3 Watershed Overview

Because the previous OWEB assessment addressed much of the general watershed information, this chapter primarily addresses details considered essential to a general overview of the project area.

3.1 Physical Setting

Located in the Coast Range mountains of northwestern Oregon, the Wilson River flows off their western flank and, along the lower river, through the city of Tillamook, eventually emptying into Tillamook Bay, one of five major river systems to do so. Nestled between the Trask River to the south, the crest of the Coast range to the east, the Kilchis River to the north, and Tillamook Bay to the west, the Wilson River watershed is comprised of eight subwatersheds (6th field HUCs; Map 2). Spanning roughly 123,000 acres, the Wilson River drainage is 30+ miles long while the width varies from <1 mile to >13 miles. The lowland alluvial plains – once forested but containing numerous hydrologically connected sloughs – are currently utilized primarily for dairy farming and rural residential housing while the forested uplands are utilized primarily for timber production and recreation (see Section 3.3).

3.1.1 Ecoregion

The Wilson River watershed, part of the Coast Range Physiographic Province described by Franklin and Dyrness (1973) and WPN (1999), spans portions of the Coastal Lowlands, Coastal Uplands and Coastal Volcanic Uplands ecoregions (Omernik and Gallant 1986). Ecoregions, which are characterized based on climate, geology, physiography, vegetation type, land use, wildlife and hydrology, allow watersheds to be classified according to the patterns that shape and form the biological and ecological functions within each watershed.

Coastal Lowlands, for example, occur in valley bottoms along the Oregon and Washington coasts and are characterized by marine estuaries and terraces with low gradient meandering streams, low elevations (e.g. 0-300 feet), moderate annual rainfall (e.g. 60-85 inches) and vegetation that typically includes a mosaic of Sitka spruce, western hemlock, western red cedar, Douglas-fir, grand fir, red alder, and estuarine wetland plants (Franklin and Dyrness 1973, WPN 1999). Also found along the Oregon and Washington coasts, Coastal Uplands are associated with the upland areas that drain into the Coastal Lowlands and are characterized by terraces with medium to high gradient streams, low to moderate elevations (e.g. 0-1,000 feet), moderate to heavy annual precipitation (e.g. 70-125 inches), and, with the exception of relatively few estuarine wetland plants, vegetation similar to the Coastal Lowlands (Franklin and Dyrness 1973, WPN 1999). The Coastal Volcanic Uplands, which extends from the upper extent of

the Coastal Uplands ecoregion up and over the crest of the Coast Range mountains, are characterized by steep-sided mountain slopes, high gradient, cascading streams, moderate to high elevations (e.g. 1,000-4,000 feet), moderate to high annual precipitation (e.g. 70-200 inches), and, except for the absence of estuarine wetland plants, vegetation similar to the Coastal Uplands (Franklin and Dyrness 1973, WPN 1999).

3.1.2 Geology, Landforms and Soils

The rocks and soils of the Coast Range mountains were formed through a combination of depositional, erosional and volcanic processes. The Wilson River watershed is located in the Tillamook Highlands, a geologic province of the north Coast Range that was formed in the Eocene epoch some 35 to 55 million years ago, where volcaniclastics and marine sedimentary rocks typically account for about 95% of the geology (Map 3 and Table 2; Wells et al. 1995).

Table 2. Geology of the Wilson River watershed by acreage and percentage of watershed area.

Category	Type	Description	Acres	% of Total
Surficial Deposits				
	Qf	Fluvial and Estuarine (Holocene)	3,590.8	2.9
	Qls	Landslide	2,916.8	2.4
	Qt	Fluvial and Estuarine (Pleistocene)	459.7	0.4
Volcanic/Sedimentary Rocks				
	Tbl	Lower porphyritic basalt flows	16,837.3	13.7
	Ty	Yamhill Formation (upper middle Eocene)	16,070.1	13.1
	Tbr	Submarine basalt tuff and breccia	15,376.4	12.5
	Thpb	Basalt of Hembre Ridge (lower-middle/lower Eocene)	9,414.7	7.6
	Tbpl	Lower plagioclase-porphyritic basalt	8,331.1	6.8
	Tpb	Submarine basalt	5,507.6	4.5
	Tybs	Basaltic mudstone	4,790.4	3.9
	Tbu	Upper porphyritic basalt flows	3,568.7	2.9
	Tbs	Basaltic sandstone (upper and upper middle Eocene)	3,457.2	2.8
	Tbpu	Upper plagioclase-porphyritic basalt	2,216.0	1.8
	Tet	Tyee Formation (lower middle Eocene)	1,336.1	1.1
	Tal	Alesa Formation (lower Miocene and Oligocene)	920.5	0.7
	Tn	Nestucca Formation (upper Eocene)	444.5	0.4
	Tals	Feldspathic sandstone	439.3	0.4
	Tbru	Upper submarine basalt lapilli tuff and breccia	427.7	0.3
	Tyt	Lower tuff unit mudstone	384.4	0.3
	Ths	Basaltic sandstone	270.1	0.2
	Tsf	Subaerial dacite, rhyodacite, and rhyolite	159.7	0.1
	Tba	Aphyric basalt	35.1	<0.1
	Tts	Epiclastic silicic tuff and tuff breccia	3.4	<0.1
Intrusives Rocks				
	Tidb	Diabase (middle Eocene)	25,448.3	20.7

Category	Type	Description	Acres	% of Total
	Tiab	Porphyritic basalt (late middle Eocene)	393.8	0.3
	Tib	Basalt dikes and sills (late middle Eocene)	164.0	0.1
	Tidb?	Presumed Diabase (middle Eocene)	143.4	0.1
	Teib	Basalt sills (late Eocene)	16.7	<0.1
Miscellaneous				
	–	Undescribed geology	3.8	<0.1
		TOTALS	**123,127.8**	**100.0**

Siltstone and sandstone deposits, along with basaltic intrusions, make up the most distinctive landforms in the watershed and the basalt formations are thought to be relic remains of an oceanic island formed during the Eocene some 40 million years ago (Wells et al. 1995). The newer siltstone and sandstone formations were formed primarily during the late Eocene but some portions were formed later in the Oligocene and lower Miocene epoch some 20 million years ago (Beaulieu 1973, Neim and Neim 1985).

The north coast is typified by long, continuous shorelines punctuated by steep cliffs and the occasional estuarine bay containing rich lowland marshes and deep, alluvial-deposited terraces. Inland, the mountains rise up sharply to elevations greater than 3,500 feet while broad, alluvial, lowland valleys disappear into narrow, steep-sided canyons where high-gradient, cascading streams and landslides predominate.

Primarily an Astoria-Hembre association, prevailing soil types in the Wilson River watershed (Appendix A) consist of deep, well-drained, highly-productive fluvial and estuarine deposits in the lowlands with moderately deep soils covering very steep terrain in the uplands (ODF 2003, TBNEP 1998). The lowland soils are collectively known as the Nehalem-Brenner-Coquille association and, with sufficient drainage, are among the most fertile soils in the surrounding area. Although much of the watershed is still forested, most of the lowlands have been cleared for agricultural production (e.g. dairy farming). The high to medium organic content soils found between the coastal lowlands and the forested uplands are known as the Quillayute-Knappa-Hebo association. Often found in extensive, broad terraces, these soils, while still fertile, are typically less fertile than the lowland soils but constitute nearly 50% of the Tillamook Basin's tillable lands (TBNEP 1998).

3.1.3 Climate

Situated in the coastal temperate rainforest, the climate in the Wilson River watershed is strongly influenced by the Pacific Ocean and its related weather

patterns (Taylor and Hatton 1999). Typical of Pacific Northwest climate, the Wilson River watershed experiences an extended, mild, winter rainy season followed by a moderately warm and relatively dry summer season. Precipitation generally falls as rain and increases with elevation as warm, moisture-laden air rises over higher terrain, causing the air to cool and drop precipitation (orographic effect). Mean annual precipitation in the city of Tillamook is just over 90 inches, increasing dramatically further up in the watershed to around 200 inches at the summit. Over 50% of the precipitation falls from November through February (average is nearly 13 inches per month) but nine months out of each year typically receive 3 inches or more of rain (refer to Sections 3.4.2 and 5.2.1 for detailed hydrology discussions). Average high temperatures hover around the mid-fifties (Fahrenheit) in the winter months and the high sixties during the summer months. Average low temperatures dip to the mid-thirties during the winter and the mid- to upper fifties in the summer.

3.1.4 Ownership

This watershed analysis recognizes five classes of land ownership: Private Industrial, Private Non-Industrial, State Administered Lands, Federally Administered Lands, and Miscellaneous city/county/state administered lands (Map 4). The Wilson River watershed covers some 123,128 acres and State lands account for the largest proportion by land area at slightly less than 98,000 acres (~80%; Table 3). Approximately 31,330 acres are administered by the Forest Grove ODF district and the remaining 66,423 acres are administered by the Tillamook ODF district (Map 2). The remaining acreage is split between Private Industrial (~12.3%), Private Non-Industrial (~5.2%), Federally Administered Bureau of Land Management (BLM) lands (2.9%), and Miscellaneous lands administered by the City of Tillamook, Tillamook County, or the State Department of Transportation (~0.5%; Table 3).

Table 3. Wilson River watershed land ownership by acreage and percentage of watershed area.

Owner Administration Class	Acres	% of Total
State-Administered Lands	97,320.3	79.0
Private Industrial	15,160.7	12.3
Private Non-Industrial	6,383.7	5.2
Federally-Administered Lands	3,703.3	3.0
Miscellaneous Administered Lands	559.8	0.5
TOTALS	**123,127.8**	**100.0**

3.1.5 Waterboundaries

This watershed analysis is organized according to a hierarchy of hydrologic unit codes (HUCs) delineated by the US Geological Survey. The Wilson River watershed, a 5th-field HUC, falls within the Wilson-Trask-Nestucca 4th-field HUC (17100203) and is further divided into eight 6th-field HUCs (subwatersheds) consisting of the Lower Wilson River, Little North Fork Wilson River, Middle Wilson River, Upper Wilson River/Cedar Creek, Jordan Creek, North Fork Wilson River, Devils Lake Fork Wilson River, and South Fork Wilson River (Map 2 and Table 4). The other prominent water feature in the watershed is Tillamook Bay, into which the Wilson River empties.

Table 4. Wilson River subwatersheds (6th field HUCs) by acreage and percentage of subwatershed area.

Subwatershed (6th field HUC) Name	Acres	% of Total
Devils Lake Fork	22,106.0	18.0
North Fork Wilson River	17,296.6	14.0
Lower Wilson River	16,893.3	13.7
Jordan Creek	16,201.0	13.2
Upper Wilson River / Cedar Creek	14,307.0	11.6
Middle Wilson River	13,486.7	11.0
Little North Fork Wilson River	12,620.5	10.2
South Fork Wilson River	10,216.7	8.3
TOTALS	**123,127.8**	**100.0**

3.2 Biological Setting

3.2.1 Early European Settlement

The historical characteristics of Tillamook Bay (and the Wilson River watershed) prior to the mid-1800's are not well documented. Our current understanding of the natural resources during exploration and settlement is limited to a handful of written accounts from early explorers and pioneers and to research into and accounts from Native American culture.

While the Spanish Bucareli expeditions and Captain James Cook explored much of the northern Oregon Coast in the 1770's, it wasn't until 1788 that John Meares, a fur trader and former lieutenant in the British navy, had the opportunity to explore the Tillamook Bay region (Elliot 1928). His accounts provide the first written records of the natural resources of the area.

Mears describes the countryside (probably the southern portion of the bay) as "an open champaign country extending a considerable distance, where it was confined by a boundary of lofty mountains" (Elliot 1928), the implication being that the lowland countryside was open and had little timber blocking his view. The next written account comes from the Lewis and Clark expedition during the winter of 1805-1806 when Clark describes a river to the north of Tillamook Bay (the Necanicum; then called the Neah-Hoxie)[7] as being "entirely boarded by overhanging trees" and the mountains of the Nehalem basin, located just north of Tillamook Bay, as "covered with a verry [sic] heavy growth of pine and furr [sic], also the white cedar or arbor vita and a small proportion of the black alder, [which] grows to the height of sixty or seventy feet and from 2 to 3 feet in diamiter [sic]" (Bancroft 1886).

Distinguished explorer William Clark, through his communications with the Native Americans of the area, learned that most of the Native Tillamook peoples lived in numerous houses at the mouths of three rivers that entered the bay, they caught many salmon in the small creeks, and when salmon were scarce, "found sturgeon and a variety of other fish thrown up by the waves and left by the tide" (Bancroft 1886). While this doesn't give us an idea of how large the salmon runs were, it does suggest that salmon were plentiful enough to support a large settlement of Native Americans living in the area, at least for portions of the year. Later archaeological explorations found evidence for at least ten different Native American villages around Tillamook Bay, the earliest dating back at least 1,000 years (USACE 1975).

The Tillamook countryside supported other vast food resources (e.g., fish, shellfish, crab, berries, roots big game, etc.) and anthropological and archaeological evidence indicates that the Native Tillamook peoples were not agrarian, relying instead on these plentiful resources (Taylor 1974). While they may not have actively planted crops, Jesse Applegate, a prominent Oregon pioneer, noted that the Tillamook, similar to many of the other Native American tribes of the area, had a custom to "burn off the whole country" late in the autumn every year to harvest grain. The Native Americans were also reported to set fires in old growth spruce and fir to clear areas for their ponies and encourage verdant re-growth (Winters 1941).

William Clark also noted another disturbance around the Tillamook Bay and surrounding coastline in the 1800's, although likely not anthropogenic in nature. His journals from the winter of 1805-1806 note that tremendous landslides were visible in the coastline around the Nehalem River, located just north of

[7] Although this translation is taken directly from Bancroft 1886, there is some confusion as to which river is actually being referenced (e.g., Necanicum versus Nehalem).

Tillamook Bay, were "fifty or a hundred acres" across (Bancroft 1886). While these notes pertain mostly to coastline hillslopes, they suggest that landslides were probably common in the area prior to European settlement and may have also been found further inland as hillslope gradients increased.

At the time of early European exploration, the Tillamook Basin was (and still is) evenly distributed between the Sitka spruce and western hemlock vegetation zones (Franklin and Dyrness 1973). The dense stands of timber the early explorers encountered (Bancroft 1886) would have included Sitka spruce, western hemlock, western red cedar, Douglas fir, grand fir, Pacific yew, red alder, bigleaf maple, black cottonwood, and Oregon ash (TBNEP 1998). The lush vegetation they encountered (Bancroft 1886) would have included a variety of shrubs, ferns and mosses like the western sword fern, bracken fern, thistle, fireweed, wood sorrel, red and green huckleberries, salal, red elderberry, salmonberry, vine maple, Oregon grape and rhododendron (TBNEP 1998).

3.2.2 Vegetation

The Wilson River watershed straddles parts of both the Sitka spruce and western hemlock vegetation zones (Franklin and Dryness 1973). Both vegetative zones extend from British Columbia south to Northern California, roughly running parallel with the Eastern Pacific coastline (Franklin and Dryness 1973). The spruce zone, typically found at elevations of less than 450 feet above sea level, covers the lower portion of the watershed and is characterized by moderate to heavy annual rainfall (e.g., 78-118 inches/year) with frequent dry season moisture coming in the form of dense fog banks. The western hemlock vegetative zone typically extends from 450 feet elevation up to the subalpine zone of the Coast Range, receives heavy annual rainfall (e.g., ~142 inches/year) but receives the summer fog moisture found at lower elevations, and frequently experiences a dry season that extends from the late spring through the fall. Both vegetative zones typically have well-developed soils that are rich in organic matter and support a myriad of lush, dense overstory and understory vegetation.

Although much of the watershed has been heavily influenced by both natural and human-caused disturbance (see sections 3.4 Natural Disturbances, 4.7 Channel Modifications, and 4.8 Historic Channel Disturbances), the current set of vegetative species is probably similar to pre-European conditions (see Chapter 6 Riparian and Wetlands). The structure of the vegetative communities, (i.e., successional stages and species compositions), however, has been heavily influenced by humans. In the late 1800's and early 1900's, large sections of the lowlands and tidal areas were cleared of timber, the wetlands drained, and the rivers diked for agricultural use, often resulting in profound impacts to the vegetative communities. Much of the uplands were logged and/or burned over (both naturally- and human-influenced) and, with some exceptions, replanted

primarily with one species of tree, the Douglas fir. More recently, replanted Douglas fir (many of the seedlings were from an off-site seed source) have been increasingly infected with Swiss needle cast, a foliage disease resulting in defoliation and reduction in growth, which carries with it the potential for very significant forest health issues (e.g., decreased production and disease/insect resistance, increased fire danger and severity, etc.). Nonetheless, as we learn more about the ecology, natural processes, and community interactions of the area, the management of the Tillamook State Forest is continually refined to bring about more natural conditions while still providing for natural resource demands (for detailed vegetation discussions, refer to Chapter 6, Riparian and Wetlands).

3.2.3 Fish

Of particular importance to the ODF is an understanding of how watershed processes may be influencing salmonid populations and their habitats. Understanding historic and current conditions of salmonid populations allows managers to better predict how different land use practices may influence target populations. While a variety of other non-salmonid fishes are known to occur within the basin, salmonids are of primary importance to managers as they provide substantial ecological, economic, and cultural benefits for the citizens of Oregon and are often used as indicator species of overall aquatic health. For a detailed list of non-salmonid species known to occur with in Tillamook Bay and the Wilson River, see the Tillamook Bay National Estuary Project (TBNEP; 1998) and E&S Environmental Chemistry (2001) reports.

A variety of anadromous salmonid species are known to occur within the Wilson River watershed, including chum (*O. keta*; Map 5), Chinook (*Oncorhynchus tshawytscha*; Map 6), and coho salmon (*O. kisutch*; Map 7), steelhead trout (*O. mykiss*; Map 8), and both resident and sea-run forms of cutthroat trout (*O. clarki*, no map available). While their life histories and habitat requirements differ, all are freshwater obligate spawners and spend portions of their life in freshwater, estuarine, and marine (except for resident cutthroat trout) environments before completing their life cycle in their natal streams.

Salmonid bones have been found in Native American middens, the prehistoric equivalent of a trash dump, dating back at least 1,000 years (USACE 1975). In fact, some of the earliest accounts of interactions between Europeans and the Native Tillamook peoples indicate that they subsisted on the many salmon they caught in the small creeks, at least for portions of the year (Bancroft 1886). Additionally, given the historic size of many of the coastal salmon runs and their importance as a food source for many aquatic and terrestrial organisms, it is likely that large portions of the Wilson River watershed were also dependent on the salmon, relying on the large annual influx of (marine-derived) nutrients.

For a more detailed look at historic and current salmonid abundance and distributions, refer to Chapter 9 – Fish and Fish Habitat.

3.3 Social Context

3.3.1 Historical Land Use

Native Americans have inhabited the Tillamook Bay landscape for at least the last 1,000 years, living primarily at the mouths of the rivers that empty into the bay (Bancroft 1886, USACE 1975, Winters 1941). Because written accounts of the area don't start appearing with any frequency until the later half of the 19th century (after European settlement), it is difficult to assess the impacts Native Americans may have had on the landscape prior to European settlement. What is known, however, is that the Native Tillamook peoples, similar to other tribes of the area, appear to have routinely burned the lowlands and sometimes the uplands to promote rigorous plant regeneration and to clear areas for pasturage (Winters 1941). The frequency, extent and severity of these fires, however, is unknown but oft-debated. Nevertheless, mapping of 100- to 200- year old tree growth in the southern part of the Tillamook Basin watershed in 1850 indicates possible fire disturbances extending as far back as the mid 1600's (Botkin 1995) and natural stands of Douglas-fir in the watershed may also indicate a revegetation process controlled by fire (Coulton et al. 1996).

One of the earliest documented major fires in the Tillamook Basin occurred in 1845 but started in the Willamette Valley near Champoeg in Marion County and, after several weeks, crested over the coastal mountains and rapidly continued burning coastward, driving many Native Americans to Nestucca Spit and Sand Lake (Johannessen 1961). In 1851, the first European settler arrived in Tillamook, after which, fires in the area were documented in greater detail and over increasing areas up through 1874 (Coulton et al. 1996). A big fire in 1868 started in Clatsop County but quickly spread south and burned much of the Tillamook uplands, settlers and Native Americans both saying it was the largest fire they had ever seen.

As more Europeans began settling in the Tillamook region, the demands for lumber increased. The earliest logging operations, mostly clearing the lands for farming, supplied the personal needs of the settlers and occurred within close proximity to the lowland homesteads to minimize labor expenditures. By the early 1860's, however, the first commercial logging began in earnest. Three lumber mills opened in 1863, all one-man operations, to supply lumber for the growing settler population. By 1870, however, all three mills had closed.

The lowlands of the Tillamook region were highly valued as farmland and property values in the area increased rapidly through the end of the 1800's. By

the late 1800's, nearly all the tidelands adjacent to the Tillamook Bay shoreline were privately owned (T.J. Murray & Associates 1982) and, with the help of an increasing network of dikes and drainage ditches, utilized primarily for agriculture. The uplands, however, largely inaccessible due to their steep topography, were still in the public domain.

By the end of the 1800's and early part of the 1900's, farmland property values in the Tillamook region began declining as large lumber companies from the Great Lakes region began purchasing many of the private lowland farms while concurrently purchasing large tracts of the public domain upland forests, the change from agriculture to forestry more pronounced in Oregon than other western states (Swift 1909). While early logging was done by hand and in close proximity to the mills, large-scale logging and the mills that processed the logs into lumber began in earnest in the 1880's, with trees felled by hand but drug by oxen teams to the mills in summer months to be milled in the wet winter months. This early industrial logging was also confined mostly to the foothills but also began to move further inland along major waterways, including the Wilson River, where large log drives to move timber to valley sawmills became commonplace (Photographic Plate 1; Farnell 1980). While splashdamming was commonplace in the Tillamook River, it was a technique apparently not utilized in the Wilson River (Sedell and Duval 1985). Instead, large log drives that occurred during high water events (Photographic Plate 1) were the norm and occurred as far upstream as the Lee's Camp area (~30 miles upstream; Sedell and Duval 1985; refer to Section 4.4 for a detailed discussion on historic channel modifications resulting from log drives).

Logging initially focused on the selective harvest of the largest Douglas fir trees along accessible waterways but by the early 1900's, oxen teams were replaced by steam donkeys and railroad access to interior portions of the watersheds made previously inaccessible timber available for clear-cut basin harvest (Coulton et al. 1996). Operators usually burned the slash in the cutover areas to protect against wildfire and then moved on to the next tract, leaving the cut areas behind with no reforestation efforts (Fick and Martin 1992). Many of the cut-over lands were allowed to go tax delinquent, a process exacerbated by the Great Depression and large wildfires that burned much of the region repeatedly from 1933 to 1951. Collectively called the Tillamook Burn, much of the remaining timber in the Wilson River watershed was burned over in the 1933, 1939, and 1945 Tillamook fires, leaving the timber companies that owned the forested land with little incentive to keep up with the taxes (refer to Sections 3.4.1 and 3.5.2 for detailed wildfire discussions).

Tax-delinquent lands were later seized for the counties by the State, creating a vast new public domain. Because the lands had been removed from tax roles, the

counties were left with a crushing tax unit burden (Fick and Martin 1992). The counties, in an effort to recoup some of the lost income, turned to cattle grazing in the burned-over areas in the 1930's (clear through to the early 1950's), but thick vegetation made grazing unpractical (Fick and Martin 1992). Left with few options for recouping the lost income from tax-delinquent lands, the counties looked to other agencies to manage the lands.

The Oregon Department of Forestry, created in 1911 with the primary goal of controlling forest fires, was authorized to acquire forested lands to manage. In its early years, however, no lands were acquired but later State legislatures revised the acquisition portion of the agency to make land acquisition easier. In 1939, Oregon Governor Charles Sprague expressed a desire to create a strong Forestry Department to manage the tax foreclosed forested lands and the State Legislature responded by passing the State Forests Acquisition Act of 1939. The law directed the Board of Forestry, which oversees the Forestry Department, to acquire and consolidate forested lands and rehabilitate and manage them in perpetuity in trust for the counties (and other taxing units).

Senate Bill 261, enacted by the State Legislature in 1941, allowed the State to acquire forested county lands (as opposed to simply managing them for the counties) with the approval of the county or board of commissioners of the county, while still providing the counties with revenues generated from the sale of timber on those lands. In 1943, Tillamook County entered into a timber agreement with the Department of Forestry where title to the land was transferred to the State but 90% of the proceeds from timber sales associated with those lands would go the counties for a period of 10 years[8]. The result was that the vast majority of the watershed was transferred from County to State hands and, in 1944, the Board of Forestry adopted an official Land Policy that, with few revisions, still provides the foundation for how the State-owned portions of the Wilson River watershed is managed today.

Legal sales and court-rulings transferred a small portion of the Wilson River's forested uplands back into private hands from the 1950's through the 1970's. While the majority of the forested uplands in the Wilson River watershed are still under State control, a small portion is managed by private timber interests. Even though some of the Wilson River lowlands were sold to Great Lakes lumber companies in the late 1800's and early 1900's, the majority of the lowlands are still under private agricultural interests and are utilized primarily for raising dairy cows.

[8] Currently, the counties receive roughly 64% and ODF receives the remainder.

3.3.2 Current Land Use

Land management practices can have significant impacts on processes operating in a watershed. For example, timber harvest can alter a watershed's hydrology by increasing road densities and clearing vegetation, resulting in increased peak flows and changes to sedimentation and erosion rates (Naiman and Bilby 1998). Due to the abundance of rich organic soils, coastal wetlands are/were often drained for agricultural use, disconnecting the floodplains from the river, resulting in habitat losses for floodplain dependent species and dramatic decreases in deposition of rich organic matter. Through a better understanding of how land management activities affect biological and landscape processes, managers can better evaluate the effects of disturbances and work to mitigate the impacts.

The dominant land use in the Wilson River watershed is forestry, accounting for roughly 95% of the watershed's total area (Map 9 and Table 5). The coastal lowland areas in the watershed are dominated by agricultural use, primarily for dairy pastures (~2% of the total watershed area), but development, mostly in and around the City of Tillamook, also accounts for about 2% of the total watershed area (Map 9 and Table 5). Forest management, agricultural use, and urban development have the potential to influence a variety of watershed processes in the Wilson River and a summary list of watershed issues, organized by major land use activity, is included in Appendix C (summarized from WPN [1999]).

Table 5. Wilson River land use by acreage and percentage of total watershed area.

Land Use Type	Acres	% of Total
Forestry	118,591.4	96.3
Agriculture	2,238.5	1.8
Rural Residential	2,111.4	1.7
Park and Recreation	85.7	0.1
Rural Industrial	59.8	<0.1
Rural Commercial	29.6	<0.1
Urban	11.5	<0.1
TOTALS	**123,127.8**	**100.0**

Additionally, recreation has long been an important and valuable output of the Tillamook State Forest and the Wilson River watershed delivers the majority of opportunities compared to the rest of the forest. Traditional pursuits like hunting, camping and fishing have continued to draw visitors, while new uses have rapidly increased in intensity and distribution. That trend has been fueled by

population growth, change in technology and the development of road access across the forest from salvage and reforestation activities.

The biggest increases in recreation use is associated with OHVs, with a 50% increase in OHV ownership between 1997 and 2001. OHVs are used 1) in support of traditional recreation pursuits and 2) as a stand-alone recreational tool. The Wilson River highway provides easy access to the watershed for users from both sides of the Coast Range. Correspondingly, recreation development is more intense near the highway.

From the late 1960s to the early 1990s ODF concentrated on forestry activities while OHV recreation spread across the forest with little active management and control. The adoption of old (legacy) roads and trails for OHV use has exacerbated the impacts from heavy informal OHV use and organized events. With the passing of House Bill 2501 in 1991, ODF had the management directive, funding and technical support from the Oregon Parks and Recreation Department needed to craft a comprehensive recreation management plan. The core purpose of the plan was to address the host of resource impacts, management issues and social conflicts that had developed over time.

Since the plan was developed in 1993, considerable progress has been made in addressing the impacts, issues and conflicts through the development of regulations, staff, programs and enforcement presence in partnership with local law enforcement agencies. In addition, ODF has developed proactive programs to inform, educate and involve users in the planning, design, construction and maintenance of facilities and trails.

Several important factors contribute to the difficulty in keeping watershed impacts at a manageable level, they are:

- Extensive penetration into all corners of the forest by OHV and vehicle based recreational users.
- Extensive use of RVs and OHVs by hunters puts additional pressure on dispersed campsites and trails during the wet season.
- Intensive use of accessible riparian areas for dispersed camping and OHV recreation causing localized but chronic erosion and resource damage
- Cut bank riding and road drainage sedimentation
- Garbage, human waste, dumping and temporary campsite remains
- Uncontrolled target shooting and associated trash

- User defined trails with high resource impacts
- Vandalism to signs, structures, private property and forest resources
- Unmanaged and unrestricted minor forest products gathering

ODF has had some success in tackling these problems over the last 15 years but continue to face challenges that prevent staff from keeping up with increasing user demand, facility maintenance and preventing new impacts. Decreasing club membership and changes among recreational communities sometimes work against efforts to build partnerships, volunteerism and ownership in the facilities provided for them by ODF. Rapid population growth, a drop in club ownership (less than 10% of users) and a high degree of independence makes communicating information about recreation management more difficult.

Oregon is fortunate in having funding programs to assist clubs and agencies in developing and maintaining recreation facilities, and ODF has been very successful in securing grants for these purposes. With the completion of the Statewide Trails Plan, motorized, non-motorized and water trails have a framework and additional funding for meeting recreation demand and satisfying needs across the state. It is hoped that this report, the Second Party Recreation Assessment (Reed 2007) and ODF's past successes will help direct and leverage the necessary support for tackling resource impacts identified within the watershed.

3.3.3 Economies

Similar to many coastal towns, Tillamook County's economy was largely driven by the timber industry until the industry collapsed in the late 1980's. While the Forest accounts for over three quarters of the watershed by land area, the economies of Tillamook County are now largely farm driven. Farm jobs, however, only account for 6.5% of the jobs by occupation while 1) management, professional (and related), and 2) sales and office jobs account for nearly half of the jobs (49.1%) by occupation (US Census Bureau). From an industry perspective, agriculture, forestry, fishing, hunting and mining-related jobs provide the 4th largest number of jobs in Tillamook County and accounts for 11% of individuals older than 16 that are employed. The educational, health and social service sector accounts for the largest number of industry-related jobs in the county at 16.1% with, rounding out the top five, manufacturing second at 13%, retail trade third at 12.4%, and arts, entertainment, recreation, accommodation and food services fifth at 10.7% (US Census Bureau).

The vast majority (89.2%) of Tillamook County residents are of Anglo-American descent. There is, however, a growing population of Hispanic or Latino origin

peoples immigrating to the county and, while still lower than the statewide average of 9.9%, they now account for 7% of the county residents. Similar to the statewide average, nearly 85% of the county residents age 25 and older have a high school diploma, while, slightly lower than the statewide average of 25%, nearly 20% have a Bachelor's or higher degree. Nearly 72% of the residents own their own home (the statewide average is 64.3%) but the median annual family income is $34,727, nearly 20% lower than the statewide average.

3.3.4 Population

The Wilson River drainage contains only one population center; the city of Tillamook. During the first half of the 20th century, the population in Tillamook County increased dramatically from 4,471 individuals in 1900 to 18,606 in 1950, due largely to the increases in farming and timber harvest activities. Tillamook County experienced a population decline in the 1960's, a sharp increase in the 1970's through the first part of the 1980's followed by a steady increase through 2000 (US Census Bureau). The most recent US Census (2000) counted 24,262 individuals in the county and estimated that the population would grow by just over 4% through 2005, slightly less than the projected State population growth of 6.4% (US Census Bureau).

Although the county has continued to experience population growth, data from the Center for Population Research and Census (1997) indicate that birth rates in Tillamook County have been decreasing while death rates have been increasing. According to the TBNEP (1998) report, Tillamook County's population growth can be attributed to migration/relocation of families into the county, primarily persons of Hispanic or Latino origin (US Census Bureau).

3.4 Natural Disturbances

Episodic natural and human-caused disturbances are an intrinsic property of landscapes including the northern Oregon Coast Range. Disturbances such as fires and large storms deliver the majority of sediment, and a large proportion of large wood (LW) to streams. Consequently, landslides, debris flows, and floods shape many attributes of riverine conditions, including fish habitat. It is important to consider the history and role of natural disturbance in the Wilson River watershed because it can provide an important context from which to consider how human disturbances, such as timber harvest, road construction, and river engineering projects, are changing the natural environment.

There is little information available, however, pertaining to the natural disturbance history of the Wilson River watershed and surrounding areas, particularly regarding mass wasting, wood recruitment, and channel conditions. Additionally, historical maps, aerial photographs and written accounts of

historical fires provide limited information on wildfire behavior in the watershed. Yet, some information exists relating to the history of forest fires, large floods and wind storms in the watershed in the last century and it is presented below.

To supplement the limited historical information on natural disturbances, computer simulation results covering natural variability of wildfire occurrence, forest ages, landslides and debris flows, and wood recruitment from humid temperate landscapes in the Oregon Coast Range and southwest Washington are presented in Appendix E. Additionally, NOAA-Fisheries is currently conducting computer simulations of natural disturbance and its consequences to the types and abundance of aquatic habitats in the Oregon Coast Range (Earth Systems Institute - research, in progress).

3.4.1 Fire as an Historic Disturbance

Prior to Euro-American settlement, wildland fires were the dominant natural disturbance in the Coast Range (Wimberly 2002); site moisture and ignition opportunities limited the probabilities for large-scale fire events. When large-scale fires would occur, they generally occurred with high severity (~70% mortality) at large spatial scales (thousands of acres), at a relatively long fire return frequency (100 – 200 years). Fires from Native American influences would occasionally escape the Willamette Valley margin into the Coast Range, increasing the fire return frequency in the ecotonal areas along the Coast Range/ Valley interface.

Since Euro-American settlement (mid 1800's), fire frequencies increased in the region through treatment of logging slash, railroad and small engine spark scatter, and settler development (e.g. pasture establishment). Large-scale, high-severity fire events burned the majority of the analysis area in the past century, most notably the Tillamook Fire in 1933, which burned ~240,000 acres of forestland within and around Tillamook County (Map 10). The Saddle Mountain Fire in 1939 (~190,000 acres) and the Wilson/Salmonberry Fire complex in 1945 (~180,000 acres) largely occurred on the same land areas in the Wilson River watershed as the Tillamook Fire, resulting in high residual mortality, severely damaged soils, and inhibited natural regeneration for the majority of the watershed. Salvage logging, roads and subsequent (smaller scale, slash-derived) fires further shaped the overstory vegetation of the uplands and riparian zones (Photographic Plate 2), minimizing the shade, bank stability, and recruitment of large wood (LW) to the stream system.

Though no large-scale peak flow events appear to be outside of normal for the time period following the fire events[9] (between the 1930s and the 1970s), there was likely a high range of disturbances that affected the riparian zones and plant community successional dynamics, especially in lower-order (small and medium) stream channels. Channel migration and mass-wasting events, with limited LW recruitment to aid in channel stability, created a highly dynamic near-stream environment that shaped the establishment and trajectories of the riparian plant communities. These combined effects of high-severity fires, salvage logging, and stream migration/ mass wasting have contributed to shifts away from late successional, "disturbance intolerant" species (western hemlock and western red cedar) to early-successional species that are "disturbance tolerant", or even dependent upon disturbance, such as red alder, black cottonwood, shrubs, and herbaceous species. When given enough time between disturbance events, Douglas-fir was able to establish and *resist* many smaller-scale disturbances, resulting in a mixed hardwood/conifer community that currently dominates the riparian landscape[10]. For a more detailed discussion on the Tillamook Burn, refer to Section 3.5.2.

3.4.2 Flooding as an Historic Disturbance

Periodic flooding was relatively common in the Tillamook Basin and historic summaries of past and present flooding in the region are provided in Levesque (1980), Tillamook County (1996) and Coulton and others (1996). Data on annual peak flows, extending back several decades, are available from only one gage within the Wilson River watershed (Wilson River near Tillamook, #14301500; drainage area = 161 mi^2), located at River Mile 11.4 (Figure 1). Recurrence intervals were calculated for the period of record using techniques described by the Interagency Advisory Committee on Water Data (1982).

[9] See Hydrology Section, Peak Flows section 5.3.
[10] See Riparian Vegetation Current Conditions, section 6.1.5.

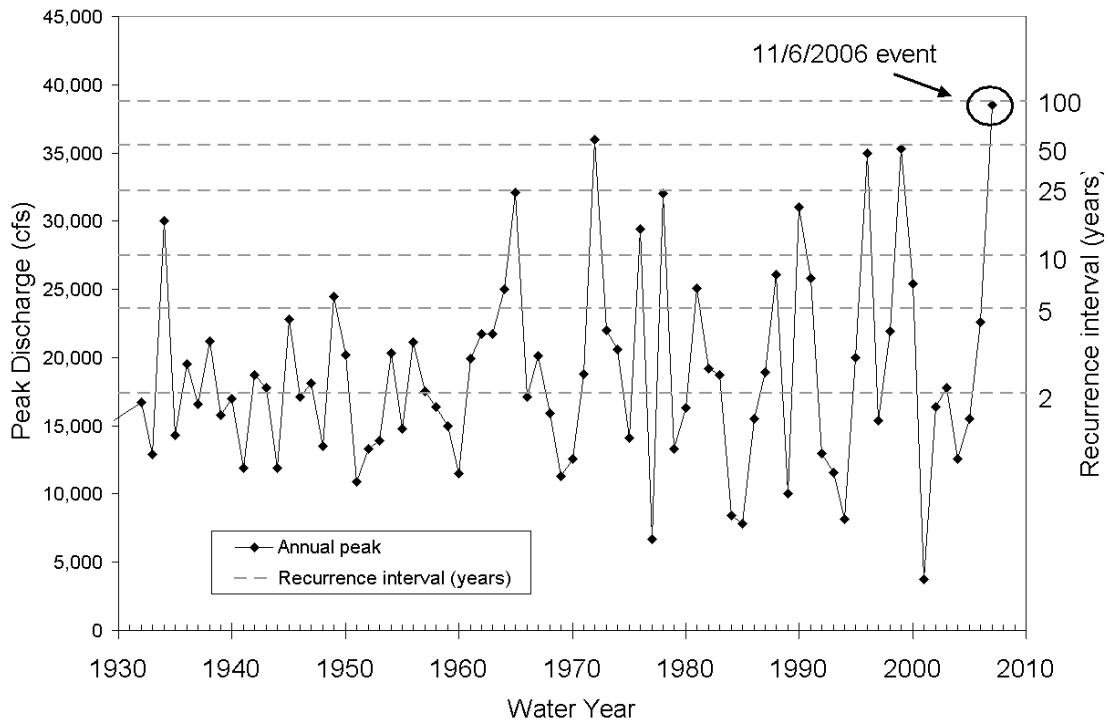

Figure 1. Recurrence interval and probability of occurrence associated with annual peak flow events at the Wilson River stream gage. Values for the 11/6/2006 event are provisional.

The largest recorded peak flow event was the flood of November 6th, 2006, having an estimated recurrence interval of ~100 years (Table 6). Seven of the nine annual events having a recurrence interval of 10 years or greater have occurred within the second half of the period of record. For a more detailed discussion on the Wilson River hydrology, refer to Chapter 5, Hydrology and Water Use.

Table 6. Wilson River stream gage annual peak flows with a recurrence interval of 10 years or more.

Date of annual peak flow	Water year	Peak flow magnitude (cfs)	Approximate recurrence interval (years)
11/6/2006	2007	38,500	94
1/20/1972	1972	36,000	55
12/27/1998	1999	35,300	47
2/8/1996	1996	35,000	44
12/22/1964	1965	32,100	24
12/13/1977	1978	32,000	24
12/4/1989	1990	31,000	20
12/21/1933	1934	30,000	17
12/4/1975	1976	29,400	15

3.4.3 Windstorms as an Historic Disturbance

Fall and winter storms are common along the northeastern Pacific coastlines and have helped shape the Oregon Coast for millennia. Information on significant wind events in the vicinity of the Wilson River watershed is available from the National Oceanic and Atmospheric Administration (NOAA)[11]. Data on windstorm events that occurred further back than about 50 years, however, become more sporadic. The largest and most damaging event on record was the Columbus Day storm of 1962, which caused wide-spread damage state-wide. The later half of the 1990's also experienced several large wind events but it is not known to what extent these storms damaged forested areas in the Wilson River Watershed.

[11] http://www.wrh.noaa.gov/pqr/paststorms/wind.php and http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms

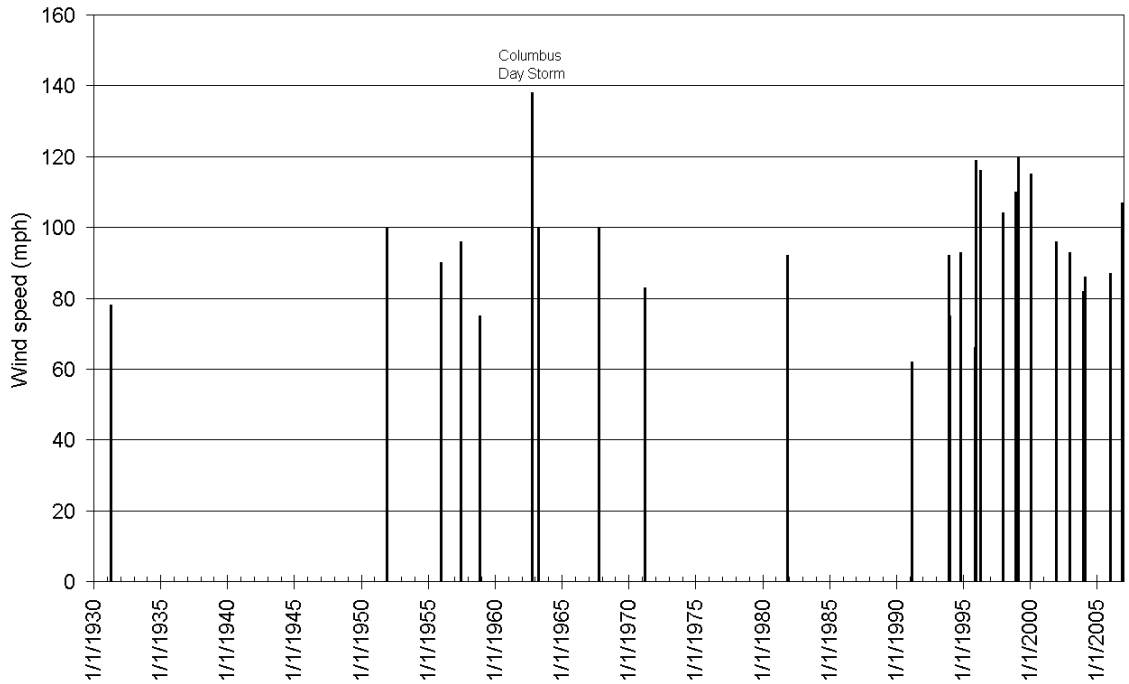

Figure 2. NOAA records for large wind events along the northern Oregon Coast.

3.4.4 Simulation Models and NetMap Analyses

The geomorphic component pertaining to natural disturbances in this analysis consists of (1) simulation modeling of fires, storms, landslides and debris flows, channel sedimentation, and large in-stream wood that was conducted in a landscape similar to north coastal Oregon (located in Appendix D), (2) predictions of inherent channel disturbance potential in the Wilson River watershed using the software program NetMap (refer to Benda et al. 2007 for an overview of NetMap or the Technical Support section of ODF's NetMap tools), and (3) predictions of frequency and magnitude of sedimentation using NetMap. The channel disturbance index and the frequency-magnitude analysis can be used to understand which channel reaches are most prone to natural disturbances such as landslides, debris flows, sedimentation, and flooding impacts. Thus, a high channel disturbance index can identify reaches where habitat restoration or in-stream monitoring may be infeasible while a low channel disturbance index can be used to identify areas appropriate for long term monitoring or restoration projects.

A "channel disturbance" index was created using the Channel Disturbance Tool in NetMap and three watershed attributes were used in the calculation: 1) debris flow susceptibility at tributary junctions of headwater streams with larger

channels; 2) segment scale annual sediment yield, and 3) confluence probabilities[12]. The model predicts that numerous discrete areas within the Wilson River watershed are naturally prone to disturbances involving the input and routing of sediment and large wood (LW; Map 11). It is likely that these areas would also be responsive to a human modified disturbance regime (e.g., accelerated debris flow activity), such as at tributary confluences.

A key relationship between river networks and sediment related watershed disturbance regimes are the frequency and magnitude of channel sedimentation. Reaches in the Wilson River watershed that are predicted to have a high to moderate magnitude and low to moderate frequency may be more prone to natural disturbance compared to areas with a high frequency of low to moderate sedimentation. In NetMap, the skew of the probability distribution function (PDF) of sediment yield is used to predict how sediment supply frequency and magnitude vary down the network. It predicts that the highest magnitude and the lowest frequency of sediment fluctuations due to debris flows should occur at the confluences of first- and second-order streams with higher order channels (Map 12). A sediment yield analysis, using a headwater skew of 20 as defined by Benda 1994, reveals that areas of highest natural disturbance are concentrated within the upper watersheds, where numerous first- and second-order channels intersect larger, fish bearing streams at a high spatial frequency (Map 12). Maps 11 and 12 can be used in conjunction with one another to identify channel segments prone to natural disturbance and thus could be used to help inform restoration planning and in-stream monitoring.

3.5 Forest Management

3.5.1 Early European Land Uses

The forested lands in the Wilson River watershed occur from the lowlands through the uplands, the majority extending upward from the foothills. Prior to European settlement, the Native Americans of the Tillamook area would frequently burn the forested lowlands and surrounding areas to clear the areas of brush, stimulating vigorous, tender, vegetative regrowth for ponies to feed on and to allow them to harvest various seeds and other resources (Winters 1941). As settlers moved into the Tillamook area, they began clearing some of the forested lowlands to create farmlands suitable for plowing. As more settlers arrived and worked to clear the lands, fires in the area were documented in greater detail and over increasing areas up through 1874 (Coulton et al. 1996). Additionally, much

[12] For definitions, refer to Appendix D – Natural Disturbance Theory and Simulation, Appendix E – Detailed Methodologies, Appendix R – NetMap Analysis of Critical Road Locations and Appendix T – Slope Stability Assessment.

of the land adjacent to the tidewaters was diked and drained to allow the fertile soils to be turned into farmlands. Settlers ignored the uplands, however, because they were too steep for farming so they remained largely in the public domain until the end of the 1800's.

As farming interest took hold in the valley through the end of the 1800's, large Great Lakes timber companies, realizing the profits that could be made from harvesting the large old-growth Douglas-fir trees of the region, began buying up some of the forested lowlands and laying claim to much of the timbered uplands (Fick and Martin 1992). Early efforts to log the area occurred primarily in the lowlands and were often one-man operations. As technologies improved and roads and railroads pushed further into the watersheds and up the mountains, the size and extent of the timber harvest increased.

Toward the end of the 19th century, logging operations moved from one man hand operations to oxen pulled multi-man operations. Shortly after the turn of the 20th century, the use of steam-donkeys ushered in a new era of logging, allowing dozens of men to harvest entire hillsides, something almost entirely unheard of up to that point. Steam donkeys, followed by chainsaws around the middle-half of the 1900's, remained the primary pieces of logging equipment until after the Second World War. After the war, diesel equipment began to be utilized with increasing frequency, allowing even larger portions of lands to be harvested in an even more efficient manner.

3.5.2 The Tillamook Burn and Reforestation

Forest fires were relatively commonplace in the Coastal Mountains but a series of catastrophic burns, ignited in 1933 and following every six years until 1951, drastically changed the landscape from one of dense forests to one of barren and denuded wasteland. Collectively called the Tillamook Burn (refer to Map 10)), this series of wildfires prompted land managers to completely rethink the way in which timber harvest occurred. Up to that point, logging operations would often simply cut over large tracts of land, often harvesting only the largest of the old growth trees and leaving the others behind, burn the slash, and move to the next tract. Reforestation efforts were nearly unheard of and, after repeated burns that made much of the timber unfit for harvest, private timber companies often stopped paying taxes on the lands, allowing them to go tax-delinquent.

As the embers from the first Tillamook Burn (1933) faded, public outcry over the loss of timber (and the revenue it generated, both in timber sales and in taxes) prompted the Department of Forestry to formulate a plan to rehabilitate and reforest the burned areas. The plan that followed was unprecedented both in its goals and scope of the work. The US Forest Service, at the request of the counties and with permission from the Department of Forestry, undertook two

natural reproduction studies (1935 and 1937) with the purpose of studying the natural regeneration of Douglas-fir and associated species following catastrophic fires. Results from these studies were largely responsible for shaping future rehabilitation efforts.

Additionally, to reduce the hazardous conditions in the Tillamook Burn, the Forest Service recommended 1) that roads be constructed to salvage log the area, 2) firebreaks be developed along the railroads and roads by felling snags, cleaning debris and forced burning, and 3) continue to close the area to the public during severe weather conditions. To reforest the area, the Forest Service recommended 1) protecting the remaining seed trees in the area from logging and slash burning and 2) seeding and planting of areas lacking seed trees after salvage logging had occurred.

Although the Forest Service provided these recommendations to the State, the Forest Service felt that it would be the best equipped, indeed, the only entity that could carry out a plan of this magnitude. The State, however, disagreed but continued to work cooperatively with the Forest Service from 1941 through 1947 on rehabilitation and reforestation efforts. In 1947, the Forest Service agreed that it did not have the money to undertake such a large project, leaving the State and counties to finish the rehabilitation and reforestation efforts.

Early reforestation efforts, carried out by both the Department of Forestry and volunteer organizations, got underway in January 1941 when the initial hand plantings (Port Orford cedar seedlings) took place along the trail from the Wilson River Highway to Cedar Butte Lookout. The Second World War, however, sequestered most of the manual labor needed for tree planting and little reforestation occurred until after the end of the war. Removal of snags and the construction of logging roads, part of the original Forest Service recommendations, decreased reforestation costs when large-scale reforestation efforts again resumed in 1949, the official start of the rehabilitation and reforestation program. Prior to 1949, however, the State had already begun sporadic snag-falling and tree planting, especially around the Owl Camp area and the upper Wilson River watershed. Additionally, they had undertaken an experimental aerial seeding program on a 600 acre burned plot in Tillamook County (1945-1946).

Reforestation efforts began in earnest with the official kick-off in 1949 and continued through 1973 with initial plantings peaking in 1963 and replanting peaking in 1970 (Fick and Martin 1992). Unfortunately, the fire had consumed much of the fertile topsoil, creating difficult growing conditions for plant/tree growth. As a result, many animals switched to foraging on the tender shoots of the newly planted trees, creating a serious obstacle to successful reforestation. Early in the 1940's the State initiated a rodent control program that could be

carried out while hand planting the trees. As aerial seeding became the preferred method of reforestation, aerial rodent control also gained attention and, by 1946, was in full production.

By the end of the 1940's, rodent damage to seedling had decreased considerably but another seedling damage problem was rapidly raising alarms and, by the mid 1950's, surveys of replanted areas found nearly 80% of the replanted seedlings had been damaged by foraging from deer and elk. The Oregon Game Commission responded to calls from the State to control deer and elk populations and, starting in the fall of 1956, controlled either-sex deer hunts in the burned regions began thinning out cervid populations. These controlled either-sex hunts continued, with moderate success, until the early 1960's when it was determined that the damage to seedlings was within acceptable levels.

Reforestation efforts were also hampered by faster growing plant species that shaded out the young seedlings (e.g., ferns, salmonberry, thimbleberry, vine maple, alder, cherry, hazelnut, etc.). By 1958, the Department of Forestry recognized that they could no longer ignore the rapidly spreading hardwood thickets that had taken over much of the burned areas. Of particular concern were the stands of alder that had rapidly moved up the hillslopes from the stream bottoms. Thickets of salmonberry and thimbleberry were also creating shade problems for seedling growth and survival. Early manual efforts to control these stands/thickets met with limited success and, in 1958, aerial applications of herbicides became relatively commonplace and continued until 1973 (Fick and Martin 1992).

Early in the 1960's, however, it became clear that another problem was hampering the growth of the new forests. Early reforestation efforts had planted trees at relatively thick densities and overcrowding by other seedlings resulted in competition for limited nutrients. Starting in 1962, aerial application of herbicides targeting young hardwood species was initiated and carried out with relative success until 1973 (Fick and Martin 1992). Additional manual thinning of overcrowded tracts was started in 1965 and continued through until 1973 (Fick and Martin 1992).

In July of 1973, an official ceremony marking the end of the Tillamook Burn rehabilitation effort was held, 40 years after the first Tillamook Burn and just 24 years after the official rehabilitation kick-off ceremony. Tree planting, however, continued in some of the burned areas that had still not been replanted while stands continued to be actively thinned to prevent overcrowding. Even though the rehabilitation efforts had been officially concluded, the effects from the fires would be evident for generations and are still being actively addressed today.

3.5.3 Recent Forest Management and Associated Policies/Regulations

Large-scale, stand-replacement fires shaped early (organized) riparian management. Following the fires, a public/private conglomerate enterprise called the Consolidated Timber Company was created to conduct salvage operations (West Consulting 2000), with the intent to increase fire control, intensively harvest salvaged trees, fall snags, and construct a vast network of fire roads to increase fire control and facilitate the planting (and eventual harvest) of even-aged Douglas-fir.

Following the salvage logging period (early 1950s), organized management goals became official with standards enacted by the Oregon Forest Practices Act in 1972. Part of this legislation involved guidelines for the establishment of streamside buffer strips. In 1987, a comprehensive revision to harvesting and road construction rules was made, with additional rules to protect riparian zones. The revision specifically required set numbers and sizes of conifer trees to be retained in riparian management areas in western Oregon. Other aspects included site-specific protections for endangered and threatened species and ecologically significant areas, including wetlands.

Over the last few decades, a new forest management concept has emerged; the concept of managing riparian zones for *ecosystem services*. Beginning in 1988 and adopted in 1991, rules were established to provide specific numbers and sizes of residual conifer tree species in riparian zones, within 100 feet of all Class I streams, and within 300 feet of ecologically sensitive areas, including wetlands. Incentive programs were developed in the mid-1990s to provide for stream enhancement, and an initial designation of a *desired future condition* was established to manage classes of riparian stands for "mature forest" and to provide for conversion management options to revert hardwood-dominated stands to conifer dominance in areas where conifers were historically dominant.

The Forest Management Plan (FMP), approved in 2001[13], provided management standards designed to produce riparian zones in mature forest condition. These riparian areas, conceptually, would provide *ecosystem services* to the stream channel, including stream shading, large wood (LW) recruitment, and other less quantifiable functions, such as sediment retention. The major goals of the Forest Management Plan are to provide for:

- Sustainable timber production, and

[13] ODF 2000. Northwest Oregon State Forests Management Plan, Final Draft. http://www.odf.state.or.us/DIVISIONS/management/state_forests/sfplan/nwfmp01-final/31-J-Aqua-Rip.prn.pdf

- Properly functioning aquatic habitat; habitat for native species, protect soil, air and water, and to provide recreation.

3.5.4 Forest Recreation

Recreation has also long been an important use of the Tillamook Basin and Wilson River. The Wilson River has been a hunting, fishing and camping destination since the pioneering era when those traditions were established. However, the series of fires known as the "Tillamook Burn" interrupted those activities and changed the face of the forest completely. In the four to five decades since the fires, salvage and replanting program era, the forest has seen a steady increase in the level and range of recreational pursuits. Traditional pursuits like hunting, fishing and camping have gradually been overtaken or extended by fast growing technology. Off-highway vehicle (OHV) use has increased by 50% during the 1997 to 2001 period.[14] Nationally, the number of OHV users climbed sevenfold in the last 30 years--from five million in 1972 (1 in 42 persons) to 36 million in 2000 (1 in 8 persons).[15]

Off road motorcycle riding and four-wheel driving have long been commonplace in the Tillamook State Forest. Some clubs representing these users have been in existence for 50+ years and have third generation members being recruited into the sport as soon as they are big enough to handle a mini-bike.

From 1945 to 1975 the ODF established 12 campgrounds primarily focused on concentrating campers into stream side campgrounds to reduce fire risk. The program was cut back in 1980 leading to campground closures, loss of recreation staff and halting of fee collection for designated campsites. From 1980 until the new Recreation Management Plan came into effect in 1993, camping became dispersed and unmanaged leading to resource impacts, social conflicts and long term occupancy (homeless camps). Motorized recreation impacts worsened and users had free reign to ride anywhere and any season. OHV impacts on riparian zones were especially pronounced because vehicles and motorcycles were routinely using the streams and campsites as motocross and obstacle courses. OHV events were being routed down streams in the middle of spawning seasons. Clubs held events with little oversight or restriction except in fire closure periods.

The legacy of firebreaks, logging roads, and skid trails from railroad logging, firefighting, salvage operations and reforestation became the network OHV users

[14]In an October 30, 2003 letter from the NM Tourism Department to The Consumer Products Safety Commission (CPSC) using CPSC April 23, 2003 data to present OHV legislative initiative in New Mexico
[15] In a July 7, 2004 press release issued by Forest Service announcing their release of proposed OHV rule available at
http://www.fs.fed.us/news/2004/releases/07/off-highway-vehicle.shtml.

explored and reestablished. Many of these roads and skid trails were not built or intended for long term use. Steep grades, poor or non-existent drainage, and placement in riparian areas have all resulted in failures of the road structure and failure of puncheon bridges. OHV pressure continues on these roads and stream crossings until made impassable, or the site of multiple ad hoc alternatives.

Until the mid-1990s there were no geographic or seasonal restrictions on OHV use across the watershed. Events were largely unmanaged and routes not assessed before or after the activity. Problems with resource damage, productivity loss and public safety mounted over time. Tree damage from target shooting has been a long standing problem across the forest with little to no restrictions on where or when shooting can occur. Regulations were not fully developed for state forests, seldom posted, rarely enforced and widely ignored resulting in an array of disturbance patterns, which include;

- Extensive penetration into all corners of the forest by OHV and vehicle based recreational users.
- Extensive use of RVs and OHVs by hunters puts additional pressure on dispersed campsites and trails during the wet season.
- Intensive use of accessible riparian areas for dispersed camping and OHV recreation
- Chronic erosion and resource damage
- Cut bank riding and road drainage sedimentation
- Garbage, human waste, dumping and temporary campsite remains
- Uncontrolled target shooting and associated trash (skeet fragments, lead, shells, man-made targets, appliances and tree damage)
- User defined trails with high resource impacts
- Vandalism to signs, structures, private property and forest resources
- Unmanaged and unrestricted minor forest products gathering
- Little or no restriction on OHV event course location.

The 1993 Tillamook State Forest Recreation Management Plan (RMP) was developed to address these issues and an array of user education, experience and management goals. Steady progress has been made implementing the RMP to the extent that staff estimate more than 90% of action items have been accomplished.

However, user demands and especially OHV event management pressures continue to outstrip staff capacity and mitigation efforts. Resource damage continues to be a serious issue, particularly erosion from the OHV trail system and riparian vegetation impacts from dispersed camping, although stream crossings on the designated trail system have been gradually replaced by bridges, culverts or reroutes. For more detailed recreation-related forest issue discussions, see section 6.7 – Recreational Impacts on Riparian Vegetation – Direct and Indirect Effects and section 7.5 – Recreation-Related Issues.

3.5.5 Stream-Road Crossings

Over time, the ODF has changed the way it manages stream crossings at culverts. Originally, culverts were designed to allow water to flow freely and to prevent debris from collecting inside. A successfully designed culvert was one that moved water quickly through the smallest diameter pipe possible (Paul et al. 2002.) With the passing of the Endangered Species Act, managers began considering culverts in terms of barriers to fish passage. In 1995, ODF released the first document about constructing stream crossings at Type F streams (Mills and Stone 1995) with emphasis on juvenile fish passage. After the flood producing storm in February 1996, ODF accelerated culvert replacement using money allocated to the State by the Federal Emergency Management Agency (Mills personal communication). Within this time frame ODF forest practice rules changed regarding culverts. In 1994, culvert volume requirements went from a 25 year flow with unspecified headwater to a 50 year flow with headwater at the top of the culvert. Since 1996, ODF has, when dealing with all stream crossings, designed culverts with fish use in mind and has followed ODFW Fish Passage statutes and criteria since their adoption in 2001. Today culverts are designed to optimize fish passage, and cross-drains are designed to filter road run-off sediment away streams. For more detailed stream-culvert crossing discussions, see section 7.4.6 Stream Crossings and section 9.13 Fish Passage Barriers.