many tribal and agency representatives who generously gave their time and knowledge while participating in surveys, interviews, and site visits. Their contributions are greatly appreciated.

We also want to thank Laura Alvidrez, the Program Manager for the Intertribal Timber Council and Steve Andringa, Anchor Forest Project Manager for the Yakama Nation, for their continual support throughout the project.

A special thanks to the following supporters and contributors

Anchor Forest Project Manager

Steve Andringa – Yakama Nation

Anchor Forest Coordinators

Vincent Corrao, Mark Corrao, Tera King – Northwest Management, Inc.

Anchor Forest Oversight Committee

Gary Morishima, Quinault Nation, ITC Representative
Philip Rigdon, Yakama Nation DNR Director, ITC President
Ron Saranich, USFS, R6 COR for the contract
Allen Estep, WA DNR, Olympia
Jamie Barbour, USFS, Science Delivery Program
Don Motanic, ITC Technical Specialist

Implementation Team of Consultants and Cooperators

Ryan Haugo, Reese Lolley and Lloyd McGee, The Nature Conservancy
Brian Boyle, Luke Roger, John Perez-Garcia, University of Washington
Jay O'Laughlin, Dana Dolsen, University of Idaho
Jim Erickson and Don Motanic, Intertribal Timber Council

Photography

Photos provided by The Yakama Nation, Northwest Management, Inc., and The Confederated Tribes of the Colville Reservation.

Cover photograph of Hells Canyon – Inland Northwest by Dana Rand Photography.

Funding support for this study was provided by the Northwest Regional Office of the USDA Forest Service through a Domestic Grant (2011 DG-11062765 026) with the Intertribal Timber Council and the Bureau of Indian Affairs. In accordance with Federal law and U.S. Department of Agriculture (USDA) policy, this institution is prohibited from discriminating on the basis of race, color, national origin, sex, age, disability or retaliation. To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, Room 326-W Whitten Building, 1400 Independence Avenue SW, Washington, DC 20250-9410 or call (202) 720-5964 (Voice and TDD). USDA is an equal opportunity provider and employer.

Dana Rand Photography

Anchor Forest Task Assessments

The Anchor Forest task assessments were completed to evaluate the viability of the Anchor Forest concept as a framework for institutionalizing collaborative cross-boundary forest ecosystem management, and the potential of Anchor Forests to form the cornerstones needed to overcome forestland fragmentation and address ecosystem function at a landscape scale. Recommendations focus on the identified opportunities available through existing personnel, expertise, and forestry infrastructure, given the implementation of an Anchor Forest and the "social license" attainable through inclusion of diverse landowner interests. All task findings were used to evaluate the potential of Anchor Forests, existing processes, and authorities to maintain forest ecosystem function and improve forest health through "working forests."

As an institutionalized collaborative framework, Anchor Forests have the potential to assist land managers in sustainably accomplishing cross-boundary ecosystem management while maintaining a balance of social/cultural, economic and ecologic practices at a landscape scale. Within eastern Washington, assessments showed Anchor Forests can offer valuable tools for prioritizing investments that address forest health decline and increase ecosystem resilience. The Anchor Forest framework combines opportunities for landowners, communities, agencies, and tribes seeking to achieve landscape-scale projects that address forestland conditions with cost-effective solutions. Anchor Forests, spanning multiple ownerships, recognize and respect the prerogatives and obligations of individual landowners, and offer a foundation for the development of actionable strategies targeting collaborative landscape-scale management that will accrue shared benefits for all willing to work together in a respectful, trust-based atmosphere.

The six (6) task assessments used to address the Anchor Forest study objectives are presented in this document as consecutive chapters.

Task 1

Eastern Washington Forestry Infrastructure, Commodity Production and Biomass

Task 2

Collaborative Forest Restoration Frameworks and the Anchor Forests Concept

Task 3

Evaluation of Institutional Capacity

Task 4

Identification of Barriers to Cooperative, Collaborative Cross-Boundary Forest Management

Task 5

Anchor Forest Information, Programs, and Financial Assistance Database

Task 6

Socio-Economic Forestland Values and Non-market Benefits of Ecosystem Services

Contents

Task 1 Report: Infrastructure for Commodity Production and Biomass

Prepared for the:

Intertribal Timber Council

by

V. Corrao, G. Howisey, and M. Corrao, Ph.D.

Northwest Management, Inc.

January 2016

(This page intentionally left blank)

Introduction

Eastern Washington is experiencing severe forest-health issues as a result of insect and disease infestations, over-stocked forest conditions, and increasing wildfire severity further intensified by a changing climate. Without strategically planned ecological restoration throughout the region, these conditions will continue to persist, further impacting communities and forested landscapes through catastrophic wildfire and landscape-scale tree mortality. The objective of Task 1 was to assess the existing manufacturing, harvesting and transportation infrastructure throughout eastern Washington. The assessment focused on current forestry infrastructure, opportunities to improve forest health and ecosystem function, and economic differences between geographic regions. Findings present current forest biomass utilization, employment and economic opportunities and barriers throughout the forestry sector, and recommendations for successfully implementing the Anchor Forest concept. The Anchor Forest concept in its entirety, seeks to improve overall forest health conditions, ecosystem function, and economic sustainability at a landscape scale through collaborative efforts across multi-jurisdictional ownership boundaries.

Focused on the concept of forest sustainability in eastern Washington and how deteriorated forest conditions, facing a changing climate, can be pro-actively managed; the recommendations of this assessment seek to increase forest ecosystem resilience, and improve the diversity of forest ecosystem processes and services. Increasing regional temperatures, drought conditions and wildfire severity will continue to impact forests at the landscape-scale altering forest ecosystem services such as clean water, clean air, biodiversity, soil fertility, aesthetics, and recreational opportunities from decades to centuries into the future. Current regional trends are expected to worsen forest health conditions across eastern Washington over the coming years with projections of a continued 150 to 200% increase in insect and disease tree mortality every decade (DNR 2014) and an increase in burned acres of 300% or more each year by 2100, as compared to the conditions of 2000 (Littell et al. 2010; Snover et al. 2013).

Deteriorating forest health conditions in eastern Washington are not new; however recent fire seasons have renewed a sense of urgency surrounding forest health conditions and the need to be proactive. In 2007, the Washington State legislature amended state law to emphasize the need for improved forest health at a landscape-scale as well as coordination and assistance efforts across multi-jurisdictional boundaries. Amendments defined "forest health" broadly as: "*the condition of a forest being sound in ecological function, sustainable, resilient, and resistant to insects, diseases, fire and other disturbance, and having the capacity to meet landowner objectives.*" (RCW 76.06.020). In 2011 the Washington Department of Natural Resources (DNR) initiated the State's first forest health hazard warning process in November and convened a Forest Health Technical Advisory Committee. In 2012, based on committee findings (DNR 2012a) the first "Forest Health Hazard Warnings" were issued in August for four counties in eastern Washington (Goldmark 2012).

In April 2014 Governor Inslee proposed a number of eastern Washington Federal Insect and Disease Designation Areas and in October of 2014 the Eastern Washington Forest Health, Hazards, Accomplishments and Restoration Strategy (DNR Restoration Strategy) report was completed providing an assessment of forest health threats in eastern Washington (DNR 2014). On March 6, 2015 Governor Inslee's proposed Insect and Disease Designation Areas were

approved by the U.S. Department of Agriculture's Forest Service (USFS) Chief, Thomas Tidwell. Recommendations from the DNR Restoration Strategy report confirmed areas expected to be severely impacted and estimated a timeline of 15 years. Additionally, the 2012 National Insect and Disease Forest Risk Assessment report previously produced a series of maps containing a nationwide strategic assessment of tree mortality "risk" due to insects and disease (Krist et al. 2014). Risk, or more appropriately termed *hazard*, was defined as: "*The expectation that, without remediation, at least 25% of standing live basal area greater than one inch in diameter will die over a 15-year time frame (2013 to 2027) due to insects and diseases."* Based on this expectation the report used a 15-year timeframe to determine how many acres should be targeted for treatment across all landownerships to address forest health risks.

Moreover, a recent analysis by The Nature Conservancy (TNC) and the USFS identified nearly 2.7 million acres of eastern Washington forestland requiring some type of active treatment to restore forest structure and transition conditions more toward their Natural Range of Variability (NRV); a state more resilient to insects, disease and wildfires (Haugo et al. 2015). Additionally, Haugo et al., (2015) identified 4.2 million acres of USFS lands (outside of wilderness and inventoried Roadless areas) within eastern Washington and Oregon in need of active restoration. Despite the number of identified acres in need of treatment, land managers between 2009 and 2013 have only applied an annual average of 143,200 acres of mixed mechanical harvest, hazardous fuels reduction, and prescribed fire on forest lands in eastern Washington (DNR 2014). Regardless of the success of forestland treatments on these lands, the current level of restoration activity is not keeping pace with increased forest losses due to insects, disease, and wildfire in eastern Washington (Table 1).

To increase restoration efforts from "Current" to "Target" levels and to meet the restoration needs of projected declines in forest health over the next 15 years, there will be a need to increase the estimated annual acres to 23,300 acres treated. This increased annual target represents an additional 349,500 acres over a 15 year period. The largest increase in treatment acres (Current to Target) would occur on USFS lands and would require a 67% (14,500 acre) increase to accomplish restoration activities on nearly all operable acres within a 15 year timeframe (Table 1). The projected restoration need within the Anchor Forest concept is conservative when considering requests made by Governor Inslee (719,150 acres) and recent approvals by the USFS of 711,457 acres (Tidwell 2015) for national forest lands in the Okanogan-Wenatchee, Colville, Umatilla, and Gifford Pinchot National Forest after exclusion of wilderness and Non-USFS land in-holdings (USDA 2015).

Restoration of the Target acres identified on USFS ownerships (+14,500 acres, Table 1) across the three study regions for 15 years would enable treatment of only ~217,000 acres of the 711,000 USFS-approved acres, leaving ~494,000 designated priority acres untreated and at risk of further degradation. Moreover, increasing annual treatment by 23,300 acres would produce approximately 117 million board feet (MMBF)[1] of timber products and 94,770 bone dry tons[2] of biomass through harvest operations. An increase of 117 MMBF could be fully utilized by

[1] Assuming an average harvest volume of 5 million board feet per acre.
[2] Assuming 0.81 bone dry tons of biomass produced per 1000 board feet (MBF).

existing processing capacities within the three regions as some facilities are operating at less than 70% capacity (an increase of 30% would equate to nearly 159 MMBF). The utilization of the additional biomass would, however, be subject to market value, which has been low throughout the study areas of this task.

Table 1. Current treatment and proposed target acres in need of restoration within the Anchor Forest study regions by ownership. The 'Total Acres' column includes "restricted acres" which encompass wilderness areas, inventoried roadless areas and other federally restricted management areas. Operable acres are acres not restricted from management and therefore exclude land designated as Wilderness, Inventoried Roadless and other federally protected land. Operable acres are identified restoration acres requiring "Disturbance Only and Disturbance then Succession" (Haugo 2015) and include both greater than 45% slope and less than 45% slope areas (Rogers et al. 2012). The Readily Accessible acres are those in need of restoration at less than 45% slope and considered easier to access. The Current Treatment Level acres (DNR 2014) represent average annual mechanical forest treatments from 2009 through 2014 and include commercial timber harvest and non-commercial forest treatments.

Ownership	Total Acres	Treatable Acres		Treatment Levels (acres/year)		Years to Treat	
		Operable	Readily Accessible			Operable	Readily Accessible
USFS	1,079,000	546,000	438,000	Current	21,000	26	21
				Target	**35,500**	**15**	**12**
State	305,000	251,000	214,000	Current	17,000	15	13
				Target	**17,500**	**14**	**12**
Tribal	455,000	352,000	306,000	Current	25,967	14	12
				Target	**33,000**	**11**	**9**
Industrial Private	311,000	290,000	255,000	Current	24,233	12	11
				Target	**24,500**	**12**	**10**
Non-Industrial Private	498,000	452,000	415,000	Current	55,000	8	8
				Target	**56,000**	**8**	**7**
Total for Three Study Regions	2,648,000	1,891,000	1,628,000	Current	143,200	13	11
				Target	**166,500**	**11**	**10**

This assessment report provides data on each of the land ownerships within the three Anchor Forest Study regions (South Central (SC), North Central (NC) and Northeast (NE)) (Figure 1) including: the forest health hazards and wildfire risks in each region; and an evaluation of the timber, biomass supply, and processing capabilities of existing sawmills and biomass facilities. The transportation networks, cost, and processing infrastructure were also evaluated for each of the study areas by county: SC (Kittitas, Yakima, and Klickitat Counties); NC (Chelan, Okanogan, and Douglas counties); and NE (Ferry, Stevens, Lincoln, Spokane, and Pend Oreille counties).

Additionally, site visits to the Yakama, Colville, Spokane, and Coeur d'Alene Indian Reservations were conducted to explore opportunities for tribal forest lands to be Anchor Forests. Assessment results provided current measures and future projects of timber supply for

sawlog manufacturing and biomass under existing management as well as estimations of forest health treatment acres, by landowner classification, needed to begin restoring deteriorated forest ecosystem functions and increase forest resilience against the threats of insects, disease, and wildfire severity. Current forest and forestry-sector conditions specific to each study region are provided following a background and general industry overview for eastern Washington. Within each study region opportunities, barriers, and recommendations are presented for restoration of forest health, and maintenance of timber and biomass supply as well as the transportation, processing, and manufacturing infrastructure necessary to achieve desired treatment objectives.

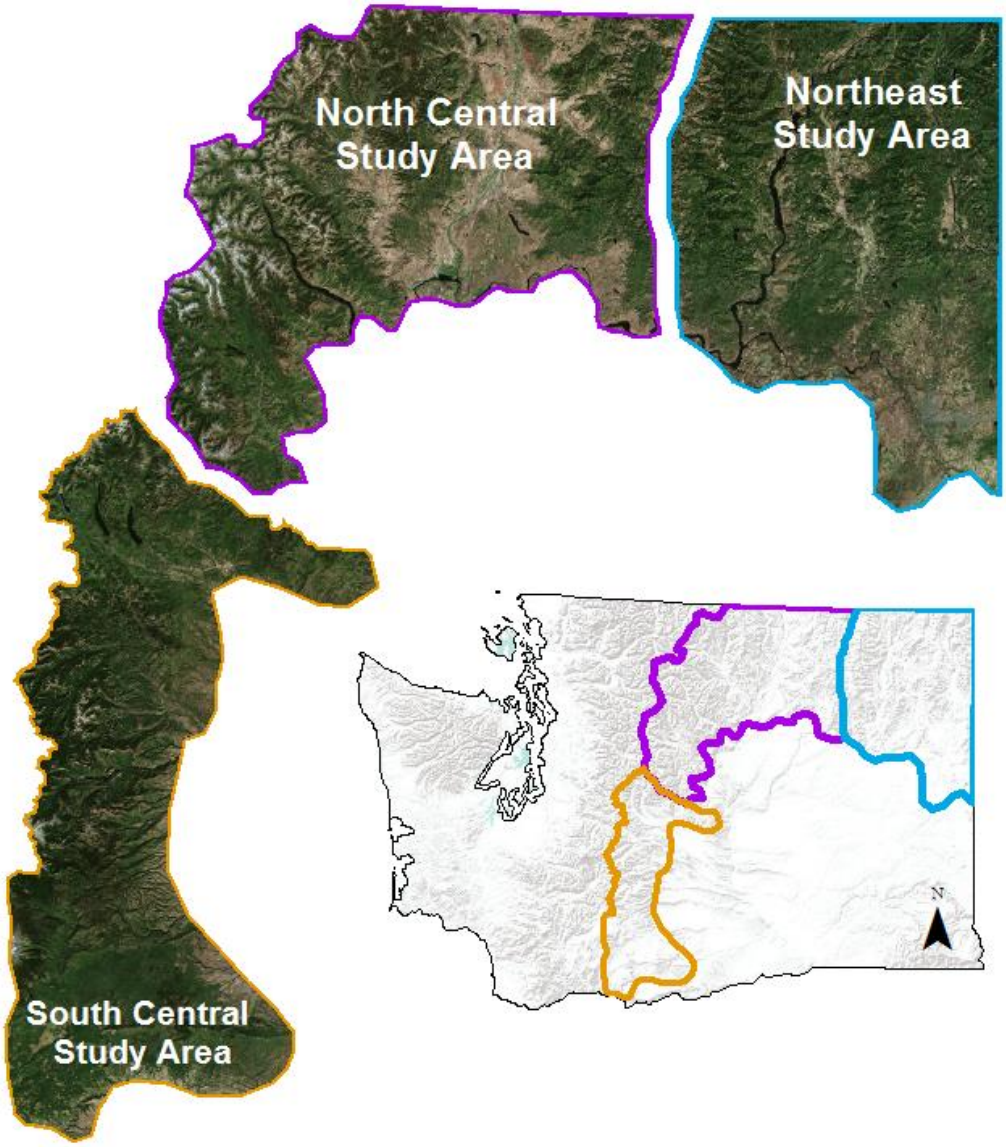


Figure 1. Assessments of forest health and forest industry infrastructure were completed for three study regions within eastern Washington to inform the Anchor Forest concept.

Background and Current Status

For more than one hundred years, North American foresters and resource policy makers have sought to achieve sustainability (Flyod 2002). In the last several decades sustainability and stewardship have been the focus of many forest management plans and legislative discussions; portrayed as interlocking circles reflecting a balanced intersection of three realms, these two principals are similar in character and function (Figure 2). Public and private forest managers have long struggled with attempts to integrate stewardship of ecological processes with maximized return on investment, and have been met with mixed success. A recently completed report on sustainable forestry (USDA Forest Service 2011), identified a number of threats to America's forests, ranging from fragmentation and development, to forest fires, insect-induced mortality, and invasive species with many of these threats being influenced by a changing climate.

The forecasted potential for altered distribution of forest cover, species, and disturbance patterns across entire landscapes, means climate change may present one of the greatest challenges for future land management (Vose et al. 2012). For example, increases in temperature can reduce the growth of some species in the drier forest and increase the growth of others at higher elevations. Decreased snow cover depth, duration and extent would lead to drier local conditions in some areas, leading to decreased tree vigor and increasing stress making trees more susceptible to insects and pathogens. Tree mortality would therefore increase in many western forests, especially those with older trees, overstocked stands conditions, and in already water-limited areas.

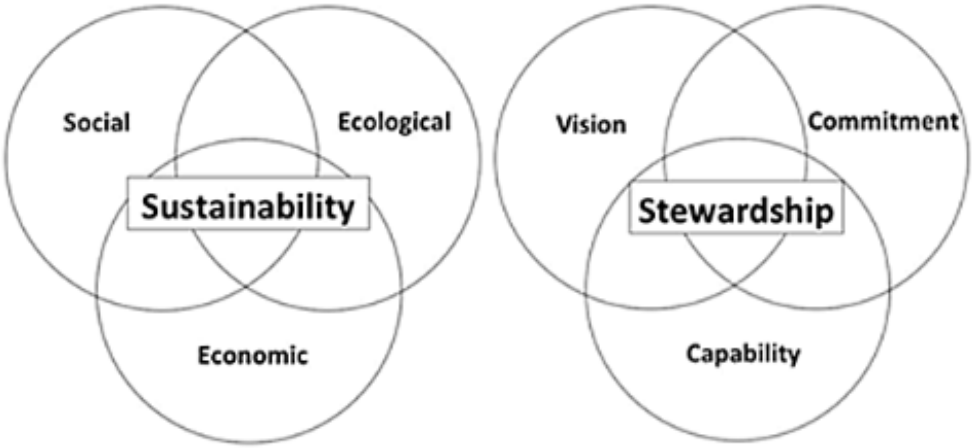


Figure 2. The "triple bottom line" of sustainability combining social, ecological and economic dimensions inextricably coincides with the foundation of stewardship. Stewardship for sustainability has been described as the intersection between vision, commitment, and capability. *Vision* represents the ability to establish and convey a shared sense of "what can be", *Commitment* represents relationships that maintain respect, trust, and collaboration over the long-term, and *Capability* represents the availability of competent interdisciplinary staff with the information and resources to implement multiple-use multiple-resource management plans (IFMAT 2013). The overlapping circles of sustainability highlight the required balance between societal, ecological, and economic need, adapted from Bare, (2002).

The Anchor Forest concept was developed to provide a comprehensive approach for expansion of collaborative efforts between forest owners in eastern Washington to a boarder more ecologically appropriate landscape-scale. Undertaking cross-boundary or multi-jurisdictional management of a resource as diverse as the forest requires comprehension of processes and planning that address holistic ecosystem management, inclusive of road systems, wildlife habitats, forest health, water resources, soils and recreation. The Anchor Forest concept was developed to reverse declining forest system health and improve the available economic and employment opportunities supporting local communities by addressing landscape-scale ecosystem function and services (IFMAT 2013).

Challenges facing cross-boundary forest management stem from depressed markets for forest products and a lack of forestry infrastructure. These lead to shortfalls in revenue, job losses, and a diminished ability to provide the level of management needed to achieve sustainable forest conditions (USDA Forest Service 2012) which results in continually increasing frequency and severity of wildfires and their associated costs (Ingalsbee 2010). Recent studies show that nationwide more than 1,160 mills have closed since 2005, and from 2005 to 2010, United States lumber production has decreased by 40 percent (IFMAT 2013). Additionally, the escalating costs of fire suppression have led to a redirecting of funds away from conservation strategies such as forest hazardous fuels treatments, water resource conservation, wildlife habitat, and recreation (USDOI 2015). As the investments to ensure forest ecosystem sustainability and resilience dwindle, the threats and costs of wildfire will continue rise and further impact ecosystem functions and landscapes at unprecedented rates.

Within the State of Washington forest lands are a valuable part of the social/cultural, economic and ecologic balance spanning from coastal waters to the semiarid areas of the Columbia Basin. There are 20 counties located in eastern Washington that include approximately 9.9 million acres of forest (Haugo et al. 2015). Of this area 6.5 million acres is classified as timberland. The WA DNR defines timberland as forested land capable of producing 20 cubic feet or more of wood volume growth per acre per year (DNR 2007). Nearly 40% of unreserved portions of these timberlands in eastern Washington are administered by the federal government (Figure 3), specifically the U.S. Department of Agriculture Forest Service (USFS) contained within the Colville National Forest, Okanogan-Wenatchee National Forest, and Umatilla National Forest. Non-industrial forest lands represent the next largest ownership category comprising nearly 20% of the unreserved timberlands. Indian forests account for approximately 16% and the forest industry manages approximately 14% with state and local governments administering the remaining balance.

In many of the Interior Pacific Northwest forest ecosystems previous studies have documented patterns of departure from historical forest conditions, as described by Haugo et al., (2015), despite highly publicized calls to increase the pace and scale of forest restoration (Rasmussen et al. 2012; USDA Forest Service 2012). Within eastern Washington approximately 41% of all coniferous forests were found to be in need of transition to a different stage of succession or structure in order to exhibit a condition near a Natural Range of Variability (NRV) reference condition (Haugo et al. 2015). NRV describes a suite of ecosystem characteristics that include forest structure and have ties to spatial and temporal references within a particular period that serves as a “baseline” condition.

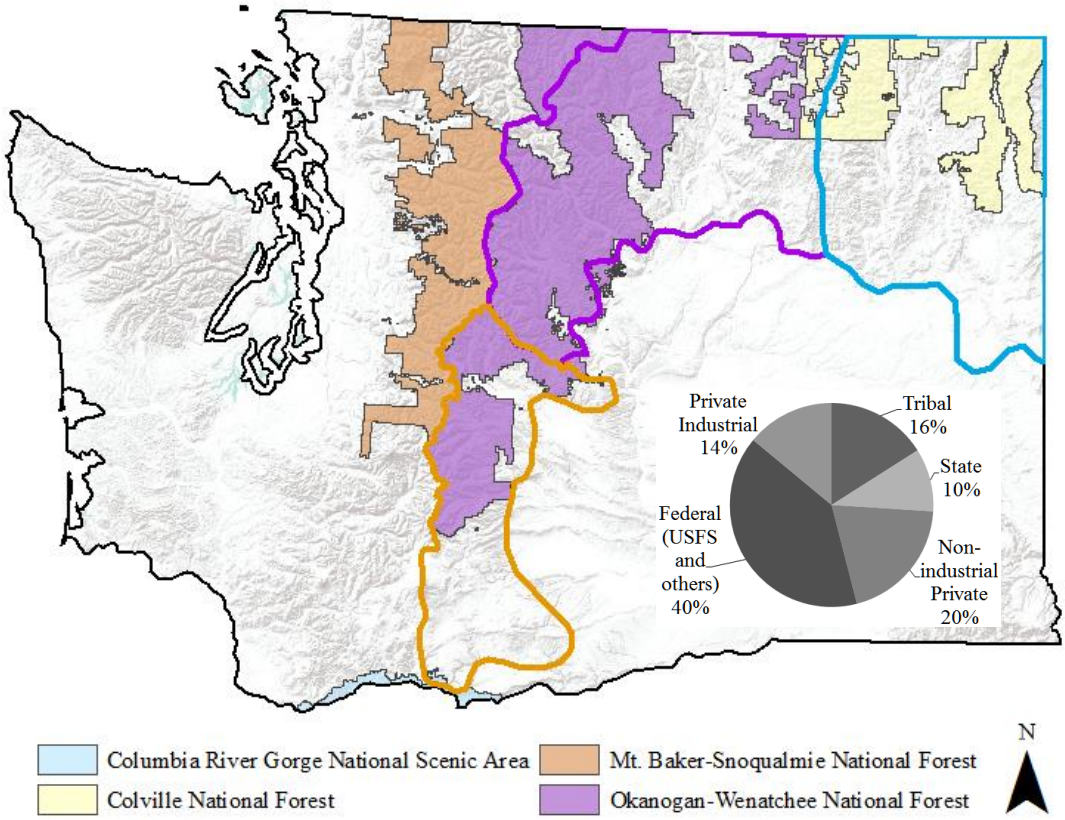


Figure 3. Nearly 40% of the unreserved 6.5 million acres of timberland in eastern Washington are administered by the federal government and are contained within the Colville, Okanogan-Wenatchee, and Umatilla National Forests.

Managing fire prone landscapes involves understanding the past disturbance dynamics and how succession will impact terrestrial and aquatic habitats in the future. Many of the ecological and physical processes of eastern Washington forests have been altered in space and time thereby influencing the frequency, size, and intensity of disturbances that once sustainably configured these landscapes. A number of core principles for restoration of fire prone landscapes have been presented in the literature (Hessburg et al. 2015). These, sometimes innovative principles, have been proposed to inform future management efforts in defining the scope and extent to which ecological functions are impacted and intertwined.

A recent analysis by The Nature Conservancy (TNC) and the USFS identified nearly 2.7 million acres of eastern Washington forestland requiring some type of active treatment to restore forest structure to a state more resilient to insects, disease and wildfires (Krist et al. 2014). The major landowners in eastern Washington currently apply an average of 143,000 acres of mixed mechanical harvest and hazardous fuels reduction and 18,000 acres of prescribed fire to eastern Washington lands annually since 2009 (DNR 2014). Despite these efforts the current level of restoration activity is not keeping pace with deteriorating forest conditions of eastern Washington (DNR 2014; USDA 2015; Goldmark 2012; DNR 2012a).

In considering changing climate conditions and an ever increasing wildfire threat an increase in the extent and scale of forest restoration is needed. Without active management these forests will likely succumb to large costly wildfires such as the Carlton Complex fire of 2014, which burned 256,108 acres and more than 300 homes, representing the largest fire in Washington State history. The impact of these catastrophic fires takes valuable resources away from proactive management efforts aimed at improving ecosystems and mitigating future disasters. A lack of resources, such as what occurred during the 2015 wildfires on the Yakama and the Colville Indian reservations, led to significantly more burned forest acres now resulting in deteriorated water quality, soil health and anadromous fish habitat that will likely persist for decades.

If left untreated forest insect and disease conditions will continue to exacerbate large wildfires across eastern Washington, reduce the value of harvestable timber, impact local jobs and economies, and reduce the potential for treatment revenue to offset the costs of restoration. Without access to forest product markets, and an ability to prepare and implement management prescriptions, without the income generated from harvest to offset costs of forest health treatments, our forests face increasing tree mortality, wildfire, and land conversion, therefore transitioning forest from a community asset to a community liability (IFMAT 2013).

The Agricultural Act of 2014, better known as the "Farm Bill" authorized State Governors to request that the Secretary of Agriculture "designate one or more landscape-scale areas in at least one national forest in each State that is experiencing an insect or disease epidemic" (Tidwell 2014). In his April 8, 2014 letter, Governor Inslee requested 719,150 acres of National Forest land in the Okanogan-Wenatchee, Colville, Umatilla, and Gifford Pinchot National Forests receive the priority designation, of which 711,457 acres where approved after the exclusion of wilderness, designated roadless areas, and non-USFS land in-holding (Tidwell 2015). These lands were designated as landscape-scale areas experiencing an insect or disease epidemic as defined by section 602 of the Healthy Forest Restoration Act (HFRA) of 2003 (16 U.S.C. 6591a) and meeting one of the following criteria: 1) the area is experiencing declining forest health based on annual forest health surveys; 2) the area is at risk of experiencing a substantial increase in tree mortality over the next 15 years due to insect and disease infestation as indicated by National Insect and Disease Risk Mapping; or 3) the area is located where hazard trees pose an imminent risk to public infrastructure, health or safety (USDA Forest Service 2014).

To improve current and future forest health conditions this report identifies the minimum harvesting, manufacturing, processing, transportation capacity and infrastructure needs that can be combined with the social/culture, economic, and ecologic balance within the Anchor Forest concept to promote sustainable stewardship at a landscape-scale. Developing, applying, and adapting practices that meet forest health challenges will restore ecosystem resilience and improve an array of ecosystem services such as clean air, clean water, increased biodiversity and recreation as well as provide support of forest-dependent communities and the Nation as a whole.

Forest Health

Climate change is expected to worsen wildfire and forest health conditions across eastern Washington over the coming years with projections of higher summer temperatures and decreased precipitation. These conditions are predicted to maintain the 150 to 200% increase in insect and disease tree mortality observed in eastern Washington every decade following the 1990's (DNR 2014) and are expected to lead to an increase in annual burned area of approximately 300% by 2100, with some areas increasing as much as 500%, when compared to the conditions of 2000 (Littell et al. 2010; Snover et al. 2013).

Communities, forest infrastructure and natural and economic values remain at risk from wildfires across much of eastern Washington (DNR 2014) as demonstrated by the 2014 wildfire season where a total of 368,972 acres burned including the 256,108-acre Carlton Complex fire in Okanogan County, the 22,571 acre Mills Canyon Fire in Chelan County, and four other major fires including the Snag Canyon fire near Ellensburg, the Watermelon Hill fire near Cheney, the Chiwaukum Complex near Leavenworth, and Lake Spokane fire near Spokane. Similarly, the 2015 wildfire season has continued the increasing trend of frequent catastrophic wildfire with nearly 1 million acres burned in eastern Washington, one half of which were forested acres. Two of the largest fires in the state; the North Star Complex (>217,000 acres) and the Cougar Creek fire (>53,000 acres) occurred on the Colville and Yakama Nation Indian reservations, respectively.

Data collected by the DNR and USFS indicate eastern Washington forests have experienced increasing insect and disease damage over the past four decades with total forest acres affected over the past decade increasing from an annual average of 730,000 acres in the 1970's to 1.12 million acres per year in the 2000's (Krist et al. 2014). Statewide western pine beetle (WPB) mortality has more than doubled from the levels reported in 2013. A significant increase in mortality due to Douglas fir beetle was also detected in northern Klickitat County and southern Chelan County. This damage is related to the lingering impacts of the 2012 wildfires and chronic defoliation by the western spruce budworm.

The forest in eastern Washington are out of balance, historically approximately 5 million acres of forestlands within eastern Washington experienced low severity fire, on average, every 35 years (DNR 2014). The results of fire exclusion and past forest management are intersecting with seasonal droughts and a changing climate to create wildfire-prone conditions. The acres of trees that have been killed or damaged by forest insects and diseases over the past decade is 150% greater than in the 1990s, 200% greater than in the 1980s, and 175% greater than in the 1970s (DNR 2014). The National Insect and Disease Risk Assessment has projected increasing levels of damage (Krist et al. 2014) on nearly 2.7 million acres of Washington state forestlands from insects and disease over the next 15 years. In 2013 insect and disease damage in Washington was 593,000 acres (USDA 2015). Currently, eastern Washington forest ownership is dominated by the USFS, DNR, Tribal, Industrial, and small private landowners (Table 2) with the majority of forestland management occurring under the discretion of the USFS (51%) and tribal nations (14%).

Table 2. Major eastern Washington forestland owners (Rogers et al. 2012).

Landowner	Forest Acres
USFS	4,882,331
WA DNR	762,633
Tribal	1,376,318
Small Private	1,583,685
Industrial	949,837
Total	9,554,804

Currently, forest health improvements are achieved through a variety of mechanical treatment methods or prescribed fire, with each landowner tailoring their activities to individual management objectives and capabilities. The WA DNR has compiled information on commercial timber harvest and noncommercial forest treatments completed by State agencies, the USFS, Yakama Nation, Colville Confederated Tribes, Bureau of Land Management, Washington Department of Fish and Wildlife and private landowners in eastern Washington in order to gauge the average annual percent of mechanical forest treatments by landownership since 2009 (Figure 4), as well as the average acres treated by ownership (Table 3) (DNR 2014).

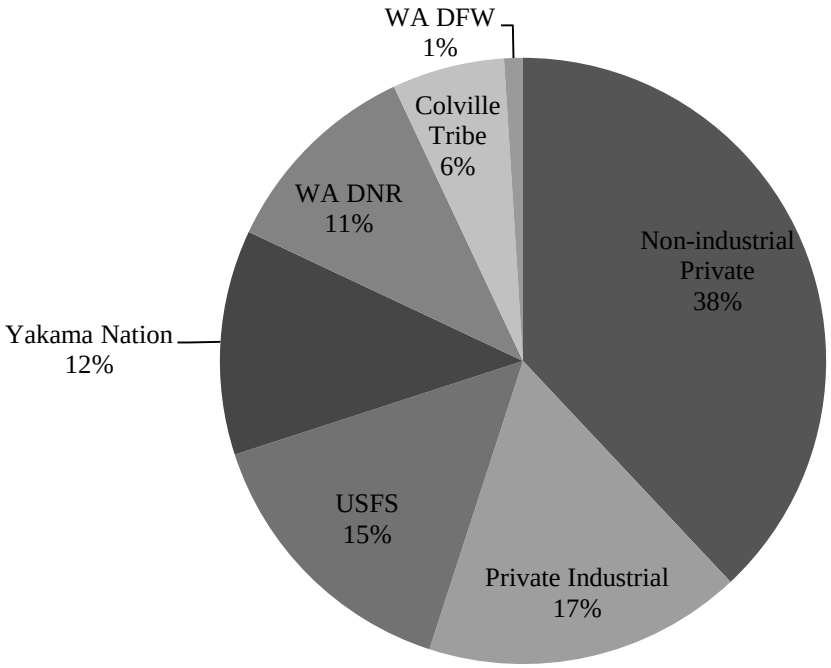


Figure 4. Percent of eastern Washington forest treatments by landowner between 2009 and 2014 (DNR 2014).

Table 3. Average acres treated per year by each landowner class identified by the Washington State Department of Natural Resources for eastern Washington from 2009 to 2014.

Landowner	Commercial Harvests (acres/year)	Non-commercial Thinning (acres/year)	Total (acres/year)
US Forest Service	7,930	13,038	20,968
Bureau of Land Management	879	315	1,194
Washington State Dept. of Natural Resources	10,940	5,287	16,227
Washington State Dept. of Fish and Wildlife	910	100	1,010
Private Industrial	24,223	Not available	24,223
Non-industrial Private	49,326	5,893	55,219
Yakama Tribe	12,249	4,548	16,797
Colville Confederated Tribes	9,170	Not available	9,170
Total	115,627	29,181	144,808

Mechanical harvest and forestland management throughout eastern Washington are driven by the timber market conditions, agency budgets, federal appropriations and funding impact the ability and willingness of landowners to treat forest conditions. In addition to market driven mechanical treatments, prescribed fire is used to help reduce wildfire hazard caused by fuels buildup and can be used as a restoration strategy to maintain or achieve desired forest structure. In Washington the prescribed fire average acres by landownership classification from 2009 to 2013 varied from 0 to more than 18,000 (Table 4).

Table 4. Washington State average annual acres treated with prescribed fire between 2009 and 2013 for forested and non-forest lands as described by the National Interagency Coordination Center and Washington State Department of Fish and Wildlife.

Landowner	Average Annual Acres of Prescribed Fire
Bureau of Indian Affairs	7,096
Bureau of Land Management	461
US Fish and Wildlife Service	955
National Park Service	76
State (WDFW)	575
Other	0
US Forest Service	9,000
Total	18,163

Forest Ecosystem Restoration and Avoided Costs

The importance of forest restoration and increasing ecosystem resilience is to reduce the occurrence of catastrophic wildfires that endanger lives, destroys property, and degrades public resources as well as curtail costs associated with wildfire activities that financially impact the ability of land managers to achieve forest and non-forest ecosystem service objectives. For example, at the federal level in 1991 firefighting accounted for only 13% of the USFS budget whereas in 2014 and 2015 it consumed nearly half of the agency budget. A 2012 economic assessment from Oregon's Federal Forest Advisory Committee found that every $1 spent on restoration potentially avoids a $1.45 in fire suppression cost (Rasmussen et al. 2012). In addition to avoided costs the 2012 Oregon study estimated that a $1 million investment in restoration could return approximately $5.7 million to the local economy.

Similarly, Lippke et al. (2005) found that "a cost/benefit analysis broadened to include market and nonmarket considerations indicates that the negative impacts of crown fires are under estimated and that the benefits of government investments in fuel reductions are substantial. The study used some of the factors such as loss of life, homes and properties, impacts to recreation tourism, loss of visuals and aesthetics and loss of habitat for threatened and endangered species as well as others to summarize present value cost and benefits associated with investments in fuel removals for fire risk reduction using the Okanogan and Fremont National Forest. Calculating the positive net benefits of fuel reduction treatments on market and nonmarket values has provided estimates of per-acre value ranging from $606 for moderate to $1402 for high-risk forest land. The authors note that these values are expected to increase if the per acre economic values tied to habitat protection, air and water quality protection, carbon credits, and others are also considered (Lippke et al. 2005).

Additionally, the Mokelumne Watershed Avoided Cost Analysis (Sierra Nevada Conservancy 2014) sought to answer the following question: "Does it make economic sense to increase investment in proactive forest management to reduce the risk of large damaging wildfires?" Authored by a diverse set of stakeholders including the USFS, TNC, among others, the study found *"thinning the forest and reducing hazardous fuels would substantially reduce the probability, extent, and intensity of wildfire in the watershed, leading to quantifiable cost savings"*, and concluded that strategic fuel reduction treatments produce multiple benefits to all stakeholders and the public in general.

The restoration needs in eastern Washington are founded by current levels of forest management activity including the assessment of operable limits, accessibility, and timelines for implementation of the work. Other factors such as; forest growth, mortality, forest conversion, seasonal drought, and a changing climate affect forested acres and the occurrence of wildfire. The forested acres requiring restoration within the three study regions of this assessment were generated by the TNC and USFS for the Tapash and North Central Washington Forest Collaborative (Table 1).

Statewide Forest Sector Attributes and Infrastructure

Job Retention and Recruitment

The forestry workforce is composed of those professionals, owners, operators and workers who manage, tend, harvest, and transport forest resources (Garland 2013). The first part of the 21st century has seen many changes to the forestry workforce such as the retirement of many forest workers who began their career decades ago in a vastly different work environment. Forest jobs are predominately available through small firms of less than 10 employees although some firms in logging and trucking can exceed 100 employees. Many in the workforce are sole proprietors operating equipment and/or owning their own trucks. Within the industry there are opportunities to work as contractors for private or public forestland managers, providing services such as; tree planting, thinning, silvicultural treatments, wildland fire fighting or the application of prescribed fire. Workers are predominantly male, and depending on type of work and geographic region, immigrant workers can represent a significant portion of the workforce (Garland 2013).

The timber harvesting industry in eastern Washington struggles with recruitment and retention of a well-qualified workforce for many reasons including; competing job opportunities, aging workers, public perceptions of the industry, low annual wages, job danger and a steadily decreasing number of wood product manufacturing facilities (Garland 2013). Additionally, hiring companies find it difficult to recruit skilled workers for positions that require travel from home to remote locations, working in inclement weather, long hours, and seasonal layoffs. This is partially driven by a general uncertainty about future employment in the forest industry and a limited availability of training programs for the development of job-specific timber harvest technical skills.

A number of reasons have led major career websites to list “lumberjack” as the worst job in America; citing wages, working conditions in inclement weather, and job dangers as the most common basis for the low ranking (www.bankrate.com and www.careercast.com). Additionally, depictions of logging work on reality television shows may be contributing to the negative view of forestry work in the U.S. (Garland 2013).

The economic recession of the last decade had significant impacts on the forest industry as a whole with 30 large-scale mills closing permanently between 2009 and 2010 and nearly every timber mill in the West experiencing operation restrictions (Keegan et al. 2012). As an industry, capacity utilization decreased from 83% in 2005 to below 60% in 2010. Lumber production fell by nearly 50% and employment in the forest products industry throughout the West declined by more than 40,000 workers (30%) from 2004 to 2010 (Keegan et al. 2012). Authors noted this was in part the result of U.S. housing starts declining from 2 million in 2005 to a 50 year low of 554,000 in 2009.

Additionally the logging workforce is faced with generational differences between older, experienced workers and young prospective employees, each with vastly different expectations and skills (Garland 2013). The older generation understands and accepts the working conditions in the forest that make for long hours under often challenging circumstances, whereas the new generation brings computer skills and an understanding of technology to logging where high tech, computer-based machines are becoming common. Communication between generations

can be especially difficult and challenge workers and managers in the forestry industry (Garland 2013).

Logger Training

The Washington Contract Loggers Association, Inc. (WCLA) offers a wide range of services such as; insurance programs, worker's compensation claims management education, and safety programs. There are 15 WLCA chapters located statewide with five chapters located in eastern Washington. The five eastern Washington chapters have 233 certified individuals that represent 124 organizations and companies.

The Master Logger Program (MLP) program was developed by WCLA in cooperation with timber industry leaders, the Washington State Department of Natural Resources, Washington State University Cooperative Extension, Washington Farm Forestry Association and the Washington Department of Labor and Industries. The MLP is a voluntary education program, structured to reach business owners, foremen, and supervisors, that accredits individuals and the companies they represent. The MLP was designed to further educate loggers and other harvest related businesses about sustainable forestry, safety, forest practices, as well as holistic forest and business management through continuing education and professionalism in the industry. As of March, 2015 there were 846 individuals certified in the State of Washington Master Logger Program.

Transportation Infrastructure

The log trucking industry, and ultimately its capacity, is influenced by the rising cost of operations, extended hours of service, an aging workforce, poor driver recruitment, and increased roadway congestion (Alderson et al. 1997). Log trucking in Washington is generally a small-operator dominated industry. Beginning in the late 1930s state regulations mandated haul rates, and established safety standards. With the 1995 federal deregulation of the trucking industry haul rates are no longer controlled by regulation. Unstable economics have contributed to declines in the number of Washington log truck companies which is compounded by the industry's struggle to recruit young drivers given industry competition and the costs of recruitment, training, wages, and competitive benefits.

In 2008, *The Washington Log Trucking Industry: Costs and Safety Analysis* report was prepared for the Washington State Legislature by the University of Washington Rural Technology Initiative and the Washington State University Transportation Research Group (Mason et al. 2008). The report details a statewide survey of the log truck industry to which 129 companies operating 336 trucks responded. The results showed 64% of respondents reported operation west of the Cascades, 13% east of the Cascades, and 23% operated statewide. Additional findings of the survey results contained in the report are summarized in the following capacity, safety, and future implications sections.

Capacity

The average age of a log truck driver in Washington was 55 as of the 2008 report. The average experience in log truck operation spanned 27 years and the majority of log hauling companies (64%) were owner-driver operations with a single truck and trailer (Mason et al. 2008). The average company had been in business for 21 years with the most common equipment being a

1990's model six-axle "long logger" truck with a fuel efficiency (diesel) of five miles per gallon and an average gross legal weight limit of 88,000 pounds and net payload potential of 58,835 lbs. The popularity of the long-logger partially results from timber purchaser preferences for long-length logs, which has consequently meant many log purchase orders require length averages in excess of thirty feet, and discounted prices for shorter logs.

Logs were hauled an average of 12.2 hours per day for 5.1 days per week with 6.8 hours per week required for maintenance. The average work week was 69 hours, with an average of three loads of logs delivered to a mill daily. The average one-way distance from point-of-loading to delivery location was 67.4 miles of which 17% were traveled on gravel. Logs were hauled 42 weeks per year with 5.7 weeks per year commonly lost to fire season restrictions, road closures and other constraints and an additional 1.7 weeks per year lost to equipment breakdowns/repairs. On average during 2006 drivers hauled logs more than 66,000 miles and earned $33,404 in personal income (Mason et al. 2008).

Safety

Survey respondents overwhelmingly (89%) indicated that traffic and road conditions are considered to be the most dangerous part of their job. Only 11% of drivers felt that the loading and unloading of logs presented the greatest danger. A total of 76% of respondents felt that Washington paved roadways are in a worse condition today than compared to 10 years ago with 99% of survey respondent indicating that traffic is worse today. Respondents report an average of 21.3 stops per year for weight and equipment inspections with each stop lasting approximately 25 minutes. A majority of respondents (75%) reported getting voluntary annual equipment inspections for their log trucks with 50% stating that voluntary inspections helped to reduce time lost during road checks. While survey responses suggest that many log truck drivers regularly operate beyond legal hours of service, no evidence was found to indicate that such practice resulted in unsafe log truck operation.

Future Implications

The majority of respondents (87%) reported that it was very difficult to find and keep skilled truck drivers and 99% report that skilled drivers are harder to find today than 10 years ago (Mason et al. 2008). An analysis of Washington Department of Licensing data revealed that the number of log trucks registered in Washington has declined by 36% from 2,059 trucks in 1998 to 1,325 trucks in 2006. Survey responses from 2006 showed 28% of log hauling companies lost money, 50% broke even, and 21% reported making a profit and that of the total respondents, 38% of reported plans to retire or otherwise leave the industry, 6% reported plans to stay the same, 13% expected to diversify into other trucking industries, 12% intend to downsize, and 1% plan to expand hauling operations (Mason et al. 2008). When asked to rate the business environment in Washington for the log hauling industry, 83% of respondents reported poor, 17% said average, and 0% selected good.

Washington Trucking Associations - Log Truckers Conference (LTC)

The LTC was formed in 1952 by members of the log trucking industry and has its own constitution and bylaws, officers, and board of directors that maintain complete autonomy and a statewide membership directory. The LTC has representation on the board of directors and committees of the Washington Trucking Associations and actively participates in formation of

policy and direction of industry programs. Member services include; assistance with permits, group health insurance, safety programs, drug and alcohol testing programs, and political representation.

Issues of Regional Significance

Seasonal road closures for local roadways affect a diverse group of people. Placing weight restrictions during freeze/thaw cycles prevent excessive road wear that can lead to economic hardship for regional employers and local economies. During wet weather periods counties will put weight restrictions on roads to protect roads from excessive damage and particularly in situations where freezing and thawing breaks up the road base.

State Highways of Local Significance

The Washington Department of Transportation (WSDOT) states Highways of Statewide Significance (HSS) include interstate highways and other principal arterials needed to connect major communities throughout the state. The designation is said to assist with the allocation and direction of funding mandated by the 1998 legislature through enactment of House Bill 1487 and codified into RCW 47.06.140 (www.wsdot.wa.gov planning/HSS). As of 2009, HSS routes comprise 3,649 miles (53%) of the States total 7,042 miles (WSDOT 2009) (Figure 5).

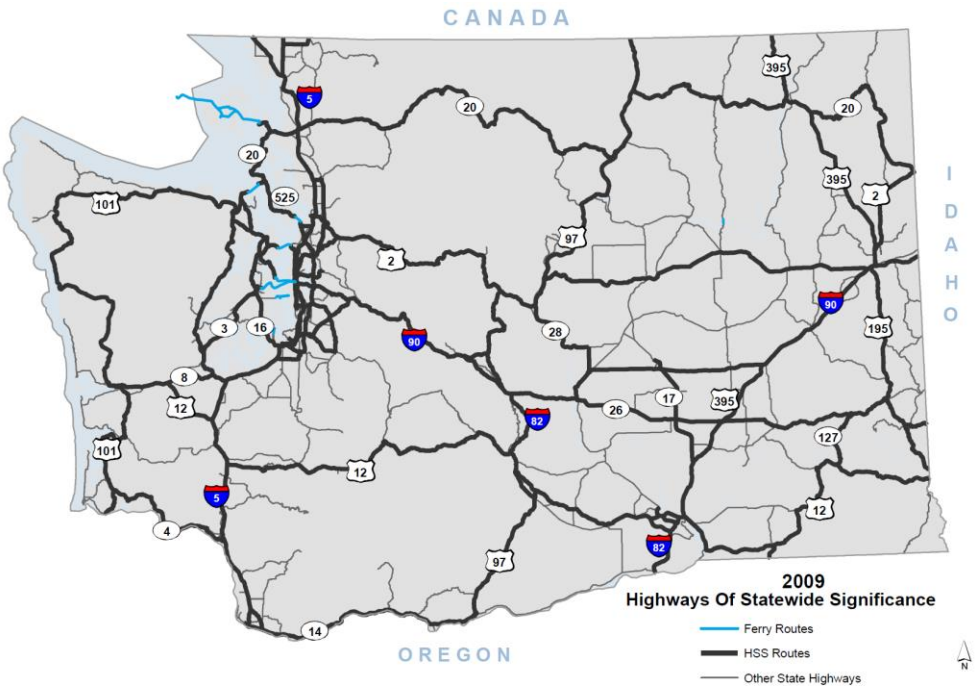


Figure 5. The Washington State Department of Transpiration lists more than 50% of the State's highways as significant for continued operation and State economy (WSDOT 2009).

National Forest Transportation Plans

National Forest transportation plans in eastern Washington focus on road systems that are safe to the public, responsive to public needs, environmentally sound, affordable, and efficient to manage (USDA Forest Service 1999). Road construction standards are typically the minimum

necessary to meet user and resource management needs as a direct result of the objectives the road is intended to serve. The cost of construction and maintenance are associated with the road standard and operational uses. The USFS classifies roads in one of the following three categories; Functional Class, Traffic Service Level or Maintenance Level (Table 5).

Most arterial and collector roads are managed for general public use except for restrictions of short duration for heavy commercial hauling. Local roads are subject to seasonal use restrictions for wildlife habitat protection, use conflicts between recreationists, and use conflicts between recreationists and commercial hauling. Newly constructed local roads will generally be for high clearance vehicle use only and to serve the purposes of timber harvest operations and recreation.

Seasonal or long-term road closures are implemented to protect public safety; protect resource values such as threatened and endangered wildlife species and their habitat, cultural resources, soil and water quality, and wildlife as well as prevent damage to the road system, comply with cost-share agreements, and eliminate traffic on single use roads after an activity in order to reduce maintenance needs. Single use and new construction roads are most often planned with the intention of returning the road surface to vegetation following completion of the use objectives.

Table 5. The United States Department of Agriculture Forest Service road classifications used to uphold the management objectives within the National Forest system. Table reproduced from (USDA Forest Service 1999).

Functional Class	Traffic Service Level	Maintenance Level
Arterial: Provides service to large land areas. Connects with other arterials or public highways. **Collector:** Serves smaller land areas than arterials. Connects arterials to local roads or terminal facilities. **Local:** Single purpose road. Connects terminal facilities with collectors or arterials.	**A:** Free flowing, mixed traffic; stable, smooth surface; provides safe service to all traffic. **B**: Congested during heavy traffic, slower speeds and periodic dust; accommodates any legal-size load or vehicle. **C:** Interrupted traffic flow, limited passing facilities, may not accommodate some vehicles. Low design speeds. Unstable surface under certain traffic or weather. **D**: Traffic flow is slow and may be blocked by management activities. Two-way traffic is difficult, backing may be required. Rough and irregular surface. Accommodates high clearance vehicles. Single purpose facility.	**Level 1** Closed more than 1 year. **Level 2** High-clearance vehicles. **Level 3** Passenger vehicles—surface not smooth. **Level 4** Passenger vehicles–smooth surface. **Level 5** Passenger vehicles–dust free; possibly paved.

Federal Lands Transportation Program (FLTP)

The Federal Lands Transportation Program (FLTP) provides funds to the following agencies for transportation program administration, planning, research preventative maintenance, engineering, rehabilitation, restoration, construction, and reconstruction of Federal lands facilities (USDOT 2012): the National Park Service, USFS, the U.S. Fish and Wildlife Service, and the U.S. Corps of Engineers.

Railroads

The economic vitality of Washington state requires a strong rail system capable of providing its businesses, ports and farms with competitive access to North American and international markets. There are over 3,000 miles of railroad lines in Washington State, providing mobility for freight and passengers into, out of, within, and throughout the state (WSDOT 2014). Two Class I railroads, the Burlington Northern Santa Fe (BNSF) Railway and the Union Pacific Railroad, as well as 24 short-line railroads operate throughout Washington State. As of March 2014 the WSDOT is expecting increased demand in railway (predominantly private Class I) needs for passenger and freight services over the next 20 years (WSDOT 2014). This expectation is also founded on knowledge of an emerging trend in proposals for the construction of new export facilities within the State, suggesting even greater potential demand on railways and increased expenditure for the accompanying infrastructure.

South Central Region

There are 2,356,000 forested acres in the SC eastern Washington study region distributed across the Yakama Reservation, Okanogan-Wenatchee National Forest, Ahtanum State Forest, Naneum Ridge State Forest, and private ownerships within the Kittitas, Klickitat and Yakima Counties. The forest health situation in this region has been evaluated by the TNC and USFS to show approximately 450,000 acres are outside of the desired ecological range of variability and at an increased risk of additional tree mortality and damage by insects, disease and wildfire within the next 15 years (Haugo et al. 2015). Many of these acres have been classified as forest structures needing restoration in the form of "Disturbance Only" and/or "Disturbance then Succession" as defined by (Haugo 2015).

The SC region has established management plans with approved annual harvest volumes of 343 MMBF, and a current annual harvest of 288 MMBF[3]. The total harvest volume in this region has been declining since 2000, with sporadic short-term peaks due to fire salvage in some areas. There are three sawmills in operation within this region (Figure 6) processing more than 70% (203 MMBF) of annual harvest volume with 29.5% (85 MMBF) being processed outside of the three-county area. Operable acres, those including both >45% slope and <45% slope in the SC region across all ownerships are 450,000 acres, of these 398,000 acres are considered Readily Accessible (<45% slope).

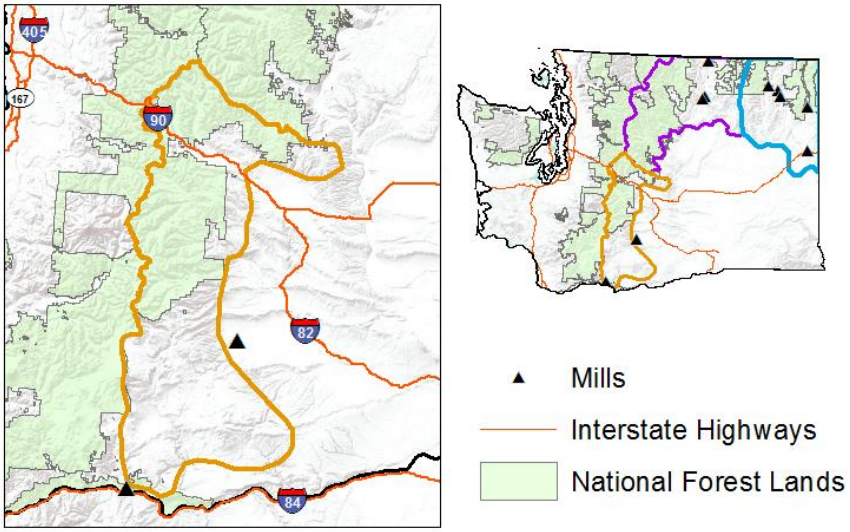


Figure 6. Existing timber milling facilities within the South Central study region of eastern Washington Anchor Forest assessment project.

Currently 43,743 acres of the forest lands identified in Table 1 are treated within the SC region annually across all ownerships (Table 6). If successful in completing the annually approved harvest an additional 55 MMBF volume of sawlogs and an approximate 44,550 BDT of biomass would be available. This volume is approximately five times greater than the projected restoration need (11 MMBF) identified through the Anchor Forest assessment. An increase of 55

[3] Many of the current management plans are dated and most are in revision, consequently, "planned harvest" volume is likely to change in order to more appropriately match the present management needs of these landscapes.

MMBF annually, given current infrastructure, regulations and recent wildfires, is unlikely. However, the proposed annual supply increase of 11 MMBF is feasible and sustainable under current regulations and through existing infrastructure over a 15 year time period. Management efforts with a focus on ecosystem function and forest resilience should center on the identified operable acres as shown in Table 6.

For example, in order to begin addressing currently deteriorated forest health conditions and wildfire threats at a rate sufficient to minimize or mitigate these conditions, a proposed total increase of 2,257 acres annually (46,000 acres total annually) across all ownerships is needed for a minimum 15 year period (Table 6 "Target"). Treatment of an additional 2,257 acres would generate an estimated 11 MMBF of sawlogs and 8,910 bone dry tons (BDT) (17,820 green tons (GT)) of biomass annually. The currently existing infrastructure within the SC region is anticipated to fully accommodate the increased volume of sawlogs; however the utilization of additional biomass would be subject to market pricing and infrastructure capacity. There are 11 existing biomass facilities in Washington State that purchase product from the SC region at an estimated annual volume of 39,130 BDT (78,260 GT). This example and the proposed annual increase in forest treatment is however, only a starting point to begin addressing deteriorating forest ecosystem conditions. Future management efforts and forestry infrastructure will likely need to be expanded and improved to keep pace with increasing insect, disease, and wildfire impacts.

Table 6. The South Central region total active forest restoration need by ownership as presented in Haugo (2015). The 'Total acres' column includes "restricted acres" which encompass wilderness areas, inventoried roadless areas and other federally restricted management areas. The restoration needs analysis included forest ownership mapping from the University of Washington Rural Technology Initiative and identified the operable acres. Readily accessible acres are those areas with less than 45% slope. Current treatment levels were determined from Washington Department of Natural Resources forest health reports (DNR 2014) and documented mechanical forest treatments occurring between 2009 to 2014.

Ownership	Total Acres	Treatable Acres		Treatment Levels (acres/year)		Years to Treat	
		Operable	Readily Accessible			Operable	Readily Accessible
USFS	158,000	53,000	42,000	Current	2,038	26	21
				Target	**3,500**	**15**	**12**
State	121,000	101,000	85,000	Current	6,841	15	12
				Target	**7,000**	**14**	**12**
Tribal	144,000	114,000	103,000	Current	16,797	7	6
				Target	**17,000**	**7**	**6**
Industrial Private	115,000	107,000	99,000	Current	8,941	12	11
				Target	**9,000**	**12**	**11**
Non-Industrial Private	84,000	75,000	69,000	Current	9,126	8	8
				Target	**9,500**	**8**	**7**
South Central	622,000	450,000	398,000	Current	43,743	10	9
				Target	**46,000**	**10**	**9**

Employment in the SC region includes 4,782 jobs (Rogers 2013) that produce a combined $198 million in wages and $7.8 million in local taxes. An increase of 11 MMBF could increase the number of direct and indirect jobs by 187 and thereby produce an additional annual $7.7 million in wages and $304,997 local taxes. The treatment of 2,257 additional acres annually also has the potential to avoid $1.3 to $3.1 million in fire suppression costs while improving ecological function and economic stability. These savings applied over a 15 year period would then equate to cost savings of between $19.5 and $46.5 million, and be in addition to the project revenue generated by additional harvest of $12.3 to $123 million, depending on market prices.

Timber and Biomass Harvest Summary by Ownership

The SC region has an estimated allowable timber harvest of 343 MMBF per year across five different ownership classifications. This estimate is approximately 55 MMBF greater than the current average volume harvested per year, calculated for the period of 2000 to 2013 (Table 7). The timber products volume harvested from 2000 to 2013 within the SC study region was approximately 288 MMBF per year and has been steadily decreasing (Figure 7). The Yakama Reservation in particular has harvested the largest portion of this region's volume (42%), with the Non-Industrial Private Forest (NIPF) owner timber sales also generating a significant portion (31%) of the total harvest (Figure 8).

Table 7. Average allowable and actual annual timber harvest for each of the five ownership classifications within the South Central region (2000 to 2013). Across all ownerships classifications there are approximately 55 million board feet of timber products not being harvested annually in the South Central region that have been designated and approved for harvest in existing management plans.

Ownership	Allowable Harvest (MMBF)	Actual Harvest (MMBF)
Yakama Nation	134.2	122.2
NIPF	88.0	88.0
IPF	42.7	42.7
State	26.0	26.0
Federal	51.8	9.2
Total	342.7	288.1

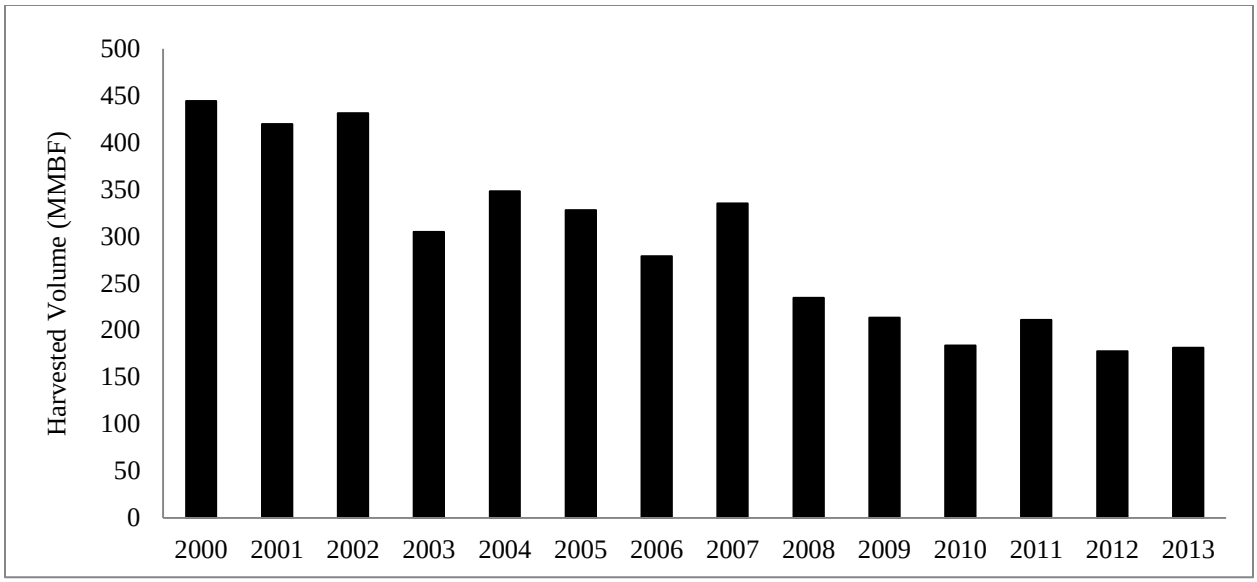


Figure 7. Total volume harvested within the five land ownership classifications for the South Central region. Each of these classes has differing land management goals and harvest targets, some based largely on public input. The average annual harvest for this region during the years shown is approximately 290 million board feet.

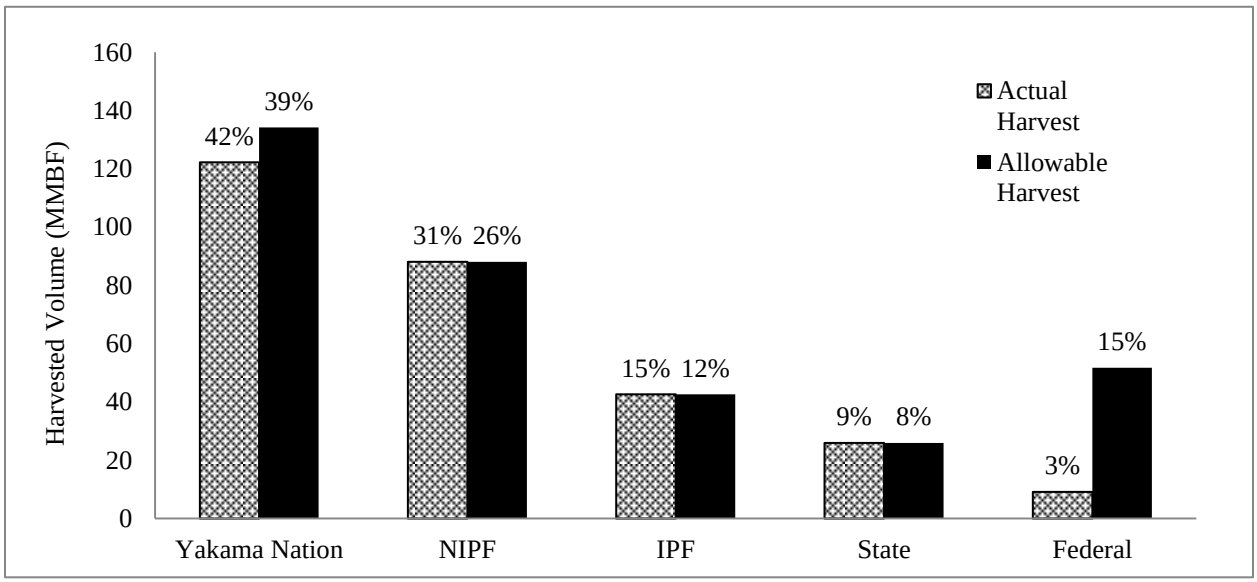


Figure 8. Average allowable and actual harvests per year for each of the five ownership classifications are presented for the South Central region from 2000 to 2013. The combined average allowable harvest for the region is 343 million board feet per year. The combined average actual harvest for the region is 288 million board feet per year. The Yakama Nation and the USFS harvest efforts, on average, do not achieve the planned allowable annual harvest. The percentages shown for each column represent the harvest volume contribution of that sector to the region's actual and allowable average harvest.

The USFS through the National Forest Management Plan currently treats approximately 2,000 acres annually. Annually the State of Washington treats approximately 6,800 acres and tribal ownerships, working through established management plans, treat approximately 17,000 acres within the SC region. Industrial Private Forest (IPF) landowners operate through forest management plans; however they are not publicly available and therefore could not be fully detailed: however treatments occurred on approximately 8,900 acres annually between 2000 and 2013. NIPF landowners may or may not have individual management plans, and similar to the IFP owners, their plans are not publically available. NIPF harvest typically follows market prices and often increase during strong markets and decrease during weak market conditions. Acres treated by NIPF owners were approximately 9,000 acres annually between 2000 and 2013.

Federal Timber Harvest

Actual Harvest Reported by Counties
Within Kittitas, Klickitat and Yakima counties annual timber harvest on federal lands has varied since 2000. On average, federal lands in Kittitas County produced 2.8 MMBF per year, while those in Yakima County produced 6.4 MMBF per year. It should be noted that both counties experienced a substantial change in volume harvested on federal lands during the economic recession of 2008 (Figure 9). There is no federal harvest in Klickitat County.

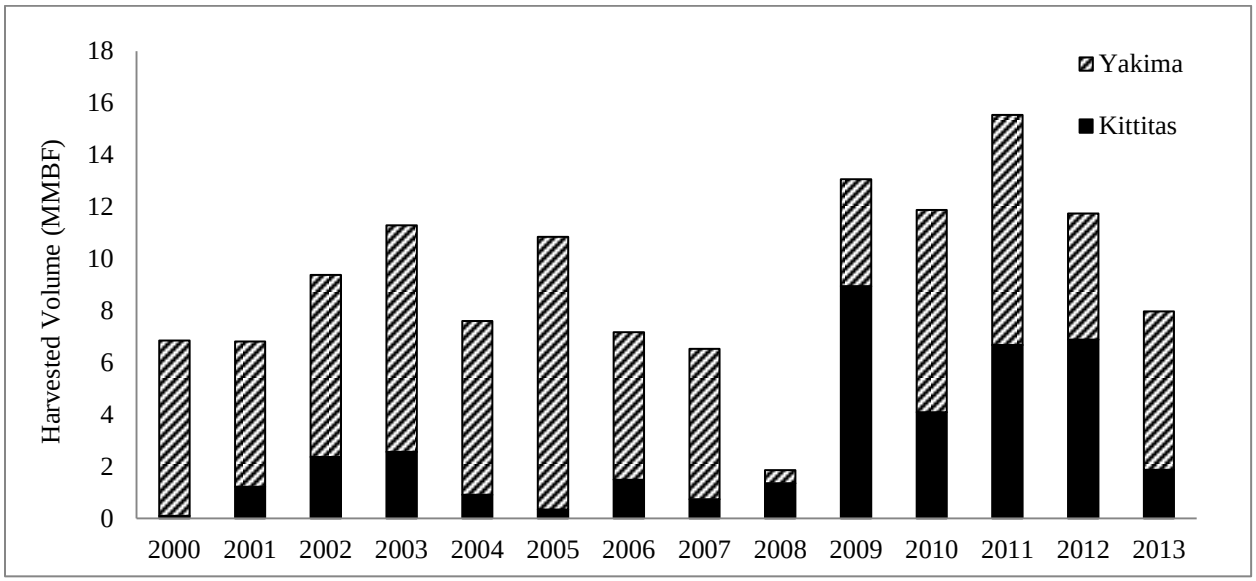


Figure 9**.** Timber volume harvested from federal lands by county within the South Central region. The average harvest from federal lands in the South Central region was 9.2 million board feet per year. These values were reported by the counties and are assumed to include 24% of the annual harvested volume from the Okanogan-Wenatchee National Forest.

Allowable Harvest Defined by the Okanogan-Wenatchee National Forest
The Okanogan National Forest Land and Resource Management Plan identifies a harvest goal of 75.8 MMBF of timber products annually (USDA Forest Service 1989) and the Wenatchee National Forest Land and Resource Management Plan established an annual harvest goal of 136 MMBF (USDA Forest Service 1990). Prior to 2009 timber harvest data for these two National

Forests were published separately; since 2009 these data have been combined thereby representing the average timber harvest for the Okanogan-Wenatchee National Forest goal of 211.8 MMBF per year.

Approximately 1,040,581 acres (24.45%) of the Okanogan-Wenatchee National Forest lie within the SC region. The remainder of this National Forest occurs primarily within the North Central region (USDA Forest Service 2013). This split makes the determination of allowable timber harvest by study region difficult. Therefore, for estimation purposes the proportion of the National Forest within each region was used to estimate the allowable harvest. Under this assumption, the SC region would have an average allowable annual harvest of 52 MMBF (24.45% of 211.8MMBF) from the Okanogan-Wenatchee National Forest. A comparison of actual and allowable federal harvest reported by counties in the SC region shows on average an additional 42.6 MMBF per year could be harvested from federal lands in the region, but is not being accomplished.

Additionally, 50,030 acres (3.3%) of the Gifford Pinchot National Forest and 7,368 acres (0.36%) of the Mt. Baker-Snoqualmie National Forests are included within the boundaries of the SC study region. These forests encompass landscapes exhibiting similarly deteriorated conditions as others presented in this assessment and may offer opportunities for treatment within the SC region. However, specific data for these Forests have not been included given the relatively minor extent within the SC study region and that management plans and leadership direction for these areas occurs predominantly outside of the geographic scope of the SC region.

State Timber Harvest

Since 2000, an average of nearly 26 MMBF of timber products has been harvested annually from Washington DNR lands within the SC study region with a consistent average decline in harvest levels since 2008 (Figure 10). As a result of statewide surveys showing the increased threat to State forests from insects and disease as well as wildfire (DNR 2012b; DNR 2007) the DNR established an annual allowable harvest level across all ownerships of 550 MMBF for the ten year period from 2005 to 2014. Specific data on allowable harvest volume for the SC region were not available; however, for the period of 2014 to 2017, the Washington DNR has forecasted a total of 2,164 MMBF to be harvest from all state lands (Smith 2013).

Since 2000, eastern Washington counties have accounted for approximately 11.8% (82.5MMBF) of the annual statewide harvest from State lands. During this time period, the SC region has contributed approximately 31% (26 MMBF) of this total harvest volume. If these trends continue, under the assumption of a total statewide harvest volume of 2,164 MMBF from 2014 to 2017 (Smith 2013), the approximate harvest volume produced from State lands within the SC region during the same period would likely be near 107 MMBF (26.7 MMBF/year) or 5% of the forecasted future harvest.

Harvest volume for Yakima County substantially increased during the economic recession of 2008 due to the State emergency insect and disease harvest sales and access to nearby processing facilities; however timber harvest in Kittitas and Klickitat Counties declined for the same period (Figure 10) due to poor markets and little infrastructure to process the volume. Annual timber

harvest in Kittitas continued to decline following 2008 and remain below 2 MMBF from 2010 to 2013.

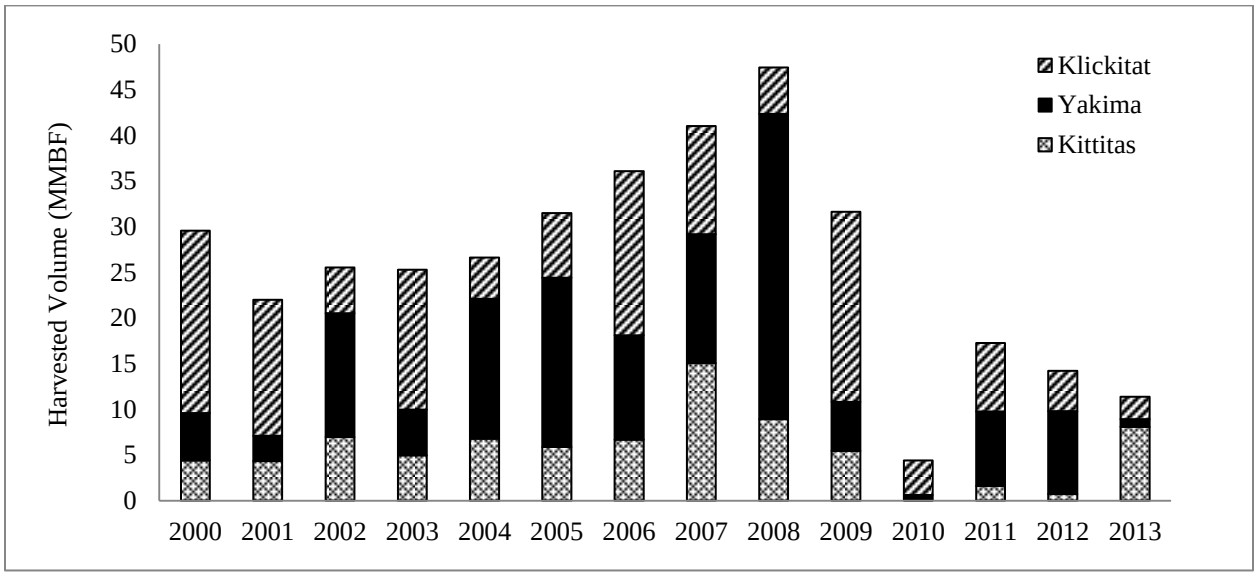


Figure 10. On average the Washington State Department of Natural Resources timber harvest volume in the South Central region is approximately 26 million board feet per year.

Tribal Land Timber Harvest

The 1993 Yakama Reservation Forest Management Plan provided for an allowable annual harvest of 143 MMBF from Reservation lands. As a result of the western spruce budworm outbreak and accompanying accelerated timber harvest, more than 100% of the annual allowable volume was harvested for several years between 2000 and 2011 (Figure 11). In 1998 a resolution, resulting from a forest health emergency caused by the western spruce budworm was passed, to allow for the accelerated timber harvest. This resulted in a 2003 revision of the tribal Forest Management Plan in order to align timber harvest with the western spruce budworm impacts.

More recently, Forest Management Alternative 4 (selected by Yakama Tribal Council – Resolution T-021-04), established an annual harvest volume of 158 MMBF for 2005 decreasing to 143 MMBF in 2014 with a total volume not to exceed 1,509 MMBF over the ten year period (BIA 2005). From 2000 to 2013 the actual average harvest volume was 122 MMBF per year therefore lagging behind the allowable harvest volume for all years following 2005 with the exception of 2011 due to an allowable harvest volume of just under 80 MMBF (Figure 11).

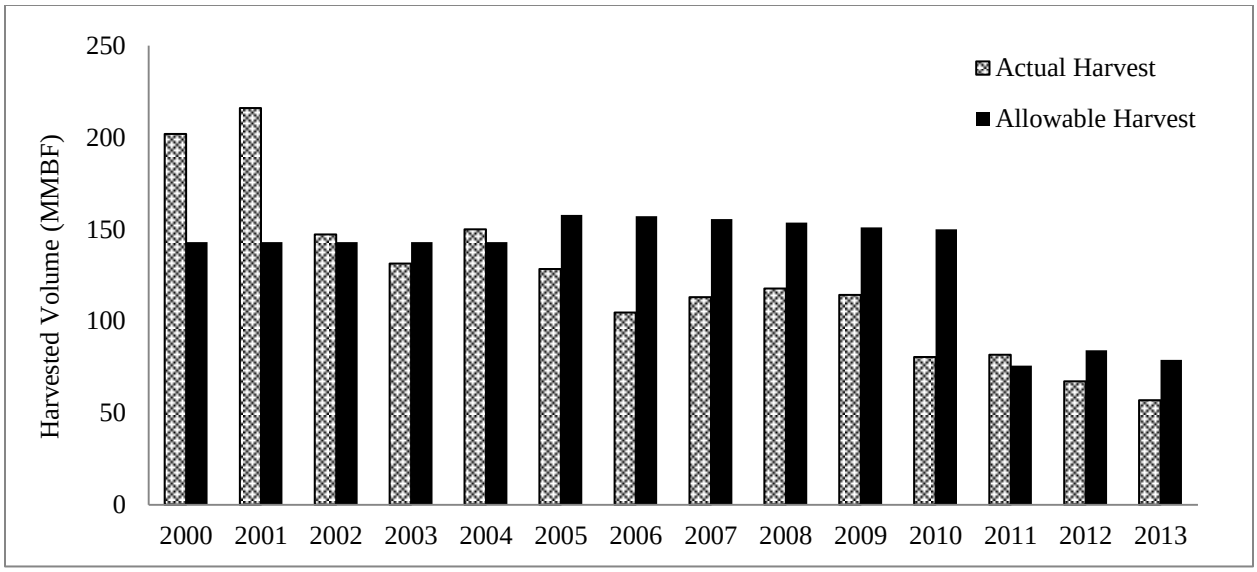


Figure 11. Allowable timber harvest volume compared to actual volume harvested for the Yakama Nation in the South Central region. The total average the allowable harvest was 134 million board feet per year and the average annual actual harvest was 122 million board feet for the entire period shown.

Private Land Timber Harvest

Industrial Private Forest Lands

Harvest activity on IPF lands for the SC region during the market recession of 2007/2008 ceased as a result of log and lumber prices. Harvest activity has begun to return for Klickitat and Yakima Counties since 2009 (Figure 12) however, harvest in Kittitas County has remained below reportable levels in part due to the large percentage of federal forest land within the county and the consistent decline in forest management on federal lands. The prediction of future harvest levels is difficult to estimate for the IPF sector, as there is a rapidly changing demographic among managers and owners and inventory data is not commonly available. The average volume harvested from IPF lands during the assessed period (Figure 12) was approximately 43 MMBF per year.

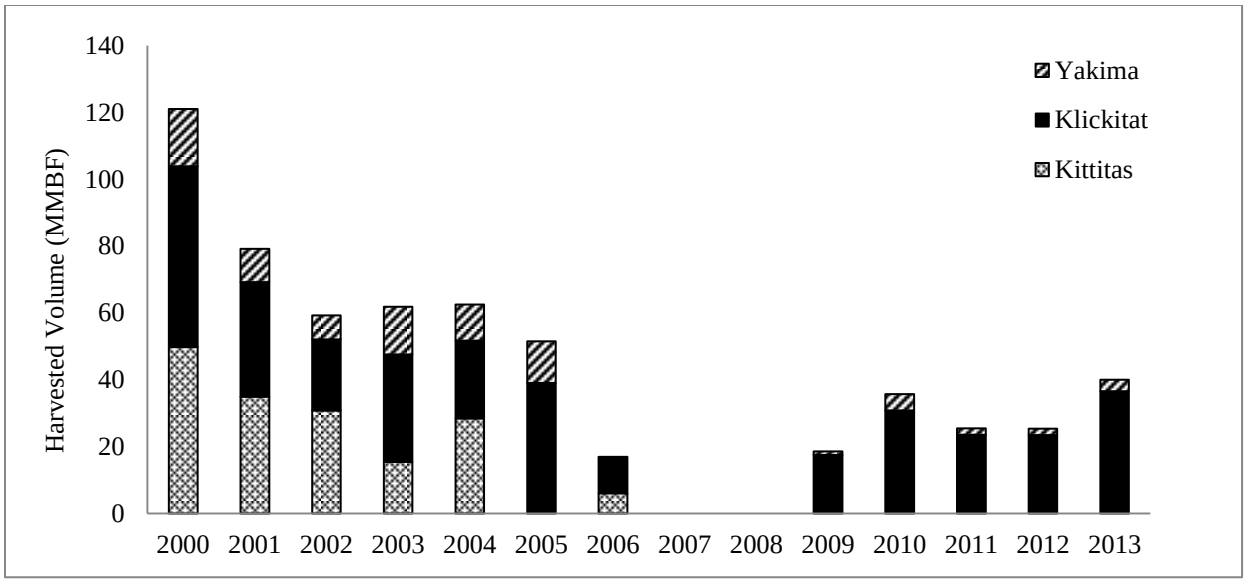


Figure 12. Industrial private forestland timber harvest volume in the South Central region averaged 42.7 million board feet per year.

Non-Industrial Private Forest Lands

Within the NIPF sector, log market values have the strongest influence on the annual level of harvest. This can produce abrupt changes in annual harvest levels as shown in 2007 and 2008 (Figure 13). Harvest levels for both Kittitas and Yakima Counties have remained low following the recession of 2007/2008, however for Klickitat County harvest has increased since 2008, likely due to increased interest by local processors within reasonable hauling distances. Similar to IPF timber harvest estimates, NIPF harvest volumes can be difficult to establish due to a lack of consistent data. The available data showed that from 2000 to 2013 the average harvest from NIPF lands within the SC region was 88 MMBF per year (Figure 13).

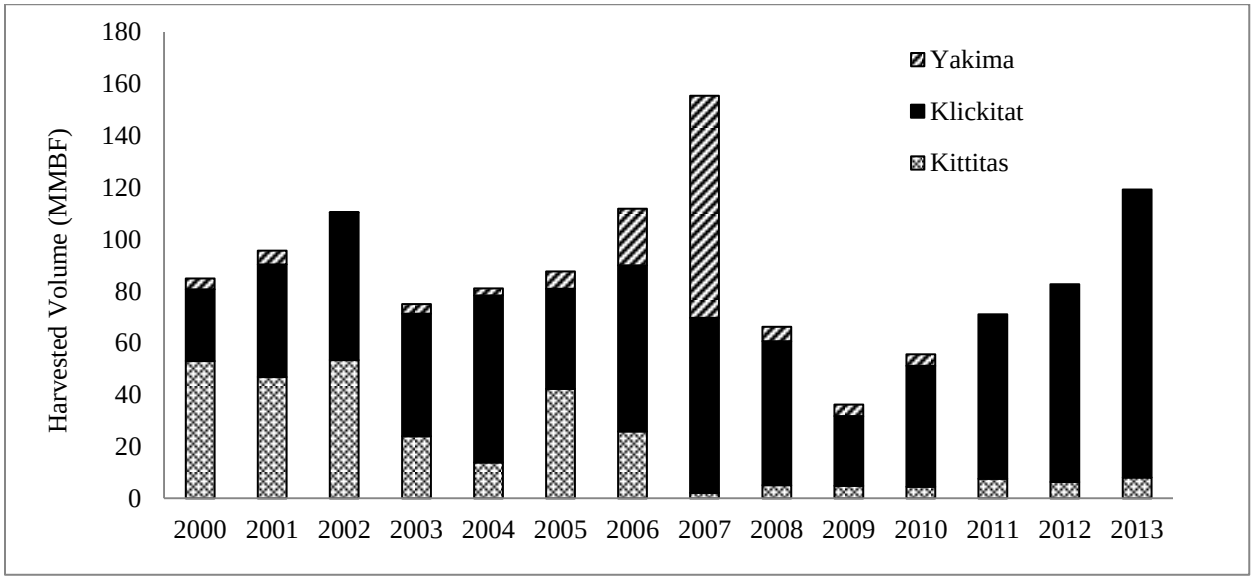


Figure 13. Non-industrial private lands timber harvest volume in the South Central region. On average, the NIPF sector harvests 88 million board feet per year.

South Central Region Timber Harvest Summary

The SC region has an estimated allowable timber harvest of 343 MMBF per year across the five ownership classifications. This estimate is approximately 55 MMBF greater than the average volume actually harvested per year as calculated for the period of 2000 to 2013 (Figure 8) using the following assumptions: 1) available harvest volumes for IPF and NIPF are equal to the 14-year average of harvest from 2000-2013; 2) the SC study region harvest volume will not deviate from the historic trend moving forward and can therefore be estimated from the 2014-2017 projected DNR statewide harvest, and; 3) allowable federal harvest is estimated as *'achieving'* the allowable cut for the Okanogan-National Forest and portioned by percentage of the National Forest within the South Central region. This is in contrast to the 'actual' federal harvest which was determined from data reported by the counties within the South Central region.

Total harvest within the SC region was dominated by the Yakama Nation (42%) with significant volume being contributed by IPF and NIPF harvest showing a combined 46% (Table 7). The NIPF, IPF, and Washington State allowable harvest volumes are shown as being nearly equal to actual harvest volume as a result of limited or unavailable data to support analysis of differing allowable harvest levels. Allowable federal harvest within the SC region is 15% (51.5 MMBF), however actual harvest is only 3% (approximately 10.3 MMBF) of the total volume for this region (Figure 8) representing an approximate 41 MMBF gap in management on the Okanogan-Wenatchee National Forest.

Summary of Available Biomass by Landowner

The eastern part of Washington has a considerable amount of forest biomass that consists of both standing inventory and what is produced during active harvest operations. Biomass generated as part of a timber harvest process consists of tops, live/dead branches, foliage and stem segments including breakage and defect. This information was provided in the Washington Forest Biomass Supply Assessment Report (Perez-Garcia et al. 2012), prepared for the DNR by University of Washington. Current statewide biomass utilization is estimated at 498,500 BDT (Perez-Garcia et al. 2012), with 18.2% (approximately 90,727 BDT) being attributed to eastern Washington following the trends of timber harvest records. For Example, the SC region averages approximately 43% of the total annual timber harvest volume for eastern Washington; therefore 43% (39,411 BDT) of the produced biomass in eastern Washington is assumed to come from the SC region. This estimated current annual production of biomass within the SC region (39,411 BDT) contrasts with the Washington Biomass Calculator (UW 2015) showing estimates of 504,598 BDT (1,009,196 GT) of potentially available biomass annually within the SC region (Table 8).

If restoration activities are able to treat the total acres identified within the SC region (46,000 annually) the available biomass as shown by the Washington Biomass Calculator (504,598 BDT) would overwhelm existing infrastructure, as it would represent an increase of 12 times the current total utilization within this region. The significance of this can be shown through the cost of investments in infrastructure that would be needed to enable production of electricity through utilization of biomass, which has been estimated at $3.2 to $3.4 million per megawatt (MW). One example of these investments would be the establishment of a co-generation facility that

could utilize the total modeled biomass within the SC region (1,009,196 GT). This would require the production of approximately 115 MW of power and require a $380 million investment in order to use approximately 2,765 GT per day of biomass annually (Cantrell 2015).

The cost of production related to processing and transport of biomass ranges from $16 to $35 BDT (Perez-Garcia et al. 2012). Transportation costs of $70 to $115 per hour and move-in and move out costs ranging from $700 to $1100 per operation (Perez-Garcia et al. 2012) must also be factored into cost calculations. For markets located within 60 miles haul distance one way, the total cost to harvest and deliver the product to the facilities generally ranges from a minimum of $25 GT to a high of $34 GT. Biomass often requires more handling than pulpwood sometimes requiring on-site chipping, this in combination with longer haul distances, makes this product too costly to deliver to some markets. A study conducted by TSS (2009) in 2009 identified the cost per BDT to harvest and deliver timber residuals varied between $47 and $56 BDT for a 40 mile one-way haul. In 2010 the market could have sustained a production of 1.3 million BDT at a price of $100 BDT ($50 GT) (Perez-Garcia et al. 2012). This price without subsidies will be difficult to attain as current pulpwood prices in eastern Washington average between $25 GT ($50 BDT) and $33 GT ($66 BDT).

Current market conditions for biomass throughout the Pacific Northwest as a whole are poor to non-existent, and further impacted by low market prices, representing the dominant barriers to the use of and investment in biomass. This appears to be consistent with many of the observed trends in alternative energy sources for more than a decade. During this same time, the pulpwood market in general has experienced a considerable swing in prices ranging from lows of $22 GT (~$44 BDT) to $60 GT (~$130 BDT). The demand for renewable energy and biofuel is expected to rise due to increasing interests in bio jet fuels (Perez-Garcia et al. 2012) among other products. The Northwest Advanced Renewables Alliance (NARA) is helping to develop a sustainable industry in the Pacific Northwest using wood residuals to make bio jet fuel. NARA will be producing approximately 1000 gallons of cellulosic based bio jet fuel from tree limbs and branches and is working with Alaska Airlines to complete a demonstration flight in 2016 using this fuel which may present additional opportunities for biomass in the future.

Regional Biomass Modeling and Results

One of the accomplishments of the Washington Forest Biomass Supply Assessment report was the development of a biomass database that is spatially explicit and contains a rich set of alternative forest management operations across the diversity of owner groups and forest types in the state of Washington. The database created for the assessment is accessible through a web based portal for individual use (http://wabiomass.cfr.washington.edu/). NMI utilized this web-based portal to generate custom biomass reports for each study identifying the existing facilities (Table 8). The customized reports display BDTs of scattered biomass, roadside biomass (*harvested biomass*), and market biomass. The definitions of the different products produced in the Biomass Calculator are:

> ***Scattered biomass -*** *The volume that was left scattered in the woods as a product of having been broken off or tops and limbs cut when commercial logs were yarded to the landing was noted as residual harvested volume (Perez-Garcia et al. 2012).*

Roadside biomass *- (harvested biomass)-The biomass that was brought to the landing along roadside was calculated and recorded in the biomass database as harvested biomass (Perez-Garcia et al. 2012).*

Market biomass *- was the portion of the potential market biomass that actually was loaded on a truck and the accounting was complete when the volume of biomass reaching the market was recorded (Perez-Garcia et al. 2012). This was the volume used to identify the total available biomass in each region.*

Table 8. Summaries of the University of Washington Biomass Calculator (UW 2015) model output showing input parameters for the South Central study region scenario evaluating existing facilities only. Biomass production was based on the number of existing facilities at a price of $45 bone dry ton. The model estimates were similar to those of Perez-Garcia et al. (2012) who estimated between 439,000 and 558,000 BDT of biomass would be delivered to facilities across eastern Washington during 2010.

Run: Average Statewide Harvest Model

Year: 2020

Geographies: Kittitas (19), Klickitat (20), Yakima (39)

Facilities: Bingen: Existing, Camas: Existing, Cosmopolis: Existing, Everett: Existing, Hoquiam: Existing, Longview: Existing, Mount Vernon: Existing, Port Angeles: Existing, Port Townsend: Existing, Tacoma: Existing, Wallula: Existing, Winton: Existing

Cost: Medium

Price: $45

Max Haul Time to Facility: 130 minutes

Reporting Fields: County, Owner Class

Field Options: Names

County	Owner Class	Scattered Biomass (BDT)	Roadside Biomass (BDT)	Market Biomass (BDT)	Residual Value ($)
Kittitas	Federal	6,673	2,873	1,648	$792.41
Yakima	Federal	130	59	160	$240.00
Kittitas	Municipal	1,091	1,675	1,312	$549.67
Kittitas	Private	72,233	82,462	59,880	$9,073.97
Klickitat	Private	173,496	215,137	187,036	$1,286,022.34
Yakima	Private	7,797	8,718	7,119	$8,030.73
Kittitas	State	16,112	17,717	12,047	$15,785.90
Klickitat	State	42,522	33,932	18,132	$138,972.45
Yakima	State	12,135	12,171	5,552	$23,368.01
Klickitat	Tribal	8,643	8,854	8,013	$10,127.29
Yakima	Tribal	205,753	205,265	203,699	$269,579.19
TOTAL				504,598	$1,762,542

Existing Processing and Manufacturing Infrastructure

Sawlog Consumption

Sawlogs are the primary feedstock for the mills located in the SC study region. The products produced from sawlogs include dimensional lumber and boards. Peeler logs are also common, which are utilized to produce plywood and veneer products. The SC region includes three large-scale sawlog and peeler processing facilities which include Yakama Forest Products (operating two mills), and SDS Lumber Company. A brief summary of each facility follows and is presented in Table 9.

Yakama Forest Products (YFP) – Small Log Mill
This operation of YFP is a small business directed towards logs within the range of 4”- 12”. They use a different phase of their company to handle all logs of larger diameter.
Purchase - saw logs to produce both dimensional lumber and boards through procurement of ponderosa pine as well as Douglas fir and white fir.
Current log usage - 60 MMBF (per year)
Location: White Swan, WA. Yakima County

Yakama Forest Products (YFP) – Large Log Mill
This is YFP’s phase of their yard that handles logs 13” and greater and is considered a small business.
Purchase - saw logs for cutting/export from species of ponderosa pine as well as Douglas-fir and white fir.
Current log usage - 60 MMBF
Location: White Swan, WA. Yakima County

SDS Lumber Company
SDS is a two-part company, operating a sawmill and a plywood mill.
Purchase - saw logs to produce stud boards from primarily Douglas-fir and grand fir residing east of the Cascades only. Peeler logs are procured for the plywood mill, primarily of Douglas-fir.
Current log usage - 50 MMBF (sawlog mill), 33 MMBF (plywood mill). Total log consumption is 83 MMBF.
Location: Bingen, WA. Klickitat County

Table 9**.** Total sawlog consumption by each mill in the South Central Region.

Mill Name	Annual Log Usage (MMBF)
Yakama Forest Products Mill A	60
Yakama Forest Products Mill B	60
SDS Lumber Company	83
TOTAL	203

Small Diameter Logs/Forest Restoration Products

Small diameter harvests and restoration products include sawlogs with diameters smaller than about 11 inches and chip-wood logs. Such products are often associated with restoration because

they are harvested from improvement cuttings which take place in overstocked stands where individual tree competition limits diameter growth and overtime degrades stand health. Yakama Forest operates the only small sawlog mill in the SC region and utilizes primarily small logs for dimensional lumber. Sawing these smaller logs requires specialized milling technology and equipment. Small diameter sawlogs are commonly purchased to a minimum small-end diameter of between four and five inches.

Biomass Processing by Existing Sawmill Facilities

Sawmills typically separate their clean chips from their bark and sawdust. Clean chips and sawdust are sold to paper mills and can be a significant source of income for sawmills located within short haul distances, thereby minimizing the costs of transportation. Bark residuals are often used in boilers to generate steam and operate facility processes such as kilns or power generation. The three sawmills in the SC region process 203 MMBF annually. Using the lowest estimated average BDT per harvested thousand board feet (MBF) conversion factor (2015), of 0.81 (Perez-Garcia et al. 2012), this region could potentially produce 164,430 BDT of biomass annually from harvest operations alone. Presently the SC region markets approximately 39,000 BDT and it is unlikely that additional biomass will be used without subsidies or cost share opportunities.

Many biomass contractors estimate that an average of 61% of woody biomass created from harvest or treatment operations can be recovered (Perez-Garcia et al. 2012). Expectations of biomass recovery range from 39% to 61%, however modeling has shown that only a fraction of the biomass produced during harvest (47%) would be transported from the forest and that only 14% of post-timber harvest biomass was successfully marketed (Garcia-Perez et al. 2012).

Within the SC region the SDS Lumber Company utilizes wood residuals (mostly bark and other wood waste) to fuel a steam plant which generates electricity and provides steam for kiln-drying lumber and sale of electricity on the open market. Currently, SDS produces 10 megawatts per hour at full capacity and sells the majority of this power with only a minimal amount used in-house (SDS Lumber Co).

Ecological and Infrastructural Restoration Need

The acres in need of restoration in the SC region within the Anchor Forest pilot generated by the TNC and USFS for the Tapash and North Central Washington Forest Collaboratives are presented in (Table 6). Within the SC region the Readily Accessible (<45% slope) acres could be prioritized as the first treatment areas since they are expected be easier to access. Completing the readily accessible acres only would leave approximately 52,000 operable acres untreated. This assessment evaluated the level ‘Target’ treatments would need to be applied in order to meet restoration needs on the identified operable acres within a 15 year time period given the current treatment levels. The Target acres were then estimated with the objective of treating 100% of the identified Operable acres in 15 years or less based on (Haugo 2015) and current federal forest health conditions for eastern Washington (USDA 2015).

Harvesting Capacity and Capability

Increasing the current annual harvest of 288 MBF by 11 MMBF as discussed previously would result in a 4% increase in sawlog harvesting and potentially generate an additional 8,900 BDT of

biomass. By increasing the number of acres treated by 2,257 and generating an additional 11 MMBF there would be a need for an additional five (5) log trucks to deliver product to existing facilities. The additional trucking need was calculated using the estimated weight of 11 MMBF (74,800 GT, using a conversion of 6.8 tons per MBF) and the ability of a truck to haul 3 loads per day (rate of approximately 81 GT per truck per day) multiplied by 170 average annual working days (13,770 GT per year).

Capital expenditures to build additional harvesting capacity to recover biomass are estimated at $18 GT for ground based systems (stump to on-board truck). This is based on a total equipment cost of $1,375,000 (weekly production of 1,680 GT) and production of approximately 75,600 GT annually, using average logging conditions for the western U.S. (Barynin et al. 2013). Biomass harvesting is most cost efficient when combined with sawlog harvest operations where sawlogs, pulp and biomass are removed in one entry thereby minimizing transportation and operation costs. Costs are expected to be greater if biomass is harvested as a separate product.

The capital investment required to harvest an additional 17,800 GT (8,900 BDT) of biomass from the proposed increase in treatment acres (2,257) is approximately $320,400. The capital investment required to harvest the maximum-predicted supply of biomass within the SC region as modeled using the University of Washington Biomass Calculator 1,009,196 GT (504,598 BDT) would be approximately $18,165,528. If expansion and renovations are conducted at the existing facilities in order to utilize biomass for heat, kiln-drying, or co-generation power production, there is potential for a significant volume of biomass to be used. However, as of this assessment current market prices for power within the Pacific Northwest provide little to no financial incentive to invest in this type of facility infrastructure. Under the present market conditions encouraging investments in biomass utilization will likely require subsidies, tax incentives, and potentially policy/legislative changes to make them attractive to a broad audience.

The cost of management to prepare the additional acres needed for restoration (2,257 acres per 11 MMBF) ranges from $66 to $71 per MBF for actions on State-managed lands within Washington totaling between $148,962 and $160,247 (IFMAT 2013). Based on USFS cost per MBF it was calculated that preparation costs for the same number of acres/volume would range from $338,550 to $496,540 using the $150 per MBF National USFS average or the $220 per MBF USFS Region 1 average (IFMAT 2013). For forest health projects on NIPF lands targeting fuel reduction treatments and forest health improvements in eastern Washington, the DNR costs ranged from $899 to $1085 per acre from 2009 to 2013 when federal cost-share funding was available (Mason et al. 2008).

Transportation Infrastructure

The transportation infrastructure currently is handling the harvest production on approximately 43,743 acres. An increase in harvest on 2,257 acres that produces 11 MMBF would require an additional five log trucks (2,777 loads) to deliver sawlogs, and an additional two trucks to accommodate the increased biomass generated totaling an estimated 659 truckloads. Therefore, restoration efforts on the 2,257 acres would require seven additional trucks delivering approximately 3,436 truckloads on the existing transportation system network. This would most likely require additional maintenance and repair on the highways and county roads within the

region, but also increases the tax base, employment opportunities, and the economic base within these counties.

To address the total available biomass modeled within the region (504,598 BDT) it would require approximately 37,000 truckloads (13.5 BDT per log truck) and an additional 73 trucks working 170 days a year if they could deliver three loads a day. This volume of biomass is not expected to be utilized in the near future and would require significant investment in infrastructure. As an example, the capital investment to start up the seven additional trucks needed to treat 2,257 acres is estimated at $1.2 million ($175,000 per truck) equaling an average cost of $2.50 per ton over a five-year amortization timeframe. To adequately address an increase of 8,900 BDT (17,800 GT) of biomass would require capital investment in two additional trucks, not including the added expenses of fuel, operating expenses, permits and the cost of other regulatory requirements. Anticipated wages for a total of seven additional trucks, driving ~66,000 miles year and earning $33,404 in 2008 dollars (Mason et al. 2008), would be approximately $233,828.

Transportation efficiency can be increased through implementation of trucking logistic concepts that support the log supply chain such as a central dispatch. This practice has been widely implemented in forest regions around the world and has recently been established in North Central Washington through collaborative efforts involving multiple private industry stakeholders within the natural resource sector. The Central Dispatch methods are being used to manage log flow, build contractor relationships, and increase the efficiency and profitability for individual trucks and drivers (Sessions et al. 2015). The Central Dispatch operation has provided an opportunity to move more volume more efficiently with fewer trucks and reduce fuel consumption, wear, and maintenance need for trucks and roadways.

Processing and Manufacturing Infrastructure

The current sawmill processing capacity within the study area utilizes approximately 203 MMBF of sawlog volume annually. There is 288 MMBF (Table 7) being harvested within this region and the remaining volume is processed outside the region. Most mills stated they could increase processing capacity by 10 to 30% if the timber supply was available. The existing processing facilities are anticipated to fully process the estimated additional volume of 11 MMBF from proposed treatment of 2,257 acres annually within the SC region.

To establish a small mill that could utilize a larger range of diameters, process lower-volume (less than 50 MMBF) and use mixed species to cut specialty products would be between $1 and $1.5 million dollars per MMBF. Sight specific prices for the SC region have been estimated at between $25 and $36 million to establish a mill able to process 25 MMBF annually (Cantrell 2015).

Additional benefits of building a new facility would be gained through the addition of an on-site co-generation facility to utilize produced biomass for energy production. An estimated one GT of biomass is needed per MW per hour. The construction and operation of a biomass co-generation facility would cost between $3.2 and $3.4 million per MW. Studies conducted in eastern Washington have identified the requirement of a 16 MW plant, as a stand-alone operation, to sustainably compensate for the cost of extracting and delivering the needed quantity of biomass

(Cantrell 2015). Fore reference, a state-of-the-art sawmill utilizing 40 MMBF would be able to produce enough biomass (sawdust) to sustain a six to seven MW facility.

The job opportunities for developing this type of infrastructure are based on both full-time and part-time employment with the acknowledgment that workers can have more than one job. It is estimated that 18 jobs, 10 in the forest products industry plus eight indirect and induced jobs in supporting industries are produced for each MMBF harvested and that these jobs produce nearly $528,000 in wages and more than $3.2 million in the sales of goods and services (Cook et al. 2015). Therefore, increasing production in the SC region by 11 MMBF would provide approximately 187 new jobs in the forest products industry, including indirect and induced jobs in supporting industries, and generate approximately $7.8 million in wages and $305,000 in the sales of goods and services. Job creation is not linear; this number is specific to the SC region which currently employs approximately 4,782 people in the forest products industry (Rogers 2013). The current number of employees for each region was used to estimate the additional jobs created.

South Central - Opportunities, Barriers, and Recommendations

The restoration need assessment completed by Haugo et al. (2015) uses a combination of publically available data to make the determinations of forest restoration need supported by the USFS and aligning with the guidelines presented in the recent Farm Bill for identifying treatment areas. Additional analysis completed by several states employ the National Insect and Disease Assessment maps in order to identify similarly high-risk forest condition and designate areas in need of treatment, commonly on a 15 year timescale (Krist et al. 2014).

The total restoration need identified for the SC region within areas of ‘operable acres’ (Table 6) represent a total area of 450,000 acres. Current annual treatments within this study region are approximately 43,743 acres. At current treatment rates all landowners except the Forest Service (26 years) can treat the identified operable acres within 15 years, and several will complete treatments sooner (Table 6). At the proposed total target treatment level of 46,000 acres annually, restoration needs could potentially be completed for all identified operable areas across all ownerships within a 15 year time period.

Sawmill manufacturing infrastructure in the SC region is comprised of three sawmills presently processing an annual volume of 203 MMBF and the ability to increase their capacity by 10 to 30% (20 to 60 MMBF). Currently this region produces 288 MMBF, of which approximately 85 MMBF is processed outside the three-county area. Additionally, transportation and milling infrastructure within the region is capable of maintaining current production levels and is expected to fully utilize the additional 11 MMBF projected within the SC region. The proposal of treatment on 2,257 addition acres annually would provide an increase of 11 MMBF (+4%) in harvesting activity and require approximately five to seven additional trucks (3,436 loads per year) to maintain the transportation infrastructure. The capital investment for seven trucks driving ~66,000 miles year and earning $33,404 in wages (2008 dollars, Mason et al. 2008), would total approximately $233,828 with fuel, operating expenses, permits and the cost of other regulatory requirements being in addition to this initial investment.

Opportunities

- ✓ Many areas need to reduce over stocked tree densities and reduce biomass (fire fuels) in order to return the landscape to a more natural range of variability. An increase of 2,257 treatment acres provides an opportunity for local employment in the area and increases the economic sustainability of local communities. For example, increasing management activity on 2,257 acres that produces 11 MMBF will provide approximately 187 new jobs, including both indirect and induced jobs, generating approximately $7.8 million in wages and salaries, and nearly $305,000 in taxes. The proposed annual target treatment of 2,257 acres would also represent the first step toward management efforts that align with current forest ecosystem needs and bring annual planning efforts and the revised future forest management plans more in-line with on-the-ground conditions for this study region (Table 7).

- ✓ A nationwide interest in clean energy and reduction in the use of fossil fuels have the potential to increase the market value of biomass which could lead to substantially improved recovery and use of this renewable green resource. An increased interest and incentive to use biomass has the potential to provide additional jobs, wages, and taxes to local communities while reducing wildfire fuel loads thereby, increasing safety and improving overall ecosystem function. Additionally, biomass can be aligned with carbon sequestration and air quality through its properties as a carbon sink and reduction in wildfire smoke and particulate matter.

- ✓ Proposed target treatment levels provide an opportunity to begin addressing the current and increasing insect, disease, and wildfire conditions occurring across eastern Washington within the SC study region. Treatment of identified acres under the Anchor Forest concept would occur across ownership boundaries and therefore provide an example of landscape-scale management founded on ecological function, forest resilience, soil protection, water quality, and wildlife habitat as well as aesthetics, recreation, and economic support for local communities and human well-being.

Barriers

- ✓ Planning needs to look at how historical management has affected ecosystems, particularly with regard to fire exclusion on dry fire-prone landscapes such as those in the SC study region. This is critical in motivating restoration efforts because insect, disease, and wildfire impacts have increased significantly throughout the past few decades, impacting a significantly greater area than current management efforts on highly deteriorated lands are addressing. Nearly all landowners with the exception of the USFS have been successful in achieving their forest planning objectives (Figure 8). The USFS inherently has challenges unique to its's role as a federal land management agency that impact forest planning and management activities. Recent research has identified some challenges unique to the USFS to be: frequent leadership turnover, a lack of leadership direction, inconsistent support for activities within the organization, excessive financial resource allocations to wildland fire, and individual personnel attitudes, values, and beliefs (Keele et al. 2006; ITC 2013; O'Toole 2007; GAO 2007; USDA Forest Service 2015).

- ✓ Public perception of forest management and the social license needed to plan and implement actionable restoration activities presents a barrier to correction of the landscape-scale ecosystem degradation occurring due to un-natural tree densities, the exclusion of fire, and increasing tree mortality. These deteriorated forestland conditions, if not corrected, will continue to fuel the already increasing frequency and severity of wildfires that have destroyed homes and wildlife habitat, impacted water resources, and altered entire ecosystems for decades into the future (Wu & Kim 2013; Franklin 1993; Franklin et al. 2008; Noss et al. 2006).

- ✓ Limited capital investments are expected for harvesting equipment and trucking needs estimated to accomplish restoration on the identified acres. These investments would be prior to and not include future maintenance costs associated with the use of existing facilities and infrastructure to accommodate an increased volume of approximately 11 MMBF annually. In addition to these costs the cost of management to prepare timber harvest operations on the identified acres is significant ranging from $66 to $71 per MBF on State-managed lands and $150 to $220 per MBF on USFS Region 1 lands (IFMAT 2013). Forest restoration projects on private lands often target fuel reduction treatments and forest health improvements through the DNR with costs ranging from $899 to $1085 per acre (2009 to 2013) (Mason et al. 2008).

- ✓ Although there is a nearly limitless volume of biomass within the SC region the resources needed to address an estimated total of 504,598 BDT (1,009,196 GT) annually would require approximately 37,000 truckloads (27 GT per truck). To transport this amount of biomass would require an additional 73 trucks, working 170 days a year, delivering 3 loads a day. Existing biomass facilities will not likely be able to accommodate this volume of biomass due in part to limits in capacity as well as market constraints associated with harvest and transportation costs, making biomass produced products (electricity) less competitive in areas where sources such as hydropower are available. Therefore, it is unlikely that increased biomass within this region could be utilized in the near future without significant increases in production and supply incentives as well as the market value of generated products.

- ✓ The workforce demographic of the forestry sector is aging, and training and education for new and existing opportunities are limited throughout the State of Washington as a whole, regardless of study region.

- ✓ Forestland fragmentation and conversion to other use increases wildfire risk and the cost of wildfire suppression through increasing the complexity of the landscape in fire-prone ecosystems (Society of American Foresters 2009). Permanent forestland conversion away from working forests often leads to increased runoff and sedimentation, higher peak streamflow and loss of riparian vegetation, as well as an increased need for channel stabilization infrastructure. Forestland fragmentation as a result of conversion often decreases outdoor recreation opportunities increasingly important to the growing urbanized population. Forest that are fragmented generally have parcels too small to support investment in forest management and support of ecosystem processes (Society of American Foresters 2009). Similar to the workforce challenges described previously, this

is a barrier to landscape-scale forest ecosystem management throughout the State of Washington, regardless of study region, and becomes more important within areas of greater population density.

Recommendations

- ✓ In order to combat the challenges of an aging demographic workforce in the forestry sector programs that encourage and educate students on the importance of forestry and silviculture as well as teach the value of communication skills and the social license required for forestry are needed (Sample et al. 2015; Sharik et al. 2015). These could be incorporated at the high school level and gain support through efforts at the state and local community levels to match employment opportunities with local residents.

- ✓ Proposed treatment levels are provided by ownership in Table 6; the need for action is most significant on lands managed by the USFS as compared to all other ownerships. Targeting a treatment on USFS ownerships, focusing specifically on the identified operable acres, will equate to an overall increase in management activity of nearly 70% from the current annual average in the SC region. Although this would represent a significant gain, treatment of additional acres must be encouraged given the significant increases in tree mortality, insect and disease infestations, and wildfire over the past decade (Goldmark 2012; Ray et al. 2012; Tidwell 2015; Krist et al. 2014; USDA Forest Service 2014). Focusing on the 'Readily Accessible' acres identified within the USFS lands would omit approximately 11,000 acres from the total operable acres. The readily accessible areas are expected to provide easier to access for management operations and may provide future "previously-permitted" access locations where they are adjacent to the omitted 11,000 acres.

- ✓ Long-term contract commitments to active management and timber supply are necessary to encourage capital investments needed to outpace deteriorated forest ecosystem conditions across the State of Washington, regardless of study region. A minimum of 15 year supply agreements are needed to align with current research timescales of forest condition research (Haugo et al. 2015; Krist et al. 2014), and to amortize industry investments in infrastructure to encourage establishment of the infrastructure necessary to complete the restoration activities identified within the SC region. Long-term (15+ year) contracts and agreements utilizing Stewardship Contracting and the Tribal Forest Protection Act should target landscape-scale (50,000 to 200,000 acre) projects and focus on the utilization of as much non-merchantable small-diameter (<12 inches diameter at breast height) material as feasible to incurred the least amount of stakeholder resistance within currently established guidelines and policies (Perez-Garcia et al. 2012; Schultz et al. 2012; Butler et al. 2015).

- ✓ Increased efforts to restore forest and treat fuels are required to reduce federal expenses associated with fire suppression. A 2012 economic assessment from Oregon's Federal Forest Advisory Committee found that every $1.0 spent on restoration potentially avoids $1.45 in fire suppression cost (Rasmussen. et al. 2012). This is exemplified by the conclusions of Mason et al. (2006) stating: *"a cost/benefit analysis broadened to include market and nonmarket considerations indicates that the negative impacts of crown fires*

are underestimated and that the benefits of government investments in fuel reductions are substantial." Calculating the positive net benefits of fuel reduction treatments on market and nonmarket values has provided estimates of per-acre value ranging from $606 for moderate to $1402 for high-risk forest land with higher values expected if the per acre economic values are tied to habitat protection, air and water quality protection, or carbon credits among other ecosystem services (Lippke et al. 2005).

- ✓ Monitoring is needed to evaluate applied practices and new opportunities that can sustain and expand activities that out-pace the currently increasing insect, disease, and wildfire impacts throughout eastern Washington and the West. As progress is made toward more resilient forest conditions managers can better assess opportunities to maintain or establish additional infrastructure such as co-generation facilities, evaluate transportation efficiencies and determine if haul logistics can improve costs, hours, and fuel consumption.

- ✓ Incorporation of silvicultural treatments with activities that can offset restoration costs through generation of product sales revenue can maximize the value of available funding. Long-term project monitoring is required of many projects utilizing federal funding programs and, regardless of requirements, will help land managers gain a better understanding of ecosystem function encompassing social/cultural, economic, and ecologic values and identify improvements that maximize efforts toward achieving desired conditions at the landscape-scale. This would increase the future availability of established sustainable infrastructure, perpetuate lower operating costs and over time, increase the ability of managers to improve forest resilience and ecologic function by protecting public safety, resources, and benefits such as clean water, forest regeneration, recreational opportunities, and wildlife habitat.

North Central Region

There are 3,276,000 forested acres in the NC eastern Washington study region distributed across the Colville Indian Reservation, Okanogan - Wenatchee National Forest, Loup Loup State Forest, Loomis State Forest, and on private ownerships within the Douglas, Chelan and Okanogan Counties. The forest health situation in this region has been evaluated by the TNC and USFS to show approximately 834,000 acres outside the desired ecological range of variability and at an increased risk of tree mortality and damage by insects, disease and wildfire within the next 15 years. Many of these acres have been classified as forest structures needing restoration in the form of "Disturbance Only" and/or "Disturbance then Succession" as defined by Haugo et al. (2015).

The NC region has established management plans with approved annual harvest volumes of 220 MMBF, and a current annual harvest of 77 MMBF[4]. The total harvest volume in this region showed little variability from 2000 to 2008 and then dropped significantly during 2009 and has remained lower than the previous-year averages until 2013 (Figure 15). There are two sawmills in operation within this region (Figure 14) processing more than 79% (61 MMBF) of annual harvest volume, with 21% (16 MMBF) being processed outside of the three-county area. Operable acres, those including both >45% slope and <45% slope in the NC region across all ownerships are 468,000 acres, of these 374,000 acres are considered Readily Accessible (<45% slope) (Table 10).

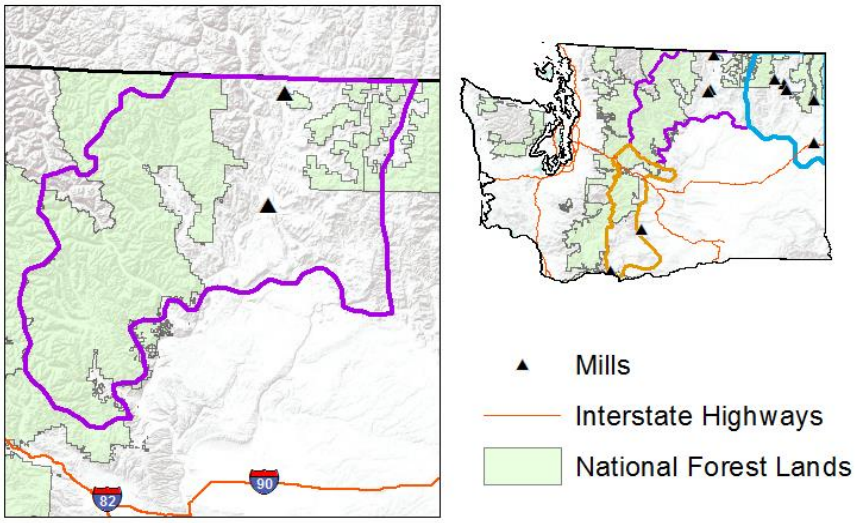


Figure 14. Existing timber milling facilities within the North Central study region of eastern Washington Anchor Forest assessment project.

Currently 28,992 acres of the forest lands identified in Table 1 are treated within the NC region annually across all ownerships (Table 10). If successful in completing the annually approved harvest (Figure 16) an additional 143 MMBF volume of sawlogs and an approximate 115,830

[4] Many of the current management plans are dated and most are in revision, consequently, "planned harvest" volume is likely to change in order to more appropriately match the present management needs of these landscapes.

BDT of biomass would be available. This planned harvest volume represents nearly twice the amount utilized currently and is approximately four times greater than the projected restoration need (35 MMBF) identified through the Anchor Forest assessment. The recommended annual increase in forest treatment and projected increase of 35 MMBF is however, only a starting point to begin addressing deteriorating forest ecosystem conditions and future will likely need to expand to keep pace with increasing insect, disease, and wildfire impacts. These management recommendations do however; include a projected increase of 68% in treatments on USFS lands and an overall increase of 24% in treated acres throughout this study region.

For example, in order to begin addressing currently deteriorated forest health conditions and wildfire threats at a rate sufficient to minimize or mitigate these conditions, a proposed total increase of 7,008 acres annually (36,000 acres total annually) across all ownerships is needed for a minimum 15 year period (Table 10). Treatment of an additional 7,008 acres would generate an estimated 35 MMBF of sawlogs and 28,350 BDT (56,700 GT) of biomass annually. The existing infrastructure within the NC region is not able to fully utilize the projected additional volume without improvements in mill capacities, reopening of the Colville Precision Pine mill (closed due to fire damage), or investment in new infrastructure such as a small-capacity (20 to 30 MMBF) sawmill within the region. Moreover, the utilization of additional biomass would be subject to market pricing and infrastructure capacity as there are 12 existing biomass facilities in Washington State that currently purchase an estimated annual volume of 10,920 BDT (21,840 GT) from the NC study region.

Table 10. The North Central region total active forest restoration need by ownership as presented in Haugo (2015). This includes "restricted acres" which encompass wilderness areas, inventoried roadless areas and other federally restricted management areas. The restoration needs analysis included forest ownership mapping from the University of Washington Rural Technology Initiative and identified the operable acres. Readily accessible acres are those areas with less than 45% slope. Current treatment levels were determined from Washington Department of Natural Resources forest health reports (DNR 2014) and documented mechanical forest treatments occurring between 2009 to 2014.

Ownership	Total Acres	Treatable Acres		Treatment Levels (acres/year)		Years to Treat	
		Operable	Readily Accessible			Operable	Readily Accessible
USFS	549,000	232,000	172,000	Current	8,923	26	19
				Target	**15,000**	**15**	**11**
State	91,000	72,000	60,000	Current	4,876	15	12
				Target	**5,000**	**14**	**12**
Tribal	88,000	70,000	65,000	Current	4,402	16	15
				Target	**5,000**	**14**	**13**
Industrial Private	20,000	17,000	11,000	Current	1,421	12	8
				Target	**1,500**	**11**	**7**
Non-Industrial Private	86,000	77,000	66,000	Current	9,369	8	7
				Target	**9,500**	**8**	**7**
North Central	834,000	468,000	374,000	Current	28,992	16	13
				Target	**36,000**	**13**	**10**

Employment in the NC region includes 1,015 jobs (Rogers 2013) that produce a combined $42 million in wages and $1.7 million in local taxes. An increase of 35 MMBF could increase the number of direct and indirect jobs by 455 and thereby produce an additional annual $19 million in wages and $742,000 in local taxes. The treatment of 7,008 additional acres annually also has the potential to avoid $4.2 to $9.8 million in fire suppression costs while improving ecological function and economic stability (Lippke et al. 2005). These savings applied over a 15 year period would then equate to cost savings of between $63 and $147 million, and be in addition to the project revenue generated by additional harvest of $2.6 to $27 million, depending on market prices.

Timber and Biomass Harvest Summary by Ownership

Average allowable and actual harvests per year for each of the five ownerships in the North Central Region from 2000 to 2013 can be found in Table 11. The combined average allowable harvest for the region is 220 MMBF per year. The combined average actual harvest for the region is 77 MMBF per year. The Colville reservation and the USFS, on average, do not achieve the planned allowable harvest as shown by percentage for each sector's contribution to the region's total actual and allowable volume (Figure 16).

The NC region forest management plans at the time of this assessment show an estimated allowable timber harvest of 220 MMBF per year across five different ownership classifications. This estimate is approximately 143 MMBF greater than the current average volume harvested per year, calculated for the period of 2000 to 2013 (Table 11). The timber products volume harvested from 2000 to 2013 within the NC study region was approximately 77 MMBF per year with a marked decrease in 2009 and an upward trend through 2013 (Figure 15). The Colville Tribe in particular has harvested the largest portion of this region's volume (36%), with State and USFS timber sales generating a significant portion of annual average timber harvest, 23% and 22%, respectively (Figure 16).

Table 11. Average allowable and actual annual timber harvest for each of the five ownership classifications within the North Central region (2000 to 2013). Across all ownerships classifications there are approximately 143 million board feet of timber products not being harvested annually in the North Central region that have been designated and approved for harvest in existing management plans.

Ownership	Allowable Harvest (MMBF)	Actual Harvest (MMBF)
Colville Tribe	37.3	27.9
NIPF	14.1	14.1
IPF	0.6	0.6
State	17.7	17.7
Federal	150.4	16.8
Total	219.9	77.0

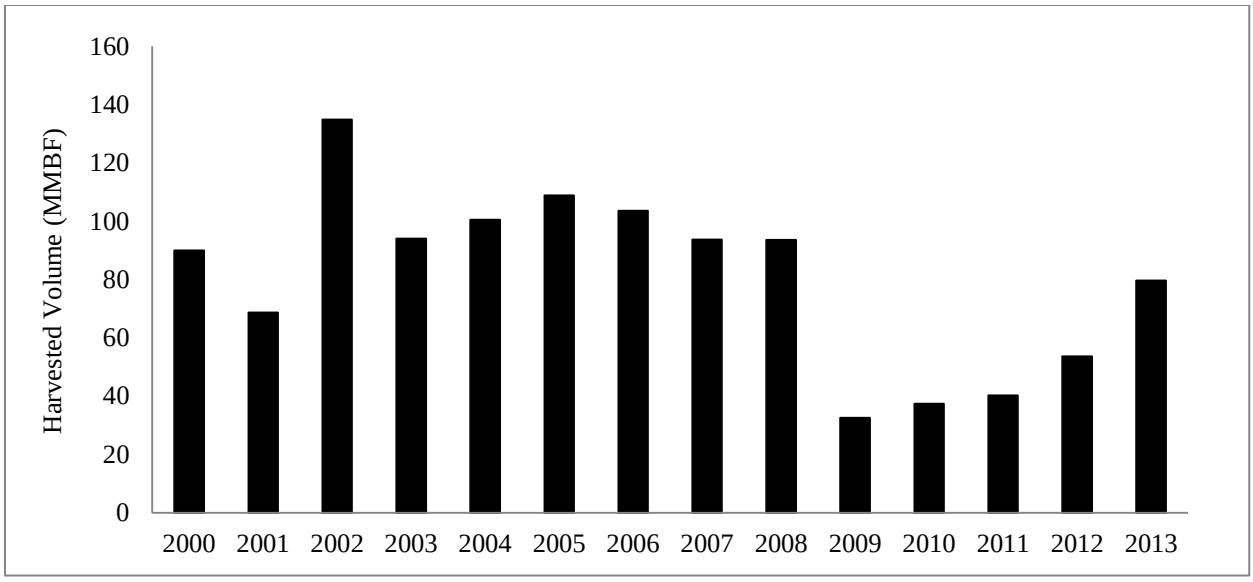


Figure 15. Total volume harvested within the five land ownership classifications for the North Central Region. Each of these classes has differing land management goals and harvest targets, some based largely on public input. The average annual harvest for this period was approximately 77 million board feet.

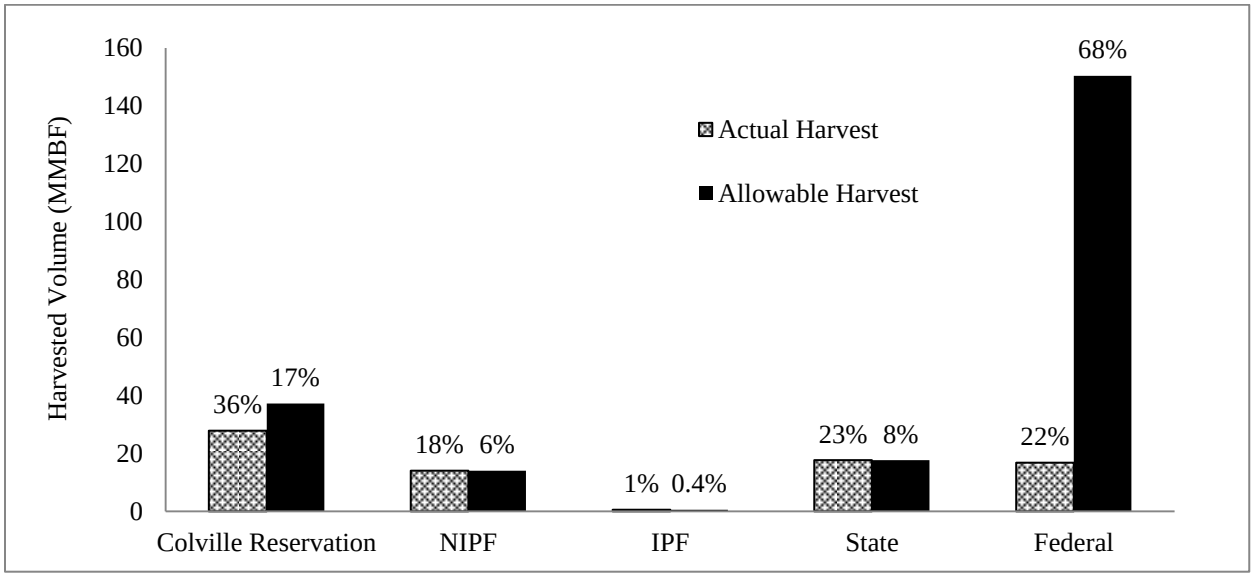


Figure 16. Average allowable and actual harvests per year for each of the five ownerships in the North Central region from 2000 to 2013. The combined average allowable harvest for the region is 220 million board feet per year. The combined average actual harvest for the region is 77 million board feet per year. The Colville reservation and the USFS do not achieve the maximum allowable harvest. The percentages show each sector's contribution to the region's actual and allowable harvests.

The USFS through the National Forest Management Plan currently treats approximately 8,923 acres annually. Annually the State of Washington treats approximately 4,876 acres and tribal ownerships, working through established management plans, treat approximately 4,402 acres within the NC region. Industrial Private Forest (IPF) landowners operate through forest management plans; they are not publicly available and therefore could not be fully detailed: treatments occurred on approximately 1,421 acres annually between 2000 and 2013. Non-industrial Private Forest (NIPF) landowners may or may not have individual management plans, and similar to the IFP owners, their plans are not publically available. NIPF harvest typically follows market prices and often increase during strong markets and decrease during weak market conditions. Acres treated by NIPF owners were approximately 9,369 acres annually between 2000 and 2013.

Federal Timber Harvest

Actual Harvest Reported by Counties

Approximately 71 percent of the Okanogan-Wenatchee National Forest lies within the NC region. The annual allowable harvest on the Okanogan-Wenatchee National Forest is 211.8 MMBF. Under the assumption that harvested volume reflects percentage of ownership within the region; the NC region would have an allowable annual harvest of approximately 150 MMBF from the Okanogan-Wenatchee National Forest (71% of 211.8). Federal timber harvest by county within the NC Region is shown in Figure 17. Douglas County timber harvest was less than 1 MMBF on average during this period and therefore was not included in the following figure.

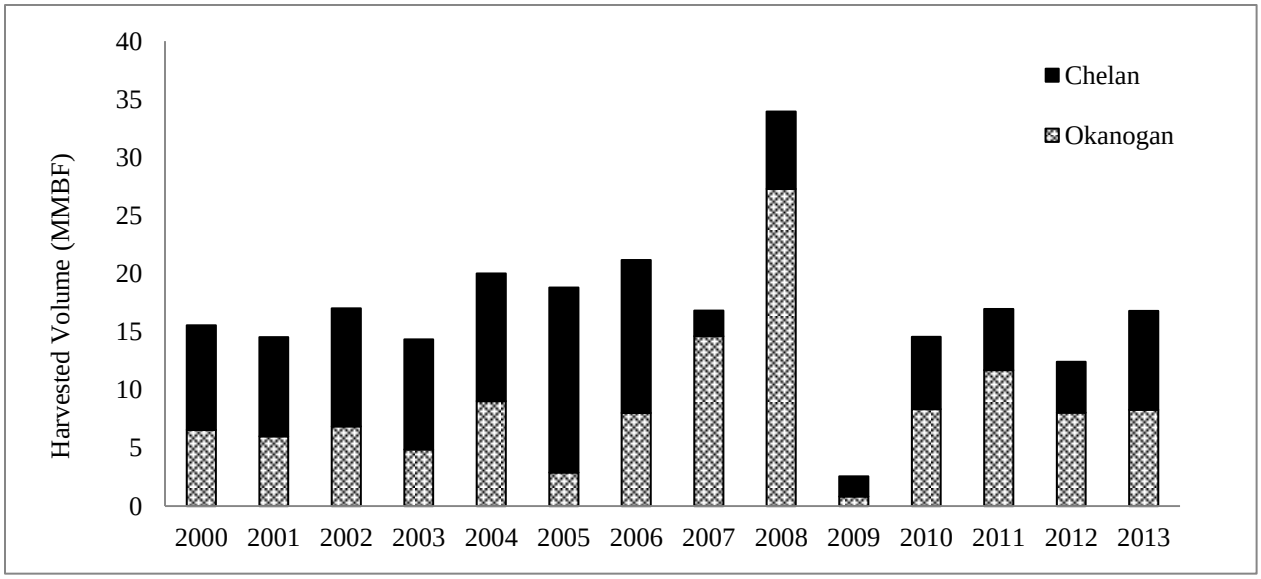


Figure 17. Timber volume harvested from federal lands by county within the North Central region. The average harvest from federal lands in the North Central region was 16.8 million board feet per year. These values were reported by the counties and are assumed to include 71% of the annual harvested volume from the Okanogan-Wenatchee National Forest. The allowable cut for the Okanogan-Wenatchee National Forest in the North Central Region is 150.4 million board feet per year.

State Timber Harvest

Since 2000, an average of nearly 18 MMBF of timber products has been harvested annually from Washington DNR lands within the NC study region with a consistent average decline in harvest levels since 2008 (Figure 18). As a result of statewide surveys showing the increased threat to State forests from insects and disease as well as wildfire (DNR 2012b; DNR 2007) the DNR established an annual allowable harvest level of 550 MMBF across all DNR ownerships for the ten year period from 2005-2014. Specific data on allowable harvest volume for the NC region were not available; however, for the period of 2014 to 2017, the Washington DNR has forecasted a total of 2,164 MMBF to be harvest from all state lands (Smith 2013).

Since 2000, eastern Washington counties have accounted for approximately 11.8% (82.5 MMBF) of the annual statewide harvest from State lands. During this time period, the NC region has contributed approximately 21% (17.7 MMBF) of this total harvest volume. If these trends continue, under the assumption of a total statewide harvest volume of 2,164 MMBF from 2014 to 2017 (Smith 2013), the approximate harvest volume produced from State lands within the NC region would likely be near 73 MMBF (18.2 MMBF/year) or 3.4% of the forecasted future harvest.

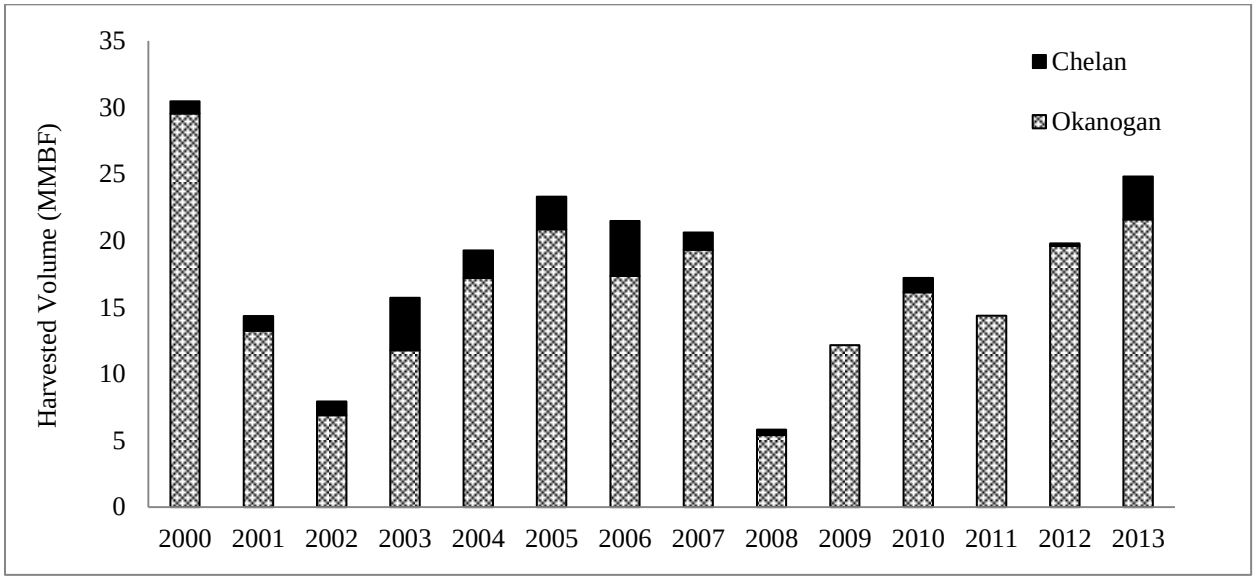


Figure 18. On average the Washington State Department of Natural Resources timber harvest volume in the North Central Region is approximately 18 million board feet per year in the North Central study region.

Tribal Land Timber Harvest

Approximately 48% of the Colville Reservation is located within the NC region. The Tribe's 2001 Forest Management Plan provided for an annual average harvest of 77.1 MMBF from 2000 to 2014 for a total of 778.6 MMBF. From 2000 to 2009, 765.8 MMBF (98.4%) of the planned total volume was harvested (Figure 19). This was in part, a result of insect and disease forest mortality and wildfire salvage. On average the Colville Reservation harvests the greatest volume within the NC region, contributing approximately 36% (Figure 15).

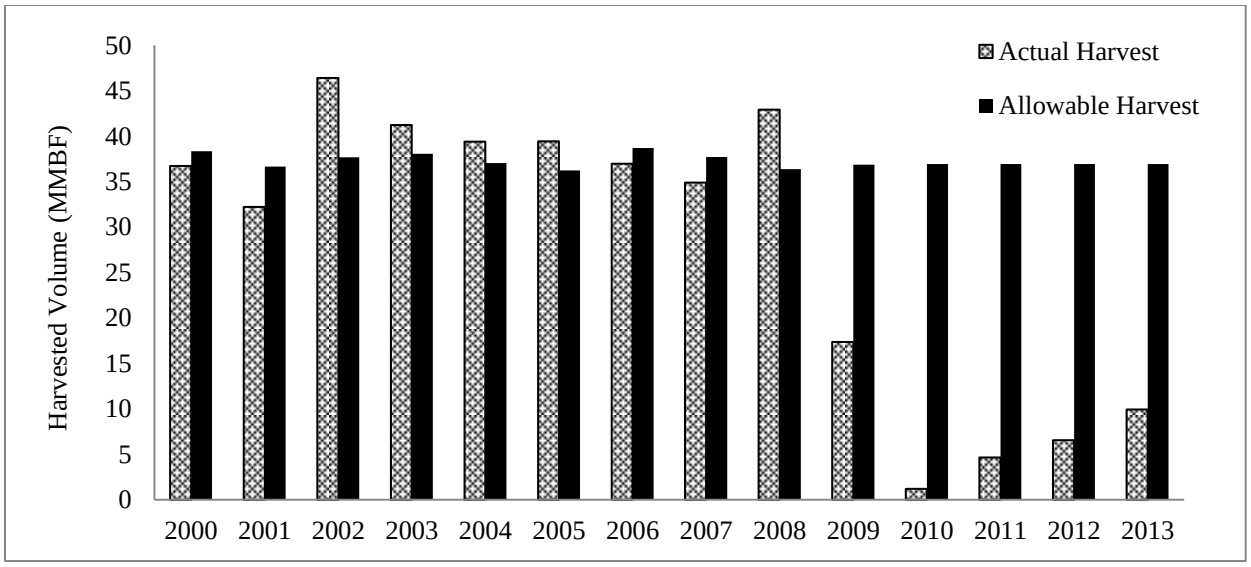


Figure 19. Allowable timber harvest volume compared to actual volume harvested for the portion of the Colville Tribe (48%) in the North Central region. On average the allowable harvest in the North Central region is 37.3 million board feet per year and actual harvest has averaged 27.9 million board feet per year throughout the period shown.

Private Land Timber Harvest

Industrial Private Forest Lands

Harvest from the IPF landowners in the NC region is calculated as 0.6 MMBF (Figure 20) and is due to a lack of ownership acreage within this region. Additionally, target harvest levels are difficult to estimate for the IPF sector, as there are a wide variety of management objectives and closely-held inventory data. Many IPF owners are Real Estate Investment Trust (REITs) or Timber Investment Management Organizations (TIMOs) managing lands for investors on a 10 to 15 year cycle.

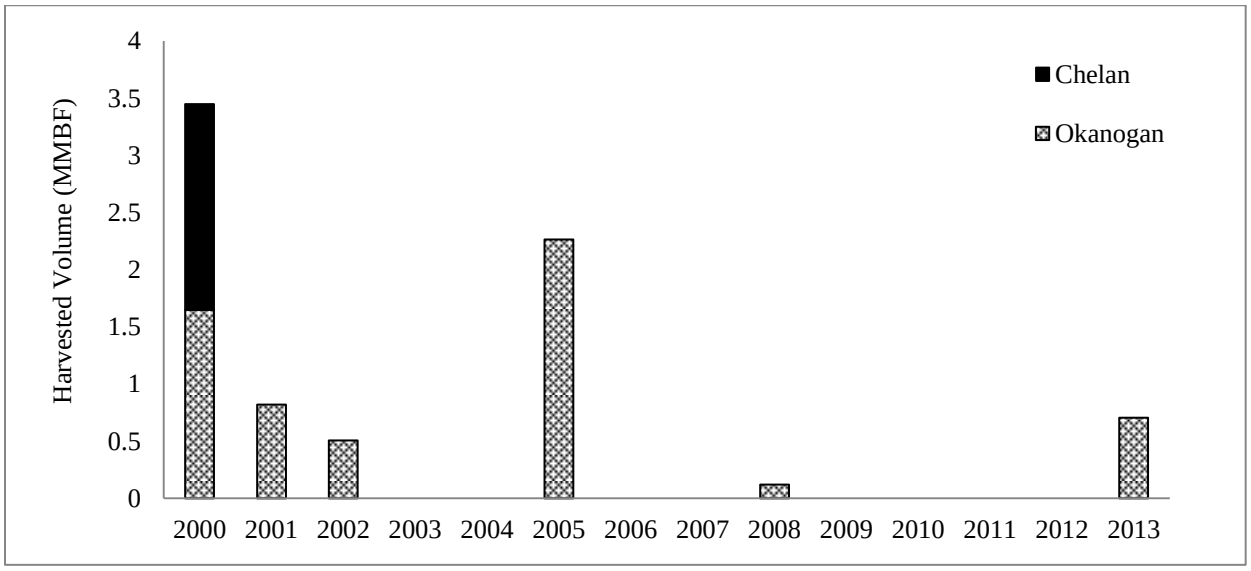


Figure 20. Industrial private forest lands timber harvest volume in the North Central region. On average these lands harvest approximately 0.6 million board feet per year.

Non-Industrial Private Forest Lands

Within the NIPF sector, log market values have the strongest influence on the annual level of harvest. This can produce abrupt changes in annual harvest levels as shown from 2008 to 2011 for the NC region (Figure 21). Harvest levels for both Douglas and Okanogan Counties have remained low following the recession of 200/2012, however Chelan County harvest has increased since 2010, likely due to wildfire salvage projects and a return in the housing market to near pre-recession levels in some markets. Similar to IPF timber harvest estimates, NIPF harvest volumes can be difficult to establish due to a lack of consistent data. The available data showed that from 2000 to 2013 the average harvest from NIPF lands within the NC region was 14 MMBF annually (Figure 21).

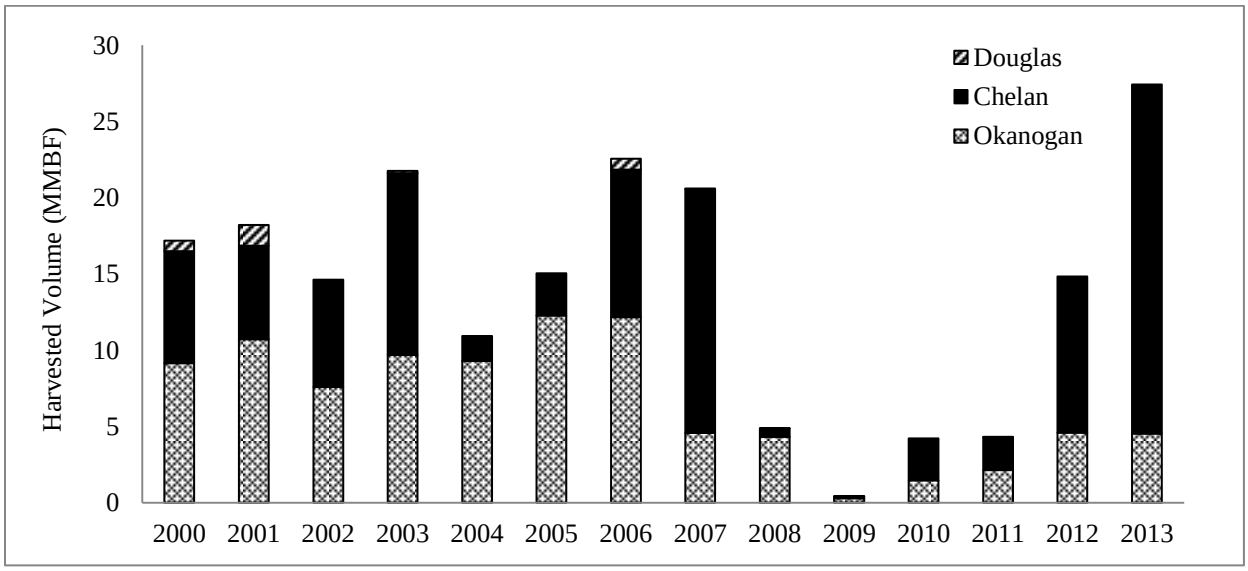


Figure 21. Non-industrial private lands timber harvest volume in the North Central region. On average these lands harvest approximately 14 million board feet per year.

North Central Region Timber Harvest Summary

The NC region has an estimated allowable timber harvest of 220 MMBF per year across the five ownership classifications. This estimate is approximately 143 MMBF greater than the average volume actually harvested per year calculated for the period of 2000 to 2013 (Figure 16) using the following assumptions: 1) available harvest volumes for NIPF and IPF equal the 14-year average harvest levels from 2000-2013; 2) the NC study region harvest volume will not deviate from the historic trend moving forward and can therefore be estimated from the 2014-2017 projected DNR statewide harvest, and; 3) allowable federal harvest is estimated as *'achieving'* the allowable cut for the Okanogan-National Forest and portioned by percentage of the National Forest within the NC region. This is in contrast to the 'actual' federal harvest which was determined from data reported by the counties within the NC region (Table 11).

Total harvest within the NC region was nearly evenly distributed among all ownership sectors with the exception of IPF lands (Figure 16). The NIPF and Washington State allowable harvest volumes are shown as being nearly equal to actual harvest volume as a result of limited or unavailable data to support analysis of allowable harvest levels. Allowable federal harvest within the NC region is 68% (150.4 MMBF) (Table 11), however actual harvest is only 22% (16.8 MMBF) of actual total volume harvested for this region (Figure 16) representing an approximate 133 MMBF gap in management on forest lands within the Okanogan-Wenatchee National Forest.

Summary of Available Biomass by Landowner

The eastern part of Washington has a considerable amount of forest biomass that consists of both standing inventory and what is produced during active harvest operations. Biomass generated as part of a timber harvest process consists of tops, live/dead branches, foliage and stem segments including breakage and defect. This information was provided in the Washington Forest Biomass Supply Assessment Report (Perez-Garcia et al. 2012), prepared for the DNR by University of Washington. Current statewide biomass utilization is estimated at 498,500 BDT (Perez-Garcia et al. 2012), with 18.2% (approximately 90,727 BDT) being attributed to eastern Washington following the trends of timber harvest records. For Example, the NC region averages approximately 11.6% of the total annual timber harvest volume for eastern Washington; therefore 11.6% (10,537 BDT) of the produced biomass in eastern Washington is assumed to come from the NC region. The estimated current annual production of biomass within the NC region (10,537 BDT) contrasts with the Washington Biomass Calculator (UW 2015) showing an estimate of 81,220 BDT (162,440 GT) potentially available biomass annually within the NC region (Table 12).

If restoration activities are able to treat the total acres identified within the NC region (36,000 acres annually) the available biomass as shown by the Washington Biomass Calculator (81,220 BDT) may overwhelm existing infrastructure, as it would represent an increase of seven times the current total utilization as currently contributed to existing facilities by this region. The significance of increased available biomass can be shown through the cost of investments in infrastructure that would be needed to enable production of electricity through utilization of biomass, which has been estimated at $3.2 to $3.4 million per megawatt (MW). One example of these investments would be the establishment of a co-generation facility that could utilize the total modeled biomass within the NC region (162,440 GT). This would require the production of

approximately 18.5 MW of power and require a $61 million investment in order to use approximately 445 GT per day of biomass annually (Cantrell 2015).

The cost of production related to processing and transport of biomass ranges from $16 to $35 BDT (Perez-Garcia et al. 2012). Transportation costs of $70 to $115 per hour and move-in and move out costs ranging from $700 to $1100 per operation (Perez-Garcia et al. 2012) must also be factored into cost calculations. For markets located within 60 miles haul distance one way, the total cost to harvest and deliver the product to the facilities generally ranges from a minimum of $25 GT to a high of $34 GT. Biomass often requires more handling than pulpwood sometimes requiring on-site chipping, this in combination with longer haul distances, makes this product too costly to deliver to some markets. A study conducted by TSS (2009) in 2009 identified the cost per BDT to harvest and deliver timber residuals varied between $47 and $56 BDT for a 40 mile one-way haul. In 2010 the market could have sustained a production of 1.3 million BDT at a price of $100 BDT ($50 GT) (Perez-Garcia et al. 2012). This price without subsidies will be difficult to attain as current pulpwood prices in eastern Washington average between $25 GT ($50 BDT) and $33 GT ($66 BDT).

Current market conditions for biomass throughout the Pacific Northwest as a whole are poor to non-existent and further impacted by low market prices. These represent significant barriers to the use of, and investment in, biomass. This is consistent with observed trends in alternative energy sources for more than a decade, despite investments in wind and solar energy sources. During this same time, the pulpwood market in general has experienced a considerable swing in prices ranging from lows of $22 GT (~$44 BDT) to $60 GT (~$130 BDT). The demand for renewable energy and biofuel is expected to rise due to increasing interests in bio jet fuels (Perez-Garcia et al. 2012) among other products. The Northwest Advanced Renewables Alliance (NARA) is helping to develop a sustainable industry in the Pacific Northwest using wood residuals to make bio jet fuel. NARA will be producing approximately 1000 gallons of cellulosic based bio jet fuel from tree limbs and branches and is working with Alaska Airlines to complete a demonstration flight in 2016 using this fuel which may present additional opportunities for biomass in the future.

Regional Biomass Modeling and Results

One of the accomplishments of the Washington Forest Biomass Supply Assessment report was the development of a biomass database that is spatially explicit and contains a rich set of alternative forest management operations across the diversity of owner groups and forest types in the state of Washington. The database created for the assessment is accessible through a web based portal for individual use (http://wabiomass.cfr.washington.edu/). NMI utilized this web-based portal to generate custom biomass reports for each study identifying the existing facilities (Table 12). The customized reports display BDTs of scattered biomass, roadside biomass (*harvested biomass*), and market biomass. The definitions of the different products produced in the Biomass Calculator are:

> ***Scattered biomass -*** *The volume that was left scattered in the woods as a product of having been broken off or tops and limbs cut when commercial logs were yarded to the landing was noted as residual harvested volume (Perez-Garcia et al. 2012).*

Roadside biomass *- (harvested biomass)-The biomass that was brought to the landing along roadside was calculated and recorded in the biomass database as harvested biomass (Perez-Garcia et al. 2012).*

Market biomass *- was the portion of the potential market biomass that actually was loaded on a truck and the accounting was complete when the volume of biomass reaching the market was recorded (Perez-Garcia et al. 2012). This was the volume used to identify the total available biomass in each region.*

Table 12. Summaries of the University of Washington Biomass Calculator (UW 2015) model output showing input parameters for the North Central study region scenario evaluating existing facilities only. The biomass production was based on the number of existing facilities at a price of $45 bone dry ton. The model estimated approximately 81,220 bone dry tons at a residual value of $370,756.59 would be delivered to existing facilities within eastern Washington.

Run: Average Statewide Harvest
Year: 2020
Geography: County
Geographies: Chelan (4), Douglas (9), Okanogan (24)
Facilities: Bingen: Existing, Colville: Existing, Everett: Existing, Kettle Falls: Existing, Mount Vernon: Existing, Port Angeles: Existing, Port Townsend: Existing, Tacoma: Existing, Usk: Existing, Wallula: Existing, Winton: Existing
Cost: Medium
Price: $45
Max Haul Time To Facility: 240 minutes
Reporting Fields: County, Owner Class
Field Options: Names

County	Owner Class	Scattered Biomass (BDT)	Roadside Biomass (BDT)	Market Biomass (BDT)	Residual Value ($)
Chelan	Federal	24,965	26,713	15,496	$77,598.03
Chelan	Municipal	411	666	666	$6,437.27
Chelan	Private	19,266	24,789	17,204	$146,117.34
Okanogan	Private	902	1,298	912	$1,027.17
Chelan	State	5,470	4,762	3,008	$35,415.35
Okanogan	Tribal	58,674	49,892	43,934	$104,161.44
TOTAL				81,220	$370,757

Existing Processing and Manufacturing Infrastructure

Sawlog Consumption

Sawlogs are the primary feedstock for the mills located in the NC study region. The products produced from sawlogs include dimensional lumber and boards. Peeler logs are also common, which are utilized to produce plywood and veneer products. The NC region includes two sawlog processing facilities which include Zosel Lumber Company and Colville Indian Precision Pine. A brief summary of these facilities follows with processing volumes provided in (Table 13).

Zosel Lumber Company

Zosel is a small privately owned lumber company out of Oroville, WA.
Purchase - sawlogs for sawmill to produce dimensional lumber as well as boards.
Current log usage - 11 MMBF
Location: Oroville, WA. Okanogan County

Omak Wood Products, LLC

Omak Wood Products, LLC (formerly Colville Indian Power and Veneer) is a wholly-owned subsidiary of Wood Resources, LLC, a portfolio company of Atlas Holdings.
Purchase - Douglas-fir peeler logs primarily from for their plywood and veneer products.
Current log usage - 50 MMBF
Location: Omak, WA. Okanogan County

Colville Precision Pine

This mill, owned by the Colville Tribe, was shut down in the early 2000's due to a fire that severely damage the mill. Repairs to the mill have not yet been completed and plans for startup are unknown.

Table 13. Total sawlog consumption by existing milling facility within the North Central study region.

Mill Name	Annual Log Usage (MMBF)
Zosel Lumber Co.	11
Omak Wood Products	50
Colville Indian Precision Pine	- [a]
TOTAL	61

[a] This mill, owned by the Colville Tribe, was shut down in the early 2000's due to a fire that severely damage the mill. Repairs have not yet been completed and plans for startup are unknown.

Small Diameter Logs /Restoration Products

There are no known facilities within the North Central region which process small-diameter sawlogs or pulp.

Biomass Processing by Existing Sawmill Facilities

There are no current biomass processing facilities in the North Central region and biomass produced by the NC region is shipped outside of the three-county area.

Sawmills typically separate their clean chips from their bark and sawdust. Clean chips and sawdust are sold to paper mills and can be a significant source of revenue for sawmills located within short haul distances, thereby minimizing the costs of transportation. Bark residuals are often used in boilers to generate steam and operate facility processes such as kilns or power generation. The two sawmills in the NC region process 61 MMBF annually. Using the lowest estimated average BDT per harvested thousand board feet (MBF) conversion factor for 2015, of 0.81 (Perez-Garcia et al. 2012), this region produces a potential 62,370 BDT of biomass annually from current harvest operations (77 MMBF) and would produce an additional 28,350 BDT if harvest increased by 35 MMBF on the proposed 7,008 additional acres needing treatment.

Many biomass contractors estimate that an average of 61% of woody biomass created from harvest or treatment operations can be recovered (Perez-Garcia et al. 2012). Expectations of biomass recovery range from 39% to 61%, however modeling has shown that only a fraction of the biomass produced during harvest (47%) would be transported from the forest and that only 14% of post-timber harvest biomass is commonly successfully marketed (Garcia-Perez et al. 2012).

Ecological and Infrastructural Restoration Need

The acres in need of restoration in the NC region within the Anchor Forest pilot generated by the TNC and USFS for the Tapash and North Central Washington Forest Collaboratives (Haugo et al. 2015) are presented in (Table 10). Within the NC region the Readily Accessible (<45% slope) acres could be prioritized as the first treatment areas since they are expected be easier to access. Completing the Readily Accessible acres only would leave approximately 94,000 Operable acres untreated. This assessment evaluated the level of 'Target' treatments needed in order to meet restoration objectives on operable acres within the 15 year time period. The Target acres were then estimated with the assumption of treating 100% of the operable acres within the 15 year period or less and are based on Haugo (2015) and current federal forest health conditions for eastern Washington (USDA 2015).

Harvesting Capacity and Capability

Capital expenditures to build additional harvesting capacity to recover biomass are estimated at $18 GT for ground based systems (stump to on-board truck). This is based on a total equipment cost of $4,284,000 (assumed weekly movement of 1,680 GT) and production of approximately 238,000 GT annually, using average logging conditions for the western U.S. (Barynin et al. 2013). Biomass harvesting is most cost efficient when combined with sawlog harvest operations where sawlogs, pulp and biomass are removed in one entry thereby minimizing transportation and operation costs. Costs are expected to be greater if biomass is harvested as a separate product.

The capital investment required to harvest an additional 56,700 GT (28,350 BDT) of biomass from the proposed increase in treatment acres (7,008) is approximately $1,020,600. The capital investment required to harvest the maximum-predicted supply of biomass within the NC region as modeled using the University of Washington Biomass Calculator (UW 2015) 162,440 GT (81,220 BDT) would be approximately $2,923,920. If expansion and renovations are conducted at the existing facilities in order to utilize biomass for heat, kiln-drying, or co-generation power production, there is potential for a significant volume of biomass to be used. However, as of this

assessment current market prices for power within the Pacific Northwest provide little to no financial incentive to invest in this type of facility infrastructure. Under the present market conditions encouraging investments in biomass utilization will likely require subsidies, tax incentives, and potentially policy/legislative changes to make them attractive to a broad audience.

The cost of management to prepare the additional acres needed for restoration (7,008 acres per 35 MMBF) ranges from $66 to $71 per MBF for actions on State-managed lands within Washington totaling between $462,528 and $497,568 (IFMAT 2013). Based on USFS cost per MBF it was calculated that preparation costs for the same number of acres/volume on federal lands would range from $1 million to $1.5 million using the $150 per MBF National USFS average or the $220 per MBF USFS Region 1 average, respectively (IFMAT 2013). For forest health projects on NIPF lands targeting fuel reduction treatments and forest health improvements in eastern Washington, the DNR costs ranged from $899 to $1085 per acre from 2009 to 2013 when federal cost-share funding was available (Mason et al. 2008).

Transportation Infrastructure

The transportation infrastructure currently is handling the harvest production on approximately 28,992 acres. An increase in harvest on 7,008 acres that produces 35 MMBF would require an additional 17 log trucks (8,807 loads) for sawlogs, and the biomass generated would total an estimated 2,108 truckloads thereby requiring an additional four trucks for the NC region. Therefore, restoration efforts on the 7,008 acres would require 21 additional trucks in total delivering approximately 10,915 truckloads on the existing transportation system network. This would most likely require additional maintenance and repair on the highways and county roads within the region, but also increases the tax base, employment opportunities, and the economic base within these counties.

To address the total available biomass modeled within the region (81,220 BDT) it would require approximately 6,016 truckloads (13.5 BDT per log truck) and an additional 12 trucks working 170 days a year if they could deliver three loads a day. This volume of biomass is not expected to be utilized in the near future and would require a significant investment in infrastructure. For example, the capital investment to start up 17 additional log trucks to accommodate the increased sawlog volume is estimated at approximately $3 million ($175,000 per truck) equaling an average cost of $2.50 per ton over a five-year amortization timeframe. To adequately address an increase of 81,220 BDT (162,440 GT) of biomass would require an additional investment of $700,000 for four more trucks in addition to fuel, operating expenses, permits and the cost of other regulatory requirements. Anticipated wages for 21 additional trucks, driving ~66,000 miles year and earning $33,404 in 2008 dollars (Mason et al. 2008), would be approximately $701,484.

Transportation efficiency can be increased through implementation of trucking logistic concepts that support the log supply chain such as a central dispatch. This practice has been widely implemented in forest regions around the world and has recently been established in North Central Washington through collaborative efforts involving multiple private industry stakeholders within the natural resource sector. The Central Dispatch methods are being used to manage log flow, build contractor relationships, and increase the efficiency and profitability for individual trucks and drivers. The Central Dispatch operation has provided an opportunity to

move more volume more efficiently with fewer trucks and reduce fuel consumption, wear, and maintenance need for trucks and roadways.

Processing and Manufacturing Infrastructure

The current sawmill processing capacity within the study area utilizes approximately 61 MMBF of sawlog volume annually. There is 77 MMBF (Table 11) being harvested within this region with the remaining volume (16 MMBF) being processed outside the region. Most mills stated processing capacity could be increased by 10 to 30% if the timber supply was available. Existing processing facilities are anticipated to continue to utilizing approximately 61 MMBF and may be able to process a portion of the additional harvested volume currently being transported outside of the region if given favorable hauling distances and competitive pricing. However, it is unlikely the NC study region could utilize the additional volume of 35 MMBF from proposed treatments on 7,008 additional acres annually given current facility capacities and staffing. This additional volume would need to be utilized by an increase in processing infrastructure that would likely require, reopening of previously-closed mills or investments in a new facility.

To establish a small mill that could utilize a larger range of diameters, process lower-volume (less than 50 MMBF) and use mixed species to cut specialty products would be between $1 and $1.5 million dollars per MMBF. Sight specific prices for the NC region have been estimated at between $25 and $36 million to establish a mill able to process 25 MMBF annually (Cantrell 2015).

Additional benefits of building a new facility would be gained through the addition of an on-site co-generation facility to utilize produced biomass for energy production. An estimated one GT of biomass is needed per MW per hour. The construction and operation of a biomass co-generation facility would cost between $3.2 and $3.4 million per MW. Studies conducted in eastern Washington have identified the requirement of a 16 MW plant, as a stand-alone operation, to sustainably compensate for the cost of extracting and delivering the needed quantity of biomass (Cantrell 2015). For reference, a state-of-the-art sawmill utilizing 40 MMBF of sawlogs would be able to produce enough biomass (sawdust) to sustain a six to seven MW facility.

The job opportunities for developing this type of infrastructure are based on both full-time and part-time employment with the acknowledgment that workers can have more than one job. It is estimated that 18 jobs, 10 in the forest products industry plus eight indirect and induced jobs in supporting industries are produced for each MMBF harvested and that these jobs produce nearly $528,000 in wages and more than $3.2 million in the sales of goods and services (Cook et al. 2015). Therefore, increasing production in the NC region by 35 MMBF would provide approximately 630 new jobs in the forest products industry, including indirect and induced jobs in supporting industries, and generate approximately $18.48 million in wages and $112 million in the sales of goods and services. Job creation is not linear; this number is specific to the NC region which currently employs approximately 1,015 people in the forest products industry (Rogers 2013). The current number of employees for each region was used to estimate the additional jobs created.

North Central - Opportunities, Barriers, and Recommendations

The restoration need assessment completed by Haugo et al. (2015) uses a combination of publically available data to make the determinations of forest restoration need supported by the USFS and aligning with the guidelines presented in the recent Farm Bill for identifying treatment areas. Additional analysis completed by several states employ the National Insect and Disease Assessment maps in order to identify similarly high-risk forest condition and designate areas in need of treatment, commonly on a 15 year timescale (Krist et al. 2014).

The total restoration need identified for the NC region within areas of 'operable acres' (Table 11) represent a total area of 468,000 acres. Current annual treatments within this study region are approximately 28,992 acres. At current treatment rates all landowners except the Forest Service (26 years) can treat the identified operable acres within 15 years, and several will complete treatments sooner (Table 10). At the proposed total target treatment level of 36,000 acres annually, restoration needs could potentially be completed for all identified operable areas across all ownerships within a 15 year time period.

Sawmill manufacturing infrastructure in the NC region is comprised of two sawmills presently processing an annual volume of 61 MMBF and the ability to increase their capacity by 10 to 30% (12 to 18 MMBF). Currently this region produces an annual average of 77 MMBF, of which approximately 16 MMBF is processed outside the three-county area. Additionally, transportation and milling infrastructure is capable of maintaining current production levels within the NC region, but would require additional resources to accommodate increases in available timber and processing capacity. The proposal of treatment on 7,008 addition acres annually would provide an increase of 35 MMBF (+45%) in harvesting activity and require approximately 21 additional trucks (10,915 loads per year) to maintain the transportation infrastructure. The capital investment for 21 trucks driving ~66,000 miles year and earning $33,404 in wages (2008 dollars, Mason et al. 2008), would be approximately $701,484 with fuel, operating expenses, permits and the cost of other regulatory requirements being in addition to this initial investment.

Opportunities

- ✓ Many areas need to reduce over stocked tree densities and reduce biomass (fire fuels) in order to return the landscape to a more natural range of variability. An increase of 7,008 treatment acres provides an opportunity for local employment in the area and increases the economic sustainability of local communities. For example, increasing management activity on 7,008 acres that produces 35 MMBF will provide approximately 455 new jobs, including both indirect and induced jobs, generating approximately $19 million in wages and salaries, and nearly $752,000 in taxes. The proposed annual target treatment of 7,008 acres would also represent the first step toward management of the annually planned for and not harvested 143 MMBF in existing forest management plans for this study region (Table 11).

- ✓ A nationwide interest in clean energy and reduction in the use of fossil fuels have the potential to increase the market value of biomass which could lead to substantially improved recovery and use of this renewable green resource. An increased interest and incentive to use biomass has the potential to provide additional jobs, wages, and taxes to

local communities while reducing wildfire fuel loads thereby, increasing safety and improving overall ecosystem function. Wood energy supports carbon reductions through carbon sequestration, increased oxygen, reduced smoke and particulate matter.

- ✓ Proposed target treatment levels provide an opportunity to begin addressing the current and increasing insect, disease, and wildfire conditions occurring across eastern Washington within the NC study region. Treatment of identified acres under the Anchor Forest concept would occur across ownership boundaries and therefore provide an example of landscape-scale management founded on ecological function, forest resilience, soil protection, water quality, and wildlife habitat as well as aesthetics, recreation, and economic support for local communities and human well-being.

Barriers

- ✓ Planning needs to look at how historical management has affected ecosystems, particularly with regard to fire exclusion on dry fire-prone landscapes such as those in the NC study region. This is critical in motivating restoration efforts because insect, disease, and wildfire impacts have increased significantly throughout the past few decades, impacting a significantly greater area than current management efforts are addressing. Nearly all landowners with the exception of the USFS, and to a lesser degree the Colville Tribe, have been successful in achieving their forest planning objectives (Figure 16). The USFS inherently has challenges unique to its's role as a federal land management agency that impact forest planning and management activities. Recent research has identified some challenges unique to the USFS to be: frequent leadership turnover, a lack of leadership direction, inconsistent support for activities within the organization, excessive financial resource allocations to wildland fire, and individual personnel attitudes, values, and beliefs (Keele et al. 2006; ITC 2013; O'Toole 2007; GAO 2007; USDA Forest Service 2015).

- ✓ Public perception of forest management and the social license needed to plan and implement actionable restoration activities presents a barrier to correction of the landscape-scale ecosystem degradation occurring due to un-natural tree densities, the exclusion of fire, and increasing tree mortality. These deteriorated forestland conditions, if not corrected, will continue to fuel the already increasing frequency and severity of wildfires that have destroyed homes and wildlife habitat, impacted water resources, and altered entire ecosystems for decades into the future (Wu & Kim 2013; Franklin 1993; Franklin et al. 2008; Noss et al. 2006).

- ✓ Limited capital investments are expected for harvesting equipment and trucking needs estimated to accomplish restoration on the identified acres. These investments would be prior to and not include future maintenance costs associated with the use of existing facilities and infrastructure to accommodate an increased volume of approximately 35MMBF annually. In addition to these costs the cost of management to prepare timber harvest operations on the identified acres is significant ranging from $66 to $71 per MBF on State-managed lands and $150 to $220 per MBF on USFS Region 1 lands (IFMAT 2013). Forest restoration projects on private lands often target fuel reduction treatments

and forest health improvements through the DNR with costs ranging from $899 to $1085 per acre (2009 to 2013) (Mason et al. 2008).

- ✓ The workforce demographic of the forestry sector is aging, and training and education for new and existing opportunities are limited in all study regions.

- ✓ Although there is a nearly limitless volume of biomass within the NC region (as market prices increase) the resources needed to address an estimated total of 81,220 BDT (162,440 GT) annually would require approximately 6,016 truckloads (27 GT per truck). To transport this amount of biomass would require an additional 12 trucks, working 170 days a year, delivering 3 loads a day. Existing biomass facilities will not likely be able to accommodate this volume of biomass due in part to limits in capacity as well as market constraints associated with harvest and transportation costs, making biomass produced products (electricity) less competitive in areas where sources such as hydropower are available. Therefore, it is unlikely that increased biomass within this region could be utilized in the near future without significant increases in production and supply incentives as well as the market value of generated products.

Recommendations

- ✓ In order to combat the challenges of an aging demographic a focus on the values of forestry and silviculture and the importance of communication skills and the social license required for forestry are needed within the education system at multiple levels (Sample et al. 2015; Sharik et al. 2015). These could be incorporated at the high school level supported through efforts at local levels to match employment opportunities with local residents.

- ✓ Proposed treatment levels are provided by ownership in Table 10; however the need for action is most significant on lands managed by the USFS as compared to all other ownerships. Targeting a treatment on USFS ownerships, focusing specifically on the identified operable acres, will equate to an overall increase in management activity of nearly 68% from the current annual average in the NC region. Although this would represent a significant gain, treatment of additional acres must be encouraged given the significant increases in tree mortality, insect and disease infestations, and wildfire over the past decade (Goldmark 2012; Ray et al. 2012; Tidwell 2015; Krist et al. 2014; USDA Forest Service 2014). Focusing on only the 'Readily Accessible' acres identified within the USFS lands would omit approximately 60,000 acres from the total operable acres. The readily accessible areas are expected to provide easier to access for management operations and may provide future "previously-permitted" access locations where they are adjacent to the omitted 60,000 acres.

- ✓ Long-term contract commitments to active management and timber supply are necessary to encourage capital investments needed to outpace deteriorated forest ecosystem conditions. Approximately 16 MMBF of harvested volume is being processed outside of the NC study region which could be utilized by the existing sawmills given a commitment to a stable supply. Under management of the proposed acres an additional 35 MMBF would be generated annually for 15-year, thereby providing an opportunity to

invest in an efficient low-volume (<35 MMBF) sawmill capable of processing 20 to 30 MMBF within this study region. An example of this investment in forest health and infrastructure is presently underway in southern Colorado on the Trinchera Ranch where declining forest health and increasing wildfire threaten forests throughout the area.

- ✓ Increased efforts to restore forest and treat fuels are required to reduce federal expenses associated with fire suppression. A 2012 economic assessment from Oregon's Federal Forest Advisory Committee found that every $1.0 spent on restoration potentially avoids $1.45 in fire suppression cost (Rasmussen. et al. 2012). Additionally, calculations of the positive net benefits following fuel reduction treatments on market and nonmarket products/services has provided estimates of per-acre value ranging from $606 for moderate to $1402 for high-risk forest land with higher values expected if the per acre economic values are tied to habitat protection, air and water quality protection, or carbon credits among other ecosystem services (Lippke et al. 2005).

- ✓ Monitoring is needed to evaluate applied practices and new opportunities that can sustain and expand activities that out-pace the currently increasing insect, disease, and wildfire impacts throughout eastern Washington and the West.

Northeast Region

There are 1,808,000 forested acres in the NE eastern Washington study region distributed across the Colville, Spokane, and Kalispell Indian reservations, the Umatilla, National Forest, the Colville National Forest, and private ownerships within the Stevens, Spokane, Pend Oreille, Lincoln and Ferry Counties. The forest health situation in this region has been evaluated by the TNC and USFS to show approximately 1,192,000 acres are outside of the desired ecological range of variability and at an increased risk of additional tree mortality and damage by insects, disease and wildfire within the next 15 years (Haugo et al. 2015). Many of these acres have been classified as forest structures needing restoration in the form of "Disturbance Only" and/or "Disturbance then Succession" as defined by (Haugo 2015).

The NE region has established management plans with approved annual harvest volumes of 427 MMBF, and a current annual harvest of 298 MMBF[5]. The total harvest volume in this region has been declining since 2000, however there has been a recent increase of approximately 20 MMBF per year following 2010 (Figure 23).

There are currently six sawmills in operation within this region (Figure 22) processing more than 89.6% (267 MMBF) of annual harvest volume with 10.4% (31 MMBF) being processed outside of the five-county area. Operable acres, those including both >45% slope and <45% slope in the NE region across all ownerships are 973,000 acres, of these 856,000 acres are considered Readily Accessible (<45% slope) (Table 14).

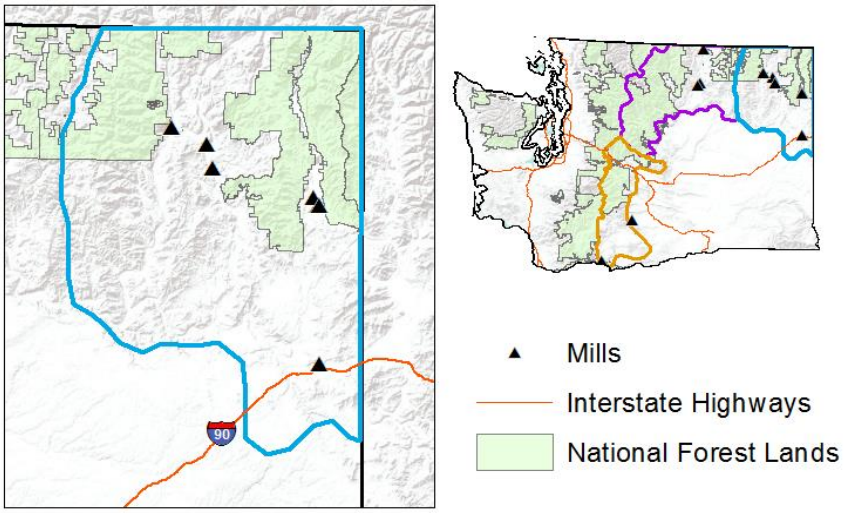


Figure 22. Existing timber milling facilities within the Northeast study region of eastern Washington Anchor Forest assessment project.

Currently 70,465 acres of the forest lands identified in Table 1 are treated within the NE region annually across all ownerships (Table 14). If successful in completing the annually approved harvest an additional 129 MMBF of volume of sawlogs and an approximate 104,490 BDT (208,980 GT) of biomass would be available. This volume is approximately two times greater

[5] Many of the current management plans are dated and most are in revision, consequently, "planned harvest" volume is likely to change in order to more appropriately match the present management needs of these landscapes.

than the projected restoration need (70 MMBF) identified through the Anchor Forest assessment. An increase of 129 MMBF annually, given current infrastructure, regulations and recent wildfires, is unlikely and potentially unsustainable. However, the proposed annual supply increase of 70 MMBF is reasonable and sustainable under current regulations using existing infrastructure throughout a 15 year time period. However, management efforts will likely need to focus on ecosystem function and forest resilience within the identified operable acres as shown in Table 6.

For example, in order to begin addressing currently deteriorated forest health conditions and wildfire threats at a rate sufficient to minimize or mitigate deteriorating forest conditions, a proposed total increase of 14,035 acres annually (84,500 acres total annually) across all ownerships is presented, for a minimum 15-year period (Table 14). Treatment of an additional 14,035 acres would generate an estimated 70 MMBF of sawlogs and 56,700 BDT (113,400 GT) of biomass annually. The currently existing infrastructure within the NE region is anticipated to fully accommodate the increased volume of sawlogs however, utilization of additional biomass would be subject to market pricing and infrastructure capacity as there are five existing biomass facilities purchasing an estimated 40,950 BDT (81,900 GT) from the NE study region annually. This example and the proposed annual increase in forest treatment is however, only a starting point to begin addressing deteriorating forest ecosystem conditions and future efforts and will likely need to be expanded to keep pace with increasing insect, disease and wildfire impacts.

Table 14. Northeast region total active forest restoration need by ownership as presented in Haugo (2015). The 'Total acres' column includes "restricted acres" which encompass wilderness areas, inventoried roadless areas and other federally restricted management areas. The restoration needs analysis included forest ownership mapping from the University of Washington Rural Technology Initiative and identified the operable acres. Readily accessible acres are those areas with less than 45% slope. Current treatment levels were determined from Washington Department of Natural Resources forest health reports (DNR 2014) and documented mechanical forest treatments occurring between 2009 to 2014.

Ownership	Total Acres	Treatable Acres		Treatment Levels (acres/year)		Years to Treat	
		Operable	Readily Accessible			Operable	Readily Accessible
USFS	372,000	261,000	224,000	Current	10,038	26	22
				Target	**17,000**	**15**	**13**
State	93,000	78,000	69,000	Current	5,283	15	13
				Target	**5,500**	**14**	**13**
Tribal	223,000	168,000	138,000	Current	4,768	35	29
				Target	**11,000**	**15**	**13**
Industrial Private	176,000	166,000	145,000	Current	13,871	12	10
				Target	**14,000**	**12**	**10**
Non-Industrial Private	328,000	300,000	280,000	Current	36,504	8	8
				Target	**37,000**	**8**	**8**
Northeast	1,192,000	973,000	856,000	Current	70,465	14	12
				Target	**84,500**	**12**	**10**

Employment in the NE region includes 6,849 jobs (Rogers 2013) that produce a combined $284 million in wages and $11.1 million in local taxes. An increase of 70 MMBF could increase the number of direct and indirect jobs by 1,610 and thereby produce an additional annual $67 million in wages and $2.6 million in local taxes. The treatment of 14,035 additional acres annually also has the potential to avoid $8.5 to $9.7 million in fire suppression costs while improving ecological function and economic stability. These savings applied over a 15 year period would then equate to cost savings of between $128 and $296 million, and be in addition to the project revenue generated by additional harvest of $5.2 to $53 million, depending on market prices.

Timber and Biomass Harvest Summary by Ownership

The NE region has an estimated allowable timber harvest of 427 MMBF per year across five different ownership classifications. This estimate is approximately 129 MMBF greater than the current average volume harvested per year, calculated for the period of 2000 to 2013 (Table 15). The timber products volume harvested from 2000 to 2013 within the NE study region was approximately 298 MMBF per year and has been steadily decreasing since 2002 (Figure 23). The NIPF landowners in particular have harvested the largest portion (50%) of this region's total volume harvested (Figure 24).

Table 15. Average allowable and actual annual timber harvest for each of the five ownerships in the Northeast region from 2000 to 2013. Across all ownerships classifications there are approximately 129 million board feet of timber products not being harvested annually in the Northeast region that have been designated and approved for harvest in existing management plans.

Ownership	Allowable Harvest (MMBF)	Actual Harvest (MMBF)
Tribal	50.1	36.7
NIPF	149.0	149.0
IPF	42.1	42.1
State	38.8	38.8
Federal	146.8	31.0
Total	426.8	297.7

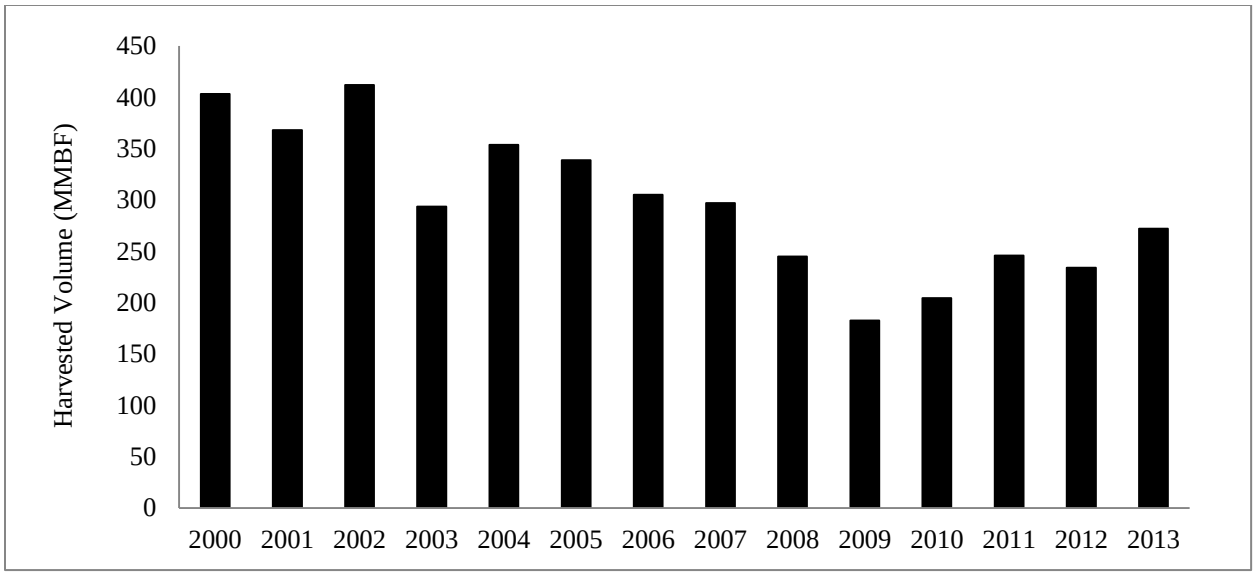


Figure 23. Total volume harvested from the five landownership classifications within the Northeast region. Each of these classes has differing land management goals and harvest targets, some based largely on public input. The average annual harvest for this region during the years shown is approximately 298 million board feet.

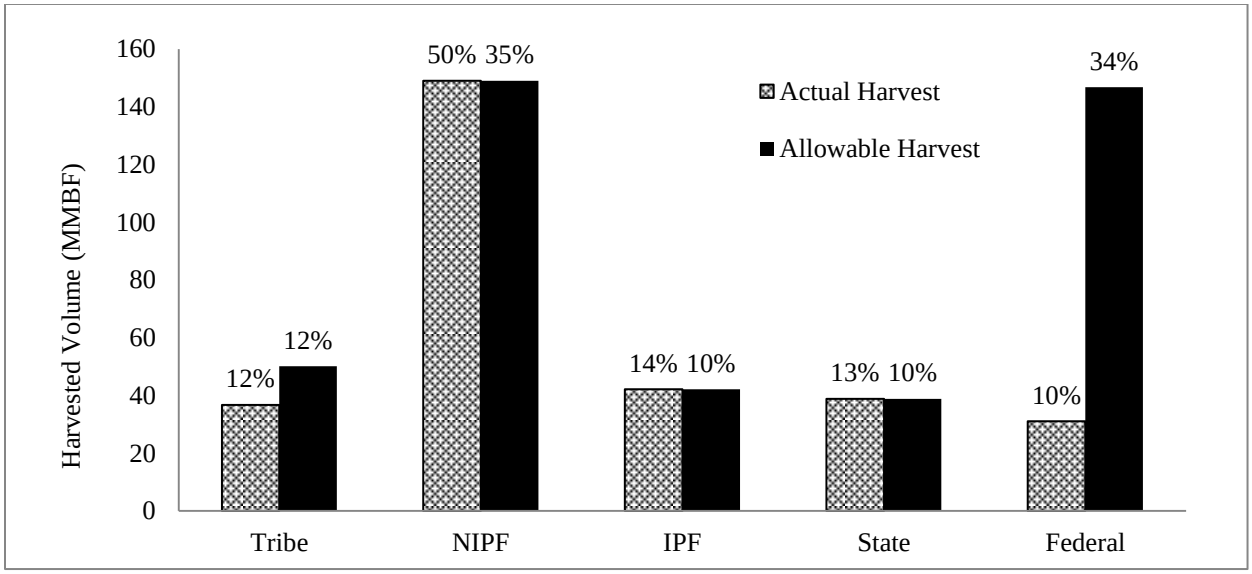


Figure 24. Average allowable and actual harvests per year for each of the five ownership classifications are presented for the Northeast region from 2000 to 2013. The combined average allowable harvest for the region is 427 million board feet per year. The combined average actual harvest for the region is 298 million board feet per year. Tribal and USFS efforts, on average, do not achieve the planned allowable annual harvest. The percentages shown for each column represent the harvest volume contribution of that sector to the region's actual and allowable average harvest.

The USFS through the National Forest Management Plan currently treats approximately 10,038 acres annually (Table 14). Annually the State of Washington treats approximately 5,283 acres

and tribal ownerships, working through established management plans, treat approximately 4,768 acres within the SC region. Industrial Private Forest (IPF) landowners operate through forest management plans; however they are not publicly available and therefore could not be fully detailed: however treatments occurred on approximately 13,871 acres annually between 2000 and 2013. NIPF landowners may or may not have individual management plans, and similar to the IFP owners, their plans are not publically available. NIPF harvest typically follows market prices and often increase during strong markets and decrease during weak market conditions. Acres treated by NIPF owners were approximately 36,504 acres annually between 2000 and 2013.

Federal Timber Harvest

Actual Harvest Reported by Counties

The 1988 Colville National Forest Land and Resource Management Plan identify an allowable annual harvest of 147 MMBF. During the period of 2000 to 2013 approximately 38 MMBF (26%) of the annual allowable timber products were harvested, representing a gap in land management action of approximately 1,414 MMBF on the Colville National Forest. By county federal timber harvest in Pend Oreille and Ferry Counties represent a substantial volume within the NE region (Figure 25), likely due to their proportionately large acreages of USFS land, approximately 686,000 and 506,000, respectively. Conversely, Stevens County is the second highest producer of federal timber within the NE region, and with only approximately 288,000 acres of USFS forestlands, has shown the greatest percent of active management on federal ownership.

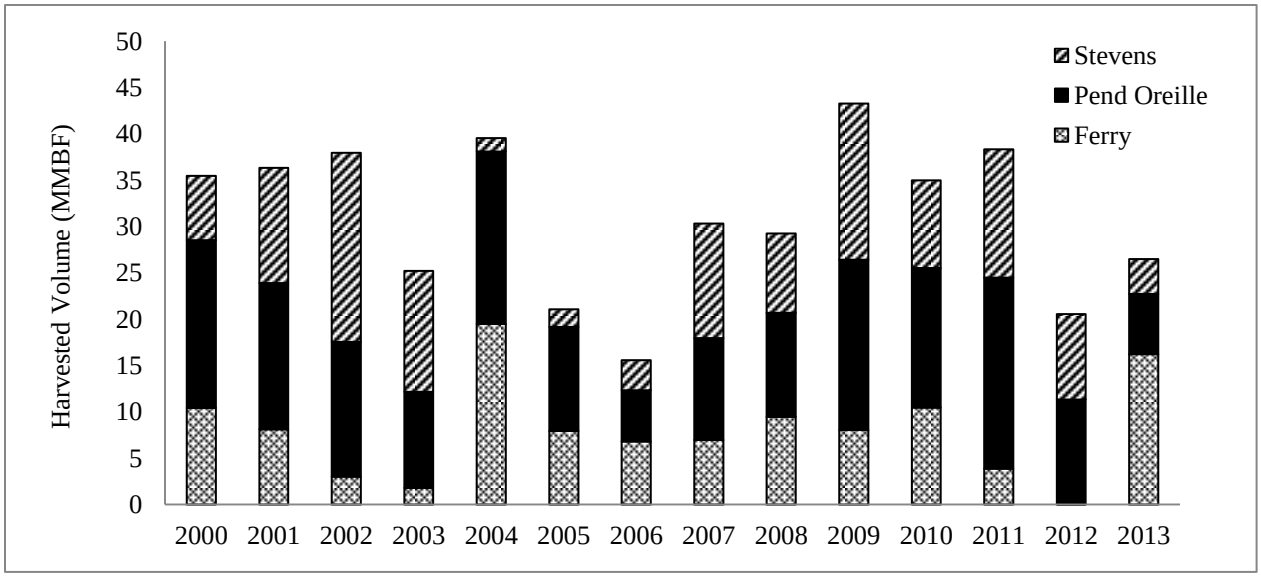


Figure 25. Timber volume harvested from federal lands by county within the Northeast region. The average harvest from federal lands in the Northeast region was 31 million board feet per year. The allowable cut from federal lands in this region is approximately 147 million board feet per year.

State Timber Harvest

Since 2000, an average of nearly 39 MMBF of timber products has been harvested annually from Washington State lands within the NE study region with a consistent average increase in total harvest levels since 2000 (Figure 26). As a result of statewide surveys showing the increased threat to State forests from insects, disease, and wildfire (DNR 2012b; DNR 2007) the DNR established an annual statewide allowable harvest level of 550 MMBF for the ten year period from 2005 to 2014. Specific data on allowable harvest volume for the NE region were not available; however, for the period of 2014 to 2017, the Washington DNR has forecasted a total of 2,164 MMBF to be harvest from all state lands (Smith 2013).

Since 2000, eastern Washington counties have accounted for approximately 11.8% (82.5MMBF) of the annual statewide harvest from State lands. During this time period, the NE region has contributed approximately 47% (39 MMBF) of this total harvest volume. If these trends continue, under the assumption of a total statewide harvest volume of 2,164 MMBF from 2014 to 2017 (Smith 2013), the approximate harvest volume produced from State lands within the NE region would likely be near 156 MMBF (39 MMBF per year) or 7% of the forecasted future harvest. Harvest volume for Stevens County has provided a substantial volume of the harvested during the period of 2000 to 2013 (Figure 26), while Lincoln and Ferry Counties have provided infrequent volumes, likely due to the dominance of federal land ownership within these Counties.

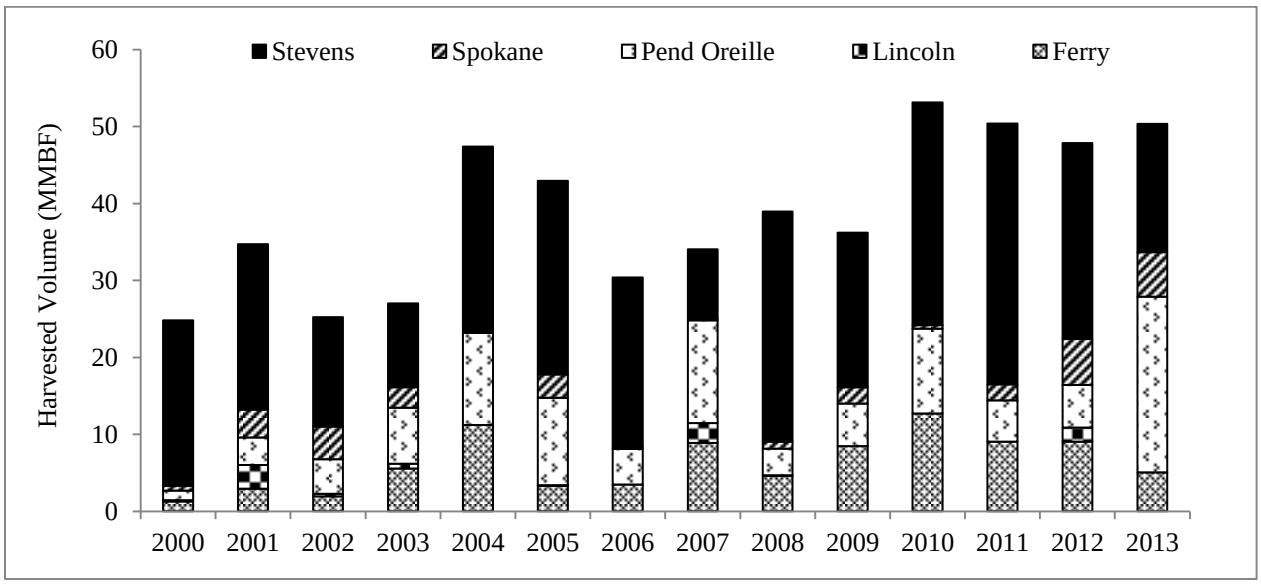


Figure 26. On average the Washington State Department of Natural Resources timber harvest volume in the Northeast region is approximately 38.8 million board feet per year, with an average annual increase of two percent per year during the period of 2000 to 2013.

Tribal Land Timber Harvest

Approximately 52% of the Colville Reservation is located within the NE region. The Tribe's 2001 Forest Management Plan provided for an annual average harvest of 77.1 MMBF from 2000 to 2014 for a total of 778.6 MMBF. From 2000 to 2009, 765.8 MMBF (98.4%) of the planned total volume was harvested (Figure 27). This was in part, a result of insect and disease forest

mortality and wildfire salvage. On average the Colville Reservation harvests approximately 12% of the volume within the NE region (Figure 24).

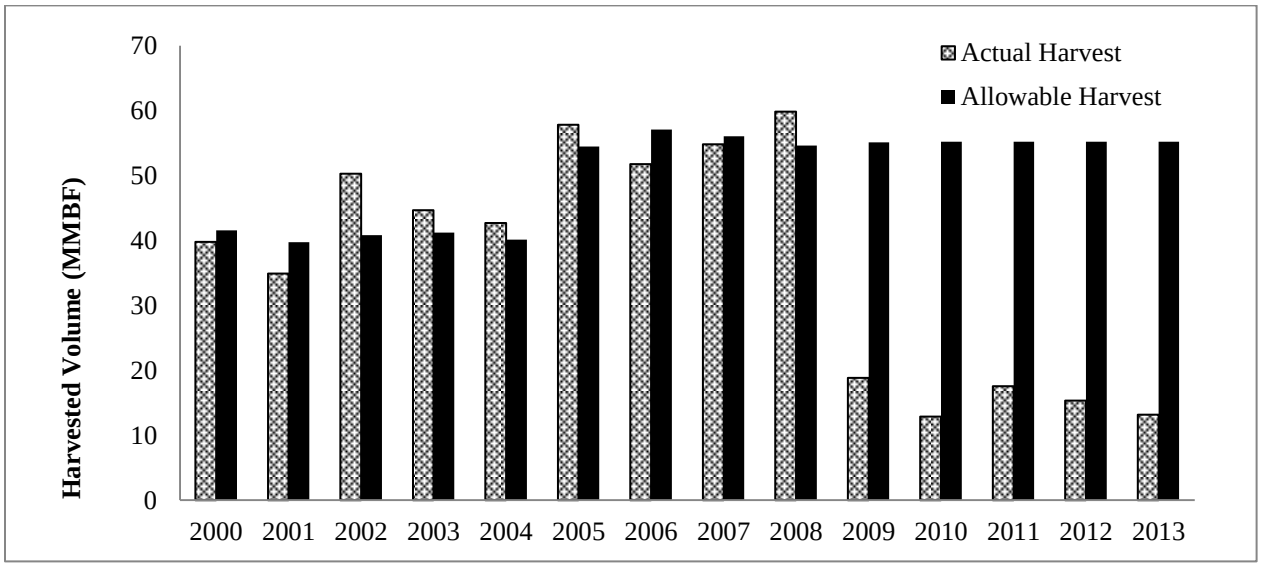


Figure 27. Allowable timber harvest volume compared to actual volume harvested for the portion (52%) of the Colville Tribe in the Northeast region and the Spokane and Kalispell Tribes. On average the allowable tribal harvest in the Northeast Region is 50 million board feet per year while the actual harvest is 37 million board feet per year.

Private Land Timber Harvest

Industrial Private Forest Lands

Harvest from the forest industry in the Northeast region is the third-largest timber source in this study area. Target harvest levels are difficult to estimate for the industrial sector, as this is a rapidly changing demographic with closely held inventory data. Many of the Industrial Private Forest owners are Real Estate Investment Trust (REITs) or Timber Investment Management Organizations (TIMOs) managing lands for investors on a 10 to 15 year cycle.

Harvest activity on IPF lands for the NE region during the market recession of 2007/2011 showed a dramatic decline as a result of falling log and lumber prices (Figure 28), however, harvest activity has begun to increase for all Counties since 2010. The prediction of future harvest levels is difficult to estimate for the IPF sector, as there is a rapidly changing demographic among managers and owners, and inventory data is not commonly available. The average volume harvested from IPF lands during the assessed period was approximately 42 MMBF per year.

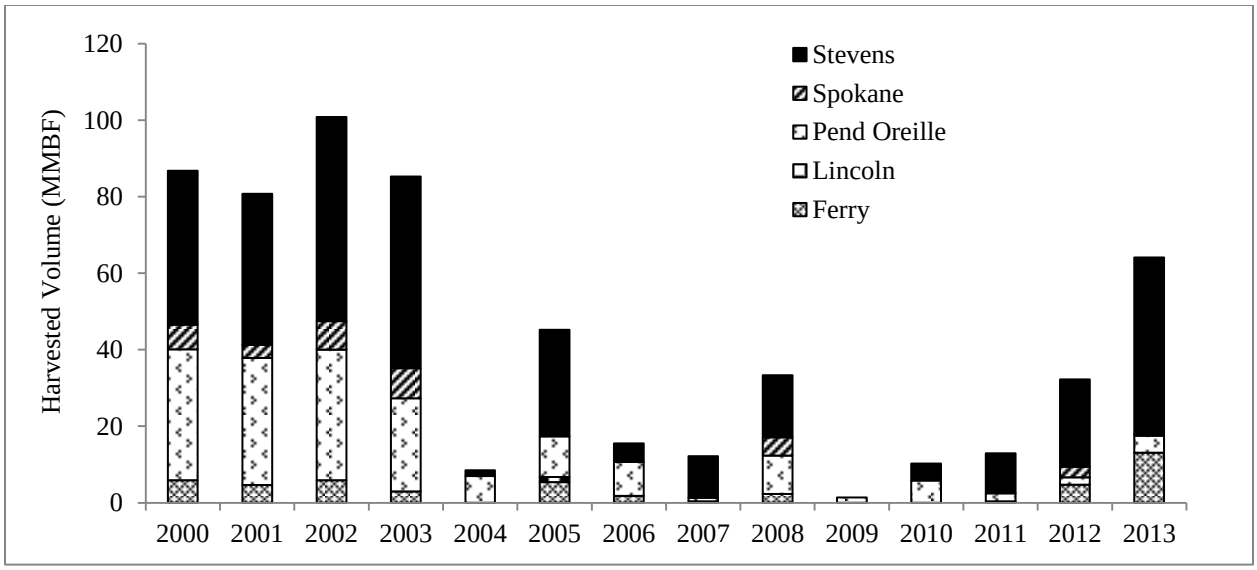


Figure 28. Industrial private forestland timber harvest volume in the Northeast region averaged 42 million board feet annually between 2000 and 2013.

Non-Industrial Private Forest Lands

Within the NIPF sector, log market values have the strongest influence on the annual level of harvest. This can produce abrupt changes in annual harvest levels as shown in 2008 and 2010 (Figure 29). Harvest levels for both Kittitas and Yakima Counties have remained low following the recession of 2008 through 2012. Similar to the IPF timber harvest estimates, NIPF harvest volumes can be difficult to establish due to a lack of consistent data. The available data showed that from 2000 to 2013 the average harvest from NIPF lands within the NE region was approximately 149 MMBF per year (Figure 29).

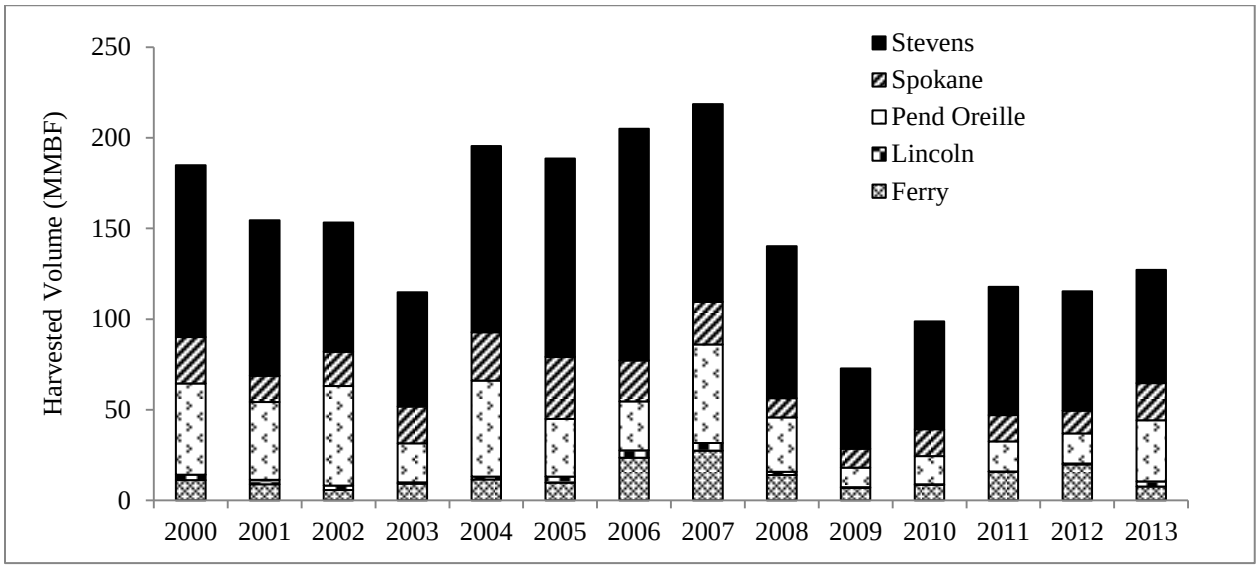


Figure 29. Non-industrial private forestland timber harvest volume in the Northeast region averaged 149 million board feet annually between 2000 and 2013.

Northeast Region Timber Harvest Summary

The NE region has an estimated allowable timber harvest of 427 MMBF per year across the five ownership classifications. This estimate is approximately 129 MMBF greater than the average volume actually harvested per year as calculated for the period of 2000 to 2013 (Table 15 and Figure 24) using the following assumptions: 1) available harvest volumes for IPF and NIPF are equal to the 14-year average of harvest from 2000-2013; 2) the SC study region harvest volume will not deviate from the historic trend moving forward and can therefore be estimated from the 2014-2017 projected DNR statewide harvest, and; 3) allowable federal harvest is estimated as *'achieving'* the allowable cut for the National Forest lands within the region and portioned by percentage of National Forest within the region. Actual federal harvest is determined from data reported by the counties within the NE region.

Total harvest within the NE region was dominated (50%) by NIPF landowners (Table 15 and Figure 24). The NIPF, IPF, and Washington State allowable harvest volumes are shown as being nearly equal to actual harvest volume as a result of limited or unavailable data to support analysis of differing allowable harvest levels. Allowable federal harvest within the NE region is 34% (146.8 MMBF), however actual harvest is only 10% (approximately 31 MMBF) of the total volume for this region (Figure 24) representing an approximate 116 MMBF gap in management on the National Forest lands within the NE study region.

Summary of Available Biomass by Landowner

The eastern part of Washington has a considerable amount of forest biomass that consists of both standing inventory and what is produced during active harvest operations. Biomass generated as part of a timber harvest process consists of tops, live/dead branches, foliage and stem segments including breakage and defect. This information was provided in the Washington Forest Biomass Supply Assessment Report (Perez-Garcia et al. 2012), prepared for the DNR by University of Washington. Current statewide biomass utilization is estimated at 498,500 BDT (Perez-Garcia et al. 2012), with 18.2% (approximately 90,727 BDT) being attributed to eastern Washington following the trends of timber harvest records. For Example, the NE region averages approximately 45% of the total annual timber harvest volume for eastern Washington; therefore 45% (40,779 BDT) of the produced biomass in eastern Washington is assumed to come from the NE region. This estimated current annual production of biomass within the NE region (40,779 BDT) contrasts with the Washington Biomass Calculator (UW 2015) showing estimates of 799,575 BDT (1,599,150 GT) of potentially available biomass annually within the NE region (Table 16).

If restoration activities are able to treat the total acres identified within the NE region (84,500 annually) the available biomass as shown by the Washington Biomass Calculator (799,575 BDT) would overwhelm existing infrastructure, as it would represent an increase of 20 times the current total utilization within this region. The significance of this can be shown through the cost of investments in infrastructure that would be needed to enable production of electricity through utilization of biomass, which has been estimated at $3.2 to $3.4 million per megawatt (MW). One example of these investments would be the establishment of a co-generation facility that could utilize the total modeled biomass within the NE region (1,599,150 GT). This would require

the production of approximately 183 MW of power and require a $604 million investment in order to use approximately 4,381 GT per day of biomass annually (Cantrell 2015).

The cost of production related to processing and transport of biomass ranges from $16 to $35 BDT (Perez-Garcia et al. 2012). Transportation costs of $70 to $115 per hour and move-in and move out costs ranging from $700 to $1100 per operation (Perez-Garcia et al. 2012) must also be factored into cost calculations. For markets located within 60 miles haul distance one way, the total cost to harvest and deliver the product to the facilities generally ranges from a minimum of $25 GT to a high of $34 GT. Biomass often requires more handling than pulpwood sometimes requiring on-site chipping, this in combination with longer haul distances, makes this product too costly to deliver to some markets. A study conducted by TSS (2009) in 2009 identified the cost per BDT to harvest and deliver timber residuals varied between $47 and $56 BDT for a 40 mile one-way haul. In 2010 the market could have sustained a production of 1.3 million BDT at a price of $100 BDT ($50 GT) (Perez-Garcia et al. 2012). This price without subsidies will be difficult to attain as current pulpwood prices in eastern Washington average between $25 GT ($50 BDT) and $33 GT ($66 BDT).

Current market conditions for biomass throughout the Pacific Northwest as a whole are poor to non-existent, and further impacted by low market prices, representing the dominant barriers to the use of and investment in biomass. This is consistent with the observed trends in alternative energy sources for more than a decade, despite investments in other alternative energy such as wind and solar. During this same time, the pulpwood market in general has experienced a considerable swing in prices ranging from lows of $22 GT (~$44 BDT) to $60 GT (~$130 BDT). The demand for renewable energy and biofuel is expected to rise due to increasing interests in bio jet fuels (Perez-Garcia et al. 2012) among other products. The Northwest Advanced Renewables Alliance (NARA) is helping to develop a sustainable industry in the Pacific Northwest using wood residuals to make bio jet fuel. NARA will be producing approximately 1000 gallons of cellulosic based bio jet fuel from tree limbs and branches and is working with Alaska Airlines to complete a demonstration flight in 2016 using this fuel which may present additional opportunities for biomass in the future.

Regional Biomass Modeling and Results

One of the accomplishments of the Washington Forest Biomass Supply Assessment report was the development of a biomass database that is spatially explicit and contains a rich set of alternative forest management operations across the diversity of owner groups and forest types in the state of Washington. The database created for the assessment is accessible through a web based portal for individual use (http://wabiomass.cfr.washington.edu/). NMI utilized this web-based portal to generate custom biomass reports for each study identifying the existing facilities (Table 16). The customized reports display BDTs of scattered biomass, roadside biomass (*harvested biomass*), and market biomass. The definitions of the different products produced in the Biomass Calculator are:

> ***Scattered biomass -*** *The volume that was left scattered in the woods as a product of having been broken off or tops and limbs cut when commercial logs were yarded to the landing was noted as residual harvested volume (Perez-Garcia et al. 2012).*

Roadside biomass *- (harvested biomass)-The biomass that was brought to the landing along roadside was calculated and recorded in the biomass database as harvested biomass (Perez-Garcia et al. 2012).*

Market biomass *- was the portion of the potential market biomass that actually was loaded on a truck and the accounting was complete when the volume of biomass reaching the market was recorded (Perez-Garcia et al. 2012). This was the volume used to identify the total available biomass in each region.*

Table 16. Summaries of the University of Washington Biomass Calculator (UW 2015) model output showing input parameters for the Northeast study region scenario evaluating existing facilities only. Biomass production was based on the number of existing facilities at a price of $45 bone dry ton. The model estimates were greater than those of Perez-Garcia et al. (2012) who estimated between 439,000 and 558,000 BDT of biomass would be delivered to facilities across eastern Washington during 2010.

Run: Average Statewide Harvest

Year: 2020

Geography: County

Geographies: Ferry (10), Lincoln (22), Pend Oreille (26), Spokane (32), Stevens (33)

Facilities: Colville: Existing, Kettle Falls: Existing, Lewiston: Existing, Usk: Existing, Wallula: Existing, Winton: Existing

Cost: Medium

Price: $45

Max Haul Time To Facility: 240 minutes

Reporting Fields: County, Owner Class

Field Options: Names

County	Owner Class	Scattered Biomass (BDT)	Roadside Biomass (BDT)	Market Biomass (BDT)	Residual Value ($)
Ferry	Federal	39,250.96	41,134.69	20,023.85	$145,748.16
Pend Oreille	Federal	79,466.39	74,882.62	43,521.53	$152,204.23
Stevens	Federal	54,117.65	55,435.22	32,532.44	$219,921.34
Pend Oreille	Municipal	673.6	1,165.14	948.88	$5,419.50
Stevens	Municipal	157.11	263.42	192	$88.00
Ferry	Private	28,994.49	34,057.12	24,678.85	$105,259.89
Pend Oreille	Private	165,412.80	223,083.26	146,145.97	$905,062.02
Spokane	Private	43,260.00	61,875.39	41,439.86	$149,245.83
Stevens	Private	321,090.20	378,937.65	269,674.30	$1,471,698.87
Ferry	State	16,047.80	21,206.49	13,764.51	$70,755.79
Pend Oreille	State	21,965.92	29,081.79	20,803.18	$140,432.08
Spokane	State	5,242.95	7,457.50	5,481.14	$28,830.05
Stevens	State	67,772.51	82,892.41	54,201.20	$383,941.37
Ferry	Tribal	146,098.50	109,897.63	92,841.12	$349,265.74
Stevens	Tribal	47,653.80	39,645.00	33,325.87	$67,746.57
Total				799,575	$4,195,619

Existing Processing and Manufacturing Infrastructure

Sawlog Consumption

Sawlogs are the primary feedstock for the mills located in the NE study region. The products produced from sawlogs include dimensional lumber and boards. Peeler logs are also common, which are utilized to produce plywood and veneer products. There are six sawlog and peeler processing facilities within the NE study region. A summary of each facility follows and annual processing volumes are presented in Table 17.

Boise Cascade Wood Products, LLC

Boise Cascade is classified as a large corporate mill based out of Kettle Falls, WA. Boise operates three facilities in Stevens County (Kettle Lumber, Arden, Kettle Plywood) which produce dimensional lumber, appearance-grade boards, and plywood. Boise Cascade's total log consumption is 117 MMBF

Kettle Falls Lumber – procures primarily 11-inch and lager ponderosa pine and lodgepole pine saw logs.
Current log usage - 22 MMBF
Location: Kettle Falls, WA. Stevens County

Arden Mill – procures primarily 6 through 12-inch ponderosa pine and lodgepole pine saw logs.
Current log usage - 25 MMBF
Location: Arden, WA. Stevens, County

Kettle Falls Plywood – procures Douglas-fir and western larch peeler logs.
Current log usage - 70 MMBF
Location: Kettle Falls, WA. Stevens County

Columbia Cedar

Columbia Cedar is a small privately owned company located just north of Kettle Falls, WA along the west bank of the Columbia River. Columbia Cedar deals exclusively with western red cedar products.
Purchase - western red cedar saw logs for boards, decking and siding.
Current log usage - 16 MMBF
Location: north of Kettle Falls, WA. Ferry County

Vaagen Brothers Lumber, Inc.

Vaagen Brothers Lumber is a privately-owned company with facilities in Colville (Stevens County) and Usk (Pend Oreille County), WA. Vaagen Brothers produces mostly stud boards from various species.
Purchase - saw logs to produce stud boards with the majority of their species being Douglas-fir, western larch, hem-fir, and ponderosa pine. In addition to sawlogs, both facilities process "hew wood" logs to produce stud boards from small-diameter logs with small-end diameters down to 4.5 inches. In addition, Vaagen Brothers also processes pulp logs at both facilities. These products are purchased by the ton.

Usk mill log usage – 37 MMBF (includes hew wood volumes converted to MMBF)

Colville mill log usage – 97 MMBF (includes hew wood volumes converted to MMBF)

Table 17. Northeast Study Region – Sawlog Consumption

Mill Name	Annual Log Usage (MMBF)
Boise Cascade – Kettle Falls Lumber	22
Boise Cascade – Arden Mill	25
Boise Cascade – Kettle Falls Plywood	70
Columbia Cedar	16
Vaagen Bros – Usk	37
Vaagen Bros – Colville	97
TOTAL	267

Small Diameter Sawlogs and Pulpwood Products

Small diameter harvests and restoration products include sawlogs with diameters smaller than 11 inches and chip-wood logs. Such products are often associated with restoration because they are harvested from improvement cuttings which take place in overstocked stands where individual tree competition limits diameter growth and overtime degrades stand health. Within the NE study region approximately 290,000 tons of pulp wood and small-diameter logs are processed annually, with the potential for 700,000 tons at full capacity (Table 18).

The NE study region has three facilities which process small-diameter logs in the form of "hew wood" and pulp logs. Vaagen Brothers Lumber, Inc. operates two facilities which process both hew wood logs and pulp logs at a rate of approximately 600,000 tons per year between both facilities (Colville – 460, 000; Usk – 140,000). These volumes are included in the total MMBF volumes presented in Table 17. Additionally, Vaagen Brothers has processed, on average, approximately 90,000 tons of pulp wood between the two facilities since 2012 and has a total pulp wood processing capacity is 500,000 tons per year.

Resolute Forest Products (Ponderay Newsprint) operates a facility in Usk, WA, where they purchase pulp logs to augment their mills residuals (chips) which are converted to paper products (primarily newsprint). Resolute began taking pulp wood at their facility during 2014 and are now operating an on-site chipper to process purchased round-wood. Prior to this, pulp log shipments were received and chipped at different locations and then transported to the Usk facility. Resolute Forest Products procures approximately 200,000 tons of pulp logs annually.

Table 18. Northeast Study Region –Small Diameter Log Consumption

Mill Name	Annual Log Usage (Tons)
Resolute Forest Products (Ponderay Newsprint)	200,000
Vaagen Brothers Lumber, Inc. – Usk and Colville	90,000*
TOTAL	290,000

* The Usk and Colville mills have a 500,000 ton maximum combined total capacity.

Biomass Processing by Existing Sawmill Facilities

Sawmills typically separate their clean chips from their bark and sawdust. Clean chips and sawdust are sold to paper mills and can be a significant source of revenue for sawmills located within short haul distances, thereby minimizing the costs of transportation. Bark residuals are often used in boilers to generate steam and operate facility processes such as kilns or power generation. The six sawmills in the NE region process 298 MMBF annually. Using the lowest estimated average BDT per harvested thousand board feet (MBF) conversion factor for 2015, of 0.81 (Perez-Garcia et al. 2012), this region could potentially produce 241,380 BDT of biomass annually from harvest operations alone. Presently the NE region markets approximately 40,950 BDT and it is unlikely that additional biomass will be used without subsidies or cost share opportunities.

Many biomass contractors estimate that an average of 61% of woody biomass created from harvest or treatment operations can be recovered (Perez-Garcia et al. 2012). Expectations of biomass recovery range from 39% to 61%, however modeling has shown that only a fraction of the biomass produced during harvest (47%) would be transported from the forest and that only 14% of post-timber harvest biomass was successfully marketed (Perez-Garcia et al. 2012).

The primary biomass processing facility is the NE study region is the Kettle Falls Biomass Generating Station operated by Avista Corporation. This facility, established in 1983, was the first electric generator of its kind within the U.S. with the sole purpose of producing electricity from wood waste (Avista). The facility can produce 53 MW of electricity and utilize approximately 70 GT of wood waste (or “hog fuel”) per hour at full capacity. The facility was operating at full capacity during its involvement in the Biomass Crop Assistance Program (BCAP) which began in 2009; however, biomass deliveries were significantly curtailed when the program funding ceased in 2012. Without subsidies for procuring biomass, the facility has been running at a significantly reduced capacity. BCAP was reauthorized by the 2014 Farm Bill; however, the Kettle Falls Generating Station is not currently an enrolled participant (USDA 2014). Additionally, energy generated from the plant is currently being used to help Avista meet the requirements of the Washington State Energy Independence Act (EIA) (Washington Department of Commerce 2014). The EIA has established targets for conservation and renewable energy calculated as a percentage of customer load, which increase over time, with the objective of reaching 15% of supply by 2020 (RCW Title19 Chapter 19.285.040).

Additional biomass processing facilities in the NE region include Vaagen Brothers Lumber (Colville) and Vaagen Brothers Lumber (Usk). These mills both have boiler systems which primarily operate from on-site mill residues (sawdust). The amount of biomass they purchase on the open market varies and is dependent on other sawmill residuals and the cost of natural gas.

Boise White Paper operates a pulp mill in Wallula, WA (along the Columbia River) and incorporates the use of biomass into milling equipment operations. The current biomass use-capacity is estimated at 680,000 BDT annually with approximately 80% of supply coming from round wood pulp. Boise White Paper is currently one of 36 facilities enrolled in the BCAP assistance program and the only facility within the State of Washington (USDA 2014). The primary function of BCAP funding is to assist in the cost of transporting raw biomass to the facilities.

Ecological and Infrastructural Restoration Need

The acres in need of restoration in the NE region within the Anchor Forest pilot generated by the TNC and USFS for the Tapash and North Central Washington Forest Collaboratives are presented in (Table 14). Within the NE region the Readily Accessible (<45% slope) acres could be prioritized as the first treatment areas since they are expected be easier to access. Completing the readily accessible acres only would leave approximately 117,000 operable acres untreated. This assessment evaluated the level 'Target' treatments would need to be applied in order to meet restoration needs on the identified operable acres within a 15 year time period given the current treatment levels. The Target acres were then estimated with the objective of treating 100% of the identified Operable acres in 15 years or less based on (Haugo 2015) and current federal forest health conditions for eastern Washington (USDA 2015).

Harvesting Capacity and Capability

Increasing the current annual harvest of 298 MBF by 70 MMBF as discussed previously, would result in a 23.5% increase in sawlog harvesting and potentially generate an additional 56,700 BDT (113,400 GT) of biomass. By increasing the number of acres treated by 14,035 and generating an additional 70 MMBF there would be a need for an additional 34 log trucks to deliver product to existing facilities. The additional trucking need was calculated using the estimated weight of 70 MMBF (476,000 GT, using a conversion of 6.8 tons per MBF) and the ability of a truck to haul 3 loads per day (rate of approximately 81 GT per truck per day) multiplied by 170 average annual working days (13,770 GT per year).

Capital expenditures to build additional harvesting capacity to recover biomass are estimated at $18 GT for ground based systems (stump to on-board truck). This is based on a total equipment cost of $8,568,000 (annual production of approximately 476,000 GT), using average logging conditions for the western U.S. (Barynin et al. 2013). Biomass harvesting is most cost efficient when combined with sawlog harvest operations where sawlogs, pulp and biomass are removed in one entry thereby minimizing transportation and operation costs. Costs are expected to be greater if biomass is harvested as a separate product.

The capital investment required to harvest an additional 113,400 GT (56,700 BDT) of biomass from the proposed increase in treatment acres (14,035) is approximately $2,041,200. The capital investment required to harvest the maximum-predicted supply of biomass within the NE region as modeled using the University of Washington Biomass Calculator 1,599,150 GT (504,598 BDT) would be approximately $28,784,700. If expansion and renovations are conducted at the existing facilities in order to utilize biomass for heat, kiln-drying, or co-generation power production, there is potential for a significant volume of biomass to be used. However, as of this assessment current market prices for power within the Pacific Northwest provide little to no financial incentive to invest in this type of facility infrastructure. Under the present market conditions encouraging investments in biomass utilization will likely require subsidies, tax incentives, and potentially policy/legislative changes to make them attractive to a broad audience.

The cost of management to prepare the additional acres needed for restoration (14,035 acres per 70 MMBF) ranges from $66 to $71 per MBF for actions on State-managed lands within Washington totaling between $4.6 and $4.97 million (IFMAT 2013). Based on USFS cost per

MBF it was calculated that preparation costs for federal lands on the same number of acres/volume would range from $10.5 to $15.4 million using the $150 per MBF National USFS average or the $220 per MBF USFS Region 1 average (IFMAT 2013). For forest health projects on NIPF lands targeting fuel reduction treatments and forest health improvements in eastern Washington, the DNR costs ranged from $899 to $1085 per acre from 2009 to 2013 when federal cost-share funding was available (Mason et al. 2008).

Transportation Infrastructure

The transportation infrastructure of the NE region is currently handling the harvest production on approximately 70,465 acres. An increase in harvest on 14,035 acres that produces 70 MMBF would require an additional 34 log trucks (17,629 loads) to deliver sawlogs, and an additional eight trucks to accommodate the increased biomass generated totaling an estimated 4,200 truckloads. Therefore, restoration efforts on the 14,035 acres would require 42 additional trucks delivering approximately 21,829 truckloads on the existing transportation system network. This would most likely require additional maintenance and repair on the highways and county roads within the region, but also increases the tax base, employment opportunities, and the economic base within these counties.

To address the total available biomass modeled within the region (799,575 BDT) it would require approximately 59,000 truckloads (13.5 BDT per log truck) and an additional 116 trucks working 170 days a year if they could deliver three loads a day. This volume of biomass is not expected to be utilized in the near future and would require significant investment in infrastructure. As an example, the capital investment to start up the 34 additional trucks needed to treat 14,035 acres is estimated at $5.95 million ($175,000 per truck) equaling an average cost of $2.50 per ton over a five-year amortization timeframe. To adequately address an increase of 56,700 BDT (113,400 GT) of biomass would require capital investment in eight additional trucks, not including the added expenses of fuel, operating expenses, permits and the cost of other regulatory requirements. Anticipated wages for a total of 42 additional trucks, driving ~66,000 miles year and earning $33,404 in 2008 dollars (Mason et al. 2008), would be approximately $1.4 million.

Transportation efficiency can be increased through implementation of trucking logistic concepts that support the log supply chain such as a central dispatch. This practice has been widely implemented in forest regions around the world and has recently been established in North Central Washington through collaborative efforts involving multiple private industry stakeholders within the natural resource sector. The Central Dispatch methods are being used to manage log flow, build contractor relationships, and increase the efficiency and profitability for individual trucks and drivers (Sessions et al. 2015). The Central Dispatch operation has provided an opportunity to move more volume more efficiently with fewer trucks and reduce fuel consumption, wear, and maintenance need for trucks and roadways.

Processing and Manufacturing Infrastructure

The current sawmill processing capacity within the study area utilizes approximately 267 MMBF of sawlog volume annually. There is 298 MMBF (Table 15) being harvested within this region and the remaining volume is processed outside the region. Most mills stated they could increase processing capacity by 10 to 30% if the timber supply was available. The existing processing

facilities are anticipated to fully process the estimated additional volume of 70 MMBF from proposed treatment of 14,035 acres annually within the NE region.

To establish a small mill that could utilize a larger range of diameters, process lower-volume (less than 50 MMBF) and use mixed species to cut specialty products would be between $1 and $1.5 million dollars per MMBF. Sight specific prices for the NE region have been estimated at between $25 and $36 million to establish a mill able to process 25 MMBF annually (Cantrell 2015).

Additional benefits of building a new facility would be gained through the addition of an on-site co-generation facility to utilize produced biomass for energy production. An estimated one GT of biomass is needed MW. The construction and operation of a biomass co-generation facility would cost between $3.2 and $3.4 million per MW. Studies conducted in eastern Washington have identified the requirement of a 16 MW plant, as a stand-alone operation, to sustainably compensate for the cost of extracting and delivering the needed quantity of biomass (Cantrell 2015). Fore reference, a state-of-the-art sawmill utilizing 40 MMBF would be able to produce enough biomass (sawdust) to sustain a six to seven MW facility.

The job opportunities for developing this type of infrastructure are based on both full-time and part-time employment with the acknowledgment that workers can have more than one job. It is estimated that 18 jobs, 10 in the forest products industry plus eight indirect and induced jobs in supporting industries are produced for each MMBF harvested and that these jobs produce nearly $528,000 in wages and more than $3.2 million in the sales of goods and services (Cook et al. 2015). Therefore, increasing production in the NE region by 70 MMBF would provide approximately 1,260 new jobs in the forest products industry, including indirect and induced jobs in supporting industries, and generate approximately $36.96 million in wages and $224 million in the sales of goods and services. Job creation is not linear; this number is specific to the NE region which currently employs approximately 6,849 people in the forest products industry (Rogers 2013). The current number of employees for each region was used to estimate the additional jobs created.

Northeast - Opportunities, Barriers, and Recommendations

The restoration need assessment completed by Haugo et al. (2015) uses a combination of publically available data to make the determinations of forest restoration need supported by the USFS and aligning with the guidelines presented in the recent Farm Bill for identifying treatment areas. Additional analysis completed by several states employ the National Insect and Disease Assessment maps in order to identify similarly high-risk forest condition and designate areas in need of treatment, commonly on a 15 year timescale (Krist et al. 2014).

The total restoration need identified for the NE region within areas of 'operable acres' (Table 14) represent a total area of 973,000 acres. Current annual treatments within this study region are approximately 70,465 acres. At current treatment rates all landowners except the Forest Service (26 years) can treat the identified operable acres within 15 years, and several will complete treatments sooner (Table 14). At the proposed total target treatment level of 84,500 acres annually, restoration needs could potentially be completed for all identified operable areas across all ownerships within a 15 year time period.

Sawmill manufacturing infrastructure in the NE region is comprised of six facilities presently processing an annual volume of 267 MMBF and the ability to increase their capacity by 10 to 30% (30 to 89 MMBF). Currently this region produces 298 MMBF, of which approximately 31 MMBF (10%) is processed outside the five-county area. Additionally, transportation and milling infrastructure within the region is capable of maintaining current production levels within the NE region. The proposal of treatment on 14,035 addition acres annually would provide an increase of 70 MMBF (+23.5%) in harvesting activity and require approximately 42 additional trucks (17,629 loads per year) to maintain the transportation infrastructure. The capital investment for 42 trucks driving ~66,000 miles year and earning $33,404 in wages (2008 dollars, Mason et al. 2008), would be approximately $1.4 million with fuel, operating expenses, permits and the cost of other regulatory requirements being in addition to this initial investment.

Opportunities

- ✓ Many areas need to reduce over stocked tree densities and reduce biomass (fire fuels) in order to return the landscape to a more natural range of variability. An increase of 14,035 treatment acres provides an opportunity for local employment in the area and increases the economic sustainability of local communities. For example, increasing management activity on 14,035 acres that produces 70 MMBF will provide approximately 1,260 new jobs, including both indirect and induced jobs, generating approximately $36.96 million in wages and salaries, and nearly $224 million in the sales of goods and services. The proposed annual target treatment of 14,035 acres would also represent the first step toward management of the annually planned for and not harvested 129 MMBF in existing forest management plans for this study region (Table 15). The NE regions milling infrastructure including; small log, pulp, and biomass processing capacity may be in the best position to implement additional treatment acres.

- ✓ The NE study region has a well-developed forestry sector, with multiple milling/processing facilities that span the availability of sizes and types of harvest materials. This affords the NE region an increased flexibility to supply the current of future established biomass facilities. An increased interest and incentive to use biomass

has the potential to provide additional jobs, wages, and taxes to local communities while reducing wildfire fuel loads thereby, increasing safety and improving overall ecosystem function.

- ✓ Proposed target treatment levels provide an opportunity to begin addressing the current and increasing insect, disease, and wildfire conditions occurring across eastern Washington within the NE study region. Treatment of identified acres under the Anchor Forest concept would occur across ownership boundaries and therefore provide an example of landscape-scale management founded on ecological function, forest resilience, soil protection, water quality, and wildlife habitat as well as aesthetics, recreation, and economic support for local communities and human well-being.

Barriers

- ✓ Planning needs to look at how historical management has affected ecosystems, particularly with regard to fire exclusion on dry fire-prone landscapes such as those in the NE study region. This is critical in motivating restoration efforts because insect, disease, and wildfire impacts have increased significantly throughout the past few decades, impacting a significantly greater area than current management efforts on highly deteriorated lands are addressing.

- ✓ Nearly all landowners with the exception of the USFS, and to a lesser degree tribes, have been successful in achieving their forest planning objectives (Figure 24). The USFS inherently has challenges unique to its's role as a federal land management agency that impact forest planning and management activities. Recent research has identified some challenges unique to the USFS to be: frequent leadership turnover, a lack of leadership direction, inconsistent support for activities within the organization, excessive financial resource allocations to wildland fire, and individual personnel attitudes, values, and beliefs (Keele et al. 2006; ITC 2013; O'Toole 2007; GAO 2007; USDA Forest Service 2015).

- ✓ Public perception of forest management and the social license needed to plan and implement actionable restoration activities presents a barrier to correction of the landscape-scale ecosystem degradation occurring due to un-natural tree densities, the exclusion of fire, and increasing tree mortality. These deteriorated forestland conditions, if not corrected, will continue to fuel the already increasing frequency and severity of wildfires that have destroyed homes and wildlife habitat, impacted water resources, and altered entire ecosystems for decades into the future (Wu & Kim 2013; Franklin 1993; Franklin et al. 2008; Noss et al. 2006).

- ✓ Limited capital investments are expected for harvesting equipment and trucking needs estimated to accomplish restoration on the identified acres. These investments would be prior to and not include future maintenance costs associated with the use of existing facilities and infrastructure to accommodate an increased volume of approximately 70 MMBF annually.

- ✓ In addition to capital needed for harvesting and trucking, the cost of management to prepare timber harvest operations on the identified acres is significant ranging from $66 to $71 per MBF on State-managed lands and $150 to $220 per MBF on USFS Region 1 lands (IFMAT 2013). Forest restoration projects on private lands often target fuel reduction treatments and forest health improvements through the DNR with costs ranging from $899 to $1085 per acre (2009 to 2013) (Mason et al. 2008).

- ✓ Although there is a nearly limitless volume of biomass within the NE region the resources needed to address an estimated total of 799,575 BDT (1,599,150 GT) annually would require approximately 59,000 truckloads (27 GT per truck). To transport this amount of biomass would require an additional 116 trucks, working 170 days a year, delivering three loads a day. Existing biomass facilities will not likely be able to accommodate this volume of biomass due in part to limits in capacity as well as market constraints associated with harvest and transportation costs, making biomass produced products (electricity) less competitive in areas where sources such as hydropower are available. Therefore, it is unlikely that increased biomass within this region could be utilized in the near future without significant increases in production and supply incentives as well as the market value of generated products.

- ✓ The workforce demographic of the forestry sector is aging, and training and education for new and existing opportunities are limited throughout the State of Washington as a whole, regardless of study region.

- ✓ Forestland fragmentation and conversion to other use increases wildfire risk and the cost of wildfire suppression through increasing the complexity of the landscape in fire-prone ecosystems (Society of American Foresters 2009). Permanent forestland conversion away from working forests often leads to increased runoff and sedimentation, higher peak streamflow and loss of riparian vegetation, as well as an increased need for channel stabilization infrastructure. Forestland fragmentation as a result of conversion often decreases outdoor recreation opportunities increasingly important to the growing urbanized population. Forest that are fragmented generally have parcels too small to support investment in forest management and support of ecosystem processes (Society of American Foresters 2009). Similar to the workforce challenges described previously, this is a barrier to landscape-scale forest ecosystem management throughout the State of Washington, regardless of study region, and becomes more important within areas of greater population density.

Recommendations

- ✓ In order to combat the challenges of an aging demographic in the forestry sector programs that encourage and educate students on the importance of forestry and silviculture as well as teach the value of communication skills and the social license required for forestry are needed (Sample et al. 2015; Sharik et al. 2015).

- ✓ Proposed treatment levels are provided by ownership in Table 14; however the need for action is most significant on lands managed by the USFS as compared to all other ownerships. Targeting a treatment on USFS ownerships, focusing specifically on the

identified operable acres, will equate to an overall increase in management activity of nearly 69% from the current annual average in the NE region. Although this would represent a significant gain (6,962 acres annually), treatment of additional acres must be encouraged given the significant increases in tree mortality, insect and disease infestations, and wildfire over the past decade (Goldmark 2012; Ray et al. 2012; Tidwell 2015; Krist et al. 2014; USDA Forest Service 2014). Focusing on the 'Readily Accessible' acres identified within the USFS lands would omit approximately 117,000 acres from the total operable acres. The readily accessible areas are expected to provide easier to access for management operations and may provide future "previously-permitted" access locations where they are adjacent to the omitted 117,000 acres.

- ✓ Long-term contract commitments to active management and timber supply are necessary to encourage capital investments needed to outpace deteriorated forest ecosystem conditions across the State of Washington, regardless of study region. A minimum of 15 year supply agreements are needed to align with current research timescales of forest condition research (Haugo et al. 2015; Krist et al. 2014), and to amortize industry investments in infrastructure to encourage establishment of the infrastructure necessary to complete the restoration activities identified within the NE region. The lack of long term contracts and agreements supporting a sustainable and consistent timber supply is a barrier to the NE region despite this region having the greatest amount of established milling infrastructure and capacity as compared to the other two study regions.

- ✓ Increased efforts to restore forest and treat fuels are required to reduce federal expenses associated with fire suppression. A 2012 economic assessment from Oregon's Federal Forest Advisory Committee found that every $1.0 spent on restoration potentially avoids $1.45 in fire suppression cost (Rasmussen. et al. 2012). Calculating the positive net benefits of fuel reduction treatments on market and nonmarket values has provided estimates of per-acre value ranging from $606 for moderate to $1402 for high-risk forest land with higher values expected if the per acre economic values are tied to habitat protection, air and water quality protection, or carbon credits among other ecosystem services (Lippke et al. 2005; Skog et al. 2008).

- ✓ Monitoring is needed to evaluate applied practices and new opportunities that can sustain and expand activities that out-pace the currently increasing insect, disease, and wildfire impacts throughout eastern Washington and the West. Long-term project monitoring is required of many projects utilizing federal funding programs and, regardless of requirements, will help land managers gain a better understanding of ecosystem function and identify improvements that maximize efforts toward achieving desired conditions at the landscape-scale.

Summary

The east Cascades region of Washington State has experienced a reduction in sawmilling capacity over the past few decades and has a shortage of biomass facilities. These conditions represent a loss of forest management infrastructure and capacity available to support cross-boundary forest ecosystem management. When milling facilities and infrastructure are sparsely distributed within an area in need of forest management there can be substantial increases in product transportation and harvesting costs as well as decreased competitive bidding for timber resources and low market values for many products. These conditions lead to lost job opportunities and the reduction of an already limited workforce. However, the deteriorating conditions of many forestlands and the threat of increasing wildfire within the three study regions may encourage public participation and investment in efforts to sustain existing, and promote additional, infrastructure. Moreover, increasing public awareness of forestland conditions may present opportunities to develop education and actionable alternatives targeting conservation and restoration of desired ecosystem services, such as municipal water sources, clean air, recreation, wildlife habitat and public safety, in the face of a changing climate, and annually increasing wildfire frequency and severity.

South Central Study Region

Within the SC study region there are 2,356,000 forested acres with an estimated 450,000 operable acres (Table 6) at an increased risk of additional tree mortality and damage by insects, disease and wildfire within the next 15 years. There are currently three sawmills in this region processing and average of 203 MMBF annually, thereby providing 4,782 jobs and approximately $107.2 million in wages and $649.6 million in the sales of goods and services. An annual increase of 2,257[6] treatment acres, as recommended for Anchor Forests, would generate approximately 11 MMBF in forest products, 198 new jobs, $5.8 million in wages, and $35.2 million in produced goods and services. If current forest management within the region (43,743 acres per year) is increased by 2,257[6] acres annually it would require approximately 10 years to treat the SC's currently identified 450,000 operable acres across all ownerships.

With more than 1 million acres of forest land being impacted annually by insects and disease within the State of Washington (Krist et al. 2014; Tidwell 2015), and annual increases in the size and frequency of wildfire, >9.4 million acres burned nationwide in 2015 (NIFC 2015), an increase in annually treated acres beyond the recommended 2,257[6] for the SC study region will be required to keep pace with deteriorating forestland conditions. Currently, most mills within the SC region are operating at a reduced capacity of between -10% and -30%. This means there is potential to process an estimated additional 20 to 61 MMBF (203_{MMBF} * 10% and 30%) annually using currently established infrastructure.

If the milling capacity within the SC study region was increased by 30% this would equate to the production of an estimated 61 MMBF and the treatment of approximately 12,000[6] acres

[6] Approximate acres treated were calculated based on an assumption of 5,000 board feet of harvest per acre. The number of acres needing treatment and the timeline to address those acres will likely vary depending on actual on-ground timber volume per acre, local forest management capacities, and the spread of insect and disease tree mortality in future years.

annually. This would represent an additional 9,943[6] acres beyond the target acres identified for an Anchor Forest (2,257 acres), thereby increasing the target acres in Table 6 from 46,000 to 55,943 acres. To accomplish additional management on 9,943[6] acres, increases in silvicultural and timber-sale layout personnel will be required. Furthermore, processing any volume in addition to the Anchor Forest target of 2,257[6] acres (11 MMBF) would likely require some investments in harvesting, trucking, transportation system, and training/educational infrastructure as well as additional biomass utilization opportunities.

North Central Study Region

Within the NC study region there are 3,276,000 forested acres with an estimated 468,000 operable acres (Table 10) at an increased risk of additional tree mortality and damage by insects, disease and wildfire within the next 15 years. There are currently two sawmills in this region processing and average of 61 MMBF annually, thereby providing 1,015 jobs and approximately $32.2 million in wages and $195.2 million in the sales of goods and services. An annual increase of 7,008[6] treatment acres would generate approximately 35 MMBF in forest products, 630 new jobs, $18.5 million in wages, and $112 million in produced goods and services. If current forest management within the region (28,992 acres per year) is increased by 7,008[6] acres annually it will require approximately 13 years to treat the currently identified 468,000 operable acres across all ownerships.

The urgency of increased proactive forest management within eastern Washington is undeniable, and faces a myriad of challenges. The greatest potentially being; protection of forest ecosystems on federal lands in the NC study region due to nearly 50% (232,000 acres) of the identified at-risk forestlands are under USFS management. An increase in regional capacity and multi-jurisdictional ownership collaboration will be a critical part in keeping these forested lands green and resilient to wildfire in the face of increasing insect, disease, and climate constraints over the next 15 years.

With increase in forest mortality reaching new heights every year (Krist et al. 2014; Tidwell 2015), and annual increases in wildfire such as that during 2014 and 2015 (NIFC 2015), an increase in annually treated acres beyond 7,008[6] for the NC study region will likely be required to keep pace with deteriorating forest conditions. Currently, mills within the region are capable of processing an estimated additional 18 MMBF annually without significant increases in infrastructure due to operations at a reduced capacity of between -10% and -30%.

If milling within the NC study region was increased by 30% an additional 18 MMBF annually would equate to the treatment of only, approximately 3,600[6] acres. Based on current forest health conditions the Anchor Forest target for the NC study region is 7,008 acres (35 MMBF) therefore, an additional 17 MMBF of volume beyond the projected processing capacity of current infrastructure would be generated. Successful treatment of the Anchor Forest target acres annually could subsequently present a consistent 13 year supply of timber to support investment in new infrastructure such as a small sawmill (15 to 30 MMBF) or biomass facility. Achieving treatment of the Anchor Forest target (7,008 acres) for this study region would likely require investments in harvesting, trucking, and training; and, has the potential to incentivize investments in new processing/ milling infrastructure.

Northeast Study Region

Within the Northeast study region there are 1,808,000 forested acres with an estimated 973,000 operable acres (Table 14) at an increased risk of additional tree mortality and damage by insects, disease and wildfire within the next 15 years. There are currently five sawmills in this region processing and average of 267 MMBF annually, thereby providing 6,849 jobs and approximately $140.9 million in wages and $854.4 million in the sales of goods and services. An annual increase of 14,035[6] treatment acres would generate approximately 70 MMBF in forest products, 1,260 new jobs, $37 million in wages, and $224 million in produced goods and services. If current forest management within the region (70,465 acres per year) is increased by 14,035[6] acres annually, it will require approximately 12 years to treat the currently identified 973,000 operable acres. The need for increased proactive forest management within the NE study region will face many of the same challenges as the other study regions, the most crucial being that nearly 27% (261,000 acres) of the at-risk forestlands are under federal and/or tribal ownership where management has fallen short of planned and approved objectives, on average, every year for the past decade.

There is an urgency to 'act' among those who live, work, and recreate in the forests of eastern Washington. This urgency is based on increasing losses of forest sector jobs, renewable forest products, spiritually significant areas, recreational opportunities, and water quality as a result of conditions that promote insects, disease and ecosystem-replacing wildfire. Similar to the other study regions, as increases in forest mortality and wildfire reach new levels every year (Krist et al. 2014; Tidwell 2015; NIFC 2015), an increase in annually treated acres beyond the Anchor Forest target of 14,035[6] for the NE study region will likely be required to keep pace with deteriorating forest conditions. However, with many mills throughout this study region operating at an estimated reduced capacity of between -10% and -30%, there is an opportunity to process an additional potential 27 to 80 MMBF annually with increased use of currently established infrastructure.

If the milling capacity within the NE study region was increased by 30% this would equate to production of approximately 80 MMBF and the treatment of approximately 16,000[6] acres annually. This would represent an additional 1,965[6] acres beyond the target acres identified for an Anchor Forest (14,035 acres), thereby increasing the target acres in Table 14 from 84,500 to 86,465. To accomplish management on 1,965[6] acres that yields 10 MMBF in addition to the identified Anchor Forest target and estimated volume, the NE study region would not likely require significant increases in investments of personnel, harvesting, trucking, transportation system, or training/educational infrastructure.

In total, the annual treatment of identified target acres across all three study regions of this assessment will be required to address deteriorating forest health conditions. In order to accomplish this, the framework provided by Anchor Forests requiring multi-jurisdictional, cross-boundary participation, collaboration and management, will be key in achieving forest ecosystem function objectives. Within these treatments the opportunity to address landscape-scale ecological needs that improve the resilience of the forest and preserve biodiversity, soils, water quality, and wildlife habitat will help guide management activities that consider the aesthetics, recreation and infrastructure required to implement such activities and maintain working forests.

The Anchor Forest concept provides the framework to accomplish sustainable forest ecosystem management through a foundation focused on the triple bottom line of balanced social/cultural, economic, and ecologic forest ecosystem needs at a landscape-scale. Collaboratively implementing consistent treatment on the proposed 'target' acres presented in this assessment will begin to address currently deteriorating forest health over the next 15 years. Moreover, full utilization of existing infrastructure through the Anchor Forest concept can provide an opportunity to expand forestland management with minimal investment while incorporating a greater diversity of social/cultural perspectives, provide actionable economically sustainable management, and improve forest resilience and ecosystem services for future generations.

Literature Cited

Alderson, L.C., Jessup, E. & Casavant, K.L., 1997. *Transportation Characteristics and Needs of Forest Products Industries Using Eastern Washington Highways Economic Structure of the Industry*, Washington State University, Department of Agricultural Economics, Pullman, Wa.

Bare, B., 2002. Defining the Scientific Basis of Sustainability. *University of Washington, College of Forest Resources. Seattle, WA*, pp.1–10. Available at: http://faculty.washington.edu/bare/sus2.html [Accessed January 1, 2015].

Barynin, P. et al., 2013. *Wood Supply Chain Analysis: Special Market Analysis Study 2013*, Washington, D.C.

BIA, 2005. *Forest Management Plan - Yakama Reservation*, Yakama Agency Branch of Forestry and the Yakama Nation, Toppenish, WA.

Butler, W.H., Monroe, A. & McCaffrey, S., 2015. Collaborative Implementation for Ecological Restoration on US Public Lands: Implications for Legal Context, Accountability, and Adaptive Management. *Environmental Management*, 55(3), pp.564–577.

Cantrell, G., 2015. Personal communication with Gary Cantrell - President of Affiliated Timber Investment Conversion Advisors, Inc (ATICA).

Cook, P.S. et al., 2015. *Idaho's Forest Products Industry Current Conditions and 2015 Forecast*, Moscow, Idaho.

DNR, 2014. *Eastern Washington Forest Health: Hazards, Accomplishments and Restoration Strategy*,

DNR, 2012a. *Recommendations of the Forest Health Technical Advisory Committee to the Commissioner of Public Lands*, Olympia, WA.

DNR, 2012b. *Staff Report Forest Health Technical Advisory Committee*,

DNR, 2007. *Washington's Forests, Timber Supply, and Forest-Related Industries*, Seattle, WA: State of Washington Department of Natural Resources. Available at: http://www.dnr.wa.gov/publications/em_fwfeconomiclow1.pdf.

Flyod, D.W., 2002. *Forest sustainability: The history, the challenge, the promise*, Durham, NC: Forest History Society. Available at: http://foresthistory.org/Publications/Issues/floyd.html.

Franklin, J.F., 1993. Preserving biodiversity: species, ecosystems, or landscapes? *Ecological Applications*, 3(2), pp.202–205.

Franklin, J.F. et al., 2008. *The Case for Active Management of Dry Forest Types in Eastern Washington: Perpetuating and Creating olf forest structures and functions*, Olympia, WA: Washington Department of Natural Resources.

GAO, 2007. *A Cohesive Strategy and Goals Are Needed for Federal Agencies to Manage Wildland Fire Activities Effectively*, Washington, D.C.

Garland, J.J., 2013. *The changed forestry workforce: Issues, opportunities and the future*,

Goldmark, P., 2012. Declaration of Forest Health Warning - State faces serious Forest Health Problems and Wildfire Risk. *Washington State Department of Natural Resources*, p.1.

Haugo, R. et al., 2015. Forest Ecology and Management A new approach to evaluate forest structure restoration needs across. *Forest Ecology and Management*, 335, pp.37–50.

Haugo, R.D., 2015. *Tapash Forest Collaborative analysis of forest restoration needs and mechanical treatment opportunities*, Seattle, WA.

IFMAT, 2013. *Intertribal Timber Council: Assessment of Indian forests and forest management in the United States, Volume I*,

Ingalsbee, T., 2010. Getting Burned: A Taxpayer's Guide to Wildfire Suppression Costs. *FUSEE*, p.43.

ITC, 2013. *Fulfilling the Promise of The Tribal Forest Protection Act of 2004: An Analysis by the Intertribal Timber Council in Collaboration with USDA Forest Service and Bureau of Indian Affairs*, Portland, Oregon.

Keegan, C. et al., 2012. The “Great Recession” and the Western Forest Products Industry. In *Society of American Foresters*. Missoula, MT: University of Montana and the Bureau of Business and Economic Research, p. 23.

Keele, D.M. et al., 2006. Forest Service Land Management Litigation 1989-2002. *Journal of Forestry*, 104(4), p.7.

Krist, F.J.J. et al., 2014. *2013–2027 National Insect and Disease Forest Risk Assessment*, Fort Collins, CO.

Lippke, B., Robbins, A. & Mason, L., 2005. Applied Science and Technology Transfer for Avoided Costs and Protected Forest Values. In *International Conference on Transfer or Forest Science Knowledge and Technology*. Seattle, WA, pp. 15–23.

Littell, J.S. et al., 2010. Forest ecosystems, disturbance, and climatic change in Washington State, USA. *Climatic Change*, 102(1-2), pp.129–158.

Mason, C.L. et al., 2006. Investments in Fuel Removals to Avoid Forest Fires Result in Substantial Benefits. *Journal of Forestry*, 104(1), pp.27–31.

Mason, C.L. et al., 2008. *The Washington Log Trucking Industry: Costs and Safety Analysis*, Report to the Washington State Legislature. Washington State University. Seattle, WA.

NIFC, 2015. National Interagency Fire Center. *October 30, 2015*. Available at: https://www.nifc.gov/fireInfo/nfn.htm [Accessed October 31, 2015].

Noss, R.F. et al., 2006. Managing Fire-Prone Forests in the Western United States. *Frontiers in Ecology and the Environment*, 4(9), pp.481–487.

O’Toole, R., 2007. *The Perfect Firestorm Bringing Forest Service Wildfire Costs under Control*, Washington, D.C.

Perez-Garcia, J. et al., 2012. *Washington forest biomass supply assessment*, Available at: http://www.dnr.wa.gov/Publications/em_finalreport_wash_forest_biomass_supply_assess.pdf.

Rasmussen, M. et al., 2012. *National Forest Health Restoration An Economic Assessment of Forest Restoration on Oregon’s Eastside National Forests. In: Prepared for Governor John Kitzhaber and Oregon's Legislative Leaders.*,

Ray, L. a., Kolden, C. a. & Chapin, F.S., 2012. A case for developing place-based fire management strategies from traditional ecological knowledge. *Ecology and Society*, 17(3).

Rogers, L., 2013. Forest Industry Economic Impact in Washington State. , pp.4–5. Available at: www.wfpa.org.

Rogers, L.W., Cooke, A.G. & Comnick, J.M., 2012. Washington State Biomass Database.

Sample, V.A. et al., 2015. The Promise and Performance of Forestry Education in the United States : Results of a Survey of Forestry Employers, Graduates, and Educators. *Journal of Forestry*, 113(6), pp.528–537.

Schultz, C. a., Jedd, T. & Beam, R.D., 2012. The Collaborative Forest Landscape Restoration Program: A History and Overview of the First Projects. *Journal of Forestry*, 110(7), pp.381–391.

Sessions, J. et al., 2015. World Overview of Log Truck Scheduling and Opportunities for the Pacific Northwest. In *Central Dispact*. Kona, HI: Pacific Logging Congress, p. 43.

Sharik, T.L. et al., 2015. Undergraduate Enrollment in U.S. Natural Resource Academic Programs: Trends, Drivers, and Implications for the Future of the Profession. *Journal of Forestry*, 113(6), pp.538–551.

Sierra Nevada Conservancy, 2014. *Mokelumne Watershed Avoided Cost Analysis: Why Sierra Fuel Treatments Make Economic Sense*,

Skog, K.E. et al., 2008. Woody Biomass Supply from Thinnings to Reduce Fire Hazard in the U.S. West and Its Potential Impact on Regional Wood Markets. *Woody biomass utilization challenges and opportunities*, (Gao 2005), pp.3–14.

Smith, D., 2013. *Washington timber harvest resport 2013*, Olympia, WA. Available at: http://www.dnr.wa.gov/TimberHarvestReports.

Snover, A. et al., 2013. *Climate Change Impacts and Adaptation in Washington State: Technical Summaries for Decision Makers*, Seattle, WA.

Society of American Foresters, 2009. Loss of U.S. Forest Land - A Position Statement of the Society of American Foresters. , p.7.

Tidwell, T., 2015. USDA - Forest Service acceptance of Washington State lands at risk of insect and disease. *2400 (8097250)*, p.1.

Tidwell, T., 2014. USDA - Forest Service notification of State Governor ability to request land impacted by insects and disease. *2400/3400*, p.2.

TSS, 2009. *Wood Supply Assessment for Commercial-Scale Biomass Power Cogeneration and Biomass Utilization Projects in Central Washington*, Rancho Cordova, CA.

USDA, 2014. Farm Bill 2014: Biomass Crop Assistance Program. *USDA Release No. 0157.14*. Available at: http://www.usda.gov/wps/portal/usda/usdahome?contentid=2014/07/0157.xml&navid=NEWS_RELEASE&navtype=RT&parentnav=LATEST_RELEASES&edeployment_action=retrievecontent [Accessed December 7, 2015].

USDA, 2015. *Forest Health Highlights in Washington — 2014*, Seattle, WA.

USDA Forest Service, 2012. *Increasing the Pace of Restoration and Job Creation on Our National Forests*,

USDA Forest Service, 2014. Insect and Disease Area Designations. *Farm Bill - Section 8204*. Available at: http://www.fs.fed.us/farmbill/areadesignations.shtml [Accessed June 22, 2015].

USDA Forest Service, 2013. Land areas of the National Forest System. , FS-383, p.184.

USDA Forest Service, 2011. *National report on sustainable forests-2010*,

USDA Forest Service, 1989. *Okanogan National Forest Plan*, Available at: http://prdp2fs.ess.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5315031.pdf.

USDA Forest Service, 1999. *Roads Analysis: Informing Decisions about Managing the National Forest Transportation System.*, Misc. Report FS-643. Washington, D.C.: U.S. Department of Agriculture Forest Service.

USDA Forest Service, 2015. *The Rising Cost of Fire Operations: Effects on the Forest Service's Non- Fire Work*, Washington, D.C.

USDA Forest Service, 1990. *Wenatchee National Forest Plan*, Final Environmental Impact Statement - Wenatchee National Forest. Available at: http://prdp2fs.ess.usda.gov/Internet/FSE_DOCUMENTS/fsbdev3_053285.pdf.

USDOI, 2015. *Budget justifications and performance information fiscal year 2015: Wildland fire management*,

USDOT, 2012. Federal lands transporation program (FLTP). Available at: https://www.fhwa.dot.gov/map21/factsheets/fltp.cfm.

UW, 2015. University of Washington Biomass Calculator. Available at: http://wabiomass.cfr.washington.edu/ [Accessed November 11, 2015].

Vose, J.M., Peterson, D.L. & Patel-Weynand, T., 2012. *Effects of climatic variability and change on forest ecosystems: a comprehensive science synthesis for the U.S. forest sector*, Portland, Oregon.

Washington Department of Commerce, 2014. *Energy Independence Act: 2014 Renewable Energy for Washington Qualifying Utilities*, Seattle, WA. Available at: http://www.commerce.wa.gov/Programs/Energy/Office/EIA/Pages/EnergyIndependence.aspx.

WSDOT, 2009. Transportation Commission List of Highways of Statewide Significance.

WSDOT, 2014. *Washington State Rail Plan*, Washington State Department of Transporation, Olympia, WA.

Wu, T. & Kim, Y.-S., 2013. Pricing ecosystem resilience in frequent-fire ponderosa pine forests. *Forest Policy and Economics*, 27, pp.8–12.

Task 2 Report: Collaborative Forest Restoration Frameworks and the Anchor Forests Concept

Prepared for the:

Intertribal Timber Council

by

T. King and M. Corrao, Ph.D.

Northwest Management, Inc.

January 2016

(This page intentionally left blank)

Introduction

Currently forest health throughout the western U.S. is in decline due to fire exclusion, insect infestations, disease outbreaks, and a lack of active forest management (Krist et al. 2014). National wildfire suppression policies and litigation, predominantly on National Forest System (NFS) lands against the U.S. Department of Agriculture Forest Service (USFS) regarding forest management (Keele et al. 2006), have led to homogenous over-stocked forest conditions across much of this landscape (Weber 2003; Lippke et al. 2007; IFMAT 2013). The disadvantages associated with these homogeneous conditions are founded in the density of trees, accumulation of fire fuels, and a domination of tree species increasingly more susceptible to insects and disease and less resistant to wildfire (Ingalsbee 2010; Ray et al. 2012). Moreover, these conditions and threats are further amplified by the influences of a changing climate (Vose et al. 2012). Across the Northwest and particularly within eastern Washington, actions to reverse or mitigate these threats have been largely unsuccessful as shown by increased tree mortality and annual increases in wildfire size and severity (Millar & Stephenson 2015; Krist et al. 2014).

Recent recommendations by the Washington State Department of Natural Resources (DNR) have focused on increasing forest restoration across multiple ownerships, improving markets for small-diameter wood, and improving workforce capacity and expertise, while developing collaborative relationships among forest landowners and other stakeholders (DNR 2014). Similarly, a number of collaboratives have identified treatment goals targeting forest health restoration such as; reduce and redistribute forest density either through mechanical thinning or prescribed fire or a combination of both; increase the occurrence of large-diameter trees in various forest types across the landscape, transition to late successional forest structure through a combination of mechanical treatments and controlled burning; and allow maturation of stands to transition from early and mid-aged forest structures to late-successional forest structures through passive management (Haugo et al. 2015; USDA Forest Service 2007; Schultz et al. 2012; O'Laughlin 2013). Despite these goals forest health across much of eastern Washington has continued to decline, and the frequency and severity of wildfire has continued to increase (Goldmark 2012).

The objectives of this report were to assess the governance structures as well as opportunities and barriers used in a number of large-scale collaborative forest restoration examples within the western U.S. and include examples from each of the three Anchor Forest study regions where available (Figure 30); provide an overview of the opportunities and challenges facing collaborative forest restoration through the Collaborative Forest Landscape Restoration Program (CFLRP), Tribal Forest Protection Act (TFPA), and Stewardship End-result Contracting (stewardship contracting), among others; and lastly, assess recommendations gained from these collaboratives and other research valuable for land managers looking to further define the framework for Anchor Forests.

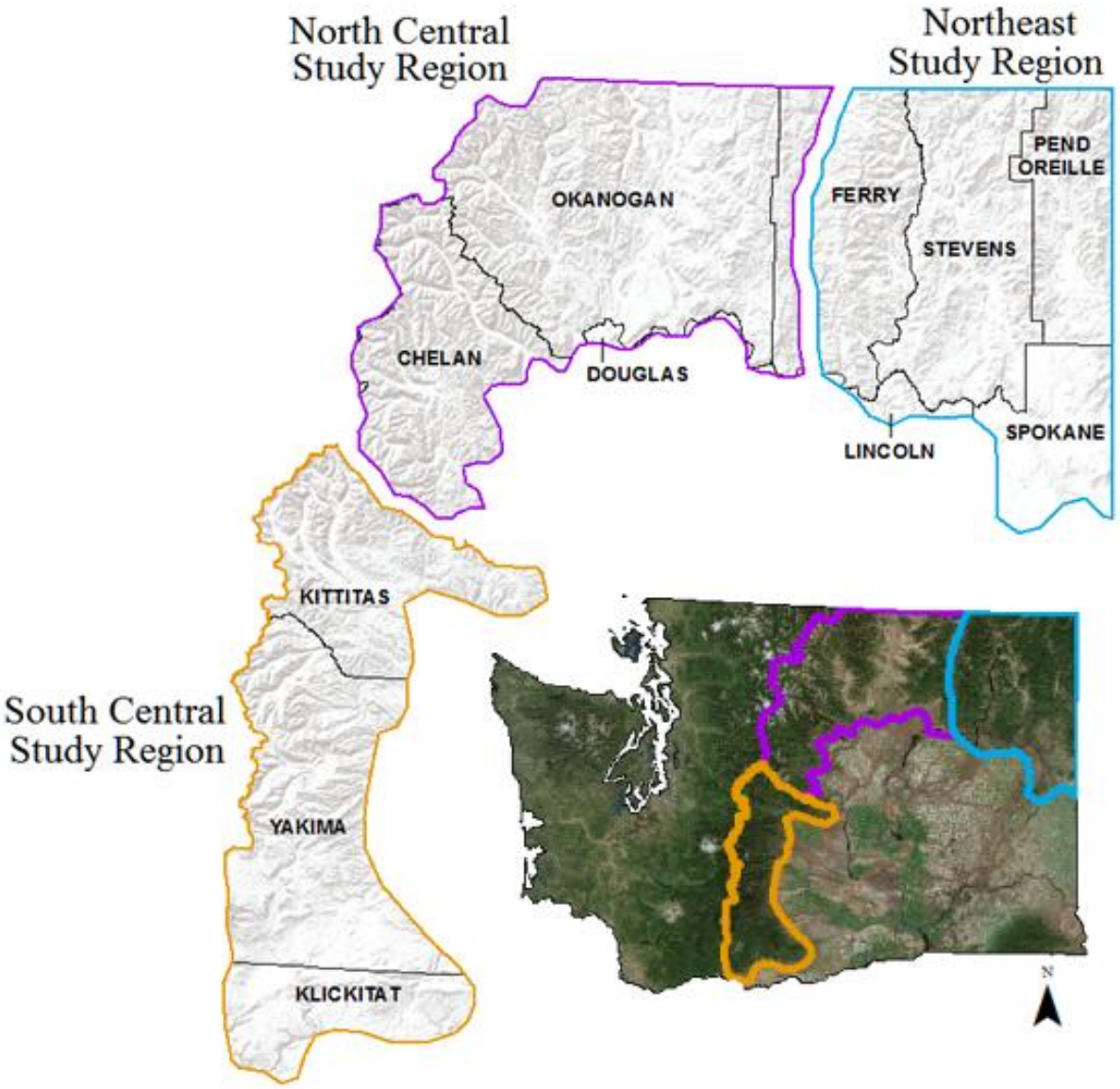


Figure 30. The State of Washington showing the three regions assessed for the Anchor Forest Study.

Land Management Collaboratives

Cheng & Sturtevant (2012) accurately noted that agency managers and stakeholders are increasingly utilizing collaborative approaches to address public natural resource management challenges due to shortcomings in the existing regulatory and bureaucratic environments, gridlock among stakeholder positions, and increased emphasis nationally on collaboratively developed, landscape scale projects. Often governmental agencies seek collaboration opportunities in order to secure stakeholder buy-in; however, many federal forest-reliant communities and tribes have been driven to engage collaborative approaches due to concern over forest health and wildland fire threats as well as economic distress resulting from the downturn in the timber programs of the USDA Forest Service and U.S. Department of the Interior Bureau of Land Management (BLM) (Cheng & Sturtevant 2012). While court appeals and injunctions limiting harvest operations on federal lands often cite protection of biological diversity or other ecological values (Gambino-Portuese et al. 2009; Keele et al. 2006), forest health conditions are rapidly declining in the West due to increased occurrences of widespread insect and disease infestations, changes in species composition, over stocked forest stands, and a changing climate (Krist et al. 2014; Snover et al. 2013; Littell et al. 2010).

Tribes maintain reserved treaty rights as sovereign nations on federal forestlands and have a specific interest in insuring that federal lands are managed in ways that effectively protect their treaty rights which may include grazing rights, hunting and fishing rights, gathering rights and interests, water rights, and/or subsistence rights depending on the scope and allocation language in specific tribal treaties. Within the Anchor Forest concept tribal rights and needs complement the triple bottom line goal of balancing social/cultural, economic, and ecologic forest stewardship. The trust responsibility of the U.S. Government is a permanent legal obligation to exercise statutory and other legal authorities to protect tribal lands, assets, resources, and treaty rights for Indian tribes (IFMAT 2013). Therefore, collaboratives offer tribes an opportunity to work directly with government agencies to develop projects that meet specific objectives. Stakeholders' working with tribes during the project development stage encourages discussion and analysis of social/cultural, economic, and ecological issues prior to the more formal public National Environmental Protection Act (NEPA).

Tribal participation in collaboratives is critical to success given the unique and long-term interest in the health and viability of forest landscapes and tribal permanence of management and culture. Despite long-standing tribal ecosystem knowledge tribal participation in collaboratives must be caveated by their government-to-government relationship with the United States. For example, many tribes have determined that voting on consensus-based decisions (collaboratives) is an infringement on this relationship. This does not prevent tribes from taking active or leadership roles in collaborative efforts, but it does require an understanding from all of the participating stakeholders of how leadership dynamics (governance) will likely be different from other collaborative group organizations.

There are currently three collaborative organizations working on forestry issues within the three study regions of eastern Washington. These collaboratives were assessed based on their experiences and governance structures. Assessments were used to inform an Anchor Forest framework and to meet the management needs of degraded forest ecosystems requiring restoration or re-establishment of ecosystem functions (Corrao et al. 2016; Boyle et al. 2016).

The three collaboratives are: The Tapash Sustainable Forest Collaborative (within the South Central region of the Anchor Forest study), the Northeast Washington Forestry Coalition's (within the Northeast region of the Anchor Forest study), and the North Central Washington Forest Health Collaborative (within the North Central region of the Anchor Forest study).

The mission, purpose, objectives, and governance structure as well as a brief history are provided for each collaborative. The purpose of this assessment was to identify challenges, barriers, and opportunities for landscape-scale collaboratives, similar to that of an Anchor Forest, may encounter. This information was then used to help identify the skills, capabilities, instruments, and support required for an Anchor Forest framework to overcome some of the legacy barriers facing multi-jurisdictional landscape-scale restoration of ecosystem functions.

The Tapash Sustainable Forest Collaborative

In 2003 The Nature Conservancy (TNC), the Washington Department of Fish and Wildlife (WDFW), the Washington Department of Natural Resources (DNR), and the Okanogan-Wenatchee National Forest came together to facilitate a transfer of 10,400 acres of Plum Creek Timber Company holding's in Tieton Canyon (Oak Creek) to the WDFW in order to avoid development of these checkerboard ownership lands and to address forest health conditions (Lolley & Bloomfield 2010). These lands became the foundation of a multi-ownership collaborative, then referred to as the Tieton Forest Collaborative (USDA Forest Service 2011). In 2006, the collaborative was renamed the Tapash Sustainable Forest Collaborative (Tapash), loosely meaning "dry or pine forest lands" in the Yakama language, to reflect the addition of the Yakama Nation and the expansion of the project into a regional partnership (Schultz et al. 2012).

The Tapash Collaborative encompasses a 1,629,959 acre landscape that includes 625,364 acres (38%) of the Okanogan-Wenatchee National Forest, 209,448 acres (13%) of National Forest Wilderness (Norse Peak, William O'Douglas, Goat Rocks, and Alpine Lakes National Wilderness Areas), 386,485 acres (24%) of Yakama Nation lands, 59,618 acres (4%) of WDFW, 171,938 acres (11%) of WA DNR, and 162,214 acres (10%) of private land. The Collaborative has recently begun to identify and prioritize locations within these acres needing restoration, at risk of being lost as "working forests" or at risk of land conversion. For areas at risk of land conversion, the Collaborative has prioritized land purchases based on ownership. For lands needing restoration, the Collaborative has begun categorizing areas using methods that consider the Natural Range of Variability (NRV), Fire Regime Condition Class (FRCC) programs, and forest vegetation structural conditions (Haugo et al. 2015). By analyzing the landscape in this way the Collaborative has been able to separate current forest conditions into one of three transition classes (*disturbance only*, *succession only*, or *disturbance then succession*). Disturbance transitions included a reduction in tree density / cover. Succession transitions included the growth of larger / older trees. Disturbance then succession transitions required both of these steps by first reducing tree density / cover and then following with growth of larger / older trees (Figure 31).

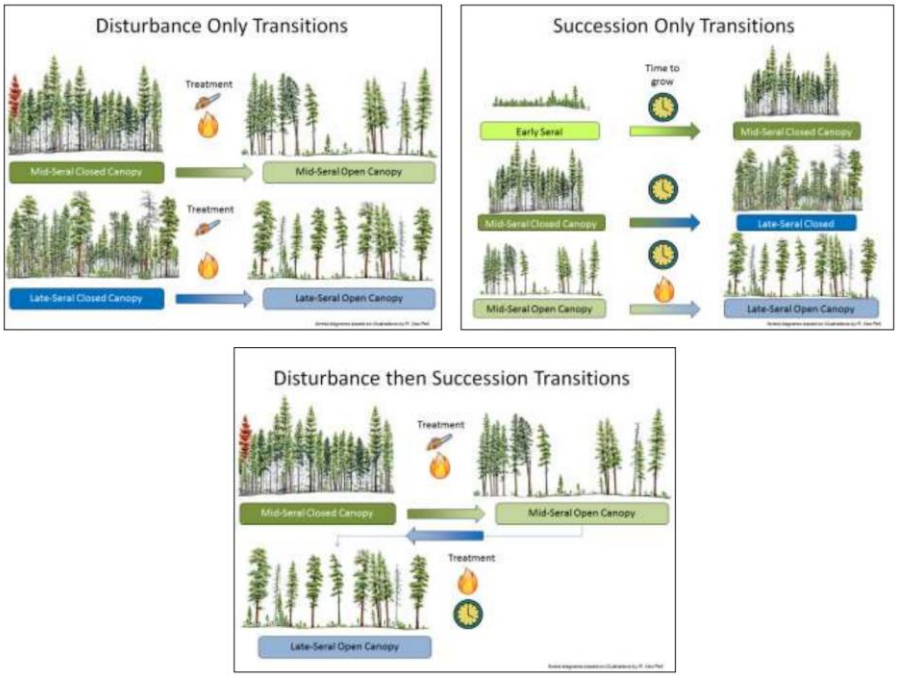


Figure 31. Example of potential restoration for each of the forest class categories identified using Natural Range of Variability, Fire Regime Condition Classes and forest vegetation structural conditions (Haugo 2015).

Mission (Tapash) - *"To improve the ecosystem health and natural functions of the landscape through active restoration projects backed by best science, community input, and adaptive management"* (Tapash 2015a)

Purpose (Tapash) - *"The Tapash Sustainable Forest Collaborative provides and convenes venues that structure organizational support and encourage accountability for conserving at-risk forest lands; implements forest and ecological restoration; and enhances and maintains a forest restoration economy"* (Tapash 2015a)

Guiding Principles of the Tapash Sustainable Forest Collaborative

- ✓ *Prioritize cross boundary forest restoration activities at the landscape scale; cross boundary, seamless management is emphasized, but not exclusive if a project can be done within a single ownership property.*
- ✓ *Use the best science and traditional knowledge to support timely, effective decision making and implementation.*
- ✓ *Utilize active management as a tool for improving ecosystem health and function.*
- ✓ *Develop and support local infrastructure and workforce that enables active forest restoration.*

- ✓ *Build and maintain strong working relationships to encourage local community support.*
- ✓ *Recognize and honor treaty rights.*
- ✓ *Follow adaptive management principles.*
- ✓ *Give priority to projects that best meet the mission and goals of the Collaborative.*

Memorandum of Understanding

A Memorandum of Understanding (MOU) signed in 2007 provides the framework for cooperation and coordination between the signatory parties of the Tapash Collaborative. It also clarifies expectations by charging each signatory group with specific tasks and provides guidelines meant to be flexible and encourage the sharing of information for adaptive management (USDA Forest Service 2007). Additionally, the MOU establishes the legal procedural requirements and limitations of the collaborative; however as of March 2015, an updated Tapash Sustainable Forest Collaborative MOU was drafted, but had not been promulgated.

Collaborative Structure

The Tapash Collaborative is a landowner and stakeholder-based partnership with a top-down structure directed by an Executive Team (Figure 32) comprised of representatives from the Washington Departments of Fish and Wildlife and Natural Resources, The Nature Conservancy, the U.S. Forest Service, and the Yakama Nation. The Executive Team is tasked with focusing on policy to facilitate guidance of the Working Group Membership and the Task Force groups. The members of the Executive Team have decision-making authority from their agency or organization.

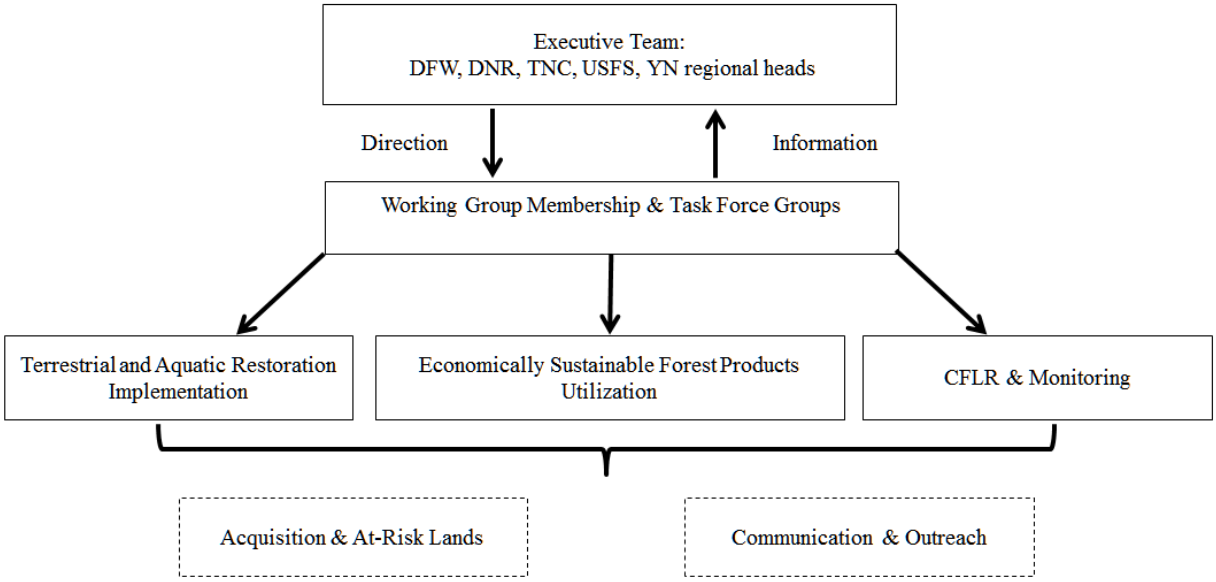


Figure 32. General collaborative governance structure for the Tapash Sustainable Forest Collaborative as described by the USDA Forest Service (2007) Memorandum of Understanding.

Tribal Participation
The Yakama Nation is represented on the Executive Team for the Tapash Collaborative and actively participates in Working Group discussions and Task Force projects. The Tribe provides financial support along with the agencies and TNC to employ a staff position to help coordinate the efforts of the Collaborative.

Northeast Washington Forestry Coalition's Colville National Forest "Blueprint"

The Northeast Washington Forestry Coalition (Coalition) began in 2002 after many recognized the need for management of the forests in the Colville National Forest and the gridlock that was obstructing any options. In 2006 the Coalition drafted the "blueprint" collaborative management proposal to help address concerns on the Colville National Forest. Participants in the drafting of this collaborative were the USFS, DNR, and Colville Confederated tribes, as well as foresters, scientists, conservation groups and recreational interests (Coalition 2015).

The USFS provided much of the leadership and guidance beginning with Forest Service-led forest plan "summit" workshops throughout 2006. Workshop attendance included a county commissioner from each of the three respective counties as well as a highly diverse group of 80 citizens. In addition to the workshops a total of six more USFS and county collaborative work sessions were held.

The Coalition's draft forest management proposal was presented at the first workshop and was used to form the basis of group decision-making. Summit participants endorsed the Blueprint's Active and Restoration Management zones and through consensus agreed to support protection of areas with "wilderness characteristics" already designated as Inventoried Roadless Areas (IRAs). The Colville National Forest made a commitment to Summit participants to give significant weight to their decisions for protection of the wilderness characteristics of the IRAs and maintain the Blueprint as a working document through an adaptive approach (Coalition 2015). Lessons learned throughout the workshops and collaborative working sessions were used by the Coalition to inform revisions of the Blueprint proposal before submission to the Forest Planning Revision Team.

In 2009 Senator Maria Cantwell and Rep. Cathy McMorris Rodgers co-hosted a Forum in Spokane, WA to discuss the success of the Coalition, and still unresolved, issues associated with forest management on the Colville National Forest (Coalition 2015). The Forum spawned a new collaborative named the "Roundtable" that was facilitated by Aaron Everett and organized by congressional staff of the Senator and Congresswoman. Within the Roundtable collaborative groups were formed by all participants (e.g., recreation interests, commissioners, conservationists, timber interests, cattlemen, and mining interests) establishing four issue committees: 1) Mining, 2) Recreation, 3) Ranching, and 4) Highway 20 (tribal issues). Coalition prescriptive guidelines for projects focused on thinning, roads, old growth and harvesting guidelines both pre- and post-fire. Each committee was tasked with seeking agreements regarding Inventoried Roadless Area management, and in particular, proposals for new wilderness areas. The Roundtable concluded in March 2009 and the Forestry Coalition borrowed what it learned during this collaborative to further refine its Blueprint. The results were: proposing 347,000 acres for active forest management, 279,000 acres for forest restoration,

215,000 acres of new wilderness, 145,700 acres in a new Kettle Range National Conservation Area, and 70,500 acres in three new National Recreation Areas (Coalition 2015). Additionally, since its inception, the Coalition has successfully collaborated on and implemented 36 forest restoration projects on the Colville National Forest with full collaborative support and very limited objections or appeals.

> ***Mission -*** *To demonstrate the full potential of restoration forestry to enhance forest health, public safety and community economic vitality.*
>
> ***Objectives -*** *To design and implement forest restoration and fuels reduction projects that demonstrate innovative approaches to forestry.*
>
> *To demonstrate how a diverse coalition of stakeholders can work together to successfully promote restoration forestry and community protection from wildfire.*
>
> *To use the projects to educate the public about the ecological and socio-economic benefits of restoration forestry and fuels reduction strategies.*
>
> *To develop model forest restoration and fuels reduction projects that can be emulated in other regions of the country.*

Guiding Principles of the Northeast Washington Forestry Coalition

> ***The First Principal:*** *Our Coalition operates under the principal that if we have the community of loggers, mill owners, environmentalists, business owners, local governments and citizens at large involved early on in the planning process with the Forest Service, and there is an authentic exchange of ideas during the project design phase, then the Forest Service projects are less likely to be appealed, if at all.*
>
> ***The Two Operational Parameters:*** *First, we are not interested in accessing old growth. Our focus is on the hundreds of thousands of acres that have already been logged once or twice, i.e., the "already managed and roaded forest lands". Second, we do not support extensive new road systems. In fact we support the elimination of some roads.*
>
> ***The Wildland Urban Interface Commitment:*** *The Coalition has made a decision to proceed with WUI fuels reduction projects first. They are less controversial and the need to protect human life and property is a high priority. We will build trust through these WUI fuels reduction projects and then move towards larger restoration projects in the forest landscape.*
>
> ***Commitment to Problem Solving:*** *We will not allow ourselves to devolve back into the conflicts over forest resource management of the past twenty years. We are not here to fight. We will use our best creative thinking to solve the problems that are preventing forest restoration and fuels reduction projects. If you can't go*

along with this commitment to problem solving, then you are not welcome at this table. It is also understood that our "collaborative projects" do not prevent any party from taking different or opposing stands on projects that we have not brought within our circle. This is not an "all or nothing" proposition for any interests; it is an attempt to find common ground.

Rules of Conduct: *The Coalition insists that its members adhere to the following rules of conduct when involved in any aspect of Coalition activities or when it might appear that they are involved in Coalition activities.*

- ✓ *We will not resort to disrespectful or confrontational dialogue.*
- ✓ *We will not use the Coalition as a forum to "soapbox" or "rant" about one's interests or position on a topic. This is not meant to squelch discussion.*
- ✓ *We will respect and comply with the behavior directions given by the facilitator, including removal from the premises if requested.*
- ✓ *We will use a good faith effort to resolve differences through a peaceful process*

Memorandum of Understanding

In July 2005, the USFS Colville National Forest and the Coalition entered into an MOU intended to provide a framework of cooperation and facilitation for community-based collaborative process to restore forest health conditions and complete restoration activities on the Colville National Forest lands that include the USFS, the coalition and the public. The MOU also clarified participant roles and helped to foster trust between stakeholders through establishment of common ground in the discussion and application of natural resource management on the Colville National Forest in a timely manner (Coalition 2015).

Collaborative Structure

The Coalition is a 501(c)(3) community-based partnership with a group-centered structure directed by an executive committee and a board of directors (Figure 33). The Board is made up of representatives of the collaborative with organizational guidance provided by an MOU with the USFS Colville National Forest and bi-monthly meetings inclusive of a variety of other stakeholders.

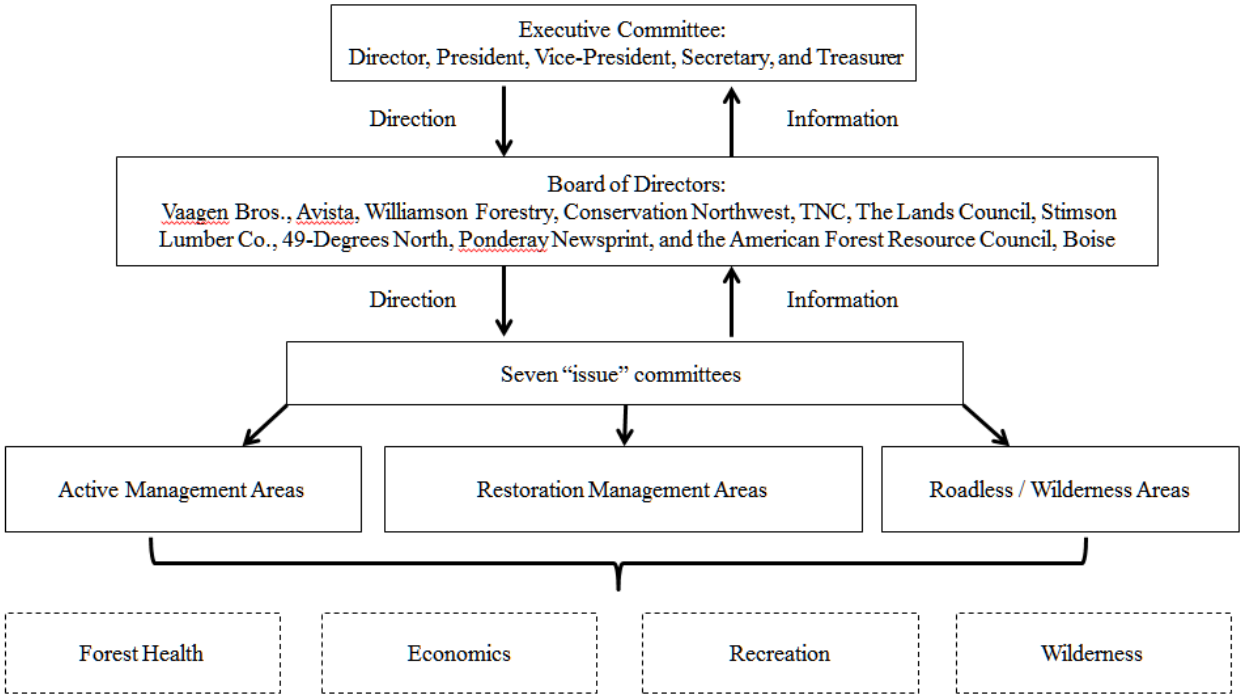


Figure 33. Collaborative structure for the Northeast Washington Forestry Coalition "Blueprint", adapted from Coalition (2015).

Tribal Participation

The Colville Tribe participates in the Coalition in a technical advisory capacity, and do not necessarily participate in the governance of the collaborative or provide specific input on projects. However, the relationship between the Coalition and the Colville Tribe is well-supported and founded in positive communication.

North Central Washington Forest Health Collaborative

The North Central Washington Forest Health Collaborative (NCWFHC), launched in 2013 with facilitation by the Upper Columbia Salmon Recovery Board (UCSRB), is a diverse group of local stakeholders represented by timber industry, conservation groups, and local, state, federal and tribal land managers. The NCWFHC is working to obtain the resources and support to accelerate landscape-scale forest restoration on the three-million acres of Okanogan-Wenatchee National Forest (OWNF) lands that make up 70% of the land base in Chelan and Okanogan counties. Successes of the collaborative can be seen in treated forest conditions that are more resilient to insect and disease infestations and consequently, reduced fuel loads and tree densities that discourage crown fire and promote ecosystem diversity (Figure 34).

The collaborative strives to advance forest health through transparent actions that improve forest resiliency, preserve terrestrial and aquatic wildlife habitat, protect natural resources, provide recreational opportunities, promote utilization of natural resources, and support local economies in the region.

The NCWFHC has been actively supporting legislation and policies, and seeking funding, that can accelerate restoration on the OWNF. Additionally, the NCWFHC Outreach Workgroup communicates with the broader public through NCWFHC.org website, press releases, public workshops and brochures. The NCWFHC Projects Workgroup is also leveraging resources and putting boots-on-the-ground to support pre-planning efforts on the OWNF. This work is focused on application of the OWNF's Restoration Strategy, which analyzes landscapes for current conditions and departure from historic, more resilient conditions, and is then used to develop potential treatments to restore landscape-scale ecosystem resiliency. In 2015 the Projects Workgroup supported pre-planning analysis on 50,000 acres in the Methow Valley Ranger District (MVRD), surveyed 15 miles of stream, 80 miles of closed and unauthorized roads, and 5,400 acres of potential vegetation treatment units. This information will be considered by the MVRD in developing a project in early 2016.

> ***Goal*** *- The North Central Washington Forest Health Collaborative is a diverse group of stakeholders working together to obtain the resources and community support to accelerate landscape-scale forest restoration on the Okanogan-Wenatchee National Forest in Chelan and Okanogan counties.*(NCWFHC 2015).
>
> ***Purpose -*** *The purpose of the North Central Washington Forest Health Collaborative is to advance forest health through transparent actions that improve forest resiliency, preserve terrestrial and aquatic wildlife habitat, protect natural resources, provide recreational opportunities, promote utilization of natural resources, and support local economies in Chelan and Okanogan Counties* (NCWFHC 2015).

Figure 34. Untreated and treated forest ecosystem conditions accomplished by the North Central Washington Forest Health Collaborative efforts to reduce insect and disease infestations and discourage stand-replacing wildfire that destroys (replaces) entire ecosystems. *Figure reproduced with permission from (NCWFHC 2015).*

Collaborative Structure

The NCWFHC is a stakeholder-based partnership (19 member organizations/agencies) with oversight provided by a Steering Committee (Figure 35). The Steering Committee is a balanced representation of the full NCWFHC. The UCSRB serves as a backbone organization, facilitating and coordinating the NCWFHC, and serving as a 501(c)(3) fiscal sponsor as needed for fundraising efforts.

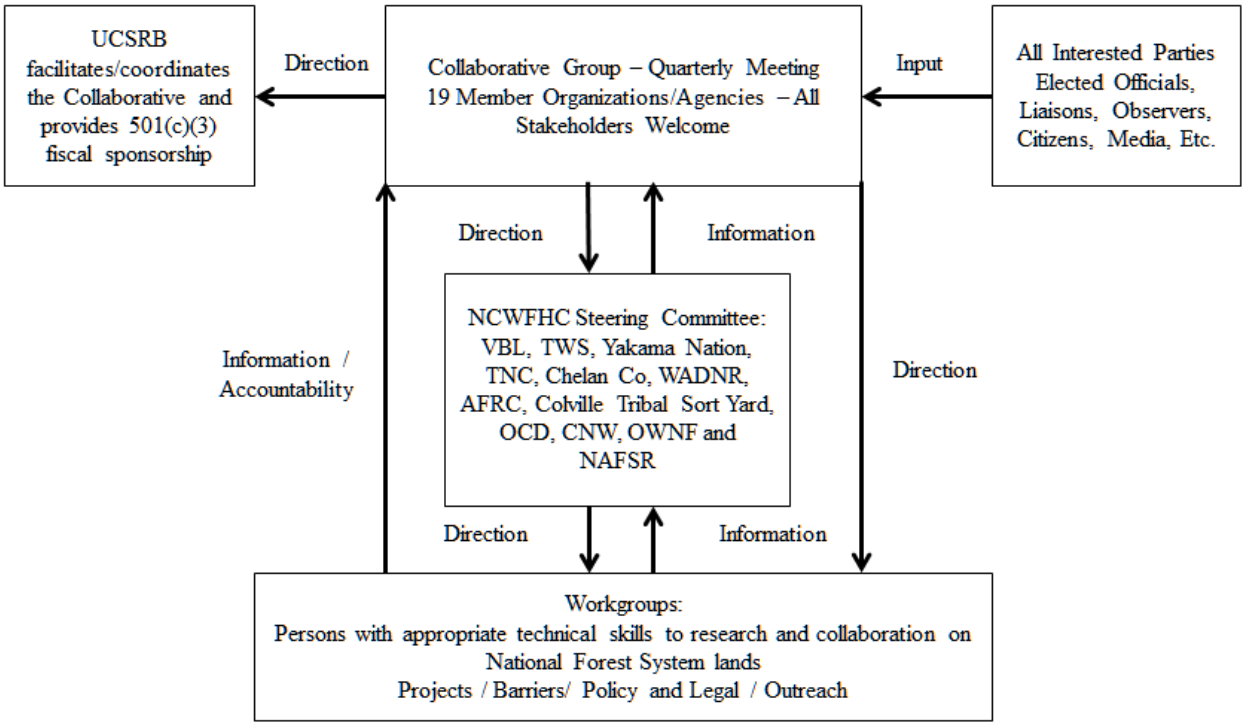


Figure 35. Organizational structure for the North Central Washington Forest Health Collaborative, adapted from (NCWFHC 2015).

Tribal Participation
The Yakama Nation co-chairs the North Central Collaborative as well as participates in the development of Workgroup discussions and projects. The Colville Tribe is also an active participant in collaborative efforts and assistance with project development.

Summary of Study Area Collaboratives

The Tapash, NEWFC, and the North Central Collaborative are actively working with the USDA Forest Service on projects designed to increase the scale, size, and success of timber management and restoration projects on federal and adjacent lands. The membership of each collaborative is relatively stable with active participation from the original participating agencies and organizations. Additionally, each group is expanding its collaborative capacity by leveraging its institutional and relational capital (Cheng & Sturtevant 2012), to build new relationships, seek funding sources, reach out to the general public, etc. all of which have benefits to the participating members.

From a tribal perspective, full engagement by member tribes in leadership roles within various collaborative structures appears to result in better outcomes for the tribe and other stakeholders as specific concerns are expressed and made a priority by the collaborative from the onset. Due to the tribes' government-to-government relationship with federal agencies, having a tribal representative with decision-making authority in a leadership role as with the Tapash Collaborative and the North Central Washington Forest Health Collaborative tends to alleviate any concerns about maintaining treaty rights and opens doors to cross-boundary collaboration that wouldn't be available otherwise. Additionally, tribal representatives in management positions often have a better understanding of the unique tools and resources that tribes have with the federal government and how to leverage that relationship on a project-by-project basis.

All collaboratives experience growing pains as their participants learn to work together, build relationships, and actively engage on the development of projects or the pursuit of other collaborative goals. Based on Anchor Forest meetings, forums, and other discussions, some of the lessons learned by collaboratives within the three Anchor Forest Study Areas include ensuring that all project partners and supporters clearly understand any limitations associated with sought after funding streams, the development of proposals is realistic given the partners' collective time and resources, the economic feasibility of restoration projects is vetted early in the development process, and that any guidance developed by the collaborative doesn't become a redundant or excessive burden on other partners. Additionally, collaboratives must be aware that partners have limited staff and capacity to devote to collaborative efforts; thus, the focus area and breadth of issues addressed must be regional in nature so that multiple collaboratives groups are not required in a single operating area.

Opportunities for Collaboration

- Better representation from stakeholders early in project development will result in better support for projects.
- Stakeholder input on federal projects often results in projects that have more widespread social and economic benefits for the associated communities.
- Tribes' government-to-government relationship provides a direct forum to protect the public trust to prevent despoliation of the commons – the land, water, air, fish and

wildlife for the sake of future generations of all peoples, Tribal resources, and labor force.
- Collaborative discussions provide a forum for alternative interpretations of science, economics, and policy paradigms.
- Tribal commitments to long-term, multi-purpose stewardship could help bridge differences in values.
- As participants learn more about their partners, synergies in other programs and projects are often enhanced.

Barriers for Collaboration
- Collaboration on projects requires a significant commitment of time and resources from participants.
- Consistent funding is a barrier for most collaborative groups.
- Collaboration builds widespread support for projects, but the task of developing projects often takes significantly longer.
- Lack of familiarity with available programs and tools may limit their use by the collaborative.
- Funding and/or availability of U.S. Forest Service planning staff is a bottle-neck for projects.
- Even though collaboration produces widespread buy-in among a variety of stakeholders, the collaborative is only one member of the general public.
- High turnover and short term tenure of U.S. Forest Service leadership has resulted in delays in project implementation as relationships must be constantly rebuilt.

Collaborative Tools in the Anchor Forest Framework

Several relatively new federal authorities require some level of collaborative involvement including components of the 2014 Agricultural Act (Farm Bill), the Collaborative Forest Landscape Restoration Program (CFLRP) and the 2012 Planning Rule. These tools and others provide insight into the development and management of an Anchor Forest framework. In order to be successful in the long-term, an Anchor Forest will likely make use of more than one of the following authorities or tools as objectives and landscape needs evolve.

Collaborative Forest Landscape Restoration Program

The purpose of the CFLRP is to encourage the collaborative, science-based ecosystem restoration of priority forest landscapes. The CFLRP expands collaborative landscape partnerships to encourage ecological, economic, and social sustainability; leverage local resources with national and private resources; facilitate the reduction of wildfire management costs, through re-establishing natural fire regimes and reducing the risk of uncharacteristic wildfire; demonstrate the degree to which various ecological restoration techniques achieve ecological and watershed health objectives; and, encourages utilization of forest restoration by-products to offset treatment costs, to benefit local rural economies, and to improve forest health.

Congress established the CFLRP with Title IV of the Omnibus Public Land Management Act of 2009 including appropriation of up to $40 million annual for fiscal years 2009-2019. There are

currently 23 CFLRP projects nationwide, two within the Anchor Forest Study Areas; The Tapash Sustainable Forest Collaborative project and the Northeast Washington Forest Vision 2020 submitted by the Northeast Washington Forestry Coalition.

The CFLRP can fund 50% of the cost of carrying out and monitoring ecological restoration treatments on National Forest System land up to $4 million annually per project, not to include any planning costs. Five years into the ten year program, the CFLRP has resulted in more than 1.45 million acres treated to reduce the risk of catastrophic fire, treated 84,570 acres to achieve healthier conditions through timber sales, improved wildlife habitat on 1.33 million acres, treated 73,600 acres for noxious weeds and invasive plants, and resulted in an estimated $661 million in local labor income and 76.1 million in partner matching contributions.

The Tapash Collaborative's CFLRP project was initiated in 2010 and is tied directly to the Okanogan-Wenatchee National Forests' Restoration Strategy. The main goals were to create a landscape that is more resilient to fire, insects, and disease in the face of a changing climate (USDA Forest Service 2007; Haugo 2015; USDA Forest Service 2010). This would affectively create an ecosystem structure that can maintain and restore natural processes, patterns, and functions thereby mimicking the natural mosaic of patterns historically left by insects, disease, and fire, known to reduce the risk of uncharacteristically severe wildfire and the unsustainably high suppression and restoration costs (O'Toole 2007; Fitch et al. 2013; USDOI 2015). In addition to tree health and fire-cost reductions, the Tapash proposal focused on ecosystem restoration as a whole, to improve protection of water quality and quantity following fires, minimize sediment loading and increase flood plain function.

One specific challenge within the early planning phase of the Tapash came in the form of a lack of understanding for the limitations of CFLRP and clarity regarding the USFS role in the collaborative as well as limitations of CFLRP funding for planning purposes. The collaborative has continually met challenges in their efforts to maintain a set of clear, consistent goals, and objectives, as well as in tracking and reporting accomplishments. Due to the initial setbacks, including: budget timing, NEPA requirements, smoke limitations, lower timber values and receipts, the associated lack of success in initial stewardship contracting efforts, and a significant investment of resources for the National Forest Roads and Trails Act workload on the Forest during 2013 (USDA Forest Service 2014); the Collaborative did not meet the projected outputs and began to re-evaluate the goals of the initial proposal during 2014. Despite initial setbacks the region has a history of successful stewardship contracting (Table 19), with a current proposal for the Nelli Stewardship project.

Table 19. The five year quantitative accomplishments from both of the CFLRP projects in the Anchor Forest Study Areas are presented below. The NEWFC's Forest Vision 20/20 project was initiated in 2012; therefore, there are only 3 years of reporting to-date.

FY	Project	Acres of Forest Vegetation Established	Acres of Invasive Plant and Noxious Weed Treatments	Miles of Stream Habitat Improved	Acres of Terrestrial Habitat Improved or Restored	Timber Volume Sold (ccf)	Acres of Hazardous Fuels Treatments within the WUI	Acres of Hazardous Fuels Treatments Outside the WUI	Miles of Roads Decommissioned	Miles of Passenger Roads Improved	Miles of High Clearance Roads Improved	Soil and Water Resources Restored or Enhanced for Water Quality	Acres Treated through Timber Sales
2012	NEWFC Forest Vision	79	534	9	1,679	37,006	6,745	1,268	-	43	-	-	-
2013	NEWFC Forest Vision	-	-	-	-	33,329	4,709	672	-	12	-	163	936
2014	NEWFC Forest Vision	-	-	12	5,181	21,273	5,181	298			7	725	267
TOTAL	NEWFC Forest Vision	79	534	21	6,860	91,608	16,635	2,238	-	55	7	888	1,203
2010	Tapash	-	-	-	-	2,566	5,100	-	-	-	-	-	-
2011	Tapash	-	-	1	2,907	29,262	-	-	-	1	1	-	-
2012	Tapash	-	1,318	-	746	13,445	3,869	1,104	-	0	3	-	518
2013	Tapash	-	679	4	1,657	26,408	794	4	-	-	-	-	397
2014	Tapash	-	1,969	10	12,490	20,946	2,893	3,040	4				674
TOTAL	Tapash	-	3,966	14	17,800	92,627	12,656	4,148	4	1	3	-	1,589

Table and information provided in USDA Forest Service (2010)

As a potential model for an Anchor Forest framework involving cross-agency coordination, there are several advantages and disadvantages to the CFLRP that should be considered. One of the most significant drawbacks is that CFLRP funds can only be spent on National Forest System lands; however, that does not inhibit co-management of resources off Tribal lands in cooperation with federal agencies.

Advantages of the CFLRP:

- CFLRP projects are collaboratively developed and managed.
- Provides direct funds for accelerated restoration projects.
- There is a third party monitoring requirement, which allows stakeholders to review the effective management of the funds as well as ecological and social outputs of the project.
- High priority, but economically impractical restoration projects can be subsidized.
- Promotes agreements with outside entities including tribes for project work.

Disadvantages of the CFLRP:

- Funds can only be used on National Forest System lands.
- Funding cannot be spent on planning, which can be a major barrier to implementation of collaboratively supported projects.
- The 50% match requirement can be difficult for some projects to meet, especially if their project acreage is relatively small.
- CFLRP projects cannot include permanent road construction.

Tribal Forest Protection Act

The Tribal Forest Protection Act of 2004, PL 108-278 (TFPA) was passed in the aftermath of catastrophic wildfire losses in order to provide a means for the Secretaries of Agriculture and Interior to consider tribal proposals that would protect their rights, lands, and communities by reducing threats from wildfire, insects and disease, and other sources. The TFPA also provides for restoration objectives. Under the TFPA, the Secretaries of Agriculture and Interior are authorized to enter into agreements or contracts, pursuant to tribal proposals, to address hazardous conditions on Forest Service or Bureau of Land Management administered lands that border or are adjacent to tribal trust lands or resources (ITC 2013).

The TFPA could prove to be crucial to the ability to implement the Anchor Forests concept by providing a tool to enable treatment of National Forest System lands and make materials removed from national forests available to support sustainable harvesting, transportation, and processing infrastructure. TFPA is also a valuable tool to help identify, prioritize, plan, and treat risks originating on National Forest lands by linking them to management activities on tribal lands, which opens the way for large landscape-scale treatments.

Implementation of TFPA projects during the first ten years of the Act was very limited due the lack of familiarity of the Act by tribes, BIA and Forest Service employees and leadership. Only eleven projects were initiated and six implemented treating less than 20,000 acres. This led to the implementation of two regional TFPA workshops (Spokane/Albuquerque) in 2015 to jump start fifteen new TFPA projects. Early results are encouraging that this format provides an effective way to initiate more landscape scale projects as either standalone TFPA projects or as part of larger Anchor Forest projects. Tribes have the option to conduct narrow scale projects that only

involve the Forest Service or initiate larger scale projects that expand collaboration to additional local stakeholders (Erickson 2016).

Under an agreement or contract with the Secretary, and Indian tribe may carry out planned activities to achieve land management goals and reduce risk to tribal lands from Federal land that borders or is adjacent to the Indian forest land or rangeland under the jurisdiction of the Indian tribe. The Federal land must pose a fire, disease, or other threat to the Indian forest land or rangeland under the jurisdiction of the Indian tribe, a tribal community, or be in need of land restoration activities to protect tribal treaty rights.

Advantages of TFPA:

- TFPA supports tribes participating in stewardship agreements and contracts.
- By tribes proposing projects on neighboring National Forest System lands, opportunities are created to form effective partnerships between tribes and National Forests to address landscape risks (wildfire, insects, invasive species, and climate change).
- Tribal support and involvement in forest restoration efforts can be instrumental in overcoming opposition to necessary treatments.

Disadvantages of TFPA:

- The TFPA authority, guidance, and implementation process are not well understood by tribes, the U.S. Forest Service, or the BIA.
- tribes are reluctant to pursue projects because they are unfamiliar with Forest Service administrative procedures, priorities, and operating restrictions.
- tribes are reluctant to invest limited staff and resources to prepare and pursue TFPA proposals because they are not confident they can be planned and implemented in a timely manner.

The ability to fund TFPA projects has largely been dependent on congressional USDA appropriations. Opportunities to defray treatment costs (e.g., goods for services) are becoming increasingly scarce due to the decline of viable markets for forest products. Nevertheless, TFPA is an excellent tool for tribes to launch an Anchor Forest project and leverage relationships with federal partners and other surrounding landowners and managers.

Stewardship End-result Contracting

Congress created stewardship contracting to give the U.S. Forest Service (USFS) and Bureau of Land Management (BLM) the authority “to perform services to achieve land management goals for the national forests and the public lands that meet local and rural community needs.” This authority was permanently authorized in the 2014 Agricultural Act and allows the U.S. Forest Service to enter into long-term contracts with a state or other entity for restoration projects on national forest and to fund restoration projects by trading the value of goods (timber) for the value of services (restoration).

There are four types of stewardship agreements; integrated resource timber contracts (IRTC) (value of the goods are greater than value of services), integrated resource service contracts (IRSC) (value of goods is less than the value of services so funds are added to the contract from appropriated dollars or retained receipts), service contracts, and stewardship agreements.

Stewardship contracting is the mechanism most often employed by federal agencies to implement integrated resource management projects originating from collaborative processes and/or programs such as CFLRP and TFPA.

Stewardship agreements are used to designate large stewardship areas where a mutual interest and mutual benefit between the Forest Service and a partner exists. The Forest Service may enter into stewardship agreements with any entity that has the ability to either perform the work or contract it out. This can include, state and local governments, federally recognized tribes, and non-profit organizations. The Wyden amendment allows for the Forest Service to accomplish work on non-federal lands providing that the work benefits adjacent federal land.

Advantages of Stewardship Agreements:

- Projects under stewardship agreements can be implemented on national forests and non-federal lands.
- Retained receipts from forest products that need to be removed to meet restoration objectives can be applied to needed service work within the stewardship project or transferred to another stewardship project.
- Trade of goods for services, can be awarded on a best-value basis, can be applied to a wide range of services, can help move forest products, can add to appropriate funds, and they are semi-long-term contracts requiring a single solicitation.
- Contracts and agreements are good for 10 years.
- Agreements are very flexible and additional work can be added after the contract is finalized.
- NEPA decisions remain with federal agencies, but information gathering, analysis, and documentation can be assisted by other parties.

Disadvantages of Stewardship Agreements:

- Stewardship contracts or agreements require a large investment in time and capacity and often money from the contractor or partner. Agreements require the partner to contribute at least 20% of the total project costs.
- Procurement and timber sale contracting clauses/provisions are complex.
- Implementation of stewardship agreements requires management and accountability from a very stable and long-term partner.

Good Neighbor Authority

The purpose of the Good Neighbor Authority is to authorize the Secretaries of Agriculture and the Interior to enter into cooperative agreements with State foresters authorizing States to provide certain forest, rangeland, and watershed restoration and protection services on National Forests and public lands. Activities that could be undertaken using this authority include: (1) activities to treat insect infected trees; (2) activities to reduce hazardous fuels; and (3) any other activities to restore or improve forest, rangeland and watershed health, including fish and wildlife habitat.

The Authority excludes wilderness areas, wilderness study areas, and areas where the removal of vegetation is prohibited or restricted by an Act of Congress or Presidential proclamation from the definition of ``federal land'' on which authorized restoration services can be performed under the

bill. The Authority also excludes construction, reconstruction, repair, or restoration of roads or parking areas, and the construction, alteration, repair, or replacement of public buildings or works.

The Authority requires the Secretary to provide or approve all silviculture prescriptions and marking guides in all timber sales conducted on Federal land under the Act. The Authority requires federal retention of decision making under the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 et seq.).

While the Good Neighbor Authority is specific to States, it is a good tool for achieving broader-scale cross-agency land management goals as designed in the Anchor Forest framework.

Advantages of the Good Neighbor Authority:

- The bill authorizes the states to act as agents for the Secretary and would provide that states could subcontract with private entities for services authorized under this bill. This would allow state foresters to accomplish similar work under one contract in areas where state and federal lands are located in close proximity.
- Projects can be on federal and non-federal land.
- The U.S. Forest Service has developed new forms for agreements under the Good Neighbor Authority that are very similar to those for Stewardship Contracting.

Disadvantages of the Good Neighbor Authority:

- No special funding comes with this authority. Project funding is based on available appropriated funding for needed work.
- An environmental impact assessment is required for this program.
- Specific to agreements between the Secretary and Governor, there is no mention of tribes.
- The authority to enter into contracts or agreements under the bill would expire on September 30, 2019.

Landscape-scale Treatment Areas

Section 602 of the 2014 Agricultural Act provides for the designation of landscape-scale treatment areas and the use of expedited procedures to implement treatment projects on National Forests. In order to qualify for designation, an area is required to be either:

- experiencing declining forest health according to Forest Service surveys,
- at risk of substantially increased tree mortality, or
- posing an imminent risk to public infrastructure, health, or safety.

For projects aimed at reducing infestations, the Agricultural Act authorizes the Forest Service to use the same expedited procedures that the HFRA provides for hazardous fuels reduction projects. Specifically, the agency can limit the number of NEPA alternatives considered to the proposed action, the no-action alternative, and one additional action alternative. Also, in the event of litigation, the HFRA's expedited judicial review provisions apply:

- cases must be heard in the local federal district court;
- court proceedings are to be completed as soon as practicable; and
- preliminary injunctions are generally limited to 60 days and must be based on a court's weighing of short and long-term effects of undertaking versus not undertaking a project.

The insect and disease treatment projects must be consistent with the Forest Service's local management plans and other relevant policies, and they cannot take place in designated wilderness or wilderness study areas. In addition, projects must "maximize the retention of old-growth and large trees, as appropriate for the forest type, to the extent that the trees promote stands that are resilient to insects and disease".

Categorical Exclusion of Collaborative Restoration Projects. Section 603 provides additional streamlining authorities for insect and disease treatment projects that meet certain criteria. For projects that qualify, they can be categorically excluded from NEPA requirements and are exempt from the administrative objection process. The most important eligibility criteria are that the treatment project must be:

- developed through a collaborative process that includes multiple interested persons representing diverse interests and is transparent and non-exclusive,
- maximizes retention of old-growth and large trees as appropriate for the forest type,
- must be in the WUI or in Condition Class 2 or 3 in Fire Regime Groups I, II, or III outside the WUI,
- cannot include the establishment of permanent roads,
- temporary roads must be decommissioned within 3 years after the project is completed,
- no larger than 3,000 acres in size, and
- the project must "consider the best available scientific information to maintain or restore the ecological integrity, including maintaining or restoring structure, function, composition, and connectivity".

Advantages of the Landscape-scale Treatment Areas:

- Projects must be developed and implemented through a collaborative process that includes multiple interested persons representing diverse interests and is transparent and non-exclusive.
- Projects up to 3,000 acres in size may qualify for a categorical exclusion.
- Projects in Landscape-scale Treatment Areas for which NEPA scoping is initiated prior to September 30, 2018 can be carried out using requirements similar to those for HFRA fuels reduction projects.

Disadvantages of Landscape-scale Treatment Areas:

- Treatment Areas are limited to National Forest System lands.
- The bill authorizes (but does not automatically appropriate) up to $200 million to be spent annually for the next ten years to implement.

Additional Tools Available to Collaboratives

Opportunities for landscape scale, cross ownership treatments has improved with the Two Chiefs Joint Landscape Initiative that provides Forest Service funding to treat National Forest lands and Natural Resource Conservation Service funds to treat non-federal lands. In addition, the evolution of ecosystem service funding such as watershed partnerships help to generate non-federal matching funds to help increase the scope and scale of landscape restoration projects. Finally, emerging Partnership funding programs are attracting private and corporate funding to treat additional acres (Erickson 2016).

Other administrative tools that are available to help collaboratives develop and implement Anchor Forest projects include memoranda of understanding; partnership, cost-share, and participating agreements; and other agency programs like the Conservation Stewardship Program offered by the Natural Resource Conservation Service.

Working Within a Collaborative Structure

Community-based collaborative capacity has been defined as ‘‘the collective ability of a group to combine various forms of capital within institutional and relational contexts to produce desired results or outcomes’’ (Beckley et al. 2008). Within the framework of community-based collaboration identification of available resources is vital. These resources also referred to as “collaborative capital”, have been defined by Chaskin (2001) as: “the interaction of human capital, organizational resources, and social capital existing within a given community that can be leveraged to solve collective problems and improve or maintain the well-being of a given community”.

Within a collaborative, the capacity of stakeholders, agencies and organizations and the resources available must be identified in order to facilitate the organizations development and guide its efforts (Table 20). Resources such as human, economic, natural, and social assets possessed or accessible to stakeholders, as well as the knowledge, specialized skills, job experiences, and health of individuals within or accessible to the collaborative (Cheng & Sturtevant 2012) constitute the foundation of a collaborative and define its collaborative capacity. Defining the available resources and capacity of participating members allows an organization to identify additional resources and stakeholders needed to fulfill their collaborative objectives. Often collaboratives can leverage available resources within a community or region to achieve their objectives. In the context of public forest management, Chaskin (2001) refers to this as the inclusion of environmental, social, and economic assets as well as legal, political, and bureaucratic elements.

In the collaboratives reviewed in this study many of the successful projects as well as the collaboratives themselves were preceded by a catalyzing event, such as a crisis or a window of opportunity, prompting a community or group to mobilize. Catalyzing events are often either singly or a combination of: a catastrophic wildfire event, an economic downturn, threats to lifeways, new funding opportunities, or changes in leadership. Whatever the reason, development of a successful organization requires: organization, learning, leadership, action, results, evaluation, and above all, long-term commitment. Obvious outcomes of collaborative success in public forest management would be improvements in the desired biophysical conditions of managed forest lands, decreased size and severity of wildfire, increases in local community family-wage jobs, and increased participation in collaborative efforts, measured by reduced planning time and litigation as well as increases in stakeholder participation. Within the literature collaboration and collaborative efforts have been discussed (Burns & Cheng 2005; Mattor 2013; Butler et al. 2015) and some frameworks available to aide collaborative groups in development or in assessing their capacity and needs (Cheng & Sturtevant 2012) may be of assistance to readers (Figure 36).

Table 20. Collaborative capacities for success and the actions supporting collaborative capacity at different social levels within an agency or organization.

Collaborative Capacities	Level of Social Agency		
	Individual	Collaborative Group	Home/External Organizations
Organizing	Leadership committed to group success Systems thinking ability Social networks	Ability to recruiting and retain right participants Systems for regular communications internally and externally Knowledge of effective organizational design Conflict management competencies Grant-writing, project management, & writing skills Human and financial resources to carry out tasks	Authority and resources for representatives to participate Technology & technical expertise Logistics assistance Procedures beneficial to collaborative outcomes
Learning	Leadership committed to learning Systems thinking ability Communication competencies—active listening and effective speaking and writing skills	Learning facilitators Access to external expertise & knowledge Access to data and information; skills and resources to compile and synthesize information Report organization and writing skills Physical, financial, and human resources to carry out learning tasks	Data, information, geo. Information systems assistance Subject matter specialists
Deciding	Communication and negotiation skills Authority to decide on behalf of constituency or organization Standing and persuasion within constituency or organization	Knowledge of decision space Ground rules governing behavior, interactions, and decision-making Strategic planning experience/competency Report organization and writing skills Physical, financial, and human resources to carry out planning & decision-making tasks	Authority to representatives to make decisions on behalf of organization Technical expertise and assistance
Acting	Knowledge of how to operationalize desired goals/activities Knowledge of what constitutes operational feasibility Knowledge of contracting mechanisms appropriate for tasks	Acquire and coordinate adequate human, technical, & financial resources Ability to develop and follow-through with intermediate outcomes, e.g., pilot, demo Organizational structure and personnel that ensure assets are applied to activities Knowledge, skills & resources for effective advocacy	Ability to exert authority over work plans, personnel, & budgets to contribute to implementation of group goals in short time frame Assigning operations-oriented technical expertise to operationalize group goals Contract, administration, and accountability mechanisms to ensure work gets done correctly
Evaluating	Champion or group of champions advocating for monitoring & evaluation Expert knowledge and/or experience in both ecological and socio-economic monitoring	Ability to sustain the organizational structure, time and space for monitoring and evaluation Access to expertise, data and information through social networks Data storage, analysis, and interpretation resources and competencies Report organization and writing skills Sufficient human, financial and technical resources to conduct monitoring	Field crews, subject matter experts Data, information, remotely-sensed imagery, and GIS technology Recruiting and organizing volunteers Training in measurement techniques
Legitimzing	Social networks encompassing community leaders and other collaborative groups Social networks encompassing individuals at higher authority levels 'Standing' within one's peer group or organization Persuasion skills	Human, financial, and technical resources to develop and disseminate communication materials Knowledge, skills, and resources for advocacy in state and federal policy venues	Explicit leadership support for organizational representatives' participation Explicit political and financial support for collaborative group functioning and activities

*Table reproduced from Cheng & Sturtevant (2012) with permission.

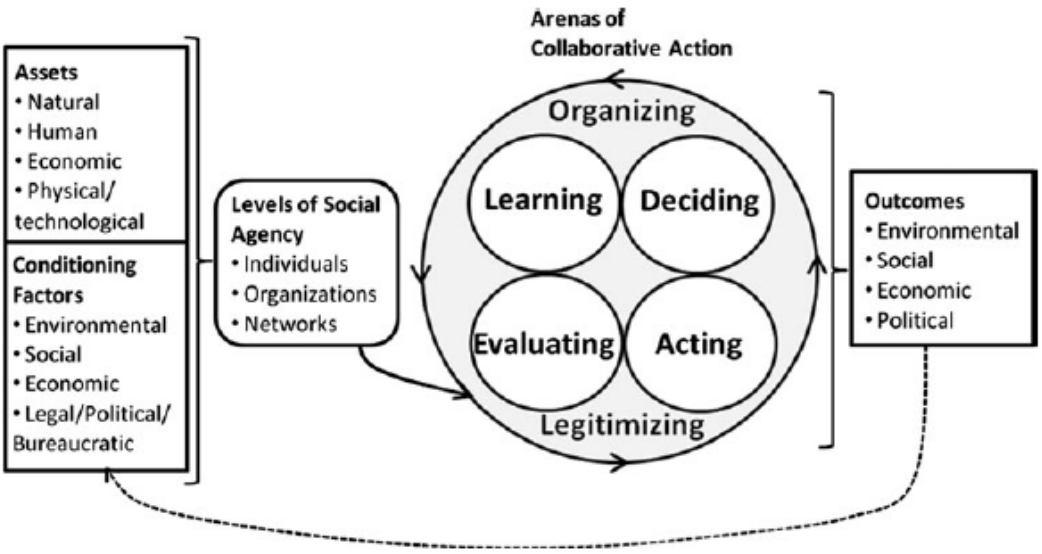


Figure 36. A proposed framework to facilitate the understanding and assessment of collaborative capacity associated with community-based public forest management. Reproduced from Cheng & Sturtevant (2012) with permission.

Outside Factors Affecting the Success of Collaboratives

The NEPA process, throughout the West in particular, has reduced the ability of the USFS to complete planning and application of timber sales predominantly due to appeals and litigation from parties not participating in the collaborative process. This is supported by the Council on Environmental Quality's records indicating the USFS is the most common federal defendant in NEPA litigation (Mortimer & Malmsheimer 2011). As a result the agency's fear of administrative appeals, litigation and perception of risk has led to smaller and more narrowly scoped projects, significantly increasing per unit costs (Nie 2011). However, programs like CFLRP and TFPA as well as pressure from collaborative groups has helped renew efforts for landscape level and integrated resource projects. Collaborative efforts to classify landscapes or regions of similar conditions may support more efficient NEPA analysis over larger areas and minimize the need for either highly complex assessments over widely varying conditions or a great number of small projects, each with their own NEPA assessment.

Factors, such as the misuse of legislation like the Equal Access to Justice Act (EAJA), which allows litigants to recapture court costs from the federal government if they prevail in litigation against U.S. federal agencies, without the reciprocal if the Agency wins, reduces already limited funding and staff resources needed by the USFS and other federal agencies that could be directed toward collaborative and forest planning efforts. A study by Mortimer & Malmsheimer (2011) showed that many EAJA cases involve administrative technicalities rather than environmental impact issues; thus, future efforts that inhibit misuse of the EAJA could be valuable to collaborative efforts.

The framework for collaboration and public input can present challenges such as; a collaborative collectively, only has one voice within the administrative and judicial review structure therefore

not representing “collaboration” within U.S. Forest Service guidance. This in turn requires the agency to meet with individuals or groups who are not participating in the collaborative process, thereby exposing the “collaborative process” to third party litigation, known to discourage stakeholder participation and consume already limited collaborative and U.S. Forest Service resources (Keele et al. 2006; Miner et al. 2010; Gambino-Portuese et al. 2009). Therefore, the collaborative process, while good for creating better projects and building a social license, may take as long or longer than the normal NEPA and appeals process further discouraging participants. Agreements or policies that protect the “collaborative process” and participant efforts from non-participant appeals and litigation would significantly improve collaborative efficiency and may encourage participation from additional stakeholders.

Lastly, based on input from Anchor Forest meetings and stakeholder forums, many feel that the upper tiers of management in the Forest Service is lacking good leadership and a clear mission; thus, staff at the regional and local levels are often confused about priorities or misdirected by supervisors with their own agendas. Additionally, there is a great deal of precedent-setting case law surrounding environmental statutes effecting U.S. Forest Service decisions requiring personnel to not only be experts in their field, but also legal analysts. The annual nature of the Forest Service funding cycle makes it difficult to plan long-term projects and keep projects on schedule. Funding is often allocated late, leading forest-level personnel to award potentially premature contracts and agreements given a reduced time-frame. This is further complicated by a lack of operational experience and good leadership on some national forests due to frequent turnover of Forest Service personnel, thereby weakening the impetus for achieving management goals and targets. This all leads to additional time spent planning and re-planning, and inefficient or inadequate decision-making. Policies or programs that allowed multi-year projects to be funded throughout an agreed upon life-span, would improve planning and implementation efficiencies as well as encourage investment in the Forest if timelines are sufficient to offset initial investments.

Conclusions

Forest health throughout the western U.S. is continuing to decline due to fire exclusion, insect infestations, disease outbreaks, and a lack of active forest management. In the wake of national wildfire suppression policies and litigation, predominantly on NFS lands, degraded forest conditions are accelerating and impacting neighboring landowners across much of the West. These degraded forestland conditions, multi-faceted and only treatable through proactive management and collaboration, are just now being acknowledge throughout the Nation. There is a need to back the growing number of forest-health related legislation supporting such as those authorized in the 2014 Agricultural Act, the increasing severity and extent of wildfires (Goldmark 2012), and the 2015 requirements for inclusion of ecosystem services in federal planning (Donovan et al. 2015) emphasize the magnitude of the forest health issues we are facing as a Nation and the urgency of needed actionable management decisions.

The collaborative groups and partnerships discussed in this study have shown successes in ecosystem stewardship through active forest management and the potential gains for increased job security in local communities (Tapash 2015b; Coalition 2015; NCWFHC 2015). Specifically, the Tapash Collaborative and the Northeast Washington Forestry Coalition are successfully utilizing tools like CFLRP and TFPA to address forest health issues on National Forest System lands. The North Central Washington Forest Health Collaborative is also showing progress in seeking funding for large scale integrated resource management projects due in a large part to the leadership roles of the Yakama and Colville tribes. These examples should be examined as guidance components for an Anchor Forest framework. Where project implementation has been limited or sporadic, success may be improved with consistent well-informed leadership, the inclusion of more diverse stakeholders, increased collaborative capacity, increased public awareness and communication of the problem, and/or the development of more realistic goals and solutions for addressing forest health issues.

Throughout the West, divergent interests are negotiating how they would like particular national forestlands to be managed. Many proposals include provisions for protection of lands, economic development, timber harvesting, forest restoration, and funding mechanisms, among other things (Nie 2011). In order to accomplish their objectives many of these collaborative efforts seek to codify their agreements in law or formalize them in memoranda of understanding (MOUs) with the USFS. Assessments of place-based national forest legislation (Nie 2011; Nie & Metcalf 2015; Nie & Fiebig 2010), suggest success in forest management can be gained through place-based legislation, stewardship contracting, and other existing tools and authorities within the collaborative atmosphere may provide some certainty to stakeholders.

Some of the challenges associated with forest management collaboratives are largely systemic, involving issues at a national scale associated with public land law and governance (Cook & Wilson 2015; Nie & Metcalf 2015), federal environmental laws such as NEPA, National Forest Management Act (NFMA) and the Endangered Species Act (ESA) (Keele et al. 2006; Miner et al. 2010), as well as planning, funding, and organizational/agency culture (Schultz et al. 2012; Butler et al. 2015). For these reasons and others, collaboration is a slow process requiring patience, communication, relationship building, conflict resolution, leadership and commitment to realize the objectives and management needed to restore forest health and the vital ecosystem services provided to our nation by forests.

The programs and tools available for successfully implementing cross-boundary collaborative projects will have varying degrees of suitability and availability depending on the chosen landscape's specific restoration needs and land ownership composition as well as the organizational structure and local collaborative capacity. The programs and tools summarized in this report have been shown to be mostly effective given a stable partnership, a strong willingness to push forward from all of the stakeholders, and good leadership with a clear understanding of the anticipated outcomes.

While a top-down governance structure may not be the best model for a collaborative group in general, the Tapash Collaborative's landowner-based Executive Team and working group/task group structure may be the most applicable to implementing an Anchor Forest project. Any Anchor Forest project will require direct decision-making authority from the various landowners and land management agencies. The mandates and goals of the individual participants cannot be delegated to a collaborative decision-making body, especially given the sovereign rights of the Tribe to have a government-to-government relationship with the federal agencies. However, the opportunities to improve the development of landscape level restoration projects, support the socio-economic needs of the community, maintain restoration infrastructure, and monitor the effects of restoration projects not to mention opportunities to receive funding through programs like CFLRP and increase NEPA efficiencies are gained through a broader stakeholder collaboration effort such as those demonstrated by the North Central and Northeast Washington collaboratives.

An Anchor Forest project can provide guidance to Congress for improving administrative processes and legislative policies that could increase the pace of restoration efforts on federal lands and encourage additional stakeholder participation in the collaborative environment. Many collaboratives are testing the boundaries of the collaborative process with large integrated projects, facing the challenge of representing diverse public interests. An Anchor Forest spanning multiple land ownerships at a regional scale led by collaboration between the U.S. Forest Service and participating Tribal Nations would set a new precedent for collaboration and has the potential to address forest health restoration on a time-scale sufficient to combat increasingly frequent catastrophic wildfire and ecosystem challenges in the face of a changing climate.

Literature Cited

Beckley, T.M. et al., 2008. Multiple capacities, multiple outcomes: Delving deeper into the meaning of community capacity. *Journal of Rural and Community Development*, 3(3), pp.56–75.

Boyle, B., Perez-Garcia, J. & Corrao, M., 2016. *Anchor Forest Pilot Study: Task 6 Report - Recommendations to Quantify Socio-Economic Values of Forestland and Estimate Non-market Benefits of Ecosystem Services*, Moscow, Idaho: Northwest Management Inc.

Burns, S. & Cheng, A.S., 2005. *The Utilization of Collaborative Processes in Forest Planning*, Fort Collins, CO.

Butler, W.H., Monroe, A. & McCaffrey, S., 2015. Collaborative Implementation for Ecological Restoration on US Public Lands: Implications for Legal Context, Accountability, and Adaptive Management. *Environmental Management*, 55(3), pp.564–577.

Chaskin, R.J., 2001. Building Community Capacity: A Definitional Framework and Case Studies from a Comprehensive Community Initiative. *Urban Affairs Review*, 36(3), pp.291–323.

Cheng, A.S. & Sturtevant, V.E., 2012. A framework for assessing collaborative capacity in community-based public forest management. *Environmental Management*, 49(3), pp.675–689.

Coalition, 2015. Northeast Washington Forestry Coalition - Blueprint. *www.newforestrycoalition.org*. Available at: http://www.newforestrycoalition.org/ [Accessed October 24, 2015].

Cook, P.S. & Wilson, P., 2015. *Policies Affecting Implementation of Landscape-scale Treatments on National Forest System Lands at High Risk of Insect and Disease Mortality*, Moscow, Idaho.

Corrao, V., Howisey, G. & Corrao, M.V., 2016. *Anchor Forest Pilot Study: Task 1 Report - Infrastructure for Commodity Production and Biomass*, Moscow, Idaho: Northwest Management Inc.

DNR, 2014. *Eastern Washington Forest Health: Hazards, Accomplishments and Restoration Strategy*,

Donovan, S., Goldfuss, C. & Holdren, J., 2015. Memorandum for Executive Departments and Agencies: Incorporating ecosystem services into federal decision making. , (October 7, 2015), p.5.

Erickson, J., 2016. *Personal Communcation Via E-Mail*, Coulee Dam, Washington: Intertribal Timber Council.

Fitch, R.A., Kim, Y.-S. & Waltz, A.E.M., 2013. *Forest Restoration Treatments: Their Effect on Wildland Fire Suppression Costs*, Flagstaff, AZ.

Gambino-Portuese, B. et al., 2009. Litigants' characteristics and outcomes in US Forest Service land-management cases 1989 to 2005. *Journal of Forestry*, 1, pp.16–22.

Goldmark, P., 2012. Declaration of Forest Health Warning - State faces serious Forest Health Problems and Wildfire Risk. *Washington State Department of Natural Resources*, p.1.

Haugo, R. et al., 2015. Forest Ecology and Management A new approach to evaluate forest structure restoration needs across. *Forest Ecology and Management*, 335, pp.37–50.

Haugo, R.D., 2015. *Tapash Forest Collaborative analysis of forest restoration needs and mechanical treatment opportunities*, Seattle, WA.

IFMAT, 2013. *Intertribal Timber Council: Assessment of Indian forests and forest management in the United States, Volume I*,

Ingalsbee, T., 2010. Getting Burned: A Taxpayer's Guide to Wildfire Suppression Costs. *FUSEE*, p.43.

ITC, 2013. *Fulfilling the Promise of The Tribal Forest Protection Act of 2004: An Analysis by the Intertribal Timber Council in Collaboration with USDA Forest Service and Bureau of Indian Affairs*, Portland, Oregon.

Keele, D.M. et al., 2006. Forest Service Land Management Litigation 1989-2002. *Journal of Forestry*, 104(4), p.7.

Krist, F.J.J. et al., 2014. *2013–2027 National Insect and Disease Forest Risk Assessment*, Fort Collins, CO.

Lippke, B. et al., 2007. *Study 1: Timber Supply and Forest Structure in The Future of Washington's Forests and*

Forestry Industries, Final Report by the College of Forest Resources, University of Washington. Seattle, WA.

Littell, J.S. et al., 2010. Forest ecosystems, disturbance, and climatic change in Washington State, USA. *Climatic Change*, 102(1-2), pp.129–158.

Lolley, M.R. & Bloomfield, B., 2010. Tieton Forest Collaborative – Using Conservation Action Planning for Collaborative Fire and Restoration Planning. , pp.1–3.

Mattor, K., 2013. *Evolving Institutions of Environmental Governance: The Collaborative Implementation of Stewardship Contracts by the USDA Forest Service*. Colorado State University.

Millar, C.I. & Stephenson, N.L., 2015. Temperate forest health in an era of emerging megadisturbance. *Science*, 349(6250), pp.823–826.

Miner, A.M.A. et al., 2010. Twenty Years of Forest Service National Environmental Policy Act Litigation. *Environmental Practice*, 12(02), pp.116–126.

Mortimer, M.. & Malmsheimer, R.., 2011. The Equal Access to Justice Act and US Forest Service Land Management: Incentives to Litigate? *Journal of Forestry*, pp.352–358.

NCWFHC, 2015. North Central Washington Forest Health Collaborative. Available at: http://www.ucsrb.org/ncwfhc/ [Accessed November 18, 2015].

Nie, M., 2011. Place-Based National Forest Legislation and Agreements: Common Characteristics and Policy Recommendations. *Environmental Law Reporter*, 41, pp.10229–10246.

Nie, M. & Fiebig, M., 2010. Managing the National Forests through Place-Based Legislation. *Society and Conservation Faculty Publications*, (Paper 25), pp.1–52.

Nie, M. & Metcalf, P., 2015. The contested use of collaboration and litigation in national forest management. , (October), p.30.

O'Laughlin, J., 2013. *Wildland Fire Management: Are actively managed forests more resilient than passively managed forests?*, Moscow, Idaho.

O'Toole, R., 2007. *The Perfect Firestorm Bringing Forest Service Wildfire Costs under Control*, Washington, D.C.

Ray, L. a., Kolden, C. a. & Chapin, F.S., 2012. A case for developing place-based fire management strategies from traditional ecological knowledge. *Ecology and Society*, 17(3).

Schultz, C. a., Jedd, T. & Beam, R.D., 2012. The Collaborative Forest Landscape Restoration Program: A History and Overview of the First Projects. *Journal of Forestry*, 110(7), pp.381–391.

Snover, A. et al., 2013. *Climate Change Impacts and Adaptation in Washington State: Technical Summaries for Decision Makers*, Seattle, WA.

Tapash, 2015a. *Tapash Strategic Plan*, The Tapash Sustainable Forest Collaborative.

Tapash, 2015b. Tapash Sustainable Forest Collaborative. *www.tapash.org*. Available at: www.tapash.org [Accessed October 23, 2015].

USDA Forest Service, 2010. *Collaborative Forest Landscape Restoration Program (CFLRP) - Tapash Sustainable Forest Collaborative*, Washington, D.C.: United States Department of Agriculture Forest Service.

USDA Forest Service, 2007. *Memorandum of Understanding establishing the Tapash Sustainable Forests Collaborative*, Washington, D.C.: United States Department of Agriculture Forest Service.

USDA Forest Service, 2011. *People Restoring America's Forests: A report on the Collaborative Forest Landscape Restoration Program*, Washington, D.C.: United States Department of Agriculture Forest Service.

USDA Forest Service, 2014. *USDA Forest Service manual - Travel Management*, Washington, D.C.: United States Department of Agriculture Forest Service.

USDOI, 2015. *Budget justifications and performance information fiscal year 2015: Wildland fire management*,

Vose, J.M., Peterson, D.L. & Patel-Weynand, T., 2012. *Effects of climatic variability and change on forest ecosystems: a comprehensive science synthesis for the U.S. forest sector*, Portland, Oregon.

Weber, E.P., 2003. *Bringing society back in: Grassroots ecosystem management, accountability, and sustainable communities.*, Cambridge, MA: Massachusetts Institute of Technology Press.

(This page intentionally left blank)

Task 3 Report: Evaluation of Institutional Capacity

Prepared for the:

Intertribal Timber Council

by

M. Corrao, Ph.D, D. Dolsen, and J. O'Laughlin, Ph.D.

Northwest Management, Inc.

January 2016

(This page intentionally left blank)

Introduction

Anchor Forests are intended to provide a foundation to foster collaboration and cooperation across ownership boundaries and among disparate interests. The Anchor Forest concept is based on the triple bottom line of balanced social/cultural, economic, and ecologic sustainability through maintaining healthy working forests. An Anchor Forest is a contiguous area of land with four major characteristics:

- ✓ A reasonable expectation for sustainable wood commodity production as a major management objective; and
- ✓ Production levels sufficient to support economically viable manufacturing, processing, and work force infrastructure within accessible transportation; and
- ✓ Long-term management plans, supported by inventory systems, professional staff, and geographic information systems; and
- ✓ Institutional and operational capacity for implementation.

The overarching goal of this assessment was to evaluate regional partners and stakeholder interest in operationalizing cross-boundary forest management projects, based on the Anchor Forest concept, using collective resources, knowledge, expertise, and information. This task provides an assessment of perceived institutional capacity regarding on-the-ground implementation of an Anchor Forest Pilot Project (AFPP) as provided by interview participants in the South Central, North Central, and Northeast regions of Washington State (Figure 37). To accomplish this, perspective participants were identified in each region as described in Corrao et al. (2015). Meetings were accomplished via teleconference and in-person interviews. Supporting information has been provided through a review of existing literature and citations are provided at the end of the document following numerical reference within the text.

Prior to this assessment a questionnaire was prepared and sent to individuals identified by members within each region, and their participation was requested for stakeholder meetings (O'Laughlin & Corrao 2016). Target participants included: The U.S. Forest Service, state agencies, private industry, Indian tribes and environmental organizations. In the South Central (SC) and Northeast (NE) study regions, 10 participants provided responses to interview questions targeting their perceived capabilities and the resources available for implementation of an AFPP. It should be noted that stakeholders from the NC region overlapped greatly with those in the NE region and differences between the NE and NC study regions, when identified by interviewees, are presented. However, to avoid duplication, interviews conducted for overlapping participants were assumed to be representative of both regions and presented in aggregation.

Across all regions the majority of participant responses suggest support for investment in, and implementation of, an AFPP. An expectation of respectful partnerships and successes addressing currently poor forest health conditions was raised during interviews and has been found to be a motivating factor in other studies (Cook & O'Laughlin 2014; O'Laughlin 2013; Krist et al. 2014). Additional value for stakeholders can be achieved through steps taken to address policy that can support collaborative tools such as stewardship contracting, landscape-scale treatment areas, and the good neighbor authority (ITC 2013; IFMAT 2013). Respondents noted protection of the "collaborative process" is needed in order to encourage outsiders to join the process and

discourage non-participant litigation and appeals. This finding is similar to other studies regarding federal agency forestland management decisions and planning (Keele et al. 2006; Stern & Mortimer 2007).

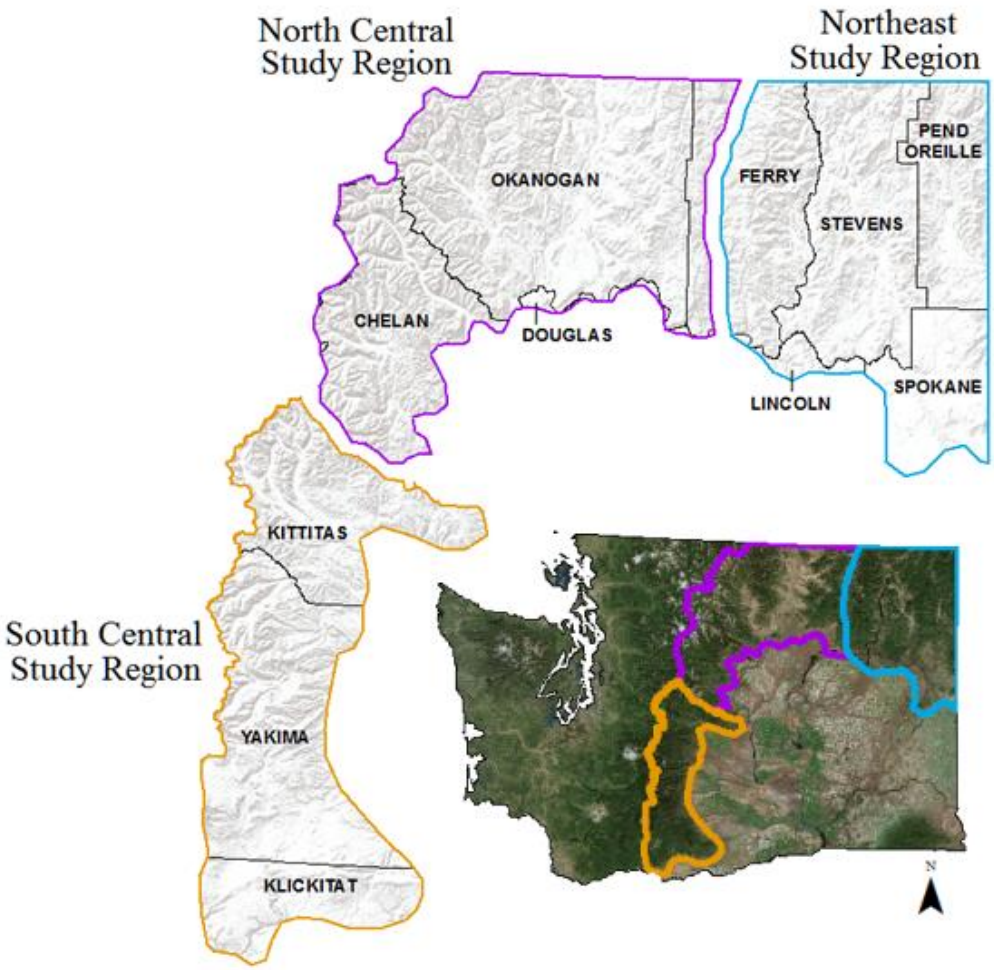


Figure 37. Study regions in eastern Washington State for interviews of the perceptions and potential feasibility of an Anchor Forest Pilot Project given current project demands and institutional capacities.

Collaboration under the Anchor Forest concept would produce on-the-ground restoration of forest health, ecosystem resiliency, long-term economically-sustainable forest management, local jobs, and community support. The feedback from interviewed participants demonstrates perceptions regarding the success of an AFPP and the resources needed to achieve success and maximize the value of a collaborative approach. Recommendations based on interview responses, in support of a successful AFPP, are provided at the end of this report.

Survey Methodology

This research took place in Washington State east of the Cascades, where degraded forest health conditions resulting from insects, disease, and wildfire have been amplified though reductions in forest management infrastructure, job losses and litigation surrounding forest land management. The combination of these factors has impacted the sustainability of forest ecosystems throughout eastern Washington (IFMAT 2013). Within the three study regions of eastern Washington (Figure 37) Northwest Management Inc. (NMI) staff met with Tribal representatives to discuss the Anchor Forest concept and the potential for interest in an AFPP. Tribal Nations within these study regions included the Yakima Nation in the SC region, the Colville Tribe in the NC region, and the Spokane and Coeur d'Alene Tribes in the NE region. Initial meetings were also used as scoping/stakeholder-identification forums to assess participation in the AFPP. Scoping meetings were conducted during October 2013, November 2013, and January 2014 for the NE, SC and NC regions, respectively (O'Laughlin & Corrao 2016).

Following these initial meetings NMI requested a master list from each of the participating tribes identifying agencies, organizations, private industries, and other interested stakeholders they believed should be included as stakeholders for an AFPP. The Yakima Nation (SC region) and the Colville Tribe (NC and NE regions) expressed interest in the AFPP process and developed detailed lists of anticipated stakeholder participants. The Spokane and Coeur d'Alene Tribes did not express interest in the AFPP and subsequently did not provide a list of potential stakeholders. Additionally, there was substantial overlap in interviewees identified for both the NC and NE regions, therefore response analysis focused on aggregate survey data from the NE/NC regions and provided a comparative analysis of these regions to the SC region. Aggregate responses for the NE/NC regions were assumed to be an accurate representation of both regions for analysis purposes and provided a secondary benefit of reduced respondent redundancy.

Using the master lists provided by participating tribes (O'Laughlin & Corrao 2016) and feedback from the initial scoping-meetings, a paper survey was developed. This survey included questions regarding respondent assessments of current timber supply, existing institutional structure and capacity (e.g., staff, equipment, facilities, and internal support), willingness to participate, and availability of informational resources in relation to an Anchor Forest project targeting forest ecosystem function. The target audience included all tribal, state, federal, university, and private parties currently working in the forest management sector as well as any others interested in the health and resilience of forestlands. Surveys were mailed to all participants April 1st 2014 and preliminary results (O'Laughlin & Corrao 2016) were presented at a series of focus group meetings on April 28th 2014 in the SC and NC study regions.

Following the focus group meetings, a list was compiled (Table 21) identifying the survey participants interested in the Anchor Forest concept and a future AFPP. Leaders and managers within the identified participant entities were then interviewed to gather feedback regarding the institutional capacity, existing or needed, in support of an Anchor Forest project. Interviews were conducted both in-person and over the phone throughout 2014. Interview responses are provided throughout this report and AFPP recommendations based on interview responses were developed.

Table 21. This table provides a list of the industry, agency, private, and institutional participants interviewed regarding timber supply, institutional structure and capacity, willingness to participate, and the availability of informational resources in relation to an Anchor Forest Pilot Project.

Participant - Business Sector	Count by Region		
	South Central	Northeast	North Central
Federal	1	2	**
Tribal	1	1	**
State	1	1	**
Environmental	1	*	*
Private	1	2	1

* Interviewees were not contained to one geographic region and responses were applied to multiple regions.

** Interviewees overlapped in jurisdiction with the Northeast region and responses were applied to both the Northeast and North Central analysis.

South Central Study Region

The SC study region encompasses the Kittitas, Klickitat, and Yakima Counties. There were five participants interviewed during September, 2014 from the SC region regarding their organizations capacity and willingness to engage in an Anchor Forest project (Table 21). Interview results revealed a variety of expressed or perceived definitions of what an Anchor Forest would be as well as the sector-specific needs for each of the forest management categories presented in (Table 22). For this study we defined institutional infrastructure and capacity as the staff, equipment, facilities, and managerial support available for investment in an Anchor Forest landscape-scale management strategy in addition to existing operational requirements.

South Central Region Stakeholder Interpretations of "Anchor Forests"

When asked to provide an explanation of what Anchor Forests are, collectively respondents touched on holistic ecosystem relationships, collaboration across land ownerships, and inclusion of Indian forestlands as well as the importance of tribal engagement. Individual stakeholder responses however, did not fully envelope the Anchor Forests concept and revealed an opportunity to emphasize the value identified in an AFPP by all stakeholders as well as a need for increased communication of the purpose and objectives of an AFPP.

> ***Federal:*** *Anchor Forests are a way for federal forests to partner with adjacent tribes to keep mills running, keep infrastructure in place (or put new infrastructure in place), promote jobs, a healthy economy, and a healthy environment. There is value in avoiding expensive, very destructive large scale fires, and maintaining natural spaces not taken over by subdivisions.*
>
> ***Tribal:*** *Anchor Forests are a multi-landownership base whose partners support long-term sustainable forest management, backed by some level of infrastructure, and technical expertise, endorsed publically and politically to achieve the management objectives of the various landowners.*
>
> ***State:*** *Anchor Forests are looking at how tribal lands can provide mutual benefits to surrounding lands or neighbors.*
>
> ***Environmental:*** *Anchor Forests engage and integrate Native Americans beyond tribal boundaries in forested landscapes by incorporating tribal personnel to achieve multiple benefits from active management and restoration goals supporting social, economic, and ecological outcomes.*
>
> ***Private:*** *Anchor Forests are sustainably managed forest ecosystems that provide an annual flow of forest products, integrate multiple stakeholders in different ownerships, and maintain economic, social, cultural, and environmental integrity.*

Table 22. This table provides a summary of participating stakeholder responses from the South Central study region, distinguished by business sector, regarding staff needs at the current time followed by a description of each forest management function category.

Business Sector	Current Full-Time Employees (FTEs)	Forest Management Planning[1]	Forest Development[1]	Forest Protection/ Restoration[1]	Forest Product Sales[1]	Milling Operations/ Processing[1]
Federal	45	+10	+5	0	+4	4
Tribal	50	+2	+5	+4	+7	-[a]
State	10	+1	+1-2	0	+1-2	-[a]
Environmental	8	NA	NA	NA	NA	NA
Private	200	-[a]	-[a]	-[a]	-[a]	+86

[1] No. of Full-Time Employees that respondents believed are needed prior to establishment of an Anchor Forest.
[a] Response not provided during interview.

South Central Region Capacity by Forest Management Category

Five forest management task categories were used for analysis of institutional capacity through the assessment of time and staffing resources allocated within each category for current work obligations. A description and the perceived percentage of time and staffing resources dedicated to each category are presented in the following by organizational/industry sector interviewed. The five categories used for classification included:

- ✓ Forest Management and Inventory Planning
- ✓ Forest Development
- ✓ Forest Protection
- ✓ Forest Product Sales
- ✓ Milling and Processing

The *Forest Management and Planning* category includes policy, budget, oversight, program administration, administration support, multi-use management and forest research. Within the SC region federal participants stated 40% of their time and personnel resources were currently committed to this category (Figure 38), and that there is a need for 10 additional full time employees (FTEs) to reach full capacity with current workloads and to participate in an AFPP. Similarly, environmental, tribal, and state respondents indicated time and employee resources for forest management planning were significant at 40%, 25%, and 10% respectively, however significantly fewer or no new FTEs were needed to reach full capacity and participate in an AFPP (Table 22). Respondents from the private sector did not comment on time and staffing resources needed in this category to participate in an AFPP.

The *Forest Development* category includes reforestation, stand improvement, and road design/construction/maintenance. Tribal and federal participants reported time and staffing resources of 25% and 30% respectively, allocated toward current forest development tasks (Figure 38), and each identified the need for five additional FTEs to accomplish current workloads and participate in an AFPP (Table 22). Similarly, State respondents reported current

time and staff resource allocations of 35% for forest development work, however only one or two additional FTEs would be needed to become fully staffed and participate in an AFPP. Environmental organization respondents reported an allocation of 15% of staff time devoted to aspects of forest development with no need for new staff to address current projects and support an AFPP. Respondents from the private sector did not comment on the time and staffing resources available or needed for forest development in the SC region.

The *Forest Protection and Restoration* category includes fire-fuels management plans, trespass, fire preparedness, applied fuels management, endangered species, forest rehabilitation, and forest related education and training. The environmental organization and tribal participants reported current time and staffing resources of 20% and 25% respectively, allocated toward forest protection tasks (Figure 38). The tribal entity was the only respondent in the SC region in need of additional FTEs (four) for forest protection and restoration to accomplish current workloads and fully participate in an AFPP (Table 22). State and federal respondents reported a 10% and 15% respective allocation of time and staff resources to current forest protection tasks with no additional staff needed to participate in an AFPP. Respondents from the private sector did not comment on time and staffing resources for this category.

The *Forest Product Sales* category includes timber and non-timber pre-sales, sales, and administration. Tribal respondents indicated 25% of time and staff resources were currently dedicated to forest product sales (Figure 38), with a need for seven additional FTEs to accomplish current workloads and participate in an AFPP (Table 22). State participants noted nearly half of their time and staff resources (45%) were currently committed to forest product sales, however only one to two new FTEs were needed to fully staff current demands and support an AFPP. Federal and environmental organization participants reported spending 15% and 10% of staff time and resources respectively, on forest product sales, with a need for four more federal, and no environmental, FTEs to accomplish current workloads and join an AFPP. Respondents from the private sector did not comment on time and staffing resources within this category or potential needs required to participate in an AFPP.

The *Milling Operations and Processing* category includes milling of delivered timber and processing of finished products both timber and non-timber. Private respondents operating saw mills within the area indicated nearly 100% of time and staff resources are currently devoted to milling and processing (Figure 38). An assessment of the industry infrastructure showed there were two mills in operation within the SC region and together they made up the entire processing infrastructure. These facilities are currently operating at about 66% capacity and employ 200 FTEs. Considering forest restoration needs and a subsequent increased timber supply following the establishment of an AFPP, respondents anticipate the need for 50 to 86 new FTEs to reach full operational capacity at both facilities (Table 22). Environmental organization participants indicated current staff and resources allocations of 15% to milling and processing with no additional new staff needed to complete current workloads and participate in an AFPP. Tribal, state, and federal participants did not have time or staff resource commitments in this category and did not know what would be needed to support an AFPP.

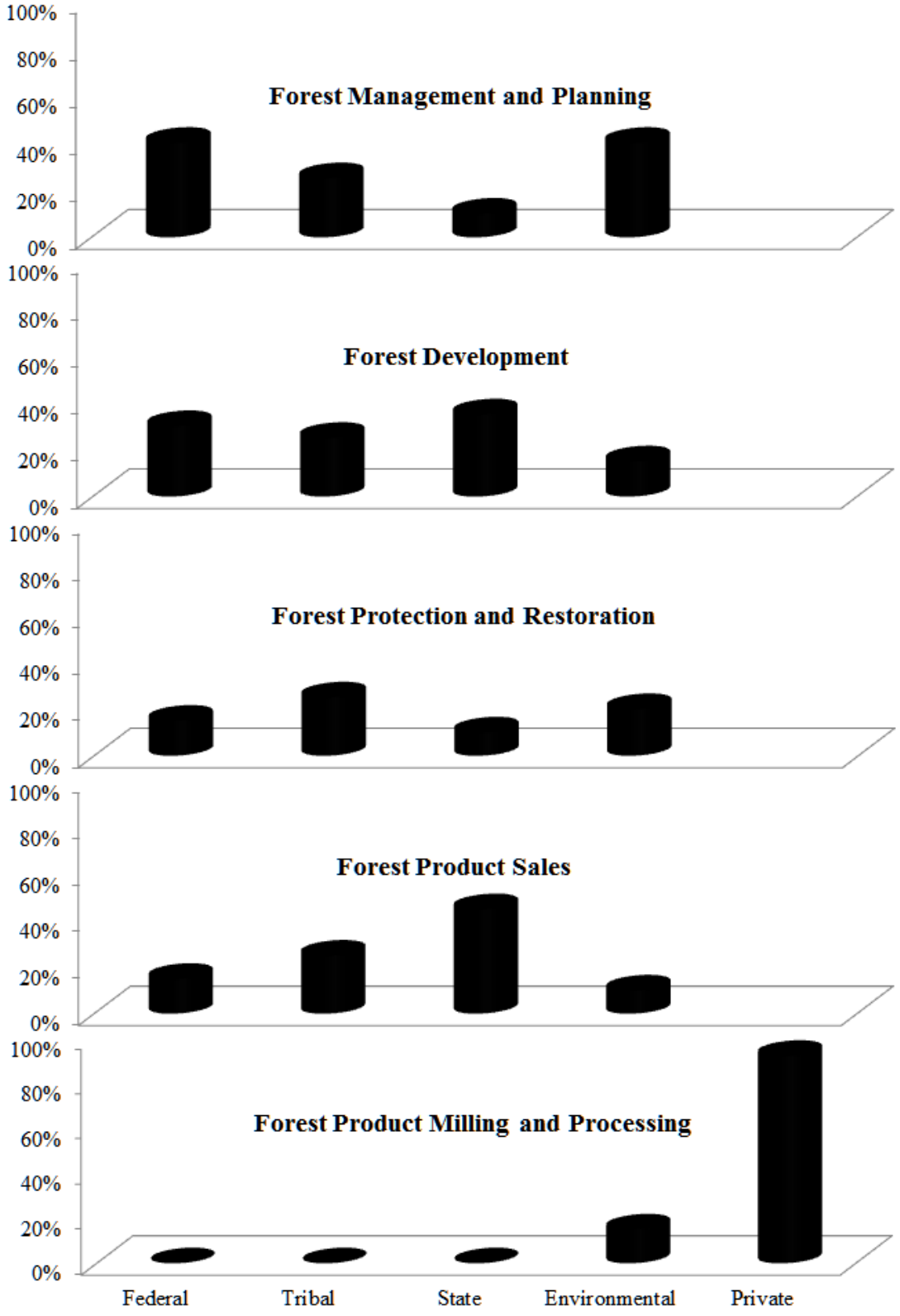


Figure 38. Perceived percentage of time and staffing resources dedicated to each of the five management categories used to assess the capacity of organizational/industry sector to participate in an Anchor Forest Pilot Project.

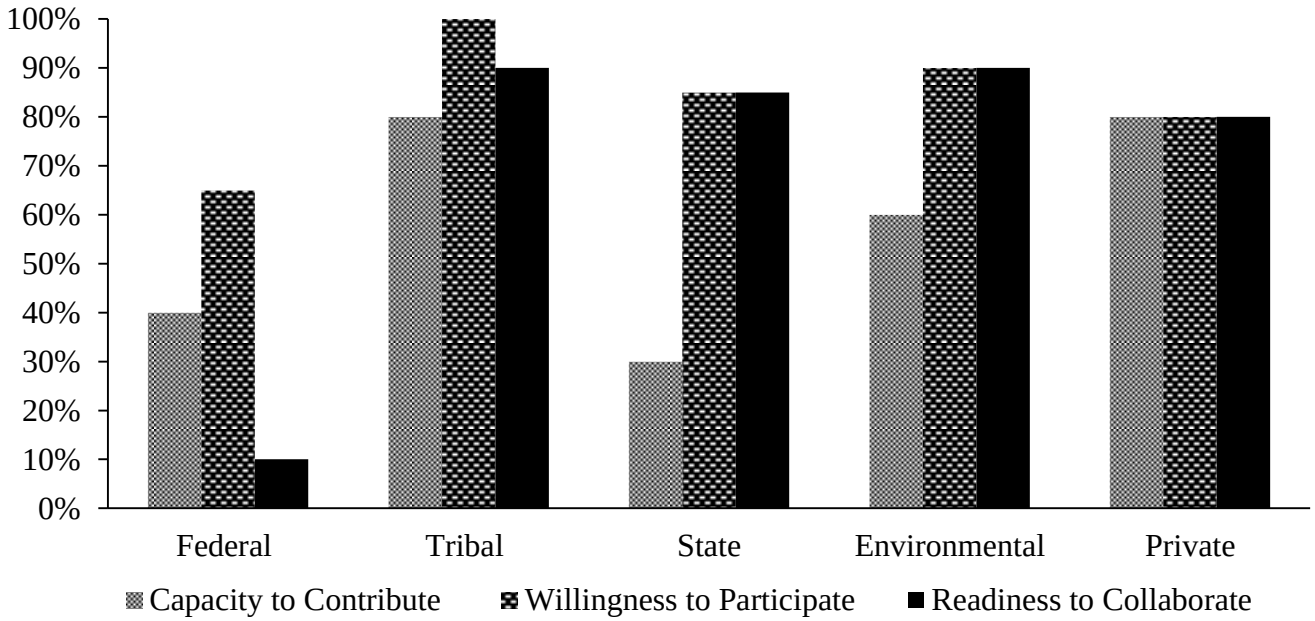
South Central Region Overall Capacity, Willingness, and Readiness

All surveyed participants within the SC region indicated their organization had some level of capacity to contribute to an AFPP; with tribal and private sector participants having the greatest perceived capacity to contribute and tribes also indicating a similarly high perceived willingness (verbalized desire to participate in an AFPP) and readiness (physical staffing and tangible resources available to put toward an AFPP) to participate (Table 23). State and environmental organization participants had the highest perceived willingness and readiness to participate collaboratively, while the federal participants offered the lowest overall capacity, willingness and readiness (Table 23). The federal respondents noted internal and external staff, policy, and regulation barriers were limiting factors controlling their participation in an Anchor Forest project.

Table 23. Interviewee responses regarding capacity, willingness, and readiness to collaborate in an Anchor Forest pilot project within their region.

Business Sector	Overall Capacity to Contribute[1]	Overall Willingness to Participate[1]	Overall Readiness to Collaborate[1]
Federal	4	6.5	1
Tribal	8	10	9
State	3	8.5	8.5
Environmental	6	9	9
Private	8	8	8

[1] Rankings were provided by interviewees on a scale of 0 to 10, with "0" being "Not at all" and "10" being "Extremely High" when asked about an Anchor Forest project.



South Central Region Willingness to Share as an Anchor Forest Participant

The willingness of region participants to share equipment, facilities, staff, and institutional support (e.g., leadership commitment) varied from sector to sector with the federal respondents perceiving the lowest willingness of their organization to share as compared to all others. All other respondents believed there were supportive resources and/or leadership personnel available to support an AFPP. Private sector participants were not available to interview for this section and subsequently no comments on opportunities and barriers we provided. Survey responses by sector are shown below for each participating sector.

> ***Federal:*** *Nothing to spare. Policies have been so constraining that there is less than nothing left. Respondent noted "[the] Late-Successional Reserves (LSR): dictate management actions be neutral or of beneficial effect to old growth forest" creating challenges for any management efforts on many forest lands.*

> ***Tribal:*** *There is great upper management, staff commitment, and leadership ability from tribal members and Tribal Council to lead and support an AFPP across all partners in adjacent land ownerships.*

> ***State:*** *We need to have WA DNR leadership commitment allocating staff and budget resources for our agency so an AFPP will succeed. Success is expected to support the livelihood of those relying on forestland employment, increasing community vitality and ensuring long-term, sustainable forest health and economic benefits.*

> ***Environmental:*** *Our sector 'model' centers on working with diverse landowners to improve forest health protection, forest development, and management planning. We have already completed projects at the regional and watershed level (90,000 acres) to test both the implementation of an Anchor Forest concept and landowner successes in increasing the pace of planning and scale of forest restoration. Much of this work has been accomplished with the Tapash Sustainable Forest Collaborative.*

South Central Region Priorities for Anchor Forest Project Participation

All study participants were asked to share their thoughts on what the highest priority needs are for their participation in, and success of, an AFPP. Responses from the participants in the SC region are summarized below by institutional sector, with the exception of the private sector as there were no interviewees available for interview on the topic.

> ***Federal:*** *Streamline & simplify policy, i.e., NEPA, Endangered Species Act focus only based upon today's habitats, not the needed future habitat conditions; In Okanogan-Wenatchee Forest only 17 sections can be managed for timber production/conservation, e.g., Western larch will eventually not be recoverable due to ESA/NEPA policy restrictions (a recent sale in the LSR area was highly successful for Western larch habitat). Sister agencies have too short a time frame and limited reference on how to allow USFS to competently manage 200,000*

acres; 460 sections of old growth forest; 443 sections are in LSR; and only 17 sections not limited by managerial restrictions.

Tribal: *There is a need to dedicate "key" staff to participate in the AF concept, where "key" staff are qualified, capable, competent and motivated people. Tribes need to be driving this process, and not all tribes have the resources, or "key" staff, to spare for this commitment. Tribes need to support position(s) from the top down in their respective organizations. Tribes need to address the question, "What's in it for us?" in that the outcome of a successful project needs to be measurable and have some positive value for Tribes. An easy metric may be a log supply, but it could also mean work for tribal members and/or tribal enterprises. Restoration of treaty right lands may be a metric of success, but far less measurable and to a degree, dependent on the person viewing the restoration project. Projects should all be multi-ownership and all parties should be able to identify and define the respective benefits.*

State: *Partner cooperation via the Tapash Collaborative is critical and can help our leaders further demonstrate cross-boundary pilot projects work and that a large-scale Anchor Forest project will succeed if everyone comes to the table.*

Environmental: *Additional assistance with forest product sales as well as milling, and processing infrastructure.*

South Central Region Opportunities and Barriers

In order to better understand how each participant could contribute to the success of an AFPP, respondents were asked to identify opportunities and barriers in each of the five forest management categories. Responses provided for each category, by correspondent, are listed below.

Forest Management & Planning

Opportunity

Tribal: *Can offer a very good continuous inventory, a dedicated team for forest/stand analysis, and have technical assistance available.*

State: *Can assist with budget savings, ecological applications, and administration support.*

Environmental: *The work already being done will help better meet the goals of how much and where to harvest, at a regional scale. Already have experience working within multiple watersheds across multiple landowners to coordinate planning and implementation. Tribal Forest Protection Act may open some doors for better collaboration among participants.*

Barrier

Federal: *Federal employees believe they are underfunded currently regardless of the establishment of an Anchor Forest. The application of policies and regulations varies within and between agency staff. Federal statutes and legislative requirements for monitoring requirements and assessments, such as those in the NEPA, ESA and others, consume a great deal of staff time and resources, further complicated by threatened or filed litigation.*

Tribal: *Lacking a full time professional for forest measurements and inventory.*
State: *Policies and procedures vary between collaborators and impede planning and management functions.*

Forest Development

Opportunity

Tribal: *We have experienced staff and qualified contractors available for timber sales, reforestation, and forest improvements such as thinning, burning, planting, fisheries, water resources etc.*

State: *The State is interested in having the tribes inform them on how to best protect tribal cultural sites. The tribe can provide input and expertise on water and fisheries issues and possibly share in staffing needs for stand improvement activities, if cultural-site policy can be modified.*

Environmental: *Explore potentials around stewardship contracting with the USFS for tribes.*

Barrier

Tribal: *Our own in-house work has limited contractor availability and can present unique challenges related to cultural resource values and differences in tribal and non-tribal culture.*

State: *Cross-boundary work seems to be hampered by a lack of shared resources on each participant's land. State agency budget enables contractual work at a lower cost than others (often lower than the tribe can provide). We need supplemental grant dollars and budget enhancements to get more done in collaboration with tribes.*

Forest Protection and Restoration

Opportunity

Tribal: *We have a highly experienced forest protection staff available to work at many levels within the Anchor Forest concept.*

State: *At the state level we are capable of integrating tribal and state agency (DNR) fire programs. We can assist the Yakama Nation in their efforts through budget and/or policy decisions.*

Barrier

Federal: *Oversight agencies (USFWS) are operating in gridlock with USFS; Litigation, law and polices all impact the management of fuels and have led to increased wildfire and related costs thus delaying forest restoration; Many federal employees see a lack of coordination between federal regulatory agencies who are not actively at the table during collaborative processes, yet still affect decisions.*

Tribal: *We are facing a shrinking work force due to retirement and staff work requirements – both from technical and physical standards (fire and fuels courses) inhibiting new staff recruitment; a need to spend time both on and off the reservation.*

State: *Present policies limit where the DNR can apply management. Fighting fires in or near the tribal reservation is challenging due to culturally significant resource areas.*

Forest Product Sales

Opportunity

State: *There is a bid advantage for the tribe due to close proximity of Yakama Mill (lower transport costs).*

Environmental: *We see an opportunity to collaboratively market active forest management for mills and consumers to emphasize the triple-bottom-line economic, ecologic, and social benefits of an Anchor Forest project.*

Barrier

State: *Sales cannot be sold directly to tribes; Washington DNR must go to auction to sell timber so tribes are not guaranteed a supply from State sales.*

Milling Operations and Processing

Opportunity

Tribal: *A diverse forest in the eastern Cascades has an array of species and gentle topography affording efficient timber sale layouts and restoration prescriptions. There are tribal forests in the south central region that provide a good example of a working forest where sustainable harvest of more than 70-80 million board feet has occurred, yielding an aesthetically pleasing, fire resilient, healthy landscape.*

Private: *The milling facilities currently in place are operating at about two thirds capacity and would be able to accommodate additional harvest volume produced by an Anchor Forest project, therefore bringing mill operation up to optimized full-manufacturing capacities.*

Barrier

> ***Tribal:*** *We are limited on management options on federal lands and in many places where unhealthy forest conditions exist. Additionally, management restrictions such as those of the NEPA and ESA monitoring and assessment requirements as well as a lack of funding to address T&E issues is still a challenge and delay to applications of active restoration procedures.*

South Central Region Institutional Capacity - Summary

Survey participants varied regarding overall institutional capacity in support of an AFPP as there were three respondents highly motivated and able to participate and two under opposing circumstances. Given a maximum of 10; tribal and private sector survey responses indicated a capacity of 8, environmental organizations 6, and federal and state entities reported the most limited capacity at 4 and 3, respectively. Tribal, state, and environmental participants offered to share resources such as staff, expertise, and equipment, with the caveat that their commitment to do so would depend, to a degree, on availability and timing as well as the level of leadership required. Federal participant responses were less optimistic indicating no spare resources were available for an AFPP.

Many of the SC regional participants have substantive portions, 20-40%, of staff time and resources focused on Forest Management and Planning (Figure 38) and many mentioned the need of more full-time staff in order to participate in an AFPP. The Forest Development and Forest Product Sales categories had the next highest demand on time and staffing resources ranging from 10-45%. For the private sector, an operational capacity increase of 30% would be needed for existing milling facilities to reach their full capacity and better support an AFPP. In general, the aggregate responses of all participants noted the highest priority-needs for a successful project were funding, staffing, and leadership, coupled with policy changes that reduce the barriers currently delaying forest restoration actions and discouraging some from fully participating in collaborative efforts.

While policies present obstacles across most forest management actions, specific barriers noted by SC participants were: an aging workforce, reduced availability of contractors, diminished capacity to conduct forest development work, appeals and litigation, funding, and an inability to maintain competitive prices for forestry services and products. Despite the many challenges identified by SC region participants there was a general consensus that Forest Development and Forest Product Sales can be improved, in impact and efficiency, if partners collaborate within an Anchor Forest framework focused on the triple-bottom-line of social/cultural, economic, and ecological sustainability.

Northeast & North Central Regions

The NE and NC regions are separate geographic areas (Figure 37), however there is substantial overlap in state, federal, tribal, and private sector participants; therefore, this section presents aggregate interview responses for most questions and draws attention to specific differences between regions where available. The NE study area is located predominantly in Ferry, Lincoln, Pend Oreille, Spokane, and Stevens Counties of northeast Washington, while the NC study area is located within the Chelan, Douglas, and Okanogan Counties of north-central Washington. Institutional infrastructure and capacity refer to the staff, equipment, facilities, and managerial support available for investment in an AFPP in addition to existing work obligations. There were four participants interviewed in the NE region during September, 2014 and one additional (non-overlapping) participant from the NC region not accounted for in the NE region interviews (Table 21). Interview results revealed a variety of expressed or perceived definitions of what an Anchor Forest would be, as well as the sector-specific needs for each of the forest management categories (Table 24).

NE and NC Region Stakeholder Interpretations of "Anchor Forests"

When asked to provide an explanation of what Anchor Forests are, collectively respondents touched on holistic ecosystem relationships, collaboration across land ownerships, and inclusion of Indian forestlands and tribal engagement. Individual stakeholder responses however, similar to the SC region, did not fully describe the Anchor Forest concept further revealing an opportunity to emphasize the value of an AFPP as well as a need for increased communication regarding Anchor Forest goals and objectives.

> ***Federal:*** *A forest that provides all the economic, social, and cultural benefits to a region/area. To provide an opportunity for tribes to manage off-reservation lands and develop a coordinated effort that will provide forest products and economic benefits to local communities.*
>
> ***Tribal:*** *An Anchor Forest is a forest that operates on a sustained yield basis supporting restoration of forest health and forest management infrastructure for local communities, as well as provides a triple-bottom-line of cultural, economic, environmental benefits.*
>
> ***State:*** *Anchors Forests are the tribes looking at collaboratively managing forests more globally rather than at a smaller landowner scales. This encompasses how the federal, state, and tribal forests relate to, and cooperate with, one another.*
>
> ***Private:*** *Anchor Forests are a collaborative effort to restore forest health and support local communities using forest management.*

Table 24. This table provides a summary of participating stakeholder responses from the North Central and Northeast study regions, distinguished by business sector, regarding staff needs at the current time followed by a description of each forest management function category.

Business Sector	Current Full-Time Employees (FTEs)	Forest Management Planning[1]	Forest Development (Silviculture)[1]	Forest Protection/ Restoration[1]	Forest Product Sales[1]	Milling Operations/ Processing[1]
Federal	210	+3	+6	0	+6	+0
Tribal	120	+8	+8	+0	+10	+0
State	-[a]	-[a]	-[a]	-[a]	-[a]	-[a]
Private	80	+0	+0	+0	+0	+0

[1] No. of Full-Time Employees that respondents believed are needed prior to establishment of an Anchor Forest.

[a] Response not provided during interview.

NE and NC Region Capacity by Forest Management Category

Within the same five forest management task categories as described in the SC region (page 10); analysis of institutional capacity through the assessment of time and staffing resources allocated within each category for current work obligations was also completed for the NE and NC regions. A description and the perceived percentage of time and staffing resources dedicated to each category are presented in the following by organizational/industry sector interviewed.

The *Forest Management and Planning* category includes policy, budget, oversight, program administration, administration support, multi-use management and forest research. The federal respondents stated 25% of their time and personnel resources were currently committed to this category (Figure 39), and that there is a need for three additional full time employees (FTEs) in the NE region to reach full capacity and participate in an AFPP, given current obligations. Similarly, tribal respondents indicated time and employee resources for forest management and planning were significant at 35% with the need for eight additional FTEs to reach full capacity and adequately support an AFPP (Table 24). State and environmental organization respondents did not comment on time and staffing resources, or other needs required, to participate in an AFPP within this category. Private sector participants did not comment on current staff allocation; it was mentioned that no additional staff were required.

The *Forest Development* category includes reforestation, stand improvement, and road design/construction/maintenance. Tribal and federal participants within both the NE and NC regions reported current allocations of time and staffing resources at 35% and 25% respectively, for forest development (Figure 39). Both sectors for these regions also identified the need for six to eight additional FTEs to accomplish current workloads and participate in an AFPP (Table 24). State and environmental organization respondents did not comment on current time and staffing resources for this category. The private sector respondents stated there was no need for additional staff at this time.

The *Forest Protection and Restoration* category includes fuels management plans, trespass, fire preparedness, applied fuels management, endangered species, forest rehabilitation, and forest

related education and training. Tribal and federal participants reported current time and staffing resources of 20% and 25% respectively, allocated toward forest protection tasks (Figure 39). The tribal entity specifically in the NE region, indicated the need for additional FTEs in support of an AFPP, however they were unsure of the number required (Table 24). State and environmental organization respondents did not comment on time and staffing resources for this category and private sector participants stated there was not a need for additional staff to support an AFPP.

The *Forest Product Sales* category includes timber and non-timber pre-sales, sales and administration. Tribal and federal respondents indicated current time and staff resource allocations of 10% and 25% respectively were dedicated to forest product sales (Figure 39), with a need for an additional six to ten FTEs required to accomplish current obligations and participate in an AFPP (Table 24). Private sector participants only in the NE region said 100% of their time and staff resources were dedicated to forest product sales however; there was no need for additional staff to accomplish current workloads and support an AFPP. State and environmental organization respondents did not comment on time and staffing resources for this category.

The *Milling Operations and Processing* category includes milling of delivered timber as well as processing of any finished products both timber and non-timber. Current infrastructure assessments provided by Corrao et al. (2015) show there are two mills in operation within the NC region and six mills in operation within the NE region together making up the total processing infrastructure for these regions. The interviewer was not able to reach any of these processing facilities despite multiple contact attempts. Tribal, state, and federal interview participants did not have time or staff resources currently committed to this category (Figure 39), and were unsure of the required staffing and resource needs required to support an AFPP. Environmental organization respondents did not comment on time and staffing resources for this category.

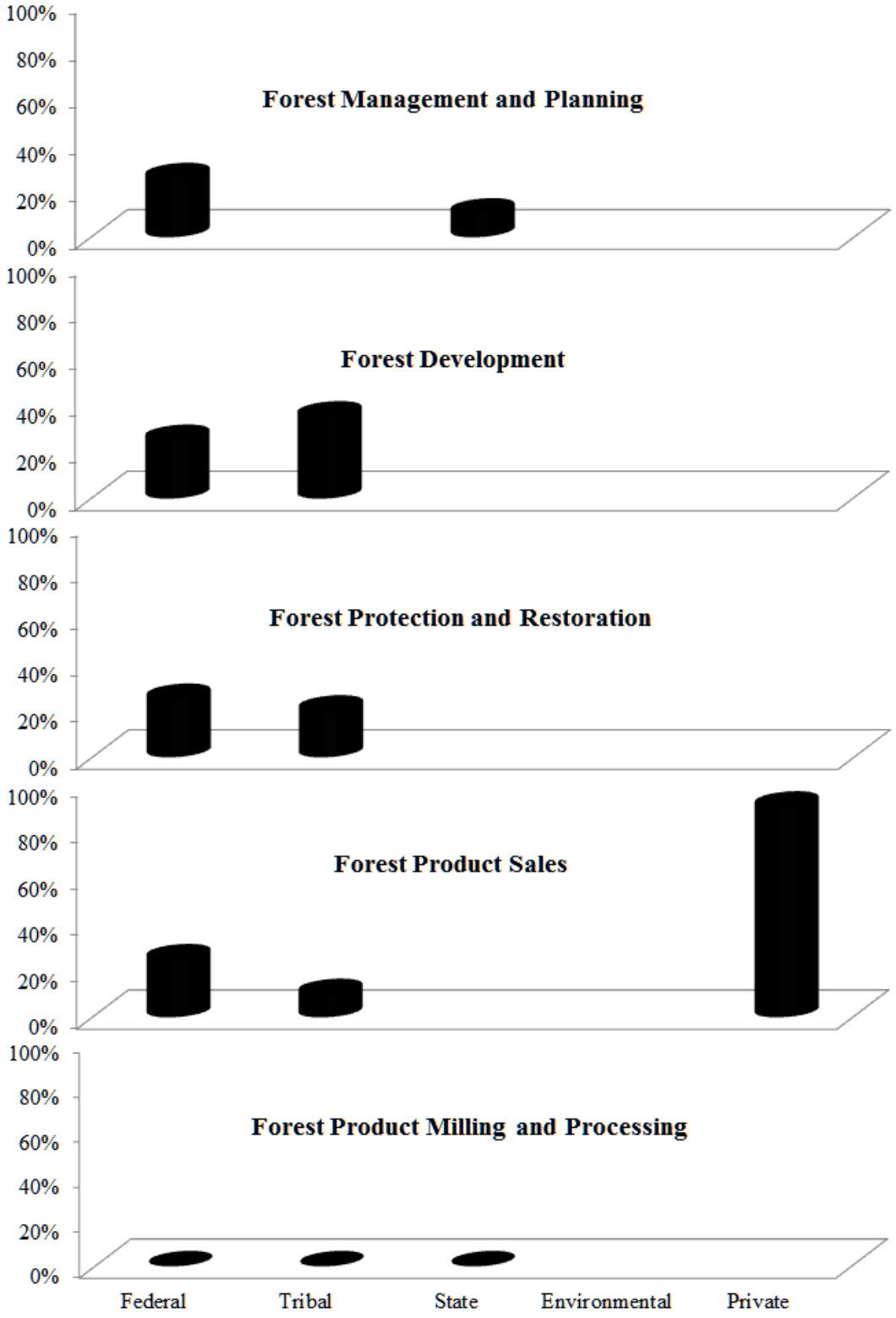


Figure 39. Perceived percentage of time and staffing resources dedicated to each of the five management categories used to assess the capacity of organizational/industry sector to participate in an Anchor Forest Pilot Project.

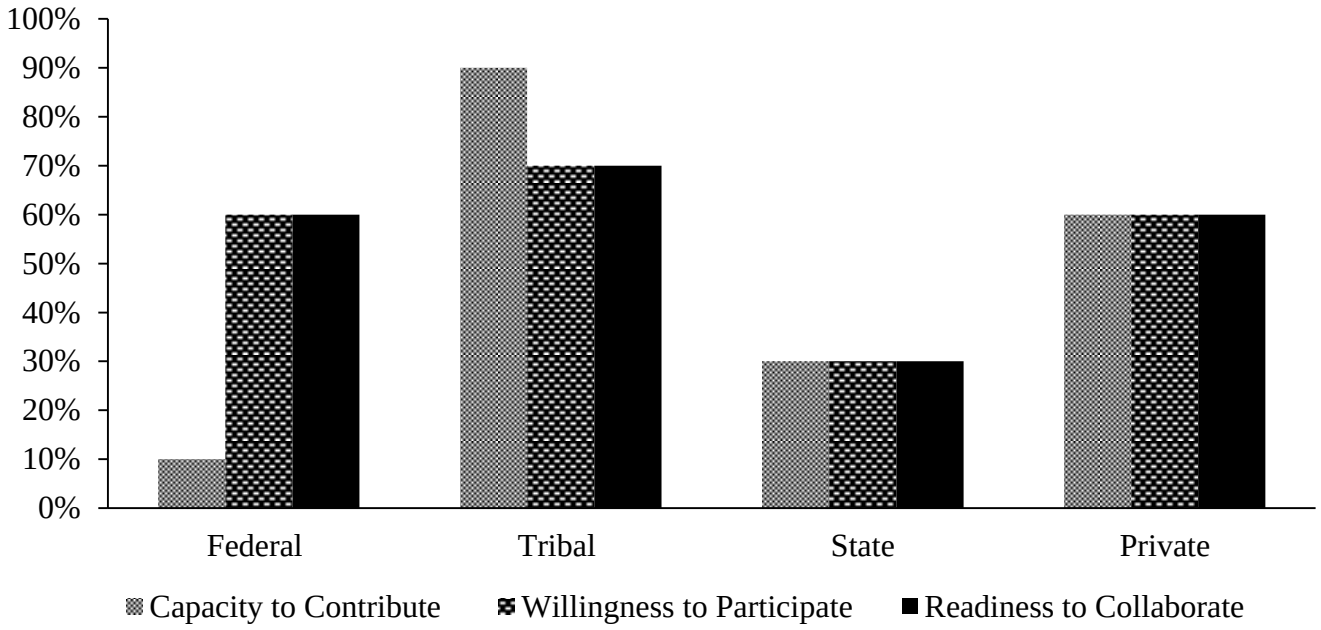
NE and NC Region Overall Capacity, Willingness, and Readiness

All surveyed parties in the NE and NC regions indicated their organization had some capacity (infrastructure, organization, leadership, and management) to contribute to an Anchor Forest-based project, with tribal and private sector participants having the greatest perceived capacity to contribute as well as the highest perceived willingness (verbalized desire to participate in an AFPP) and readiness (physical staffing and tangible resources available to put toward an AFPP) (Table 25). State and federal agency participants had the lowest perceived overall capacity to participate collaboratively in an AFPP. The perceived willingness and readiness of the federal participants was similar to tribal and private respondents even though their overall capacity to participate in an AFPP was the lowest. State sector readiness and willingness were the lowest as compared to all others, suggesting the greatest opportunity for promotion of Anchor Forest value, in order to support an AFPP. The state and federal respondents noted internal and external staff inconsistencies, policy, and regulation barriers were the dominant factors limiting their capacity to participate as well as their willingness and readiness to support an AFPP.

Table 25. Interviewee responses regarding capacity, willingness, and readiness to collaborate in an Anchor Forest pilot project within the Northeast and North Central regions.

Business Sector	Overall Capacity to Contribute[1]	Overall Willingness to Participate[1]	Overall Readiness to Collaborate[1]
Federal	1	6	6
Tribal	9	7	7
State	3	3	3
Private	6	6	6

[1] Rankings were provided by interviewees on a scale of 0 to 10, with "0" being "Not at all" and "10" being "Extremely High" when asked about an Anchor Forest project.



NE and NC Region Willingness to Share as an Anchor Forest Participant

The willingness of participants in both the NE and NC regions to share equipment, facilities, staff, and institutional support (e.g., leadership commitment) varied from sector to sector with the state respondents perceiving the lowest willingness of their institution to share as compared to other sectors (Table 25). All other respondents believed there are supportive resources or leadership personnel available to support an AFPP. Readers should note environmental participants were not available for interview in these regions however the statewide availability of staff for organizations such as the TNC may indicate responses from the South Central region can be applied in other regions. Survey responses by sector are provided below for all other sector participants.

> ***Federal:*** *Both NE and NC noted definitive limitations due to currently being at full capacity with public trust management issues, however, they could provide some forest management and inventory planning institutional support. Some respondents noted tradeoffs in other programs will be required before they could participate; however, if personnel and dollars are made available, then participation will definitely occur.*
>
> ***Tribal:*** *We can do our best to share limited equipment and complete treatments on other land-owners through extra contractors if harvested values are economically feasible. We can share limited resources and facilities; however we are currently short on staff. We do have dedicated funding for some tasks as well as institutional support from council members and the forestry program.*
>
> ***State:*** *No comments were provided for willingness to share in an AFPP.*
>
> ***Private:*** *We can commit staff, unless overburdened by other immediate obligations (we have a generally supportive administration).*

NE and NC Region Priorities for Anchor Forest Project Participation

Participants in the NE and NC regions were asked to share their thoughts on what the highest priority need for their participating in, and success of, an AFPP would be. Responses are summarized below by institutional sector.

> ***Federal:*** *The greatest area of need is staffing in forest product sales, and forest development.*
>
> ***Tribal:*** *The greatest priority is an increase in staffing and access to funding to help retain qualified staff and incentivize current staff.*
>
> ***State:*** *Some state and county leaders are seeking additional information (promotion, increased awareness, explanation, examples) of the Anchor Forests concept and its benefits to motivate county residents, businesses, and community leaders to join.*
>
> ***Private:*** *If the tribes in the NE and NC regions were to reengage in milling operations (currently just broker logs) there would be a greater opportunity to share milling facility resources. A greater economic return would result if both*

internal and external supplies of logs could be made available to milling facilities. Private tribal facilities in the NC are ready to directly participate in an Anchor Forest project.

NE and NC Region Opportunities and Barriers

In order to better understand how each participant could contribute to the success of an AFPP, respondents were asked to identify opportunities and barriers in each of the five forest management categories. Responses provided for each category are listed below by corresponding sector.

Forest Management & Planning

Opportunity

Federal: *Use authorities granted through the Tribal Forest Protection Act to provide benefits to tribes because of the ability to effect lands through forest management actions done adjacent to tribal lands*
Tribal: *Treatments can be coordinated across landscapes; share resources.*
State: *If tribes can share forest generated revenue, local counties could provide some advantages through administrative support, with secondary benefits of increased tribal employment in local enterprise.*

Barrier

Federal: *Federal participation on Tribal trust lands result in certain obligations, restrictions, and barriers which may limit actions to protect forests from outside impacts. Overall there is a lack of understanding of what Anchor Forests would mean for each stakeholder. Federal participants see a barrier from current capacity for sharing with others. Inefficiencies are anticipated during project start up; these should be overcome by all participants together.*
Tribal: *There's a mix of BIA and Tribal staff, so when one staff is doing planning on another agency's land it is confusing at times – that affects funding allocation and use of time.*
State: *Some type of revenue sharing needs to be included in the overall project. Nonfederal forest harvesting would be revenue generating through excise taxes. Some fear the Tribes want to keep all their forest harvest revenues internal in an Anchor Forest project, and need reassurance of a collaborative advantage for all participants.*

Forest Development

Opportunity

Tribal: *Treatments can be coordinated across landscapes and available resources could be shared to increase effectiveness and efficiency.*

Barrier

Federal: *Same as comments in the Forest Management & Inventory Planning question.*

Forest Protection and Restoration

Opportunity

Federal: *By protecting Tribal trust lands, both economic/environmental benefits may be derived from the ecosystem connectivity and for diversity, wildlife habitat through the Anchor Forest effort.*
Tribal: *Same as comments in the Forest Management & Inventory Planning question*

Barrier

Federal: *Same as comments in the Forest Management & Inventory Planning question.*

Forest Product Sales

Opportunity

Tribal: *Treatments can be coordinated across landscapes with share resources.*
Private: *Increased revenues could be realized from pursuing sustainable forest management.*

Barrier

Federal: *There are fears of "run-away" forest harvest driven by financial goals of economic sustainability. Contractually, there may be hurdles that need to be worked through to provide Tribes procedurally sound ways to ensure stewardship contracts get an Anchor Forest project off the ground.*
Tribal: *Some staff within our agencies do not fully understand how forest revenue would be generated and how the Tribe can be self-sustaining.*

Milling Operations and Processing
No entity commented in milling operations or maintenance function during interviews.

NE and NC Region Institutional Capacity - Summary

Survey participants varied regarding overall institutional capacity in support of an AFPP as there were two sectors highly motivated and able to participate and two unlikely to be able to participate (Table 25). The overall readiness to collaboratively participate in an AFPP varied by participants with some expressing a willingness and readiness to participate, but were constrained by a lack of capacity. Nearly all interview respondents indicated the sharing of resources, staff, expertise, and equipment available for an AFPP would be based upon leadership support as well as the availability and timing of needed resources. Readiness across all participants in these two regions was generally constrained by a lack of understanding in the goals and objectives of an Anchor Forest and a reduced milling capacity and infrastructure as well as limited time, staffing, and financial resources.

The majority of NE and NC region partners believed an AFPP merits investment and implementation due to the unique attributes of the partnership as well as the forest lands involved. Across most forestry functions, the majority of participants were committed to dedicate staff time to a collaborative project. Participants' indicated the greatest need for an AFPP was funding and staffing specifically in regard to forest management, forest development, and forest product sales. A need to establish a better public communication-education process was also identified to increase awareness for residents and promote the importance of an Anchor Forest to restore forest ecosystem function and provide economic sustainability to local communities. All participants acknowledged the need for processing infrastructure if forest management actions were to be undertaken and harvest increased.

While policies present obstacles across most forest management actions, specific barriers noted by participants were similar to those in the SC region. Many of the opportunities brought forth by respondents centered on the availability of professional staff for inventory, forest analysis, planning, and expertise to collaboratively conduct operations across boundaries, as well as mutually support activities. There is a general consensus that forest ecosystem health can be improved if Anchor Forest partners can take advantage of the ability to collaboratively market an AFPP centered on the triple-bottom-line of social/cultural, economic, and ecologic sustainability.

Conclusions & Recommendations

Between the SC and NE/NC regions differences in support of an AFPP were associated with access to or availability of milling and processing infrastructure. Currently, there is insufficient milling infrastructure in the NC region to accommodate an increase in forest restoration such as identified by the target acres for treatment described in Task 1 (Corrao et al. 2016), however there may be in the NE region, but interviewees were not available for comment. At present there is sufficient milling infrastructure to accommodate current harvesting within the NE region, however it is unclear what capacity exists or what additional needs would be required to support an AFPP. Milling infrastructure within the SC region is operating at less than efficient levels (66%) and leaders in the region have expressed the ability to increase staffing sufficiently to accommodate increased wood products by 11 to 40-millon board feet depending on timing of harvest. Participant responses in each region regarding other management categories were variable with the lowest overall capacity resulting from a lack of funding, focused in the state and federal sectors, and a general overall willingness to support and participate in an AFPP from all sectors.

With respect to understanding the goals an objective needed for an AFPP; aggregate response of all participants defined the Anchor Forest concept as an integrated, collaborative forest management effort that expressly includes the role of Tribes and/or tribal lands to provide cross-boundary benefits to forest ecosystem function. This may be one of the more important insights into the establishment of an AFPP in that all participants saw value in the Anchor Forest concept, however all potential stakeholders will approach a collaborative through a different lens (Burns & Cheng 2005). The opportunity here is through efforts invested into communicating a singular message with a defined goal that participants can understand and unite behind.

Interview responses indicated the capacity to contribute was driven by budget constraints, staffing requirements, and collaborative trust in the sharing of responsibility. Respondents at the state and federal levels were most concerned with funding while others were focused to a higher degree on actionable decisions, deliverables, and accountability. This dichotomy of driving concern is likely part of the trust challenge between participants and their willingness or un-willingness to share or make resources available. Neither side of this dichotomy is inaccurate as both are a derivative of policy, regulation, and responsibility imparted on these sectors. For example, state and federal staffing is driven by policy, funding, appeals, litigation, and a social license to operate in a certain manner (Miner et al. 2010; King et al. 2007; Gambino-Portuese et al. 2009; Keele et al. 2006). Conversely, non-governmental organizations and the private sector are often funded through opportunities available through state and federal agencies under the expectations of successfully navigating the agency culture and policy governing the access and use of such funding.

This dichotomy, while presenting certain challenges, also provides a unique opportunity for collaboratives that include Indian tribes. For example the balance of these differences provides a unique opportunity for an Anchor Forest to engage leadership from tribes; as sovereign nations with legislation and statutory authorities on federal lands, they present an opportunity to manage and restore sustainable forest ecosystem conditions on federal lands held in trust (Wood 2003; Wood 2014; Recker 2013). Moreover, Indian tribes can provide a depth of holistic forest ecosystem understanding (Traditional Ecologic Knowledge) no other participant has and offer

guidance and contracting to organizations and private sector stakeholders able to utilize state and federal funding. With supportive leadership and respectful collaboration, the goals of the Anchor Forest concept, founded in the triple-bottom-line of sustainable forest management, offer the opportunity for an AFPP to be "self-funding" through revenue generated by management prescription, recreational fees, and/or institutional resources in support of forest ecosystem function.

Participant comments indicated willingness to participate in an AFPP is linked to funding and available staff time and resources. If stakeholders could come together in a collaborative environment "protected" from appeals and litigation by non-participants the opportunity to build a framework of trust, and bridge differences toward a singular goal, would be far more accessible (Thomas 2011; Cook & Wilson 2015). Examples of success in many different forms are powerful and innovative ideas often build momentum through trust and familiarity (Rogers 2003; Hubbard & Sandmann 2007; Pannell et al. 2006), therefore the opportunity for an Anchor Forest to provide this foundation will help incentivize stakeholder participation and foster trust toward a universal goal of restored forest ecosystem function.

Through this study we observed the connection of readiness to capacity and willingness to participate. Participants indicated that with improved policies, and a collaborative atmosphere supportive of participants, readiness would likely improve with increases in capacity and the currently elevated willingness of all respondents to participate. Assessments detailing the available funding sources and tools (King et al. 2016), and the gaps in forest restoration management and infrastructure (Corrao et al. 2016) in support of collaborative frameworks, will become increasingly valuable as teams seek to implement sustainable forest restoration actions.

Across all three study regions in this task the majority of participant responses supported investment in, and implementation of, an AFPP with an expectation of respectful partnerships and successes addressing degraded forest health conditions (Cook & O'Laughlin 2014; O'Laughlin 2013; Krist et al. 2014) through achieving a balance of socially/culturally, economically, and ecologically sustainable management efforts initiated through working forests. In order to continue fostering optimism surrounding Anchor Forests steps need to be taken to further policy in support of collaborative tools such as stewardship contracting, landscape-scale treatment areas, and the good neighbor authority (ITC 2013; IFMAT 2013). Moreover, protection of the "collaborative process" needs to be considered in order to encourage outsiders to join the process and discourage or block non-participant appeals and litigation of collaboratively developed plans and actions (Keele et al. 2006; Stern & Mortimer 2007).

Literature Cited

Burns, S. & Cheng, A.S., 2005. *The Utilization of Collaborative Processes in Forest Planning*, Fort Collins, CO.

Cook, P.S. & O'Laughlin, J., 2014. *Fuel Treatments in Idaho's Forests: Effectiveness, Constraints, and Opportunities*, Moscow, Idaho.

Cook, P.S. & Wilson, P., 2015. *Policies Affecting Implementation of Landscape-scale Treatments on National Forest System Lands at High Risk of Insect and Disease Mortality*, Moscow, Idaho.

Corrao, V., Howisey, G. & Corrao, M.V., 2016. *Anchor Forest Pilot Study: Task 1 Report - Infrastructure for Commodity Production and Biomass*, Moscow, Idaho: Northwest Management Inc.

Gambino-Portuese, B. et al., 2009. Litigants' characteristics and outcomes in US Forest Service land-management cases 1989 to 2005. *Journal of Forestry*, 1, pp.16–22.

Hubbard, W.G. & Sandmann, L.R., 2007. *Using Diffusion of Innovation Concepts for Improved Program Evaluation*, Athens, GA.

IFMAT, 2013. *Intertribal Timber Council: Assessment of Indian forests and forest management in the United States, Volume I*,

ITC, 2013. *Fulfilling the Promise of The Tribal Forest Protection Act of 2004: An Analysis by the Intertribal Timber Council in Collaboration with USDA Forest Service and Bureau of Indian Affairs*, Portland, Oregon.

Keele, D.M. et al., 2006. Forest Service Land Management Litigation 1989-2002. *Journal of Forestry*, 104(4), p.7.

King, M.A. et al., 2007. Co-Management or Contracting? Agreements Between Native American Tribes and the U. S. National Park Service Pursuant To the 1994 Tribal Self-Governance Act. *Education*, 31(c), pp.475–530.

King, T.K., Corrao, V. & Corrao, M.V., 2016. *Anchor Forest Pilot Study: Task 5 Report - Database of Contact Information, Programs and Financial Assistance*, Moscow, Idaho: Northwest Management Inc.

Krist, F.J.J. et al., 2014. *2013–2027 National Insect and Disease Forest Risk Assessment*, Fort Collins, CO.

Miner, A.M.A. et al., 2010. Twenty Years of Forest Service National Environmental Policy Act Litigation. *Environmental Practice*, 12(02), pp.116–126.

O'Laughlin, J., 2013. *Wildland Fire Management: Are actively managed forests more resilient than passively managed forests?*, Moscow, Idaho.

O'Laughlin, J. & Corrao, V., 2016. *Anchor Forest Pilot Study: Task 4 Report - Identifying Barriers to Cooperative, Collaborative Cross-Boundary Forest Management*, Moscow, Idaho: Northwest Management Inc.

Pannell, D. et al., 2006. Understanding and promoting adoption of conservation practices by rural landholders. *Australian Journal of Experimental Agriculture*, 46(11), p.1407.

Recker, R., 2013. United States Department of the Interior Bureau of Indian Affairs response letter to the proposed directives for Forest Service land management planning. , p.2.

Rogers, E., 2003. *Diffusion of innovations* 5th ed., New York: Free Press.

Stern, M.J. & Mortimer, M.J., 2007. Comparing NEPA Processes Across Federal Land Management Agencies. , p.101.

Thomas, J.W., 2011. The Future of the National Forests – Who Will Answer an Uncertain Trumpet? , (September), p.30.

Wood, M.C., 2003. Indian Trust Responsibility: Protecting Tribal Lands and resources through Claims of Injunctive Relief against Federal Agencies. *Tulsa Law Review*, 39(2), pp.355–368.

Wood, M.C., 2014. Tribal Trustees in climate crisis. *American Indian Law Journal*, 2(2), pp.518–546.

Task 4 Report: Identifying Barriers to Cooperative, Collaborative Cross-Boundary Forest Management

Prepared for the:

Intertribal Timber Council

J. O'Laughlin, Ph.D. and V. Corrao

Northwest Management, Inc.

January 2016

(This page intentionally left blank)

Introduction

The objectives of Task 4 were to convene facilitated focus-group forums in three study regions within eastern Washington State (e.g. South Central (SC), North Central (NC), and Northeast (NE)) and to identify barriers to collaborative cross-boundary forest management and provide recommendations for overcoming them. These study regions were selected, in part, due to the diversity of potential stakeholders including the U.S. Department of Agriculture Forest Service (USFS), Washington State Department of Natural Resources (DNR), private industry, and multiple Indian tribes, scientists, academics, and conservationists. Focus-group discussions centered on sharing perspectives regarding prospects, limitations, objectives, and opportunities an Anchor Forest framework may encounter/offer for collaboratively managing currently degraded forestland ecosystems. Individuals knowledgeable about local resource conditions, economies, values, and policies were able to come together within the focus group setting and provide candid and constructive, sometimes divergent, perspectives on forest management and help collectively devise strategies to overcome identified barriers.

Focus-group meeting results revealed a general belief that currently degraded forestland conditions should be our highest priority and that particular legislation, local laws, and policies are very time consuming and in some cases too slow to effectively facilitate the restoration needed on many of these lands. Participants acknowledged the value of partnerships between stakeholders with differing opinions, the importance of federal agency and tribal input, and the need for some type of protection for the “collaborative process” from non-participant appeals and litigation that delay and discourage collaboratively developed decisions and efforts. Moreover, the need for a united voice, with a singular clear and consistent message, and motivated leaders were recognized as critical aspects of cooperation vital to effectively moving any collaborative project forward. These focus-group findings are similar to the findings described in Task 2 (King & Corrao 2016) regarding opportunities, barriers, and successes experienced within other collaborative frameworks.

The majority of participants viewed success of an Anchor Forest in two forms: (1) projects completed should meet the triple bottom line of balanced social/cultural, economic, and ecologic benefits, and; (2) the establishment of a landscape-scale (>1,000,000 acre) project area and completion of forest management activities that positively influence ecosystem resilience and function at a pace that offsets current insect, disease, and increasing wildfire conditions, should be considered.

Study Methodology

From October 2013 to January 2014, Intertribal Timber Council (ITC) members and Northwest Management Inc. (NMI) staff met with various potential stakeholders for scoping and development of a framework to assess potential stakeholder perspectives of an Anchor Forest Pilot Project (AFPP). Included within these potential stakeholders were four tribal nations; the Yakima Nation in the SC region, the Colville Tribe in the NC region, and the Spokane and Coeur d'Alene Tribes in the NE region. Initial meetings were used for stakeholder-identification forums and to assess participation interest in an Anchor Forest study.

In order to achieve the objectives of this task a combination of surveys aimed at gathering information from potential stakeholders on their impressions of the Anchor Forest concept were developed (Appendices A and B) and used in combination with several facilitated focus-group meetings (Corrao et al. 2016). These initial surveys attempted to gather local information regarding potential barriers facing the establishment of an Anchor Forest in each study region and gather feedback on the Anchor Forest concept. Survey results were then provided at each of the focus-group meetings to facilitate discussions. Focus-group meetings were held on the reservations of the Yakama Nation and the Confederated Tribes of the Colville (Colville Tribes). During focus groups participants were encouraged to discuss challenges and barriers to cooperatively managing forestlands across multi-jurisdictional boundaries within the context of the Anchor Forest concept. It should be noted that participation from the NE region was extremely limited, as the targeted potential stakeholders were either unavailable or declined to participate.

Following each focus-group meeting a list of potential participants was requested from each of the participating tribal nations to identify the agencies, organizations, private industries, and other interested stakeholders they believed should be included as stakeholders in an AFPP. The Yakima Nation and the Colville Tribes provided detailed lists of anticipated participants and expressed interest in participating in the AFPP planning process. The Spokane and Coeur d'Alene Tribes did not express interest in an Anchor Forest project at this time, and subsequently did not provide a list of potential stakeholders. As a result of the Colville Tribes presence in the NC and NE regions there was substantial overlap in identified potential stakeholders.

Using the lists provided by participating tribes as well as the focus-group meeting feedback, a second survey was developed to gain a deeper understanding of stakeholder capacity and interest in the Anchor Forest concept (Appendix B). Survey questions included respondents' assessment of current timber supply, existing institutional structure and capacity (e.g., staff, equipment, facilities, and internal support), willingness to participate in an Anchor Forest project, and the availability of informational resources regarding Anchor Forests and the connection to forest ecosystem functions. The intended audience of survey participants was all tribal, state, federal, university, and private parties with an interest in the health and condition of national forests and those currently working in the forest management sector. Surveys were sent to all potential stakeholders in NC/NE and SC regions on April 1st, 2014. The resulting survey responses for the NC and NE regions are presented as an aggregate due to the overlap of participants and general lack of participation by the NE region. Additionally, differences between the NC and NE regions are identified where available, and a discussion comparing the similarities and differences between all regions is presented in the summary section below.

Anchor Forest Survey Responses

The surveys provided to participating stakeholders included multiple sections covering; Goals and Objectives, Programs and Policies, Management, Collaboration, and Available Resources. Participants were asked to provide feedback, both constructive suggestions and criticisms, for each of the survey sections. The following lists underscore the most common suggestions and criticisms identified by participants across all study regions for each survey section.

Responses: "Goals and Objectives for Sustainable Forest Management and Ecosystem Services"

- Environmental regulations are needed that promote balanced economic and social needs with environmental objectives.
- Stop deferring acres from timber harvest that limits restorative active forest management.
- Fluctuating harvest levels and declining revenues have negatively impacted the ability to manage forests.
- Inadequate funding and staffing have negatively impacted our ability to practice sustainable forest management.
- Changing fire regime as a result of climate change impacts have negatively impacted ecosystem services and forest health.
- Increasing policy oversight, specifically through NEPA and ESA on public land forests, has negatively impacted sustainable forestry and ecosystem services.
- Planning and plan revisions take too long.
- More accountability is needed for line offices to complete projects on time.
- The lack of milling infrastructure hurts restoration efforts.

Responses: "Institutional Capacity for Underutilized Programs and Policies"

- On public lands, the power of the public (perceived or actual) has stymied management and restoration.
- Forest health issues seem to be irrelevant on many fronts.
- The Tribal Forest Protection Act is not being used by the tribes to influence management on adjacent federal lands.
- It will require increased involvement from counties to support local economies.

Responses: "Institutional Capacity for Management Effectiveness"

- 70% of respondents believe forest management improves ecological and watershed conditions.
- 54% of adjacent landowner respondents felt that institutional capacity is effective in accomplishing landscape scale ecological objectives.
- Institutional capacity is currently budget and policy limited.

Responses: "Institutional Capacity for Collaboration Effectiveness"

- 60% of respondents felt that collaborative efforts can meet objectives.
- The process is too slow for project implementation at larger scales.
- There is skepticism in the thought that collaboration increases restoration or environmental resiliency, as there is often more talk than action.
- Other respondents said collaboration does increase restoration and resiliency, and that cross-boundary management would be more effective.
- Support for salvaging dying or dead timber was both supported and refuted by participants.
- There is a need to recognize differences in the spectrum of land management philosophies.
- Collaboration is very effective, different agencies and owners bring different perspectives to the table. Collaboration projects that include economic, environmental, and recreational goals are less apt to be challenged.

Responses: "Institutional Capacity for Information and Resource Availability"

- Environmental activist appear willing to work with USFS, but environmental rules stand in the way of forest health.
- USFS appears to use environmental rules to slow down applied restoration projects.
- Information is lacking in stand surveys for forest health, infrastructure assessment, and marketing data. Cost analyses to get products to market are not available.
- Stand exams and the use of GIS are needed and would be beneficial in developing a common platform and databases multi-ownership projects.
- Funding and staff resources are lacking.

Focus-Group Questions & Most Common Topics

Two overarching questions were used to begin dialog during focus-group meeting. These questions led to a number of central topics for discussion that participants felt were most valuable to address at a local-level with respect to an Anchor Forest project.

Overarching questions used to begin conversation were:

1. How do we identify the key leaders and gather information on their motivations and concerns?
2. Can we identify the opportunities and communication needed for active management of forest lands to achieve restoration goal?

Topics of interest generated during group discussions center around:

1. Wildfire, insect and disease outbreaks, and invasive species. These discussions were used to build understanding of the losses being experienced and provide an opportunity to discuss what measures can be taken to prepare or mitigate for them.
2. How state and federal management agencies could support the objectives and benefits attainable from collaborative management. Either through continued acknowledgment of the magnitude of forest health problems (e.g., the Forest Service has publically stated that there are between 60 and 80 million acres of forest in need of restoration and treatments), or through research and reporting of conditions.
3. What value-added uses for construction and energy production could be promoted, recognizing wood as “green” and renewable material?
4. What models, tools, and/or policies could be developed or modified to visually and operationally convey the influences of action or inaction on future forest conditions, to identify opportunities that benefit from collaborative actions?
5. How can forums or open sessions be used to foster community engagement where diverse perspectives can be openly aired and factually discussed?
6. What curricula could be developed and implemented in K-12 education to improve public understanding of forest ecosystem balance and the factors contributing to deterioration of overall forest health?
7. Would mass media through social media/messaging provide incentives to spur interest, support, and effectively convey information?

Focus-Group Responses

Focus-group responses provided insight into the interest of area participants as well as identification of the potential barriers, and opportunities associated with an Anchor Forest project. Focus-group discussion was facilitated through the use of the two overarching questions described in the previous section and survey responses provided following the initial scoping meetings. The insights gained through survey responses and focus-group discussions identified the following characteristics participants said would be needed to implement a successful Anchor Forest project.

1. Articulate effective leadership in support Anchor Forests at the local, regional, and national levels. Tribes could play a prominent role, stressing the critical importance of collaborative long-term working relationships, and guidance through experience. Additionally, tribal involvement would help overcome some barriers to collaboration between stakeholders and agencies.
2. Local knowledge is needed to provide multi-generational multipurpose stewardship, as well as expertise in the selection and application of management practices, regional policy, and available science.
3. Establish an effective communication system to: (1) create a critical mass of collaborative relationships in support of a "social license" for active forest management; and (2) efficiently monitor and report outcomes to maintain accountability and adaptability.
4. Management objectives that satisfy balanced economic, environmental, social, and cultural values.
5. Dynamic forests maintained across diverse landscapes that protect soils, biodiversity, water, and wildlife habitat while generating economic value from harvested products and recreation.
6. Proactive, transparent forest treatments at a scale sufficient to reduce threats from wildfire, insects, and disease within acceptable time frames, given increasing drought frequencies and the influences of a changing climate.
7. Economic returns from harvested forest products and recreation sufficient to retain working forests on the landscape.
8. Economically viable harvesting, transportation, and processing infrastructure supported by a commitment to provide a reasonable expectation of average annual harvest (≥150 million board feet of forest products within an~60 mile radius of processing facilities for a 20 year period). The 150 million board foot annual volume would be sufficient to avoid the creation of captive markets and improve competition for the sale of forest products. A 60 mile radius supports optimal and economically efficient harvesting and transportation infrastructure. A 20 year period would enable amortization of investments and reduce the costs of initial expense.
9. Thriving rural economies that create opportunities for meaningful long-term employment and entrepreneurship, provide for public health and safety, and support healthy social structures.

10. Assurance that limited capital for investments in infrastructure and ecological functions would be effectively and efficiently applied.
11. Collaborative management approaches that reduce cost and improve operational efficiency would be utilized.
12. Collaborative arrangements would be employed to reduce risks and take advantage of economies of scale in forest certification, marketing forest products, and environmental services such as carbon credits.
13. Traditional knowledge and insights from local operational expertise (e.g., loggers, truckers, machinists, and field technicians) would be valued and applied in on-the-ground management.

In addition to the comments received during focus-group meetings regarding the Anchor Forest concept participants across all three study regions were asked to provide feedback on; the success of current forest management practices they use (Figure 40); the effectiveness of their neighboring landowners' in collaborating to achieve similar forest management objectives (Figure 41), and; how effective they perceive collaborative forest management efforts are in general (Figure 42). Responses to these questions provide a number of opportunities for an Anchor Forest project to increase awareness of the urgency needed in addressing degraded forest ecosystem conditions (Krist et al. 2014; USDA Forest Service 2014; Aplet & Wilmer 2002; O'Laughlin 2013; Goldmark 2012), and clearly communicate the objectives and framework of an AFPP to increase support as well as avoid some of the barriers encountered by other collaboratives (King & Corrao 2016; Butler et al. 2015; Mattor 2013).

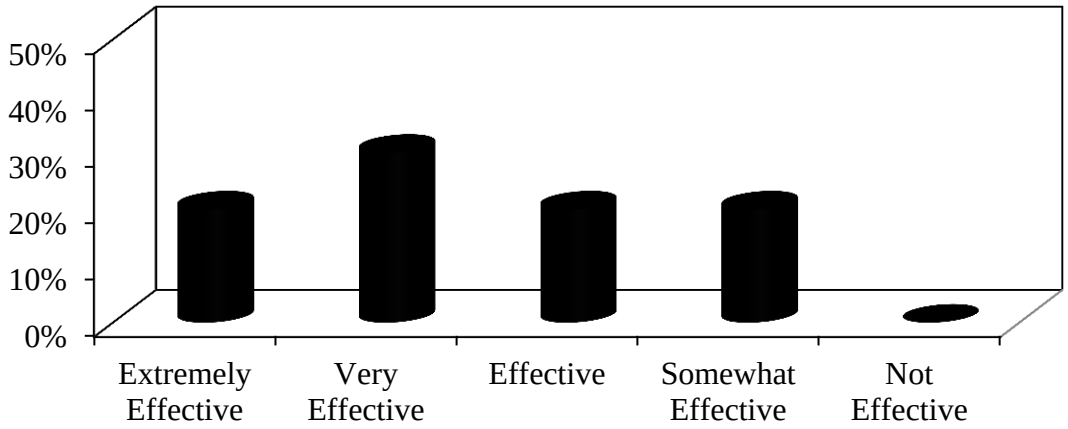


Figure 40. Survey-participant responses to: "How well do you believe your forest management improves ecological and or watershed conditions within your lands?"

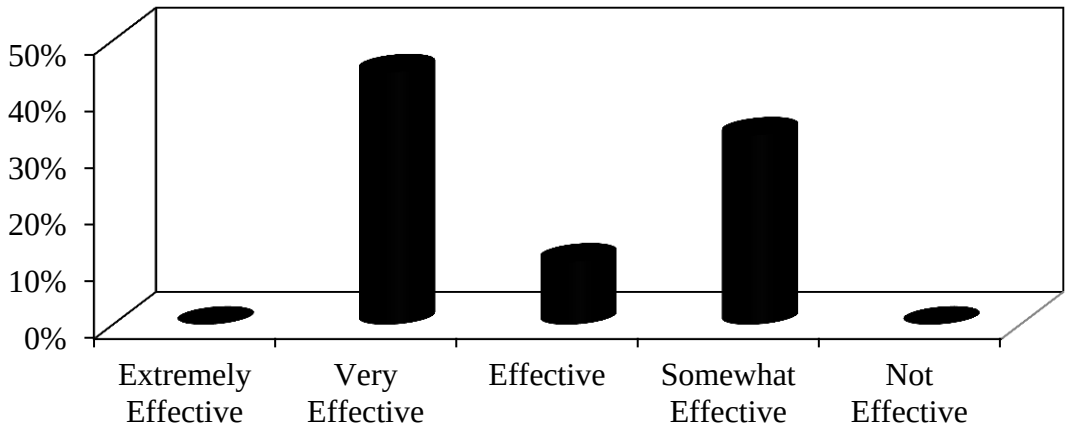


Figure 41. Survey responses from participants regarding their evaluation of; "neighboring property-owners' effectiveness to accomplish shared landscape-scale ecological objectives across ownership boundaries."

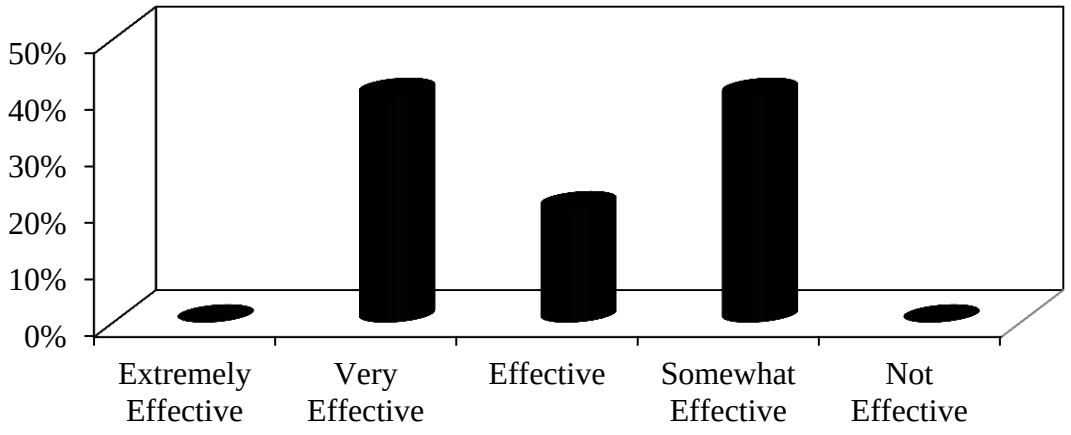


Figure 42. Survey-participant responses to: "How effective do you think collaborative forest management effort can be in meeting its objective(s)?"

Summary

In summarizing the comments of respondents from the three study regions similarities and differences emerged (Table 26,Table 27, and Table 28) that provide some insight into opportunities and challenges an Anchor Forest project could encounter in each region. In general focus groups discussion for all regions believed the current degraded forest health conditions should be our highest priority. Many participants commented that the NEPA process is very time consuming and too slow to effectively facilitate restoration efforts that could correct the current national forestland health conditions. Additionally, the collaborative process particularly under the umbrella of the ESA is also too slow to effectively address forest health conditions due to conflicting environmental requirements. Participants suggested that working directly with the USFS on forest plan revisions would help in communicating and prioritizing areas in need of management. It was believed the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Fish and Wildlife Service (FWS) do not have the capacity to participate in the process but are critical to include throughout the consultation period.

A “champion” and leader is needed in each agency and tribal organization to prioritize and direct any Anchor Forest project. A united voice with a singular message, clear and consistent, is critical to effectively move any project forward. Leaders must be committed to the process and demonstrate this by continually seeking to building trust and relationships between collaborators in order to gain the social license required for any successful project. Participants across all regions indicated the importance of identifying funds for planning and defining the collaborative participation of key members. There was a general consensus in that collaborative processes and projects require considerable investments of time and resources and that relationship building to accomplish win-win outcomes is critical.

Participants viewed success as; (1) projects completed that meet the triple bottom line of the Anchor Forest objectives for social/cultural, economic, and ecologic benefits, and; (2) the establishment of a landscape-scale (≥1,000,000 acres) project area with treatment zones that include multiple ownerships, specifically Tribal Nations and federal lands, at the sub-watershed scale (10,000 to 50,000 acres).

Table 26. Participant feedback for the South Central region provided through survey responses and during focus-group meetings.

South Central Region - Predominantly Tribal and Federal Sector presence with Active Forest Management on Tribal Lands	
+	A collaborative process lead by tribes and the U.S. Forest Service is preferred.
+	There is a desire to include more stakeholders from a broader audience in the already formed collaborative processes, and would carry over to an Anchor Forest.
+	There is a focus on forest health and sustainable ecosystem function and services in this region equal to or more so than timber production.
+	There is a significant active tribal presence with a background in active forest management and a large contiguous land base.
+/-	Forest treatment capacity is more limited than funding for some ecosystem restoration activities. There is a need for additional personnel training.
+/-	There is a need for more participation and corporation from the U.S. Forest Service in active land management or adjacent forest lands to minimize threats to management tribal lands.
+/-	U.S. Forest Service funding and resources are tied up in planning not in action.
-	Tribes identified mismanagement as the largest threat to forest health and the occurrence of uncontrollable wildfire due in part to conditions on adjacent lands has impacted water quality, fishery resources, cultural sites and whole ecosystem functions in general.

+ Generally represents an opportunity for an Anchor Forest Project.

+/- Represents an opportunity as well as a challenge for an Anchor Forest Project.

- Represents a challenge or a barrier for an Anchor Forest Project.

Table 27. Participant feedback for the North Central region provided through survey responses and during focus-group meetings.

North Central Region - Predominately Federal and State Sector presence with Limited Forest Management	
+	There is support for a collaborative process from the U.S. Forest Service in support of an Anchor Forest
+	Collaboration and communication are needed and generally support by all participants within the study region.
+/-	There is limited milling capacity for forest products and substantial investment would be required to increase capacity.
+/-	There is limited timber supply due to restricted forest management and agency resources.
+/-	Tribal participants have limited resources within this area.
+/-	Private landowners within this region are concerned that Anchor Forests would "add another layer of regulation to forest activities".
+/-	There is lacking infrastructure and markets in general for wood products especially "large wood".
+/-	There is a lack of logging personnel across all business sectors.
+/-	This region has the greatest number of acres designated as unhealthy forest conditions. The majority of acres are on federal lands and many are not restricted from treatment by wilderness or roadless designations.

+ Generally represents an opportunity for an Anchor Forest Project.

+/- Represents an opportunity as well as a challenge for an Anchor Forest Project.

- Represents a challenge or a barrier for an Anchor Forest Project.

Table 28. Participant feedback for the Northeast region provided through survey responses and during focus-group meetings.

Northeast Region - Predominantly Industry and Private Sector presence with Active Forest Management	
+	Collaboration was preferred for forest management based on experience.
+	There is a focus on timber supply and forest product utilization through active management.
+	Goals are support for local communities through jobs and use of a diversity of forest products.
+	There is well established private sector milling capacity and marketing.
+/-	The majority of unhealthy forest conditions are on federal lands and many are not restricted from treatment by wilderness or roadless designations.
+/-	There is a need to define "sustainability" in support of active forest management for communication purposes.
+/-	The public perception of forest health needs modification and attention needs to be drawn toward the implications for non-management.
+/-	There is lacking infrastructure and reduced markets for "large wood".
+/-	There is a lack of Tribal milling capacity and a general lack of logging personnel across all business sectors.
+/-	There is a lack of U.S. Forest Service support and leadership regarding active forest management.
+/-	U.S. Forest Service funding and resources are tied up in planning not in action.
-	Tribes identified mismanagement as the largest threat to forests - noting management for "Desired Future Conditions" can be an obstacle for adaptive management.

\+ Generally represents an opportunity for an Anchor Forest Project.

+/- Represents an opportunity as well as a challenge for an Anchor Forest Project.

\- Represents a challenge or a barrier for an Anchor Forest Project.

Recommendations

Through survey responses from both the SC and NE region participants identified three dominant motivations in support of the Anchor Forest concept; (1) the ability to influence forest management activities; (2) opportunities to overcome barriers and challenges facing implementation of sustainable forest health activities, and; (3) the potential for multi-jurisdictional forested landscape management. Additionally, respondents suggested forest restoration infrastructure as well as the institutional capacity to succeed must be evaluated and reassessed to focus current and future forest needs as well as identify collaborative challenges. These conclusions are similar to those presented in both agency (USDA Forest Service 2010a; USDA Forest Service 2010b) and peer-reviewed literature (Butler et al. 2015; Butler 2013) regarding collaborative frameworks and the efficient use of limited resources among differing stakeholder views.

Many of the key findings from this study point to a lack of funding or staff resources, which is similar to the findings of IFMAT (2013) showing tribes receive nearly one third of the funding per acre as the USFS for forest management. Additionally, a significant investment of time and financial resources is required to participate in a collaborative process, which has been known to discourage participants for some projects in the past (ITC 2013). To keep landowners and organizations at the table incentives are needed to increase the quality and interaction of collaborative efforts. Incentives such as process efficiencies, protection of the collaborative process from litigation, financial resources, and/or staff training would be beneficial in all of the three study regions.

It was noted that one of the most detrimental factors severely limiting collaborative efforts and efficiencies was the ability of nonparticipating members to appeal decisions and delay collaborative team efforts, thereby using additional, already-limited, resources (Miner et al. 2010; Mortimer & Malmsheimer 2011; Gambino-Portuese et al. 2009). The ability of nonparticipating parties to appeal is being discussed in some legislation. However, there is a need for these actions to be minimized in regard to forest restoration activities focused on public safety as well as the health and future of entire ecosystems (Cook & Wilson 2015; Franklin 1993; Thomas et al. 2006). The collaborative authority needs to be binding; similar to the concept of baseball arbitration where a member of the National Association of Arbitrators, trained to look at information from multiple perspectives, can make a decision that will “stand” throughout the duration of a collaborative project.

The Tribal Forest Protection Act among other tools such as the Tribal Trust Doctrine (Wood 2014) need to have a greater authority within the USFS, providing for more consultation with tribes in order to balancing the social/cultural, economic, and ecologic objectives (ITC 2013; Mason et al. 2012). The USFS has recently begun increasing communication and collaborative efforts around the topic of forestland health conditions; however, additional resources and collaboration is needed between agencies and forest-owning tribes to meet the identified needs, goals, and objectives for a sustainable ecosystem. The feedback from participant responses further supports the commitment required for a successful collaborative process and emphasizes the significance of support from federal agencies given their responsibility and authority to lead consultation and cooperative efforts with Tribal Nations.

The current lack of leadership and commitment from the USFS as an organization, coupled with frequent staff turnover, have been recognized at many levels and within all three study regions, as a specific and significant delay for collaborative processes. These findings are similar to those described in other studies assessing the challenges of collaborative actions where federal agencies are involved as either participates or leaders (ITC 2013; Butler 2013; Butler et al. 2015). Survey results suggest federal employees should be incentivized to effectively implement the collaborative process and build lasting relationships within localized regions. This could be accomplished through a metric of successes recognized through advancement, participation, and/or the number of completed partnership projects. The effects of this may be manifest in more efficient efforts conducting the NEPA process (Miner et al. 2010), and/or monitoring and evaluation under the ESA (Keele et al. 2006). Above all there is a need to recognize when federal lands represent high risk threats to adjacent properties from insects, disease, or wildfire and that a seamless efficient process is necessary to reduce these threats and maintain sustainable healthy conditions. The significance of this for collaboratives with participating tribal representatives and lands is in the Federal Government's fiduciary responsibility to sovereign nations and the public to maintain and protect the social/cultural, economic and ecologic functioning condition of lands held in trust (Wood 2014).

Literature Cited

Aplet, G.H. & Wilmer, B., 2002. The Wildland Fire Challenge: Protecting Communities and Restoring Ecosystems. *Management*, 22(4), pp.32–44.

Butler, W.H., 2013. Collaboration at Arm's Length: Navigating Agency Engagement in Landscape-Scale Ecological Restoration Collaboratives. *Journal of Forestry*, 111(November), pp.395–403.

Butler, W.H., Monroe, A. & McCaffrey, S., 2015. Collaborative Implementation for Ecological Restoration on US Public Lands: Implications for Legal Context, Accountability, and Adaptive Management. *Environmental Management*, 55(3), pp.564–577.

Cook, P.S. & Wilson, P., 2015. *Policies Affecting Implementation of Landscape-scale Treatments on National Forest System Lands at High Risk of Insect and Disease Mortality*, Moscow, Idaho.

Corrao, M., Dolsen, D. & O'Laughlin, J., 2016. *Anchor Forest Pilot Study: Task 3 Report - Evaluation of Institutional Capacity*, Moscow, Idaho: Northwest Management Inc.

Franklin, J.F., 1993. Preserving biodiversity: species, ecosystems, or landscapes? *Ecological Applications*, 3(2), pp.202–205.

Gambino-Portuese, B. et al., 2009. Litigants' characteristics and outcomes in US Forest Service land-management cases 1989 to 2005. *Journal of Forestry*, 1, pp.16–22.

Goldmark, P., 2012. Declaration of Forest Health Warning - State faces serious Forest Health Problems and Wildfire Risk. *Washington State Department of Natural Resources*, p.1.

IFMAT, 2013. *Intertribal Timber Council: Assessment of Indian forests and forest management in the United States, Volume I*,

ITC, 2013. *Fulfilling the Promise of The Tribal Forest Protection Act of 2004: An Analysis by the Intertribal Timber Council in Collaboration with USDA Forest Service and Bureau of Indian Affairs*, Portland, Oregon.

Keele, D.M. et al., 2006. Forest Service Land Management Litigation 1989-2002. *Journal of Forestry*, 104(4), p.7.

King, T.K. & Corrao, M., 2016. *Anchor Forest Pilot Study: Task 2 Report - Collaborative Forest Restoration Frameworks and the Anchor Forests Concept*, Moscow, Idaho: Northwest Management Inc.

Krist, F.J.J. et al., 2014. *2013–2027 National Insect and Disease Forest Risk Assessment*, Fort Collins, CO.

Mason, L. et al., 2012. Listening and Learning from Traditional Knowledge and Western Science: A Dialogue on Contemporary Challenges of Forest Health and Wildfire. *Journal of Forestry*, 110, pp.187–193.

Mattor, K., 2013. *Evolving Institutions of Environmental Governance: The Collaborative Implementation of Stewardship Contracts by the USDA Forest Service*. Colorado State University.

Miner, A.M.A. et al., 2010. Twenty Years of Forest Service National Environmental Policy Act Litigation. *Environmental Practice*, 12(02), pp.116–126.

Mortimer, M.. & Malmsheimer, R.., 2011. The Equal Access to Justice Act and US Forest Service Land Management: Incentives to Litigate? *Journal of Forestry*, pp.352–358.

O'Laughlin, J., 2013. *Wildland Fire Management: Are actively managed forests more resilient than passively managed forests?*, Moscow, Idaho.

Thomas, J.W. et al., 2006. The Northwest Forest Plan: Origins, Components, Implementation Experience, and Suggestions for Change. *Conservation Biology*, 20(2), pp.277–287.

USDA Forest Service, 2010a. *All Lands, All Hands. Sustaining America's state and private forests*, Washington, D.C.: National Association of State Foresters and the USDA Forest Service.

USDA Forest Service, 2010b. *Collaborative Forest Landscape Restoration Program (CFLRP) - Tapash Sustainable Forest Collaborative*, Washington, D.C.: United States Department of Agriculture Forest Service.

USDA Forest Service, 2014. Insect and Disease Area Designations. *Farm Bill - Section 8204*. Available at: http://www.fs.fed.us/farmbill/areadesignations.shtml [Accessed June 22, 2015].

Wood, M.C., 2014. Tribal Trustees in climate crisis. *American Indian Law Journal*, 2(2), pp.518–546.

Appendix A

Anchor Forest Mail-back Survey

RETURN TO:

University of Idaho
c/o Department of Conservation Social Sciences
Policy Analysis Group
College of Forestry, Wildlife & Range Sciences
ATTN: ANCHOR FORESTS PROJECT

BUSINESS USE ONLY

US Postage Prepaid

TO:

First Name, Last Name
c/o Organization Name
Street Address
Post Office Box # *(If applicable)*
Town/City
State Zip Code

QID 00000

Anchor Forests

Upper Columbia River Watershed

Tribal Member Survey

1. Please identify the name of your organization, your title, and the role you play regarding forests or forestry.
   Organization: _____
   Your Title: _____
   Your Forests/Forestry Role: *(Consider adding specific categories)*
   _____
   _____

2. Does your organization own forest lands? □ NO (*Skip to Q6, p. 3*)
   YES: ___ total acres in Anchor Forest pilot project area *(see map)*;
   YES: __ number of full time Anchor Forest management workers.

3. Please identify your organization's goals and objectives for timber resources management. *(Specify any quantitative measures used e.g., annual cut, sustained yield. Please insert 2nd sheet w/ more.)*
   Goal: _____
   Objective: _____
   Goal: _____
   Objective: _____
   Goal: _____
   Objective: _____

4. Please identify the primary factors, e.g., barriers, preventing your goals(s) or objective(s) from being reached. *(Please be brief.)*
   _____
   _____
   _____

5. If any of these factors exist due to existing public policies (e.g., planning requirements, tax policies), please detail any policy change(s) you think might address its resolution.
   _____
   _____
   _____
   _____
   _____

6. Does your organization manage other landowners' forests? □ NO
   □ YES → If YES: ___ number of full time workers managed.

7. Does your organization sell logs to others in the Anchor Forest pilot project area? □ NO □ YES → If YES *(enter # below)*:
   ___ quantity (BF) per year (please use avg sold for past 3 years).

8. Does your organization conduct logging operations?
   □ NO: If not, what logging firm?_____
   □ YES: If so, # of full time employees?_____

9. Does your organization own &/or operate log processing facilities (e.g. sawmill)? □ NO → If not, skip to Q 10) □ YES

9.a. From where do the processed logs originate, & in what portions?
   _____ provides ___ % of total
   _____ provides ___ % of total
   _____ provides ___ % of total
   _____ provides ___ % of total

9.b. How many 8-hour shifts during a 24 hour period does your facility operate? ____ number of 8 hour shifts in 24 hours.
   Also, please specify the total number of full time employees:___.

9.c. If additional logs were available within 60 miles of your facility, would you increase shifts and/or employment? □ YES
   □ NO → If not, why not? *(Please specify any limiting factors.)*
   _____
   _____
   _____

9.d. Do any of these factors exist due to existing public policies (e.g., tax policies)? □ NO □ YES → If so, please detail any policy change(s) you think might address its resolution.
   _____
   _____
   _____

Thank you for your cooperation and input! Please share an email address to receive results highlights: _____@_____._____

Appendix B

Anchor Forest Potential Stakeholder Survey

Anchor Forests

Anchor Forest Survey

1. **Organizational Structure**

1.1 What is your organization's name:

What is your title:

and, what is your role with forests/forestry:

1.2 Does your organization own forest lands? Yes ☐ No ☐ → **If No:** *Please skip to Q 2.1 (Page # 2)*

If Yes: Approximately how many full time employees manage your organization's forest lands? ____ employees

1.3 Please paraphrase **your organization's primary forest management goals**.

Goals: *(Please insert additional goals here.)*

A

B

C

Anchor Forests

1.4 Please identify and then quantify your organization's objectives or targets for each goal (for example, timber production, **sustainable harvest, annual or periodic harvest, create stand diversity**, etc.). *[Objectives set specific, measurable, achievable, repeatable, and time-bound parameters/targets.]*

Goal A Objectives: *(Please insert additional goal A objectives here.)*

A1

A2

A3

Goal B Objectives: *(Please insert additional goal B objectives either here.)*

B1

B2

B3

Anchor Forests

Goal C Objectives: *(Please insert additional goal C objectives here.)*

C1

C2

C3

1.5 Please **identify the primary administrative and/or operational challenge/barrier that prevents your organization from reaching each objective.** *If none, please state "None." (Please insert additional challenges/barriers for each goal's objectives here.)*

Challenge/Barrier to **Goal A, Obj. 1:**

Challenge/Barrier to Goal A, Obj. **2:**

Anchor Forests

Please **identify the primary administrative and/or operational challenge/barrier that prevents your organization from reaching each objective.** *If none, please state "None." (Please insert additional challenges/barriers for each goal's objectives here.) CONTINUED...*

Challenge/Barrier to Goal A, Obj. **3:**

Challenge/Barrier to **Goal B, Obj. 1:**

Challenge/Barrier to Goal B, Obj. **2:**

Challenge/Barrier to Goal B, Obj. **3:**

Challenge/Barrier to **Goal C, Obj. 1:**

Challenge/Barrier to Goal C, Obj. **2:**

Challenge/Barrier to Goal C, Obj. **3:**

Anchor Forests

1.6 Do any of these objectives' challenges/barriers exist due to public policies (e.g., planning requirements, tax policies, internal policy directives)? Yes ☐ No ☐

If Yes: Please identify, for each objective's challenge/barrier, which public policies are involved. *(Please add goal & objective identifiers.)*

Chall/Barr to Goal __, Obj. __; Policy:

Chall/Barr to Goal __, Obj. __; Policy:

Chall/Barr to Goal __, Obj. __; Policy:

1.7 For each policy challenge/barrier, please share your suggestion(s) for policy change(s) that might improve that situation and/or improve your ability to achieve that objective. *(Please add goal & objective identifiers.)*

Chall/Barr to Goal __, Obj. __; Policy Change:

Chall/Barr to Goal __, Obj. __; Policy Change:

Chall/Barr to Goal __, Obj. __; Policy Change:

2. Non-Timber and Timber Supply Analysis

2.1 Are non-timber forest products part of your organization's revenue stream? Yes ☐ No ☐ *(If NO, go to Q 2.2)*

→ **If Yes:**

a. About what percentage of your income involves non-timber products? ____ %

b. **What percent of your non-timber forest revenue is generated by:** *(enter 999 for % if Not Applicable)*

berries ____ %, **native seed** ____ %, **mushrooms** ____ %, **craft materials, e.g., mistletoe** ____ %, **other** *(specify)* _____ / ____ %

2.2 Does your organization sell logs to others? Yes ☐ No ☐

If Yes: On average what volume of logs are sold annually (in recent years, e.g., 1-2 year average)? _____ MBF

Anchor Forests

a. **What mill (or who) buys** those logs (approximately how far away is **the mill/buyer** in miles from the average point of sale)?

Place A: _____ ; Miles distant: _____ # miles

Place B: _____ ; Miles distant: _____ # miles

Place C: _____ ; Miles distant: _____ # miles

2.3 Does your organization conduct logging operations, i.e., **harvesting and hauling, without hiring a contractor**? Yes ☐ No ☐

If No: Who harvests?

Who hauls?

a. Are there qualified contractors (i.e., properly equipped, insured, and trained) available for logging and other restoration activities?

Yes ☐ → [**If Yes:** Are there enough qualified firms available in your area? Harvest: Yes ☐ No ☐ Haul: Yes ☐ No ☐]

No ☐ → [**If No:** Why not?]

b. Do qualified contractors **typically** have the appropriate equipment for the projects being offered?

Yes ☐ No ☐ Not sure ☐ ; → **If No:** What percent of past contractors have lacked equipment? Avg ____% of contractors.

2.4 Does your organization own and/or operate forest products processing facilities (e.g., sawmill)?

Yes ☐ No ☐ → **If No,** please go to Question 3.1, ***Section 3 – Page 4.***

a. **What type of type of processing facility do you have? Sawmill** ____ **Post & Pole Mill** ____, **Pellet Mill** ____, Other? ____

b. What products do you produce?

i.

ii

iii.

Anchor Forests

c. **Please list your primary raw material suppliers and approximate percent of total supply:**

i _____ - ____%;

ii _____ - ____%;

iii _____ - ____%;

iv _____ - ____% *(Total = 100%).*

d. **How many shifts in a 24 hour period do you operate? → ____ # of shifts**

Processing Facility type: _____ **Hours per shift** ____ **and employees per shift?** ____

Processing Facility type: _____ **Hours per shift** ____ **and employees per shift?** ____

Processing Facility type: _____ **Hours per shift** ____ **and employees per shift?** ____

f. If additional raw material was available, would you increase **the number of shifts?** Yes ____ No ____

i. **If No:** Why? →(Please identify any challenges/barriers or factors that are limiting supply.)

ii. Do these challenges exist due to public policies (e.g., tax policies)? Yes ____ No ____

iii. **If Yes:** Please suggest policy change(s) that you think might improve the situation or address the challenge.

e. **What factors limit your organization from the production of biomass for profit?**

Anchor Forests

3. Institutional Capacity

3.1 What program tools and/or policy authorities are available **for enhancing forest management**, if any, that aren't being utilized which you think would work (e.g., Tribal Forest Protection Act, Master Stewardship Agreements, etc.)?

3.2 How effective do **you believe your organization's forest management** has been in improving ecological and/or watershed condition within your ownership? *(Check one response / # only.)*

extremely effective ____ very effective ____ effective ____ somewhat effective ____ not effective ____

Why?

3.3 **Please specify how adjacent landowners would evaluate your effectiveness in accomplishing shared landscape scale ecological objectives across ownership boundaries?** *(Circle one response / # only.)*

extremely effective ____ very effective ____ effective ____ somewhat effective ____ not effective ____

Why?

3.4 Do you think collaboration increases the rate of restoration Yes ____ No ____ Not sure ____ ; and increases forest ecosystem resiliency? Yes ____ No ____ Not sure ____

Why?

Anchor Forests

3.5 **Are you currently participating in any collaborative processes?** Yes ☐ No ☐

i. **How effective do you think a collaborative effort can be in meeting its objective(s)?** *(Check one response / # only.)*

extremely effective ☐ very effective ☐ effective ☐ somewhat effective ☐ not effective ☐

Why?

4. Availability of Information and Resources

4.1 **What information are you lacking in order to be a more active participant in the Anchor Forest program?**

4.2 **What resources are you lacking in order to be a more active participant in the Anchor Forests program?**

4.3 **What tools and/or methods are useful to assess forest condition and/or product supply availability?**

Thank you! We value your input and assure you that your participation will make a difference in Anchor Forest's success!

(This page intentionally left blank)

Task 5 Report: Database of Contact Information, Programs and Financial Assistance

Prepared for the:

Intertribal Timber Council

by

T. King, V. Corrao, and M. Corrao, Ph.D.

Northwest Management, Inc.

January 2016

(This page intentionally left blank)

Introduction

The objectives of Task 5 focused on providing a database of contact information, programs, and financial assistance networks available to support conservation and infrastructure investment in eastern Washington, specifically applicable to the three Anchor Forest study regions identified in Figure 1. Some of the presented financial assistance programs, analytical tools, and models can be used in landscape analysis and to evaluate alternative strategies. In our acknowledgment of a forests influence on water quality and quantity we have become increasingly aware of public and private interest. Tribal nations as well as public and private landowners can present a cost-efficient means to manage and supply water for drinking, industrial use, energy production, flood stabilization, drought protection, aquifer protection and reduced erosion and sedimentation in support of biodiversity and aquatic resources.

Anchor Forests establish a framework for putting the right tools to work in the right places at the right time to meet resource needs (e.g. commodity production, wildlife and fisheries habitat, recreation, and protection of water supplies). Forest ecosystems and the natural environment are complex and it is unreasonable to expect all goals and ecosystem services for every stakeholder can be managed for on every land parcel. The reality is that some properties are better suited for certain purposes than others. A desire to maintain diversity and increase resiliency to advance ecosystem functions will lead to reduced income potential for some lands. Additionally, in a manner similar to the use of development rights as a means to further societal goals, forestry cooperatives could provide compensation to property owners for reductions in income potential by providing ecosystem services while at the same time providing reduced restrictions on other lands more suited for commodity-produced income.

Cooperatives are employed in the United States and worldwide, with forestry cooperatives thriving in at least 17 countries, involving over 3.6 million landowners, and managing more than 60 million acres of forest lands (Hull & Ashton 2008). Anchor Forests could provide a framework for evaluating the potential contributions of public and private forest lands to the maintenance of ecosystem functions, and promote more efficient and effective use of available funding to achieve desired services. By evaluating potential contributions of private forests to advance landscape-level objectives, priorities can be established to concentrate limited funding in areas that will produce the greatest benefit.

The database resulting from the Task 5 assessment provides a compilation of 90 funding sources within numerous programs and identifies 24 different organizations providing grants, loans, cost share, and assistance that can be used in support of Anchor Forests (Figure 44). These include funding for: wildlife and wetland programs, climate concerns, research, sustainable economic development, hazard mitigation, forest enhancement as well as other biodiversity, landscape and community opportunities. Additionally, the database categorizes funding type by; (public/private), eligible recipients, type of funding (grants, cost share, technical assistance), contact names, office locations, email addresses and/or website addresses. Assembled in the database are vast array of state, federal, and private programs, and mechanisms available to incentivize and support natural resource stewardship, that further the landscape-scale management objectives of the Anchor Forests concept.

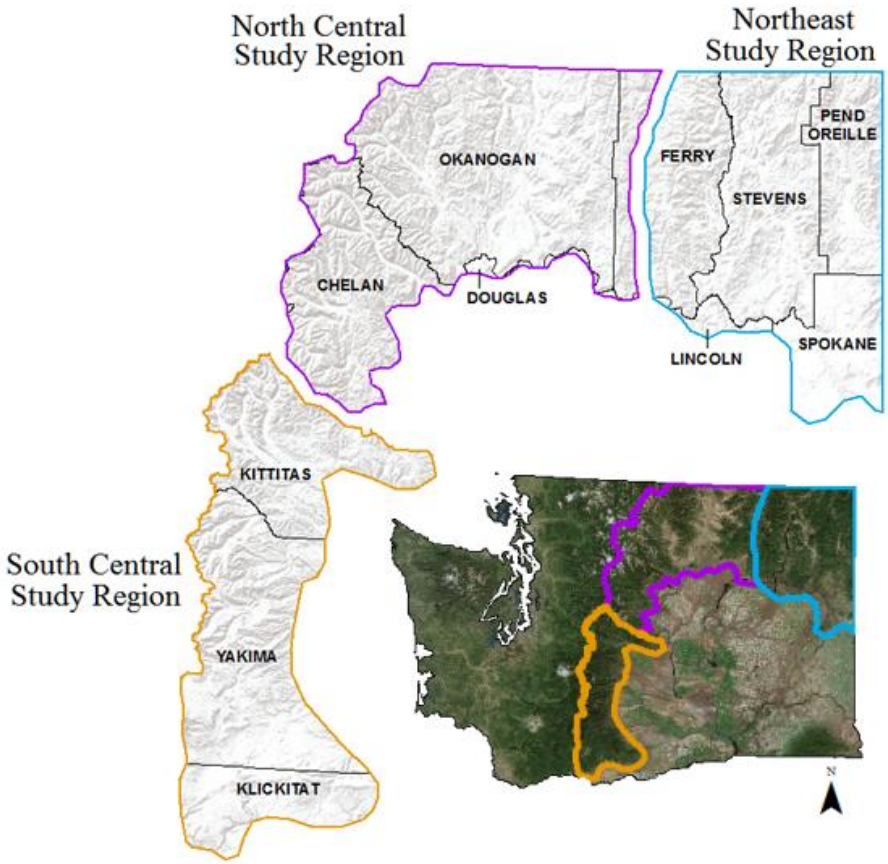


Figure 43. Assessments of forest health and forest industry infrastructure were completed for three study regions within eastern Washington to inform the Anchor Forest pilot project study.

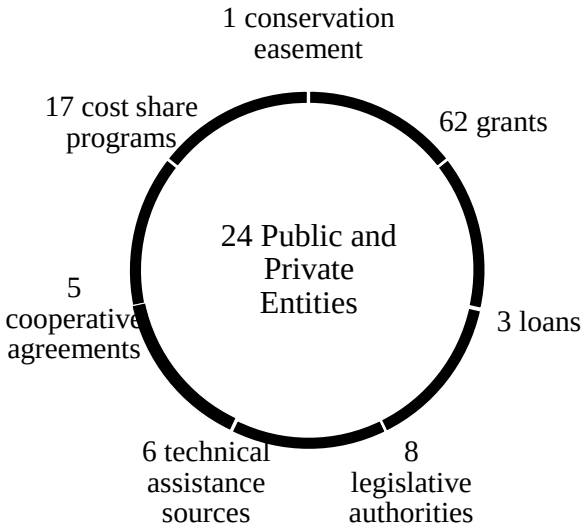


Figure 44. Twenty four entities were identified that offer a diversity of funding for collaborative natural resource projects, infrastructure, and organizational needs. The framework of Anchor Forests allow its members to apply for many of these sources as they seek to balance social/cultural, economic and ecologic stewardship of forestlands to promote desired ecosystem functions.

Funding Opportunities

The United States Department of Agriculture's Forest Service (USFS) as well as state and private forestry programs through the 2014 Farm Bill and 2015 Resilient Federal Forests Act have opportunities for funding specifically associated with State priorities for forest management. The Washington State Forest Action Plan, for example, sets priorities which collaborative groups can use to support proposals and management actions. These collaborative groups, comprised of both public and private participants, are therefore afforded the opportunity to apply funding to actions at larger scales and across differing ownerships.

Currently, the Natural Resource Conservation Service (NRCS) is looking at state forest action plans to prioritize funding and use the Environmental Quality Incentives Program (EQIP) to address special areas of concern in many ecosystems including forestlands. Moreover, the Good Neighbor Authority is available to state entities and tribes and provides one opportunity to co-manage federal forestlands throughout the State. For tribal nations in particular, additional opportunities are available through the Reserve Treaty Rights Lands Plan (RTRL) where funding for fuels management has been appropriated for the purposes of treating and restoring tribal landscapes within and adjacent to reserve treaty right lands as of fiscal year 2015 (BIA 2015). Due to the unique relationship of tribal nations and the federal government (Wood 2003) opportunities such as this provide a potential approach for restoring ecosystem function and forestland resilience on National Forest System lands.

Additionally, there are a number of state-administered grants available to help tribes, nonprofit organizations, local agencies, and educational institutions protect, enhance, and conserve forest resources. The Collaborative Forest Landscape Restoration Program (CFLRP), for example, began in 2009 to encourage collaborative, science-based ecosystem restoration of priority forest-landscapes. The CFLRP offers annual funding for projects over 10-year periods, however it may only be used on National Forest System lands. Although the funds may not be used to cover planning cost, there are opportunities for monitoring project actions such as ecological restoration treatments.

Challenges to Landscape-Scale Practices

Eastern Washington is experiencing severe forest-health issues as a result of insect and disease infestations, over-stocked forest conditions, and increasing wildfire severity further intensified by a changing climate. Without strategically planned ecological restoration throughout the region, these conditions will continue to persist, further impacting communities and forested landscapes through catastrophic wildfire and landscape-scale tree mortality. Increasing regional temperatures, drought conditions and wildfire severity are projected to continue to impact forests at the landscape-scale altering forest ecosystem services such as clean water, clean air, biodiversity, soil fertility, aesthetics, and recreational opportunities from decades to centuries into the future. Current regional trends are expected to worsen forest health conditions across eastern Washington over the coming years with projections of a continued 150 to 200% increase in insect and disease tree mortality every decade (DNR 2014) and an increase in burned area-extent of 300% or more each year by 2100, as compared to the conditions of 2000 (Littell et al. 2010; Snover et al. 2013).

A recent analysis by The Nature Conservancy (TNC) and the USFS identified nearly 2.7 million acres (nearly 40%, Figure 3) of eastern Washington forestland requiring some type of active treatment to restore forest structure and transition conditions more toward their Natural Range of Variability (NRV); a state more resilient to insects, disease and wildfires (Haugo et al. 2015). Additionally, Haugo et al., (2015) identified 4.2 million acres of USFS lands (outside of wilderness and inventoried Roadless areas) within eastern Washington and Oregon in need of active restoration. Despite the number of identified acres in need of treatment, land managers between 2009 and 2013 have only applied an annual average of 143,200 acres of mixed mechanical harvest, hazardous fuels reduction, and prescribed fire on forest lands in eastern Washington (DNR 2014). Regardless of these treatment successes, the current level of restoration activity is not keeping pace with increased forest losses.

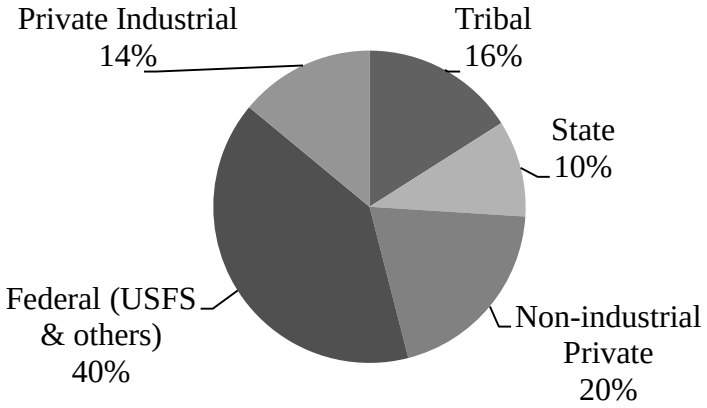


Figure 45. Nearly 40% of unreserved 6.5 million acres of timberland in eastern Washington are administered by the federal government and are contained within the Colville, Okanogan-Wenatchee, and Umatilla National Forests.

When milling facilities and supportive infrastructure is sparsely distributed within areas in need of forest treatment there are substantial increases in product transportation costs and decreased competitive bidding for timber resources along with reduced job opportunities and a limited workforce. The degrading conditions of many forestlands within the three study regions of

eastern Washington and the threat of wildfire plays a vital part in encouraging public participation and investment in new and current infrastructure required to improve forest ecosystem resilience on these degraded lands. Additionally, increasing public awareness of current forest conditions throughout the West is starting to present opportunities to increase education and actionable alternatives on federal lands in order to preserve and restore desired ecosystem services, such as municipal water sources, clean air, recreation, wildlife habitat and public safety, in the face of annually increasing wildfire frequency and severity (LaRocco & Deal 2011; Wu & Kim 2013).

There is an urgency to 'act' among those who live, work, and recreate in the forests of eastern Washington. This urgency is founded in the increasing loss of forest sector jobs, renewable forest products, spiritually significant places, recreational opportunities, and water quality as a result of conditions that promote insects, disease and ecosystem-replacing wildfire. The treatment of acres identified within the three study regions of Anchor Forest Pilot Study will require multi-jurisdictional participation and management.

Challenges and Available Funding

Funding is available through many sources for forest management planning and can be used to address the effects of historical management on ecosystems, particularly in regard to fire exclusion on dry fire-prone landscapes. The use of these funding sources has not been fully developed and is critical in motivating restoration efforts in the wake of increasing insect, disease, and wildfire impacts that have significantly outpaced current management efforts. Nearly all landowners with the exception of the USFS, and to a lesser degree tribal nations, have been successful in achieving most of their forest planning objectives (V. Corrao et al. 2016). For example the cost of management to prepare timber harvest operations is significant ranging from $66 to $71 per thousand board feet (MBF) on State-managed lands in Idaho and Montana, and $150 to $220 per MBF on USFS Region 1 and Region 6 lands, respectively (IFMAT 2013). The USFS has additional challenges unique to its's role as a federal land-management agency that impact forest planning and management activities, in addition to a lack of designated forest planning funding. Recent research has identified some of these challenges to be: frequent leadership turnover, a lack of leadership direction, inconsistent support for activities within the organization, excessive financial resource allocations to wildland fire, and individual personnel attitudes, values, and beliefs (Keele et al. 2006; ITC 2013; O'Toole 2007; GAO 2007; USDA Forest Service 2015).

The public perception of forest management and the social license needed to plan and implement actionable restoration activities presents a barrier to the correction of landscape-scale ecosystem degradation occurring due to un-natural tree densities, the exclusion of fire, and increasing tree mortality. There is a need to increase public awareness of currently degraded forestland conditions, that if not corrected, will continue to fuel the already increasing frequency and severity of wildfires that have destroyed homes and wildlife habitat, impacted water resources, and altered entire ecosystems for decades into the future (Wu & Kim 2013; Franklin 1993; Franklin et al. 2008; Noss et al. 2006). The cost-share and grant programs available to Anchor Forests through many of the funding opportunities identified within the database can help incentivize stakeholder participation, and support public education and outreach opportunities

that expose more people to the conditions of our forests and the need for "balanced" actions to maintain and improve the services we all enjoy.

Currently there is a lack of motivation to make capital investments in increased harvesting equipment, trucking, and milling infrastructure as well as to cover the additional costs associated with expanding the use of existing facilities in order to accomplish the estimated restoration needs on these forest lands. Anchor Forests provide a collaborative framework that allows participants to utilize many of the funding opportunities identified within the database through the inclusion of diverse landowners and project areas at a landscape-scale. The inclusion of tribes and their unique relationship to the federal government is one of the key components to expanding treatment onto federal forest lands held in trust and applying fuel treatments, forest resilience efforts, and available funding to increase ecosystem function (Mason et al. 2008).

Although there is a nearly limitless volume of biomass within eastern Washington, the transportation and processing infrastructure required to utilize this amount of biomass would require significant increases in production and supply incentives as well as the market value of generated products (V. Corrao et al. 2016). Existing biomass facilities are not able to accommodate the available volume of biomass due to limited capacity and market constraints associated with harvest and transportation costs, making biomass produced products (electricity) less competitive in areas where sources such as hydropower are available. The USFS Community Wood Energy Program specifically targets biomass use and development with grant funding on a 1:1 match ratio. This program and others on a state-by-state basis are available to promote biomass use; however overcoming the costs associated with transportation and power-generation infrastructure remain high without subsidies.

The workforce demographic of the forestry sector is aging, and training and education for new and existing opportunities are limited throughout the State of Washington as a whole. Within the database there are a number of grant and loan funding sources available to economically assist rural communities and businesses through the U.S. Department of Agriculture Rural Business Development program. These funds can be used in many different capacities by federal, state, tribal, non-profit groups and higher education entities. The organization of an Anchor Forest collaborative offers opportunities to apply many of these funding sources through status as a non-profit, partnership with tribal nations, or leadership by state or federal stakeholders. For example, programs that encourage and educate students on the importance of forestry and silviculture as well as teach the value of communication skills and the social license required for forestry are needed (Sample et al. 2015; Sharik et al. 2015). These could be incorporated at the high school level, as training courses for public employees, or seminars and continuing education workshops put on by tribal, federal, state, community, private, and non-profit leaders within the Anchor Forest framework to gain support at local levels and match employment opportunities with local residents.

Administrative appeals and long-term litigation surrounding forest lands and forest restoration has resulted in the closing of timber mills and fragmentation of forest ownerships through the economic draw of "higher-and-better-uses". These losses coupled with a highly complex regulatory environment discourages investments in forest restoration and further degrades ecosystems that embolden wildfire (ITC 2013). Forestland fragmentation and conversion to other

uses increases wildfire risk and the cost of wildfire suppression through increasing the complexity of the landscape in fire-prone ecosystems (Society of American Foresters 2009). Additionally, fragmentation often leads to increased runoff and sedimentation, higher peak streamflow and loss of riparian vegetation, as well as an increased need for channel stabilization infrastructure (Bradley et al. 2007; Bradley et al. 2009). Forestland fragmentation as a result of land conversion often decreases outdoor recreation opportunities important to the growing urbanized population. Forests that are fragmented generally have parcels too small to support investment in forest management and support of ecosystem processes (Society of American Foresters 2009). This is a barrier to landscape-scale forest ecosystem management across the State of Washington, regardless of study region, and is increasingly critical within areas of greater population density. Grant, loan, and coast-share funding that incentivize forest treatments to promote resilience and ecosystem function are available, including sources specific to wetlands, riparian areas, endangered species, recreation, biomass and urban health among others as presented in the included database and listed in Appendix A.

Additional Recommendations

Long-term contract commitments to active management and forest products will encourage capital investments needed to outpace degraded forest ecosystem conditions and reduce the level of additional agency and public investment needed. For example, a minimum of 15 year supply agreements that align with timescales of forest condition research (Haugo et al. 2015; Krist et al. 2014), will help industry amortize investments and encourage establishment of the infrastructure necessary to complete restoration activities. Long-term (15+ year) contracts and agreements utilizing Stewardship Contracting and the Tribal Forest Protection Act could target landscape-scale (50,000 to 200,000 acre) projects and focus on the utilization of as much non-merchantable small-diameter (<12 inches diameter at breast height) material as feasible to reduce fire fuels and maximize currently established guidelines and policies (Perez-Garcia et al. 2012; Schultz et al. 2012; Butler et al. 2015).

Increased efforts to restore forest ecosystem function and treat fire fuels are required in order to reduce federal expenses associated with fire suppression. A 2012 economic assessment from Oregon's Federal Forest Advisory Committee found that every $1.0 spent on restoration potentially avoids $1.45 in fire suppression cost (Rasmussen et al. 2012). Calculating the positive net benefits of fuel reduction treatments on market and nonmarket values has provided estimates of per-acre value ranging from $606 for moderate to $1402 for high-risk forest land with higher values expected if the per acre economic values are tied to habitat protection, air and water quality protection, or carbon credits among other ecosystem services (Lippke et al. 2005; Skog et al. 2008). The framework of Anchor Forests enables and encourages the restoration and treatment of currently degraded forest ecosystem conditions through balanced social/cultural, economic, and ecologic methods that will achieve and improve these per-acre values of forestlands within Washington and throughout the West.

Monitoring is needed to evaluate the practices applied and assess new opportunities that can sustain and expand activities that out-pace the currently-increasing insect, disease, and wildfire impacts throughout eastern Washington and the West. With monitoring, as progress is made toward more resilient forest conditions, managers can better assess opportunities to maintain or establish additional infrastructure such as co-generation facilities and transportation efficiencies.

Long-term project monitoring is required of many projects utilizing federal funding programs and, regardless of requirements, will help land managers gain a better understanding of ecosystem function and identify improvements that maximize efforts toward achieving desired conditions at the landscape-scale. Additionally, the availability of established sustainable infrastructure resulting from long-term contracts and monitoring efforts will perpetuate lower operating costs and over time increase the ability of managers to improve forest resilience and ecological function.

Summary

Anchor Forests can provide a foundational framework for strategic investment of funding resources identified within the Task 5 database through programs that seek to advance resource conservation or economic development in support of landscape management. The analysis provided in other Anchor Forest Task Reports (V. Corrao et al. 2016; King & Corrao 2016; M. Corrao et al. 2016; Boyle et al. 2016) exemplifies the need to identify the attributes of individual land parcels particularly valuable for attainment of desired ecosystem objectives. This will provide a basis for the strategic investment of limited resources for the greatest success (e.g. conservation on some properties and alleviation of management restrictions on others). Programs and tools (e.g., Stewardship Contracting, CFLRP, TFPA, Cooperative Agreements, Memoranda of Understanding, conservation easements, EQIP, etc.) that could be employed to help implement Anchor Forests are presented within the database.

Landowners working together can reduce the cost of management activities by combining workforces and implementing activities at the landscape-scale. Cost savings can be realized through wildfire mitigation projects, marketing forest products, forest stewardship certifications, implementing carbon sequestration programs, conservation easements, and ecosystem restoration activities. Developing these opportunities for partnerships at the landscape-scale are incentivized through longer duration (15+ year) agreements with tribal, state and federal agencies. This also increases participation in these projects by tribes, the private sector, and non-profit organizations which can generate significant resources in personnel, infrastructure, and traditional knowledge (tribal forest stewardship) to improve forest health, reduce insect and disease impacts, and reduce wildfire damage. In particular, tribes with their long-term commitments to forest stewardship, can enter into a co-management role on federal lands and provide the same level of care and maintenance to these lands as they do on their reservations. The private sector can assist in the development of NEPA processes and provide personnel and funding for forest inventory, transportation, and implementation of silvicultural prescriptions.

Literature Cited

BIA, 2015. *Bureau of Indian Affairs Fiscal Year 2015 Reserved Treaty Rights Lands Plan*, Washington, D.C.: Bureau of Indian Affairs, Office of Trust Services.

Boyle, B., Perez-Garcia, J. & Corrao, M., 2016. *Anchor Forest Pilot Study: Task 6 Report - Recommendations to Quantify Socio-Economic Values of Forestland and Estimate Non-market Benefits of Ecosystem Services*, Moscow, Idaho: Northwest Management Inc.

Bradley, G. et al., 2009. *Retention of High-Valued Forest Lands at Risk of Conversion to Non-Forest Uses in Washington State*, Prepared for the Washington State Legislature and Washington Department of Natural Resources. Seattle, WA.

Bradley, G. et al., 2007. *Study 4: Forest Land Conversion in Washington State*, Seattle, WA.

Butler, W.H., Monroe, A. & McCaffrey, S., 2015. Collaborative Implementation for Ecological Restoration on US Public Lands: Implications for Legal Context, Accountability, and Adaptive Management. *Environmental Management*, 55(3), pp.564–577.

Corrao, M., Dolsen, D. & O'Laughlin, J., 2016. *Anchor Forest Pilot Study: Task 3 Report - Evaluation of Institutional Capacity*, Moscow, Idaho: Northwest Management Inc.

Corrao, V., Howisey, G. & Corrao, M.V., 2016. *Anchor Forest Pilot Study: Task 1 Report - Infrastructure for Commodity Production and Biomass*, Moscow, Idaho: Northwest Management Inc.

DNR, 2014. *Eastern Washington Forest Health: Hazards, Accomplishments and Restoration Strategy*,

Franklin, J.F., 1993. Preserving biodiversity: species, ecosystems, or landscapes? *Ecological Applications*, 3(2), pp.202–205.

Franklin, J.F. et al., 2008. *The Case for Active Management of Dry Forest Types in Eastern Washington: Perpetuating and Creating olf forest structures and functions*, Olympia, WA: Washington Department of Natural Resources.

GAO, 2007. *A Cohesive Strategy and Goals Are Needed for Federal Agencies to Manage Wildland Fire Activities Effectively*, Washington, D.C.

Haugo, R. et al., 2015. Forest Ecology and Management A new approach to evaluate forest structure restoration needs across. *Forest Ecology and Management*, 335, pp.37–50.

Hull, R.B. & Ashton, S., 2008. Forest cooperatives revisited. *Journal of Forestry*, 106(2), pp.100–105.

IFMAT, 2013. *Intertribal Timber Council: Assessment of Indian forests and forest management in the United States, Volume I*,

ITC, 2013. *Fulfilling the Promise of The Tribal Forest Protection Act of 2004: An Analysis by the Intertribal Timber Council in Collaboration with USDA Forest Service and Bureau of Indian Affairs*, Portland, Oregon.

Keele, D.M. et al., 2006. Forest Service Land Management Litigation 1989-2002. *Journal of Forestry*, 104(4), p.7.

King, T.K. & Corrao, M., 2016. *Anchor Forest Pilot Study: Task 2 Report - Collaborative Forest Restoration Frameworks and the Anchor Forests Concept*, Moscow, Idaho: Northwest Management Inc.

Krist, F.J.J. et al., 2014. *2013–2027 National Insect and Disease Forest Risk Assessment*, Fort Collins, CO.

LaRocco, G.L. & Deal, R.L., 2011. Giving credit where credit is due: Increasing landowner compensation for ecosystem services. *USDA Forest Service - General Technical Report PNW-GTR*, (842), pp.1–32.

Lippke, B., Robbins, A. & Mason, L., 2005. Applied Science and Technology Transfer for Avoided Costs and Protected Forest Values. In *International Conference on Transfer or Forest Science Knowledge and Technology*. Seattle, WA, pp. 15–23.

Littell, J.S. et al., 2010. Forest ecosystems, disturbance, and climatic change in Washington State, USA. *Climatic Change*, 102(1-2), pp.129–158.

Mason, C.L. et al., 2008. *The Washington Log Trucking Industry: Costs and Safety Analysis*, Report to the

Washington State Legislature. Washington State University. Seattle, WA.

Noss, R.F. et al., 2006. Managing Fire-Prone Forests in the Western United States. *Frontiers in Ecology and the Environment*, 4(9), pp.481–487.

O'Toole, R., 2007. *The Perfect Firestorm Bringing Forest Service Wildfire Costs under Control*, Washington, D.C.

Perez-Garcia, J. et al., 2012. *Washington forest biomass supply assessment*, Available at: http://www.dnr.wa.gov/Publications/em_finalreport_wash_forest_biomass_supply_assess.pdf.

Rasmussen, M. et al., 2012. *National Forest Health Restoration An Economic Assessment of Forest Restoration on Oregon's Eastside National Forests. In: Prepared for Governor John Kitzhaber and Oregon's Legislative Leaders.*,

Sample, V.A. et al., 2015. The Promise and Performance of Forestry Education in the United States : Results of a Survey of Forestry Employers, Graduates, and Educators. *Journal of Forestry*, 113(6), pp.528–537.

Schultz, C. a., Jedd, T. & Beam, R.D., 2012. The Collaborative Forest Landscape Restoration Program: A History and Overview of the First Projects. *Journal of Forestry*, 110(7), pp.381–391.

Sharik, T.L. et al., 2015. Undergraduate Enrollment in U.S. Natural Resource Academic Programs: Trends, Drivers, and Implications for the Future of the Profession. *Journal of Forestry*, 113(6), pp.538–551.

Skog, K.E. et al., 2008. Woody Biomass Supply from Thinnings to Reduce Fire Hazard in the U.S. West and Its Potential Impact on Regional Wood Markets. *Woody biomass utilization challenges and opportunities*, (Gao 2005), pp.3–14.

Snover, A. et al., 2013. *Climate Change Impacts and Adaptation in Washington State: Technical Summaries for Decision Makers*, Seattle, WA.

Society of American Foresters, 2009. Loss of U.S. Forest Land - A Position Statement of the Society of American Foresters. , p.7.

USDA Forest Service, 2015. *The Rising Cost of Fire Operations: Effects on the Forest Service's Non- Fire Work*, Washington, D.C.

Wood, M.C., 2003. Indian Trust Responsibility: Protecting Tribal Lands and resources through Claims of Injunctive Relief against Federal Agencies. *Tulsa Law Review*, 39(2), pp.355–368.

Wu, T. & Kim, Y.-S., 2013. Pricing ecosystem resilience in frequent-fire ponderosa pine forests. *Forest Policy and Economics*, 27, pp.8–12.

Appendix A

Funding Sources Database

Source (Funding or Assistance)	Program Name	Funding Sourc Typ	Brief Description	Category	Subcategory	Type of Funding (Grant, Cost-Share, Agreement, Technical
Bureau of Indian Affairs	Climate Adaptation Fund	Public	Funds for tribes to work on Climate Adaptatic	Environment	Climate	Grant
Bureau of Indian Affairs	Cooperative Landscape Conservatic	Public	Funds for natural resource conservation	Environment	Planning	Grant
Bureau of Indian Affairs	Economic Development - Indian Loa	Public	Loans to benefit Federal Indian Reservation ec	Economics		Loan
Bureau of Indian Affairs	Endangered Species on Indian lands	Public	Funds for Tribes to comply with ESA	Environment	Endangered Species	Grant
Bureau of Indian Affairs	Energy and Mineral Development Pr	Public	Financial Assistance to Evaluate energy and mi	Economics	Energy	Grant
Bureau of Indian Affairs	Forestry on Indian Lands	Public	For Reforestation, Stand Improvement, Sales,	Forestry	Management	Grant
Bureau of Indian Affairs	Water Resources on Indian Lands	Public	Watershed protection including ecosystem de	Watershed/Wetland		Grant
Bureau of Land Management	Challenge Cost Share	Public	Funds for habitat conservation	Environment	Habitat	Cost-Share
Bureau of Land Management	Fish, Wildlife and Plant Conservatio	Public	Managing fish, wildlife and plants on BLM Lan	Environment	Management	Grant
Bureau of Land Management	Indian Self-Determination Contracts	Public	For numerous non-construction projects inclu	Environment		Grant
Bureau of Land Management	Management Initiatives	Public	Financial assistance awards not covered by an	Environment		Grant
Bureau of Land Management	Wildlife Fire Research and Studies F	Public	Funds for fire research	Emergency/Hazard	Fire	Grant
Bureau of Land Management	Forests and Woodlands Resource M	Public	Financial assistances for improvements of fore	Forestry	Management	Grant and Agreements
Bureau of Reclamation	Fish and Wildlife Coordination Act	Public	Habitat improvement funds	Fish & Wildlife	Restoration	Cooperative Agreement
Department of Agriculture Rural Business Development	Business and Industry Guaranteed L	Public	Guaranteed loans for rural businesses	Economics	Rural Communities	Loan
Department of Agriculture Rural Business Development	Intermediary Relending Program Los	Public	Finance facilities and community development	Economics	Rural Communities	Loan
Department of Agriculture Rural Business Development	Rural Business Development Grants	Public	Promote sustainable economic development	Economics	Rural Communities	Grant
Department of Agriculture Rural Business Development	Rural Business Enterprise Grants	Public	Facilitate development of small and emerging	Economics	Rural Communities	Grant
Department of Agriculture Rural Business Development	Rural Business Opportunity Grants	Public	Promote sustainable economic development in	Economics	Rural Communities	Grant
Department of Agriculture Rural Business Development	Rural Cooperative Development Gra	Public	Improve economic condition of rural areas	Economics	Rural Communities	Grant
Department of Agriculture Rural Business Development	Small Socially Disadvantaged Produ	Public	Funds for technical assistance	Economics	Rural Communities	Grant
Department of Commerce	Pacific Coast Salmon Recovery Fun	Public	Funds for Salmon Recovery	Fish & Wildlife	Fish	Grant
Environmental Protection Agency	Wetland Program Development Gra	Public	Wetlands Conservation	Watershed/Wetland	Wetlands	Grant
Farm Service Agency	Emergency Forest Restoration Prog	Public	Emergency Relief funds for damaged forests	Emergency/Hazard	Forests	Grant
Federal Emergency Management Agency	Hazard Mitigation Grant Program	Public	Hazard Planning Funds	Emergency/Hazard		Grant
National Park Service	Rivers, Trails, and Conservation Ass	Public	Promote community led natural resource conse	Environment		Technical Assistance
Forest Service	Community Forest and Open Space	Public	For establishing community forests	Forestry	Urban	Grant
Forest Service	Community Wood Energy Program	Public	Encourage development of community wood e	Forestry	Biomass	Grant
Forest Service	Cooperative Forestry Research	Public	Enhancement of forestry resources	Forestry	Research	Grant
Forest Service	Forest Health Protection	Public	Protect non-federal forests from damaging ins	Forestry	Health	Grant
Forest Service	Forest Legacy Program	Public	Protect conversion from forest to non-forest	Forestry	Conservation	Grant
Forest Service	Forest Stewardship Program	Public	Promote long-term active management of non-	Forestry	Management	Grant
Forest Service	Forestry Research	Public	Supports Research in Forestry	Forestry	Research	Grant and Agreements
Forest Service	National Urban and Community Fore	Public	Encourage communities to manage and protec	Forestry	Urban	Cost-Share
Forest Service	Wood Utilization Assistance	Public	Funds to assistance in wood utilization	Economics	Forests	Cost-Share
Forest Service	Urban and Community Forestry Pro	Public	Forestry and natural resources in and adjacent	Forestry	Urban	Grant
National Fish and Wildlife Foundation	NFWF Challenge Grants	Private	Restoration of habitat	Fish & Wildlife	Restoration	Grant
National Fish and Wildlife Foundation	Bring Back the Natives	Private	Habitat needs of Aquatic Invertebrates, Amphi	Watershed/Wetland	Restoration	Grant
National Fish and Wildlife Foundation	Conservation Partners	Private	Increase effectiveness of Farm Bill assistance	Fish & Wildlife	Conservation	Grant
National Fish and Wildlife Foundation	Environmental Solutions for Commu	Public	Private land stewardship, water quality, conse	Environment		Grant
National Fish and Wildlife Foundation	Five-star Restoration Challenge	Private	Restoration of wetlands, riparian, and coastal	Watershed/Wetland	Restoration	Grant
Forest Service	Collaborative Forest Landscape Re	Public	For carrying out and monitoring restoration tr	Forestry	Restoration	Cost-Share
National Fish and Wildlife Foundation	Pulling Together Initiative	Private	Funds for removable of invasive species	Environment	Invasive Species	Grant
National Forest Foundation	Community Capacity and Land Stew	Private	Collaboration for Watershed projects	Watershed/Wetland		Grant
National Forest Foundation	Matching Awards Program	Private	For projects that support National Forests ad	Forestry	Public Land	Cost-Share
National Forest Foundation	Ski Conservation Fund	Private	National Forest Stewardship	Environment	Public Land	Cost-Share
National Forest Foundation	Wilderness Stewardship Challenge	Private	Conservation projects that benefit National Fo	Environment	Public Land	Cost-Share
National Institute of Food and Agriculture	Small Business Innovation Research	Public	Innovation for business including those relatec	Economics	Forests	Grant
National Park Service	Centennial Challenge	Public	Projects for conservation, preservation, and p	Environment	Public Land	Cost-Share
National Park Service	Challenge Cost Share	Public	Funds for habitat conservation	Environment	Habitat	Cost-Share
National Park Service	Land and Water Conservation Fund	Public	Funds for outdoor recreation	Environment	Recreation	Grant
National Park Service	Natural Resource Stewardship	Public	Creates partners to join in the natural resource	Environment		Grant and Agreements
National Fish and Wildlife Foundation	Acres for America	Private	Funds to purchase conservation lands	Land Purchase/Trust/Easement	Conservation Easements	Grant
Natural Resources Conservation Service	Conservation Innovation Grant	Public	For the development and adoption of innovati	Environment	Innovation	Grant
Natural Resources Conservation Service	Conservation of Private Grazing Lan	Public	Ecology, economic and social stability of graz	Environment		Technical Assistance
Natural Resources Conservation Service	Conservation Reserve Enhancement	Public	Reduces Soil Erosion	Environment	Soil	Cost-Share
Natural Resources Conservation Service	Emergency Watershed Protection	Public	Funds for watersheds during emergency situat	Emergency/Hazard	Watershed	Grant
Natural Resources Conservation Service	Environmental Quality Incentives Pro	Public	Assistance for soil, water, and natural resourc	Environment		Cost-Share
Natural Resources Conservation Service	Healthy Forests Reserve Program	Public	Preserves forest land in an easement	Land Purchase/Trust/Easement	Conservation Easements	Cooperative Agreement
Natural Resources Conservation Service	Plant Materials for Conservation	Public	Research and development of plant materials f	Environment	Restoration	Grant
Natural Resources Conservation Service	Wetland Reserve Program	Public	Restoring wetlands from agriculture	Watershed/Wetland	Wetlands	Cost-Share
Natural Resources Conservation Service	Wildlife Habitat Incentives Program	Public	Habitat development	Fish & Wildlife	Habitat	Cost-Share
Patagonia	Patagonia Grant	Private	Supports environmental work, primarily fish.	Environment		Grant
Surdna Foundation	Sustainable Environments	Private	General grant for sustainable environments	Environment	Sustainable	Grant
Sustainable Forestry Initiative	SFI Community Grant Program	Private	Grants for community conservation	Forestry	Conservation	Grant
Sustainable Forestry Initiative	SFI Conservation Grant Program	Private	Grants for research in conservation	Forestry	Conservation	Grant
U.S. Fish and Wildlife Service	Adaptive Science	Public	Funding for broad-scale conservation objecti	Fish & Wildlife	Research	Grant
U.S. Fish and Wildlife Service	Cooperative Endangered Species C	Public	Conservation of Endangered Species	Environment	Endangered Species	Grant
U.S. Fish and Wildlife Service	Habitat Conservation Plan Land Acq	Public	Funds for land acquisition	Fish & Wildlife	Conservation	Grant
U.S. Fish and Wildlife Service	Habitat Conservation Planning Assi	Public	Conservation planning funds	Fish & Wildlife	Conservation	Grant
U.S. Fish and Wildlife Service	North American Wetlands Conserva	Public	Wetlands Conservation	Watershed/Wetland	Wetlands	Grant
U.S. Fish and Wildlife Service	Partners for Fish and Wildlife	Public	Habitat restoration	Fish & Wildlife	Restoration	Cost-Share
U.S. Fish and Wildlife Service	Recovery Land Acquisition Grant	Public	Land acquisition grants for states	Land Purchase/Trust/Easement	Land Acquisition	Grant
U.S. Fish and Wildlife Service	State Wildlife Grant Program	Public	Habitat restoration	Fish & Wildlife	Restoration	Grant
U.S. Fish and Wildlife Service	Tribal Wildlife Grants	Public	Projects to benefit fish & wildlife	Fish & Wildlife		Grant
Washington Department of Natural Resources	Community Forestry Assistance Gra	Public	Financial and technical assistance for natural re	Forestry	Urban	Grant
Washington Department of Natural Resources	Community Forestry Tree Inventory	Public	Funding for urban tree inventory	Forestry	Urban	Grant
Washington Department of Natural Resources	Community Forestry Tree Planting G	Public	Funding for urban tree planting	Forestry	Urban	Grant
Washington Department of Natural Resources	Family Forest Fish Passage Program	Public	Fish barrier removal	Fish & Wildlife	Fish	Cost-Share
Washington Department of Natural Resources	Fire Hazard Reduction	Public	Funds to aid reduction of fire hazards and dev	Emergency/Hazard	Forests	Grant
Washington Department of Natural Resources	Forestry Riparian Easement Program	Public	Partial value of trees left in riparian zone to lan	Land Purchase/Trust/Easement	Conservation Easements	Conservation Easement
Washington Department of Natural Resources	Eastern Washington Forest Landow	Public	Encourage non-federal forest owners to imple	Forestry	Health	Cost-Share
Washington Native Plant Society	Conservation Grant	Private	Further goals of conservation of Washington	Environment	Native Plants	Grant
Washington Native Plant Society	Research and Inventory Grant	Private	Further goals of Washington Native Plant Soc	Environment	Native Plants	Grant
Washington State Recreation and Conservation Office	Washington Wildlife Recreation Pro	Public	Grants in 11 categories including natural areas,	Environment	Recreation	Grant
Weeden Foundation	Weeden Foundation Grant	Private	Protecting Biodiversity, Sustainable paper co	Environment	Conservation	Grant
Western Forestry Leadership Coalition	Landscape Scale Restoration	Private	Funds for landscape scale restoration	Forestry	Restoration	Grant
Western Forestry Leadership Coalition	Wildland Urban Interface Grant Pro	Private	Funds for states to manage Wildland Urban In	Emergency/Hazard	Fire	Grant
Wildlife Conservation Society	Climate Adaptation Fund	Private	Climate adaptation grants	Environment	Climate	Grant

Task 6 Report: Recommendations to Quantify Socio-Economic Values of Forestland and Estimate Non-Market Benefits of Ecosystem Services

Prepared for the:

Intertribal Timber Council

by

B. Boyle[1] and J. Perez-Garcia, Ph.D. [2]

In cooperation with

M. Corrao, Ph.D. [3]

Northwest Management, Inc.

January 2016

[1] *Brian Boyle, MS, MBA. University of Washington School of Environmental and Forestry Sciences. College of the Environment, University of Washington, Seattle, WA (Retired). Washington State Commissioner of Public Lands, 1981-93*

[2] *John Perez-Garcia, Professor in Forest Economics, School of Environmental and Forestry Sciences. College of the Environment, University of Washington, Seattle, WA*

[3] *Mark Corrao, Hydrologist, Northwest Management Inc., Moscow, ID*

Introduction

The need to address forest health involves many considerations (e.g., ecosystem services, public expenditures for wildfire suppression, water quality and quantity, soil erosion, fish, wildlife, economic vitality, carbon sequestration, climate change mitigation, and more). When forest management is practiced within the confines of property boundaries, isolation, fragmentation, simplification, and compartmentalization of thought have resulted in exploitation and depletion of natural capital accompanied by transfer of costs to others. Consequently, we have witnessed damage to the capacity of an ecosystem to provide public services. Similar to Humpty Dumpty, broken ecosystem processes can be very hard if not impossible to put back together again and unlike modern word processors, there is no undo command. As land conversion to support a growing population occurs (Mason & Lippke 2007; Pinchot Institute for Conservation 2011), and amenities on private lands are lost (Garland 2013; Lippke et al. 2007), public lands are expected to replace them, or at least minimize the need for private land management and continue to provide public environmental values (Thomas et al. 2006; Pinchot Institute for Conservation 2014; ITC 2013).

By definition, Anchor Forests are multi-ownership, land-based areas that (i) support sustainable long-term wood and energy production at levels sufficient to support economically viable communities, competitive manufacturing, harvesting, transportation and work force infrastructure within feasible tributary distances from processing facilities, (ii) are backed by local infrastructure, inventory systems, professional staff, academic engagement, and modern monitoring technologies, and (iii) are endorsed politically and publicly through collaboration, communication, and commitment to implementation. One of the foremost challenges facing Anchor Forests is in identifying the framework needed to maintain and expand working forests on the landscape that provide resource sustainability and improve ecosystem processes, thereby increasing the value and extent of provided ecosystem services. Ecosystem processes are the naturally occurring processes describing biophysical relationships that exist whether humans benefit from them or not (Boyd & Banzhaf 2007), whereas ecosystem services are “what” the goods or processes of an ecosystem contribute to human well-being and as such, would not exist without the existence of people, societies, and respective constructed infrastructure (Turner et al. 2015).

Overall, eastern Washington State is experiencing severe forest-health issues and without strategically planned ecological restoration throughout the region these issues will continue to persist, further impacting communities and forest landscapes through catastrophic wildfire and landscape-scale tree mortality. The assessments provided in Anchor Forest Tasks 1 through 5 systematically addressed the state of forest health, stakeholder sentiment, and the capacity of available infrastructure and resources across three regions of eastern Washington (South Central (SC), North Central (NC), and Northeast (NE)). Within these areas, substantial holdings of forest lands managed by Indian tribes and the Washington State Department of Natural Resources (DNR) appear to be prime candidates in support of an AFPP. The Yakama, Colville, Spokane, and Coeur D’Alene Tribes have substantial forestlands in these areas and all maintain experienced natural resource management staff with diverse academic and operational expertise. Additionally, the Yakama Nation and The Confederated Tribes of the Colville Reservation (Colville Tribes) currently operate industrial scale forest products manufacturing facilities that could play a significant role in forest restoration efforts that meet the triple-bottom-line goals of

balancing social/cultural, economic, and ecologic drivers within an AFPP while restoring ecosystem process and improving ecosystem services. The guiding objectives of this task were to: (1) assess the potential ecosystem services supported by an AFPP in eastern Washington, (2) provide recommendations for methodologies available to quantify non-market values, and (3) suggest ways an AFPP could increase public awareness and stakeholder participation with regard to ecosystem services (e.g., fish, water, wildlife, recreation, among others).

Overcoming Declining Ecosystem Health and Community Economics

Within the past several decades, both public and private forest managers have struggled somewhat unsuccessfully to integrate stewardship of ecological processes with achieving sustainable economic returns. Pressures from a diversity of public perceptions regarding silviculture, some driven by beliefs that forestry is a detriment rather than a solution to sustainability (Zenner 2014; Winkel 2014), have provided challenges to land managers and collaboratives alike. Additionally, litigation surrounding the application of federal environmental policy (Keele et al. 2006; Miner et al. 2010; Gambino-Portuese et al. 2009) has stymied investors, led to mill closures, and encouraged many private forest lands to be passed to non-forest and short-tenure land uses that have disrupted ecosystems (Bradley et al. 2007; Bradley et al. 2009). The result has been significant declines in the rural communities and the health of national forestlands from a dismantling of the natural resource and community economic infrastructure throughout the West, particularly exemplified across eastern Washington State.

It has been argued that this has set into motion a “Death Spiral,” in which the forests, their wild inhabitants and their human beneficiaries have become victims of unending and unintended devastation (Winkel 2014). The struggles over policies and processes have resulted in altered forest ecology; elevated risks from wildfire, insect damage and invasive pathogens; and reduced health and availability of the many forest processes and ecosystem services upon which many, and most notably Indian tribes, depend for economic and cultural sustenance (ITC 2013).

The Anchor Forest concept is built on the foundation of a triple-bottom-line balance of social/cultural, economic, and ecological sustainability through holistic restoration of forest health at a watershed-to-regional scale inclusive of agency, tribal, and private landowners collaboration. The motivation behind an AFPP stems from a need to restore forest ecosystem health which in turn will, among other things; curtail catastrophic wildfires and provide for increased human safety, water quality/quantity protection, local jobs, wildlife habitat and cultural value preservation, as well as reduce fire suppression costs, erosion, flood control and drinking water infrastructure, and litigation frequency and costs for stakeholders. Monitoring within an AFPP operational plan would among other things increase knowledge of how activities affect wildlife, water flow, industry, and communities; what sectors and jobs are organized or disrupted by fire on the landscape; what impacts there are on households; and what collaborative employment can be created to bridge sectors such as forestry, agriculture, recreation, energy production, and research.

Ecosystem Processes, Ecosystem Services, and Wildfire

Ecosystem services are not fully 'captured' in commercial markets and difficult to quantify compared to traditional economic services, and therefore may not have played a significant role in the development of past policy (Costanza et al. 1997). This however is changing in the wake of new science and collaborative groups looking to restore forest health within the western U.S. facilitated by an October 2015 memorandum directing all federal agencies to include ecosystem services in federal environmental decision making as of March 30, 2016 (Donovan et al. 2015). Ecosystem services are based on human capital, but are founded in natural processes. This has been displayed conceptually through the work of Turner et al. (2015) shown in Figure 46 and discussed throughout the scientific literature (Costanza et al. 2014; Farber et al. 2006; De Groot et al. 2002; Wu & Kim 2013).

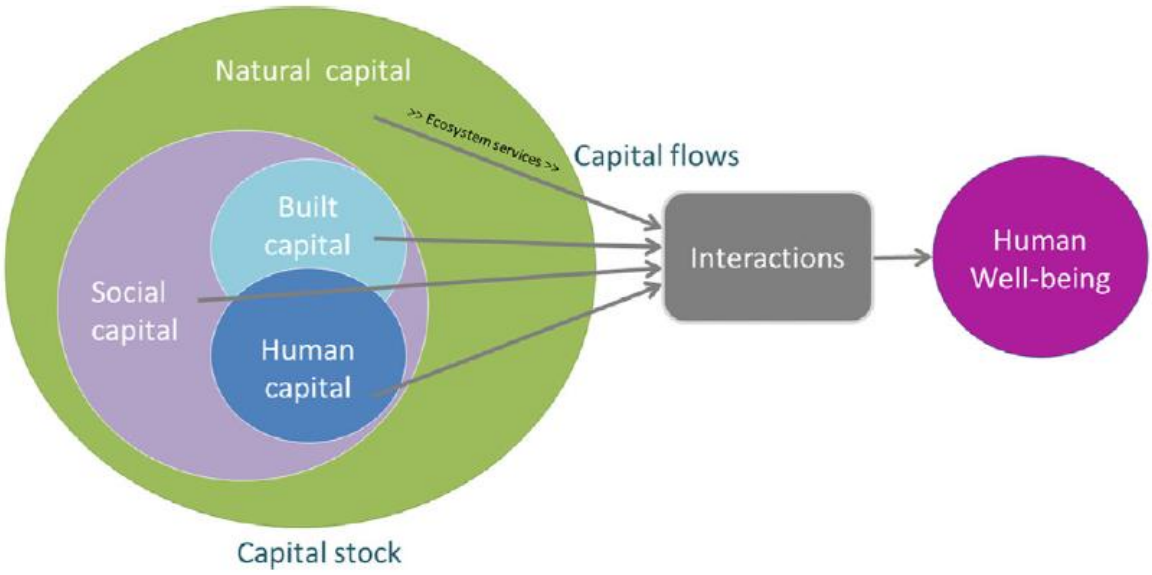


Figure 46. Human-environment interactions are formed between built, social, human and natural capital and collectively contribute to human well-being. Built (including economy) and human capital are embedded in society which is enveloped within the rest of nature. Ecosystem services are the relative contribution of natural capital to human well-being; they do not flow directly to create well-being and need the other sources of capital to exist (Costanza et al. 2014). It is therefore imperative to incorporate all facets of capital within a collaborative ecosystem framework such as an Anchor Forest. *(Figure reproduced with permission from Turner et al. (2015)).*

The significance of this new guiding memorandum and the need to include ecosystem services in natural resource planning comes in the wake of a severe wildfire season where 53,798 fires consumed more than 9.4 million acres nationwide, second only to 2006 (9.44 million acres, 86,513 fires) (NIFC 2015), and further motivated by a recognition of declining forestland health throughout the western US as a result of decades of fire suppression, insect and disease out breaking and a lack of forest resource stewardship (DNR 2014). The significance of the 2015 fire season further supports the need for forest health restoration; although the burned-acres were similar between 2015 and 2006 there were 32,715 (38%) fewer fires during 2015, indicating a

larger average fire size and continuity. This is in part due to available fire fuel buildup on these lands, particularly national forest lands (V. Corrao et al. 2016; Haugo et al. 2015; Cook & O'Laughlin 2014).

Large fires occurring in the current forest conditions cause abrupt tree mortality on spatial scales, extents and severity that surpass all records of human history (Millar & Stephenson 2015). These occurrences can alter the semiarid forest ecosystems of the western US to where it may take decades or centuries to recover; or may never recover and remain in an altered state such as a grassland or scrubland, lacking the forest ecosystem processes and services previously provided. A variety of ecosystem goods and services have been identified with their respective ecosystem function within the scientific literature (Table 29). Many of these services are linked to a variety of natural biomes, however healthy functioning forests have been shown to support the greatest diversity of ecosystem services (Costanza et al. 1997). There is a dichotomy of value therefore available with respect to forest environments, first the set of values from a functioning ecosystem and the services it provides (e.g., timber, medicines, cultural support, recreation, wildlife, aesthetics and high quality water resources), and secondly the avoided costs associated with a properly functioning forest environment (e.g., reduced fuels treatment, fire suppression, invasive species removal, erosion, water resource degradation and human infrastructure/safety).

Table 29. Ecosystem goods and service categories presented in Costanza et al. (1997) outlining the human benefits from natural biomes.

Ecosystem service*	Ecosystem functions	Examples
Gas regulation	Regulation of atmospheric chemical composition.	CO_2/O_2 balance, O_3 for UVB protection, and SO_x levels.
Climate regulation	Regulation of global temperature, precipitation, and other biologically mediated climatic processes at global or local levels.	Greenhouse gas regulation, DMS production affecting cloud formation.
Disturbance regulation	Capacitance, damping and integrity of ecosystem response to environmental fluctuations.	Storm protection, flood control, drought recovery and other aspects of habitat response to environmental variability mainly controlled by vegetation structure.
Water regulation	Regulation of hydrological flows.	Provisioning of water for agricultural (such as irrigation) or industrial (such as milling) processes or transportation.
Water supply	Storage and retention of water.	Provisioning of water by watersheds, reservoirs and aquifers.
Erosion control and sediment retention	Retention of soil within an ecosystem.	Prevention of loss of soil by wind, runoff, or other removal processes, storage of stilt in lakes and wetlands.
Soil formation	Soil formation processes.	Weathering of rock and the accumulation of organic material.
Nutrient cycling	Storage, internal cycling, processing and acquisition of nutrients.	Nitrogen fixation, N, P and other elemental or nutrient cycles.
Waste treatment	Recovery of mobile nutrients and removal or breakdown of excess or xenic nutrients and compounds.	Waste treatment, pollution control, detoxification.
Pollination	Movement of floral gametes.	Provisioning of pollinators for the reproduction of plant populations.
Biological control	Trophic-dynamic regulations of populations.	Keystone predator control of prey species, reduction of herbivory by top predators.
Refugia	Habitat for resident and transient populations.	Nurseries, habitat for migratory species, regional habitats for locally harvested species, or overwintering grounds.
Food production	That portion of gross primary production extractable as food.	Production of fish, game, crops, nuts, fruits by hunting, gathering, subsistence farming or fishing.
Raw materials	That portion of gross primary production extractable as raw materials.	The production of lumber, fuel or fodder.
Genetic resources	Sources of unique biological materials and products.	Medicine, products for materials science, genes for resistance to plant pathogens and crop pests, ornamental species (pets and horticultural varieties of plants).
Recreation	Providing opportunities for recreational activities.	Eco-tourism, sport fishing, and other outdoor recreational activities.
Cultural	Providing opportunities for non-commercial uses.	Aesthetic, artistic, educational, spiritual, and/or scientific values of ecosystems.

The valuation of ecosystem services and the benefits of avoided costs can be challenging, however a variety of methods are presented in Table 30 and these methods are paired with individual ecosystem service categories in Table 31. Additional tools and datasets available at various scales (e.g., individual, regional, national, or global) are presented by Turner et al. (2015), some of which are included in Appendix A.

Table 30. Examples of different methods for ecosystem service valuation that includes conventional economic valuation and non-monetizing valuations and assessments. *List adapted from Farber et al. (2006) reproduced with permission from Turner et al. (2015)).*

Conventional economic valuation	
Revealed-preference approaches	
Travel Cost:	Valuations of site-based amenities are implied by the costs people incur to enjoy them (e.g., cleaner recreational lakes)
Market Methods:	Valuations are directly obtained from what people must be willing to pay for the service or good (e.g., timber harvest)
Hedonic Methods:	The value of a service is implied by what people will be willing to pay for the service through purchases in related markets, such as housing markets (e.g., open-space amenities)
Production Approaches:	Service values are assigned from the impacts of those services on economic outputs (e.g., increased shrimp yields from increased area of wetlands)
Stated-preference approaches	
Contingent Valuation:	People are directly asked their willingness to pay or accept compensation for some change in ecological service (e.g. Willingness to pay for cleaner air)
Conjoint Analysis:	People are asked to choose or rank different service scenarios or ecological conditions that differ in the mix of those conditions (e.g., choosing between wetlands scenarios with differing levels of flood protection and fishery yields)
Cost-based approaches	
Replacement Cost:	The loss of a natural system service is evaluated in terms of what it would cost to replace that service (e.g., tertiary treatment values of wetlands if the cost of replacement is less than the value society places on tertiary treatment)
Avoidance Cost:	A service is valued on the basis of costs avoided, or of the extent to which it allows the avoidance of costly averting behaviors, including mitigation (e.g., clean water reduces costly incidents of diarrhea)
Non-monetizing valuation or assessments	
Individual index-based methods:	These include rating or ranking choice models, expert opinion
Group-based methods:	These include voting mechanisms, focus groups, citizen juries, stakeholder analysis

Table 31. These ecosystem service categories are available in properly functioning forested environments. Some of the appropriate methods for estimating their value are provided for reference. *Table adapted from Farber et al. (2006) reproduced with permission from Turner et al. (2015)).*

Ecosystem Services	Amenability to economic valuation	Most appropriate method for valuation	Transferability across sites
Provisioning Services			
Water Supply	+++	AC, RC, M, TC	++
Food	+++	M, P	+++
Raw Materials	+++	M, P	+++
Genetic Resources	+	M, AC	+
Medicinal Resources	+++	AC, RC, P	+++
Ornamental Resources	+++	AC, RC, H	++
Regulating Services			
Gas Regulation	++	CV, AC, RC	+++
Climate Regulation	+	CV, AC, RC	+++
Disturbance Regulation	+++	AC	++
Biological Regulation	++	AC, P	+++
Water Regulation	+++	M, AC, RC, H, P, CV	++
Soil Retention	++	AC, RC, H	++
Waste Regulation	+++	RC, AC, CV	++/+++
Nutrient Regulation	++	AC, CV	++
Cultural Services			
Recreation	+++	TC, CV, Ranking	+
Aesthetics	+++	H, CV, TC, Ranking	+
Science and Education	+	Ranking	+++
Spiritual and Historic	+	CV, Ranking	+

AC=avoided cost, CV=contingent valuation, H=hedonic pricing, M=market pricing, P=production approach, RC=replacement cost, TC=travel cost; High: +++; Medium: ++; Low: +.

Course-scale aggregate ecosystem service valuations have been completed in 1997 and 2011 for temperate forest environments (Costanza et al. 1997). The value of temperate forests in 1997 was estimated to be $746 per acre annually and increased to $7,748 per acre annually by 2011 (Costanza et al. 2014). These values encompass all of the ecosystem services identified in Table 29, with the increase being attributed to additional research and understanding of our environmental biomes gained during the interim period (Costanza et al. 2014). Within the State of Washington 22,057,837 acres (52%) of the state is considered forested area and approximately 5 million acres (56%) is managed by the USFS (Littell et al. 2010). Many of the semiarid forest lands in the western US, specifically eastern Washington and Oregon, are at risk of catastrophic wildfire and in need of restoration (Haugo et al. 2015). Given the ecosystem service value per-acre estimates from Costanza et al. (2014) and an approximation of 6,617,351 acres (30%) of semi-arid forests east of the Cascades in Washington alone, there is a threat of potentially $51 billion in lost forest ecosystem services.

In addition to this potential threat, the average annual expenditures associated with wildfire (Preparedness, Suppression, FLAME, and related programs) by the USFS have increased dramatically from less than $500 million in the 1980s to $1.4 billion in the 2000s (Ingalsbee 2010), to more than $3.3 billion (52%) of the total USFS budget in 2015 ($6,456,204,000) for wildland fire management (USDA Forest Service 2015a; USDA Forest Service 2015b). Wildfire resource needs within the USFS have equated to a 39% reduction (approx. 7,000 staff) in non-fire related personnel and a loss of more than $475 million in funding for non-fire related programs (USDA Forest Service 2015b) as shown in Table 32. The annual financial and personnel resources directed at wildland fire and the continuing decline of forest health suggests the ecosystem restoration triple-bottom-line of an AFPP would alleviate many of the these costs, protect current ecosystem processes through management for future use, generate increased ecosystem service value through adaptive restoration, and potential revenue through sustainable strategic fuels and biomass reduction practices thereby increasing public participation and local jobs.

Table 32. Reduced funding for non-fire work programs within the USDA Forest Service as a result of increased expenses relating to wildfire and wildfire suppression is presented from 2001 to 2015 in $1000's. Percent loss was identified by the USDA Forest Service (2015b) and fiscal year budget dollar amounts are provided in general from report data.

Program	FY2001	FY2015	Percent Change
Vegetation & Watershed Management	> $240	< $190	-24%
Capital Improvement & Maintenance	> $300	< $175	-68%
Recreation, Heritage and Wilderness	> $305	< $265	-15%
Landownership Management	> $115	< $80	-33%
Wildlife & Fisheries Habitat Management	> $170	< $142	-18%
Land Management Planning	> $100	< $40	-64%
Inventory & Monitoring	> $230	< $155	-35%

* Values presented in *Thousands* and adjusted to 2015 dollars (USDA Forest Service 2015b).

Ecosystem Services and the Anchor Forest Concept

An AFPP would comprise a large, contiguous acreage of forest land that sustains the forest's critical environmental services across diverse ownership boundaries, and would be comprised of more-encompassing objectives than projects currently under existing authorities such as Tribal Forest Protection Act (TFPA), Collaborative Forest Landscape Restoration Project (CFLRP), stewardship contracting, existing MOU's, and service contracts (King & Corrao 2016). Although projects would benefit from a combination of these programs and opportunities that incorporate attributes of multiple project authorities. For example, stewardship contracts and other federal land agency means of collaboration often fund reforestation activities using small amounts of revenue from forest thinning prescriptions and other sources. These produce ecological benefits and can avoid some costs associated with environmental challenges such as fire; however, given relatively short permit authorizations (10-years), extensive ecologic assessment requirements, and limited operational options, it is difficult to attract investors and collaborators to such practices at the scales needed to curtail currently declining forest health conditions (King & Corrao 2016). Additionally, stewardship contracts tend to be one-off and not easily extendable over time. For this reason, Anchor Forests offer a more attractive long-term mechanism for restoration that can incentivize renewed investment of forest restoration at economically viable and spatially appropriate time-scales that demonstrate that forest rehabilitation, sustainability and ecosystem services have committed constituents.

After years of forest management discussion (Zenner 2014), largely absent of tribal forest practices (Mason et al. 2012), Native American history and experience of integrating social/cultural, economic, and ecologic objectives into their forest management practices has begun to gain recognition as a uniquely important model for forest stewardship (ITC 2013). An AFPP would provide an historic and important opportunity to apply the successes and perspectives of Indian Country to the future of our forests and develop collaborative partnerships across a broad diversity of stakeholders (Evergreen Magazine 2014). An AFPP framework would address the economic and ecological challenges we must collectively overcome to restore and maintain the health and function of our forested ecosystems as well as provide the experiences and data needed to value ecosystem services and gain additional stakeholder interest.

Table 33 displays some of the ecosystem services, by category (Costanza et al. 1997), anticipated under an AFPP focused on restoration of forest health and re-establishment of a heterogeneous mosaic of forest conditions supportive of the triple-bottom-line balance of social/cultural, economic, and ecological forest management.

Table 33. Using the 17 categories provided in Table 29 a list (though not exhaustive) of the ecosystem goods and services an Anchor Forest project of sufficient scale (regional/landscape) would be able to manage, monitor, and develop data for are provided. Given sufficient monitoring and data collection, opportunities to assess the value of specific ecosystem services and improve the accuracy of other current estimates will increase, using tools similar to those provided in Appendix A. Table adapted from (Costanza et al. 1997).

Ecosystem Goods and Services	Ecosystem Function Support within the Anchor Forest Concept
Gas Regulation	Properly functioning vegetative ecosystems play a role in the regulation of atmospheric CO_2 and sequestration of carbon. Healthy forests are less prone to fire, burn less severely, and are more likely to be suppressed before burning human infrastructure, thereby releasing less particulate matter (smoke) and toxins into the atmosphere.
Climate Regulation	Properly functioning forested environments can play a role for regional temperature and precipitation mediation, greenhouse gas regulation (CO_2), carbon sequestration, and reduced airborne particulate matter.
Disturbance Regulation	Properly functioning forests are more resilient, and can provide a buffering affect to ecosystem perturbations such as insect and disease outbreaks and fire in the face of a changing climate. Additionally, high forest resilience allows forest managers greater opportunities and flexibility to apply adaptive/innovative management practices given increased ecosystem stability and less-significant consequences for unsuccessful innovations.
Water Regulation	Properly functioning forested environments are less water resource intensive than anthropogenic land development (paved surfaces, homes, or row-crop agriculture)
Water Supply	Properly functioning forests are less prone to high-severity wildfire with the potential to change the vegetative regime of an entire watershed, and thereby affect the hydrology and hydrologic systems relied upon by wildlife and humans. There are human safety and infrastructure implications in hydrologically unstable watersheds.
Erosion and Sediment Control	Properly functioning forests, resilient to wildfire, protect soils from wind and water erosion, decrease soil compaction thereby increasing infiltration rates, filter silt and sediment from road surfaces and help buffer temporary impacts of forest management.
Soil Formation	Properly functioning forests promote greater biotic diversity and maintain organic material at a rate and level appropriate to biotic need without excess buildup that increases fire risk and fire intensity that can degrade soil physical and chemical properties.
Nutrient Cycling	Properly functioning forests support stream nutrients, carbon sequestration, and nutrient fixation; active management (harvest and prescribed fire) can release nutrients stored in above-ground biomass.

Ecosystem Goods and Services	Ecosystem Function Support within the Anchor Forest Concept
Waste Treatment	Properly functioning forests can recover mobile nutrients from runoff, leached nutrients within soil profiles, and run-on nutrients from upland areas such as agricultural areas. Resilient forests provide shade to regulate water temperature, wetland diversity for filtration, and biotic diversity for nutrient use.
Pollination	Properly functioning forests exhibit heterogeneity of habitat conditions and promote fauna and flora diversity.
Biological Control	Properly functioning forests with established heterogenic structures provide dynamic habitats and shelter for all species, edge/fringe habitat complexities that control herbivory, and promote a diversity of species at multiple trophic levels to balance predator-prey relations and population dynamics.
Refugia	Properly functioning heterogenic forests can support resident species as well as transient species. Under the Anchor Forest concept proper management and monitoring can identify conditions where transient/migratory species habitat can be conserved or restored, wintering grounds and nursery zones can be improved or protected, and optimum timing and locations for recreational activities determined.
Food Production	Properly functioning forests provide a diversity of production as food including; fish, game, crops, nuts, fruits, and berries by hunting and gathering as well as subsistence. Diversity of vegetative structure (at sufficient scales) increases diversity of habitat and therefore the edible resources a forest can support.
Raw Materials	Properly functioning forests require disturbance at varying levels to maintain acceptable fuel loads and support a diversity of ecosystem processes. The suppression of fire by human efforts and a lack of active management on many forest lands has led to conditions requiring a natural 'reset' and possible change to non-forest environment through catastrophic wildfire or active silvicultural management (i.e., harvest, thinning, and prescribed fire) to restore forest health and provide lumber, biofuel and fodder that may generate additional resources in support of forest health.
Genetic Resources	Properly functioning forests provide a suite of unique biological materials and products used for medicines, materials science, genes for plant resistance to pathogens, pests and invasive species (pests and horticultural varieties of plants). The more resilient a forest ecosystem is the more stable the ecosystem processes will be and the greater diversity/value of services it can provide.
Recreation	Properly functioning forests can support eco-tourism, sport fishing, hunting, motorsports and other outdoor recreational activities that can help contribute to the resource and management needs required to maintain forest health and use activities into the future.
Cultural	Properly functioning forests are able to support a wide variety of aesthetic, artistic, educational, spiritual and/or scientific values. The need to identify all values and their respective forest conditions is a critical aspect of successful collaborative communication requiring all stakeholders and interested parties to participate and respect the collaborative agreements made.

Challenges of an Anchor Forest Pilot Project

Tribal, public and private forests provide a cost-efficient means to manage and support a diversity of ecosystem processes and provide a wide variety of ecosystem services. These services, as valuable to society as they are, have only recently been required in US Federal agency planning (Donovan et al. 2015). For decades forest planning and management has often been subject of support for a singular interest (e.g., species-specific management, lumber, housing, rural development, among others) to the detriment of water, wildlife, recreation, communities well-being and even the stability of the forest as a whole (Zenner 2014; Winkel 2014). Protecting forests and maintaining forest health entails a balanced understanding and management of the myriad of ecosystem processes and services a forest can provide. The Anchor Forest concept represents this need through a collaborative framework founded in balancing social/cultural, economic and ecologic needs through sustainable forest management activities that restore forest health and resilience at the landscape-scale across multiple landownerships. However, as stated by Zenner (2014), "operation within a paradigm of sustainable forestry requires expertise in such a broad array of topics that it transcends the capabilities of a single discipline," agency, organization or business sector, thereby requiring collaboration at a level not easily achieved.

The need for collaboration and the challenges facing an AFPP are not unique to the Anchor Forest concept. An assessment of collaborative forest restoration and watershed restoration projects with goals and/or objectives similar to that of Anchor Forests, within the western U.S. was described in Task 2 (King & Corrao 2016) and stakeholder interviews as well as survey data and focus-group questionnaire responses regarding all aspects of the Anchor Forest concept were presented in Tasks 3 and 4 (M. Corrao et al. 2016; O'Laughlin & Corrao 2016). The results from these assessments helped to identify some of the challenges to collaboration and some specific to the establishment of an AFPP.

Overall readiness of eastern Washington stakeholders to collaboratively participate in an AFPP varied by participant indicating sharing of resources, staff, expertise and equipment, would be based upon leadership support as well as the availability and timing of needed resources. The readiness of participants to commit to an AFPP was constrained by a lack of understanding regarding AFPP goals and objectives, a lack of area milling infrastructure, and limited time, staffing and financial resources. Participants also indicated a need to establish a better public communication-education process to increase awareness for local residents and promote the importance of an Anchor Forest in restoring forest health, function and economic sustainability in local communities. Survey results suggested how survey participants defined the Anchor Forest concept may be one of the more important insights for establishing an AFPP in that each approaches a collaborative framework through a different lens.

There are notable differences in business sectors and regulatory agencies that will need to be overcome in order to achieve the greatest successes within the Anchor Forest concept. For example, state and federal staffing is driven by policy, funding, litigation and a social license to operate in a certain manner (Miner et al. 2010; King et al. 2007; Gambino-Portuese et al. 2009; Keele et al. 2006). Conversely, for non-government organizations and the private sector, funding opportunities are often available through state and federal agencies for staffing, however, it is presented with the resource-intensive burden of successfully navigating agency regulation and

policy governing application, access and use. Many respondents suggested current limitations and drawbacks could be managed if the collaborative environment was sheltered from litigation by non-participants and outside parties, as this would encourage trust and participation to bridge differences toward a singular meaningful goal.

Although collaboration comes with challenges and differences of opinion; all stakeholders within eastern Washington who participated in the Anchor Forest surveys and focus-group discussions indicated support for investment in, and implementation of, an AFPP with the expectation of respectful partnerships and deliverables that could address current forest health conditions. The challenge for an AFPP is to gain a social license that continues to foster optimism and promote awareness of the policies and tools that can support collaborative communication and increase awareness of current forest health conditions and the value, financial and nonfinancial, of ecosystem processes and services that will be damaged or lost should actions not occur on spatially or temporally appropriate scales.

Assessing Ecosystem Services and Non-Timber Resources

Value-based accounting can be used to provide insight into the value gained by stakeholders given changes through time resulting from alterations to forest conditions brought about by management action. From an initial state, for both the economy and the environment, restorative actions will produce outcomes that will alter conditions and affect demand (interest) from a wide variety of stakeholders depending on the value-change regarding management activities. This can be a challenging endeavor given the lack of financially measureable aspects of some ecosystem services. This leads some to ask: How do we deal with a market that fails to capture social values?

Economists either regulate the production activity associated with these values to constrain (expand) its level of production so as to reduce (increase) its impact on others depending on whether it produces bad (good) value, or we create a market for the externality. Market-based approaches act as a system of accounts that allow for the participants to quantify the exchange of goods and services. Without a well-defined commodity there can be no market transactions. Knowing the physical levels of environmental assets and their flows is a precursor to market creation. For instance, experience in carbon markets has shown the need for carbon accounting schemes for carbon exchanges to function. Landell-Mills & Porras (2002) described the following characteristics of a market:

- The commodity
- The participants
- How competitive is the market?
- How do transactions take place?
- Trade
- Market maturity
- Institutional relationships

Market structures vary between locations and goods. Economists concerned with efficiency have traditionally been preoccupied with the degree of market competition. However, examining markets that are dynamic, involved varied participation, and are embedded in a wider institutional framework, it is important to survey an array of features. Seven features have been recommended to distinguish different market forms (Landell-Mills & Porras 2002):

> ***The commodity.*** *The key ingredient in any market is the commodity that is being bought and sold.*
>
> ***Characteristics of participants.*** *Participants include those demanding environmental services, those supplying services and intermediaries involved in facilitating transactions. Participants may include the private sector, the public sector, non-government sector, civil society or a combination.*
>
> ***Level of competition.*** *The level of competition determines the extent to which individual market players can influence prices – often referred to as market power. Conventionally we measure competitiveness by the number of players in a market: the fewer the players (e.g. in the case of monopolies and monopsonies),*

the greater each participant's market power and the less competitive the market. Competitive markets involve several participants. However, it is critical to distinguish between explicit and effective competition. Even where markets are highly concentrated, if there is a credible threat of entry by competitors the market may be competitive.

Payment mechanism. *Several options exist for transferring funds from buyers to sellers, including direct negotiation, broker-based markets, auction systems, and exchange-based markets.*

Geographical extent of trading. *Trades may be local, national, regional or international depending on the market and its location vis a vis political boundaries.*

Level of maturity. *Market maturity may be defined in a number of ways. Four useful criteria include: the time period since transactions were first initiated (i.e. the age of the market), the degree of price discovery attained to date, market participation and liquidity, and the level of sophistication in the payment mechanism employed.*

Nested nature. *Markets evolve in a context. Not only may markets replace existing institutional arrangements, but they build on institutional arrangements which will influence the form they take.*

It is important to understand the context and nature of inter-institutional relationships. These features are not independent and a change in one is likely to be linked to changes in others. For instance, immature markets are likely to have higher levels of public sector participation (reflecting government efforts to promote institutional development), simpler payment mechanisms and lower levels of competition than fully established markets. As competition picks up, governments are likely to become less interventionist and payment mechanisms more sophisticated.

A driving set of costs often overlooked are transaction costs associated with the creation and operation of markets. Costs of market creation include, amongst other things, defining property rights, setting up exchange systems, educating market participants, establishing monitoring and enforcement mechanisms and building confidence in the system. Market operation includes costs of information gathering, negotiation, contract formulation, monitoring and enforcement. Within an AFPP there are many opportunities to identify markets where ecosystem services may be valued and stakeholder input accomplished. Whether market-based approaches are used in a value-based accounting framework to assess the value of an ecosystem or other methods are employed for quantifying the value of specific services, time, resources and information are needed to facilitate these processes and generate accurate results.

One example for how value might be assessed to forest ecosystem services under the Anchor Forest concept has been provided by Dr. Perez-Garcia using the Washington State Input-Output Study from 1987 (Appendix B).

Conclusions

Investments in land restoration are easily quantifiable, however associated non-market services and returns can be difficult to assess with confidence. Because investments are measured using expenditure data, and economic restoration activities commonly result in a one-time economic expense, financial reports show little to no longer-term value for non-market services. Economic accounting of restoration activities is therefore reduced to quantifying the economic benefits of expenditures to the natural environment such as in the reconstruction of stream channels, pre-commercial thinning of forest stands, or species-specific habitat preservation. The impacts of these expenditures are easily measured on the general economy with existing input-output models. However, there expenses do not often lead to the quantification of ecosystem services protected or enhanced without assessment data and monitoring over time to detect changes in the status of services using quantifiable metrics.

Research and collaboration show that social and economic benefits can be achieved through Anchor Forest-based management of forest lands (IFMAT 2013; ITC 2013). Anchor Forests will support a myriad of public values, and serve as examples of environmental stewardship and conservation that will provide a solid foundation for national efforts, bridge communication between diverse opinions and stem the tide of natural resource environmental and economic loss. This Anchor Forest study focused on three areas of eastern Washington and included four tribal nations, the USFS, USDA Pacific Northwest Research Station, and the DNR as well as researchers from the University of Washington, The Nature Conservancy (TNC), and the University of Idaho. A guiding goal was to collect data and preform research useful in guiding an implementation of the Anchor Forest concept and to provide recommendations based on stakeholder input and feedback from landowners and agencies within the study areas.

The social and political network for ecosystem service values that can be gained from Anchor Forests, or lost without them, encompasses tribes, government agencies, local business and industry, recreation, river and water advocates, food producers and sellers, and hydroelectric energy producers, as well as households and health and education providers, among others. All of these stakeholders face changing conditions, demographics and competing social values which alter the collaborative and forest management environment. For landowners, this means continually increasing fire risk and insect outbreaks on public lands, and a reduction in timber industry infrastructure (V. Corrao et al. 2016), with no long-term consistent or effective action, make landownership less attractive and can motivate sales for higher-better uses (Bradley et al. 2007; Best & Constance 2002). This weakens the ‘social license’ critical to generating support for any forest management decision.

Reference Stand Conditions across all forested ownerships in Oregon and Washington have been assessed and management scenarios have been presented with the potential to address forest health at appropriate spatial and temporal scales (Haugo et al. 2015). This would produce benefits for cities and counties near managed forests such as; decreased fire danger, smoke, and other health hazards as well as long-term economic stability from local jobs, recreational use, and forest products among other ecosystem services attributed to sustainable ecosystem processes. Additionally, examples of forest stewardship have demonstrated the ability of Tribal Nations to manage forest ecosystems and maintain a level of economic objectives supporting

employment stability and sawmill operation, as well as the protection and enhancement of social/cultural, economic, and ecologic values at landscape scales (IFMAT 2013; ITC 2013).

> *"The ecological practices tribal peoples have cultivated for millennia are inherently sustainable and practical; they are time-tested methods for resource and, correspondingly, cultural survival. Today tribes are using their unique knowledge and skills in concert with modern management practices, often collectively with community and non-tribal organizations, to produce real accomplishments and model programs of excellence." (NCAI 2015)*

Tribal nations are able to work directly with federal agencies through their unique government-to-government trust relationship which allows them to manage cooperatively, federal forestland and rangelands adjacent to lands under tribal jurisdiction (Cook & Wilson 2015). This relationship allows tribes to engage in management of federal lands that pose a fire, disease or other threat; are in need of restoration; or have features unique to the tribal well-being. Tribal lands are managed to sustain a host of resources that the tribe considers essential. Their history and traditional knowledge can be valuable in understanding how to restore both the federal forests and the social license to manage those forests.

Anchor Forests with tribal management can help fulfill national goals for forest protection and restoration, improve the federal forest conditions, provide economic support for local communities, tribal enterprises, and enhance the societal, cultural and spiritual benefits derived from forest ecosystem services. Anchor Forests could alleviate the conditions of national forests that create uncertainty and risk for communities from fire, and provide support to private and state forest landowners amidst changing demographics and competing social values such as the unforeseen shifts in economic environments, globalization, population growth and urbanization which can be at odds with ecosystem values and contribute to a lack of the social license that keeps working forests working.

An Anchor Forest Pilot Project would:

- Employ tribal forest management practices as one model for the production of sustainable environmental outcomes.
- Heighten forest resilience to fires and pathogens and reduce wildfire safety concerns.
- Strengthen the economic health and well-being of tribal and local communities through improved forest health, maintenance of working forests, and local revenue generation.
- Create an environment in which water, wildlife, fire management and other non-timber ecosystem services will add to the suite of products for which forest land is valued by and managed for.
- Remove barriers to collaboration between stakeholders at multiple levels, and leverage resources to improve the health and well-being of forest-dependent communities.

Recommendations

Coalitions of tribal, federal and state agencies, coupled with local stakeholders from community, industry, conservation groups, recreational and other interests, can overcome differences and develop common, attainable goals for management of publicly-administered national forests. Several experiences around the country, such as the Tapash Sustainable Forest Collaborative, Southwestern Crown of the Continent Landscape Restoration Strategy, Northeast Washington Forestry Collation's Colville National Forest "Blueprint", and the Blackfoot Challenge, have demonstrated that forums and collaborative processes, suited to local temperaments and circumstances, have enabled diverse interests to gain a sense of community and purpose that has led to shared understandings and plans to realize forest health objectives (King & Corrao 2016).

Nevertheless, overcoming the many legacy barriers of legal and social gridlock across federal forest ownerships takes time, patience, trust, communication, and funding. Therefore, with reasonable objectives, strengthened organizational capabilities, and creative leadership, Anchor Forests can provide an example of how to break through those barriers. The following discuss recommendations for increasing the understanding of an AFPP, incorporating a broad diversity of stakeholders, and incentivizing collaborative participation to achieve restoration of degraded forestlands through upholding the triple-bottom-line of balanced social/cultural, economic, and ecological stewardship.

Develop a deliverable, visual, non-complex united message describing what an Anchor Forest is, and what it is not. An AFPP would be an operational model of forest restoration that will minimize wildfire, insect and pathogen destruction and create forest conditions that exemplify balanced social/cultural, economic, and ecological stewardship and as a whole achieve the well-being and resilience needed to provide desired ecosystem services in the face of climate change and societal growth. There is a unique opportunity for an AFPP in that tribes are sovereign nations with legislation and statute affording them the opportunity to manage many federal lands held in trust (Wood 2003; Wood 2014; Recker 2013). Tribal Nations could provide a depth of holistic forest ecosystem management no other participant has and offer guidance and contracting to organizations and private sector stakeholders able to utilize state and federal funding.

Build a framework of communication, leadership and examples that are easily accessible and digestible for stakeholders. Formal stewardship agreements or working forest easements could be negotiated and administered to improve prospects for long-term, comprehensive, landscape-level forest management. Contracts/funding availability at time scales that encourage stakeholder investment in forest restoration are needed. Upfront costs in project planning, federal environmental policy, and needed infrastructure development can be substantial (10+ years) before actions can be undertaken; therefore, appropriate project scales (≥1,000,000 acres) and timeframes of 15+ years are necessary to amortize financial investments and complete adequate and thorough analyses. Continual evaluation of restoration results throughout a 15+ year timescale will provide a picture of enhanced economic and conservation outcomes, as well as the data needed to continue valuing and enhancing available ecosystem services.

Identify ecosystem services within areas to be managed; describe their current conditions, potential benefits from forest management, drawbacks from forest management, and monitoring

program to assess changes as management occurs, and to provide feedback for adapting future activities. To date, forest yields of timber and fiber as well as the land itself have generally-accepted monetized market values (Wu & Kim 2013; Boyd & Banzhaf 2007). However, monetizing water-related ecosystem services may offer a practical, common-sense approach for protecting or valuing both forests and other ecosystem services (Garrick et al. 2009; Walker et al. 2010; Mäler et al. 2008). Additionally, clean air and clean water can be motivational arguments for better health and recreational activities and can assist community acquisition of funding thereby stimulating local economic activity. Identifying the direct and indirect impacts associated with ecosystem services is often not examined, therefore, employing methods such as value-based accounting may provide a measure of the effects of changes over time, and the results of alterations to forest conditions brought about by collaborative management activities.

Develop a framework that categorizes areas within a forest, using measureable metrics, where social/cultural, economic, and ecologic goals are prioritized and ranked to assist collaborative groups in focusing their energy. Anchor Forests could facilitate integration of management direction on forest lands and open the way for cooperative programs to reduce costs and share expertise and programs to coordinate management of ecosystem processes and services. For example, costs of securing basic information, such as terrain, forest tree height, and tree diameter data, for management and investment planning could be shared and thereby reduced through application of emerging large-scale technologies such as LIDAR (light detection and ranging) to obtain landscape and watershed geographical information for terrain, watershed conditions, forest inventories, pathogen impacts, prioritization management investments, and monitored effectiveness of operational plans.

Protect the collaborative process legally and socially from non-participant and third-party litigation. Encourage respectful communication and participation. If stakeholders could come together in a collaborative environment “protected” from litigation by non-participants, the opportunity to build a framework of trust and bridge differences toward united goals would be far more accessible (Thomas 2011; Cook & Wilson 2015). It has been shown that examples of success and innovative ideas can be powerful in building trust, familiarity, and momentum toward application of desired practices (Rogers 2003; Hubbard & Sandmann 2007; Pannell et al. 2006). An AFPP would provide the foundation to incentivize stakeholder participation and foster trust toward a universal goal of restored forest-ecosystem function. The Anchor Forest concept provides an opportunity to improve forest health through active management projects and therefore bring forests closer to their healthy reference condition (Haugo et al. 2015), make the landscape more resilient, and provide improved ecosystem services. This is a responsibility requiring all stakeholders within a project area to work together, because sustainable forestry transcends a diversity of disciplines and is out of reach for any one organization or stakeholder (Zenner 2014).

Provide a transparent public forum for dissemination of collaborative decisions, examples, results, and successes. This could take the form of a website or blog that formally recognizes the benefits received from forest ecosystems to allow ecosystem services to play a larger role in management decisions and thereby broadening the suite of products and services for which management can value. Be able to demonstrate how enhanced forest resilience and reduction of wildfire risk can be made possible through utilization of responsible forest harvest and use of

woody biomass to demonstrate the advantages related to climate change, energy security and economic development (e.g., homes, jobs, biodiversity, carbon sequestration, etc.). And finally to demonstrate that effective cross-ownership planning and partnerships can enhance forestland stewardship, coordination to leverage resources, encourage investment in working forests, and improve the quality of life in forest-dependent communities and retaining the societal well-being these lands provide.

Literature Cited

Best & Constance, 2002. America's Private Forests Challenges for Conservation. *Journal of Forestry*, 100(May), pp.14–17.

Boyd, J. & Banzhaf, S., 2007. What are ecosystem services? The need for standardized environmental accounting units. *Ecological Economics*, 63(2-3), pp.616–626.

Bradley, G. et al., 2009. *Retention of High-Valued Forest Lands at Risk of Conversion to Non-Forest Uses in Washington State*, Prepared for the Washington State Legislature and Washington Department of Natural Resources. Seattle, WA.

Bradley, G. et al., 2007. *Study 4: Forest Land Conversion in Washington State*, Seattle, WA.

Chase, R.A., Bourque, P.J. & Conway Jr, R.S., 1987. *The 1987 Washington State input-output study*, Seattle, WA.

Cook, P.S. & O'Laughlin, J., 2014. *Fuel Treatments in Idaho's Forests: Effectiveness, Constraints, and Opportunities*, Moscow, Idaho.

Cook, P.S. & Wilson, P., 2015. *Policies Affecting Implementation of Landscape-scale Treatments on National Forest System Lands at High Risk of Insect and Disease Mortality*, Moscow, Idaho.

Corrao, M., Dolsen, D. & O'Laughlin, J., 2016. *Anchor Forest Pilot Study: Task 3 Report - Evaluation of Institutional Capacity*, Moscow, Idaho: Northwest Management Inc.

Corrao, V., Howisey, G. & Corrao, M.V., 2016. *Anchor Forest Pilot Study: Task 1 Report - Infrastructure for Commodity Production and Biomass*, Moscow, Idaho: Northwest Management Inc.

Costanza, R. et al., 2014. Changes in the global value of ecosystem services. *Global Environmental Change*, 26, pp.152–158.

Costanza, R. et al., 1997. The value of the world ' s ecosystem services and natural capital. *Nature*, 387(May), pp.253–260.

DNR, 2014. *Eastern Washington Forest Health: Hazards, Accomplishments and Restoration Strategy*,

Donovan, S., Goldfuss, C. & Holdren, J., 2015. Memorandum for Executive Departments and Agencies: Incorporating ecosystem services into federal decision making. , (October 7, 2015), p.5.

Evergreen Magazine, 2014. Forestry in Indian Country: Solving Federal Forestry's Rubik's Cube. *The Magazine of the Evergreen Foundation*, p.72.

Farber, S. et al., 2006. Linking Ecology and Economics for Ecosystem Management. *BioScience*, 56(2), p.121.

Gambino-Portuese, B. et al., 2009. Litigants' characteristics and outcomes in US Forest Service land-management cases 1989 to 2005. *Journal of Forestry*, 1, pp.16–22.

Garland, J.J., 2013. *The changed forestry workforce: Issues, opportunities and the future*,

Garrick, D. et al., 2009. Water markets and freshwater ecosystem services: Policy reform and implementation in the Columbia and Murray-Darling Basins. *Ecological Economics*, 69(2), pp.366–379.

De Groot, R.S., Wilson, M. a. & Boumans, R.M.J., 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecological Economics*, 41(3), pp.393–408.

Haugo, R. et al., 2015. Forest Ecology and Management A new approach to evaluate forest structure restoration needs across. *Forest Ecology and Management*, 335, pp.37–50.

Hubbard, W.G. & Sandmann, L.R., 2007. *Using Diffusion of Innovation Concepts for Improved Program Evaluation*, Athens, GA.

IFMAT, 2013. *Intertribal Timber Council: Assessment of Indian forests and forest management in the United States, Volume I*,

Ingalsbee, T., 2010. Getting Burned: A Taxpayer's Guide to Wildfire Suppression Costs. *FUSEE*, p.43.

ITC, 2013. *Fulfilling the Promise of The Tribal Forest Protection Act of 2004: An Analysis by the Intertribal Timber Council in Collaboration with USDA Forest Service and Bureau of Indian Affairs*, Portland, Oregon.

Keele, D.M. et al., 2006. Forest Service Land Management Litigation 1989-2002. *Journal of Forestry*, 104(4), p.7.

King, M.A. et al., 2007. Co-Management or Contracting? Agreements Between Native American Tribes and the U. S. National Park Service Pursuant To the 1994 Tribal Self-Governance Act. *Education*, 31(c), pp.475–530.

King, T.K. & Corrao, M., 2016. *Anchor Forest Pilot Study: Task 2 Report - Collaborative Forest Restoration Frameworks and the Anchor Forests Concept*, Moscow, Idaho: Northwest Management Inc.

Landell-Mills, N. & Porras, I.T., 2002. *Silver bullet or fools' gold?*, London.

Lippke, B. et al., 2007. *Study 1: Timber Supply and Forest Structure in The Future of Washington's Forests and Forestry Industries*, Final Report by the College of Forest Resources, University of Washington. Seattle, WA.

Littell, J.S. et al., 2010. Forest ecosystems, disturbance, and climatic change in Washington State, USA. *Climatic Change*, 102(1-2), pp.129–158.

Mäler, K.-G., Aniyar, S. & Jansson, A., 2008. Accounting for ecosystem services as a way to understand the requirements for sustainable development. *Proceedings of the National Academy of Sciences of the United States of America*, 105(28), pp.9501–9506.

Mason, C.L. & Lippke, B.R., 2007. Jobs, Revenues, and Taxes from Timber Harvest; An Examination of the Forest Industry Contribution to the Washington State Economy. , p.63.

Mason, L. et al., 2012. Listening and Learning from Traditional Knowledge and Western Science: A Dialogue on Contemporary Challenges of Forest Health and Wildfire. *Journal of Forestry*, 110, pp.187–193.

Millar, C.I. & Stephenson, N.L., 2015. Temperate forest health in an era of emerging megadisturbance. *Science*, 349(6250), pp.823–826.

Miner, A.M.A. et al., 2010. Twenty Years of Forest Service National Environmental Policy Act Litigation. *Environmental Practice*, 12(02), pp.116–126.

NCAI, 2015. Fiscal Year 2016 Budget Request. , pp.106–115.

NIFC, 2015. National Interagency Fire Center. *October 30, 2015*. Available at: https://www.nifc.gov/fireInfo/nfn.htm [Accessed October 31, 2015].

O'Laughlin, J. & Corrao, V., 2016. *Anchor Forest Pilot Study: Task 4 Report - Identifying Barriers to Cooperative, Collaborative Cross-Boundary Forest Management*, Moscow, Idaho: Northwest Management Inc.

Pannell, D. et al., 2006. Understanding and promoting adoption of conservation practices by rural landholders. *Australian Journal of Experimental Agriculture*, 46(11), p.1407.

Pinchot Institute for Conservation, 2011. *Options for Landowner Incentives to Increase Forest Carbon Sequestration Forest Carbon Incentives Options for Landowner Incentives to*, Washington, D.C.

Pinchot Institute for Conservation, 2014. *The role of communities in stewardship contracting - FY 2013 programmatic monitoring report to the USDA forest service*, Washington, D.C.

Recker, R., 2013. United States Department of the Interior Bureau of Indian Affairs response letter to the proposed directives for Forest Service land management planning. , p.2.

Rogers, E., 2003. *Diffusion of innovations* 5th ed., New York: Free Press.

Thomas, J.W., 2011. The Future of the National Forests – Who Will Answer an Uncertain Trumpet? , (September), p.30.

Thomas, J.W. et al., 2006. The Northwest Forest Plan: Origins, Components, Implementation Experience, and Suggestions for Change. *Conservation Biology*, 20(2), pp.277–287.

Turner, K.G. et al., 2015. A review of methods, data, and models to assess changes in the value of ecosystem services from land degradation and restoration. *Ecological Modelling*.

USDA Forest Service, 2015a. *Fiscal Year 2015 Budget*, Washington, D.C.

USDA Forest Service, 2015b. *The Rising Cost of Fire Operations: Effects on the Forest Service's Non- Fire Work*, Washington, D.C.

Walker, B. et al., 2010. Incorporating Resilience in the Assessment of Inclusive Wealth: An Example from South East Australia. *Environmental and Resource Economics*, 45(2), pp.183–202.

Winkel, G., 2014. When the pendulum doesn't find its center: Environmental narratives, strategies, and forest policy change in the US Pacific Northwest. *Global Environmental Change*, 27(1), pp.84–95.

Wood, M.C., 2003. Indian Trust Responsibility: Protecting Tribal Lands and resources through Claims of Injunctive Relief against Federal Agencies. *Tulsa Law Review*, 39(2), pp.355–368.

Wood, M.C., 2014. Tribal Trustees in climate crisis. *American Indian Law Journal*, 2(2), pp.518–546.

Wu, T. & Kim, Y.-S., 2013. Pricing ecosystem resilience in frequent-fire ponderosa pine forests. *Forest Policy and Economics*, 27, pp.8–12.

Zenner, E.K., 2014. The ongoing story of silviculture on our natural public forestlands. *Journal of Forestry*, 112(6), pp.611–616.

Appendix A – Ecosystem valuation models and methods in Turner et al. (2015).

Representative selection of models to evaluate the effects of sustainable land management. Divided by aggregation scale from plot to global. For additional and more comprehensive details, including URL, see the Supporting information.

Model	Scale	Type	Brief description
CropSyst	Field	Process based model	The model was developed as an analytic tool to analyze the effect of management on both the productivity and the environment
DNDC	Plot to field	Biogeochemistry computer simulation model in agro-ecosystems	This model is process-based and concurrently models (trace-) gas emissions, soil carbon storage, as well as crop yield, in agricultural
APSIM	Field to farm	Agro-ecosystem process based model	Consists of three different modules, plant, soil and management. Each of them include a diverse range of crops, pastures and tree production, soil processes, as well as water balance, N and P transformations, soil properties, erosion and a large range of management settings
CENTURY	Field to farm	Agro-ecosystem process based model	Simulates macro nutrient dynamics, on both farm and field scale. It embodies the best understanding of the biogeochemistry of C, N, P, and S, available today
EPIC	Field to farm	Agro-ecosystem model	Cropping systems model that estimates the effects of management decisions on soil, water, nutrient and pesticide movements
APEX	Watershed	Landscape model	Watershed analysis to evaluate a range of land management strategies and take into consideration sustainability, erosion, economics, water supply and quality, soil state, plant community competition, weather, and pests
DSSAT	Farm to regional	Cropping system model (CSM) Software application program	On-farm model developed to handle precision management, with a component to analyze regional assessments of climate variability and climate change impacts
STICS	Plot to regional	Process based model	Calculates the properties of the agricultural output, and assess environmental impacts, such as nitrate leaching and greenhouse gas emissions
LPJmL	Global	Dynamic global vegetation models process based	Simulates the terrestrial carbon cycle and the effect on vegetation patterns under climate change for both natural and agricultural ecosystems
ORCHIDEE	Local to global	Dynamic global vegetation models process based	Models both natural ecosystems and human managed carbon, water, and energy dynamics from site to globe scale on sub-daily to centennial scales
CARAIB	Regional	Dynamic global vegetation models process based	This model estimates the net primary productivity (NPP) of the continental vegetation
World3	Global	Integrated global model	Systems dynamics model with five sectors: population, capital, agriculture, nonrenewable resources, and persistent pollution. Limited growth model
IMAGE	Global	Integrated global model	Incorporates different components of the earth system, including oceans, biosphere, atmosphere and anthroposphere (water use and land degradation)
IF	Regional	Integrated global model	Consists of seven submodels: a population, economy, agriculture, energy, social, international policy, environment, and a technical submodel
TARGETS	Global	Integrated global model	Five submodels: population and health, energy, land and food, and water. Each of those submodels is a DPSIR model but they are linked through a socioeconomic scenario generator, in which policy responses are explicitly incorporated
GUMBO	Global	Integrated global model	Five modules: Atmosphere, Lithosphere, Hydrosphere, Biosphere, and Anthroposphere. The Earth's surface is further divided into eleven biomes or ecosystem types. The first global model to include the dynamic feedbacks among human technology, economic production and welfare, and ecosystem goods and services

A survey of ecosystem services tools (adapted from Bagstad et al., 2013).

Name	Tool, URL, and references	Brief description
Ecosystem Services Review (ESR)	http://www.wri.org/, (World Resources Institute (WRI), 2012)	Publicly available, spreadsheet-based process to qualitatively assess ecosystem services impacts
Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST)	http://www.naturalcapitalproject.org, (Kareiva et al., 2011; Tallis et al., 2013)	Open source ecosystem service mapping and valuation models accessed through ArcGIS
Artificial Intelligence for Ecosystem Services (ARIES)	http://www.ariesonline.org (Bagstad et al., 2013; Villa et al., 2011)	Open source modeling framework to map ecosystem service flows; online interface and stand-alone web tools under development
LUCI (formerly Polyscape)	http://www.polyscape.org (Jackson et al., 2013)	Open source GIS toolbox to map areas providing services and potential gain or loss of services under management scenarios
Multiscale Integrated Models of Ecosystem Services (MIMES)	http://www.afordablefutures.org	Open source dynamic modeling system for mapping and valuing ecosystem services
EcoServ	Feng et al. (2011)	Web-accessible tool to model ecosystem services
Co$ting Nature	http://www1.policysupport.org/cgi-bin/ecoengine/start.cgi?project=costingnature	Web-accessible tool to map ecosystem services and conservation priority areas
Social Values for Ecosystem Services (SolVES)	http://solves.cr.usgs.gov (Sherrouse et al., 2011)	ArcGIS toolbar for mapping social values for ecosystem services based on survey data or value transfer
Envision	http://envision.bioe.orst.edu, (Guzy et al., 2008)	Integrated urban growth-ecosystem services modeling system; has used external models, including InVEST, or created new ecosystem service models as appropriate
Ecosystem Portfolio Model (EPM),	http://geography.wr.usgs.gov, (Labiosa et al., 2013)	Web-accessible tool to model the impacts of alternative land uses on economic, environmental, and quality of life
InFOREST	http://inforest.frec.vt.edu/	Web-accessible tool to quantify ecosystem services in Virginia
EcoAIM	Waage et al. (2011)	Proprietary tool for mapping ecosystem services and stakeholder preferences
ESValue	Waage et al. (2011)	Proprietary tool for mapping stakeholder preferences for ecosystem services
EcoMetrix	http://www.parametrix.com (Parametrix, 2010)	Proprietary tool for measuring ecosystem services at site scales using field surveys
Natural Assets Information System (NAIS)	http://www.sig-gis.com, (Troy and Wilson, 2006)	Proprietary valuation database paired with GIS mapping of land-cover types for point transfer
Ecosystem Valuation Toolkit	http://www.esvaluation.org (Ecosystem Valuation Toolkit, 2012)	Subscription-based valuation database paired with GIS mapping of land-cover types for point transfer
Benefit Transfer and Use Estimating Model Toolkit	http://www.defenders.org (Loomis and Rosenberger, 2006)	Publicly available spreadsheets, use function transfer to value changes in ecosystem services in the U.S.

Appendix B - An Economic-Value Method Example for Ecosystem Services

Written by:
Dr. John Perez-Garcia, Ph.D., Professor in Forest Economics - School of Environmental and Forestry Sciences. College of the Environment, University of Washington, Seattle, WA

Value-based Accounting

Input-output analysis is based on a detailed accounting of the monetary transactions between different sectors of the economy. Industries produce intermediate demand, while households, the government and the rest of the world produce final demand. The basis of the analysis is the intermediate transactions table known as the inter-industry, basic sectors transactions table where purchases of intermediate goods and services are recorded between basic sectors. Households and government sectors provide value-added input in the form of labor, capital and incentives (taxes) to the intermediate goods while receiving wages, interest payments and subsidies. The input-output analysis consists of examining the effect of changes in final demand on the economy.

People interested in economic development based on environmental services and restoration activities in Anchor Forest communities can describe an initial state for the economy, then measure effects restoration or other non-market activities might bring using such a table. Some modifications to the table to include environmental resources are needed, and they are present below. Such modifications can lead to the development of output measures useful to gauge levels of environmental services associated with Anchor Forest communities.

The Economy by the Numbers

A numerical example is worth exploring. Consider the Washington State economy in 1987 (Chase et al. 1987), Table 34 presents an illustration of a highly aggregated three sector representation of the Washington state economy for 1987. The local economy may be a county, a city, any other geopolitical unit, or in this case, the state of Washington. In Table 34 the economic relationship is measured by dollar values in millions of purchases or sales among producers, value added (factor input) and final demand sectors. A sector is usually any homogenous grouping of businesses, organizations, or industries. Three producing basic sectors are defined for this example: the natural resources sector, the manufacturing sector and the service sector. The final demand sector includes households and other final demand entities, such as governments. Trade activity is also considered a sector, selling goods and services overseas (export sector) and purchasing goods and services from outside the region (import sector). Each producing sector purchases goods and services from itself or other sectors (column entries for the sector) and sells goods and services to itself or other sectors (row entries for the sector). These transactions are shown in the table below. For instance, the natural resources sector purchased $464 million for other natural resource enterprises in 1987. This same sector purchased $1,445 million of labor input and $448 million from entities outside the state. The table also describes how household spend their earnings. For instance, personal consumption of natural resources goods and services amounted to $260 million. Most of the expenditures by households were in the service sector, $30,307 million.

The transactions table combined with final demand, value added and trade allow gross state income and gross state product to be calculated. Industrial value added (the sum of gray area,

$68,607 million), plus household value added (the orange area, $6,804 million), plus government value added (the sum of the green area, $9,840 million) equals total value added, a measure of Gross State Income: the sum of the blue area ($85,251 million). Personal consumption expenditures ($55,071 million, brown area) plus other final demand, which includes gross private investment and government expenditures, ($30,372 million, brown area) plus exports ($47,951 million, purple area) minus Imports ($48,143 million, purple area) is equal to Gross State Product ($85,251 million). For purposes of discussion later on, employment data measured as a physical unit in persons per year is also provided in table 6, last row.

Table 34. The input-output table approximates the regional economy by expressing an economic relationship among economic sectors.

		Producers			Final Demand			
		Natural Resources	Manufacturing	Services	Personal Consumption	Exports	Other Final Demand	Total Output
Producers	Natural Resources	464	2,071	231	260	1,135	278	4,439
	Manufacturing	367	5,263	4,696	2,738	30,078	5,271	48,412
	Services	385	4,932	16,351	30,307	16,738	11,757	80,469
Value Added	Labor Income	1,445	9,231	30,110			8,213	48,999
	Other value Added	1,331	7,463	19,028	6,804		1,627	36,252
	Imports	448	19,452	10,054	14,963		3,26	48,143
	Total Output	4,439	48,412	80,469	55,071	47,951	30,372	266,713
	Employment*	95,880	319,517	1,625,472				

*in persons/year

Input-output analysis requires that we begin by calculating technical coefficients for producing sectors, i.e., for intermediate demand (yellow area in Table 34). The technical coefficients are also known as purchase coefficients since they reflect the structure of production in the economy through recorded purchases from processing centers. The purchase coefficients for the manufacturing sector are calculated by dividing the expenditures for say natural resources with the total expenses for manufacturing on all intermediate goods and services, factor payments to households and government, and any import purchases (divide $2,071 by $48,412 is equal to 0.04279). The resulting calculation is presented in Table 35. Its interpretation is straightforward: to produce one dollar's worth of manufacturing, you require four cents worth (0.04279) of natural resources. They are input requirements (technical/purchase coefficients) for the intermediate demand sector.

Table 35. The purchase coefficients represent the expenditures for one sector with the total expenses for a given sector on all intermediate goods and services, factor payments to households and government, and any import purchases.

	Natural Resources	Manufacturing	Trade and Services
Natural Resources	0.10453	0.04279	0.00287
Manufacturing	0.08263	0.10870	0.05835
Trade and Services	0.08667	0.10188	0.20319

Knowing the purchase coefficients allows us to ask simple but useful questions. Suppose final demand manufacturing output increases by $50 million due to changes in consumer spending or government purchases or increase demand from the outlying regions. We can determine the impact on the economy of this new final demand by using the relationship between the calculated purchase coefficients and change in final demand. This process uses calculated multipliers from the purchase coefficients to determine how purchases made from the new final demand dollars result in new purchases of inputs needed to meet the new final demand. The multipliers are the result of an algebraic rearrangement involving the purchase coefficients and leads to inverse coefficients, more commonly known as a multiplier table. For instance, using the multipliers with the $50 million increase in manufacturing output leads to a $90 million increase overall economic activity in the three sectors. There is an increase in natural resources demand of $3 million ($50 times 0.06161), an increase in manufacturing demand of $60 million ($50 times 1.19323) and an increase in trade and services demand of $27 million ($50 times 0.53619).

Table 36. The multiplier table is used to calculated dollar changes in a sector's output due to changes in consumer spending in dollars

	Natural Resources	Manufacturing	Trade and Services
Natural Resources	1.13337	0.06161	0.01864
Manufacturing	0.20243	1.19323	0.17124
Trade and Services	0.74812	0.53619	1.86554

The dollar value of sectorial output is not the only important measure of economic impact. A requirement of labor needed to meet the new final demand is an example of another important economic impact. Using the same framework as described for intermediate inputs, input-output analysis allows us to calculate the required labor needed to meet the new final demands. We can calculate in monetary units or physical terms, i.e., person per year, knowing the impact of a per dollar sectorial demand using the number of employees used in each sector. Using multipliers determined in the same fashion as with purchased intermediate inputs, the total amount of employment in each sector that is needed to fulfill new final demands are determined. The employment analysis can be extended further if we know the proportion of each sector's occupation, e.g., the number of foresters, chemical engineers, etc., used by each sector so that the economic impact of new final demands can be described for employment by occupation. We can also calculate value-added multipliers and measure the impact of the $50 million expansion of manufacturing activity on value added using these multipliers: $42 million (Table 9).

Table 37. The labor and value added analyses proceed in the same fashion as the input-output analysis above.

	Natural Resources	Manufacturing	Trade and Services
	Purchase Coefficients		
Labor Income	0.32558	0.19067	0.37418
Total Value Added	0.62531	0.34483	0.61063
Total Employment per million dollars of output	21.6	6.6	20.2
	Multipliers		
Labor Income	0.688	0.448	0.737
Total Value Added	1.342	0.845	1.315
Employment	40.9	20.0	39.2

What is important to note is the generality of the method involved in input-output analysis. If you are able to measure employment impacts using input-output analysis then any input

requirement measured in physical terms can be analyzed using the same procedure. The end result is a response multiplier that can be used to measure the response of the indicated input from a change in output demand.

Environmental Input-Output Analysis

Environmental extensions to input-output models began in the 1970s. They represent a modification of the basic input-output model to deal with environmental flows. The principal problem is deciding upon the appropriate unit of measurement of environmental or ecological quantities, i.e., in monetary or physical units. Note that the method is general in that we only need to have the information to calculate the coefficients that form the basis for the multipliers, i.e., either in physical and/or monetary units.

With available data, a straightforward approach is to produce a matrix of environmental coefficients in the same vein as employment coefficients provided above, i.e., the simplest generalized input-output model extension. The amount of environmental services generated by the natural resource sector is divided by its total output to derive the environmental 'technical' coefficient. Direct and indirect environmental goods and services generated by supporting final demand are calculated by using the input-output methodology described in the previous section. For instance, if data that describes water consumed by sectors exists, then coefficients can be calculated in a manner that is similar to employment multipliers, and impacts of added demand can be measured using a water multiplier.

For instance, consider the following extended input-output table (Table 10) that contains some hypothetical water purchase data in the final row.

Table 38. An environmental input-output analysis uses a matrix of environmental coefficients.

		Producers			Final Demand			
		Natural Resources	Manufacturing	Services	Personal Consumption	Exports	Other Final Demand	Total Output
Producers	Natural Resources	464	2,071	231	260	1,135	278	4,439
	Manufacturing	367	5,263	4,696	2,738	30,078	5,271	48,412
	Services	385	4,932	16,351	30,307	16,738	11,757	80,469
Value Added	Labor Income	1,445	9,231	30,110			8,213	48,999
	Other value Added	1,331	7,463	19,028	6,804		1,627	36,252
	Imports	448	19,452	10,054	14,963		3,26	48,143
	Total Output	4,439	48,412	80,469	55,071	47,951	30,372	266,713
	Employment*	95,880	319,517	1,625,472				
	Water**	75,000	150,000	25,000				

*in persons/year, **in million gallons/ year

The corresponding water purchase coefficients and multipliers (shown with employment) are reported in Table 39.

Table 39. Water and labor purchase coefficients and multipliers are used to measure the impacts changes in final demand have on labor and water use.

	Natural Resources	Manufacturing	Trade and Services
	Purchase Coefficients		
Total Employment per million dollars of output	21.6	6.6	20.2
Total Water per million dollars of output	16.9	3.1	0.3
	Multipliers		
Employment	40.9	20.0	39.2
Water	20.0	4.9	0.8

The additional $50 million in new demand for manufacturing leads to an increase in water use of 245 million gallons per year (16.9 times $3 million plus 3.1 times $60 million plus 0.3 times $27 million). The water multiplier is interpreted as the total water consumption generated in all sectors of the economy per million dollars of output in the producing sector. For instance, the total water requirement per million dollars of natural resource industry output is 20.0 million gallons.

We can create expanded satellite accounts for energy, pollution and water as related in Table 40. Each industry sector with energy consumption and then substitute petroleum-based energy with biofuels to measure the impacts on energy, the environment and the economy a biofuels sector can have. The first step is to create the matrix of coefficients (purchase or technical) that relates total outlay in each sector with changes in the consumption of petro versus bio-based fuels, and the consequences on the environment.

Table 40. Expanded satellite accounts for energy, pollution and water

Coefficient		Industry 1 2 3	Direct Impact
Energy	1 2 3	U= .2 .3 .1 .3 .1 .2 .2 .5 .3	Oil consumption, Biofuels consumption (physical gallons)
Pollution	1 2 3	V = .2 .1 .4 .5 .2 .3 .6 .1 .2	SO2 generated lbs CO2 generated lbs
Water	1 2 3	W = 13 25 3 14 33 4 7 8 10	Million gallons consumed
Employment		E = .4 .5 .1	persons

An alternative, generalized input-output table is presented below, and differs from the example above in that the input-output model utilizes an augmented technical (purchase) coefficient matrix with additional rows and columns to reflect pollution generation and abatement activities. Consider the generation of restoration acres as a separate sector. We would need information to calculate ecosystem services coefficients and relate them to the natural resource sector i.e., forestry and agriculture. Using these coefficients, we can derive the effect an increase (or decline) in the activity impacts on ecosystem production.

Table 41. The generalized input-output table includes environmental sectors similar to intermediate sectors and are utilized in the same fashion for input-output analysis.

		Producers				Final Demand			
		Natural Resources	Manu-facturing	Services	Restoration	Personal Con-sumption	Exports	Other Final Demand	Total Output
Producers	Natural Resources				15				
	Manufacturing				20				
	Services				65				
	Restoration	75	12	13	100			500	700
	Labor Income				75				
	Other value Added				25				
	Imports				400				
	Total Output				700				
	Employment*				60				
	Water**				20				

Linking Input-Output Analysis with Market-based Approaches

Input output accounts provide a picture of the flow of goods and service through the formal economy using a given technology. Accounts provide a picture of production and use. It's a snapshot of the region's productive capacity to contribute to employment, and with extension, degrade or improve the environment. The input-output accounts form a basis to understand and study how regional economies change. They can also be used to study the implications of technology and its use on the production of environmental goods and services.

Creating Excess in Supply through Management Alternatives

For instance, say the natural resource sector can produce its output in a way that reduces its need to purchase water by one third through changes in management, i.e., a change in the technology coefficients. Rather than purchase 75,000 million gallons it switches management practices that requires it to only purchase 50,000 million gallons and still sustain its level of total output. What is the value of this change in management practice?

Economy-wide effects can be measured with the input-output model described in the previous section. For instance, the $50 million increase in manufacturing reduces the total consumption of water 12 million gallons, through indirect effects on the natural resource sector. The new manufacturing demand raises water consumption to 228 million gallons, rather than 245. In addition, the water multiplier in natural resource sector is reduced from 20.0 to 13.6. That is, for every million dollars in sector output, the natural resource sector now needs to purchase one-third less water.

The Relevance of a Market for Water

We want to link the extended input-output analysis to market-based approaches. To do so, consider water as a scarce resource, an economic requirement for water to have value. Also assume that property rights for water exists in such a way that water is a private versus a public

good. For the manufacturing sector to expand by $50 million, it requires additional water purchases. The extended input-output model identifies a potential trading scheme that involves adoption of water-saving technologies in the natural resource sector to produce an excess supply of water. This excess has the potential to produce economic gains to the natural resource sector, the manufacturing sector and the region as a whole. With verifiable savings in water usage, the natural resource sector has created water available for the manufacturing sector to purchase.

Model Goal: To measure the value of water using an extended input-output model for the Anchor Forest community

Model Task: Define Anchor Forest community boundary

The spatially defined boundary establishes the producer, consumer and trade accounts. The trade boundary is important since a comparison of import and export activity is useful to measure a community's self-sufficiency. It allows calculation of excess demand and supply, and a community's comparative advantage in trade.

Imports and exports are used to measure the impacts of an economic activity by examining the amount of goods and services it sells and buys outside the local economy. A local economy has exports and imports similar to state or national exports and imports. Wood chips harvested and processed in Grays Harbor and shipped to Coos Bay is an export that benefits the local Grays Harbor economy since the employment associated with the production and sale of the wood chips remains in Grays Harbor, but it is subsumed in the aggregate Pacific Northwest economy. An outfitter from Seattle brings money to Wenatchee's economy selling white-water rafting trips. The recreational activities are exported because they bring in outside money, such as rental on site to store kayaks, purchasing food and gasoline, etc. Exports from the local economy stimulate local economic activity. In a similar vein, imports are goods and service that consumed in the local economy and are brought in from outside the local economy. All direct and indirect impacts associated with import purchases are lost for the locale.

Model Task: Define basic sectors

United States data for input-output analysis is taken from the National Income and Product Accounts (NIPA) among other data collected by the U.S. government. The purpose of NIPA is to provide a comprehensive picture of the nation's economy. The NIPA account forms part of the input-output models accompanied by an employment satellite account and a trade sector.
US national income and product accounts and IMPLAN data are available for 440 sectors. Realistically, 440 sectors are too many to study for a small geographical region, which may contain only a small subset of the 440 sectors. So there is the need to aggregate the sectors into homogenous groups. A 67 sector representation of the US economy is created by the Bureau of Economic Analysis, and this may be useful for Anchor Forest areas. More detail in the agricultural and forestry sector however, may be required.

Model Task: Create and fill-in transition matrix

There are realistically two data sources to create a transactions table. The data can be obtained through surveys of industries and households each of the economic sectors or can be derived from general economic information developed by various government agencies. Surveys are needed to collect data about sales, purchases, to which they are sold, and from whom they purchased. The data can also be purchased from IMPLAN Inc. Nearly every state in the US completes its economic assessment using IMPLAN data. Washington State is an exception, having pioneered the use of surveys to complete its state's economic assessment.

As related in previous sectors, we also want to construct the environmental accounts, in addition to the transactions table and employment accounts. In the example of water flows, we require water use data. Collected the data may require survey instruments if no secondary source exists.

Model Task: Calculate multiplier effect

To calculate the multiplier effect of a basic sector is to calculate the re-spending associated with the value of production activity of a basic sector. If wood processing mills in Snohomish County receive $100,000 in wood product receipts, and the sector has an output multiplier of 3.5, all business sales in the county are expected to increase to $350,000 as a direct result of the $100,000 sales activity of wood processing mills and $250,000 in county sales generated by the dollars of wood product sales.

Outlays of cash or revenues received are recorded in the transactions table. Inverting the matrix is used to estimate the continuous effect of any change in one of the sectors in the model, i.e., the multiplier effect. To estimate impacts we need to derive first the purchase coefficients and then their associated multipliers. The transaction table provides the information used to derive the purchase coefficients.

This basic sector activity recorded in the transactions table begins the multiplier process. Changes in basic activity are fundamentally changes in a community's ability to bring in money, with say, a new manufacturing plant. Sectors that are not basic generally do not generate new dollars but rather operate on the circulation of dollars already present in the economy. Non-basic sectors do not initiate a multiplier effect themselves, but instead contribute to the multiplier effect of basic sectors by preventing monies from leaving the community. While output multipliers are useful in describing the interrelationships between business sectors, they do not adequately describe the amount of employment generated locally by specific business activities or water use by basic sectors.

We require the calculation of response coefficients to associate factor usage, such as labor and water, with basic sector economic activity. These response coefficients indicate how employment and water use increases or decreases with output.

Model Task: Calculate employment generated

The size of the employment coefficient is largely determined by the amount of labor required by the first money-flow cycle. In an industry that is very labor intensive, such as wood harvesting, the output multiplier may not be very large while the employment coefficient may be above average. On the other hand, if the industry goes through several transactions but is not very labor intensive throughout the process, the output multiplier may be large and the employment coefficient small. Timber harvesting in past input-output models have generally tended to be labor intensive. Because many jobs in the forestry sector are not full-time, most employment figures can be misleading. A full-time equivalent employment figure can be calculated by dividing the total personal income figure by a representative annual full-time equivalent personal income average.

We can describe water use in an analogous fashion. Sectors with high water requirements will have a coefficient that is above average, with an output multiplier that may not be very large.

Model Task: Explained results

The output multiplier calculates how money moving through the economy agitates it. Income coefficients show the wage effects, employment multipliers specify employment effect and value-added multipliers indicate the mark-up effects of newly created basic sector production. The differences between output multipliers, employment coefficients and value-added multipliers are often confused, leading to misuse.

Using output, employment and water-use multipliers requires an estimate of the total change in final demand, which is the amount of the total output that is to be added to the community. The analysis, by defining changes in final demand, estimates the impacts backwards throughout the local economy. The point at which the product is sold is therefore the important point of assessment.

Anchor Forests

Sustainable Forest Ecosystems through
Cross-Boundary, Landscape-Scale
Collaborative Management

Task Assessments

Prepared by:

Northwest Management, Inc.
Moscow, ID – Deer Park, WA – Helena, MT
www.TheNMIway.com

NORTHWEST
MANAGEMENT, INC.