Economic Impacts of the Mt. Adams Community Forest, 2014-2017

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Mt. Adams Resource Stewards

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NORTHWEST COMMUNITY FORESTS

WASHINGTON ENVIRONMENTAL COUNCIL

CINTRAFOR
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Budget Proviso Guidance

In 2017, the Washington Department of Natural Resources began convening a group of stakeholders to discuss ways to broaden support for community forest efforts underway across the state of Washington. This group identified three broad priorities towards that goal:

1. Fix and strengthen the existing DNR Community Forest Trust program so that projects like the Teanaway Community Forest can have the support they need to succeed

2. Advance the broad strategy of community forests across the landscape including support from a range of community forest ownership types including: non-profit, county, and tribal as well as by small and large private forest landowners.

3. Develop diverse coalitions that can advance individual projects and the community forest concept overall by communicating the full range of benefits these projects provide.

During the 2018 Legislative Session, the legislature passed a budget proviso in support of these priorities. Among the items funded through the proviso was a request for the Department to perform an economic and ownership analysis of an existing community forest project.

This study would serve as a case study for the Department to guide future evaluation and prioritization for funding requests through the Community Forest Trust program as well as serve as a tool for communicating the full range of benefits from community forests.

In addition, this study would provide insight into the advantages of locally-owned community forests rather than the state-owned projects held within the Community Forest Trust. This report, *The Economic Impact of the Mt. Adams Community Forest, 2014-2017*, represents that study.

Executive Summary

Founded in 2004, Mt. Adams Resource Stewards (MARS) works to support the ecological and economic health of communities in the Mt. Adams region.

Along with a number of other community-based organizations across the state of Washington, MARS began exploring the possibility of establishing a community forest project in the mid-2000s. This idea grew from concerns voiced by local community members over a number of issues including: the conversion of working forest land to development, the loss of local land use traditions, limited economic development opportunities, a growing risk of wildfire and threats to important ecosystem services.

In 2011, MARS purchased the 90-acre Mill Pond tract outside of the unincorporated community of Glenwood, WA as the first piece of the Mt. Adams Community Forest (MACF). This acquisition established the Mt. Adams Community Forest as the first non-profit, locally-owned, community forest project in the state of Washington. In 2014, MACF further expanded to add the 299-acre Pine Flats forest.

From 2014-2017, MARS also leveraged its expertise and experience managing the MACF to secure stewardship agreements with the U.S. Fish and Wildlife Service to conduct forest restoration activities on the adjoining 7,000-acre Conboy Lake National Wildlife Refuge.

Economic Impact Assessment

From 2014 to the spring of 2017, MARS completed four timber harvests and three prescribed burns on MACF property. These activities produced gross receipts of $610,000. Stewardship activities on Conboy Lake NWR resulted in an additional six timber harvests and gross receipts of about $1.1 million. In total, these timber harvests also paid $26,000 in timber excise taxes.

This report concludes that the harvest and stewardship activities carried out by MARS on the MACF properties and Conboy Lake NWR resulted in an overall countywide economic expansion of approximately $8 million and the creation of the equivalent of 59-months of full-time equivalent (FTE) employment at the median wage rate within Klickitat County.

Avoided Costs from Wildfire Risk Reduction and Ecosystem Service Protection

Furthermore, scenario modeling suggests that fuels treatment and restoration activities on the MACF and Conboy Lake NWR would provide an additional $4.1 million worth of protection against impacts from large wildfires to the local housing and agricultural sectors over the next 10 years. These activities also reduce public health risk by reducing exposure to harmful emissions associated with wildfire.

Beyond its direct economic contributions to the county, MACF also protects important ecosystem services such as carbon sequestration. The protection of these carbon stocks is significant given local conversion pressures. Currently, the MACF is a carbon sink, storing an estimated 23,444 metric tons of carbon dioxide. Depending on future harvest activities, total carbon stocks on current MARS properties are expected to increase between 20-38% by 2035.

Anticipated Economic Benefits from Future Land Acquisition

MARS has identified two parcels as near-term acquisition priorities for the MACF. These acquisitions are planned to be completed over the next two years. In total, these properties cover 607-acres. If brought into the ownership and management of the MACF, these properties will provide a combined direct and indirect economic benefit of $14.2 million and 166 months of FTE employment at the median wage rate over a 15-year period.

Future Outlook

The MACF is owned by a community-based non-profit (MARS) and governed by a board comprising members from the local community. As so, it is expected that these activities will be replicated on behalf of the community long into the future through sound and sustainable forest management practices. Furthermore, the MACF will continue to supply local community members with other opportunities for economic development as well as public access to open space and stewardship support for public and private landowners.

Beyond the direct management of the MACF, MARS is also uniquely positioned to secure additional stewardship contracts on nearby federal and state lands. By working with these additional landowners, MARS can provide additional opportunity for sustainable economic development while also reducing risk for wildfire for the community.

Goals and Rationale of the Study

The goal of this study is to describe the economic benefits realized by the community of Glenwood, Washington and, Klickitat County as a whole, as the result of forest management activities on the Mt. Adams Community Forest between 2014-2017. Additionally, goals for this study include: to provide an overview of community forests, describe current community forest activities ongoing throughout the state of Washington and to provide guidance around how the benefits of community forestry can be incorporated into local community and economic development planning.

This report examines a model of local ownership for community forests that has been identified by stakeholders, including the Northwest Community Forest Coalition, as an alternative and complementary structure to those held under the Community Forest Trust program under the Washington Department of Natural Resources (DNR). This study and the accompanying resources identified within it are presented in order that others wanting to develop similar projects within the state of Washington should have a model to follow.

Support for this study was originally sought by Mt. Adams Resource Stewards and the Washington Environmental Council from the Department through a joint proposal submitted to DNR's Rural Communities Partnership Initiative (RCPI).

All original economic and ecosystem service modeling for this report was conducted by staff and researchers from the Center for International Trade in Forest Products (CINTRAFOR) hosted at the School of Environmental and Forest Sciences of the University of Washington. The economic analysis was conducted using an input-output model developed using Impact Analysis for Planning (IMPLAN) economic impact assessment software originally developed by the U.S. Department of Agriculture and the U.S. Forest Service and now maintained by IMPLAN LLC. Additional spatial analysis was conducted using Esri's ArcGIS to examine implications from local land use and ecosystem services as a result of the development of the community forest.

This report is divided into five sections. The first provides a brief introduction to the concept of community forestry. It then describes previous efforts across the state of Washington to support community forest efforts by both local community groups and the Department of Natural Resources. The second looks specifically at the organizational history and development of Mt. Adams Resource Stewards and the Mt. Adams Community Forest. The third provides an overview of the demographic, economic and ecological trends within Klickitat County that the MACF is seeking to address through its activities. The fourth describes findings from the impacts of economic activities on the MACF forest from 2014-2017 in terms of countywide economic benefits as well as local job creation. The fifth and final section of this report looks forward at future opportunities for community and economic development on the MACF.

I. Introduction:
What are Community Forests?

Community forests are working forests owned and managed by municipalities, government agencies, Tribes and non-profit organizations for the benefit of local communities (Lyman, Grimm and Renaud Evans, 2014). Managed collaboratively, community forests operate to secure the economic, social and ecological benefits that forests provide by engaging a wide range of stakeholders in ongoing decision-making about management activities and the use of revenues earned from forest management (Charnley and Poe, 2007).

Community forests are established to respond to locally identified needs that are currently unmet by existing efforts at work on the landscape. These needs vary from place to place but are generally focused on increasing community capacity to respond to factors such as: a desire to maintain a working land base, adapt to a changing climate, achieve greater input in forest management decisions, protect water quality and important watersheds, provide open space for recreation, restore degraded ecosystems or support small value-added businesses (Charnley and Poe, 2007).

Though the activities that occur on individual community forests are as diverse as the lands they occupy and the interest of the people they represent, these projects share a common set of principles that set them apart from other types of public and private forest ownership (Urgenson et. al., 2017). These principles include:

- The community has secured access and rights to the forest resource at the community level
- The community participates in management decisions
- The community receives value and benefits from the land that can support and reinforce community priorities and economic development plans
- The community ensures the permanent protection of the conservation values of the forestland

Different too from other types of forest ownership, the revenues earned from timber harvests and other activities on community forests are reinvested at the community level into local priorities as well as the ongoing stewardship and operations of the community forest. In this way, community forests sustain themselves while building connections between people and the land by welcoming them as shareholders in the management and care of the natural resources they depend upon.

Engaged community-based decision making plays two key roles when it comes to improving economic, social and ecological outcomes from natural resource management. First, it gives local citizens the opportunity to participate in the shared responsibility of protecting important public resources. This includes not only providing space for inclusion in management decisions and long-term stewardship planning but also in determining how the benefits acquired from natural resource management are distributed to support community wellbeing. Second, it allows a platform for concerns to be addressed in a community setting before more significant conflicts arise. Towards these ends, community forests democratize decision making around the use of natural resources in order to increase civic engagement and balance multiple interests on the landscape.

The concept of the community forest is not new. Community-based ownership of forest land has been practiced across Europe for centuries (Greer, 2017). In North America, tribal communities practiced sophisticated models of common forest management long before the arrival of European settlers (Baker and Kusel, 2003). In the southwest, Hispano communities of Spanish immigrants carried on traditions of community-based forest and water resource management for hundreds of years (Baker and Kusel, 2003). In New England, centuries-old town and municipal owned forests continue to be a vital part of community life (Baker and Kusel, 2003).

However, recent trends affecting historically forest-dependent communities have revived widespread interest in community forests as a way to protect a working land base and the conservation values it provides (Lyman, Grimm and Renaud Evans, 2014). These trends include: the restructuring of traditional timber businesses to be investor oriented, shifting timber harvest practices on public lands, the fragmentation and conversion of forestland to development, rapid technological innovation that has displaced jobs in the wood products supply chain, the instability of global markets and advancing climate change.

Background:
Community-based Forestry Efforts in Washington

Though not always recognized as community forests, local communities and municipalities have long purchased and managed forest lands in order to secure important public values. In Washington, perhaps the most prominent example of these types of projects is the 90,000-acre Cedar River Municipal Watershed owned by the City of Seattle. Originally purchased in the early 1900s, the publicly-owned Cedar River Watershed provides critical protection to the drinking water supply of 1.4 million people as well as opportunities for educational programming, wildlife conservation, recreation and timber harvests (City of Seattle, 2018).

A new wave of interest in community forestry began in earnest in the early 2000s. Around this time, local groups comprised primarily of non-profit land trusts and community-based organizations around Washington began convening in order to advance locally owned community forest efforts. The interest of these groups largely followed from similar efforts underway in New England (Community Forest Collaborative, 2007). These groups favored a model of community forestry that promotes the

ownership of forest lands by nonprofit community-based organizations and local governments. Following a period or globalization and the growth of investor-based forest ownership, this model was seen as an attractive alternative to the current land ownership paradigm and would re-establish forestland ownership within communities while also securing the benefits from natural resource management around local values and priorities (Braxton Little, 2006).

These efforts began to formalize later in the decade. In 2007, the Department of Natural Resources announced plans to sell 2,500-acres in the Stemilt Basin to private interests. Under the leadership of Chelan County, the Stemilt Partnership was formed to find a way to purchase the property and manage it under community guidance (Chelan County, 2018). In 2011, in the Mt. Rainier Gateway area, a planning team composed of representatives from the National Park Service, Nisqually River Foundation, Nisqually Land Trust and Northwest Natural Resource Group initiated a series of community conversations about the potential opportunity to establish a community forest in the Nisqually Watershed (Nisqually Community Forest, 2011). In the same year, Mt. Adams Resource Stewards (MARS) completed the acquisition of the Glenwood Valley's Mill Pond and surrounding forestland as the first piece of the Mt. Adams Community Forest. This acquisition established the Mt. Adams Community Forest as the first community forest project to fully incorporate a non-profit community forest ownership model in the state (Mt. Adams Resource Stewards, 2018).

Since this time, the Mt. Adams Community Forest added a second 300-acre parcel to its holdings. In 2012, the Stemilt Partnership completed the acquisition of its priority 2,500-acre property and formerly established the county-owned Stemilt-Squilchuck Community Forest (Chelan County, 2018). Also in 2012, the Kalispel Tribe of Indians acquired 554 acres to establish the Indian Creek Community Forest (Entz, Gilrein, George and Berger, 2016). In 2016, the Nisqually Community Forest completed its first 640-acre acquisition. In 2018, it then added an additional 1,280-acres, tripling the size of the community forest. In the same year, Jefferson Land Trust and partners announced a plan to transition ownership of the 850-acre Chimacum Ridge forest to a model of community forest ownership (Jefferson Land Trust, 2018).

As additional stakeholders began to express interest in developing locally owned community forest projects of their own, the Northwest Community Forest Coalition was formed by community leaders in 2015. Later, Portland-based non-profit, Sustainable Northwest, began providing administrative and organizational support for the coalition in order to grow this community of practice (Northwest Community Forest Coalition, 2018). Since its inception, the NWCFC has focused on supporting the emergence, development and management of community forests across the Pacific Northwest states (Northwest Community Forest Coalition, 2018).

The Department of Natural Resources' Community Forest Trust Program

While local community forest efforts were initiated in the early 2000s, the Department of Natural Resources and the Washington State Legislature commissioned several studies by the University of Washington to examine the state of forest resources across different ownerships in Washington (Bradley et al., 2009). A principle concern identified by these studies was the rate of conversion of forestlands to development and non-forest uses. These studies identified that since the 1980's, more than seventeen percent of Washington's working forests have been converted to other land uses (Bradley, et al., 2009). Furthermore, the study recognized that thousands of acres of forestland continue to be at high risk of conversion. As a result, as these working forests disappear, so too do the benefits that they provide, including: local timber jobs, clean air and water, carbon storage, fish and wildlife habitat and open space for recreation.

To counteract this trend, the Washington State Legislature passed the Community Forest Trust program in 2011 to enable the Department of Natural Resources to acquire and hold forestlands in a non-fiduciary trust (Revised Code of Washington, 2011). In doing so, the Community Forest Trust program provided the Department with flexibility to assist communities in protecting at-risk lands and the benefits they provide from being lost to development. Different than other trust lands held by the agency, the Community Forest Trust program also allows for greater community engagement and input in management decisions by incorporating input from local advisory committees in management and long-term stewardship planning.

Since its adoption, the Community Forest Trust program has been used to protect and conserve the Teanaway Community Forest (Kittitas County) as well as the Klickitat Canyon Community Forest (Klickitat County) covering an area of 52,646 acres (Department of Natural Resources, 2018).

II. Overview:
Mt. Adams Resource Stewards

Mt. Adams Resource Stewards (MARS) was founded in 2004 as a locally driven response to concerns regarding trends in regional land management that impacted forest health and the wellbeing of several small, unincorporated communities in north-western Klickitat County. Stakeholders and participants came together to form the non-profit organization in order to, "promote sustainable connections between the land, local economies and rural communities in the Mt. Adams Region" (MARS, 2018). The organization is currently governed by a nine member board of area residents with various backgrounds and affiliations and is served by three full time staff and three seasonal employees.

MARS Staff

Executive Director (full-time)
Stewardship Monitoring and Outreach Coordinator (full-time)
Stewardship Crew Project Lead (full-time)
Three Stewardship Crew Members (seasonal)

Early conversations that led to the formation of MARS centered around the rural community of Glenwood given its long history and traditions in regards to the management of the privately held Klickitat Tree Farm, adjacent Gifford Pinchot National Forest, as well as other state, tribal and private ownerships. The Klickitat Tree Farm was the subject of what is claimed to be North America's first sustained yield plan for a private forest. This sustained yield plan was authored by Dr. Walter Meyers (University of Washington and Yale School of Forestry) and adopted in 1939 on behalf of the J. Neils Lumber Company. The plan laid out a program for relatively long (80-year) harvest rotations on company forest lands to provide a sustainable supply of raw material to a mill based downstream in the town of Klickitat. Departures from the plan began as the properties that historically comprised the Klickitat Tree Farm changed ownerships, with harvest dramatically accelerating under investor ownership in the early 2000's with a greater emphasis on larger block, even-age management and shortened rotations.

Concurrently, the federal timber program on the adjacent Gifford Pinchot National Forest ground to a halt in the late 1990's, in spite of a major outbreak of western spruce budworm that led to deteriorating forest health on the south slopes of Mt. Adams. Coupled with Washington DNR's de-staffing of their Glenwood work center and reductions in forest management staff out of the Husum district, communities like Glenwood felt increasingly disconnected from management decisions affecting area forests.

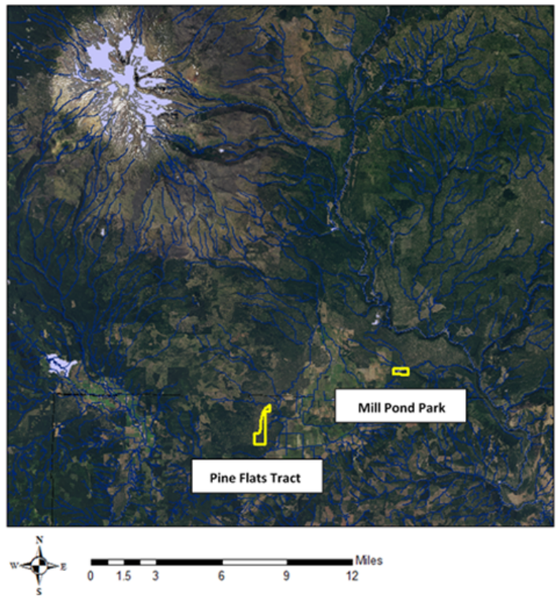

A member of MARS's stewardship crew thins suppressed trees.

Responding to these issues, a group of concerned citizens began meeting in 2003 to discuss how local communities, like Glenwood, could find innovative opportunities to meet the various challenges confronting the future of their economic and cultural mainstay: forests and forest industry. Information was shared from other community-based forestry initiatives from around the country, and eventually focal areas for a Mt. Adams area effort were identified that included:

- Using a community forest model to restore local ownership of high community-priority working forestlands;
- Identifying and developing small diameter wood products and biomass utilization opportunities that could provide a market to support forest restoration, fuels reduction and thinning projects on surrounding forests;
- Development of employment and contractual opportunities for stewardship and restoration work;
- Supporting collaborative processes to reduce gridlock surrounding federal forest management.

Through MARS' 14 year history, these interests and others have come to be reflected in a variety of programs, projects and partnerships in which the organization is engaged. In addition to acquiring two tracts of land for the Mt. Adams Community Forest, MARS has developed an all-lands stewardship program. Key to this work are partnerships with the US Fish and Wildlife Service (USFWS) through a Cooperative Land Management Agreement that directs MARS to implement forest stewardship work on Conboy Lake National Wildlife Refuge, the Gifford Pinchot National Forest - both directly and through the forest collaborative for which MARS often serves as a fiscal sponsor, and with private and conservation forest owners seeking forest management support. MARS is also working with Washington DNR staff to explore creative roles for the organization to work with the state in implementing the management plan for the Klickitat Canyon Community Forest Trust property acquired in 2016 (DNR, 2017).

MARS has also experimented extensively with the idea of creating jobs and products associated with small diameter log processing. MARS maintains a 10-acre lease on DNR land that the organization partially developed as a log yard and integrated wood products campus with the idea of incubating start-up businesses interested in this type of work. MARS worked to varying degrees with five different businesses between 2009 and 2017 to



Location of MACF tracts at Pine Flats and Mill Pond outside of the town of Glenwood.

explore production of bundled and bulk firewood, peeled post and pole products, hop poles, mulch and craft products.

In 2018, MARS launched an in-house stewardship crew designed to have multiple capabilities similar to those offered by Washington Conservation Corps crews. This effort is anticipated to expand moving forward as it was well received by partner agencies, organizations and landowners in the region.

These programs and other activities place a high value on maintaining and creating reliable living wage jobs around natural resources; demonstrating land stewardship that supports resilient ecosystems across ownerships; and connecting residents and visitors with opportunities to engage in local land-based traditions while building awareness of the importance of rural, resource-based communities within broader society.

Overview and Development of the Mt. Adams Community Forest

Early on, MARS identified community-based ownership of forests as an anchor strategy for the organization, around which, other efforts to restore and steward the region's forests could be built. MARS stakeholders recognized that successful acquisition of priority forests could curb the loss of working lands to residential sprawl in fire-prone forests, while securing an asset that could be managed in restorative fashion to earn sustainable returns that, over time, could be reinvested in exemplary forest management, as well as MARS and community priorities.

The Mill Pond Tract

Local receptivity to the community forest concept was influenced by a number of trends and values that are important to Mt. Adams communities. Ownership changes and policy shifts influencing ownerships and jurisdictions, as already described, certainly motivated interest in management that would feature far greater engagement with local communities that increasingly viewed ongoing trends in regional forestry activities in a negative light. In addition to growing threats from wildfire and perceptions that forest health was in steep decline, interest in alternative ownership structures, such as a non-profit held community forest, grew out of concerns over private timber harvest levels that were viewed as unsustainable. Many local residents openly voiced that they felt that there would not be a future in the timber industry for their children given the pace and design of timber harvests in the early 2000's. Furthermore, growing restrictions to public access on large tracts of private timberland, that had previously been accessible to local communities for generations, drove support for a different ownership model. When a large portion of the former Klickitat Tree Farm experienced its fifth owner in six years under ownership structures featuring anonymous timberland investors, MARS's pursuit of properties for a community forest was recognized as an obvious and more positive alternative by many in the community.

Community Engagement around the Development of a Community Forest

In spite of interest and support for the concept of community forestry since MARS' inception, community engagement around the idea also experienced challenges due to skepticism and lack of understanding of everything that community forestry involves. While the initial MARS Board of Directors attempted in every way possible to represent a cross section of the community and stakeholders active in the Mt. Adams region, representation was heavier from some communities over others, and many community members initially failed to engage in public meetings. Some voiced doubt that an upstart organization and small, unincorporated communities could ever muster the funds and ability to purchase forestlands. Through early conversations, the MARS Board became aware of a variety of perceptions and concerns that community forests did not in fact represent community values and interests. Rather, they were perceived as political opportunism by those on both the far right and far left of the political spectrum. Challenges to MARS' attempts to engage community members peaked in early 2006 when a High Country News article featuring the nascent project and interviews with MARS representatives and community members led to a local logging company losing work associated with management activities on a nearby a timberland investment property (Braxton Little, 2006).

In response, the MARS Board of Directors and staff decided to delay moving forward with any kind of acquisition of land for the community forest in order to focus on other activities that were important to the organization, while better defining a community engagement, outreach and messaging strategy. Efforts ramped back up in 2008-2009 and MARS convened a working group to develop a management plan for prospective Mt. Adams Community Forest lands. The group included professional foresters from various sectors, logging contractors, ranchers and conservation interests (MARS, 2008).

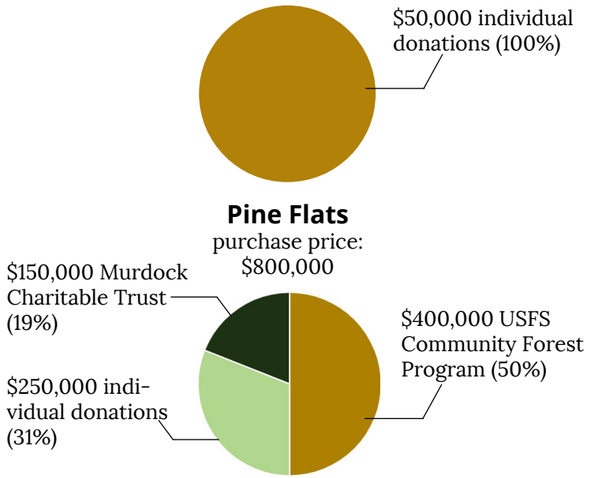
However, the most powerful engagement tool at this stage of the project was a 2009 trip to New England that included a dozen community members: to see and hear about, first hand, community forests in New Hampshire and Maine. Stories told by impassioned community members concerned about the future of working forestlands and a desire to

locally lead efforts to protect and sustainably manage these lands had a major impact with many participants in the tour. Many also voiced a renewed sense that such an undertaking could be successful.

Upon returning from New England, MARS convened a public meeting in the community of Glenwood that was attended by over thirty community members. Attendees were asked to identify interests and concerns on notecards, as well as indicate and prioritize parcels for the community forest on a large map. The sense of engagement was much stronger in comparison with earlier efforts.

Fundraising and Acquisition of MACF Properties

By 2010, MARS negotiated its first official opportunity to purchase land from a willing seller. This property was managed by Conservation Forestry, a Timber Investment Management Organization (TIMO) based in Exeter, New Hampshire, that had acquired over 10,000 acres of the former Klickitat Tree Farm in 2008. Conservation Forestry indicated an interest in working with MARS to successfully establish the Mt. Adams Community Forest and offered the organization the opportunity to purchase 100-acres of forest and wetland and most of the Glenwood Valley's Mill Pond in what came to be called the "Mill Pond Tract". The property had been the site of the valley's largest lumber mill before it was closed around 1930. As a highly visible property, on a major county road, that experienced significant use by area residents, the opportunity represented a win-win. Conservation Forestry established a saleprice of $50,000, likely due to their recognition of potential liabilities surrounding management of an aging dam that formed the pond. MARS conducted its due diligence and with strong community support opted to complete the purchase.



Fundraising efforts for the Mill Pond acquisition were fully reliant on individual donations, with the majority of donors residing in the Glenwood and Trout Lake Valleys. The largest donation came from a supporter in Vancouver, WA. Donations ranged in size from $25 to $10,000. Upon completion of fundraising the property was purchased by MARS in 2011.

A second purchase was then offered to MARS by Conservation Forestry in 2012: the 299-acre Pine Flats Tract adjacent to the Trout Lake Highway. This property spans the entrance to Conboy Lake National Wildlife Refuge. The purchase price was set by the seller at $800,000. MARS submitted a proposal to the US Forest Service (USFS) Community Forest Program's inaugural round of grants for $400,000 and was not successful in the initial round, which led to MARS purchasing a $10,000 one-year extension on its purchase and sale agreement with Conservation Forestry. In 2013, MARS was awarded funds from the USFS Program to compliment a $150,000 grant from the MJ Murdock Charitable Trust and over $250,000 in donations raised from individuals and small foundations. The property was closed on in July of 2014.

Management Priorities of the Mt. Adams Community Forest

The objective of the MACF is to protect local community and conservation values in order to ensure a quality of life in the region. Overall, the management goals of the community forest are based on principles of land stewardship and are meant to provide long-term community benefits while maintaining the health and function of ecosystems.

Lands held under the MACF are managed under guidance of a management plan that also includes specific chapters for each tract held by the community forest. The plan classifies properties into high and low forest-productivity sites, as well as special emphasis lands. The Mill Pond largely fits the special emphasis category, due to the large area of wetlands and surface water on the property, while Pine Flats blends special emphasis, and low productivity forest characteristics.

Public access is an important feature of both tracts. The public is allowed to engage in "traditional" uses of the properties. Both properties are part of grazing allotments. The Pine Flats property also served as an important piece in a broader fuels reduction, fire-adapted-community strategy. This effort has featured three consecutive years of prescribed burns that began in 2016 following extensive thinning operations. MARS also manages forestry operations on adjacent Conboy Lake NWR lands, which has facilitated cross-boundary prescribed burning operations that contributes to a buffer of treated lands upwind of the community of Glenwood.

Sustainable management of forest resources for timber production is an essential component of managing both properties. Thinning operations with small regeneration harvests have occurred in most years since acquisition. Logs are sold to both domestic mills and log exporting operations. Some small diameter logs have been utilized in MARS' small log business incubator that strives to create local markets for low value, small diameter wood.

MARS typically hosts an annual community meeting at which input on community forest management is sought. These are well attended and the community has been very supportive of management efforts thus far.

Long-term Acquisition and Management Goals for the Mt. Adams Community Forest

The acquisitions of the Mill Pond and Pine Flats sites served as a pilot phase for the community-forest concept in the Glenwood area. In the coming years, MARS is focused on adding additional acreage of high priority forest lands to the current MACF holdings. Long-term goals target the acquisition of several thousand acres that will be managed sustainably under the guidance of the organization's management plan to add value to the local community and sustain the organization and community priorities over time. Until new acreage can be brought into the community forest, MARS will continue to focus on carrying out restoration activities on its current land holdings. The goals of these activities are focused on improving forest health by reducing fire hazards, creating multiple age-classes within the forest and favoring the growth and development of underrepresented fire adapted forest types while continuing harvest activities that support a viable local forest industry.

III. Regional Trends:

Factor Influencing Community Forest Development in Klickitat County

In establishing its community and economic development goals, MARS incorporates larger regional social, economic and ecological trends into its planning. These goals include: protecting a working forestland base, providing living wage employment opportunities, responding to risk from wildfire and maintaining healthy and functioning ecosystems.

Land Use and Risk of Working Forest Conversion

The MACF is located in Klickitat County. Within the county, there are over 575,000 acres of private working forest land (Bradley et al., 2009). The ownership of these lands is primarily split evenly between large industrial owners (225,848 acres) and small forest landowners (273,961 acres) (Bradley et al., 2009). Tribal ownership of forestland in the county also accounts for about 76,000 acres.

Though the vast majority of Klickitat County is comprised of rural lands, including wide tracts of forestlands, the risk of land conversion is present. A previous study commissioned by DNR identified more than 19,000 acres of forest within the Klickitat River Watershed and 21,000 acres in the White Salmon watershed as being at high risk of conversion (Bradley et al., 2009). Overall, this area comprises approximately five percent of the total land area of both watersheds. Impacts to this land area from development pose a significant threat not only to a forest economy but also to the rural character of the landscape, critical salmon and wildlife habitat and local water quality.

Importance of Open and Working Lands and the Cost of Community Services

Beyond their value producing both public and private goods, open and working lands provide additional financial benefits to rural communities by requiring less support from community services and infrastructure. A cost of community services analysis conducted on 151 communities across the United States found that for every $1.00 created by tax revenues from lands in residential development, it costs communities $1.16 to supply services to those areas, making it difficult for those properties to pay for themselves (American Farmland Trust, 2016). Generally, this difference is made up by undeveloped open areas and working lands. For every $1.00 created by working and open space, communities saved $.63, more than accounting for the deficit created by residential development (American Farmland Trust, 2016). As open and working lands are lost to development, this surplus is eroded. Balancing the demands of these different land uses should remain a consideration for rural communities working to maintain reasonable cost of services for their residents.

Countywide Demographic and Economic Trends

Despite its rural location, increasing population trends within Klickitat County are a large reason for the elevated risk of forest conversion. This is especially true as new populations shift away from an economy dependent on families making a living from the land to one geared more towards technology oriented occupations, health care, service industries and office occupations.

Since 2000, the population of Klickitat County grew by 9% (American Community Survey, 2017). Across that same time period, employment in natural resource oriented professions declined while employment in management and business services, service occupations and sales and office occupations increased (American Community Survey, 2017). Despite these trends however, median wage earnings in natural resource jobs across the county were higher than those in either service or sales occupations, speaking to the outsized benefits that these jobs provide to communities (American Community Survey, 2017).

Today, approximately 2% of the county's wage earnings were created through the forest economy. This is down from approximately 50% in the time period between 1970-1989 (Rasker, 2017). This fact, however, has not necessarily translated to negative economic outcomes for the county. Rather, this trend speaks largely to the growth of a more diversified economy and the reduction in the overall reliance on timber harvests for wage earnings. For example, since 2000, median household income for the county rose by approximately 30% from $34,245 to $48,668 (American Community Survey, 2017). Over the same time period, both individual and family poverty levels fell, though poverty rates within the county still exceed those of Washington State overall (American Community Survey, 2017).

These changing economic trends within the county are positive. However, occupational changes and other changes in demographic factors call into question the role that forests and working landscapes play in everyday life despite the clear benefits they provide to communities. Compounding these issues are an aging population as well as one that has seen levels of owner-occupied housing decline in recent years (American Community Survey, 2017).

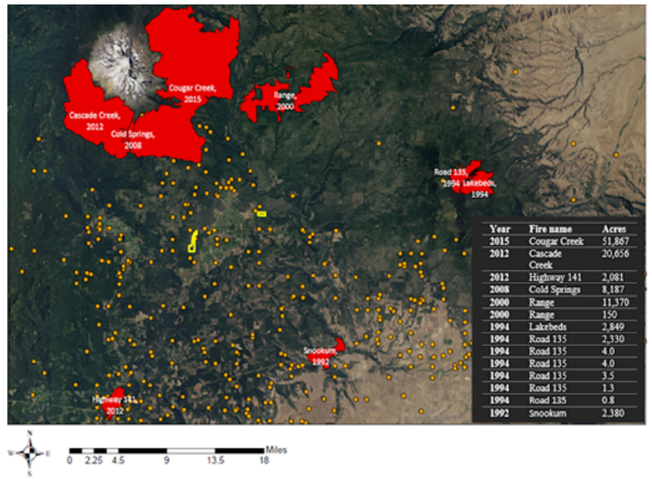
Expected Impacts to Working Forests from Climate Change

Climate change is already impacting the ecosystems of the eastside of the Cascades. Those impacts are only expected to become more extreme in the coming years. By the end of the century, precipitation levels in the region are expected to decline by as much as 30% (Mote and Snover, et al, 2014). Declining precipitation levels have significant implications for the health of an ecosystem driven by the water cycle. Less regular rainfall, decreased snowpack and shrinking glaciers will inevitably result in changes to the timing and delivery of local streamflow as well as decreased groundwater levels. This will result in a reduced water supply, especially during the late summer and other critical times of the year when the impacts of seasonal dry periods are most extreme.

Water stress within trees increases their susceptibility to disturbance events like insect outbreaks and disease as they have less available resources to put into their own defense. Drier conditions also make fires not only more likely but also more likely to result in tree mortality. By the end of the century, the average fire season is expected to lengthen significantly and burn up to five times the area that wildfire impacts on average today (Mote and Snover, et al., 2014).

These changing conditions will result in significant impacts to the forested landscape. Overall, forest productivity is expected to decline and the composition of forests will change to favor species that can survive in hotter, drier and more fire prone conditions.

Community Impacts from Wildfire



Wildfire incidents in Klickitat County. Large events are shown in red and smaller events are shown in orange.

Under future climate change scenarios, communities will have to be prepared to respond to more regular drought and increased fire risk threatening life and property. This also has implications for the financial wellbeing of communities in Klickitat County. It's estimated that 65% of the costs of fire are born by individuals and local communities through the loss of property, replacement of infrastructure, loss of tax revenue, damage to natural resources and the loss of ecosystem services (Barrett, 2018). Already, 122 square miles within the county exist within the Wildland Urban Interface (WUI) (Barrett, 2018). 32% of structures within the WUI around Glenwood are rated at a high or extreme risk for damage or loss from wildfire (McLaughlin, 2007).

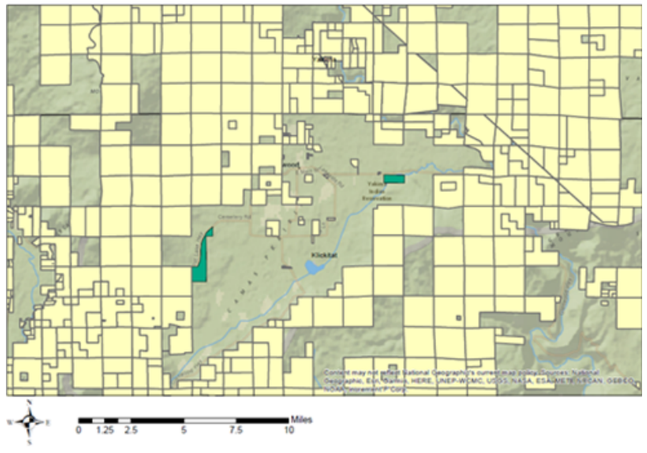
Recent fires in the area include the 2015 Cougar Creek fire that burned more than 53,000 acres northwest of Glenwood on the eastern flank of Mt. Adams as well as Cascade Creek fire on the western flank of Mt. Adams that burned an additional 20,000 acres in 2012. Smaller fires also burned close to the town in 2015, 2006 and 2002 (McLaughlin, 2007). Elsewhere in the county, the City of White Salmon has seen 12 large fires burn within 10 miles of city limits since 2000 (Barrett, 2018). Nearby Trout Lake has seen three large fires within 10 miles of town limits in the same time period (Barrett, 2018).

These fires not only pose an obvious and immediate threat to life and property but also to long term public health. Smoke from fires exasperates a range of health problems for sensitive populations including children and the elderly which can linger long after flames are extinguished. Rising asthma rates, increased sensitivity to air pollution, increased risk of heart attack and stroke and worsening responses to chronic conditions can mean that the true costs of wildfire continue to be felt through the healthcare system (Liu et al., 2017).

IV. Results:

Economic Impact Assessment of Mt. Adams Community Forest: 2014-2017

Between 2014-2017, MARS completed four timber harvests and three prescribed burns on MACF properties. These activities generated $610,000 in direct gross timber receipts and contracts for forest management activities. These revenues are unrestricted and can be reinvested into activities that are determined to be a priority by the MARS Board of Directors as well as local stakeholders. To this time, these revenues have all be reinvested into organization staffing and capacity as well as the ongoing stewardship of MACF properties.



Parcels around the town of Glenwood that have experienced timber harvests in the past decade. MACF tracts are shown in green.

In addition to activities on the MACF, MARS also leveraged its land management experience and expertise to secure stewardship agreements on the adjacent Conboy Lake NWR and one private land holding. These agreements resulted in six additional timber harvests that also employed local logging contractors and resulted in $2.64 million in direct gross timber receipts and contracts for forest management. Different than revenues earned from management on MACF properties, revenues earned from management on the Conboy Lake NWR are restricted and must be reinvested back into ongoing management and stewardship of the refuge rather than any other community identified priorities.

In total, these combined activities add-up to $3.25 million in timber harvest and restoration oriented activities generated directly from the MACF and adjacent U.S. Fish and Wildlife properties over the four-year period.

Due to the seasonal and temporary nature of most forest management contracts, job and employment figures have been reported here as months of full-time equivalent (FTE) employment at the median wage rate rather than as year-round FTE employment. Therefore, these activities should be seen as supplementing and complementing other earnings that local logging crews capture each year from other landowners in order to provide full-time, year-round work.

Distinguishing Economic Impacts

Direct: Changes in jobs, income or sales as the result of economic activities within a given sector (ex. timber harvest and restoration activities)

Indirect: Changes in jobs, income or sales in sectors that supply goods and services the support direct economic activities (ex. purchasing diesel fuel, transporting equipment and maintenance and upkeep of machinery)

Induced: Changes in jobs, income or sales that result from increased spending as the result of overall economic expansion caused by direct and indirect economic activities (ex. increased household spending as the result of more stable employment

Log landing site on the MACF

Economic Impact of Forest Management Activities on the Mt. Adams Community Forest

Prior to MARS's acquisition of the MACF, no harvest activities were planned for those properties. Therefore, recent timber harvests on the MACF represent a new economic activity within the county. Overall, the $610,000 generated in timber receipts and contracts resulted in the equivalent of 5.5 months of FTE employment opportunities at the median county wage rate and a countywide economic multiplier of 2.83 which includes all direct, indirect, and induced effects (Appendix 1; Appendix 2). These activities also result in indirect and induced economic benefits of 10 months of FTE employment opportunities at the median wage rate and a countywide economic expansion of $1.78 million (Appendix 1). Most of this expansion occurs in sectors that support forest management activities. Beneficiaries in these sectors are largely concentrated in commercial logging, machinery and equipment services, truck transportation and automotive repair. Beyond these direct and indirect benefits, timber harvests on MACF properties contributed $6,000 to the public through the timber excise tax.

Year	Project	Ownership	Timber Volume (mbf)	Gross Timber Receipts	Contracts
2014	Mill Pond Thin I	MACF	21.4	$11,856.50	$5,733.64
2015	Mill Pond Thin II	MACF	11	$4,840.58	-
2014-2015	Pine Flats Thin I	MACF	522	$249,093.30	$140,016.64
2017	Pine Flats Thing II	MACF	207.8	$113,659.50	$84,971.45

Economic Impact of Forest Management Activities on the Conboy Lake National Wildlife Refuge

Similarly, the stewardship contracts administered by MARS on Conboy Lake NWR and one private land holding created a new opportunity for economic development within Klickitat County. The $2.64 million in timber receipts and contracts results in the creation of 18 months of FTE employment and a countywide economic multiplier of 2.37 (Appendix 1). The lower multiplier for Conboy Lake NWR activities is associated with the restricted nature of the earned revenues. These results translate to indirect and induced economic benefits of 25 months of FTE employment and a countywide economic expansion of $6.24 million (Appendix 1). Again, this expansion is largely concentrated in services that support forest management activities. Beyond these direct and indirect impacts, timber harvests on the Conboy Lake NWR contributed $20,000 to the public through the timber excise tax.

Year	Project	Ownership	Timber Volume (mbf)	Gross Timber Receipts	Contracts
2013-2014	Laurel Thin	USFWS	479.1	$260,920.02	$111,100.31
2014	Mason Thin	Private	293.2	$160,174.51	$78,979.87
2015	Fraizer Meadow Restoration	USFWS	30.3	$30,161.24	$58,051.91
2015-2016	Headquarters Thin	USFWS	2,064	$704,614.47	$616,688.73
2016-2017	Kelley Thin I	USFWS	124.4	$64,598.75	$36,353.30
2017	Kelley Thin II	USFWS	64.5	$71,253.61	$44,269.11
2017	Troh Thin	USFWS	532.7	$238,049.61	$164,701.21

Total Economic Impact of Forest Management Activities Created by the Mt. Adams Community Forest

Taken in sum, the combined economic impact of activities created by the MACF from 2014-2017 can be summarized as:

- $3.25 million in direct timber receipts and contracts
- 59 months of FTE direct and indirect jobs at the median wage rate
- $8 million created through countywide economic expansion

These benefits provide additional stability and work opportunities to the local working forest economy. The linkages between activities on the MACF and other sectors also translate to benefits that affect the economy of Klickitat County at large. In fact, this study estimates that given site quality, the restoration oriented harvest activities used in the management of the MACF provides two times the employment opportunities than would otherwise be found through traditional mechanical harvesting. As management on the MACF and associated properties continues over the years, it is expected that these benefits will be sustained and potentially enhanced as the project further develops.

	MARS property forest restoration and commercial thinning activities		USFWS forest restoration and thinning activities	
	Economic Contribution	Employment (at median wage)	Economic Contribution	Employment (at median wage)
Direct Effect	$610,181	5.5 months	$2,639,916	18.4 months
Indirect and Induced Effect	$1,170,046	10 months	$3,597,970	25 months
Total Effect	$1,780,228	15.5 months	$6,237,886	43.4 months
Multiplier	2.83		2.36	

Wildfire Risk Reduction from Fuels Treatment Activities

Using historical data recorded by the Northwest Interagency Coordination Center and an understanding of local land use and fire dynamics, it is possible to estimate the probability of a large wildfire occurring within a given geography and period of time. In the Mt. Adams region, eight wildfires over 2,000 acres in size occurred between 1984-2016. In addition to these large fires, the region also saw many hundreds of other smaller fires over the same time period that were suppressed before they grew out of hand. Based on this information, this study estimates that there is a 5% probability of a 10,000-acre fire in the Glenwood Valley within the next 10-years.

Year	Project	Ownership	Acreage
2016	Pine Flats Rx Burn I	MACF	27
2017	Pine Flats Rx Burn II	MACF/USFWS	290
2018	Pine Flats Rx Burn III	MACF/USFWS	107

Fuels treatments and restoration activities on the MACF and adjoining Conboy Lake NWF are estimated to reduce wildfire risk by 20-30% on those properties. For the neighboring 10,000 acres of private and public lands, these activities correspond to a 1% reduction in overall risk from wildfire damages across the landscape. This risk reduction most directly benefits homestead owners on the northeast edge of the Pine Flats Tract as well as those to the west of the Mill Pond Tract.

Scenario Modeling for Estimating Avoided Costs to Housing and Agricultural Sectors

Within the Glenwood Valley, wildfire poses significant risk to the residential housing sector. This risk is amplified if any additional land is converted from forests to residential development. This study proposes a scenario that examines the potential impacts to the housing sector if .1% of the 10,000-acres neighboring the MACF is converted to residential development (Appendix 3). In this case, approximately $50 million of new property values will be exposed to wildfire risk. If even 5% of this new development were impacted from wildfire, this would correspond to $2.5 million in damages to the housing sector alone. These impacts have further negative implications for the countywide economy. In total, it is estimated that such impacts would have a negative economic multiplier of 6.16 and result in the loss of $12.9 million to the countywide economy and 10 months of full-time employment. Therefore, under this scenario, the fuels reduction activities on the MACF are expected to result in the avoidance of $3.1 million of these costs to the housing sector.

A prescribed burn on the Pine Flats tract of the MACF.

The agricultural sector in the Glenwood Valley is also at risk from the impacts of wildfire. These farms are diversified and represent producers growing fruits, grains, hay and livestock (USDA, 2012). Given fuels treatment and restoration activities on the MACF and Conboy Lake NWR, its estimated that work by MARS provides additional protection from wildfire damages to 20 farms and results in the avoided costs of $1.1 million in savings to the local agricultural sector (Appendix 4).

In total, based on these anticipated savings to the housing and agricultural sectors, it can be said that MACF activities will provide an additional $4.1 million in economic benefits over the next 10-years in avoided wildfire risk. Any expansion of community forest activities that reduce wildfire risk would result in further cost savings, especially if implemented in strategic locations that provide further protection around population centers.

It is important to note, that these calculations do not consider the costs of fighting fires which are otherwise captured by the state and federal government.

Ecosystem Service Benefits of Community Forest Activities for Carbon Sequestration

The MACF is currently a carbon sink. The Mill Pond Tract sequesters 135 tCO_2/year and the Pine Flats Tract sequesters 197 tCO_2/year in the Pine Flats Tract. In total, carbon stocks within the Mill Pond are 6,815 tCO_2 and 16,629 16,629 tCO_2 in Pine Flats Tract. Combined, this adds up to a total carbon stock of 23,444 tCO_2 on the MACF (Appendix 5). The carbon sequestration function provided by the MACF serves as a measure of the land's carbon mitigation potential as well as the potential for global warming impacts as the result of converting forestlands to non-forest uses. The carbon storage on the MACF is equivalent to offsetting the annual emissions of 72 cars (EPA, 2018). This is important because resource lands in Washington are being lost at a rate of "a football field every 18 minutes" (Gray et. al., 2013). In many areas, the primary driver of conversion is the dramatic disparity between the economic value of forested land for timber production and the much higher value for development. Given the risk for conversion in this area and the MACF's low-value for industrial timber management, this study estimates that the conversion of the community forest parcels to bare land or grassland to accommodate new development would result in a 90-95% loss of this carbon stock.

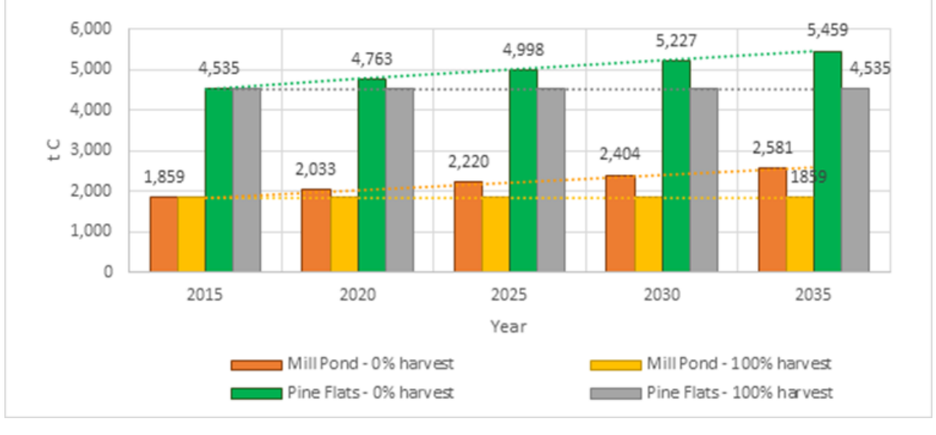
Pine Flats Tract		
Carbon sink, in 2015	tCO_2/year	tCO_2/acre year
	197	0.66
Carbon stock, in 2015	t CO_2	t CO_2/acre
	16,629	55.59
	t C	t C/ha
	4,535	37.46

Mill Pond Park Tract		
Carbon sink, in 2015	tCO_2/year	tCO_2/acre year
	135	1.50
Carbon stock, in 2015	tCO_2	tCO_2/acre
	6,815	76.06
	t C	t C/ha
	1,859	51.26

Total MARS Forest Land		
Carbon sink, in 2015	tCO_2/year	tCO_2/acre year
	331	0.85
Carbon stock, in 2015	tCO_2	t CO_2/acre
	23,444	60.31
	t C	t C/ha
	6,394	40.64

It should be noted that as harvest activities occur, carbon storage within the forest decreases before it can recover with new growth. Therefore, carbon

storage on the community forest is in flux from year to year. However, the alternative harvest practices utilized by MARS ensures that a significant amount of biomass and carbon remains stored within the forest. In this way, the MACF will be a consistent carbon sink. Additional carbon storage and savings can be had from harvest through the manufacturing of long-lived wood products that displace other products that require significant fossil fuel emissions to be made into building products.



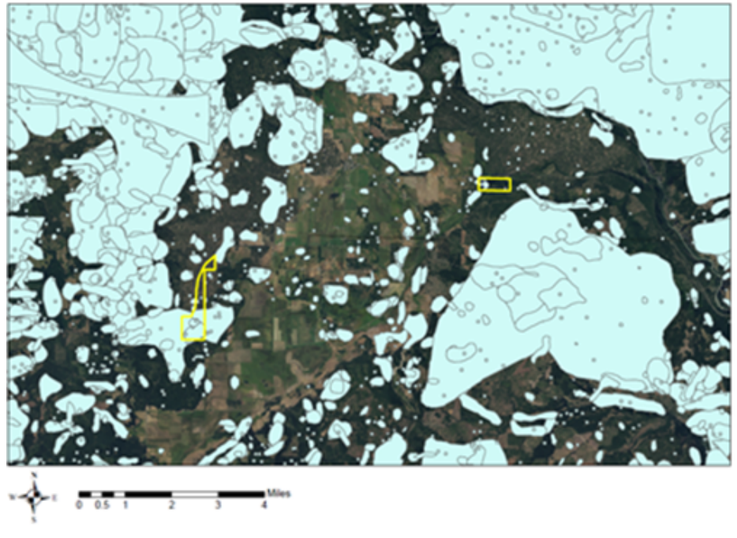
The projected carbon stocks from 2015 to 2035 are calculated for the two limited scenarios corresponding to harvesting 0% and 100% of the growth. Depending on the harvest regime, in 2035, forest carbon stocks in MARS forestland are expected to store between 4,535 and 5,459 t C (up to a 20% increase) in Pine Flats Tract, and between 1,859 and 2,581 t C (up to a 38% increase) in the Mill Pond Tract.

Wildfire and Public Health

Wildfires release a large amount of toxic emissions that can be hazardous to human health. Among the chemicals released in the atmosphere during biomass burns there are: carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxides (NO_x), volatile and semivolatile organic compounds (VOC and SVOC), particulate matter (PM10 and PM2.5), ammonia (NH_3), sulfur dioxide (SO_2) and methane (CH_4) (Wiedinmyer et al., 2006).

Of these compounds, exposure to particulate matter is a major concern. Particulate matter can be extremely dangerous to the respiratory and cardiac health of sensitive populations. Short-term exposure can cause difficulty in breathing and contribute to decrease in lung function (Haikerwal et al., 2015). It can also aggravate existing health issues such as asthma and chronic obstructive pulmonary disease (COPD). Long-term exposure can lead to an increase in hospital visits and possible death. With its aging population, this is a particular concern in Klickitat County. Forest health treatments carried out by MARS that reduce this threat contributes positively to local public health.

Managing for Natural Disturbance



Forest disturbances in the area of the MACF. Pest outbreaks and disturbance events are shown in blue. MACF properties are outlined in yellow.

Disturbance to forest ecosystems are caused by biotic and abiotic factors that cause tree mortality. In addition to disturbance by wildfire, MACF properties are also susceptible to damage from flooding as well as mountain pine beetle, western pine beetle and Douglas-fir beetle. The USFS Forest Health Area Survey indicated that MACF properties were impacted by water damage and pest outbreaks 22-times from 1980-2017 (USFS, 2017). Overtime, MARS's management practices will reduce susceptibility to these disturbance events by favoring older and more resilient trees on the landscape while removing those most likely to be impacted by disease and pest pressures. These activities will improve the value of the MACF properties and its standing timber over time.

V. Future Economic Development Opportunities

New Land Acquisition for the Community Forest

As previously stated, it is the goal of the MACF to eventually hold several thousand acres under community management. Priority properties for acquisition have been identified in the Glenwood Valley area. These are lands that hold significant local value and provide connectivity between existing protected areas that are also low-value and low-productivity lands, unsuitable for industrial management, that comprise under-represented and fire adapted forest ecosystem types on the landscape.

MARS has identified two parcels as priorities for new acquisitions for the MACF. These acquisitions are planned to be completed over the next two years. The first acquisition, called the Outlet Creek tract is split between two parcels and represents 180-acres west of the Mill Pond Tract. This property is a low-productivity site composed primarily of ponderosa pine and Oregon white oak. It is currently in industrial forest ownership and while it is ideal for restoration oriented forestry, long-term stewardship and the fostering of fire adapted ecosystems, it is of low value for intensive forest management. Fundraising for this acquisition is partially secured.

Should the Outlet Creek tract be acquired, it is expected that the property will produce $1.44 million and 17-months of direct jobs over the next 15-years. Using the previously calculated economic multiplier of 2.83, these harvest activities further translate to a countywide economic benefit of $2.6 million and the creation of 30 months of indirect and induced employment over the same time period.

Biomass growth and harvest in the additional forestland procurement proposed by MARS.

The second parcel covers 427-acres and sits east of the Mill Pond tract and adjacent to the DNR-owned Klickitat Canyon Community Forest Trust property. This land is currently owned by Columbia Land Trust and was acquired from an industrial forest landowner as part of a larger conservation strategy to protect the land around the Klickitat River from development. Due to its suitability for restoration oriented forestry, MARS signed a letter of interest to purchase the property from Columbia Land Trust and manage it in agreement with landscape conservation goals. Fundraising for this acquisition is currently in its early stages.

Should this parcel be acquired, it is expected to produce $3.6 million and 42-months of direct employment over the next 15-years. Again, using the previously calculated economic multiplier of 2.83, these harvest activities will result in a further $6.6 million and the creation of 77 months of employment opportunities over the same time period. In total, the combine benefit of these acquisitions is $14.2 million and 166 months of direct, indirect and induced jobs over a 15-year period.

It is worth noting that different than previous acquisitions completed by MARS, these lands are already managed as productive timberland. Therefore, all economic activity that results from harvest activities on these properties can be considered as continuing current economic activities rather than creating new economic development opportunities. In fact, the transition from industrial to restorative forest management practices will likely result in the reduction in of short term revenues. However, this study also estimates that the more labor-intensive restoration oriented forest management that MARS employs is likely to create twice as many jobs as traditional industrial practices. This additional employment is likely to compensate for any impact to the overall economy that would otherwise be created by the loss of short-term revenues.

The opportunity also exists for MARS to enter into a long-term stewardship and management contract with DNR on the Klickitat Canyon Community Forest Trust property. This would provide MARS the opportunity to further engage local contractors and its stewardship crews in the management of an addition 1,500-acre property.

Stewardship-based Economic Development Efforts

MARS currently holds a lease from DNR on a 10-acre log yard. This area has previously been the site of efforts by the organization to pilot new and innovative ways to utilize small-diameter wood. While no specific plans for future use of the site have been identified, it remains a priority of MARS to find a way to use the site to incubate new, small, value-added businesses around wood harvested from the MACF and additional stewardship contracts.

In 2017, the Klickitat County Public Economic Development Authority identified MARS and its Small Wood Utilization Initiative as a priority partnership for future economic activity in support of the stewardship-based economy (Klickitat County Public Economic Development Authority, 2017).

MARS will also continue its stewardship efforts on the Conboy Lake NWR and in partnership with private landowners to facilitate sustainable timber harvests as well as to address forest health and wildfire risk concerns within the Glenwood area.

MARS small-diameter wood utilization project.

Carbon Sequestration

As previously mentioned, the MACF will continue to act as a carbon sink even with the continuation of harvest practices. With current forest management practices in place, carbon stocks on existing MACF properties are expected to increase through 2035. In total, over that time period, a 20% increase (4,535-5,459 tCO2) in carbon storage is anticipated on the Pine Flats Tract while a further 38% increase (1,859-2,581 tCO2) is anticipated on the Mill Pond Tract. The protection of these properties from conversion and the additional value of this sequestered carbon will continue to add value to the state's carbon emissions reduction goals.

Future Support and Continued Engagement with the Community

Slash pile from MACF stewardship activities

In the near-term, as the MACF continues to grow, revenues earned from economic activities are expected to continue to be reinvested back into providing living wage employment opportunities for area residents as well as the ongoing stewardship and maintenance of MACF holdings and partner lands. In addition, the MACF will continue to provide space for public access, traditional land uses and local engagement in natural resource management decision making.

References

Alig, R., Plantinga, A., Haim, D., Todd, M., (2010). Area changes in U.S. forests and other major land uses, 1982 to 2002, with projects to 2062. U.S. Department of Agriculture, Forest Service. Pacific Northwest Research Center. General Technical Report. PNW-GTR-815. 98p.

American Community Survey. (2017). Klickitat County. U.S. Census Bureau. https://www.census.gov/programs-surveys/acs/

American Farmland Trust. (2016). Cost of Community Services Studies. Farmland Information Center. https://www.farmlandinfo.org/sites/default/files/Cost_of_Community_Services_Studies_AFT_FIC_201609.pdf

Baker M., and Kusel J., (2003). Community Forestry in the United States: Learning from the Past, Crafting the Future. Island Press.

Barrett, K. (2018). The Full Community Costs of Wildfire. Headwaters Economics. https://headwaterseconomics.org/wp-content/uploads/full-wildfire-costs-report.pdf

Braxton Little, Jane. (2006). Timberlands up for grabs. High Country News. 1/23/06. https://www.hcn.org/issues/314/16037

Bradley, G., Erickson, A., Robbins, A., Smith, G., Malone, L., Rogers, L., Connor, M., (2007). Forest Land Conversion in Washington State. Washington Department of Natural Resources. Future of Washington's Forest and Forest Industries Study. Study 4. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.493.6914&rep=rep1&type=pdf

Bradley, G., Boyle, B., Rogers, L., Cooke, A., Rose, R., Matheny, E., Burnett, C., Perez-Garcia, J., Rabotyagov, S. (2009). Retention of High-Valued Forest Lands at Risk of Conversion to Non-Forest Uses in Washington State. Northwest Environmental Forum. College of Forest Resources, University of Washington. Prepared for the Washington State Legislature and Department of Natural Resources. http://www.ruraltech.org/projects/wrl/sfr/pdf/RetentionReport.pdf

Charnley S., and Poe, M., (2007). Community Forestry in Theory and Practice: Where Are We Now?. Annual Review of Anthropology. Vol. 36, 301-336.

Chelan County. (2018). Stemilt Partnership. Chelan County Natural Resources. https://docs.google.com/document/d/1_V0nR5EydleuEkK88QQHxX-CIHaOPiLnQmilgaOny0Q/edit

City of Seattle. (2018). Cedar River Watershed. Seattle Public Utilities. http://www.seattle.gov/util/environmentconservation/education/cedarriverwatershed/

Community Forest Collaborative. (2007). A Community Investment Strategy: Community Forests. Community Forest Collaborative. https://www.tpl.org/sites/default/files/cloud.tpl.org/pubs/benefits_community_forests_rpt.pdf

Department of Commerce. (2014). The Social Cost of Carbon: Washington State Energy Office Recommendation for Standardizing the Social Cost of Carbon When Used for Public Decision-Making Processes. http://www.commerce.wa.gov/wp-content/uploads/2015/11/Energy-EV-Planning-Social-Cost-of-Carbon-Sept-2014.pdf

Department of Natural Resources. (2017). Forest Management Plan for the Klickitat Canyon Community Forest. https://www.dnr.wa.gov/publications/amp_sepa_other_klickitatccf_dmp.pdf

Department of Natural Resources. (2018). Forests and Trust Lands. Community Forests. https://www.dnr.wa.gov/managed-lands/forest-and-trust-lands

Entz, Ray., Gilrein, Bob., George, Bart. and Berger, Matthew. (2016). Indian Creek Management Plan. Kalispel Natural Resources Department. https://9b37abdd1c3135d9659b-298f012ea728e-fea7c302ad9a6f7bba0.ssl.cf2.rackcdn.com/knrd/Final-Draft-Indian-Creek-Management-Plan-2016-with-BPA-Comments.pdf

Environmental Protection Agency. (2018). Greenhouse gas emissions from a typical passenger vehicle. Green Vehicle Guide. https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle
Gan, J. and C.T. Smith. (2007). Co-benefits of utilizing logging residues for bioenergy production: The case for East Texas, USA. Biomass and Bioenergy. 31(9): 623-630.

Gray, A.N., Azuma, D.L., Lettman, G.J., Thompson, J.L., McKay, N. (2013). Changes in land use and housing resource lands in Washington state, 1976-2006. U.S. Department of Agriculture, Forest Service. Pacific Northwest Research Station. No. PWN-GTR-881. Portland, OR. https://doi.org/10.2737/PNW-GTR-881

Greer, Allen. (2017). Property and Dispossession: Natives, Empires and Land in Early Modern North America. Cambridge University Press.

Haikerwal, A., Muhammad, A., Del Monaco, A., Smith, K., Sim, M., Meyer, M., Tonkin, A., Abramson, M. and Dennekamp, M. (2015). Impact of Fine Particulate Matter Exposure During Wildfires on Cardiovascular Health Outcomes. Journal of the American Heart Association. Vol. 4., No. 7. https://www.ahajournals.org/doi/abs/10.1161/JAHA.114.001653

Jefferson Land Trust. (2018). Chimacum Ridge Community Forest Vision. https://saveland.org/chimacum-ridge-community-forest-vision/

Keegan, C.E., Sorenson, C.B, Morgan, T.A., and Hayes, S.W. (2012). Impact of the Great Recession and Housing Collapse on the Forest Products Industry in the Western United States. U.S. Department of Agriculture, Forest Service. Pacific Northwest Research Station. Forest Products Journal. Vol. 61, No. 8. 625-634.
https://www.fs.fed.us/pnw/ruwit/papers/daniels/ImpactoftheGreatRecession.pdf

Klickitat County. (2018). Parcel Information. Interactive Mapping Service. Department of the Assessor. https://www.klickitatcounty.org/213/Parcel-Information-Online

Klickitat County Public Economic Development Authority. (2017). Advancing Economic Prosperity in Klickitat County: 10-Year Economic Development Strategic Plan. https://www.klickitatcounty.org/DocumentCenter/View/3178/2017-05-22-Klickitat-County-Strategic-Plan?bidId=

Leontief, W.W. (1936) Quantitative Input and Output Relations in the Economic Systems of the United States. The Review of Economics and Statistics, 18, 105-125.
https://doi.org/10.2307/1927837

Liu, X. et al. (2017). Airborne measurements of western U.S. wildfire emissions: Comparison with prescribed burning and air quality implications. Journal of Geophysical Research: Atmospheres. 122, 6108-6129.

Low, L.A., and A.M. Isserman. (2009). Ethanol and the local economy: Industry trends, location factors, economic impacts, and risks. Economic Development Quarterly. 23(1);71-88.

Lyman, M.W., Grim, C., and Renaud Evans, J., (2014). Community forests as a wealth creation strategy for rural communities. Community Development. http://nwcommunityforests.org/wp-content/uploads/2017/12/Your-Forest_The-Basics_Lyman-Grim-Evans-2014_Community-Forests.pdf

McLaughlin, J. (2007). Glenwood Community Wildfire Protection Plan. Washington Department of Natural Resources. https://www.dnr.wa.gov/publications/rp_burn_cwpp_glenwood.pdf

Miller, R.E. and P.D. Blair. 2009. Input-output Analysis: Foundations and Extensions (second ed.). Cambridge University Press, Cambridge, UK.

MIG Inc. 2015. IMPLAN 2014, Economic Impact Modeling. Hudson, Wisconsin.

Milota, M., 2015. CORRIM Report: Module B. Life Cycle Assessment for the production of Pacific Northwest softwood lumber.

Mote, P., Snover, A., Capalbo, S., Eigenbrode, S.D., Glick, P., Littell, J., Raymondi, R., and Reeder, S. (2014). Chapter 21: Northwest. Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Research Program. https://nca2014.globalchange.gov/report/regions/northwest

Mt. Adams Resource Stewards. (2008). Mt. Adams Resource Stewards Community Forest Land Management Plan.

Mt. Adams Resource Stewards. (2018). Mt. Adams Community Forest: A new model of forest ownership for the West. http://www.mtadamsstewards.org/programs/mt-adams-community-forest/

Nisqually Community Forest. (2011). Introduction and Background. Nisqually Community Forest. http://nisquallycommunityforest.org/sample-page/

Northwest Community Forest Coalition. (2018). About. http://nwcommunityforests.org/about-the-coalition/

Perez-Verdin, G., D.L. Grebner, I.A. Munn, C. Sun and S.C. Grado. (2008). Economic impacts of woody biomass utilization for bioenergy in Mississippi. Forest Products Journal, 58(11), 75-83.

Rasker, R. (2017). The Transition from Western Timber Dependence: Lessons for Counties. Headwaters Economics. https://headwaterseconomics.org/wp-content/uploads/Lessons_Timber_Transition.pdf

Reaves, E., and Ceroni, M., (2013). Economic Impacts of the 13 Mile Woods Community Forest in Errol, New Hampshire. Community Forest Collaborative. https://www.tpl.org/sites/default/files/economic-impacts-nh-forest.pdf

Revised Code of Washington. (2011). RCW 79.155: Community Forest Trusts. Washington State Legislature. http://app.leg.wa.gov/rcw/default.aspx?cite=79.155

Rural Technology Initiative. (2016). Washington State Parcel Database. University of Washington. http://depts.washington.edu/wagis/projects/parcels/development.php

Sasatani D. and I.L. Eastin. 2016. Economic impacts of bio-refinery project in Western Washington and Oregon. Northwest Wood-Based Biofuels and Co-Products Conference 2016.

Schlosser, J.A., Leatherman, J.C. and Peterson, J.M., (2008). Are biofuels revitalizing rural economies? Projected versus actual labor market impacts in the Great Plains. American Agricultural Economics Association Annual Meeting, Orlando, FL.

Smith, D., Larson, K., (2017). Washington Mill Survey 2016. Series Report #24. Washington State Department of Natural Resources.

Stein, P. (2011). Trends in Forestland: Ownership and Conservation. Forest History Today. Spring 2011. 83-86.

U.S Department of Agriculture. (2012). Census of Agriculture. County Profile Klickitat County Washington. USDA National Agricultural Statistics Service.

U.S. Department of Agriculture. (2012). Census of Agriculture. County Profile Klickitat County Washington. USDA National Agricultural Statistics Service. https://www.nass.usda.gov/Publications/AgCensus/2012/Online_Resources/County_Profiles/Washington/cp53039.pdf

U.S. Forest Service. (2015). Who Owns America's Trees, Woods, and Forests? Results from the U.S. Forest Service 2011-2013 National Woodland Owner Survey. U.S. Department of Agriculture, Forest Service. Northern Research Station. https://www.fs.fed.us/nrs/pubs/inf/nrs_inf_31_15-NWOS-whoowns.pdf

U.S. Forest Service. (2017). Aerial Insect and Disease Survey GIS Data for Oregon and Washington 29147-Present. Pacific Northwest Region. https://www.fs.usda.gov/detail/r6/forest-grassland health/insects-diseases/?cid=stelprd3791643

Urgenson, L., Belsky, J., Churchill, D., Bormann, B., Bakker, J., Israel, S., Alvarado, E. (2017). Enabling Conditions and Barriers to Community Forest Development in the Pacific Northwest. The Nature Conservancy, Washington and Montana Chapters. School of Environmental & Forest Sciences, University of Washington. College of Forestry & Conservation, University of Montana. https://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/montana/cbp-community-forest-study-summary-4-4-17.pdf

Wiedinmeyer, C., Quayle, B., Geron, C., Belote, A., McKenzie, D., Zhang, X., O'Neill, S., Wynne, K.K. (2006). Estimating emissions from fires in North America for air quality modeling. Atmospheric Environment. 40. 3419-3432. https://doi.org/10.1016/j.atmosenv.2006.02.010

Appendix 1
Stewardship-based Economic Development Efforts

This study uses an input-output (I/O) analysis to provide an estimate of the importance that forest restoration activities and commercial thinning have to the regional economy. This is done by quantifying the multiplier effect of this sector in terms of total output, employment, and wages. The economic contribution analysis was done using Impact Analysis for Planning (IMPLAN) economic impact assessment software originally developed by the U.S. Department of Agriculture, Forest Service and now maintained by IMPLAN LLC., formerly Minnesota IMPLAN Group (MIG) (MIG 2014). The forestry-related sectors (e.g., logging, wood energy, solid wood manufacturing, wood furniture manufacturing, etc.), as described in the IMPLAN study area data are determined by county-wide reported economic data and represent the direct effects of sector related activities (e.g., jobs and value of production in the forestry and forest products manufacturing sector) which is the starting point of the analysis.

Data

The study utilized three major data sources. (i) Inter-industrial economic transaction and Social Accounting Matrix (SAM) data were obtained from IMPLAN (MIG Inc. 2016). (ii) The data of the various economic activities associated with the community forestry under consideration determined by information reported by Mt. Adams Resource Stewards and collected during a field visit to the Mt. Adams Community Forest. This data includes all the forestry, recreational and other direct economic activities associated with the community forestry activities and (iii) the projected forestry related income associated with additional land procurements and projected forestry related income till 2030 with these new acquisitions. Biomass data previously assembled by the University of Washington has been used to determine the impact of future economic activities from the forest, given a certain set of forest management practices.

Input Output Modeling

Many studies in the agricultural and in the forestry sectors have examined the economic impacts of utilizing biomass energy by applying an input-output analysis (I/O) (Schlosser et al. 2008; Low and Isserman 2009; Gan and Smith 2007; Perez-Verdin 2008; Sasatani and Eastin 2016). The economic impacts based on an I/O analysis are characterized as direct, indirect, and induced effects. I/O analysis was designed to help quantify the economic impacts of an exogenous activity on a regional economy by calculating the economic linkages within industrial production (Miller and Blair 2009). In this project, I/O models were developed using the inter-industrial transaction and social accounting matrices provided by IMPLAN (MIG 2015).

An I/O data and model incorporates the relationships between different industries in the economy. It is constructed from the observed data for a specific economic region, which in our case is Klickitat county. The economic activities in the region are classified into broad

categories, such as, commercial logging sector, steel sector, truck transportation sector, steel, etc. Transactional relationships between individual sellers and buyers of different commodities constitute the I/O data at large. While commodities are produced by industries, they are consumed either by other industries to produce more value-added commodities, or by the end-user institutions such as households, government and exports. The former part of demand, which is arising from industries, is called intermediate demand, and the latter part, which includes the final consuming institutions, is called final demand.

An I/O table is constructed in such a way that the total output equals the sum of all these demands put together (Leontief, 1936). Denoting this in a matrix format, with output matrix X, intermediate consumption matrix Z and the final demand matrix F; if there are N broad industries in the I/O table, then the size o each o these matrices is (NX1):

$$\mathbf{X = Z + F}$$

Z can be decomposed into two matrices; an (NXN) matrix that has the intermediate goods demanded on the rows, and the industries demanding them on the columns and an (NX1) matrix that includes merely the output matrix X. This is accomplished by dividing each element of intermediate consumption of a given commodity by its total output. By denoting this matrix of technical coefficients as A, we can modify the previous equation as follows:

$$\mathbf{X = AX + F}$$

Rearranging the equation above, we get:

$$\mathbf{X = (I\text{-}A)^{-1} F}$$

where I stands or the (NXN) identity matrix, which has all of its diagonal elements as '1' and non-diagonal elements as zero; it is the matrix equivalent of the scalar '1'; in other words, multiplying a matrix by I, would yield the same matrix.

The matrix $(I\text{-}A)^{-1}$ is the Leontief inverse matrix, whose elements represent the multiplier effects of each industry. We assume linearity, i.e., constant returns to scale (meaning that for example, doubling all inputs would double the output) and fixed coefficient of production (meaning that the share of each input to produce any output is fixed); then, the following would hold if 'Δ' denotes marginal change:

$$\mathbf{\Delta X = (I\text{-}A)^{-1} \Delta F}$$

Thus, if we know how to project the marginal change for final demand, we can estimate the changes in total output in the region (Miller and Blair, 2009). Given our linear assumption described above, the output effects may also be extended to employment and value added. We compute two types of multipliers; one based on the matrix 'A' which would comprise direct inter-industry transactions and another based

on the Leontief Inverse matrix, which would include direct, indirect and induced effects, since this involves institutional details in the 'F' matrix. The first one is called type I multipliers and the second is called type SAM (Social Accounting Matrix) multipliers. All these multipliers, however, ignore any price change effects as well as corresponding behavioral effects, which are captured better in a CGE (Computable General Equilibrium) model. CGE model is beyond the scope of this study, since it involves development of behavioral parameters and equations at county levels, which is difficult to perform in a short timeline and limited resources.

1.1 Understanding the Input-Output modeling with reference to MARS activities

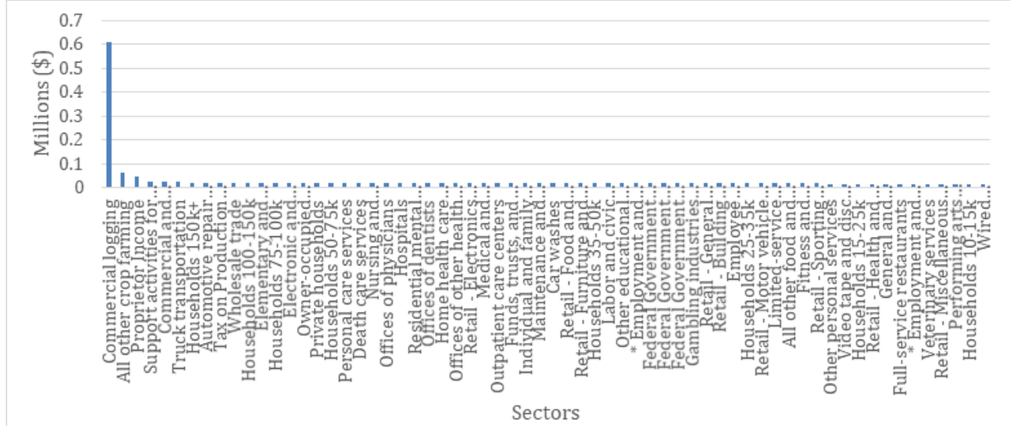
To be able to understand and interpret the econometric modeling, we need to understand the model results in context to the project under consideration. Economic impact analyses examines the economic effects that a business, project, governmental policy, or economic event has on the economy of a geographic area. In this particular case, we are investigating the economic effects of MARS restoration and harvest activities in Klickitat county. Economic impact models work by simultaneously modeling multiple sectors of the economy, **by dividing the sectors in two economies**, one where the economic event being examined occurred, the second economy is a combination of all other sectors outside the first one. By simultaneously modeling these two economies we generate estimates of the total impact of the economic activities undertaken by MARS.

Input-output (I/O) models are designed to examine all of the industries in a local economy and estimate all of the ways that spending in one sector influences each of the other sectors in the area's economy. For example, initiating a forest restoration project in the county will create a demand for contract labor within the commercial logging sector, which includes contractors, loggers, truckers etc. All the economic transaction and employment generation that happens in this sector is termed as **direct effects**. However, to be able to undertake the logging and restoration activities, project participants need to buy diesel for the trucks and hauling equipment, chainsaws for the logging operation, gloves for the workers etc. All these economic activities are termed as **indirect effects** and are triggered by the economic activities in the primary sector. In addition to these indirect impacts, these additional economic activities may trigger economic activities in completely unrelated goods and services sector, like greater demand for fast-food in the region. These economic activities are termed as **induced effects.** One can think of these effects as ripples generated in the water because of some disturbance, like, pelting stones in a lake. Two aspects determine the level of economic ripple effect on any particular sector within the economy as a result of the economic boost in the primary sector under consideration, (i) the relative economic distance of a sector from the primary sector and (ii) the level of economic boost applied to the sector under consideration. The sum of these three economic effects, direct, indirect and induced, result in the overall economic effect.

1.2 Input-Output modeling based Community Impact Assessment (CIA) for MARS properties

We employed the Input-Output (IO) table for Klickitat county from IMPLAN dataset with a base year of 2016, to derive the Leontief matrix of multipliers for every sector. While one may point out that the data is a bit dated, it has been shown in the literature that the IO tables have been stable for a period of 5-10 years, across the world, given that the technological changes take time to take effect. There are 194 sectors in this IO table. Therefore, by feeding in the expansion in timber receipts as well as that in the restoration and stewardship contracts and excise tax collections, we can assess the multiplier impact of these developments on the whole economy of this county. In the period between 2014 and 2017, the gross timber receipts from MARS property was $379 thousand and the contracts amounted to another $230,000. So, the total direct income by MARS can be determined to be around $610,000. The excise taxes on timber from the MARS property was about $6,000. Broadly, we find an overall multiplier of 2.83 for the MARS expansion in commercial logging sector either in terms of gross timber revenue.

Given that commercial logging has backward and forward linkages with several other sectors, we expect effects that are much higher than the direct revenue effect in this sector alone. For the initial part of this study, the focus is on the effects of MARS timber receipts and contracts that are exclusively on MARS lands, which total to about $610,000. Based on field observations and previously reported timber harvest activity, it was possible to determine that these harvests are completely additional to the commercial logging sector, since there would have been zero receipts on timber if MARS did not exist. Based on the median wages in the county, we calculate that a total of 5.5 months of full-time equivalent (FTE) jobs were created across the county in several sectors as a result of indirect and induced economic activities. The 'Other crops' sector is the biggest beneficiary, growing by almost $60,000. Proprietor income, support services for agriculture and forestry, machinery/equipment rental services, truck transportation services and automotive repair are other sectors that expands to the tune of $20,000-60,000. All other sectors expand by less than $20,000. The total effect on the other sectors is about $1.78 million.

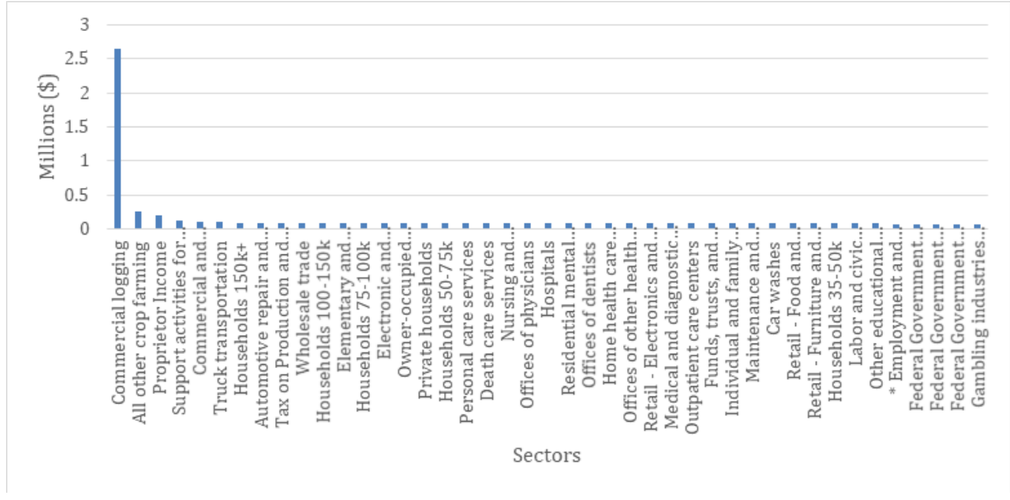


Impact of MACF management activities on other sectors with an impact of at least $10,000

1.3 Input-Output modeling based Community Impact Assessment (CIA) for MARS Stewardship Contracts

In this section, we consider the contracts given to MARS by the USFWS and by one private landowner. These contracts involve conservation of forests and wildlife that have long-term damage-avoidance effects that we separately consider, but they also consider immediate generation of income and employment for the people within the county. In the period between 2014 and 2017, the gross timber receipts from USFWS restoration activities was $1.53 million and the contracts amounted to another $1.1 million. The excise taxes on timber from the USFWS contracts were about $20,000.

Similar to the previous section, we employed the Input-Output (IO) table for Klickitat county from IMPLAN dataset with a base year of 2016, to derive the Leontief matrix of multipliers for every sector. When we feed in the expansion in timber receipts as well as that in the restoration and stewardship contracts and excise tax collections, we can assess the multiplier impact of these developments on the whole economy of this county. These results for the commercial logging, stewardship and restoration contracts in the wildlife reserves are less prominent, with an overall impact at $6.24 million for the gross timber receipts and contracts valued at $2.64 million. This amounts to a multiplier of 2.37. The jobs created by the direct economic activity is 18 months of jobs, at the median regional wage. About 25 additional months of FTE jobs were created across the county in several sectors as a result of indirect and induced economic activities. In this case, crop farming and proprietor income gain about $150,000 each, while transportation, household and employment sectors, as well as many other sectors, gain over $50,000 each.



Impact of USFWS and private contract stewardship efforts on sectors with an impact of at least $5,000.

Appendix 2
Explaining the Forest Sector Economic Multiplier

Forest management activities on the MACF are assigned different economic multipliers given the restrictions placed on the use of funds associated with the management of different parcels. Those multipliers correspond to the downstream impacts than an activity has on the economy at large. In this case, the impact of those impacts are limited to Klickitat County. In this case, the direct effect is almost always 1, while the indirect and induced effects account for the remaining value of the multiplier for each activity. To understand where the multiplier adds value, it is necessary to understand the county's forest products sector.

For this purpose, sawmill production data was used to create a wood products mix scenario, including different uses of the merchantable harvest extracted from MARS forestlands. The Washington State Department of Natural Resources conducts a biennial census of Washington's primary forest products industry (i.e., timber processors). This census provides details on timber harvest and flow, as well as comprehensive information about the state's timber processing sectors, product volumes, and mill residue.

The results are grouped into five main economic areas. As reported in the DNR's 2016 Washington Mill Survey (Smith and Larson, 2017), an economic area is determined by the similarity of economic activity in the forest products industry. Washington's main economic areas are: Puget Sound, Olympic Peninsula, Lower Columbia, Central Washington and Inland Empire, as reported in Table A.

Table A. Washington's five economic areas and corresponding counties.

Economic area	Counties
Puget Sound	Island, King, Pierce, San Juan, Skagit, Snohomish, Whatcom
Olympic Peninsula	Clallam, Grays Harbor, Jefferson, Kitsap, Lewis, Mason, Pacific, Thurston
Lower Columbia	Clark, Cowlitz, Klickitat, Skamania, Wahkiakum
Central Washington	Chelan, Douglas, Kittitas, Lincoln, Okanogan, Yakima
Inland Empire	Asotin, Columbia, Ferry, Garfield, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman

MARS forestlands falls under Lower Columbia economic area. The analysis presented in this study is limited to the wood provided by Washington forests, which correspond to about 85% of the wood processed by in-state mills or exported from Washington ports. The remaining portion of the logs processed or exported from Washington are supplied by Oregon (8%), British Columbia (5%), and Montana, Alaska and Idaho (2%). This analysis only includes wood coming from privately owned forests, corresponding to 74% of harvest.

Variable	Value (in $ million) or Share (in %)
Value of Commercial Logging sector output	$26 Million (0.5% in the total county output)
Value of Commercial Logging sector exports to other countries	$2.4 Million (9% of the output from this sector)
Value of Commercial Logging sector output sold to other parts of USA	$18.6 Million (73% of the output from this sector)
Value of inputs used by this sector from within the county	$19 Million (73% of all the inputs used by this sector)
Value of inputs bought by this sector from other parts of USA	$4.1 Million (16% of all the inputs used by this sector)

Washington's wood products mix includes lumber, roundwood chipping, pulp and board, veneer and plywood, and other products. While producing lumber, shakes, and plywood, the mills generate a large quantity of mill residues, such as chips, bark, sawdust, and shavings that were also included in the product mix. The residues are sold for pulp, as fuel for boilers and wood pellet manufacturers, as furnish for manufacturing reconstituted boards, and for landscaping, garden mulch, and livestock bedding. The majority of bark residue was used for fuel, and the remainder was used for other purposes. Less than 1% of mill residue generated by Washington mills was reported as not used. Figure B shows the primary wood processing mills by county operated in Lower Columbia in 2016.

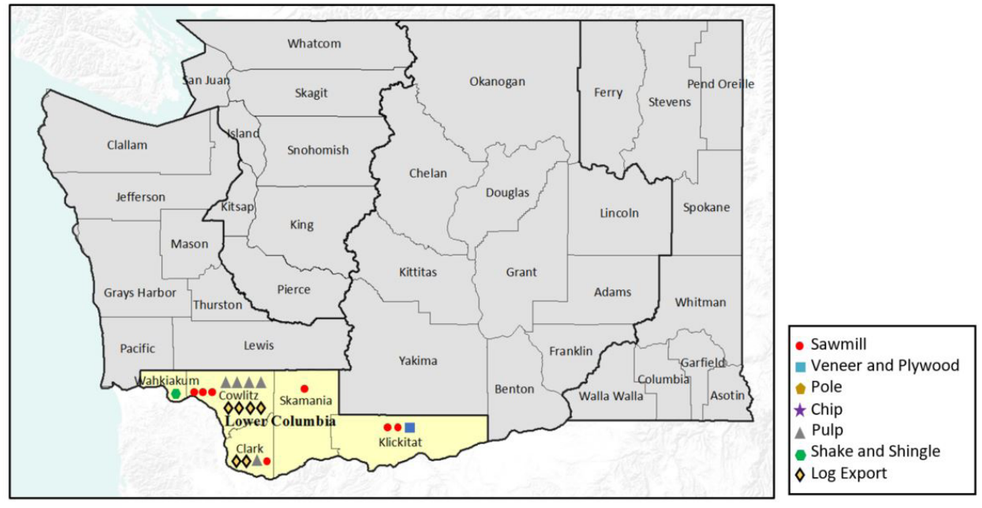


Figure A. Wood processing mills by county in Lower Columbia. Source: "Washington Mill Survey 2016. Series Report #24. Washington State Department of Natural Resources".

The Washington Mill Survey 2016 reports data about all primary log consuming operations: lumber, veneer and plywood, pulp, shake and shingle, log exports, post-pole-piling and chip operations.

To calculate the wood products mix, the primary production data from the "Washington Mill Survey 2016" was used, extracting data for large and small private industry (referred to respectively as "Forest industry" and "Farmer and misc. private"). For the log export, the same products mix was assumed.

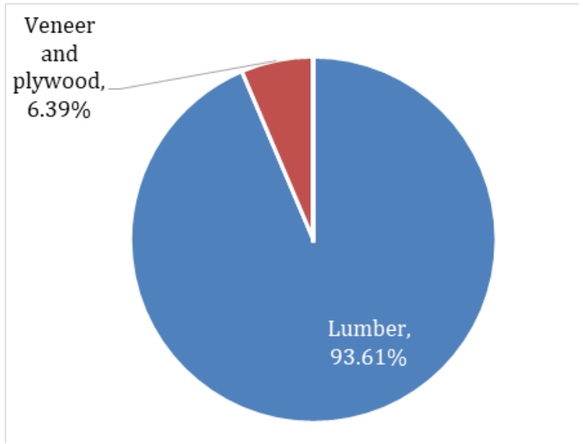


Figure B. Primary production mix from Lower Columbia's private forests in 2016. Source: adapted from "Washington Mill Survey 2016. Series Report #24. Washington State Department of Natural Resources".

About 93.61% of the harvested wood goes to the lumber industry, while 6.39% is goes to the veneer and plywood industry. We combined this data about primary production with data about the production processes in each wood product industry, which includes the inputs and outputs flows of different co-products. The inputs and outputs for the production of different wood products are shown in Table 5.

Of the harvested tree, the stem represents about 67.54%, while residues (tops, branches and foliage) represent about 32.46%. During lumber production, several co-products are produced: lumber (49.80%), chips (24.25%), sawdust (5.57%) hogfuel (13.72%), bark (6.06%) and roundwood, sold off-site (0.60%) (Milota, 2015). The plywood production leads to the production of plywood (78.60%), panel trim (8.97%), sawdust (0.84%) and wood fuel (11.59%). In the paper production, 59.88% of the biomass is converted to paper and the remaining 40.12% is waste.

It was assumed that 50% of the chips produced during lumber production and 50% of the chips produced in chip mills were used for paper production. Adding these contributions to the primary production, the overall paper production from Washington state's private forests resulted 7.73%. The hogfuel and bark produced during lumber production and the wood fuel produced during plywood production were classified as hogfuel and accounted for 10.70%. The waste generated from paper production was assumed to be disposed of in landfill and contributed to 5.18% of the total.

Table B. Inputs and outputs flows for the production of different wood products in Lower Columbia.

Total aboveground 100.00%		**1**			
Stem 67.54%		0.675			Residues 32.46% 0.32461
Lumber 93.61%	0.6322		Roundwood, sold off-site, green 0.60%	0.00379	***Total*** ***100.00%***
			Sawn lumber, softwood, green, rough, at sawmill 49.80%	0.31485	
			Chips, softwood, green, at sawmill 24.25%	0.15334	
			Sawdust, softwood, green, at sawmill 5.57%	0.03519	
			Hogfuel, softwood, green, at sawmill 13.72%	0.08672	
			Bark, softwood, green, at sawmill 6.06%	0.03833	
Plywood 6.39%	0.0432		Plywood, final product 78.60%	0.03392	
			Panel trim, dry 8.97%	0.00387	
			Sawdust, dry 0.84%	0.00036	
			Wood fuel, dry 11.59%	0.005	
Pulp and board 0.00%	0		Paper 59.88%	0	
			Waste 40.12%	0	
Other 0.00%	0				
Total ***100.00%***					

Particle boards were assumed to be produced from 50% of the chips produced during lumber production, 50% of the chips produced in chip mills, and from the sawdust and panel trim. Particle boards and the remaining contributions (i.e. roundwood discarded from lumber production and sold off-site) were classified as "miscellaneous" and contributed to 11.99% of the total.

Table C. Wood products and residues components from Lower Columbia's private forests in 2016.

Total aboveground	**1**		
Stem	67.54%	Residues	32.46%
Lumber	31.48%	Left on forest floor	32.46%
Plywood	3.39%	Slash piles	0.00%
Paper	4.59%		
Hogfuel	13.01%		
Misc.	11.99%		
Waste	3.08%		

A wood products mix was calculated for Lower Columbia. Excluding residues, hogfuel and the wood portion that ends up in landfill. About 61.19% is constituted by lumber, 8.92% paper, 6.59% plywood and the remaining 23.30% is miscellaneous wood products.

The production of these products each of these products then have linkages to other sectors. These linkages result in the indirect and induced economic benefits that can be determined to have come from any given activity.

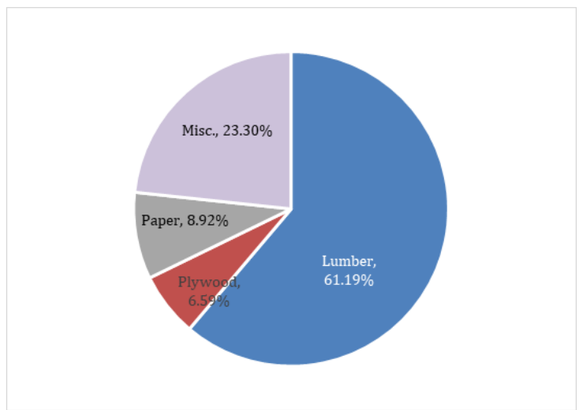


Figure C. Wood products mix from Lower Columbia's private forests in 2016.

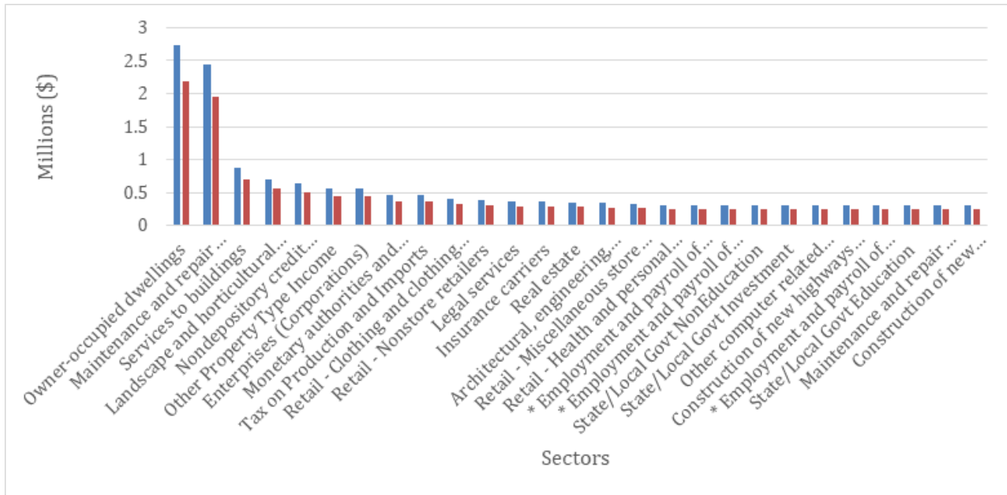
Appendix 3

Scenario Modeling for Avoided Costs Impacts to the Housing Sector

Based upon publicly available countywide parcel data reporting, it is estimated that current land sales in Klickitat County are valued at $1,000-5,000 per acre of land and $70-100/sq. ft. of built area. Therefore, assuming 10,000 acres of neighboring land can be directly impacted by MARS activities, at least $10 million worth of residential acres receive risk reduction from wildfire as a result of MACF activity.

In this scenario, assuming a further .1% of the land area is developed, this corresponds to 435,600 sq. ft., or an approximate value of $40 million. Taken together, existing property values and potential future property value can be estimated to be $50 million at the end of the 10-year period, without considering inflation and real estate value appreciation.

If 5% of this residential development is impacted by wildfire, this corresponds to potential damages of $2.5 million. Using IMPLANS and reported countywide economic data for the housing sector, it's possible to predict that this $2.5 million direct impact will result in negative economic multiplier of 6.16 and a further countywide economic impact of $12.9 million.

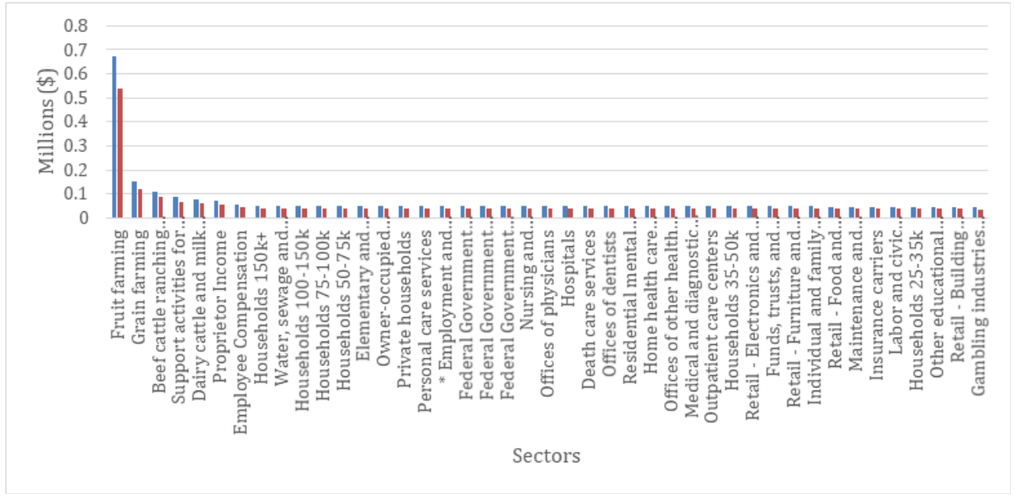


Appendix 4

Scenario Modeling for Avoided Costs Impacts to the Agricultural Sector

Information made available through USDA census provides the average size and value for farms in Klickitat County. In this case, the average farm size for the county is reported as 725-acres and valued at $95,000 (USDA, 2012). Within the 10,000-acres neighboring MACF properties and the Conboy Lake NWR, it is estimated that up to 20 farms would benefit from fuels reduction activities conducted by MARS over the next 10 years.

IMPLANS is used to examine economic factors corresponding with different agricultural products produced in the county (fruits, grains, hay, other crops and livestock), a wildfire corresponding to 5% of the agricultural land area would translate to a negative economic multiplier of 4.47 and the direct loss of $1 million to the agricultural sector as well as $4.47 million to the countywide economy. From this analysis, it's possible to determine that activities undertaken by MARS would result in the avoidance of $1.1 million in losses from the agricultural sector over the next 10-year period.



Appendix 5

Model Used for Accounting Carbon Sinks and Stocks

Of the three harvest configurations originally developed to assess how the total biomass changes under alternative forest management (conservative, midrange and aggressive), the midrange harvest outlook was considered. This scenario assumed 2015 harvest levels of 3 billion board feet (BBF) annually in an expected response to an economic recovery, then fluctuated around a narrow band following projected economic conditions fluctuations. The target level was used to constrain harvest activity up to the targeted volume in a specific area and for a specific ownership. Harvest targets were defined by county and ownership based on published WA DNR harvest reports.

Regimes were developed from three types of treatments: a precommercial thin (PCT), commercial thin (CT), and/or regeneration or final harvest (RH). Within the 20-year planning period, a regime could include no treatments (no action), PCT only, CT only, RH only, PCT and CT, CT and RH, and RH and PCT (more details about the forest operation scenarios can be found in Table 2 of the Washington Forest Biomass Supply Assessment Report). Precommercial thin, commercial thin and final harvest were simulated as described below:

Precommercial Thin: precommercial thins were simulated at age 15 on the Westside and age 20 on the Eastside. All precommercial thins retained the largest 300 trees per acre (TPA) by DBH;

Commercial Thin: commercial thins were simulated at all ages greater than a minimum age. The minimum age was 30 years on the Westside and 50 years on the Eastside. For example, for a 30 year old stand on the Westside, 5 CT only simulations were developed: CT in 2010, CT in 2015, CT in 2020, CT in 2025, and CT in 2030. All thinnings were implemented from below by diameter limit. Two intensities of CT's were simulated. On the Westside, a light CT retained the largest 250 trees per acre, while a heavy CT retained the largest 150 trees per acre. On the Eastside, one CT simulation removed all trees smaller than 12" DBH (standard forest health treatment), while another harvested down to 45 square feet of residual basal area. In most stands, removing all trees below 12" DBH was a lighter thinning;

Final Harvest: Like CT, final harvests were simulated at all ages greater than a minimum age. The minimum age depended on the half-state, forest type and ownership class. For CT and RH regimes, RH was scheduled at least 30 years after CT on the Westside. Final harvest intensities varied by forest type, ownership class and management zone. All treatments were simulated as cutting from below by diameter limit. Treatments were modeled to meet existing Washington state forest practices regulations. For example, uplands were harvested to 5 trees per acre in all cases. Inner riparian buffers were harvested to 100 trees per acre on the Eastside and 58 trees per acre on the Westside. Outer riparian buffers were

harvested to 10 trees per acre in all Westside cases and Ponderosa pine forests on the Eastside. All other Eastside outer buffers were harvested to 20 trees per acre. Wetland buffers were harvested to 75 trees per acre in all cases.

The model used inventory plot data for Washington State, growth and yield models that used the plot data, forest operation configurations and biomass equations. The forest inventory data developed by the Landscape Ecology, Modeling, Mapping and Analysis (LEMMA) group located at Oregon State University had been originally used for the Washington Forest Biomass Supply Assessment to develop inventory profiles for Washington using the Gradient Nearest Neighbor (GNN) method.

The inventory for Washington produced 6,085 unique forest class plots (FCID), of which 5,998 forested. Forested plots were simulated using the appropriate Forest Vegetation Simulator (FVS) variant, including a total of six variants to capture the variation in growth and yield in the state. All owner information and parcel geometry for the Biomass Database was derived from the 2009 Washington State Parcel Database (Rural Technology Initiative, 2016).

The model produced results stratified by land ownership categories, forest ecosystem types, species and location (parcel level). From the total database, the results for private forests (large and small) were extracted.