CHAPTER 2. REFERENCE CONDITIONS

2.1 INTRODUCTION

The temperate coniferous forest community emerged in the Oregon Coast Range approximately 11,000 years ago, at the beginning of the Holocene Epoch (Spies et al. 2002). Throughout the Holocene, forest composition shifted following wet and dry cycles, largely due to changes in the length of the average fire interval. The current forest composition has prevailed for about 2,400 years, punctuated by episodic natural disturbances (Worona and Whitlock 1995, Spies et al. 2002). The primary ecosystem disturbance processes have been major floods events, windstorms, and stand-replacing fires. Over the past several millennia, catastrophic flood events have occurred on average about once every 300 years, while stand-replacing fires occurred on average about once every 175 years (Spies et al. 2002). The impacts of disturbance have been unevenly distributed across the landscape, both in space and time. Consequently, a complex mosaic of ecosystem conditions had developed prior to Euro-American settlement.

Because of the episodic and unpredictable timing of these disturbances, uncertainty is inherent to any discussion of reference conditions. It is not possible, and meaningless from a management standpoint, to reconstruct the site-specific conditions that prevailed at a given time or place. Instead, it is more valuable to reconstruct the range of conditions that were likely to have prevailed at the landscape scale. Rather than assessing the current ecological condition of our forests based on their age, which is a few thousand years in length and represents only a few generations of conifers, we should consider the compositional diversity and structural complexity that arose from many thousands of years of adjusting to changing climatic conditions and episodes of disturbance (c.f. Spies et al. 2002). This can help to establish realistic benchmarks for use in future management. These benchmarks can be used to help assess ecological functions and processes that support desired conditions, and to establish management priorities for enhancing these functions and processes. However, it should always be recognized that these reconstructions are imperfect approximations subject to the strengths and weaknesses of their underlying assumptions.

This reference conditions chapter will reconstruct conditions existing prior to Euro-American settlement. It will then examine some of the changes that occurred following settlement.

2.2 AQUATIC

2.2.1 HYDROLOGY AND WATER QUANTITY

Prior to Euro-American settlement, the majority of the Trask watershed was heavily forested with a mosaic of late-seral old-growth coniferous forest, hardwoods, and regenerating coniferous forest subsequent to natural disturbance (c.f., Maddux 1976, Teensma et al. 1991, Coulton et al. 1996, Chen 1998). Interception of precipitation and evapotranspiration were probably high. Flooding of the watershed occurred annually, inundating the numerous floodplains, wetlands, and swamps that were present in the lowlands. Large flood events were recorded on the major

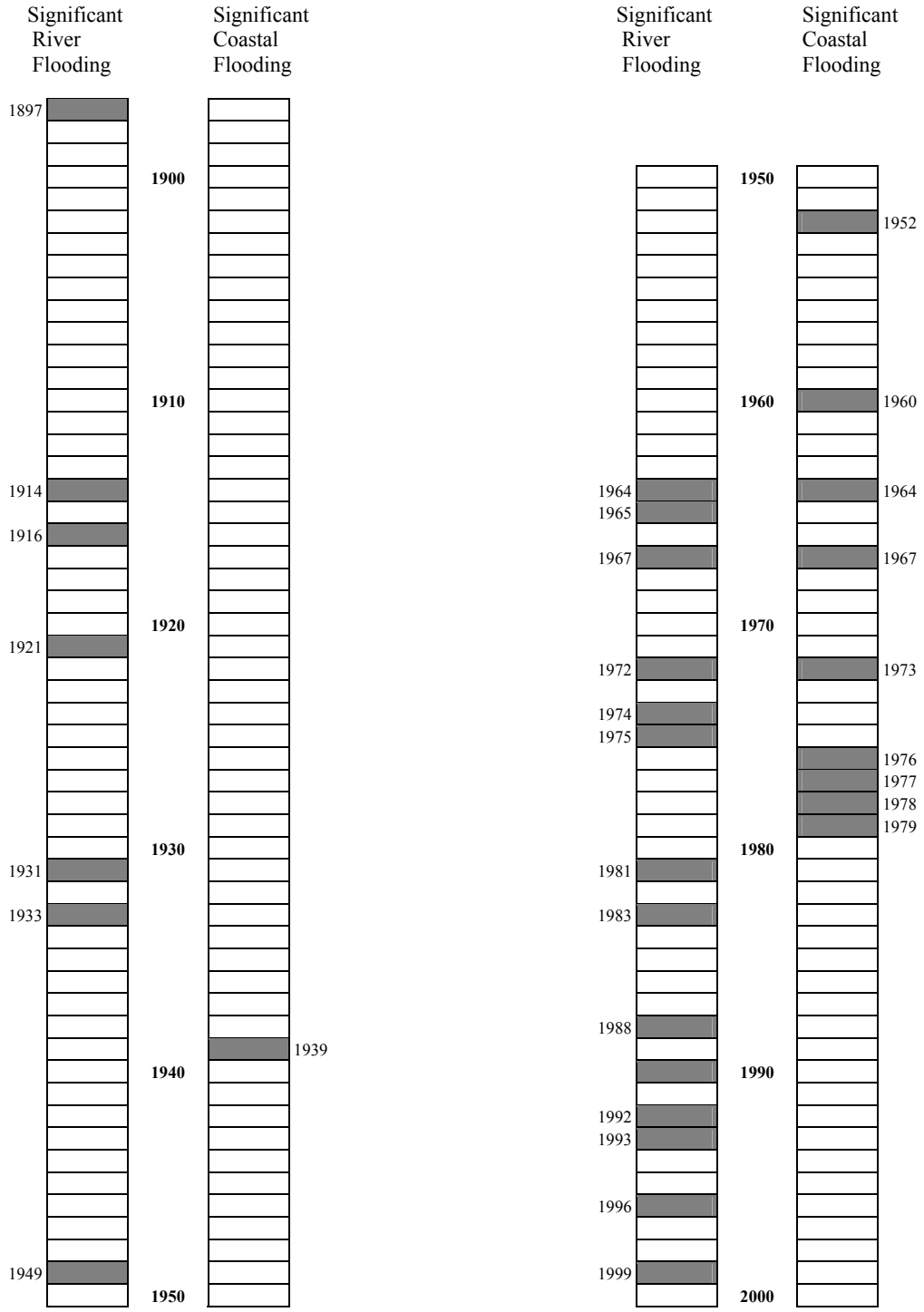

Figure 2.1. Generalized flood history of Tillamook Basin rivers and coastline. Significant flooding is defined as flooding sufficient to have resulted in newspaper coverage or other documentation. (Source: Coulton et al. 1996; modified to include floods subsequent to 1995)

rivers of the Tillamook Basin during 21 winters between 1897 and 2000 (Figure 2.1; Coulton et al. 1996).

Debris jams were common on the lower portion of the Trask River, and contributed to frequent overbank flooding (Coulton et al. 1996). In 1897, the U.S. Army Corps of Engineers (USACE) recommended that debris jams and sunken logs be removed, and banks "trimmed" along the Trask River to "permit it to carry the flood waters without flooding the farm lands" (USACE 1897, Coulton et al. 1996). Flood events also transported sediment to Tillamook Bay (Coulton et al. 1996). According to USACE reports from 1902 and 1907, "a considerable quantity of gravel, sand, and mud is annually deposited in the bay and channels by tributary streams" (Gilkey 1974). This could reflect pre-settlement conditions, or could partly be a consequence of fires in the late 1800s.

The Tillamook Burn, a series of fires between 1933 and 1951, dramatically altered forest conditions in the Trask watershed. According to one study, the 1933 burn increased total annual discharge by about 9% and the annual peakflow by about 45% (Anderson et al. 1976). Increases in peak flows following fires generally last about a decade (Agee 1993) Logging and road construction immediately following the Tillamook Burn probably served to further increase peak flows.

2.2.2 EROSION

Shallow rapid landslides, including debris slides and debris flows, have accounted for the majority of erosion in the Oregon Coast Range (Skaugset et al. 2002). Most landslides have occurred during episodic large storm events. The frequency of historic slides has not been extensively studied in the Trask watershed and is not well known. Nevertheless, timber harvesting and road-related disturbances over the past 150 years are known to have accelerated erosion above natural rates throughout the Oregon Coast Range. Clearcut timber harvesting has been associated with a 0.8 to 5 times increase in landslide occurrence on steep slopes, as compared with mature forests (Swanson et al. 1977, Ketcheson and Froehlich. 1978, Robison et al. 1999). The increase in landslide occurrence has been found to persist for about 10 years, until forest canopy cover and fine root re-establishment (Robison et al. 1999). Road-associated landslides have occurred 10 to 50 times more frequently than natural (non-road) landslides on a unit-area basis, and the volume of landslide deposits has been at least 4 times larger on average (Swanson et al. 1977, May 1998, Skaugset et al. 2002). Sediment delivery to the stream channel from landslides and debris flows is higher today than in pre-settlement times due to the additional contribution of sediment from roads.

The density and frequency of earthflows prior to Euro-American settlement is unknown, although it is unlikely that conditions have changed substantially. Surface erosion is very uncommon in the Oregon Coast Range under forested conditions. In unmanaged forests, surface erosion is generally negligible, except following stand-replacing fires (Swanson et al. 1982, Skaugset et al. 2002). It is likely that most of the land use-related erosion and sediment impacts since pre-settlement times in the Trask watershed were the result of increased landslides, road construction, and salvage logging.

2.2.3 WATER QUALITY

Water quality conditions in the Trask watershed at the time of Euro-American settlement are undocumented. However, based on descriptions of the landscape at the time, it is likely that water temperatures in the mainstem reaches of the Trask River and its tributaries were lower than they are today. Early records indicate that the streambanks and lowland floodplains were mostly wooded, with many large trees present to provide adequate shade to moderate streamwater temperature (Coulton et al. 1996).

Bacterial conditions in the upper watershed, however, are less certain. In the lower watershed, current bacterial levels exceed water quality standards due to dairy, urban, and rural residential sources of contamination. Beaver ponds have been associated with high levels of fecal bacteria in smaller tributary streams (Sullivan et al. 2002). Beaver ponds are known to have occurred throughout the watershed in pre-settlement times (Coulton et al. 1996).

Chronic turbidity and suspended sediment concentrations were probably lower in pre-settlement times than they are today. This was largely because of the absence of roads and to a lesser extent the absence of logging and other anthropogenic watershed disturbances. However, large episodic disturbance events, such as fires and floods, would have resulted in periodic spikes in turbidity and suspended sediment levels (c.f., Agee 1993).

Primary sources of nutrient loading in the streams prior to Euro-American settlement included decaying salmon carcasses subsequent to spawning and nitrogen fixation associated with plants such as red alder in the riparian zone. The timing of nutrient input has been altered and the pulse of nutrients subsequent to spawning has been reduced. Nitrogen and phosphorus loading due to salmon mortality were higher historically, and have been replaced by other sources of nutrient loading.

2.2.4 STREAM CHANNEL

Stream channel conditions in the Trask River watershed prior to Euro-American settlement were notably different than they are today. Throughout the Oregon Coast Range, including the Trask watershed, stream channel morphology has been greatly simplified, especially in lowland areas. Over the past 150 years, the availability of gravel, wood, riparian forest, floodplains, sloughs, backwater areas, and pool habitat has declined in response to the reduction in channel complexity.

Stream channels in the lowlands have likely experienced the greatest change. Prior to Euro-American settlement, the main channel was highly sinuous, with many braided channels, secondary channels, oxbows and backwaters (Coulton et al. 1996). Extensive beaver ponds were also documented in the floodplain of the lower Trask River (Coulton et al. 1996). Riparian zones were heavily wooded with a diversity of species, and many large trees were present. Loss of late-successional riparian vegetation throughout the watershed has resulted in a reduction in woody debris and consequent in-stream channel complexity in the lowlands (Coulton et al. 1996, Reeves et al. 2002).

In the uplands, channel structure was also more complex prior to Euro-American settlement. There were more pools, pools were deeper, and large logs and woody debris jams were common in the stream channel (Reeves et al. 2002). Streamside vegetation included a greater diversity of species and age classes, including large conifers which provided large woody debris to the stream channel.

2.2.5 AQUATIC SPECIES AND HABITAT

Accounts by early settlers proclaimed the incredible abundance of salmon and trout. According to one account from the early 1900s, "The Trask was full of trout and salmon… The moment the freshets came with the fall rains, the river bed would be darkened by a horde of frantic fish fighting their way upstream to their spawning grounds" (Maddux 1976). Coho salmon (*Oncorhynchus kisutch*) were one of the most abundant anadromous fish in the Tillamook Basin in pre-settlement times (Coulton et al. 1996). Coho were harvested intensively in Tillamook Bay with gill nets from the late 1800s through 1961, when the gill net fishery was permanently closed. Catch records were not kept in the early years following settlement, but in the 1930s the annual gill net catch ranged from 25,000 to 74,000 and averaged about 46,000 fish. By the late 1980s, the total combined annual harvest of naturally-produced Tillamook Bay coho in the ocean (commercial and sport fisheries), estuary (sport fishery), and fresh water (sport fishery) was estimated to have been reduced to less than 10% of the 1930s levels (Bodenmiller 1995).

In addition to coho salmon, the Trask River has witnessed substantial declines in the populations of chinook (*Oncorhynchus tshawytscha*) and chum (*O. keta*) salmon, steelhead (*O. mykiss*) and cutthroat (*O. clarkii*) trout, and Pacific lamprey (*Lampetra tridentata*). Pink salmon (*O. gorbuscha)* have been extirpated from the Oregon Coast, although it is uncertain whether or not stable populations existed historically.

Early cannery records indicate that as many as 28,000 spring and fall chinook salmon were packed annually from Tillamook Bay from 1893 through 1919. From 1923 through 1946, commercial landings remained relatively stable ranging from 12,000 to 31,000 fish and averaged about 17,000 fish (Nicholas and Hankin 1988). The commercial catch declined from 1947 until the fishery was closed in 1961. The decline may have been related in part to increased regulatory restrictions on the fishery (TBNEP 1998a).

Tillamook Bay historically supported the Oregon Coast's largest chum salmon fishery, and chum may have been the most abundant fish in the bay. An undated report by Kenneth A. Henry of the Fish Commission of Oregon, entitled *Tillamook Bay Chum Salmon*, states that harvests of chum between 1928 and 1950 ranged from a low of 178,000 lbs to a high of 2,804,000 lbs in 1928, with an average of 791,826 lbs. Assuming approximately 10 lbs per fish, the catch would range from 17,000 to 280,000 fish, with an average of 79,000 (Dave Plawman, ODFW, pers. comm., 2003). Oregon is near the southern edge of chum salmon distribution, which may, in part, account for the large interannual variability in run sizes that have been observed in Tillamook Basin streams over the years. The gill net fishery in Tillamook Bay held up longer than any of the other Oregon chum fisheries but was permanently closed in 1961 (TBNEP 1998a).

No reliable information on the historic abundance of steelhead in the Trask watershed is available. Steelhead were gillnetted commercially in Tillamook Bay from the late 1890s through the 1950s. However, harvest data for steelhead were not recorded in a reliable manner until after the fishery had been restricted to the early part of the steelhead run. Rough estimates of total coastwide steelhead run size made in 1972 and 1987 were similar (Sheppard 1972, Light 1987), suggesting that overall abundance remained relatively constant during that period. Light (1987) estimated total run size for the major stocks on the Oregon Coast (including areas south of Cape Blanco) for the early 1980s at 255,000 winter steelhead and 75,000 summer steelhead. With about 69% of winter and 61% of summer steelhead of hatchery origin, Light estimated that the naturally-produced runs totaled only 79,000 winter and 29,000 summer steelhead (note that most of the Oregon coastal summer steelhead are in the Umpqua and Rogue River systems; TBNEP 1998a).

Population levels have been so depressed that all salmonid species on the Oregon Coast have been considered for listing under the Federal Endangered Species Act (Reeves et al. 2002), and the coho salmon was listed as a Threatened species in 1998. Additionally, a number of amphibians are listed by the State of Oregon as species of special concern due to declines in abundance, including the northern red-legged frog (*Rana aurora aurora*), tailed frog (*Ascaphus truei*), and Columbia torrent salamander (*Rhyacotriton kezeri*).

The decline in suitable aquatic habitat is frequently cited as an important reason (along with ocean conditions and overharvest) for the decline in fish populations (Nehlsen et al. 1991, Bisson et al. 1992, Reeves et al. 2002). High-quality aquatic habitat was abundant in the Trask watershed prior to Euro-American settlement, both in the stream channel and in backwater and wetland areas. The diversity of habitat conditions for fish and other aquatic species was provided by the historic array of physical elements in the stream channel, including logs, woody debris, boulders, and gravel. Woody debris was common both in the uplands and in the lowland channels and floodplains. Woody debris jams could be quite extensive; for example, two wood jams in the lowlands of the nearby Wilson River each measured 800 feet in length (Coulton et al. 1996).

Early settlers removed debris jams and woody debris from channels and straightened channels to improve navigation and to allow timber to be transported downstream to mills during log drives. Between 1890 and 1920, over 9,300 snags were removed from the lower portions of the rivers entering Tillamook Bay, including the Trask River, for navigational purposes (Benner and Sedell 1987, Gonnar et al. 1988). Once the debris jams were cleared, the frequency of localized flooding was reduced, and “structures could safely be built closer to the river” (Farnell 1980). The presence of wood jams in the lowland portion of the Trask River had functioned historically to increase the frequency and timing of overbank flooding, creating hydrological connections between riverine, estuarine, and terrestrial areas (Coulton et al. 1996).

2.3 TERRESTRIAL

2.3.1 LANDSCAPE VEGETATION PATTERN

2.3.1.1 North Coast Region

Temperate coniferous forest communities replaced subalpine forests and tundra in the Oregon Coast Range approximately 11,000 years ago, as the Earth's climate warmed and entered the present interglacial period (Spies et al. 2002). Historic cycles of wet and dry periods have been accompanied by shifts in the length of the average fire interval, altering forest community composition. Present day forest communities in the Oregon Coast Range have been generally similar for the past 3,000 years, although climatic variation has caused gradual shifts in species dominance (Worona and Whitlock 1995, Spies et al. 2002).

Early explorers encountered areas of closed-canopy forests that contained large trees throughout the Oregon Coast Range. Lewis and Clark described the mountains at Nehalem 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, this alder grows to the height of sixty or seventy feet and from 2 to 3 feet in diamiter [sic]." Recent studies have estimated the coverage of old-growth forest in the Oregon Coast Range prior to Euro-American settlement to be 40% to 46%, on average, in a patchy mosaic that included canopy gaps, shrubs, hardwoods, and regenerating coniferous forest, maintained by localized natural disturbance (Teensma et al. 1991, Wimberley 2000).

2.3.1.2 Trask Watershed

Based on USGS land survey records and the descriptions of early settlers, a large proportion of the Trask River watershed prior to Euro-American settlement was late-seral old- growth coniferous forest, dominated by western hemlock (*Tsuga heterophylla*), Douglas-fir (*Pseudotsuga menziesii*), western red cedar (*Thuja plicata*), and Sitka spruce (*Picea sitchensis;* Maddux 1976, Coulton et al. 1996). However, although broadly characterized as late-seral old-growth, unmanaged forest in the Oregon Coast Range prior to settlement was generally a patchy mosaic of mixed-age and mixed-species stands (Spies et al. 2002). Fine-scale variation was caused by outbreaks of disease, windthrow, small fires, and mass soil movements, resulting in patches of tree regeneration, shrubs, hardwoods, standing dead trees, down trees, and decaying logs (Wimberley 2000, Spies et al. 2002). Although portions of the Trask watershed had burned prior to settlement, late seral forest was abundant. Subsequent to settlement (though not necessarily the result of settlement), the Tillamook Burn and other fires burned the majority of the forested region of the Trask watershed (Coulton et al. 1996, Chen 1998).

Descriptions of the coastal lowlands of the Tillamook Basin by early explorers depicted heavy forest interspersed with broad prairies. The tidelands were largely forested with Sitka spruce, western red cedar, and western hemlock (Figure 2.2), and extensive forested floodplains and wetlands were punctuated by sloughs and swamps. Native Americans are believed to have maintained prairie lands through burning, for the purpose of providing favorable conditions for game species and other food sources (Coulton et al. 1996).

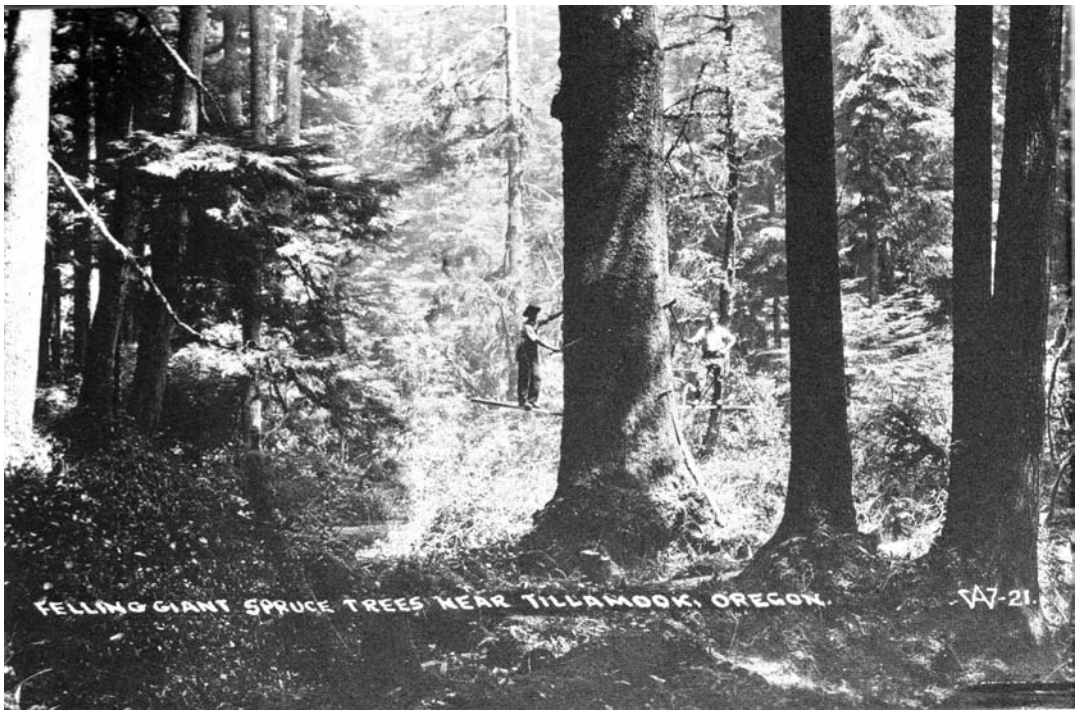

Figure 2.2. Historical floodplain forest in the Tillamook Basin. (Source: Huckleberry 1970)

2.3.1.3 Sensitive Plant Species

The pre-settlement distribution of plant species that are currently rare and the focus of concern is undocumented. They tend to have narrow habitat requirements. The presumed greater variability of vegetation age-class and species composition during pre-settlement times suggests that suitable conditions for sensitive species were probably more common historically than they are today. In addition, invasive non-native species, which can adversely impact sensitive species, would not have been introduced into the watershed in pre-settlement times.

2.3.2 WILDLIFE SPECIES AND HABITAT

2.3.2.1 Terrestrial Habitat

The mosaic of vegetation and habitat types that was distributed throughout the landscape of the Oregon Coast Range prior to Euro-American settlement supported a broad diversity of wildlife. Historical documents describe a great abundance of game species, including rabbit, deer, elk, and fish, as well as large predators, such as bear and cougar (Maddux 1976, Coulton et al. 1996). One account of life in the Trask watershed (likely in the lower watershed) in the early 1900s proclaimed, "Meat, then, while a major menu item, was no more of a problem than the effort expended in the going after it... Deer were so plentiful, in fact, you could just about have venison year round, if you desired," and "…in the summer there were large flocks of wild pigeons," and "…the hills surrounding the Trask were alive with bears and cougar." (Maddux 1976). However,

in addition to game species and predators, myriad other bird, mammal, reptile, and amphibian species were present. The prevalence of late-seral conditions provided an abundance of habitat for many species that are uncommon today, including northern spotted owl (*Strix occidentalis caurina*), marbled murrelet (*Brachyramphus marmoratus*), pileated woodpecker (*Dryocopus pileatus*), and red tree vole (*Arborimus longicaudus*).

Dead wood is a particularly important habitat element that was abundant prior to Euro-American settlement. Dead wood, such as snags and down logs, provided habitat for many species of wildlife. Snags provided cavities for bats, flying squirrels, and many species of woodpeckers and other cavity-nesting birds (Hayes and Hagar 2002). Down logs are especially important habitat for small mammals and amphibians, and provided den sites for several species of forest carnivores. In general, the large diameter logs and snags that were more prevalent in historic times provided habitat for a greater variety of species than the smaller logs that are more common today (Hayes and Hagar 2002).

Similarly, large trees are especially desirable for some wildlife species. The deeply fissured bark of Douglas-fir and other large tree species provided roosting sites for bats, and foraging sites for brown creepers (*Certhia Americana)* and nuthatches (*Sitta* sp.). Large branches provided important nest sites for marbled murrelets and red tree voles (Hayes and Hagar 2002).

Pre-settlement stand characteristics, which included greater diversity in tree density, species composition, canopy structure, and tree diameter, had direct influence on wildlife presence and abundance. Well-developed understory vegetation provided forage for many bird species, as well as nesting sites and cover for ground-nesting species.

2.3.2.2 Riparian, Wetland, and Estuarine Habitats

Riparian, wetland, and estuarine conditions in the lower watershed prior to Euro-American settlement were very different than they are today. Survey notes from the original township surveys in 1856 and 1857 described the riparian zones along the major rivers of the Tillamook Basin, including the Trask, as being lined with large trees. Trees in a bottomland area at rivermile 2.5 of the Trask River were recorded as western hemlocks ranging from 16 to156 inches in diameter, spruce from 32 to 84 inches, alder from 16 to 18 inches, and an 8 inch maple (Coulton et al. 1996).

Riparian zones in pre-settlement watersheds of the Oregon Coast Range were characteristically patchy, with a mixture of hardwoods, conifers, and shrub-dominated openings. They contained many large conifers, including an abundance of western red cedar in the mid-sized stream valleys, although alder were common as well (Maddux 1976, Coulton et al. 1996). In addition, snags and down logs were very common in the riparian zone. In general, the riparian forest was increasingly dominated by conifers higher in the watershed. Larger streams generally had a greater mix of species, and exhibited greater complexity associated with disturbance by floods, debris flows, earthflows, and less frequently by fires. Mass soil movement delivered sediment, boulders, and wood to the medium-sized streams from the steep, smaller stream channels (Spies et al. 2002).

The lowland riparian zone contained a diversity of wetland habitats, including brushy and wooded swamps, grassy swamps, grassy tidal marshes, tidally-influenced forest, and valley floodplain bottomlands (Coulton et al. 1996). As the Trask River approached Tillamook Bay, the floodplains of the Trask, Wilson, and Tillamook rivers merged, and channels crossed between these drainages. Between 1851 and 1920, nearly all floodplains and wetlands were ditched, drained, and converted to pasture in the Trask watershed (Coulton et al. 1996).

The Tillamook Bay estuary has been significantly altered since the time of Euro-American settlement, and many of these changes impact the health of salmonid fish that spawn and rear in the upper watershed. The tidally-influenced zone of the bay has been reduced by about 11% since 1867, due to artificial filling and sedimentation. The estuary was important for growth and development of anadromous salmonids, which is critical to their survival in the ocean (Pearcy 1992). In addition, woody debris and wood jams were abundant. During the late 1800s and early 1900s, the majority of this wood was removed to improve navigation, facilitate log drives, and reduce flooding. Woody debris and wood jams were important habitat elements for juvenile fish and many other species, and helped to maintain the natural seasonal flood cycle (Coulton et al. 1996).

At the same time that riparian and wetland habitat was declining, beaver ponds were systematically eradicated from the watershed. Beaver ponds were extensive in the lowland floodplains of the Tillamook Basin, as well as in small stream channels (primarily at tributary junctions) in the uplands prior to Euro-American settlement (Coulton et al. 1996, Spies et al. 2002). Modifications caused by beaver created habitat conditions that supported many other plant and wildlife species.

Finally, carcasses from spawned-out salmon were an important source of nutrients for riparian vegetation, especially at locations where nitrogen-fixing trees, such as red alder, were less abundant (Helfield and Naiman 2002). Salmon carcasses provided a seasonal pulse of nutrients that increased aquatic and riparian productivity.

2.4 SOCIAL

2.4.1 HISTORICAL CHANGES IN LANDSCAPE PATTERN

The pre-settlement coastal landscape mixture of forest and prairie was probably managed by Native Americans through burning (Coulton et al. 1996). Following Euro-American settlement, land in the lower watershed was prepared for agriculture. Prairies and tidelands were cleared of trees, logs, and brush; rivers were diked, and wetlands drained. Timber was harvested along the tidal flats and major rivers, and then further into the foothills and upland forests. Log drives were used to transport timber to mills. These drives scoured river channels of riparian vegetation and reduced channel complexity. Logging was also associated with extensive road building within the Trask watershed. A timeline of human use of, and impacts on, resources within the Trask watershed and surrounding Tillamook Basin is shown in Table 2.1.

Table 2.1. Timeline of significant events.	
11,000-14,000 BP	Climate warms, polar ice caps melt, and present day forest species associations become established. First humans arrive in Pacific Northwest.
1000 AD	Oldest dated village site in the Tillamook Basin.
1579 AD	Evidence suggests Sir Francis Drake visits Nehalem Bay in Tillamook County.
1788 AD	John Meares describes Tillamook Bay and the prairies and lowland forests. Names Tillamook Bay "Quicksand Bay".
	Robert Gray successfully enters the Bay one month later.
Early 1800s	Small pox and other diseases introduced by contact with Europeans decimate Native American population.
1806	Lewis and Clark estimate Tillamook tribal population to be about 2,200.
	Note that Tillamook have firearms and metal implements.
1845	Earliest documented major fire occurs in the northern Oregon Coast Range.
1849	Tillamook tribal population estimated at approximately 200, reduced largely by disease.
1851	First Euro-American settler, Joseph Champion, arrives at Tillamook.
1852	Henry W. Wilson brings the first cattle to the area.
	Elbridge Trask applies for the first land claim of 640 acres.
1853	Tillamook County established.
1863	Three sawmills open in the Tillamook Basin (all would close by 1870).
1866	The City of Tillamook is founded. It is incorporated in 1891.
1867	U.S. Army Corps of Engineers calls for estuary and river channel improvements.
1868	Large fire burns higher elevations away from the beach and bay.
1872	Trask Toll Road completed, connecting Tillamook and Yamhill.
1880s	Permanent logging and lumber operations begin in Tillamook Bay watershed.
	Regular dredging begins in Bay.
1888	Delivery of lumber to San Francisco by ocean steamer begins on a regular basis.
1892	Extensive diking and draining of lowlands begins.
1894	Peter McIntosh arrives in Tillamook, sparking the cheese industry.
	The timber industry considered Tillamook County's most important.
1900s	Drainage and diking districts formed.
1909	Tillamook County Creamery Association formed.
1911	Railroad linking Tillamook to Portland completed.
1913	Tillamook Clay Works was established to supply farmers with drain tile.

1923	20 sawmills operating in the County.
1933	First of the Tillamook Burn fires. Subsequent fires in 1939, 1945, 1951.
1937	Wilson River Salvage Road opened, followed by Trask River logging road 2 years later.
1940s	Salvage logging begins on a large scale.
1942	Logging companies estimate salvage of 2 billion board feet over next 3 years.
1949	Oregon Department of Forestry begins re-forestation of Tillamook Burn.
1953	610 million board feet harvested from Tillamook Basin. Salvage logging peaks.
1959	Salvage logging operations draw to a close.
1969	Fecal bacteria contamination first identified in bay waters.
1975	Trask watershed found to contain 2,168 miles of road.

2.4.2 HUMAN USES PRIOR TO EUROPEAN SETTLEMENT

The Tillamook Indians occupied many permanent and semi-permanent villages on the floodplain prairies and foothills surrounding Tillamook Bay. The earliest known Tillamook village site was estimated to be 1,000 years old, based on carbon dating (Coulton et al. 1996). One of four main native groups along the Oregon coast that split from the Chinooks to the north, the Tillamooks established themselves as a distinct cultural group as early as 1670 A.D. (Sauter and Johnson 1974). Villages were principally located at the mouths of rivers entering the Tillamook Bay. The village of Tow-er-quot-ton was located on Hoquarten Slough (Minor et al. 1980. Lewis and Clark estimated the Native American population in the Tillamook Basin to be 2,200 in 1805.

The Trask watershed was part of an area of advanced cultures with intricate social and ceremonial systems based upon a wild food subsistence economy (Newman 1959). Abundant marine, riverine, and terrestrial resources allowed the groups of the Northwest coastal areas to subsist in permanent and semi-permanent villages without the need for agriculture. The subsistence activities of the Tillamooks were largely oriented toward water resources. Salmon and steelhead were caught in great numbers in the many rivers entering the bay. Temporary fishing camps were set up during the seasonal salmon runs, and one such camp was located at the Dam Hole on the Trask River (river mile 12.7). Fish weirs and traps were used, at times spanning the entire river, and trapped fish were taken with dip nets, gigs, harpoons, or hook and line (Sauter and Johnson 1974). Marine life such as crabs, clams, mussels, barnacles, and octopus were harvested from the estuary and coastal tide pools. Seals and sea lions were harpooned or clubbed on off-shore rocks, and the occasional beached whale was salvaged whenever possible. The eggs and young of birds such as brant, coot, various ducks, and other waterfowl were also reported as food resources of the Tillamooks (Minor et al. 1980).

The Tillamooks did not frequent the upland forested areas, since most of the resources they needed were near the coast (Taylor 1974). Large game such as deer and elk were plentiful along the coast and in the foothills and valleys of the Coast Range, but reportedly were only taken to

supplement the largely marine diet of the Tillamooks. They also relied heavily on roots, berries, and fruits, as well as seaweed for salt. Seasonal availability largely determined the exploitation of food resources. Summer and fall were principally times of fishing and berry gathering, whereas fall to spring was a time for shellfish gathering. Many species of fish and game could be taken year round to augment diminishing supplies as needed. Most subsistence activities were carried out near permanent or semi-permanent villages and local areas were most heavily exploited. Occasionally, Tillamooks would travel further afield on special hunting, fishing, or collecting expeditions (Minor et al. 1980).

A significant human impact on the landscape by Native Americans was the use of fire to maintain valley and upland prairies for the purpose of increasing access to game and improving the growth of herbaceous food plants. The prairies that were first observed and recorded by early explorers and settlers may have been remnant features of a valley landscape controlled by the use of fire by Native Americans. There is evidence that during the first 50 years of Native American contact with Europeans prior to settlement there may have been a re-establishment of forests in these prairie areas as the Native American populations were decimated by disease, decreasing the amount of burning (Coulton et al. 1996). The presence of large stands of Sitka spruce and western hemlock on the tidelands surrounding the bay at the time of settlement may have been partly a result of reduced burning by Native Americans (Coulton et al. 1996).

2.4.3 EUROPEAN SETTLEMENT

Evidence exists that Sir Francis Drake may have visited Nehalem Bay in Tillamook County as early as 1579 (Sauter and Johnson 1974). In July of 1788, John Meares described the Tillamook Bay and nearby Cape Meares, but was unable to enter the bay due to a long sandy bar located across the entrance (Nokes 1998). One month later, on August 14th, Captain Robert Gray entered Tillamook Bay, finding a passage through the sand bar. During their short stay in the bay, one of the crewmen was killed in an altercation with the Native Americans and the bay was dubbed Murderers Harbour (Coulton et al. 1996). It was around this time that contacts between whites and native people became numerous or consistent, and by 1800 all coastal groups likely had Euro-American trade goods in their possession. Lewis and Clark noted that the Chinook and Tillamook had firearms and metal implements in 1806 (Newman 1959).

In the early to mid 1800s, the Tillamook group experienced a dramatic decline in population due largely to smallpox and other Euro-American diseases. From 1829 to 1832, the Chinook tribes to the north of Tillamook Bay lost 90% of their population to an outbreak of disease, which may have spread south to the Tillamook group (Coulton et al. 1996). The population of the Tillamooks was reduced from 2,200 in 1805 to 400 in 1845, and 200 in 1849 (Swanton 1968).

Tillamook County's first white settler was Joseph C. Champion, who arrived on a whaling boat in 1851 and was reported to have lived in the hollowed trunk of a dead Sitka spruce tree (Reynolds 1937). In the spring of 1852, Elbridge Trask settled 640 acres of land on the river that now bears his name (Orcutt 1951). By the end of 1852, three families and six bachelors were living in the area, and 80 settlers had moved into the newly formed Tillamook County by 1854 (TBNEP 1998a).

2.4.3.1 Agricultural Operations

Early settlers of the Tillamook area were initially drawn to the prairies surrounding the bay, as these lands proved relatively easy to cultivate. As the more desirable open areas of the tidelands and surrounding prairies became less available, settlers moved into the foothills and valley bottoms of the surrounding rivers, clearing the land of trees and brush. By the turn of the century, most of the lowland forest areas had been cleared of trees and stumps to make room for more farms. Significant portions of the lower intertidal and freshwater wetland areas were also converted to pasture by the early 1900s (Coulton et al. 1996).

The number of farms increased steadily from the 1850s until 1900, when the land area in farms in the Tillamook region, and for Oregon in general, began to decrease. By 1900, Tillamook County had among the highest number of owner-operated farms in the state. The subsequent decrease in the number of farms was associated with increasing value of timber, and the sale of some farms to timber companies (Coulton et al. 1996). From 1930 to 1940, however, the rural farm population of Tillamook County increased by 16% while the overall population of the County increased by only 4%. Through the 1940s, the number of farms steadily increased and the average size of farms decreased (Arpke and Colver 1943). Many farmers during this time were working in the timber industry, and falling back on farming during the seasonal and cyclical periods of unemployment typical of timberwork. The number of farms fell in the 1950s as forest and range lands were sold to timber companies and part-time farms were converted and combined into larger commercial farms (Coulton et al. 1996).

In 1852, Henry W. Wilson brought the first cattle into the area, laying the foundation for the dairy industry. Peter McIntosh came to Tillamook County in 1894 and taught the art of cheese making (Reynolds 1937). Shortly afterward, a number of small cheese-making factories began operation. The Tillamook County Creamery Association, a cooperative formed in 1909, has helped the dairy industry to grow by minimizing the effects of unstable milk prices, giving farmers dividends on the sale of cheese, and reducing the cost of feed and farm equipment. In 1911, the completion of a railroad connecting Tillamook to Portland greatly facilitated the profitability and the distribution of dairy products manufactured in Tillamook.

From 1910 to 1940, annual milk production increased from 4 million to 10 million gallons, and cheese production from 3 million to 11 million pounds (Arpke and Colver 1943). Increased milk production was achieved largely by improving herd quality rather than by expanding herds beyond the capacity of available pasturelands. Dairy products were a major source of income for about two-thirds of all farms in 1939, and accounted for nearly 72% of gross agricultural income (Arpke and Colver 1943). Other livestock products such as hogs, sheep, chickens, and eggs provided relatively little income and were mostly consumed locally. Mink farming in the late 1930s was profitable and in 1937 pelts from 60 farms yielded an estimated income of $150,000. Field crops consisted primarily of hay and were produced mostly for local consumption (Arpke and Colver 1943).

Between 1920 and 1975, the number of dairy cows in Tillamook was fairly stable at 15,000. Then, between 1975 and 1995 there was a 70% increase to 25,000 cows, likely resulting in increased waste contamination of the rivers. Fecal bacteria contamination of bay waters was first identified in 1969, when regular water quality monitoring began.

2.4.3.2 Timber Operations

Logging was not considered an industry during the early years of settlement in Tillamook County. Trees were considered a hindrance to farming and maintenance of pasturelands and were felled and burned or taken to the tidelands to be washed away by the tides. Several small sawmills, run solely to provide lumber for local building needs, began operating in 1863, but all closed by 1870. Sawmills began operating again around 1880, and logging activities extended into the foothills and along the major rivers. Logs were pulled to mills by oxen in summer or floated down rivers during the rainy season (Coulton et al. 1996).

Following the construction of a sawmill at Hobsonville, an early market for milled lumber was found in San Francisco in the 1880s. By 1888, the steamer Tillamook was making monthly trips to San Francisco, delivering lumber and returning with mill and logging supplies (Farnell 1980). Figure 2.3 illustrates the historical chronology of sawmills in Tillamook County from the 1860s to the 1980s. At the turn of the 20th century, the tidelands surrounding the Tillamook Bay were still forested with large amounts of Sitka spruce and western hemlock. Demand for spruce for airplane stock during World War I resulted in extensive harvest of tideland forests (Coulton et al. 1996).

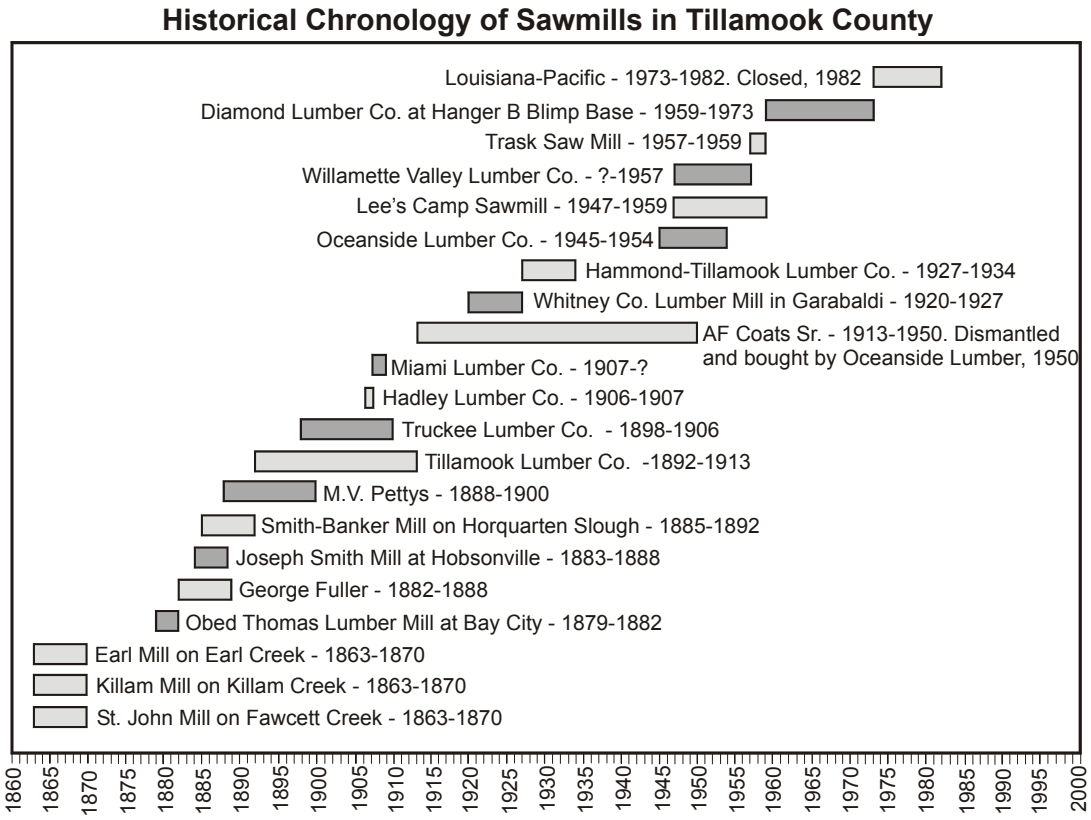

Figure 2.3. Historical chronology of sawmills in Tillamook County. (Source: Coulton et al. 1996)

By 1894, the timber industry was considered Tillamook County's most important industry (Levesque 1985). Private timber companies acquired much of the valuable forest resources with the help of the Donation Land Act of 1850, the Homestead Act of 1862, and the Timber and Stone Act of 1878 (Levesque 1985). As the value of timber increased, many homesteads in the foothills or river valleys that had initially been settled and cleared for agriculture were bought by timber companies and allowed to revegetate. The completion of the Southern Pacific Railroad line from Tillamook to Portland in 1911 allowed timber to be easily transported to mills in the Willamette Valley. Logging activities accelerated thereafter, with initially no effort to reforest harvested lands.

In 1940, forest products industries employed 22% of all workers in Tillamook County, nearly as many as agriculture (Arpke and Colver 1943). Large-scale logging and sawmill operations were just getting started when the fire of 1933 and the Great Depression provided a setback to the industry. From 1911 to 1925, an estimated 120 million board feet (Mbf) were cut annually. Annual sawlog production averaged 161 Mbf over the next 4 years, peaking at 250 Mbf in 1929. In the early 1930s, production declined to 120 Mbf annually, with a low of 43 Mbf in 1932. Production rebounded and averaged 249 Mbf from 1935 to 1939, about two-fifths of which was timber salvaged from the burn. Driven largely by wartime demands, production reached a high of over 400 Mbf by 1941. In 1942, logging companies estimated they would salvage 2 billion board feet of burned timber over the next 3 years (Arpke and Colver 1943). From 1925 to 1939, Douglas-fir accounted for 75 to 80% of the total sawlog output. Other conifers logged were western hemlock, Sitka spruce, and western red cedar (Table 2.2). Only a small percentage of sawlogs were cut or otherwise processed at local mills in Tillamook County. An estimated 90% of annual sawlog output was milled outside the county, along the Columbia River or in the Willamette Valley (Arpke and Colver 1943).

Table 2.2. Sawlog production in Tillamook County, by species, 1925-1941 (Mbf).

	Annual Averages			
Species	1925-29	1930-34	1935-39	1941
Douglas-fir	118,000	83,000	197,000	307,000
Western hemlock	19,000	15,000	26,000	49,000
Sitka spruce	20,000	7,000	14,000	32,000
Western red cedar	3,000	5,000	10,000	5,000
Balsam fir	68	309	1,000	5,000
Western white pine	232	-	-	-
Hardwoods	868	981	1,000	6,000
Total	161,000	112,000	249,000	404,000

Source: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, unpublished data.

From 1933 to 1951, a series of catastrophic wildfires swept across the Tillamook Basin, altering the forest and logging practices significantly. The fires killed most of the old-growth forests in the Trask watershed, burning some areas repeatedly (TBNEP 1998a). Salvage logging operations following the Tillamook Burn began in 1937 and continued at a high level throughout 1941 to meet the needs of the war effort (Figure 2.4). Following the 1939 fire, the new availability of gas and diesel-fueled equipment increased the efficiency of log salvage operations. Because many miles of roads were built during the salvage logging effort, smaller logging operations could now afford to log areas already cut over by the larger operations. This practice of "relogging" allowed salvage logging operations to continue for many years, until finally drawing to a close about 1960. Reforestation efforts began in November 1949, but were hampered for six years by ongoing salvage logging operations (Coulton et al. 1996).

At the time of the 1933 Tillamook fire, large private timber companies from the Great Lake States had acquired most of the valuable timber in Tillamook County. These companies were seeking new resources of raw material and had found vast areas of untouched old-growth available in the northwestern states. After the 1933 burn, however, many of the private land holdings reverted back to county ownership for delinquent property tax payments. In the 1940s and 1950s, these lands were deeded to the state to reforest and manage.

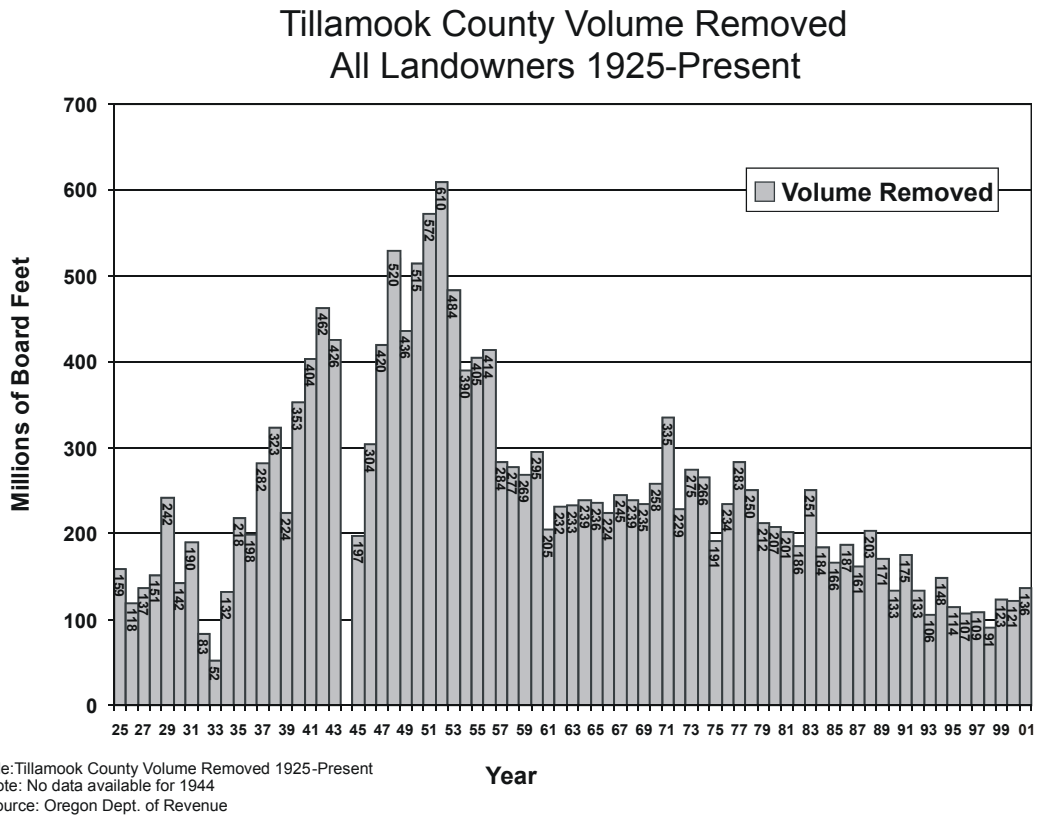

Figure 2.4. Timber harvest data for Tillamook County, Oregon.

2.4.3.3 Road Building

Transportation was a big problem for early Tillamook settlers, as they were surrounded by steep mountains to the north, south and east, and by ocean to the west. Some early roads in Tillamook County evolved from trails of the Native Americans, but it wasn't until the late 1800s that a road connecting Tillamook and the Willamette Valley was completed through the Coast Range. The Trask Toll Road, completed in 1872, was one of the earliest roads to cross the Coast Range between the Tillamook Basin and the Willamette Valley. Notorious for being rough, narrow and steep, the road ran a distance of 45 miles from Tillamook to Yamhill. Within the Trask watershed, the road followed the Trask River from Tillamook until reaching the historic Trask House, at which point it climbed steeply to the drainage divide and descended the east side of the Coast Range (Stoller 1991). Stagecoach roads provided the only land route between Tillamook and Portland until the railroad was built in 1911.

Road building increased significantly during the salvage logging following the Tillamook Burn. In the early years of salvage logging, the rugged and steep terrain made road construction difficult. Records indicate there were many problems simply maintaining roads against the elements. Photographs also show that the easiest access to downed timber was often along river corridors, and roads were built by excavating into the hillside and side-casting earth into stream channels (Coulton et al. 1996).

The Trask River logging road opened in 1939. During and after World War II, the use of gas and diesel machinery increased the rates of road building in the Trask watershed and made more remote areas accessible. Many railroad tracks were also torn up and replaced by logging roads during this time (Coulton et al. 1996). Additionally, road building on steep slopes was made possible by the use of mechanical bulldozers. A sedimentation study conducted in the Tillamook Basin found 2,168 miles of road in the Trask watershed in 1975 (Coulton et al. 1996). As the number of roads increased, so did their impact on the environment. Figure 2.5 depicts the increase in road stream crossings in the Tillamook Bay watershed from 1937 to 1970.

2.4.3.4 Wetland Conversion

Riparian and floodplain wetland ecosystems in the lower watershed have been altered dramatically since the time of settlement due to levee construction and land drainage. Such changes affected the health of salmonids that spawn and rear in parts of the upper watershed. Drainage and diking districts were formed in the 1900s to legally sponsor measures to reduce flooding of the valley areas of the Tillamook Basin (Coulton et al. 1996). Reduced flooding would mean that more pastureland would be available for dairy farms.

The Tillamook Clay Works was established in 1913 to supply clay tiling to farmers, allowing them to drain wetlands and wet meadows so that dairy herds could be turned out to pasture earlier in the season (Coulton et al. 1996). By 1940, dikes and tide gates were used to drain 2,297 acres of land. An additional 8,000 acres was recommended for draining at the time, as well as the clearing of 4,000 acres of hillside land (Arpke and Colver 1943). By 1950, seven

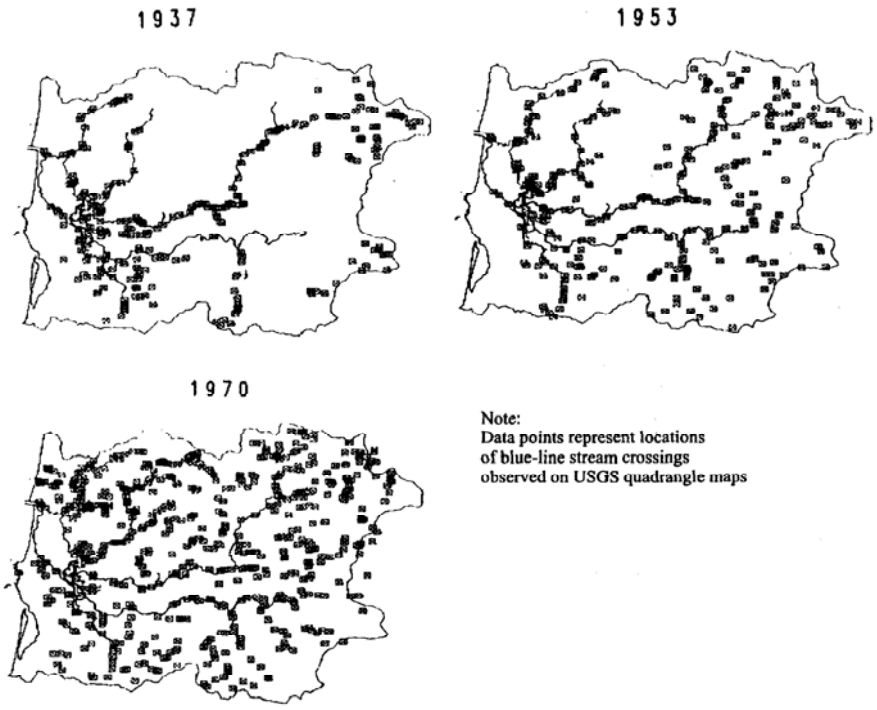

Figure 2.5. Stream crossing locations in the Tillamook Bay watershed. (Source: Coulton et al. 1996)

Table 2.3. Time periods for drainage district organization and acres drained.

Time Period	Drainage Districts Reporting	Acres Drained
Before 1900	--	--
1900-1909	--	--
1910-1919	4	3,423
1920-1929	2	1,671
1930-1939	--	--
1940-1949	1	549

Source: Data from the U.S. Department of Agriculture (1952).

drainage districts in the Tillamook Basin had drained a total of 5,643 acres, and a majority of this land had been cleared and drained by the 1920s (Table 2.3).

The use of levees, dikes, and tile drains to control flooding and drain wetlands resulted in a disconnection of the river from its surrounding floodplain. The lower river became channelized and lost structural complexity as high flow energy was concentrated in a single channel, rather than dissipated over the floodplain. Levees and dikes reduced lower elevation flooding and in turn reduced the levels of sediment and organic nutrient deposition on the floodplain. The lack of flood water overflow may have reduced the seasonal recharge of alluvial aquifers, which in

turn may have caused changes in plant and wildlife habitat due to changing soil moisture availability (Coulton et al. 1996).

Salt marshes in the Tillamook Basin have been altered and degraded, mainly due to agricultural development. Conversion of salt marsh to pastureland through diking and draining in the Tillamook Basin has left only about 15% of the original marshlands intact (http://www.harborside.com/~ssnerr/EMI%20papers/marshes.htm).

2.4.3.5 Channel Modification

The first Euro-American settlers in the Trask watershed were homesteaders who farmed the valley bottoms, and logged streamside forest to build structures and create pastures (Maddux 1976, Coulton et al. 1996). Log drives scoured channel bottoms, caused bank erosion, and destroyed riparian vegetation (Farnell 1980, Coulton et al. 1996, Reeves et al. 2002). In the 1960s and 1970s, logs and woody debris were removed with the misguided intention of improving habitat conditions for fish (Reeves 2002). The resulting loss of natural complexity has contributed to a decline in the abundance of aquatic, riparian and upland fish and wildlife species (Coulton et al. 1996, Reeves et al. 2002).

Dredging of the lower Trask and other rivers of the Tillamook Basin was conducted until 1974 for navigational and flood prevention purposes, and to maintain the Port of Tillamook Bay. In 1867, the USACE called for channel improvements along the upper estuary and river channels, so that boats could access timber located further from the Bay (Coulton et al. 1996). Low dikes along the lower Trask River were constructed from river sediments dredged from the river mouths. Extensive dredging and diking was conducted along the lower Trask River and Hoquarten Slough.

An important potential impact of river channel modification is increased erosion. A 1978 study on erosion in the Tillamook Bay watershed evaluated 111,288 feet of streambank along the Trask River and rated 1.5% to be a Critical Erosion Area. The study also found that 19% of the streambank that was evaluated had been armored or rip rapped (Tillamook Bay Task Force 1978).

It was the responsibility of the USACE to remove “snags” when the wood posed a threat or impeded navigation. Wood removal from channel areas in the Tillamook Basin has been documented since the 1890s. Between 1890 and 1920, the USACE removed about 9,300 snags from river channels around Tillamook Bay for navigational purposes. Most of these snags were removed near the mouth of the Tillamook River and Hoquarten Slough, with some from the lower channels of the Trask River (Coulton et al. 1996). Large wood jams were also prevalent further up the Trask River and were often released using dynamite. The clearing of wood jams probably reduced the frequency of floodplain inundation during flood events.

Historic logging practices had a dramatic impact on stream channels of the Trask River. Unlike many other coastal streams, there is no record of the use of splash dams on the Trask River. However, log drives provided logging companies with a cost effective means of transporting

lumber to mills. They may have been conducted on the North and South Forks of the Trask, the lower portion of Bark Shanty Creek, and the mainstem Trask from the bay to the confluence of the North and South Forks, although there is some dispute regarding the accuracy of this information. (Figure 2.6). In the neighboring Wilson watershed, the practice involved storing logs on the stream banks until winter high flows, and then pushing them into the water for transport downstream. Riparian trees were cut and snags were removed from the channel to facilitate log transport. As a result, channels and banks were heavily scoured, and large amounts of sediment were generated and transported downstream (TBNEP 1998b). Records exist in the Wilson watershed of lawsuits brought by riparian landowners for damage done to riverbanks and obstruction of boating channels by log drives. It is implied in these lawsuits that logging companies were sending two years worth of logs down the river channel at one time (Coulton et al. 1996). It is important to note that the Tillamook Basin may have used log drives to a lesser extent than surrounding coastal basins due to the relatively late development of export capabilities, reducing the early demand for logs by export sawmills (Farnell 1980).

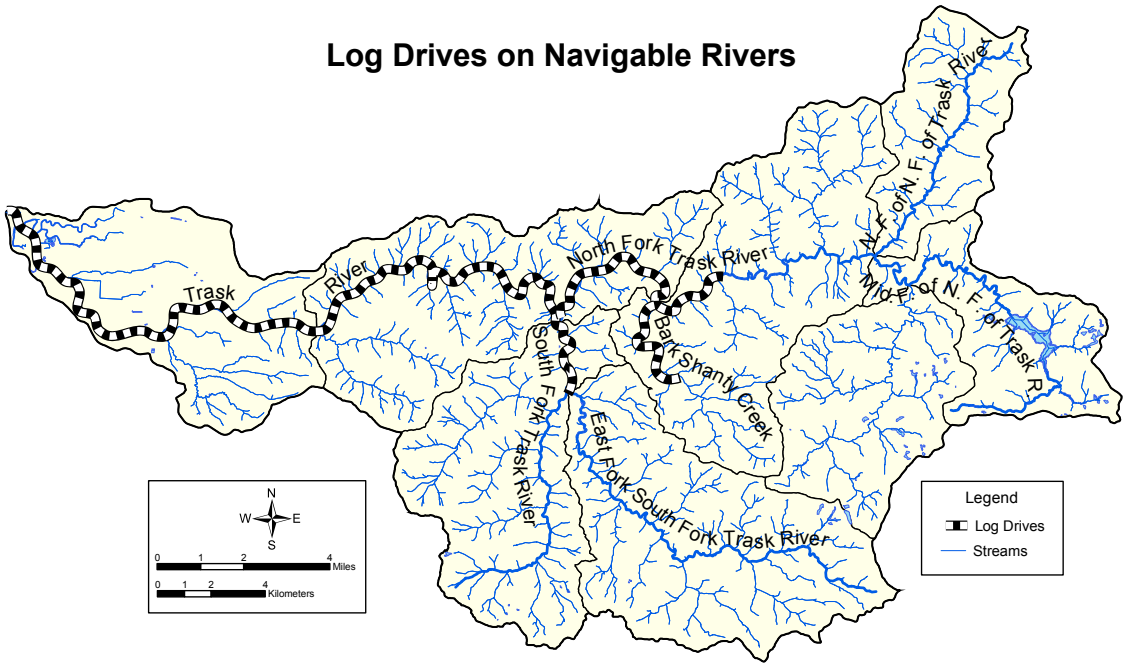

Figure 2.6. Log drives in the Trask watershed, c. 1880-1910 (Source: Coulton et al. 1996)

2.4.3.6 Expansion of Urban and Rural Residential Land Uses

The City of Tillamook was founded in 1866 and incorporated in 1891 (Arpke and Colver 1943). The population of Tillamook has grown steadily over the years, mirroring the growth of Tillamook County (Figure 2.7). In 1940, the city had a population of 2,751, about one-fifth of the county total (Arpke and Colver 1943).

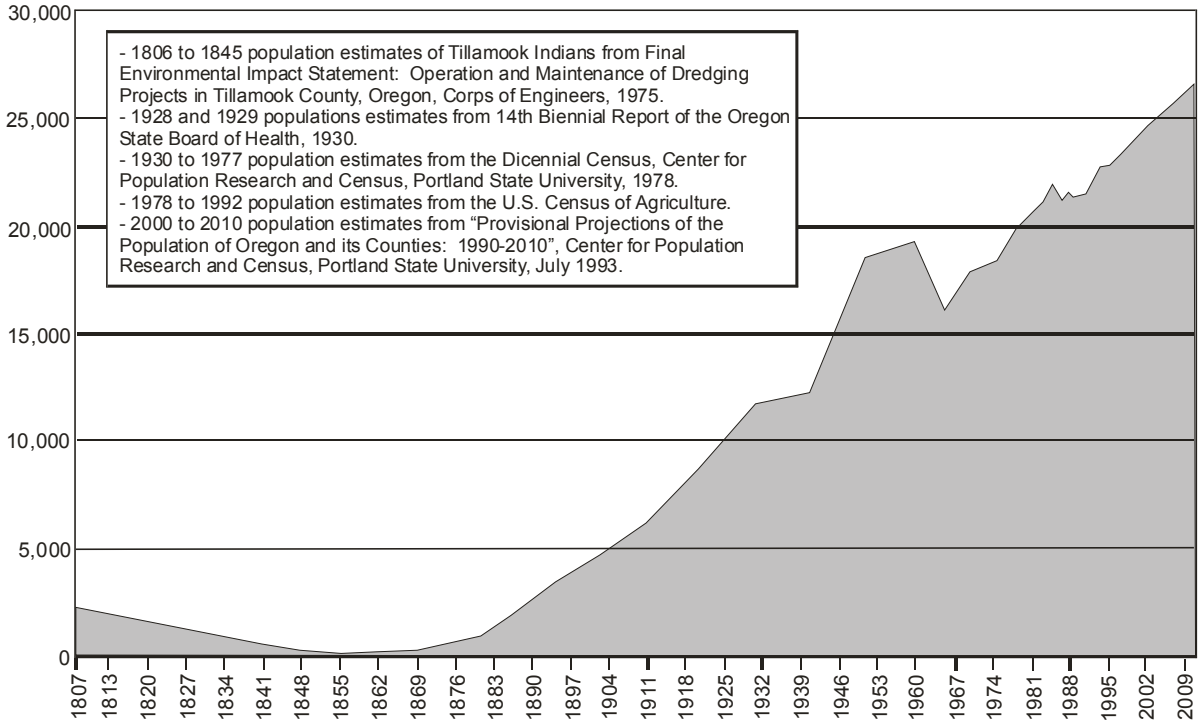

Figure 2.7. Population trends in Tillamook County. (Source: Coulton et al. 1996)

During the 1880s, the focal point of business was along Hoquarten Slough where the boats landed. By 1910, Tillamook had a fire department, a municipal water system, and a telephone company, and the first paved streets were completed in 1911. By 1941, an airport was completed south of Tillamook, and in 1942 a major military airbase was established, covering over 1,000 acres.

Urban land use in Tillamook County has historically focused on providing services for the timber and dairy industries. However, over the last several decades the economy has shifted to a greater diversity of business and industry. Tourism has recently played a more important role, accounting for approximately 25% of the jobs in Tillamook County (Southern Oregon Regional Services Institute 1996). Rural residential land uses are expanding throughout the county, as new homes are increasingly targeted toward upper income individuals looking for second or vacation homes near the coast. A recent influx of retirees has also contributed to the growth of rural and urban residential land uses.

2.4.4 EFFECTS OF NATIVE AMERICANS AND EUROPEAN SETTLERS UPON FIRE REGIMES

Prior to European settlement, there is little documentation of fires in the Tillamook area. Maps of forest stand age distribution in 1850 showed that the Oregon coast was a matrix of forests of

different ages, suggesting that fire was relatively common prior to Euro-American settlement. Also, an area of 100- to 200-year growth in the Tillamook basin indicated possible fire disturbance in the mid 1600s (Coulton et al. 1996). The presence of natural stands of Douglas-fir within the Tillamook basin may also indicate the influence of the historic fire regime. Mature Douglas-fir are more resistant to fire than other conifer species in the area, and Douglas-fir seedlings germinate better on mineral soil than on forest litter and grow better in sun than shade (Coulton et al. 1996).

Fire was used regularly by the Tillamook Indians to facilitate both hunting and berry gathering. Fire improved hunting conditions by clearing areas of small trees and brush, making travel easier and providing new browse each spring to attract deer and elk. Fire was also used to flush game into traps, or into the range of waiting hunters (Sauter and Johnson 1974). Areas of huckleberry, salal, and blackberry were also burned regularly to improve berry growth and productivity (Boyd 1999). An early Oregon pioneer, Jesse Applegate, observed that the Tillamooks had a custom to "burn off the whole country" late in the autumn every year, to facilitate the harvest of wild wheat (Coulton et al. 1996). The existence of prairies in the floodplain and at higher elevations around the bay, recorded by early settlers, may be an indication of earlier burning by Native Americans.

Settlers who did not want new crops or buildings to be jeopardized by fire halted burning by Native Americans in the 1850s. However there is evidence that fires continued to consume increasing amounts of land after Euro-American settlement. Settlers preparing land for agriculture would often burn slash in the late summer months, resulting in the spread of uncontrolled fires. A timber cruise conducted in the Tillamook Bay watershed in 1908 noted areas of recent and older burns. From evidence collected during these cruises, Coulton et al. (1996) concluded that "Large portions of the Kilchis, Wilson, and Trask River valleys had been burnt by the turn of the century…" and "Several of the burns appear to be associated with clearing activities for Euro-American settlements and are typically located along the major rivers and wagon roads."

From 1933 to 1951 a series of catastrophic wildfires, dubbed the Tillamook Burn, hit the forested uplands of the Oregon Coast Range. Beginning in 1933, a major fire occurred every six years, burning hundreds of thousands of acres of forest, and killing billions of board feet of timber. A second fire was sparked in the summer of 1939 and burned much of the same area as the 1933 fire, as well as new timber mostly to the south. Six years later a third fire started on the South Fork of the Wilson River. Unburned slash and snags of the previous two fires provided fuel as the fire covered 180,000 acres. A fourth and smaller fire occurred in 1951 and was located primarily within the Trask watershed (ODF 1997). Together, the four fires burned about 350,000 acres of timber, with some areas burned two or three times.

The Tillamook Burn resulted in increased rates of erosion and sediment delivery to streams. Subsequent salvage logging compounded erosion problems as poorly drained roads and extensive soil disturbance resulted in accelerated surface erosion and mass failures. Hydrologic processes were also disrupted, as the infiltration and water storage capacity of the forested uplands was reduced, especially in areas that burned repeatedly, altering the timing and magnitude of stream flow.