FOREST RESOURCE ASSESSMENT

Western Oregon State Forests

Abstract

This report provides essential information for understanding the extent of western Oregon state forest resources, their condition, management and uses.

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Greatest Permanent Value

The Board of Forestry (BOF) owns and manages 613,500 acres of state forestland in Western Oregon to create healthy, productive forest ecosystems that provide benefits such as a reliable source of timber, economic benefits to rural communities and schools, clean air and water, high quality habitat for native fish and wildlife, and a diversity of educational and recreational opportunities for the people of Oregon. This mission, described as Greatest Permanent Value (GPV), is codified in Oregon Administrative Rule (OAR).

The Greatest Permanent Value Rule (OAR 629-035-0020) provides a management focus for the State Forester to maintain Board of Forestry lands as forest lands and actively manage them in a sound environmental manner to provide sustainable timber harvest and revenues to the state, counties, and local taxing districts. This management focus is not exclusive of other forest resources, but must be pursued within a broader management context that:

- Results in a high probability of maintaining and restoring properly functioning aquatic habitats for salmonids, and other native fish and aquatic life
- Protects, maintains, and enhances native wildlife habitats
- Protects soil, air, and water
- Provides outdoor recreation opportunities

The Greatest Permanent Value Rule also requires that management practices must:

- Pursue compatibility of forest uses over time
- Integrate and achieve a variety of forest resource management goals
- Achieve, over time, site-specific goals for forest resources, using the process as set forth in OAR 629-035-0030 through 629-035-0070
- Consider the landscape context
- Be based on the best science available
- Incorporate an adaptive management approach that applies new management practices and techniques as new scientific information and results of monitoring become available

This document provides a brief overview of how the lands in western Oregon came into BOF ownership. The resource assessment provides a snap shot of current forest characteristics and resource conditions.

The Origin and Development of State Forests

Prior to BOF ownership, most of these state forest lands had been owned and managed by private landowners. Most of the lands deeded to the state had been burned (and possibly re-burned), cutover, salvage-logged, and roaded without contemporary best management practices. These tax-delinquent and abandoned lands reverted to county ownership as the private landowners lacked the resources or incentives to reforest and restore the lands.

Table H-1. Acquisition, management and fire history of Board of Forestry lands.

District	Acres Owned by BOF	History	Acquisition
Astoria (Clatsop State Forest)	134,837	1910 and 1940: privately owned, logged	1936 – 1964: Clatsop County deeded lands to the BOF
Forest Grove and Tillamook (Tillamook State Forest)	359,817	1933, 1939, 1945, and 1951: burned, salvage logged, extensively roaded 1948: State bond issued to fund unprecedented massive reforestation that continued on through 1970s	1942 – 1973: Columbia County deeded lands to the BOF 1939 – 1964: Washington County deeded lands to the BOF 1940s - 1970: Tillamook County deeded lands to the BOF
North Cascade (Santiam State Forest)	46,586	1880 through 1930s: Logged and fires had burned large areas	1939 - 1953: Linn, Marion, and Clackamas Counties deeded lands to the BOF
West Oregon	29,903	Great Depression	1938 – 1948: Benton, Lincoln, and Polk Counties deeded lands to the BOF
Western Lane	24,324	1910, 1917, 1922, 1929: large fires and salvage logging	1940s - 1950s: Lane County deeded lands to the BOF
Western Lane District: Coos Unit	8,898	1868: Burnt and largely cut over	1930s - 1940s: Douglas and Coos Counties deeded lands to BOF
Southwest Oregon	9,350	Historic fire ecology: low intensity high frequency burns. Effective fire suppression shifted fire behavior resulting in today's high intensity burns	1930s - 1940s: Josephine and Douglas Counties deeded lands to BOF

Beginning in 1925 a series of laws (known as the Forest Acquisition Act) was passed as the state sought to ensure the lands would be managed by responsible stewards, who would undertake the restoration and reforestation of the lands. It was also to ensure these lands remain as forest lands, to be managed over the long-term for forest crops, recreation, watershed protection, and erosion control, among other uses. In the 1940s, this multiple use management mandate "to secure the greatest permanent value of these lands to the state" was codified in Oregon law. Over time other property was acquired through land exchanges, direct donations, or purchases that consolidated ownership (Table H-1).

Tillamook State Forest

The fire and reforestation history of the Tillamook State Forest provides a particularly good example of how fire shaped the forests being managed today. Much of the area that is now Tillamook State Forest burned in a series of wildfires. The first and biggest Tillamook Fire burned 240 thousand acres of mostly old growth forest in August 1933. In what seemed to be a six-year jinx, new fires burned across the area in 1939, 1945, and 1951. Some areas reburned two or three times. By the end of 1945, a total of 355 thousand acres had been burned over and 13.1 billion board feet of timber destroyed. Salvage logging had started after the 1933 fire and accelerated to meet the lumber demands of World War II. By 1948, four billion board feet of dead timber had been recovered from the burn. An additional 3.5 billion board feet of timber was removed from 1949-1955.

After the burned timber had been salvaged, all that remained in the so-called Tillamook Burn was a heavily roaded landscape of steep slopes covered with snags and brush. In several places the soil had been so severely burned that nothing grew there for many years. Streams and fisheries were severely affected by the loss of forest cover and erosion after the fires.

Before 1933, almost all of the land that became the Tillamook Burn was privately owned. After the fires, many landowners stopped paying taxes and the properties were foreclosed and transferred to the counties. The counties began to deed these burnt-over, salvage-logged, low-value lands to the BOF in 1940 and about 255 thousand acres eventually came under state ownership.

In 1948, Oregonians approved issuance of a bond to finance rehabilitation of the Tillamook Burn. The Oregon Department of Forestry carried out a massive rehabilitation project from 1948 to 1973. Over the next 24 years, unprecedented forest restoration efforts were put into action. Tree-planting crews planted 72 million Douglas-fir seedlings. A total of 36 tons of Douglas-fir seeds were spread on the burn through aerial seeding, pioneering the first use of helicopters in aerial seeding.

In June 1973, the former Tillamook Burn was dedicated as the new Tillamook State Forest. The 364 thousand acre forest includes 255 thousand acres from the Tillamook Burn and other unburned forest land (Oregon Department of Forestry 1993b).

In recent years, Swiss needle cast, a native fungal disease, has increasingly affected Douglas-fir stands near the coast. The reasons for this are not fully known. It may be connected to the widespread reforestation of the burn with Douglas-fir from other areas, which introduced trees poorly adapted to coastal conditions. This has stagnated tree growth across the landscape, decreasing timber and wildlife value.

As a result of the Tillamook Burn, red alder rapidly colonized vast areas of the forest. Currently, approximately 65 thousand acres are dominated by red alder and approximately 50 thousand acres past the age of 50, rapidly approaching the age in which the species begins to suffer crown loss and eventual mortality. These acres are more than all other hardwood dominated stands in the plan area, and will present unique management challenges in the future.

Social Resources

Recreation, Education, and Interpretation

Description and Assessment

Demand for outdoor recreation, forest education, and interpretive opportunities in Oregon is increasing, and growing fastest near population centers such as the Portland metropolitan area and southwest Washington. Popularity of specific recreation activities changes over time, reflecting changes in user demographics, technology, the economy and outdoor recreation trends.

Recreation, Education, and Interpretation (REI) are fundamental components of the legal mandates established in the Greatest Permanent Value Rule. State forest lands comprise a significant percentage of public forest lands in northwest Oregon. In several counties, they are the largest ownership open to the public for recreational use. Most of these lands lie less than a two-hour drive from a major urban area and much of it is located close to other recreation attractions such as coastal beaches or the Cascade Mountains. These state forests have a positive impact to local economies and provide diverse recreational, educational and interpretive opportunities to local residents, visitors from nearby cities, and out-of-state travelers.

In support of REI in the Tillamook State Forest, in 1991 the Oregon Legislature passed House Bill 2501. This called on the Oregon Parks and Recreation Department and the Oregon Department of Forestry to prepare a comprehensive recreation plan for the Tillamook State Forest, to interpret the forest's history, and to provide for diverse outdoor recreation on the forest. The bill required that the plan be consistent with the primary purpose of timber production and of state forests as described in ORS 530.050. The Tillamook State Forest Comprehensive Recreation Management Plan was published in January 1993 and provides direction for recreation management on the Tillamook State Forest (Oregon Department of Forestry and Oregon Department of Parks and Recreation, 1993).

The Tillamook State Forest Interpretive Master Plan was finalized and published in March 1995. Beginning in 1996, the Tillamook State Forest Interpretive Program began implementation of the plan. In 1998, the Education and Interpretation Program began establishing a network of opportunities across the forest to encourage learning about the forest's history and current management. The hub of this network includes a staffed visitor and interpretive center located on the Wilson River Highway between Forest Grove and Tillamook. A ten-year friend and fundraising effort resulted in the award-winning Tillamook Forest Center opening in 2006.

Oregon state forests offer an opportunity to link the public to natural resource management through educational and interpretive programs and involvement of user or community groups in volunteer projects. There is a widening gap between the contact people have with natural resources and their everyday use of commodity products derived from forests. The goal of education, interpretation, and public involvement is to close the gap and improve people's

understanding of resource issues by cultivating an awareness of how state forest management works to balance a variety of resource demands.

As participation in outdoor recreation continues to grow, the positive economic impacts at the local and national level are becoming more evident. The Outdoor Industry Association reports that outdoor recreation's contributions are now being counted as part of the United States gross domestic product. On a local level, the communities adjacent to state forestland are benefitting from the increased demand for products and services visitors need. The local communities support visitors passing through and provide additional services when forest recreation facilities are at capacity.

Current Condition

State forest recreation facilities tend to fall into either semi-primitive motorized, semi-primitive non-motorized, or roaded natural settings, with most falling into the roaded natural category (Table R-1). The largest concentration and heaviest use of recreation facilities occurs in the Astoria, Forest Grove, and Tillamook Districts, with more limited, less dense, and quieter opportunities available in the remaining districts. Although there is a recognition that recreation is occurring across all state forest land. Maintaining investments in infrastructure and opportunities for recreationists add to the net asset value of the forest, such as the development and maintenance of interpretive centers, campgrounds, trails, trailheads, and other facilities.

Motorized (Off-Highway Vehicle) Use

The Tillamook and Clatsop State Forests fill an important recreation niche by offering large areas open to off-highway vehicle (OHV) use in a region where these are otherwise lacking. This is either through trails or gravel roads. OHV use is heaviest in the Tillamook State Forest, but lower levels of use occur throughout the region, such as in the Santiam State Forest and the West Oregon District. Most OHV use occurs in cooler weather, especially spring and fall. Summer use is less popular because of the dusty conditions and the availability of other riding areas that are open seasonally in the Cascades and eastern part of the state. It may also be curtailed due to Regulated Use restrictions during fire season.

Zoning has introduced designated OHV areas on state forestland based on historical use patterns and resource considerations. There are 461 miles of designated trails for motorcycles, quads, side-by-sides, and 4 wheel-drive vehicles on state forest land. Even in areas not specifically designated as OHV zones, forest road driving is a popular form of recreation. The OHV community is actively engaged in helping to manage and maintain the OHV trail system by informing and educating their peers and promoting positive trail use. There are several OHV staging and camping areas which allow OHV users to congregate.

Table R-1. Recreation opportunity spectrum setting definitions.

Recreation Opportunity Spectrum Setting Definitions	
The U.S. Forest Service developed the Recreation Opportunity Spectrum (ROS) to use in recreation planning. It is now widely used by other land management agencies. ROS provides a framework for understanding and defining various settings of recreation environments, activities, and experiences. State forest facilities generally fall into one of the setting definitions given below.	
Setting	**Definition**
Semi-primitive motorized	The area is generally 2,500 acres to 5 thousand acres in size, and 1/2 mile from Level 3 or better roads. There is strong evidence of roads and motorized use of roads and trails. The natural setting may have moderately dominant alterations, but would not draw the attention of motorized observers. Structures are rare and isolated. The social setting provides for a low to moderate contact with other parties. On-site controls are present, but subtle. Interpretation is through very limited on-site facilities along with the use of guide maps, brochures and guide books.
Semi-primitive non-motorized	The area is 1/2 mile from all roads or trails with motorized use and generally exceeds 5 thousand acres in size. The area can include primitive roads and trails if they are usually closed to motorized use. The natural setting may have subtle modifications that would be noticed but would not draw the attention of an observer in the area. Structures are rare and isolated. The social setting provides for 6 to 15 parties encountered per day on trails and 6 or less parties visible at campsites. On-site controls are present but subtle. Interpretation is through self-discovery with some use of maps, brochures and guide books.
Roaded-natural	The area is 1/2 mile or less from roads and trails open to motorized use. Resource modifications and utilization practices are evident but are harmonious with the natural environment. The social setting provides for moderate to high frequency of contact on roads and low to moderate frequency on trails away from roads. On-site use controls are noticeable, but are harmonious with the natural environment.

Non-Motorized Use

Non-motorized trail activities such as hiking, horse riding, and free-ride and cross-country mountain biking are growing in popularity. There is also increasing demand for overnight backpacking opportunities. However, there is not well-developed infrastructure to support this activity. There are currently about 143.5 miles of multi-use non-motorized trails in the planning area, as well as developed trailheads and equestrian staging facilities. Two free-ride mountain bike areas are very popular with a segment of the mountain bike community. An interagency group, the Salmonberry Trail Intergovernmental Agency, has formed to convert a rail-banked railroad line into a recreation trail from Banks through the Salmonberry River corridor and ending at the Oregon Coast. The trail crosses multiple ownerships. This is a long-term project, the success of which relies on public-private partnerships and interagency involvement.

Camping

There are 22 developed campgrounds and designated campsite fee areas for overnight stays in state forests. Campsites are available on a first-come-first-served basis with the exception of three group sites in the Tillamook State Forest and all of the campsites in Northrup Creek Horse Camp in the Clatsop State Forest. Camping facilities fall into the roaded-natural setting, with low density and limited, rustic amenities. Dispersed free camping takes place throughout the forest, with several dispersed camping areas receiving concentrated use. Camping activities are most popular during late-spring to early fall and many developed facilities are only open seasonally. Some developed campgrounds and designated campsites include facilities specifically designed and designated for OHV and equestrian use.

Day-Use Activities

The forests are popular destinations for day-use activities, particularly in the summer. This includes swimming, sun-bathing, barbecuing, and picnicking. Day-use facilities provide parking, toilets, and, in some cases, picnic tables and cooking grills. These facilities are generally rustic, and most coincide with major recreation attractions, such as rivers. There is one designed day-use building in Tillamook State Forest, Smith Homestead, available by reservation for functions and events through the Tillamook Forest Center. In total, there are 30 developed facilities on state forest lands for day-use activities. These facilities include trailheads, day-use areas, target shooting sites and a demonstration forest.

Aquatic Activities

Forest rivers are a destination for people fishing for trout, salmon, and steelhead. The agency also manages several primitive drift boat launches. Some boat launches are managed in partnership with Oregon Department of Fish and Wildlife. The most popular fishing seasons are the fall chinook, winter steelhead, and spring cutthroat trout seasons.

During the summer months, rafting, swimming, and water play are popular. There is increasing dispersed day use along rivers located adjacent to highway corridors. Whitewater river recreation is a small but growing use in the forests, with the most popular season during high water in winter and spring. Lakes in Santiam and Clatsop State Forests also provide opportunities for swimming, angling and non-motorized boating.

Hunting

Hunting may be the longest-standing recreation activity in state forests, particularly with local users. Hunting is most popular in the fall deer and elk seasons, beginning with the opening of bow season in late August and extending through the end of November. More limited hunting occurs throughout the year. This activity occurs across the landscape, but is concentrated near timber harvest and big game forage areas. The Oregon Department of Forestry (ODF) works with Oregon Department of Fish and Wildlife and hunting organizations to better manage hunting access through the use of Travel Management Areas and selected road closures. This

provides walk-in hunting experience and improves bull and buck escapement by reducing harassment from road hunting.

Target Shooting

Target shooting occurs year-round throughout the forests, most often in rock quarries, borrow pits, log landings, road cuts, and dispersed campsites. It is growing in popularity in those districts closer to the Willamette Valley and Portland metropolitan areas. It has been a mostly informal activity. Although, as the user level increases in some districts, efforts are underway to monitor and manage for public safety, fire risk, and user conflicts. These efforts include the development of the North Fork Wolf Creek Road Target Shooting Lanes in the Forest Grove District of the Tillamook State Forest.

Interpretive and Educational Programs

ODF has been supporting interpretive and education programs since the mid-1990s. The department's interpretation flagship, Tillamook Forest Center, was constructed in the Tillamook State Forest in 2006. It is a popular stopping off point between the valley and the coast on Highway 6 and is one of the region's largest forest-based learning centers. The center provides a variety of interpretation and education opportunities, including interpretive displays, a movie theater showing an award-winning film about the Tillamook Burn, ADA-accessible trails, seasonal presentations, rotating exhibits, education programs for school groups, and facility rentals for functions and events. Other interpretive offerings on state forest lands include wayside signs and markers, self-guided nature trails, and educational brochures available at district offices.

District Information and Challenges

North Coast

The Tillamook, Forest Grove and Astoria Districts contain the largest number of developed recreation facilities and trails. Due to the proximity of the Portland metropolitan area, the state forests are becoming urban forests serving the recreation needs of a rapidly expanding populous. Recreation use in the forest is year-round with the heaviest use being in the summer months along the highway corridors. The forests see diverse groups of users in a variety of sizes and types. Camping remains a popular activity with users transitioning from tents to trailers and motorhomes. Day-use and river activity surges in the summer creating challenges for parking, fire risk, and sanitation. OHV activity is the primary trail use activity, but hiking, mountain biking and backpacking continue to increase.

With high use and proximity to the urban areas, social issues from the city are migrating to the forest. Vehicle break-ins, incidents of fee theft, user conflicts, car accidents, injuries, illegal dumping and the number of non-recreational campers (people experiencing homelessness) are all increasing and straining the already limited staff and emergency service resources. Use levels are far exceeding facility and resource capacity in both developed facilities and dispersed areas.

Funding and program staff capacity has not kept pace with the increase in use, recreation trends, or operations and maintenance needs.

Tillamook Forest Center

The Tillamook Forest Center (TFC) is the visitor center for the Oregon Department of Forestry. It is an important public face of the agency, providing education and interpretive programs to help ensure ongoing public support to actively manage state forests. With increasing use in all aspects of outdoor recreation, the TFC is experiencing a growing demand for their services and programs. Use levels at the TFC, Smith Homestead Day-Use Area and the surrounding trails and public areas are ever increasing (up 40% in July 2018, as compared to July 2017). The TFC staff is challenged to meet the demand for school programs, visitor services, maintenance, and volunteer recruitment and support, while also striving to provide education and interpretation for a wide range of forest visitors. The newly constructed Forest Education Pavilion will provide additional space for programs, facility rentals, and exhibits. Additional staff and budget dollars will be needed to support and maintain this new facility. Currently the TFC is only open five days per week for nine months out of the year due to budget cutbacks. Prior to 2017, the TFC was open seven days per week in June, July and August. Funding and staffing will continue to be challenges as forest-wide use levels and the interest in the outdoors continue to rise.

Santiam State Forest

The Santiam State Forest provides opportunities for a variety of outdoor recreation. Developed recreation includes campground and motorized and non-motorized trails. The recreational use in the Santiam continues to increase as nearby populous areas grow. The District is also experiencing an increase in long-term camps and target shooting conflicts around nearby homes. Additionally, OHV use is increasing, but with limited developed trails, the users are creating their own. The Santiam State Forest is challenged with mitigating user conflicts with limited recreation staff and budget dollars.

West Oregon District

The West Oregon District has two developed recreation areas: Black Rock and Mt. Baber. Black Rock Free Riders started developing a trail system in the 1990s. The Black Rock Mountain Bike Association was organized in the mid-2000s and an adopt-a-trail agreement was developed with ODF. Use is active with daily riders, monthly trail maintenance work parties and two to four organized events per year. The Mt. Baber ATV Club adopt-a-trail agreement went into effect in the 2000s although riding in the area began in the 1960s. The majority of the trails are on private ownership. The area is used primarily on the weekends and once a month for organized events held outside of the marbled murrelet nesting season due to adjacency with trails. Challenges for these areas include conflicts with adjacent private landowners and competing uses.

Remaining Districts

Western Lane, Coos, and Southwest offer limited recreation opportunities. Ownership is mixed with private industrial and federal forests with few continuous blocks of ownership, limiting access to state lands.

Cultural Resources

Description and Assessment

Cultural resources are defined as archaeological and historical in nature. They may include objects, structures, buildings, districts, or sites used by people in the past and are valued for many reasons. Archaeological sites provide important information about past cultures. Many sites also have religious, historic, or associational values for American Indian communities. Historic sites have important interpretive, recreational, and heritage values, which are lost when artifacts and information are removed or destroyed. These resources are fragile and irreplaceable, especially objects still in their original locations. These undisturbed objects are vital in telling of the culture that created them, how long ago they were made, and what the landscape was like at the time. Cultural resources provide a meaningful record of past cultures, events, and ecological conditions in Oregon.

The northwest Oregon state forests have not been fully surveyed for cultural resources. However, the work done so far has identified potential Native American sites and over 400 European-American sites.

All sales are prescreened with the help of an Oregon Department of Transportation archaeologist. This review ensures that the departments preserves and protects archaeological sites or archaeological objects in accordance with state law (ORS 97.740 to 97.760; 358.905 to 358.955; and 390.235) and to conserve historic artifacts and real property of historic significance in accordance with state law, in consultation with the Secretary of State and the State Historic Preservation Office (ORS 358.640 and 358.653). The division will also make a reasonable effort to cooperate with tribes in the development and implementation of programs that might affect tribes in accordance with state law (ORS 182.164).

Scenic Resources

Description and Assessment

The 2013-2017 Statewide Comprehensive Outdoor Recreation Plan found that sightseeing and driving for pleasure was the third most popular outdoor activity overall in Oregon, with 58% of Oregonians participating in that activity (Oregon Department of Parks and Recreation 2012). Like many states, Oregon's population is aging (the growth rate of residents 65 or older exceeds the overall population growth rate) and, because of this, sightseeing is becoming more important as it is one of the most common activities of residents aged 42-80.

Northwest Oregon state forests are located near the state's major cities and are crossed by several major highways. Thousands of people travel these highways on their way to the Oregon coast or to the Cascades and central Oregon. State forest lands are a major part of the view along some stretches of Highways 6 and 26 in the Coast Range. Additionally, there are the river corridors and areas around campgrounds. Sightseeing is popular in state forests, consistent with the statewide trend. Scenic value also plays a major part in the quality of experience in other outdoor activities such as camping and fishing.

In many places, state forest lands blend with the general forest landscape and are not generally recognized as state lands by sightseers. The Clatsop and Tillamook State Forests, being the largest consolidated blocks of state forest land, are the state lands most likely to dominate viewsheds and to be recognized as state forests by the public as they drive through the area.

Current Condition

Along major highways, the immediate visual foreground is protected either by scenic buffers owned by the Department of Transportation or by statute. The following highways in northwest Oregon are designated as scenic for the purpose of visual corridor management (ORS 527.755) and are adjacent to state forest lands in the districts indicated.

- Highway 6 — Forest Grove and Tillamook Districts
- Highway 20 — West Oregon District
- Highway 22 — North Cascade District
- Highway 26 — Forest Grove and Astoria Districts
- Highway 30 — Astoria District
- Highway 36 —Western Lane District
- Highway 101 — Tillamook and Astoria Districts
- Highway 126 — Western Lane District

Areas with visual sensitivity are categorized as having high, moderate, low or no visual. The visually sensitive corridor is defined as the area within 150 feet (measured on the slope) of the outermost edge of the roadway along both sides of the highway. Examples of lands with visual sensitivity include: lands with established, high public use vistas, viewpoints, or significant natural features; lands immediately adjacent to campgrounds; and lands highly visible from urban centers. Special rules apply to timber harvest in this corridor. Goals for retaining scenic buffers are balanced with goals for maintaining motorist safety.

State Scenic Waterways Program

The only state scenic waterway located on state forest lands in the planning area is the Nestucca River Scenic Waterway in Forest Grove and Tillamook Districts. Administrative rules for the Nestucca Scenic Waterway are found in OAR 736-040-0041. State forest lands are within the

scenic waterway segment that extends from the river's confluence with Ginger Creek (approximately river mile 45.5) downstream to the lower end of Alder Glen Campground. Rules for this segment state that timber harvest will be permitted by the Department of Parks and Recreation only when it is substantially screened from view from the river by topography or existing vegetation. Projects may be permitted if vegetation is established that will substantially screen the project in a reasonable time, such as four to five years. Developments necessary for public outdoor recreation and resource protection or enhancement may be visible from the river, but must blend into the natural scene.

Economic Resources

Forest Condition

Description and Assessment

Based on the Oregon Department of Forestry's most recent forest inventory estimates, the total standing volume throughout the assessment area is approximately 17 billion merchantable board feet[1]. Much of that volume is currently inaccessible to timber harvest due to a variety of factors including: physical limitations related to logging systems and road building; regulatory protections stemming from the Oregon Forest Practices Act and the Federal Endangered Species Act; and internal State Forest Division policies. Accounting for all of these factors approximately 8 billion board feet remain without any specific harvest constraints. The average forested stand in the assessment area currently has a standing volume of roughly 27,400 board feet to the acre. However, that per-acre volume varies considerably from stand to stand.

As a result of their history of large fires, extensive logging, and intensive forest management, the current age distribution of Oregon state forests lands is not uniform (Figure FC-1). Stand age has a major influence on current forest condition and this non-uniform age distribution has significant implications related to forest management planning. Forest stands in the 50 to 79 year-old range are the most abundant across the assessment area and account for half of the total acreage and more than 60% of the standing volume. These acres coincide with periods of aggressive salvage logging and subsequent reforestation efforts that occurred after the Tillamook Burn. However, stand age is not the only factor that influences a stand's current condition. Site productivity, past management practices, and disturbance and disease history have all contributed to produce the forests that the Oregon Department of Forestry manages today.

Grouping stands into forest types based on species composition is a useful practice that facilitates the observation of natural patterns that are exhibited across a complex landscape. These forest types provide information about a stand's potential future condition. Then stand age and management history can reveal where a stand lies on its developmental curve. Douglas-fir (*Pseudotsuga menziesii*) is the predominate species throughout the planning area accounting for more than two-thirds of the standing volume. However, a variety of other conifer and hardwood species are also prevalent in Oregon state forests. Overall, less than half of the total state forests acreage fits the definition of a single-species Douglas-fir dominant stand (Figure FC-2).

[1] as measured in net Scribner volume using 40 feet log lengths

Figure FC-1. State Forests Age Distribution.

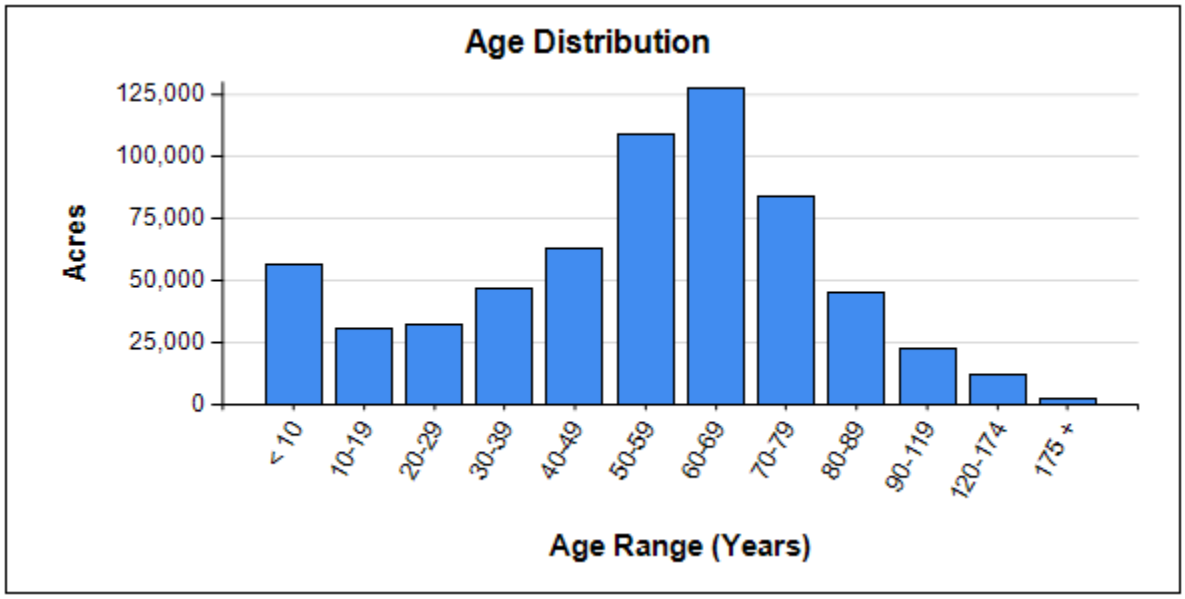
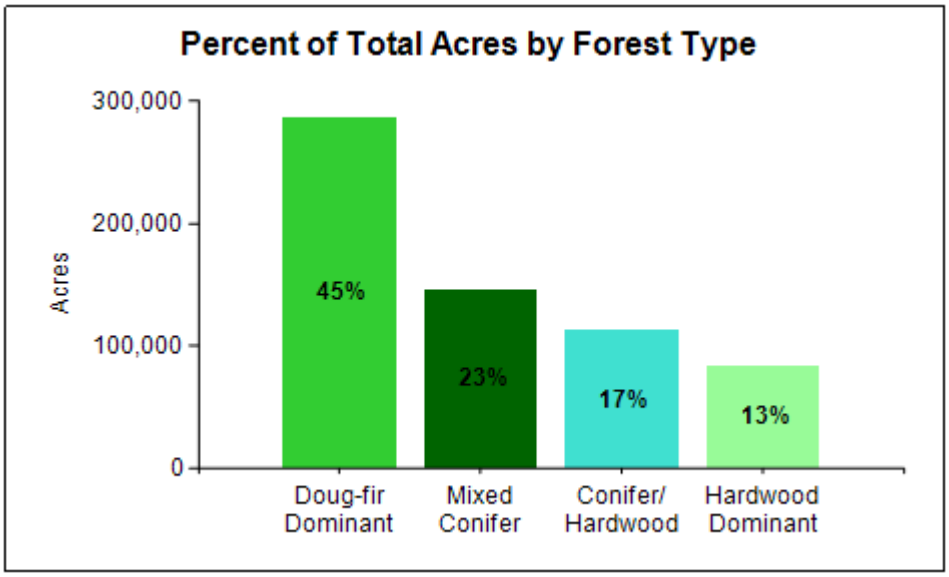


Figure FC-2. Forest Types in State Forests.



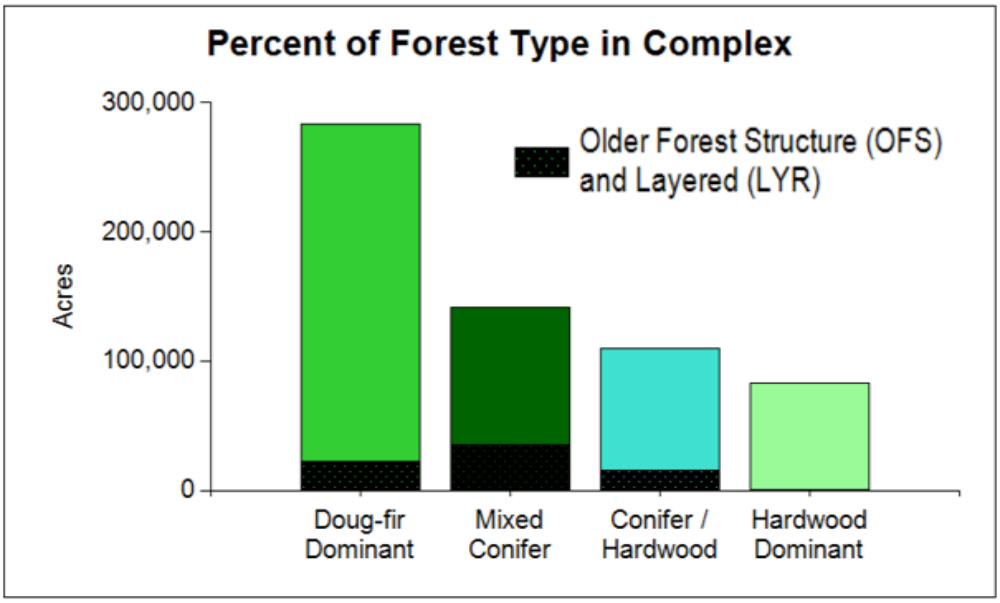
On Oregon state forests, mixed conifer stands typically include some combination of western hemlock (*Tsuga heterophylla*), Douglas-fir, western redcedar (*Thuja plicata*), Sitka spruce (*Picea sitchensis*), and noble fir (*Abies procera*). Hardwood dominant stands are usually dominated by either red alder (*Alnus rubra)* or bigleaf maple (*Acer macrophyllum*). Conifer-hardwood mix stands are most commonly Douglas-fir or western hemlock mixing with red alder. In general, each of these forest types will present distinct silvicultural challenges, offer differing economic

opportunities, and provide unique habitat potential. These differences are particularly relevant to Oregon state forests when analyzed from the perspectives of habitat development and timber production.

These four different forest types vary from one another with respect to their potential for wildlife habitat development. Complex forest habitat conditions uniquely benefit many native wildlife species. Complex habitat for native wildlife is provided in forest stands with a diversity of tree species; an understory of trees, shrubs, and herbs; and ample amounts of snags and downed wood.

The mixed conifer forest type represents just a quarter of the total land-base, yet it provides half of the total acres that currently provide complex habitat (Figure FC-3). Overall, roughly 25% of the mixed conifer acres currently have complex habitat as compared to the less than 10% of the Douglas-fir dominant acres. By definition, mixed conifer stands tend to be multispecies stands that are more prone to developing layered canopies. For similar reasons, the conifer/hardwood mix forest type also contributes disproportionately to the total acres with complex habitat conditions.

Figure FC-3. State Forests Forest Type Distribution.



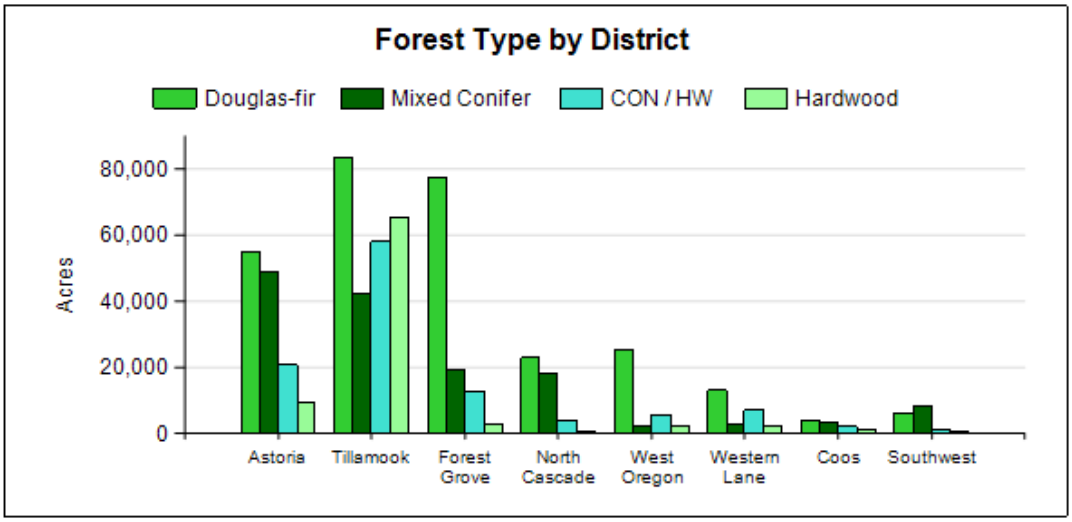
These four different forest types also vary with respect to their potential for timber production. Characterizing the forest condition in the context of timber production, net Scribner board volume per acre was analyzed for forested stands in the 50 to 80 year-old age range. For three of the four forests types, Douglas-fir dominant, mixed conifer, and conifer-hardwood mix, the median Oregon state forests stand hovers around 30 thousand board feet to the acre. However, there is a wide range of variability among stands. For both the Douglas-fir dominant and mixed conifer forest types, 90% of stands have between about 10 thousand and 60 thousand board feet to the acre. These two

conifer types have the greatest potential for timber production, with stands regularly producing upwards of 40 thousand board feet to the acre.

Access issues aside, Douglas-fir dominant stands produce the highest value timber sales: single bid species; high stumpage; relatively straightforward silviculture; and plenty of volume. Mixed conifer forest types have less Douglas-fir volume, typically produce timber sales with multiple bid species, lower bid prices, and more complicated silviculture.

Due to a variety of geographic and historic factors, these four forest types are not distributed evenly across the landscape (Figure FC-4). District coverage by the Douglas-fir dominant forest type ranges from one-third of the total acreage in the Tillamook District to two-thirds of the total acreage in the Forest Grove and West Oregon Districts. The mixed conifer forest type is common on the Astoria, North Cascade, and Southwest Oregon Districts, but the species mixes tend to be different in each of those districts. The conifer-hardwood mix forest type is common in the Tillamook and Western Lane Districts, but once again the species mixes are not necessarily the same. The hardwood dominant forest type is most common in the Tillamook District, which contains three times as many hardwood dominant acres as all other districts combined.

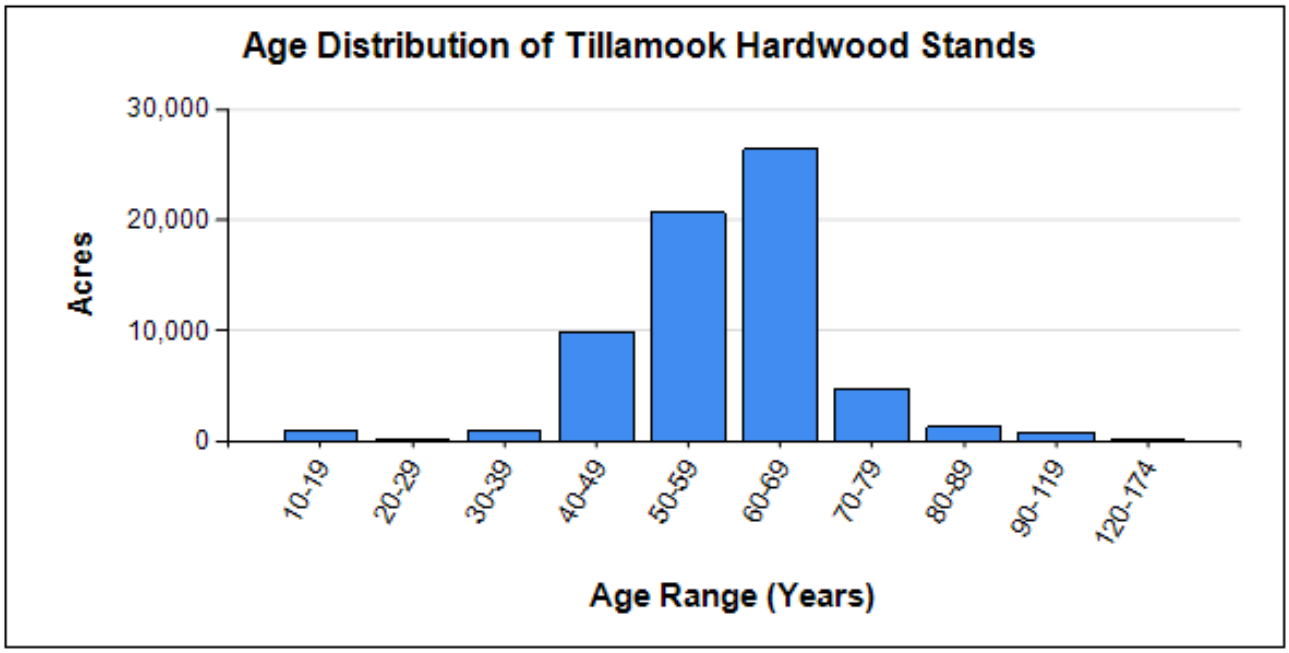
Figure FC-4. State Forests Forest Type Distribution



The age distribution of the hardwood dominant stands on the Tillamook District is revealing (Figure FC-5). Forest management since the Tillamook Burn has focused heavily on conifer stands, largely avoiding active management in these hardwood stands. This has yielded a pronounced age distribution amongst Tillamook's hardwood stands. This, in turn, is further complicated by the expected life cycle of red alder, which starts to decline around 60 to 80 years and rarely lives past 100. More than a quarter of the Tillamook District is comprised of hardwood dominant stands, made up mainly of red alder, mostly within the perimeter of the

historic Tillamook Burn. While many of those trees are healthy right now, most of the 65 thousand acres are at an age where crown dieback will soon start to outpace new growth. Projecting that age distribution forward 20 years without active management could produce a scenario with the Tillamook District experiencing large numbers of dead trees on the landscape.

Figure FC-5. Age Distribution of Tillamook Hardwood Stands



Timber Production

Description and Assessment

Timber Harvest

State Forests is required by the Greatest Permanent Value Rule to ensure a reliable and sustainable flow of timber while maintaining and conserving wildlife habitat and providing social benefits to the people of Oregon. The division is guided by the Forest Management Plan (FMP) in addition to other state and federal regulations, including the Forest Practices Act and the Endangered Species Act. State rules and internal policy also provide guidance for contracting and administrating timber sales on state forest lands.

Timber harvest revenues are split between State Forests and local governments, which include counties and local taxing districts. The majority of harvest revenues (63.75%) are distributed to local counties and taxing districts (Figure T-1). This revenue eventually makes its way to local community services, including education, law enforcement, and community health. Revenue from State Forests' timber harvest is a significant contributor to local budgets and is magnified for counties and taxing districts located in the North Coast area (Figure T-2). Timber harvest also provides social benefits, especially for local rural communities. Timber harvest directly impacts local jobs and mills and indirectly impacts numerous other jobs in those communities. The remaining 36.25% of timber revenues go to State Forests for management, fire protection, and supporting the overall agency mission. Currently, timber harvests contribute nearly all (over 98%) of the revenues that fund State Forests operations

Figure T-1. Net timber revenues distributed to counties and local taxing districts.

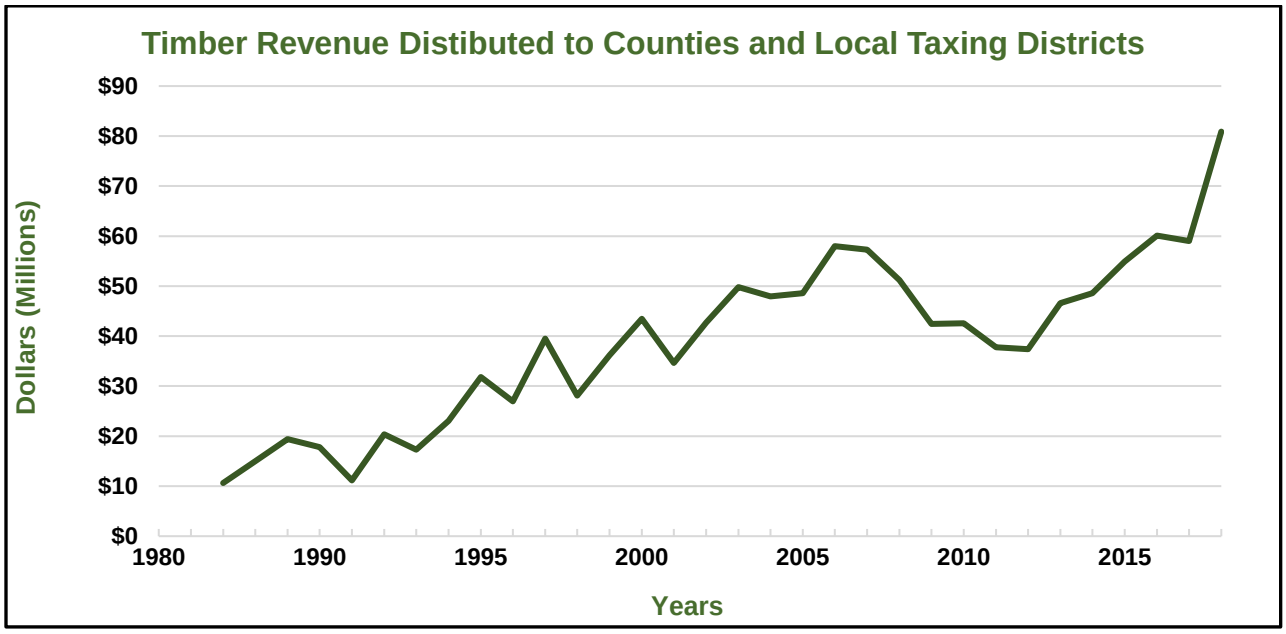
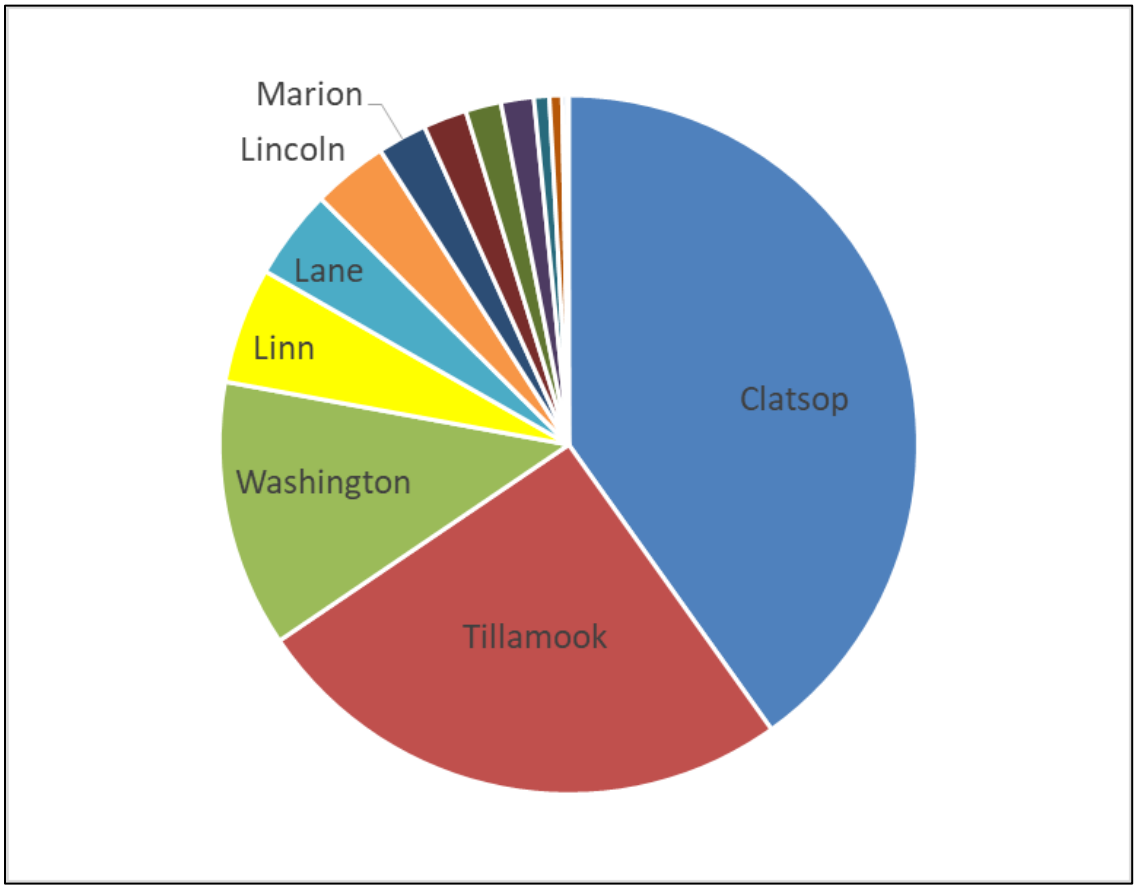
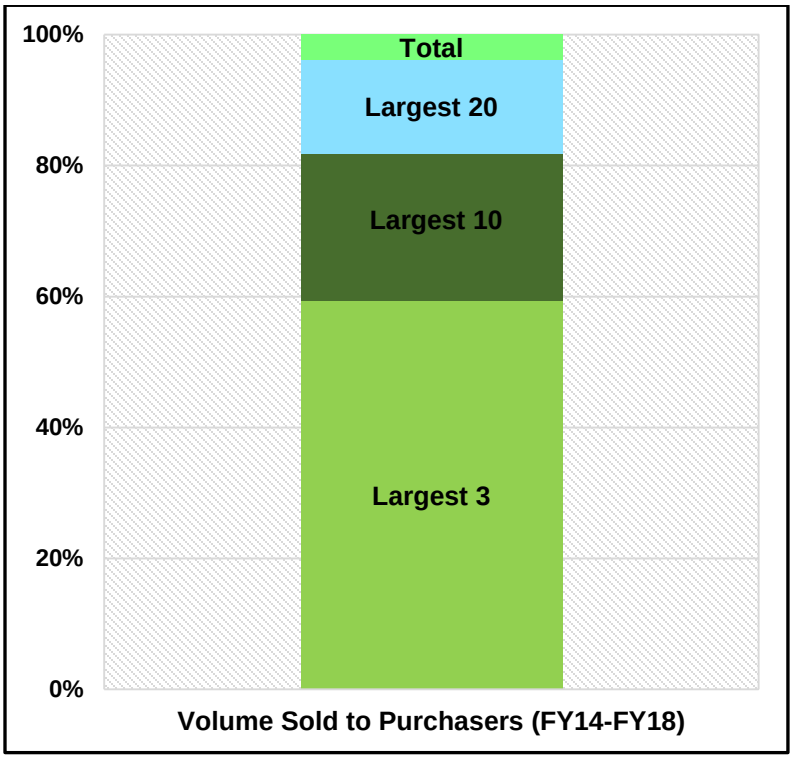


Figure T-2. Percent of revenue distributed to individual counties over the last three fiscal years (FY16-18).



Oregon law prohibits raw logs from Board of Forestry land from being exported to other countries. Most of the timber sold from state forests is processed in Oregon, the remainder is processed in neighboring states. Currently, there is a large number of local bidders (over 45) for timber from state forests lands. However, 60% of the timber volume goes to three large local purchasers and 80% of the timber volume is sold to 10 purchasers (Figure T-3).

Figure T-3. Percent of volume sold to each purchaser over the last five years. Over this time period there were over 45 purchasers of state forest timber sales.



Stumpage prices are influenced by local market fluctuations and global timber products demand. Actual timber price trends varying significantly across the planning area (Figure T-4). Timber value is affected by three primary factors: topography, natural disturbance events, and past management actions.

The timber program is guided by FMPs. Implementation on the Board of Forestry lands in Western Oregon during the early 2000s (2000-2009) resulted in an annual harvest average of 232 million board feet. Harvests focused on thinning mid- to late-seral stands in order to promote structural diversity and stand complexity (Figure T-5). These partial cut harvests were in stands typically aged 45-65 years with some up to 70-90 years that originated from natural regeneration. Timber harvested from these commercial thinnings averaged around 15 MBF per acre.

Figure T-4. Five-year average of timber prices made by purchasers for state forest sales (MBF – thousand board feet).

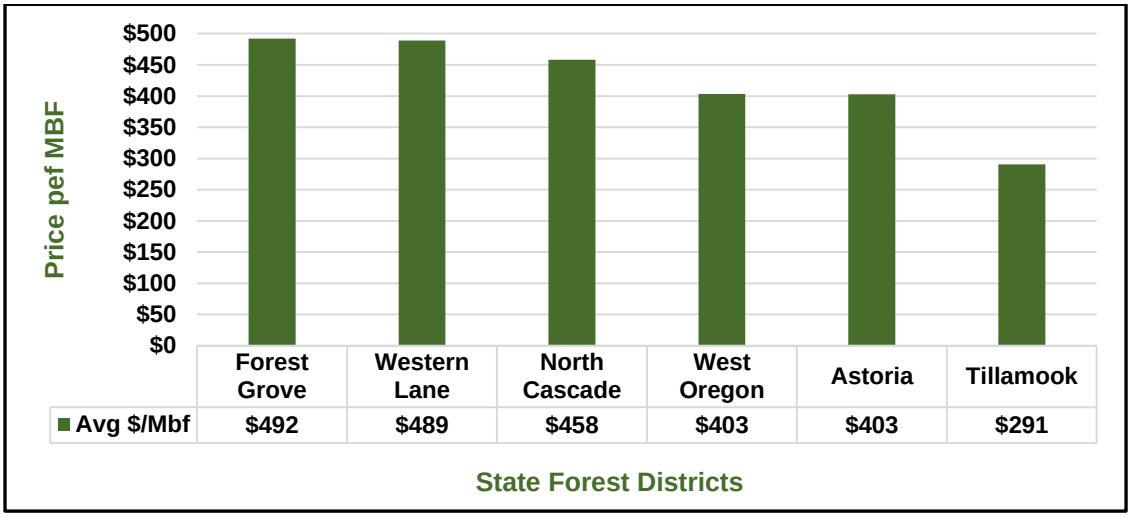
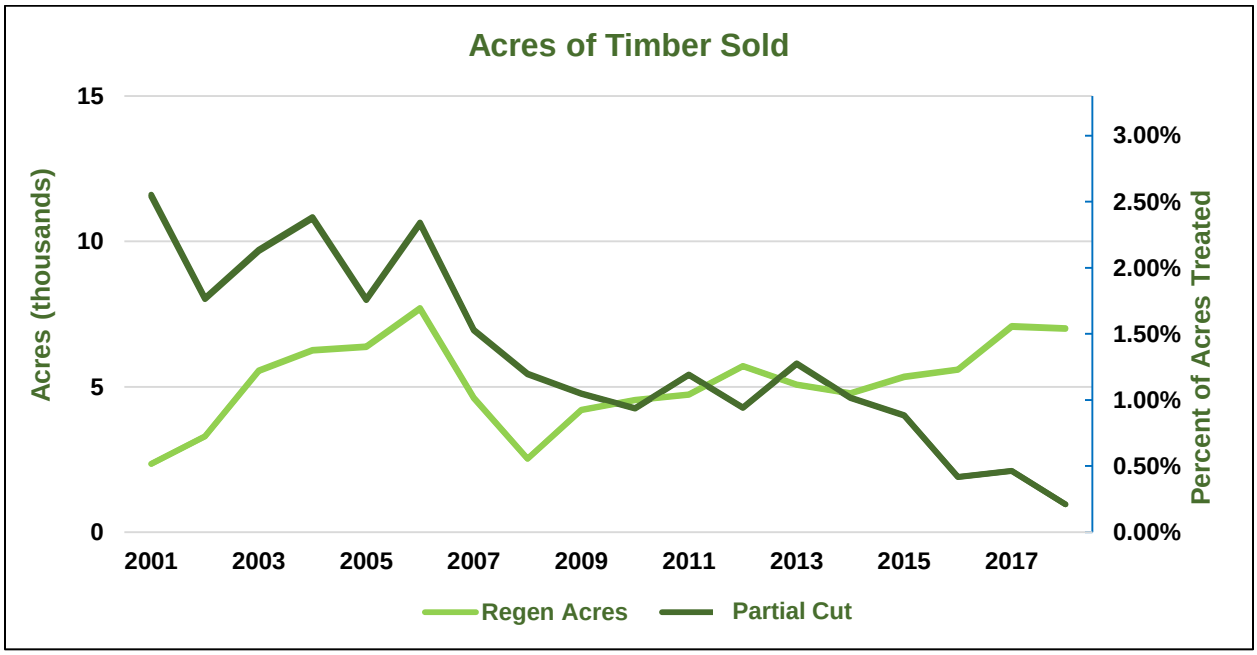


Figure T-5. Partial cut harvests and regeneration harvests of Board of Forestry lands since the beginning of the FMP.



During the past ten years (2008-2018) of implementation, there were fewer opportunities for thinning older stands and focus gradually shifted to increased regeneration harvests. Implementation during this recent period has resulted in an annual harvest average of 239 million

board feet per year. Thinning occurs on younger, more uniform stands that were reforested by planting in the 1970s and early 1980s. These thinnings result in harvests of around 7 MBF per acre and require multiple entries to produce more complex forest conditions since these stands started as plantations. An increase in lands constrained by threatened and endangered species has also impacted timber harvest. To increase finical viability, there has been a slight increase in regeneration harvests and a significant decrease in thinnings on the landscape (Figure T-5).

Products & Markets - ODF Westside Forests

The majority of products to come off of ODF lands in 2017 were saw logs with small amounts of pulp and utility poles. Douglas-fir is the preferred species for most mills that are in the market areas served by ODF. Prices and competition for Douglas-fir are stronger than any of the other species grown in significant volume on ODF forests. Some niche species and products provide price premiums compared to Douglas-fir (e.g. western red cedar, utility pole products). Red alder is currently almost as valuable as Douglas-fir. Competition is strong on the north coast because the capacity of local mills is greater than the supply. Conversely, red alder competition is weaker in southern districts due to mill locations. Utility pole product grade bring stumpage premiums and are grown primarily in the Forest Grove, North Cascade, and Western Lane Districts with a smaller concentration of poles in the Astoria District.

Purchasers are hesitant to deal with pulp due to low prices. This has translated into a reluctance to remove pulp from timber sales. There may be opportunities to increase revenue from pulp, which would increase utilization. In a pilot project on the four sort sales from 2017-2018, ODF received two to seven times the pulp stumpage when compared to conventional timber sale contracts. This demonstrates a potentially profitable pulp market, but it may be challenging due to logger reluctance to handle pulp on regular timber sales. The division does not sell into local chip and saw markets due to concerns over losing saw logs to chip and saw facilities at the lower pulp rate.

Young Stand Management

Young stand management is integral to any future timber harvest and is a critical part of forest management. Reforestation is required after any regeneration harvest, and is a critical investment to ensure a productive working forest over the long-term. There are other young stand management activities that enhance timber production and forest health. Additional silviculture treatments are implemented as needed to ensure seedlings grow into merchantable timber.

Special Forest Products

Description and Assessment

Special forest products are those products other than timber that are collected for personal and commercial uses. The special forest products industry is growing nationally and internationally and makes an important contribution to Oregon’s economy.

In the western Oregon state forests, special forest products include beargrass, evergreen boughs, cascara bark, cedar products, cones, ferns, firewood, moss, mushrooms, vine maple for transplants, poles, Oregon grape root, salal, and yew bark. The quantity and quality of products varies among districts. For most products, the number of requests to harvest is low and does not produce a large amount of revenue. However, the department does have a harvest permit program for special forest products to meet the demands for these products.

Roads and Access

Description and Assessment

The road system on State Forests' lands is an integral part of achieving GPV. The road system facilitates timber harvest and other forest management activities as well as providing access for a wide range of recreational activities. Substantial investments have been made in constructing, surfacing and maintaining the road system. There are approximately 3,900 miles of road on state lands within the planning area. Eighty-nine percent of all acres within the planning area are located within one quarter mile of a road. Approximately 88% of the roads within the planning area are surfaced.

In addition to the roads on state lands, there are numerous other roads on other ownerships which are used to access State Forests' lands. Control, permitted uses, and maintenance responsibilities can vary widely for these roads. Management complexity increases when the road system crosses multiple ownerships. For the larger blocked-up parcels, the Department controls a greater portion of the entire road system as compared to scattered parcels. For example, the Astoria District averages one easement per 1,021 acres managed as compared to the Western Lane District average of one easement per 167 acres managed.

While the road system provides the needed access to achieve the management objectives of the plan, it also has the potential to impact natural resources and public safety. Applicable laws for the management of the road system include the Federal Water Pollution Control Act (commonly referred to as the Clean Water Act) as administered by the federal Environmental Protection Agency, Oregon Department of Environment Quality, and the Oregon Department of Forestry though the Oregon Forest Practices Act; the federal Endangered Species Act as administered by the United States Fish and Wildlife Service, National Oceanic and Atmospheric Administration - Fisheries, Oregon Department of Fish and Wildlife and the Oregon Department of Forestry through the Oregon Forest Practices Act. And safety laws for forest operations and quarry operations as administered by the Oregon Occupational and Health Administration and the Mining Health and Safety Administration respectively. The road system on state forest lands within the planning area is located, constructed, used and maintained in accordance with the State Forests Road Manual, the Oregon Forest Practices Act and other applicable laws.

Road locations near streams and on steep slopes have a higher potential to impact water quality and aquatic habitat. Within the planning area, nearly one third of the total land base has slopes greater than 60%, but only 2.3% of the road system is located on slopes greater than 60%.

Approximately 17% of the road system on State Forests' lands is located within 100 feet of perennial and/or seasonal streams. While the overall percentage of the road network near streams is small, these road segments require higher relative investments for implementing best management practices to protect water quality and maintain aquatic habitats. Project work reported to the Oregon Watershed Enhancement Board as part of the Oregon Plan for Salmon and Watersheds is representative of some of these investments from 1995 through 2017. The Division has removed or replaced 288 fish barriers with fish passable structures restoring fish access to 229 miles of stream habitat. Additionally, 155.4 miles of road has been closed or vacated and 2,289 relief culverts have been installed. A total of 2,287 Type N stream crossings have been improved.

Energy and Mineral Resources

Description and Assessment

The mineral, oil, and gas potential of northwest Oregon state forests is largely unknown. According to the Department of Geology and Mineral Industries, few systematic surveys have been conducted for most commodities. Additionally, no regional geochemical studies have been made to define or eliminate areas of possible metal mineralization. However, there may be potential for production of natural gas, industrial minerals, economic metals, and geothermal resources.

The Department of Forestry does not own most of the minerals on state forest lands. The Division may use soil, clay, stone, sand, and gravel for the purpose of constructing or repairing roads or other state facilities. Or they may sell those same materials (ORS 530.050). All other mineral and geothermal resources are owned by the State of Oregon and managed by the Department of State Lands. Revenues derived from the sale of those mineral resources accrue to the Common School Fund (ORS 273.780).

The northwest Oregon state forests have provided high quality rock for local road surfacing and ballast rock. This rock is an important resource for road construction and maintenance of roads for hauling timber and recreation. Without a local source, the costs associated with construction and maintenance would be greatly impacted, which makes management of this finite resource quite important.

Grazing

Description and Assessment

The northwest Oregon state forests have limited potential for grazing. Although state laws permit agriculture and grazing on state forest lands as long as they are compatible with other forest resources, the topography of the state forests is generally not suitable for most agricultural uses. Grazing is almost nonexistent in northwest Oregon state forests. Historically, all the districts in northwest Oregon allowed grazing on burned or logged areas under the open range laws. As forests were re-established, grazing diminished. Open range grazing ended in the early 1980s.

Environmental/Conservation Resources

Wildlife

Description and Assessment

Wildlife Habitat – General

Environmental gradients, underlying geology, species distributions, and natural disturbances have always provided for variability in habitat types across state forests in western Oregon. Large-scale disturbances such as fire and wind storms continue to influence habitat conditions across the landscape. Smaller scale disturbances, such as insect and disease outbreaks, create habitat patchiness and increase spatial heterogeneity within and between individual stands.

Many of the state forest lands in western Oregon have a legacy of repeated, large-scale wildfires and/or had already been extensively logged prior to acquisition by the State. The majority of state forests in the planning area are young forests, created from natural regeneration and early reforestation efforts. On large parts of state forest lands, structurally-complex natural forest stands were replaced with more simplified even-aged stands. In more recent history, a massive reforestation and restoration effort has been implemented across these state forest lands. Managing for multiple values including timber production, forest health, aquatic systems, and wildlife habitat has produced a complex mosaic of stand types and ages and within-stand habitat features.

The variety of stand types resulting from ODF's management of state forest lands provides diverse habitat well-dispersed across the landscape at regional scales and broad connectivity to and between older forests on federal lands. As well as habitats where, comparatively, little other public forest lands exists (e.g. Clatsop State Forest). Young stands and associated early-seral characteristics are important for diverse game and non-game species, including many of state or federal concern. Older stands on the landscape foster and support a variety of late-seral associates such as northern spotted owls, marbled murrelets and red tree voles. Forests in mid-seral stages (30-80 years old) enhance broader landscape function and provide habitat for most native forest species, including early- and late-seral associates. Additional variation in stand composition and structure due to stand development, management history, site productivity, topography, region, and numerous other factors contribute to diversity across spatial scales. Riparian areas, wetlands, and other aquatic habitats along with rare or unique habitats, such as talus slopes and caves, add to diversity and also to a broader ecological function and associated resilience. Individual species utilize different stand types and habitat features at varying spatial scales. Thus protecting, maintaining, and enhancing native wildlife habitats requires consideration of all species present on the landscape and their individual habitat needs.

Wildlife Habitat – Current Conditions

Current ODF forest inventory data document the age class distribution of state forests and provide insight into the range of habitat types provided therein (see Forest Condition section). Across districts, stands less than 50 years old total approximately 37% of the forest. Just over half of the forest is 50-80 years old. Only 13% of the state forest lands in western Oregon are 80 years or older and just 2% are stands greater than 120 years old.

There is considerable variation both within and among districts in the relative proportions of age classes and associated habitat types on the landscape. Thus, state forests are providing for diverse habitat across the landscape. Harvest strategies, practices and prescriptions in young stands have promoted high-quality, complex, early -seral habitat relative to nearby public and private industrial forestlands. Mid-seral stands are highly variable in habitat structure and function depending on natural disturbance, management history, and other factors. But all provide some degree of habitat to meet various life history needs of native wildlife species and also provide connectivity between other habitat types and across basins.

The data also suggest state forests may be somewhat lacking in habitat to support late-seral species, such as northern spotted owls and marbled murrelets. Approximately 87% of state forests are less than 80 years old. In general, the districts in the central and southern Coast Range and the Santiam State Forest have a greater proportion of total acreage in older stands. The Tillamook and Clatsop State Forests have comparatively little older forest, largely due to the extensive fires and logging that occurred prior to state acquisition. Despite large improvements in habitat diversity and quality since then, the state forests' habitat story largely remains one of restoration, rehabilitation, and enhancement in a young forest landscape.

General Wildlife

Western Oregon state forests currently have habitat suitable for most native species found in forests of the Coast Range and West Cascades. ODF Forest Management Plans provide lists of vertebrate species known or suspected to be found on, adjacent to, or downstream of state forest lands in both aquatic and terrestrial environments. In total, these lists include approximately 270 species, of which 63 are mammals, 147 birds, 32 amphibians and reptiles, and 28 fishes. These lists generally exclude the many species of marine fishes, birds, and mammals that may be found in the estuaries adjacent to state forest lands unless they use state forest lands for some portion of their life history requirements.

A wide range of mammals (e.g. deer, elk, bear, cougar, and bobcat) make use of a variety of habitats in and near state forests to meet their life history needs. Forests stands are host to most native weasel species, skunks, squirrels, voles, mice, and other forest floor small mammals. The full native assemblages of forest resident and migratory songbirds and raptors, including rare and sensitive species, are present on state forests lands. Upland game birds such as grouse, quail, and turkey are present but elusive to most hunters and wildlife observers. Resident and migratory

waterfowl and other aquatic birds are dependent on riparian, aquatic, and wetland habitats within state forests. Mammals such as river otters and beavers make almost exclusive use of these habitats. Many amphibians are associated with aquatic habitats (e.g. tailed frog, torrent salamanders), yet others utilize terrestrial habitats and are strongly tied to abundance and quality of downed wood (e.g. plethodontid salamanders). Many birds, reptiles and some mammals utilize rocky habitats, including caves, for a variety of life history needs. Bats forage over nearby aquatic habitats and make use of many structures throughout the forest for denning and roosting.

Wildlife

Current Condition

ODF has an extensive survey history for species listed in the Endangered Species Act (i.e. northern spotted owls and marbled murrelets). It continues to conduct surveys driven by proposed operations and monitor activity at known sites on an annual basis. The State Forest Division, in various capacities over time, has supported research related to habitat relationships of numerous species (e.g. deer, elk, owls, murrelets, early seral birds, tree voles) and wildlife responses to forest management practices (e.g. songbirds, small mammals, amphibians). However, because relatively little inventory or monitoring work has been conducted on state lands for non-game species, some species may be present that have not been detected or documented yet (e.g. coastal marten). Other species on the lists are not currently known to be present but could become re-established as a result of habitat improvements, regional population recovery, or potential re-introductions (e.g. Pacific fisher, Oregon spotted frog).

Threats to wildlife on state forest lands include poaching, illegal dumping, habitat destruction or modification from management activities or public misuse, catastrophic fire and wind events, and disease and pest outbreaks. Many of these issues can be addressed via forest planning and management in collaboration with other agencies and stakeholders.

The effects of climate change on wildlife habitats and populations are longer-term variables that are more difficult to assess and address in a management context. It is anticipated that changes in temperature and precipitation regimes will alter patterns and abundance of habitat and resources, which will result in gradual migrations of habitats and associated wildlife species north and to higher elevations. Species that cannot migrate or shift their range quickly enough to respond to climate change are at risk. Damage by insects and plant pests, which can result in damage to native plant communities and sensitive wildlife species that rely on them, will increase with warmer temperatures and may result in alterations to the species composition of native ecosystems. Increased frequency and severity of fire or wind events can cause large-scale catastrophic damage to habitats and local populations with long-term consequences. Rare and sensitive habitats may be lost at and near latitudinal and elevation range extents.

Under GPV, the overarching goal of State Forests' strategies for wildlife is to protect, maintain, and enhance habitat for native wildlife species. Restoration and enhancement requirements remain where fire and subsequent salvage logging or reforestation have reduced habitat elements

or hindered their development (e.g. the Tillamook Burn). Diverse and complex habitats, late seral habitat features in particular, will take many decades to develop through both passive and active management approaches. While moving the landscape toward more diverse habitat conditions, there are expected to be individual species, referred to as "species of concern," and associated habitats that require special consideration.

Species of Concern

Species of concern are fish and wildlife species that have been identified as at risk due to declining populations or other factors (e.g. having a limited range). Some are thought to be largely extirpated from forests in the region (e.g. coastal marten and Pacific fisher) and these and many others are species of concern to state and federal managers and to the public. There are numerous public and private entities that designate wildlife species of concern for conservation and management, from local to global scales. At the federal level in Oregon, the U.S. Fish and Wildlife Service (FWS), U.S. Forest Service (USFS), and Bureau of Land Management all publish relevant lists for the Coast Range and Cascade Mountains Districts. At the state level, Oregon Department of Fish and Wildlife (ODFW) and the Oregon Biodiversity Information Center also publish statewide and county lists. Regional conservation organizations, such as Oregon/Washington Partners in Flight, also publish relevant lists.

ODF's species of concern list was developed using federal and state lists of threatened, endangered, and candidate species, as well as the Oregon Conservation Strategy and ODFW's sensitive species list (ODFW 2016). These resources are appropriate because they identify species that need immediate and focused conservation effort. The list is a component of the State Forests Division's species of concern operational policies and is updated semi-regularly as state and federal lists are updated or new data or science become available. Species of concern identified as part of this management plan's associated policies are currently present or have the potential to be present on state forest lands.

Threatened or Endangered Species

Forest management activities must comply with all federal and state laws, including those related to protection and conservation of wildlife populations and habitat (e.g. state and federal Endangered Species Acts, federal Bald and Golden Eagle Protection Act, federal Migratory Bird Treaty Act, state Forest Practices Act). Although many laws apply to the management of state forest lands, legal requirements for protection of threatened or endangered species can have some of the most significant impacts on planning and operations.

Of the many wildlife species potentially found on state forests lands in western Oregon, two terrestrial species are listed as threatened or endangered under the federal and state Endangered Species Acts (fish are discussed the Aquatic Resources section).

Northern Spotted Owls on State Forests

In the northern Coast Range, surveys for northern spotted owls began in the late 1970s and early 80s. These surveys found relatively low densities of owls in what was then an area with extensive forests of young Douglas-fir stands (less than 60 years old) and few remnant stands of old growth or mature forests. More systematic surveys began on state land after the U.S. Fish and Wildlife Services listed the owl as a threatened species in June 1990. ODF has surveyed timbers sales and other suitable habitat for spotted owls in state forests since 1992, covering 80% or more of each district per year at an average cost of $1.4 million/year over the past 5 years (2014-2018).

There are currently 28 active sites on BOF lands, including 18 pairs, and an additional 97 sites that are on adjacent lands but fall within the purview of State Forests spotted owl policies (Table W-1). Occupancy patterns vary across districts. On the Tillamook and Clatsop State Forests (Astoria, Forest Grove and Tillamook Districts), there are relatively few sites on or adjacent to state forests, compared to smaller districts like Western Lane (including the Coos and Southwest Units).

Table W-1. Northern spotted owl sites on or adjacent to state forest lands, 2018 (GIS Acres).

District	Number on BOF Lands		Number on Adjacent Lands		BOF Lands in Owl Sites (acres)	Percent of BOF Lands in Owl Sites
	Pair	Single	Pair	Single		
Astoria	2	0	0	0	7,765	6%
Tillamook	2	6	4	1	30,097	12%
Forest Grove	2	0	1	0	8,648	8%
North Cascades	4	1	9	1	7,625	16%
West Oregon	1	2	3	1	6,872	23%
Western Lane	2	0	35	7	13,863	57%
Coos Unit	2	0	15	1	6,494	73%
Southwest Unit	3	1	18	1	6,868	73%
All Districts	18	10	85	12	88,234	14%

Approximately 88 thousand acres of BOF lands fall within active owl sites. Tillamook has the most acres in owl sites but smaller districts tend to have a greater proportion of the district affected (Table W-1). On the Tillamook and Clatsop State Forests, owl sites cover just under 10% of the total acres (46,500), with some variability across the three districts, compared to 57% on Western Lane and 73% of the Southwest and Coos Units.

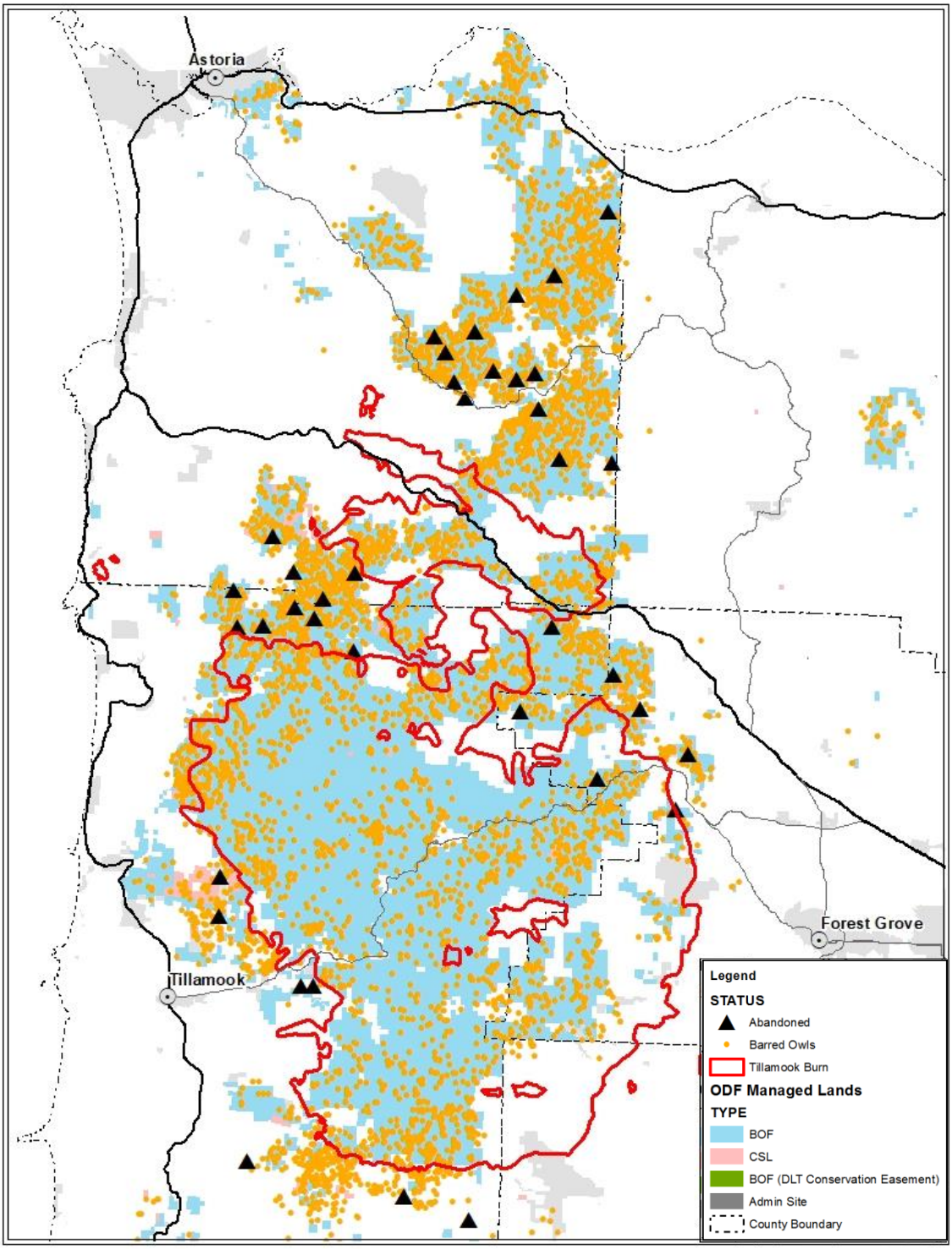
Drivers of spotted owl occupancy differ between districts. Historically, extensive logging and the Tillamook Burn reduced habitat across ownerships on the North Coast. While some habitat has

since developed in the Tillamook and Clatsop State Forests, barred owls have become a major driver of current occupancy patterns in the region (Figure W-1). Astoria is heavily saturated as are parts of Forest Grove and Tillamook Districts. In general, sites on the North Coast have shifted over time from the Clatsop to the Tillamook State Forest as barred owls densities have increased.

Over the past 10-15 years, most of the spotted owl sites on Astoria and Forest Grove had gone inactive, while a few new sites have been established on the Tillamook District. The high number of abandoned sites is consistent with patterns elsewhere, in that spotted owl territories fall apart and individuals drop out or become hard to detect. Four of the recently established sites are in the Tillamook Burn, where spotted owls were largely absent for decades and where barred owl detections map less densely (Figure W-1). Thus, it appears that barred owl competition is driving spotted owls into marginal sites in the burns where habitat is low quality or still developing. ODF has not observed any evidence of spotted owls breeding on the Tillamook or Clatsop State Forests in many years.

Spotted owls appear to be faring somewhat better on state forest lands in the central and southern Coast Range and West Cascades, likely due to the presence of suitable habitat on adjacent federal lands. There are more owl sites in and adjacent to state forests and evidence of successful breeding (e.g. a pair with juveniles) has been observed in the Santiam State Forest and Western Lane District, Southwest Oregon District, and Coos Unit within the past few years.

Figure W-1. Barred owl detections on the Tillamook and Clatsop State Forests, 2001 - 2017.



Marbled Murrelets on State Forests

The marbled murrelet is a cryptic seabird that nests inland on large tree limbs or other suitable structures in coniferous forests of the Coast Range. Because it is so difficult to observe nesting murrelets or find actual nests, surveys utilize an occupancy-based approach that does not provide an estimate of number of murrelets nesting on state forest lands. When surveys detect occupied behavior from murrelets, the State Forests Division establishes a marbled murrelet management area (MMMA) to designate, buffer and protect occupied habitat.

ODF has a long history of conducting surveys for marbled murrelets to help ensure State Forests Division's timber sale program does not violate the "take" restrictions detailed in Section 9 of the Endangered Species Act. Since 1992, ODF has conducted over 32 thousand individual surveys at more than 1,300 unique sites. This represents the largest survey efforts for marbled murrelets by any land manager in Oregon, Washington, or California. As a result of these surveys, ODF has designated over 16 thousand acres in 107 MMMAs on state forest lands, including 11,800 acres of designated occupied habitat and 4,400 acres of buffers (Table W-2).

Table W-2. MMMAs on state forest lands, last updated in 2017 (GIS Acres).

District	Number of MMMAs	Designated Occupied Habitat (acres)	Buffer (acres)	BOF Lands in MMMAs (acres)	Percent of BOF Lands
Astoria	18	1,988	1,401	3,390	3%
Tillamook	37	4,911	511	5,422	2%
Forest Grove	0	0	0	0	0%
North Cascades	0	0	0	0	0%
West Oregon	24	1,895	1,413	3,309	11%
Western Lane	16	1,852	925	2,777	11%
Coos Unit	12	1,195	138	1,332	15%
Southwest Unit	0	0	0	0	0%
All Districts	107	11,842	4,388	16,230	3%

Marbled murrelet occupancy patterns also vary across districts. Sites on Astoria and Tillamook are limited to the west side of both districts, outside the Burn, and account for just over 2% of each. As with spotted owl sites, many of the known murrelet sites on the North Coast appear to be in state forests. And where they do occur, they tend to have disproportionate effects on local management activities and related planning. West Oregon and Western Lane Districts (including the Coos Unit) are the most affected by marbled murrelet sites, which occupy 10-15% of both districts (Table W-2).

Disturbance history is a large driver of occupancy patterns for both owls and murrelets on the North Coast. Ownership patterns are bigger drivers in other districts. Where there is little other public land and relatively little habitat, spotted owls occur at lower densities and are mostly on state forest lands. In West Oregon, where private lands predominate, both species seem to key in

on habitat in state forests and spotted owls tend to occur where federal lands are nearby. In Western Lane, occupancy patterns are more related to spillover effects from adjacent federal lands. Smaller districts are disproportionately affected by owls and murrelets, particularly where federal lands are adjacent. Spotted owl sites represent over 20% of the West Oregon District and over 50% of the Western Lane District. Additionally, many of the murrelet areas fall outside of the owl sites. Thus, management constraints are compounded.

Other Species of Concern on State Forests

Several other species are either candidates for listing under the federal Endangered Species Act (ESA) or due for a status review within the next few years (e.g. the red tree vole, Oregon slender salamander, and coastal marten). These and other future listing decisions would also have differential effects on districts and would likely be additive to the current ESA compliance measures for owls and murrelets.

Red tree voles occupy coniferous forests at low to mid-elevations in western Oregon. The population in the Coast Range north of the Siuslaw River is considered a Distinct Population Segment and a candidate for listing under the federal ESA. A positive listing decision would affect planning and operations on the majority of acres in the planning area. The Oregon slender salamander is a terrestrial salamander that is associated with downed wood, and large diameter logs in particular. The species range is limited to the west side of the Cascades from the Columbia River into Lane County. A listing decision would affect operations on the North Cascades District. Coastal marten are thought to be limited to two small populations in the Oregon Dunes and Siskiyou Mountains. A listing decision restricted to those areas would have little effect on state forests due to a lack of overlap, but a broader designation could affect West Oregon and Western Lane Districts. Survey efforts for all three species have been limited in state forests and tied to external research. They provide little insight into current or potential distribution in relevant districts.

Many other species of concern are not yet proposed for listing, including many birds, bats, and aquatic amphibians. Not all are associated with late seral habitats. Several bird species of concern (e.g. flycatchers and warblers) are associated more with complex early seral habitats. Bats are tied to more specific habitat elements like suitable nest, den, or roost structures. Aquatic amphibians, such as torrent salamanders, are largely restricted to aquatic habitats. Little or no work has been done to assess these species' distributions and habitat associations in state forests, thus an assessment of current status is not possible.

Riparian and Aquatic Resources

Resource Description

Aquatic resources include surface waters (e.g. rivers, streams, lakes, springs, seeps, wetlands) and subsurface waters contained in aquifers or sub-soils. The legal directive for managing aquatic resources in state forests is that it should "result(s) in a high probability of maintaining

and restoring properly functioning aquatic habitats for salmonids, and other native fish and aquatic life" (OAR 629-035-0010 6(b), OAR 629-035-0020 1(b) and 2(a)).

Many laws and programs apply to water resources and the protection of aquatic organisms (e.g. ESA, Clean Water Act, Oregon water law, water rights, the Oregon Plan for Salmon and Healthy Watersheds, and the Forest Practices Act). There are several state and federal agencies responsible for managing specific aspects of aquatic resources. Lists of species of concern, including threatened and endangered, are compiled by the National Marine Fisheries Service, FWS, and ODFW. Issues relating to water quality are overseen by Environmental Protection Agency and Department of Environmental Quality. Maintaining navigable waterways, issuing removal and fill permits, and managing wetlands falls primarily under the guidance of US Army Corps of Engineers and Department of State Lands.

Resource Description

Aquatic ecosystems interact closely with the surrounding terrestrial systems, both at the landscape scale and at the scale of stream reaches and riparian zones. Major disturbance events such as floods and landslides, are normal processes that can add key elements that are required for healthy stream ecosystems (e.g. wood, boulders and gravel). Therefore, the health of the aquatic system depends upon forest management practices that recognize, maintain, and enhance the functions and processes that compose these terrestrial-aquatic interactions at a variety of scales.

Conceptually, the riparian area is the zone of influence between the terrestrial and aquatic environments. Riparian forests can have a profound influence on the aquatic environment, such as influencing water temperature, and provides inputs that benefit aquatic ecosystems (e.g. wood and other organic matter). Conversely, the structure and composition of riparian forests can be influenced by the aquatic environment, such as the influence of floods on forest dynamics and the deposition or erosion of material in the floodplain.

ODF's Ownership in a Watershed Context

The United States Geological Survey has adopted a scheme to classify water resources over the continental United States. This scheme defines a nested series of "hydrologic units" that range from "region" (21 total in the US) to "subwatershed". Each is identified by a unique hydrologic unit code (HUC) that ranges from a 2-digit code (the largest area, region) to a 12-digit code (the smallest area, subwatershed).

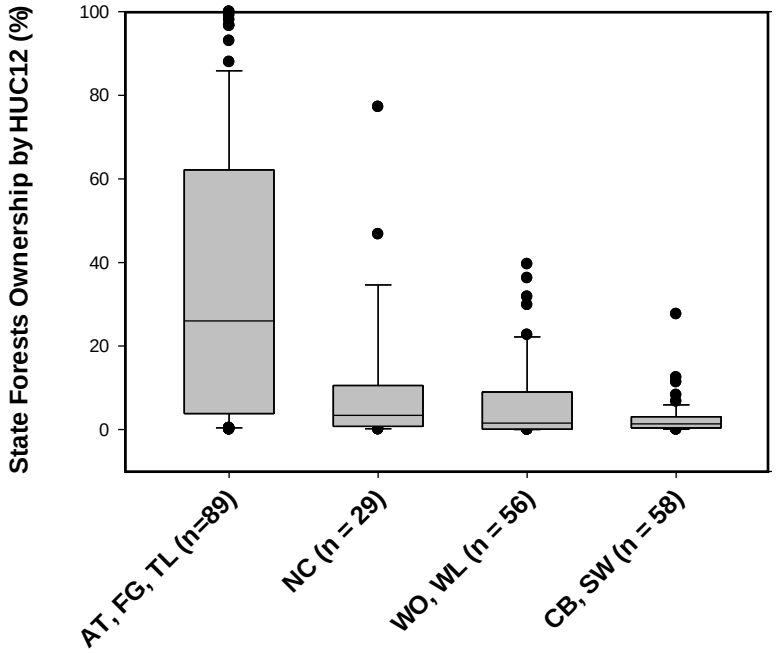
Using this scheme, the planning region falls within four sub-regions (6-digit HUCs): Lower Columbia, Northern Oregon Coastal, Southern Oregon Coastal, and the Willamette. Streams within these sub-regions drain directly into either the Pacific Ocean, the Columbia River, or the Willamette River. These sub-regions are relatively distinct in both the physical template and the biological communities.

District and sub-region boundaries generally do not coincide and districts with multiple sub-regions contain highly diverse aquatic resources. Three districts, Tillamook, Coos Bay and Southwest Oregon, are completely within a sub-region and all streams flow to the Pacific Ocean. North Cascades District is mainly within the Willamette sub-region although a portion of it is also within the Lower Columbia sub-region. Astoria District is within two sub-regions with streams that drain either into the lower Columbia or the Pacific Ocean. West Oregon and Western Lane Districts are both within the Northern Oregon Coastal and Willamette sub-regions and Forest Grove District is within three sub-regions, containing streams that flow into the lower Columbia, Willamette, and Pacific Ocean.

Currently, the sub-watershed (HUC-12) is the finest resolution defined for Oregon with a median area of 17 thousand acres for the HUC-12s within the planning region. The sub-watershed is a convenient scale to manage aquatic resources (e.g. protect, restore and enhance) provided enough of the HUC-12 is within State Forests' ownership to influence. There are a total of 232 sub-watersheds that contain at least 1 acre of land managed by State Forests within the planning area.

State forests comprises a small proportion of landscape within the planning area. Therefore, the median proportion of state forests ownership by HUC-12 is relatively low at 3%. The majority of state forests is concentrated in the Astoria, Forest Grove, and Tillamook Districts where the median percentage of State Forests' ownership by HUC-12 is 26% (range <1% to 100%) (Figure A-1). These are the sub-watersheds that State Forests can have the greatest influence on protecting, restoring, and enhancing aquatic resources. Although there are selected HUC-12s within the other districts with relatively large proportion of state forests within them (e.g. maximum of 77% for North Cascades, 36% for Western Lane/West Oregon, and 28% for Coos Bay/Southwest Oregon), State Forests' ownership within the other districts by HUC-12 is relatively low (<2%) (Figure 1).

Figure A-1. Percentage of state forests ownership in HUC-12 by district group. Shaded portion of the box plots show the 25th to 75th inner quartile range with the median represented by the solid line within the box. Whiskers are the 10th and 90th percentile and the outliers represented with filled circles. District abbreviations are as follows: AT = Astoria, FG = Forest Grove, TL = Tillamook, NC = North Cascade, WO = Western Oregon, WL = West Lane, CB = Coos Bay, and SW = Southwest Oregon.



Stream Classification and Abundance

Streams are classified by the presence of fish or absence of fish, persistence of flow, and stream size using the following criteria:

1. Fish presence:
    a. "Type F" are inhabited by native or game fish (e.g. trout and salmon) for at least some portion of the year.
    b. "Type N" streams are uninhabitable by these fish species.
2. Persistence of flow:
    a. Perennial streams have surface flow after July 15 on an average water year and seasonal streams do not.
    b. Seasonal streams are further classified as:
3. Stream size: three size classes are defined in Oregon based on average annual daily flow in cubic feet per second (cfs)
    a. Small (≤ 2 cfs),

b. Medium (> 2 cfs, and < 10 cfs)
c. Large (≥10 cfs)

The total length of stream in state forests within the planning area is estimated to be 8,239 miles of stream (Table A-1). The majority (nearly 60%) of the stream network is comprised of seasonal non-fish streams while approximately 17% of the streams are fish-bearing streams. Over the planning area, Tillamook has almost half of all the streams by length over the planning area.

Table A-1. Estimated stream length and percent within each district by stream type.

District	Fish miles	Non-fish miles	Seasonal miles	Total Miles (percent)
Astoria	422	387	1,261	2,070 (25.1%)
Forest Grove	155	292	417	864 (10.5%)
Tillamook	511	885	2,715	4,111 (49.9%)
North Cascade	93	185	78	356 (4.3%)
West Oregon	125	58	167	350 (4.2%)
Western Lane	59	35	128	223 (2.7%)
Coos Bay	30	12	67	109 (1.3%)
Southwest	14	52	91	157 (1.9%)
Total	1,408 (17.1%)	1,906 (23.1%)	4,925 (59.8%)	8,239

Riparian Habitat

The current conditions of the riparian forests are a product of both the natural and anthropogenic disturbance regimes. Natural disturbances, such as fire, windthrow, and disease outbreaks, can be influenced by land use practices. For example, the Tillamook Burn was a series of large fires that occurred from 1933 to 1954 over much of state forests considered in this management plan. These fires often left riparian areas and uplands with little vegetation to hold soil in place and shade streams. In the rehabilitation of the Tillamook Burn, salvage logging was done before new trees were planted. Many snags were removed that, if left, would have provided large wood to the streams.

Extensive logging occurred on most of the lands prior to becoming state forests. Historic logging and road-building practices did not protect streams and riparian areas. Riparian forests were usually harvested along with upland forests and large logs were frequently removed from streams. Timber harvest practices did not attempt to maintain large conifers and fallen trees in riparian and aquatic habitats.

As a result of historical logging practices and fires together with the natural disturbances, the current condition of many streams today have limited amounts of mature conifer forest in their riparian areas and have few large logs in the streams. Instead, streams often have young conifers (60-70 years old) or riparian forests of alders and other hardwoods.

According to recent studies conducted by ODFW, the overall condition of riparian and stream habitats in Oregon's coastal streams, which include state forests, indicate a lack of large wood in streams and large conifers in riparian areas. These outcomes were not unexpected given the area's history of large fires and historic logging practices, resulting in an abundance of young riparian forests over the management area. Habitat attributes such as large wood abundance and large wood key pieces can be addressed on a short-term basis through stream habitat enhancement. However, riparian areas must be managed to provide the full complement of riparian functions, which includes the long-term supply of wood to stream. This requires riparian buffers of sufficient widths be maintained as no-harvest areas and managed to obtain mature to old growth conditions.

Other Aquatic Features

Other aquatic features include wetlands, lakes, ponds, estuaries, bogs, seeps, and springs. Wetlands are often near streams or have trees, but they are ecologically distinct from streams and forests. The Forest Practices Act identifies three major types of wetlands: significant wetlands, stream-associated wetlands, and other wetlands. Significant wetlands are defined as bogs, estuaries, and both forested and non-forested wetlands larger than eight acres.

In the northwest Oregon state forests, most wetlands are located along stream channels and are forested with red alders. Other wetlands are identified as seeps and wet areas under the forest canopy. These wetlands are usually associated with red alders, devil's club, and skunk cabbage. Many wetlands have conifers also. Sitka spruce wetlands exist in the coastal spruce zone. A few Cascades wetlands have sedges and tag alder stands.

Fish and Other Aquatic Biota

Description and Assessment

The stream / riparian forest network is a prominent feature of a watershed that commonly has the highest diversity of species within the landscape. The streams, rivers, lakes, and other water bodies that compose the stream network provide habitats for a variety of aquatic species. At least 28 species of fish use habitats in the plan area for part or all of their life history or use habitats downstream from state forests that may be influenced by state forest management. Native salmonid species in the northwest Oregon state forests include fall and spring races of chinook salmon, Coho salmon, chum salmon, winter and summer steelhead trout, resident populations of rainbow trout, and both anadromous and resident races of cutthroat trout. Other native fishes include various species of lamprey, sculpin, dace, chub, sucker, and others.

The riparian forests support a diverse array of plants, birds, mammals, and insects. There are at least 32 species of reptiles and amphibians that occur within the planning area. Approximately half of these species, such as the giant pacific salamander and the coastal tailed frog, depend on the aquatic environment for at least part of their life cycle. In addition to vertebrate species, aquatic systems support a diversity of organisms that include algae, higher plants, insects, mollusks, crustaceans, and other invertebrates.

Threatened and Endangered Fish Species

Several salmon and trout species that have been federally listed under the ESA occur in state forests (Table 2). The salmon listings are based on evolutionarily significant units (ESUs) within a species, which can result in multiple listing for the same species. For example, three listed Coho ESUs are within the planning region: Oregon Coastal, Lower Columbia, and Southern Oregon/Northern California. By far the most prominent listed fish species in state forests is the Oregon Coastal Coho Salmon, which occurs in 447 miles of stream in the planning area. This accounts for 7% of the Coho streams within the planning area (Table A-2). There is one small parcel on the North Cascade District that contains the Lower Columbia Steelhead. This is within Clackamas County along Boulder Creek, a tributary of the Salmon River. There are two occurrences of Bull trout within the planning area on Western Lane District: a 660 acre parcel near Dexter Reservoir and a 40 acre parcel along Blue River tributary.

Table A-2. Miles of stream habitat (https://www.streamnet.org/) for listed salmon species within the planning region by land ownership. This analysis includes all fish distributions for any sub-watershed (HUC-12) that was at least partially within a State Forests district.

Federally Listed ESUs	BOF miles	Federal miles	NFPL miles	Private miles	Total miles (% of miles on BOF lands)
OR Coast Coho Salmon	446.7	1451.9	198.1	4328.7	6,425.4 (7.0)
L. Columbia Coho Salmon	23.9	185.1	31.2	518.5	758.6 (3.1)
S.OR N. CA. Coho Salmon	<0.1	482.1	13.9	706.9	1,202.8 (0)
L. Columbia Chinook Salmon	5.9	133.8	40.1	194.2	374.1 (1.6)
U. Willamette Chinook Salmon	3.9	442.7	12.3	659.0	1,117.9 (0.4)
U. Willamette Steelhead	23.0	141.0	14.3	815.8	994 (2.3)
L. Columbia Steelhead	<0.1	307.1	30.9	213.1	551.1 (0)
Columbia Chum Salmon	0.3	0.0	0.0	2.3	2.6 (11.6)

Stream Restoration on State Forests

State Forests has participated in the Oregon Plan for Salmon and Watersheds since its inception in 1995. Activities in state forests that contribute to the recovery effort (as defined by the Oregon Water Enhancement Board, OWEB) of Coho include projects that directly improve in-stream habitat and road-related projects that remove salmon migration barriers, decouple road drainage systems, and minimize sediment delivery to streams (Table A-3).

Table A-3. Selected in-stream and road projects reported to OWEB, 1995-2017, by district groups. Abbreviations for districts are as follows: AT = Astoria, FG = Forest Grove, TL = Tillamook, NC = North Cascade, WO = West Oregon, WL = Western Land, CB = Coos Bay, SW = Southwest.

Enhancement Projects	District			
	AT, FG, TL	NC, WO	WL, CB, SW	Total
No. In-stream Projects	98	29	65	192
No. Trees Donated	3,590	1,037	2,582	7,209
Miles of Stream Enhanced	80	27	60	168
No. Fish Barriers Removed	227	45	51	323
Miles of Fish Access Restored	167	41	50	258
No. Type N Crossing Fixed	1,590	589	113	2,292
No. of Road Relief Culverts Installed	3,567	668	188	4,423
Miles of Road Closed or Vacated	104	11	43	158
Miles of Road Improved or Relocated	1,001	80	67	1,148
ODF In-kind Contribution	$38,454,479	$3,744,474	$3,242,462	$45,441,415
Other Contributions	$4,560,853	$791,949	$4,791,080	$10,143,882

Forest Health

Description and Assessment

The state forests of Oregon provide a variety of benefits including clean water, recreation, wildlife habitat, timber and other ecosystem services. The health of these forests is directly related to their ability to increase or maintain productivity while maintaining resistance to biotic and abiotic stressors. Fire, windstorms, ice storms, people, insects, and diseases periodically impact forest health, injuring or killing trees and other living things. These disturbances are natural and necessary processes of the forest ecosystem. However, when disturbance effects are more severe and widespread than what is considered normal or acceptable, the forest is often described as unhealthy.

Although a comprehensive assessment of ecosystem health is beyond the scope of the Western Oregon State Forests Management Plan, several key indicators of forest health can be evaluated. Key indicators include levels and trends of damage from insects, disease, animals, and abiotic stressors such as fire and weather extremes. The effects of these various disturbance agents are described in the following terms: number of acres affected, number of trees killed, degree of damage, and/or reduction in tree growth rates. All of these are measured through various survey techniques.

Because they have a unique history, many of the northwest Oregon state forests are now at a critical point in terms of forest health. Much of the Tillamook Burn was planted or seeded with Douglas-fir from non-local seed sources, with unknown long-term consequences. The recent dramatic upswing of Swiss needle cast damage is a warning that the Tillamook and Clatsop forests may not be as healthy as once thought. Increasing popularity of recreational activities in state forests of northwest Oregon increases the likelihood of new invasive species being introduced, which, in turn, could affect long-term forest health.

For the western Oregon state forests, the current condition can be ascertained by long-term trends in damage from major disturbance agents. Although western Oregon state forests does not have the widespread deterioration of forests that has occurred in eastern Oregon, several diseases have reached noticeable levels of damage in recent decades. Swiss needle cast, the highly visible foliage disease of Douglas-fir in the Coast Range, is causing serious growth decline over a large area on the west side of the Coast Range, especially in the Tillamook District. Growth reduction is severe enough on some sites that the future of many stands is uncertain.

Douglas-fir has been grown and harvested repeatedly on sites infested with the fungus *Phellinus weirii*, often increasing the amount and severity of laminated root rot on many sites. However, current management practices should stabilize or reduce unwanted effects of this disease. Black stain root disease was largely unheard of before 1969. Since then, it has reached epidemic proportions in southwest Oregon and now can be found at low levels throughout young Douglas-fir stands in northwest Oregon forests.

Relatively few insect problems occur in the early to mid-successional Douglas-fir and western hemlock stands that are common in western Oregon state forests. The most significant pest is the Douglas-fir bark beetle, whose outbreaks follow major wind storm events or root rot pockets. The Sitka spruce weevil continues to limit Sitka spruce planting by altering tree form and reducing its merchantable volume. However, with future climate change scenario predicting hotter drier summers and inconsistent precipitation, drought stressed trees will provide more favorable conditions and hosts for insect outbreaks.

Bear damage is an significant problem in some young Douglas-fir stands in state forests. Tree mortality in any year or specific area is usually low, but the cumulative mortality over many years at the same site can be significant. This is especially true when damage occurs in pre-commercially thinned stands. Since the current management practices for young stands produces favorable bear habitat, the problem of bear damage is likely to persist.

Invasive species, including exotic weeds, insects, and pathogens, currently create problems in state forests of northwest Oregon. Scotch broom and Himalayan blackberry, the state's costliest weeds at nearly $80 million annually due to lost timber revenue and direct control measures, are prevalent through most of the region (Oregon Department of Agriculture). European and Asian Gypsy moth, while not established in the state, have the potential to have long lasting negative impacts on Oregon state forests if they were to establish. Emerald ash borer has caused significant damage to ash trees across the United States and, if it were to invade Oregon, it would cause local extinction within 10-20 years, likely causing changes in stream temperatures and associated changes in plant animal communities in riparian areas below 2000' elevation.

There is no question that management has altered forest ecosystems on state lands in western Oregon state forests. However, foresters do not yet fully understand the effects of management on forest health and trees' susceptibility to pests and abiotic stresses. Continued monitoring using aerial and ground surveys and detection trapping should provide early warning of new problems, and gradually improve our ability to maintain a healthy forest.

Forest Diseases

Swiss Needle Cast

Swiss needle cast (SNC) is a native disease of Douglas-fir that has intensified on coastal lands managed by the Oregon Department of Forestry since 2010 (Figure FH-1). It affects trees of all ages and causes premature loss of needles, especially in the upper crown. This reduces tree growth and vigor across affected acres. The growth reduction, especially if sustained, will not only decrease yields but also will affect our ability to manage stands into desired future conditions. While native throughout the range of Douglas-fir, it is most prevalent on the west slopes of the northern Coast Range from the coastline to 28 miles inland. There are approximately 531 thousand acres of state forest ground within the 28 mile zone.

2018 SNC Survey Results

The 2018 SNC aerial survey detected approximately 53 thousand acres of moderate to severe SNC infection (roughly 90% of infected acres being moderate). The majority of the acres are concentrated on the Astoria and Tillamook Districts (48 thousand of the affected 53 thousand acres), followed by West Oregon at five thousand acres, and the remaing acres split evenly between Forest Grove, Coos, and North Cascade Districts (Table FH-1). It should be noted that, in 2016 and again in 2018, SNC was detected in the North Cascade District for the first time, well outside the traditional 28 mile infection zone. Conversion of infected stands is the best management option. It would remove maladapted Douglas-fir and replace with species that are not affected by the disease. However, the costs associated with this management typically exceeds the Division's share of the revenues, further increasing the difficulty of managing these stands.

Figure FH-1. SNC infected acres across state forest ownership since 2010.

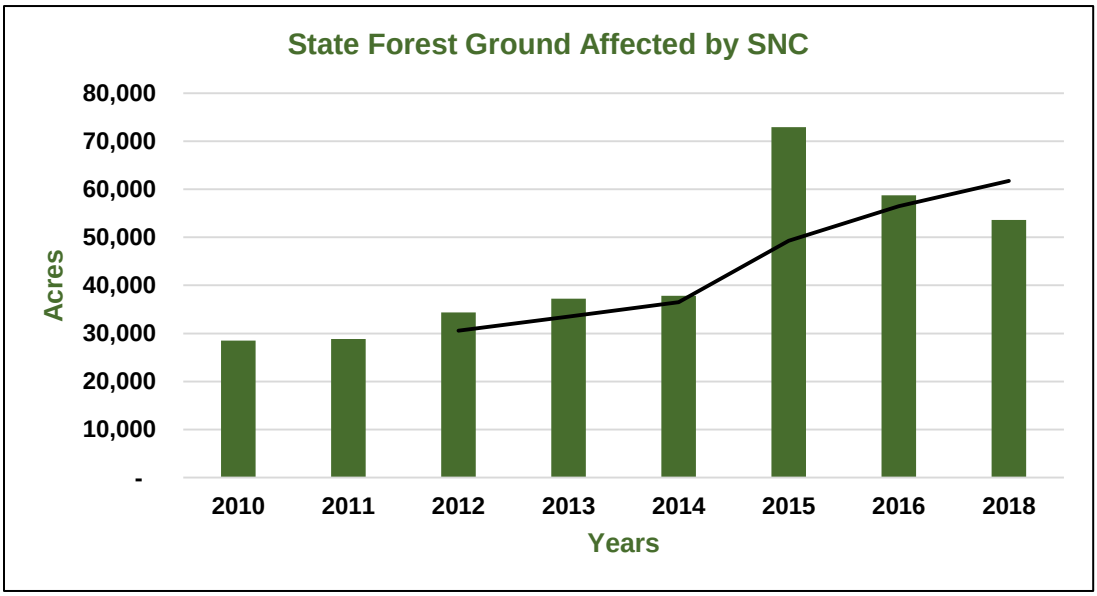


Table FH-1. Aerial survey results of SNC affected acres on Board of Forestry lands from the 2018 aerial survey.

District	Acres Affected
Astoria	12,319
Tillamook	35,909
West Oregon	4,196
Remaining Districts	1,478

Laminated Root Rot

Laminated root rot (*Phellinus weirii*), a native fungal disease that affects many conifer species, is the most widespread and destructive root disease of Douglas-fir in the Coast Range and western Cascades. On average, it effects about 5% of the Douglas-fir forest land. But the disease is distributed unevenly. Results from several surveys show that in the northwest Oregon state forests at least 10% of the Douglas-fir type is affected by this disease. The area affected in individual stands ranges from zero to over 75%. The most susceptible host species are Douglas-fir, grand fir, and mountain hemlock. Western hemlock and noble fir have intermediate susceptibility, pines and cedars are resistant, and hardwoods are immune. Trees killed by the disease provide snags and down logs which benefit certain wildlife species. The increased diversity and benefits to wildlife partially offset the large volume of timber lost to this disease annually.

Armillaria Root Disease

Armillaria root disease is far less abundant and damaging than laminated root rot, but occasionally causes significant damage in young Douglas-fir plantations. Root disease surveys have shown that in the northwest Oregon state forests, armillaria is widely scattered and occurs in very small patches, usually affecting only a few trees. Scattered dead trees from armillaria have a positive value for wildlife habitat.

Black Stain Root Disease

Black stain root disease, caused by the fungus *Leptographium wageneri*, was largely unrecognized in the Pacific Northwest before 1969. Since then, the disease has been detected in many areas, but is thought to be more localized in southwest Oregon. In recent years, reports of black stain in young, intensively managed Douglas-fir stands has increased dramatically in the northwest part of the state, especially around Hagg Lake outside of Forest Grove. Under severe infection, mortality can be as high as 50% in 10-30 year old stands.

Annosum Root Disease

Annosum root disease affects western hemlock, mountain hemlock, grand fir, and noble fir. The most significant damage occurs on western hemlock. Most decay will be associated with wounds and will be confined to woody tissues present when the trees are wounded. Losses due to annosus butt decay in hemlock stands tend to be small unless trees are older than 120 years or have been badly wounded.

Hemlock Dwarf Mistletoe

Hemlock dwarf mistletoe (*Arceuthobium tsugense*) is the only dwarf mistletoe that occurs on western Oregon state forest lands. The principal hosts are western and mountain hemlock (each has its own subspecies of dwarf mistletoe), but several true firs also can be damaged. Dwarf mistletoes are flowering seed plants that parasitize conifer trees by growing root-like structures directly into tree branches. They extract nutrients and water from host trees and cause mortality,

growth loss, deformation of tree form and crown structure, and reduced seed production (Hennon et al. 2001). In heavily infested stands, hemlock dwarf mistletoe can reduce wood volume to as little as 60% of normal. Infected trees are predisposed to damage from other stressors such as drought and bark beetles. Hemlock dwarf mistletoe can also provide food and habitat for certain wildlife species. For example, marbled murrelets have been observed nesting on hemlock branches deformed by dwarf mistletoe.

White Pine Blister Rust

White pine blister rust is caused by the invasive fungus *Cronartium ribicola* that was introduced from Europe into British Columia in 1910. Western white pine has been decimated throughout its range. Special management considerations such as pruning and planting resistant seedlings are necessary to increase survival chances.

Stem Decay

In old growth stands, decay organisms cause tree death or breakage, creating gaps in the canopy and providing rotten wood and hollow logs for wildlife. In areas with extensive young stands, the main concern may be the lack of decay and defect and its probable effect on wildlife and ecosystem processes.

Forest Insects

Douglas-fir Bark Beetle

In western Oregon, the Douglas-fir bark beetle is the most significant insect pest to western Oregon state forests. They usually infest windthrown, diseased or droughted Douglas-fir trees. When a major windstorm occurs, the large supply of high quality Douglas-fir breeding logs allows beetle populations to increase tremendously. Unless the large (more that 12” in diameter) windthrown Douglas-firs are salvaged rapidly, a bark beetle outbreak can occur when the emerging brood attacks nearby standing green trees. Outbreaks typically last 2 to 4 years, though can be prolonged when conditions are favorable.

Spruce Weevil

The Sitka spruce weevil is a significant pest of Sitka spruce regeneration in coastal Oregon. It can severly damage young, open-grown Sitka spruce. The most severe damage occurs 10 to 25 miles from the coastline, along the eastern edge of the Sitka spruce range. On these eastern sites, it is recommended that other appropiate species be planted, such as SNC tolerant Douglas-fir, western hemlock, western redcedar, grand fir, or red alder. Research suggests that a combination of higher planting desities, resistant seed, and site selection may reduce the impact of weevil infestations.

Balsam Wooly Adelgid

The balsam wooly adelgid is an invasive species introduced from Europe that has caused significant mortality in true fir species in western forests. The adelgid infests branches and

gradually reduces tree growth and vigor, eventually causing tree mortality. In more serious outbreaks, the adelgid attacks the main bole of the tree in large numbers, girdling the tree and causing death in two to three years.

Ips Beetles (Ips spp.)

The pine engraver and California five-spined Ips are significant pests to all species of pine in Oregon. Outbreaks are short-lived, usually lasting one year. However, in severe drought years, outbreaks can last for 2-3 years as trees become more and more stressed. Populations can be increased by having large amounts of their preferred host, fresh pine slash, from harvest or a disturbance event. Populations build up in slash, then spread to standing green trees.

Western Pine Beetle

The western pine beetle can cause significant mortality in ponderosa pine trees greater than 12" in diameter. Infestations commonly occur in dense, overstocked, even-aged stands. During outbreaks, western pine beetle can cause forest cover change at the landscape level.

Spruce Aphid

Spruce aphid is an invasive species that causes premature loss of older needles in Sitka spruce and eventually kills branches or the entire tree. Much of the spruce decline vsible along the Oregon coast is attributable to the spuce aphid.

Emerald Ash Borer

The emerald ash borer is an invasive species that was introduced to North American in 2002 and has since killed over 50 million ash trees across the country. While not currently in Oregon, it is reasonable to believe that it will appear in the state in the near future. The Oregon ash, an important riparian species in the cascade and coast range, is highly succeptable to infestation. A widespread outbreak of emerald ash borer has the potential to radically alter riparian forests, with widespread impacts to native bird and fish populations.

Gypsy Moth

Gypsy moth is an invasive species whose caterpillars feed on 500 tree and shrub species, including hardwoods and conifers. There are two that subspecies threaten forest resources. The European gypsy moth, or EGM, is native to temperate forests of Western Europe and was introduced to the eastern U.S. in 1869. It has since spread to 20 states and four Canadian provinces. The Asian gypsy moth, or AGM, is native to southern Europe, northern Africa, Asia and parts of the Pacific. AGM is not established anywhere in the United States. Both EGM and AGM would cause long-lasting effects on Oregon's forest economy and ecology if they were to establish in the state.

Plants

Noxious Weeds

Noxious Weed means a terrestrial, aquatic or marine plant designated by the State Weed Board under ORS 569.615 as among those representing the greatest public menace and as a top priority for action by weed control programs. Depending on the classification, the State Forests division is responsible for developing and following through with an eradication plan. Currently there are roughly 120 species listed as a noxious weed across Oregon and many of these species occur in state forests. The most common (i.e. Scotch broom, Himalayan blackberry, Canada thistle, bull thistle and Japanese knotweed) are well established throughout all of western Oregon state forests. There are other exotic species that are on the state's noxious weed list that are expanding in western Oregon state forests, such as false brome, English ivy, garlic mustard, and exotic geraniums. While not on the state's noxious weed list, there are also a number of exotic weeds that cause problems for reforestation and can harm wildlife, such as foxglove, woodland groundsel, oxeye daisy and English holly.

The most common way for new exotic or noxious weeds to be introduced is through recreation, logging equipment, or worker transportation. With increased activity across western Oregon state forests, new threats will surely be introduced, which could have long term negative implications for state forests.

Other

Drought

Droughts can take a huge toll on Oregon's conifer trees. Often, it is the primary cause of dead branches, tree tops or whole trees. Trees may also respond to drought stress by reducing root and stem growth, dropping more needles, or by producing an abnormally high number of cones ("stress crop"). Symptoms of summer droughts are not typically visible until the following spring, although recent droughts have been severe enough for symptoms to appear in late summer or fall. Many trees being affected have survived previous droughts, even on marginal sites. But past stresses and increasing water requirements due to their large size have reduced their resiliency. Drought stressed trees are often subsequently attacked by secondary agents such as insects and pathogens.

Firewood

With increased recreation use on state forests, the potential for non-native pests to be introduced via transporting of firewood dramatically increases. Both native and non-native pests and diseases can be transported via firewood and has the potential to dramatically alter the landscape. Currently there are many non-native and native insects and fungi that should be prevented from infesting state forests, including exotic emerald ash borer (*Agrilus planipennis*), Asian long-horned beetle (*Anoplophora glabripennis*), gypsy moth (*Lymantria dispar*), and the pathogen responsible for sudden oak death (*Phytophthora ramorum*) (Jacobi et al 2011).

Plants

Description and Assessment

The northwest Oregon state forests have hundreds of species of plants. Understory plants fill many roles in the forest ecosystem. They provide organic matter to forest soils, influence micro-climate and are used as cover and forage by many animals. In addition to their ecological functions, some plant species, such as beargrass and sword fern, are harvested commercially or for cultural uses. Commercial uses of understory plants are discussed in the Special Forest Products section.

This section is focused primarily on threatened, endangered, candidate, or rare plants (threatened and endangered plants), as listed under the state of Oregon's Endangered Species Act.

There has never been a comprehensive assessment or basic systematic survey for threatened and endangered plants in northwest Oregon state forests. In the late 1980s, some surveys were done specifically for the Nelson's checkermallow (*Sidalcea nelsoniana*) in the Tillamook State Forest (Forest Grove District) in cooperation with propagation studies sponsored by the city of McMinnville. The Oregon Biodiversity Information Center provides the list of rare, threatened, and endangered plants that may be found on state forest lands as well as records of known locations.

Most of these species occur in non-forested areas, such as open, high elevation rocky areas; open meadows; bluffs and coastal areas. Six species are known to be present in the state forests: Coast Range fawn lily, Nelson's checkermallow, Saddle Mountain bittercress, cold-water corydalis, Chambers' paintbrush, and frigid shooting star. The other plants have not been confirmed in northwest Oregon state forests.

The Department of Forestry is not aware of any other federally-listed threatened or endangered plant species that are likely to occur in the northwest Oregon state forests.

Current Management

The Department of Forestry protects listed plant species in accordance with the state and federal ESAs. The Department has identified listed species that occur or are suspected to occur in state forests and continues to update these lists in consultation with the Oregon Department of Agriculture. During plan implementation, districts determine if listed species occur or are likely to occur on lands where management activities are planned. If so, the district will determine if the proposed action is consistent with the conservation program for the listed species established by the Oregon Department of Agriculture and whether specific protection or mitigation measures are warranted.

Air Quality

Description and Assessment

Timber harvest and firewood gathering results in a large quantity of debris material, such as limbs, tops, and non-merchantable material. This leftover debris can be a barrier to tree planting, a fire hazard, and can increase potential for pest infestations. To eliminate the fire hazard and prepare the ground for tree planting, fire can be used as a tool to remove this material. This burning can affect air quality and is regulated under the federal Clean Air Act, the primary law regulating air quality. Under the law, the federal Environmental Protection Agency sets National Ambient Air Quality Standards.

The authority to implement the law is delegated to the states. In Oregon, the state's Department of Environmental Quality develops and carries out programs to meet the national air quality standards. Two air quality plans affect forest management directly: the Oregon Smoke Management Plan and the Oregon Visibility Protection Plan. The Smoke Management Plan (OAR 629-048) is intended to comply with the Oregon Visibility Protection Plan (OAR 340-200-0040, Section 5.2).

The Oregon Smoke Management Plan regulates prescribed burning on all forest lands in Oregon, including federal, state, and privately owned lands. Some of its objectives are to protect public health, minimize smoke intrusions into designated population areas, reduce emissions from prescribed burning in western Oregon, and protect visibility in Class I areas. Class I Areas include National Parks and certain wilderness areas (OAR 629-048-0005(5)). Appendix D has more information on laws and programs affecting air quality.

Burning is much less common than it was historically. The average annual amount of fuels burned on State Forest lands in the period from 2000-2013 is about 25% of the amount burned annually in the 80s and 90s. Current annual levels of burning on state forest lands represent less than 10% of the total burning annually in the six districts. It is estimated that prescribed burning on state lands is currently responsible for much less than 1% of the air pollution in northwest Oregon cities.

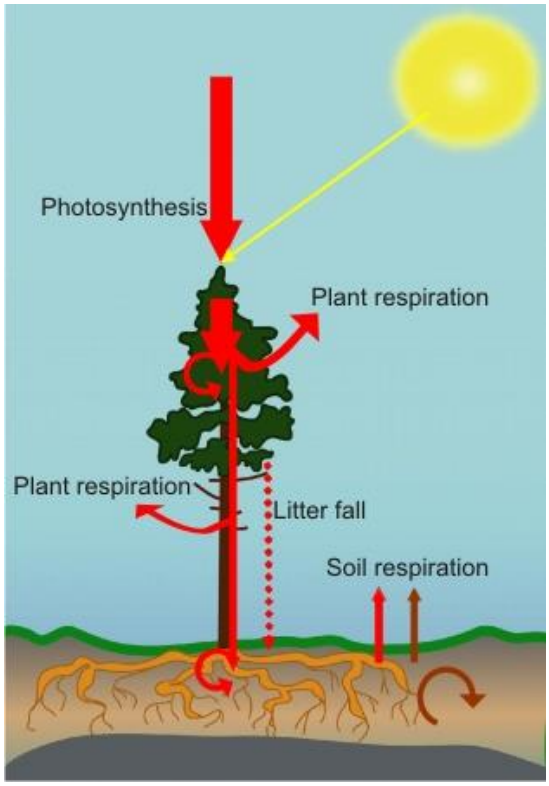
There are a number of reasons for the decline in burning on state lands. Lower quantities of slash are associated with second- and third-growth forest. More small-diameter wood is being used, also reducing the amount of debris left behind. With less slash, most units are not burned at all. When burning is used on state forest lands, the slash is typically piled on a landing and burned. On other units, spot burns treat just the pockets of heavy slash concentrations. Machinery is often used in place of burning to prepare spots for tree planting. For units that are burned, the prescribed burns are generally scheduled during spring-like conditions when fine fuels are dry but mid-sized fuels do not burn completely through.

Forest Carbon

Description and Assessment

Forest carbon is atmospheric carbon dioxide that is absorbed by trees and other vegetation through the process of photosynthesis and released during respiration and decomposition (Figure C-1). When a forest absorbs more carbon by photosynthesis than it releases through harvest, decomposition, and respiration it is considered to be a carbon sink, storing carbon absorbed from the atmosphere, to partially offset carbon emissions from anthropogenic and other sources. Conversely, if a forest releases more carbon than it absorbs, it is considered to be a carbon source. Mature forests provide long term in-situ storage of sequestered carbon in large trees, snags, down wood, vegetation, and soils. Harvesting shifts a portion of the sequestered carbon from the living biomass of trees to long-lived harvested wood products and other carbon pools. Harvest residues can be burned for energy or left on-site to slowly decay. Regenerating decadent, poorly-stocked, or under-productive stands has the potential to improve forest carbon stores over time as vigorously growing replacement stands rapidly accumulate carbon.

Figure C-1. The forest carbon cycle[2].



[2] **Source: http://www.hiilipuu.fi/articles/carbon-cycle**

State Forests has allocated forest carbon stocks into five categories, called "pools" (Table C-1). A sixth pool is recognized to account for harvested wood products. The amount of carbon in each pool is typically estimated from forest inventory variables and thus trends can be tracked over time and future change can be predicted using forest growth models. Carbon flows, or flux, describes the transitions among pools and atmospheric carbon. Stocks and flows vary considerably by stand type, ecoregion, and management history.

Table C-1. Forest Carbon Pools.

Forest Carbon Pools	Description	Proportion
Live Trees	Roots, bole, branches, bark, and foliage of live trees	38%
Standing Dead Trees	Roots, bole, branches, and bark of snags	3%
Fallen Dead Trees	Logs and large branches lying on the forest floor, larger than 3 inches diameter	7%
Forest Floor	Litter, duff, and low vegetation	7%
Soil	Organic material, excluding coarse roots	45%
Harvested Wood Products	Lumber, panels, paper, containers, and landfill	--

Factors Affecting Forest Carbon

Species

Forest tree species vary in the rate and limits that carbon can be sequestered. Many factors affect the amount of carbon that is possible on a given acre of land (e.g. differences in bole form, branch position and foliage density). Also, the density of wood varies considerably among species. For example a cubic foot of Douglas-fir has an oven-dry weight of approximately 28.1 pounds. Whereas a cubic foot of oven-dry red-alder weighs only 23.1 pounds. All other things equal a stand of Douglas-fir compared to stand of red alder with the same volume of wood will store nearly 22% more carbon.

Maximum in-forest storage of carbon is also affected by species. This is a function of life span of a tree as well as the decay rate of the wood when a tree dies. Again for comparison a Douglas-fir tree is capable of living 500 years or more. Whereas a red alder may only live to be 90 years old. Additionally, the wood of Douglas-fir is more resistant to decay and will persist as a snag or downed wood for much longer than red alder. Finally, Douglas-fir is among the tallest tree species on Earth, capable of attaining heights in excess of 300 feet. Consequently, a well-stocked Douglas-fir stand is capable of attaining a much higher volume of wood per unit area. Douglas-fir is capable of growing to 16 thousand cubic feet per acre or more by age 80, while red alder, on a productive site in the Coast Range, and might be capable of growing to 10 thousand cubic feet per acre by age 80. Coupled with the fact that Douglas-fir has higher density wood, this would result in nearly double the amount of in-forest carbon.

Mixed species stands can be beneficial for carbon storage. As result of competitive advantages among species, mixed species stands can be capable of growing productively at higher relative density that single species. This higher density can thus result in greater amount of in-forest carbon storage. Additionally, mixed species stands tend to be more resistant to insect and disease outbreaks. And in the event of a pest outbreak that affects one species, the entire stand would not be lost.

Site Productivity

Forest sites vary in their capacity to support forest growth and thus sequester atmospheric carbon. Site productivity is affected by many factors such as ecoregion, slope, aspect, elevation, soil parent material, geology, local climate, and management history. The moist forests of the Oregon Coast Range, including the Tillamook State Forest and Clatsop State Forest, are among the most productive forests in the world. Consequently they have the ability to accumulate vast quantities of carbon. Conversely, forests in Eastern Oregon persist in a climate with much lower annual precipitation, hot summers, and cold winters, leading to a shorter growing season. Coupled with the prevalence of fire in the region, these forests accumulate and store a fraction of the carbon possible in the coastal forests.

Stocking

Stocking refers to the number and size of trees per unit area. Generally stands with higher stocking will be able to capture and store more carbon. However, if a stand is overstocked, total growth could become limited due to competition for light, moisture, and other resources. Silvicultural practices (e.g. thinning) are designed to maintain the vigor of individual trees. In some cases a properly designed and executed density management regime may be able to enhance forest carbon capture and storage.

Weather

Ice, wind, drought, and other weather related factors can affect a forests ability to sequester carbon. Ice and wind can break tops out of trees, strip foliage, and break branches. While this may not immediately kill trees, it will likely reduce photosynthetic capacity, thus reducing carbon capture while the trees recover from the damage. Trees and sometimes entire stands can be completely toppled by wind and ice.

Drought has the effect of reducing the vigor of trees. The stress of prolonged drought can leave trees vulnerable to secondary stressors such as insects. In time, silvicultural practices (e.g. species composition and density management regimes) may need to be altered if drought or other adverse conditions persist due to climate change.

Wildfire

Wildfire results in carbon emissions. However, research indicates that the effective release of carbon due to wildfire is much less than commonly assumed and depends greatly on fire intensity. Combustion varies by fire intensity and the size of the fuel component, which also

affects the amount of carbon released. Duff, litter, low vegetation, foliage, and small branches, as well as small trees, snags, and down wood may be mostly or fully consumed. Whereas large trees, snags, and down wood will often only be partially consumed, with the bulk of their biomass remaining intact. Trees damaged by fire may eventually die due to environmental stressors or attacks from insects. However, low to moderate intensity fires can also have a regenerative effect on forests. Reforestation following wildfire can in some cases expedite the recovery of carbon sequestration capacity. Salvage harvesting, while beneficial for minimizing value lost to wildfire, will have a negative impact on long-term forest carbon.

Harvest

All harvesting reduces in-forest carbon in the near term. Conversion of harvested trees into wood products results in long-term storage of some of the carbon. Residues left on site will decay or become incorporated into the soil. And some portion may be burned to prepare the site for planting or to reduce wildfire hazard. Waste material and byproducts of the milling and conversion process may be burned to generate heat or electricity, offsetting fossil fuel consumption for these purposes.

Thinning, while potentially beneficial for forest health, fuel hazard reduction, and improving future product values, can have a negative impact on forest carbon. It takes many years for a stand to grow enough following thinning to return to pre-harvest in-forest carbon levels. Following a light thinning, it may take 15 years. Whereas heavy thinning may take 50 years to return to pre-harvest in-forest carbon levels (Clark, et.al. 2011).

There is ongoing and open debate as to whether carbon stored in harvested wood products, substitution of fossil fuel intensive building materials, and biomass energy production from forest residuals is sufficient to offset the losses of in-forest carbon following harvest (OGWC 2018).

Climate Change

Climate change will affect forest carbon in a variety of ways. Site-specific factors (e.g. temperature, precipitation, drought and other weather extremes) will affect the ability of a forest to sequester carbon. While temperatures and drought may increase in Oregon during the summer, annual precipitation will likely increase and winter temperatures will be warmer, leading to a longer growing season. However, there is considerable uncertainty in these assumptions. It is also likely that insect and disease prevalence will increase, counteracting any gains in productivity. Shorter and warmer winters may also be detrimental to the physiology of tree species, affecting the timing of bud set and spring release.

Current Condition

Estimates of forest carbon stocks are derived from forest inventory data. There is a direct correlation between forest inventory and above-ground carbon in that dry biomass is approximately 50% carbon. Allometric equations and component ratios are used to estimate

carbon in live trees, snags, and down wood from forest inventory data. Estimates of other forest carbon pools are made using standard methods that incorporate stand characteristics, forest type, and ecoregion. Estimates of forest carbon for State Forests are shown in the Table C-1.

Table C-2. Forest carbon estimates across the planning area. Colors represent relative stocks ranging from low (red), moderate (yellow and orange), to high (green).

		Average Carbon Stocks (tons/acre)			
	Net Area	Total Stand	Above Ground	Merchantable	Below Ground
Astoria	131,959	101.6	48.0	35.7	53.6
Coos	10,754	86.2	45.8	34.3	40.5
Forest Grove	111,698	104.8	51.1	39.1	53.7
North Cascade	46,056	109.0	50.9	38.5	58.1
Southwest	16,391	75.1	45.6	31.6	29.5
Tillamook	246,195	97.4	43.8	31.5	53.6
Western Lane	24,698	116.3	60.8	46.7	55.5
West Oregon	35,505	93.3	49.7	38.0	43.6
Total	***623,256***	***100.2***	***47.6***	***35.3***	***52.6***

NOTE: The values reported in Table C-1 are preliminary. ODF is currently evaluating carbon accounting and reporting methodologies. Future reports on carbon stocks will use methods that represent best available science and will be consistent with methods developed by the USFS Forest Inventory and Accounting Program.

Geology, Soils and Slope Stability

Description and Assessment

The landscape upon which forest management of any scale occurs is controlled by historic geologic process and their resulting formations. Volcanic activity, sediment deposition, uplift, soil formation and erosion all provide the driving forces that have given northwest Oregon its unique terrain. The soils, the most visible of the geologic materials, provide the bedding from which our forests grow. The success of this growth is determined largely by the soil character and slope aspect, both a function of the underlying formations and past geologic history. Soils and near-surface formations are moveable parts of the landscape. Landslides, part of the natural erosive process, are a testament to the changing nature of the terrain and can affect or be affected by forest management.

Geology

Volcanic activity below the surface of the ocean and offshore of an ancestral Oregon coastline, in conjunction with deposition of marine sediments derived from ancestral Cascades volcanism inland to the east, produced a submarine assemblage of volcanic rocks layered with marine siltstones, sandstones and mudstones.

Compression by tectonic activity uplifted and moved this assemblage of material east to become added to the ancient Oregon coastline. This uplift occurred in the very northwest portion of the planning area (north of the present day Tillamook Highlands) and, as a result, that area received deposition of much younger marine sediments as compared to other areas.

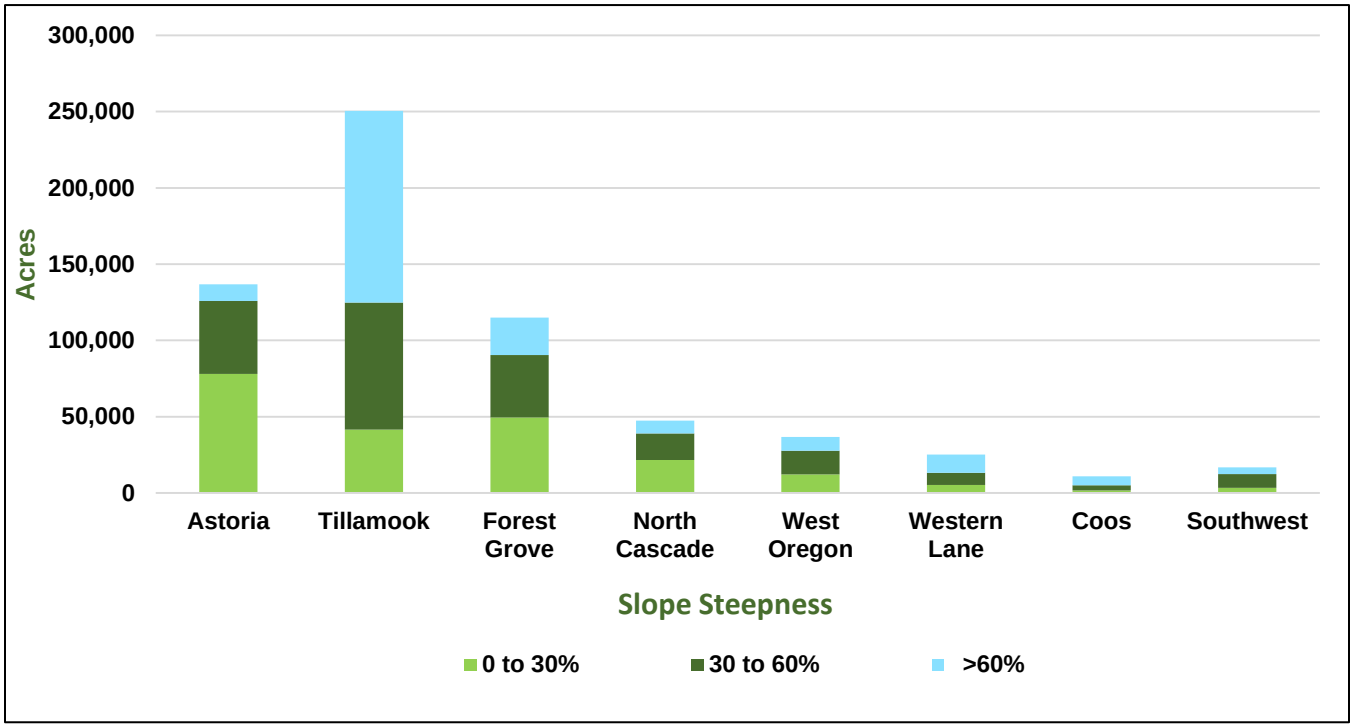
Concurrently, huge volumes of fluid basalt (flood basalts) flowed down the ancestral channel of the Columbia River Gorge, into the developing low area of the Willamette Valley, and made it to the present margin of the coastline throughout much of the northern planning area. These flood basalts seem to be absent in the area of the Tillamook Highlands and further south, indicating those areas were probably topographically higher at the time.

Erosion has modified this uplifted terrain to the highly dissected topographic expression that we observe today. Landslides, along with down cutting and transport of sediment by streams fueled by heavy rainfall, has produced the Coast Range. Concurrent tectonic activity produced periodic large earthquakes which may have triggered many of the largest, deep-seated ancient landslides observable in the planning area today. Large swaths of land area in the north part of the planning area has been extensively altered by these mega, deep-seated landslides.

Concurrent with erosion along the coastal mountains, the high Cascade volcanic mountains were formed along the eastern margin of the planning area. After volcanism, major changes to topography there were not only affected by erosion processes similar to the coastal mountains, but also glaciation.

The net effect of geology, erosion and climate can be seen in the distribution of slopes steepness across the planning area. Figure G-1 shows that nearly one-third of the acreage is greater than 60%.

Figure G-1. Slope steepness across the planning area.



Soils

From a geologic perspective there are three general soil types based on where they were formed. Soils formed from underlying volcanic formations, those formed from underlying marine formations, and those formed from alluvium (unconsolidated materials deposited by streams and rivers). Soils will almost always be thinner along ridgetops and thicker in swales due to faster and deeper weathering of underlying formations, which are wetter for longer periods and caused by gradual downslope soil movement. All soils contain varying amounts of organic and biological components in addition to the mineral fraction described below.

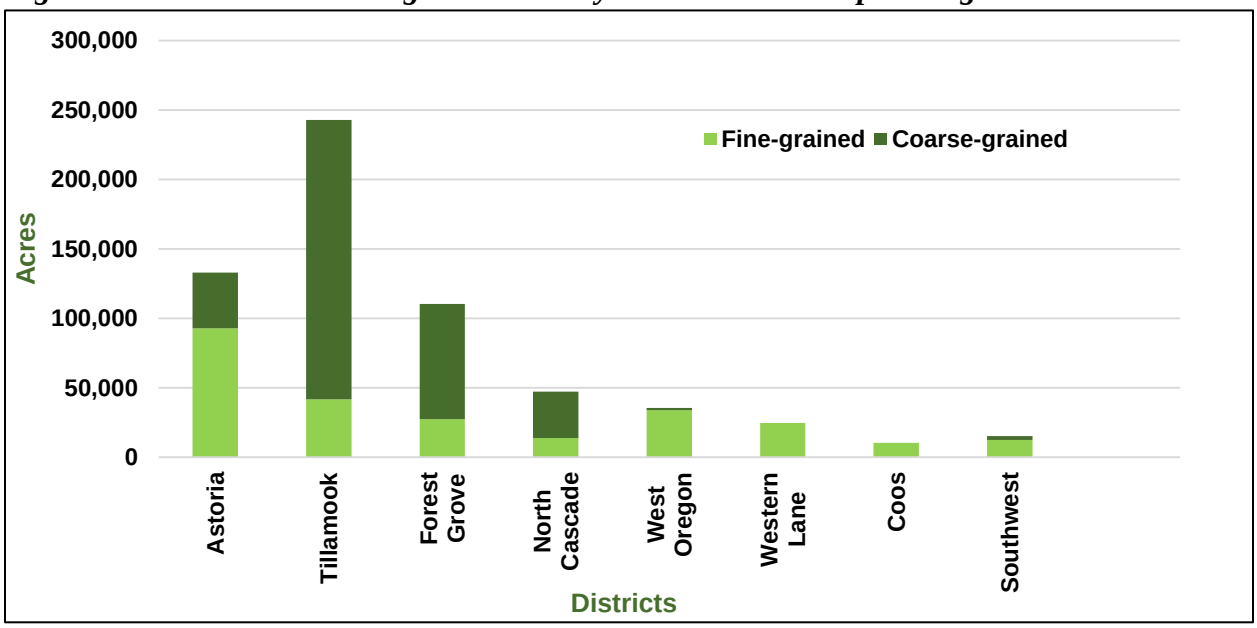
Soils formed on volcanic formations in the planning area are classed predominantly as gravels with some sand and very few silt-sized materials. These soils are very well drained, often occupy the steepest slopes in the planning area, and tend to be thinner than soils formed from marine formations or alluvium. The highest concentration of volcanic soils are located in the Tillamook Highlands, the Cascade foothills, and near the Columbia River.

Soils formed on underlying marine sedimentary formations are predominantly silts, sands and clays, with minor amounts of gravel. These are found in many areas outside the Tillamook Highlands. These soils are well-drained when occupying hillslopes but can be wet most of the year in low-lying areas. Permeability is much slower than the volcanic soils owing to their fine-grained nature. They occupy the more subdued topography of the planned area.

Alluvial soils cover a very minor percentage of the planning area because ODF lands do not cover many floodplains, which are where these soils are located. By nature of being deposited by fluvial processes, they are located on valley flats or very thin terraces adjacent to streams. These soils show little variation in character from the underlying unconsolidated alluvial material, thus they can be predominantly gravelly or silty depending on the alluvium present. The alluvial soils will generally be poorly drained due to their topographic position next to water. They are also predominantly non-plastic and non-cohesive.

By aggregating the coarse- and fine-grained soils, it is evident that the planning area consists mostly of coarse-grained soils (Figure G-2). We see that, due to the influence of ancient volcanism, Forest Grove, North Cascade and Tillamook Districts have predominantly coarse-grained soils, while the remaining districts' soils are fine-grained and were derived from softer marine sediments.

Figure G-2. Fine- and coarse-grained soils by district across the planning area.



Forest site productivity is controlled by a complex relationship between topography, slope aspect, soil depth, porosity, biology, and the availability of nutrients in the soil. Dynamic processes (e.g. forest succession, wind, and fire) affect the accumulation of organic matter in the soil. The amount and composition of organic matter affect soil fertility. Small materials such as needles and twigs have the highest concentration of nitrogen. Large materials such as down trees are important because they influence soil nutrient availability and soil moisture.

Most of the Coast Range soils vary from "highly productive" (Site Class I) for Douglas-fir to "limited in potential productivity" (low Site Class III). However, there are Site Class IV and V soils, many of which are located on or near steep rocky outcrops. Soils in the western Cascades

vary from Site Class II to Site Class V for both Douglas-fir and western hemlock. Site class productivity depends largely on soil profile depth, gravel content, topographic position, and to some extent, soil parent material. However, in general, the parent materials of these soils all provide a potential basis for highly productive soils. Observing the distribution of site class across the planning area, it can be seen that the formation of site class productivity has more complex genesis than a simple relationship to geology and topography within the planned area.

Slope Stability

All types of soil movement occur on both managed forest and forested wilderness landscapes. Landslides are observed in both mature forestland and recently harvested terrain. Sometimes in conjunction with anthropogenic influences, such as forest roads and harvest, and other times in their absence. Slides can deliver large wood along with gravels, sands and silt-sized material to streams. These organic and inorganic components are requirements for long-term aquatic health and indeed have been recognized to have contributed positively to the aquatic ecosystem. Current discussions centered around slope stability often focus on whether landslides are anthropogenic or natural and to what extent forest management activities influence them.

Examples of soil creep and the mass wasting processes of rapid- and slow-moving landslides can be easily identified across all areas, in all ownerships, in northwest Oregon and southwest Washington. These are important parts of any forest management scheme where resource protections must occur alongside economic goals. Slides are the dominant erosional process in the mountainous terrain of the northwest Oregon state forests.

Landslides, of which there are many varieties, involve different processes than soil creep. These involve a mass of soil, rock and debris that moves downward, generally together, at a similar rate. In forest management, it is useful to discuss two main categories: shallow rapidly-moving landslides and slow deep-seated slides.

Shallow rapidly-moving landslides usually only involve soils and remove them entirely from a steep slope, along with the vegetation they support. Underlying geologic formations usually form the base of these failures. Once the soil begins movement, the slide mass rapidly accelerates down-slope, often entering a stream and travelling through the stream gully for thousands of feet. As the debris passes it scours soil and entrains boulders and large wood, increasing in volume as it moves. These slides impart large forces when moving and can destroy, and sometimes completely remove, structures such as homes, concrete road barriers and guardrails.

These slides will then deposit where the stream gradient lessens, where the gully widens, or where a stream junction becomes too sharp for the debris flow to make a turn. Often, the larger components of the resulting debris deposit may then never be moved downstream due to the size of the host stream. In cases of larger steams or rivers, the debris can be shifted and re-mobilized during subsequent high-water events, which will scatter the debris downstream over time.

Shallow rapidly-moving landslides can be caused, or affected, by forest management activities. Poor road-building practices (e.g. placement of fills on steep slopes, ill-conceived culvert placement, poor attention to maintenance, and failure to recognize and plan for landslide hazards during road alignment planning and construction) can have major influence on slope stability. Timber harvest can increase the rate of occurrence of these types of slides. For a limited period after canopy removal, an increase in frequency of slides has been noted in northwest soils. Slides originating or moving through harvested slopes may not have the same large wood component incorporated into the debris to be delivered to aquatic resources.

Another common type of creeping movement that often involves both the soil and underlying geologic formation are slow-moving deep-seated landslides. This type of movement occurs faster than soil creep described above and can translate portions of the ground surface up to 20 feet each year. These phenomena, commonly involving a thousand to tens of thousands of cubic yards of material, slowly disrupting drainage patterns, destroying road grades, and, in some cases, causing large forested areas to degenerate into a mess of scarps, downed wood and swept trunks.

Within the planning area, there are hundreds of examples of these deep-seated landslides. A few are active and many more are ancient (prehistoric) and presently not moving. Almost all of these examples are naturally caused, many probably initiated by large off-shore earthquakes. However, some forest practices can affect the movement of these slides. They include large topographic modifying activities such as quarrying, aggregate stockpiling, placement of large fills, and construction of large road cuts. Especially along the toes of these features. Since these anthropogenic activities are relatively rare, the potential for destabilization of slopes and initiation of a deep-seated slide occur infrequently in our northwest forests.