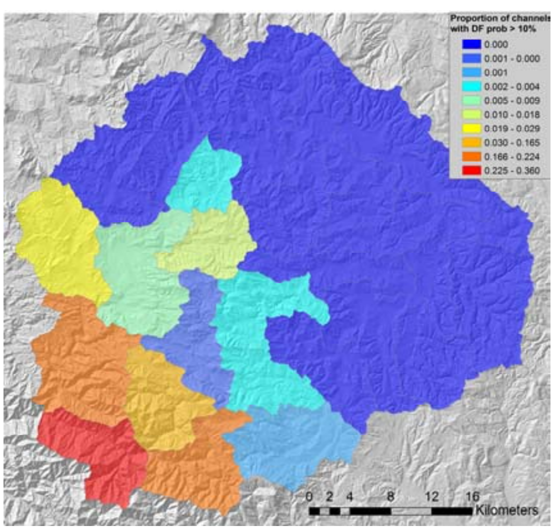
Upper Nehalem Watershed Analysis
Part I - Assessment

Prepared for:

Oregon Department of Forestry



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1. INTRODUCTION

This Upper Nehalem Watershed Analysis project area covers approximately 106,000 acres of State Forest managed lands located in the Upper Nehalem River watershed (Figure 1-1). It also includes small contiguous parcels of Oregon Department of Forestry (ODF) land in adjacent watersheds. These ODF lands are part of the Clatsop and Tillamook State Forests. Oregon Department of Forestry (ODF) is responsible for management of these state lands that are 99 percent Board of Forestry (BOF) lands and approximately 1 percent Common School lands. These forests are also home to numerous fish and wildlife species, including Lower Columbia River Chinook salmon, Lower Columbia River coho and Oregon Coast coho salmon. Lower Columbia Chinook salmon are currently listed as threatened under the federal Endangered Species Act, while Lower Columbia and Oregon Coast coho salmon runs are currently candidates for listing.

1.1 PURPOSE AND APPROACH

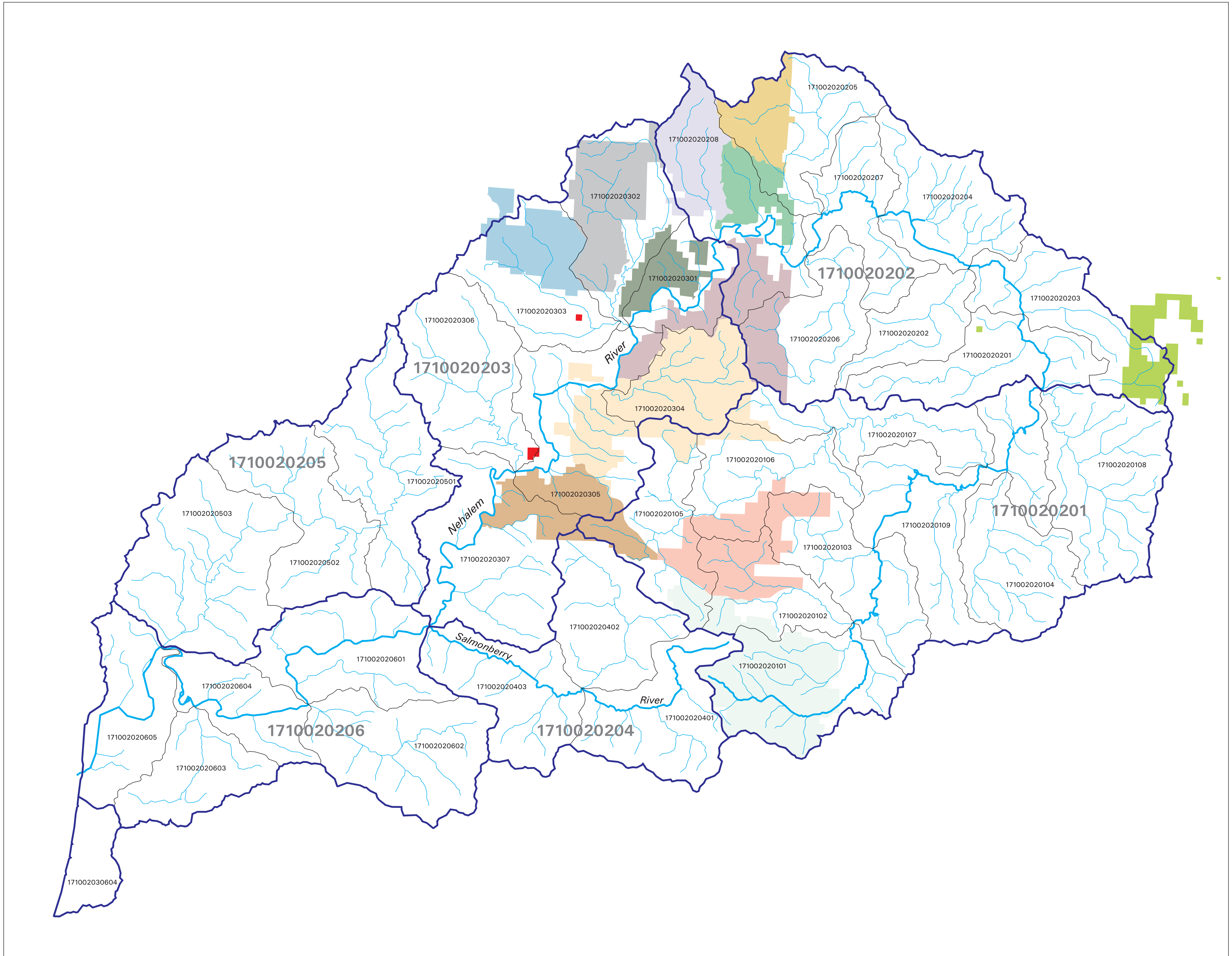
Oregon Administrative Rule (OAR 629-035-0020) and Oregon Revised Statute (ORS 530.050) directs ODF to manage BOF lands to provide the greatest permanent value to Oregonians including a full range of social, economic and environmental benefits that can be supported by managing for healthy, productive and sustainable forests. To fulfill these directives a new Forest Management Plan (FMP) was adopted for the Northwest and Southwest State Forests in 2001. The State Forest Watershed Analysis Program is the critical component of the aquatic and riparian strategy that was adopted as part of the 2001 FMP.

The ODF watershed analysis process was designed to focus on functions and processes that influence aquatic and riparian habitat conditions on State Forest lands. The watershed analysis process is consistent with strategies identified in the FMP and includes consideration of natural disturbances that have helped to define the existing aquatic ecosystem. Under the FMP, aquatic and riparian strategies call for managing for "properly functioning" aquatic systems that are inherently dynamic and include a range of natural variability over space and time. The goal of the FMP strategy is to maintain or restore proper function in aquatic and riparian habitats such that they are capable of supporting native species. Correspondingly, the primary objectives of the watershed analysis were to identify where properly functioning habitat existed, where properly functioning habitat was lacking, and what management changes could be implemented to protect or as necessary, restore proper function to those habitats.

The upper Nehalem watershed analysis was not intended to analyze all past and current information on all potential biological and ecological processes and natural resources on State Forests. Rather, it was specific to the strategies from the FMPs and focused on those issues that most directly apply to aquatic and riparian conservation and the current management strategies. Upland processes were considered in the context of how they might aquatic and riparian conditions. Within this context then, this analysis of the upper Nehalem River considered an assessment of historic conditions, current assessments of hydrology, channel conditions, water quality, riparian and wetland habitats, fish and aquatic amphibians, and sediments. The information from each of these analytical modules was then synthesized with respect to limiting factors, alternative vegetative management, slope stability, and roads to develop a thorough understanding of the relationship between forest management and proper function of aquatic and riparian habitats.

1.2 STUDY AREA

The study area for the Upper Nehalem Watershed Analysis is depicted in Figure 1-1. The Upper Nehalem Project Area is approximately 106,000 acres, most of which occurs within the Nehalem River Basin. Two small contiguous parcels of land within the project area, which total approximately 3,000 acres, are located outside the Nehalem River watershed. One parcel is located near the headwaters of the Clatskanie River in the Clatskanie Watershed, while the other is located in the upper South Fork Klaskanine River subbasin in the Young's Bay watershed.



Legend

- Beneke Management Basin
- Buster
- Crawford
- Fishhawk
- Hamilton
- Lousignont
- McGregor
- Northrup
- Quartz
- Sager
- Scattered
- Wheeler
- Wilark
- Stream
- Major River
- 5th Field HUC (1710020201)
- 6th Field HUC (171002020109)

Map Key

Nehalem River Basin

Oregon

N

1 Inch = 4 Miles

0 2

Miles

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Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 1-1
Project Area
Nehalem River Basin

2. WATERSHED OVERVIEW

2.1 PHYSICAL SETTING

The analysis area includes lands located in three watersheds: the Nehalem River basin, the Clatskanie River basin and the Klaskanine River basin that drain into Young's Bay. A brief summary of each watershed is provided in the following section, including descriptions of the biological setting, ecosystem processes, and the social and economic status within each watershed.

The Nehalem River basin is approximately 855 square miles and is located on the north Oregon Coast northeast of Nehalem, Oregon. The Nehalem River flows 118.5 miles from its headwaters in the Coast Range near Cochran, Oregon through Washington, Columbia, Clatsop and Tillamook Counties, and empties into the Pacific Ocean at Nehalem Bay. This watershed analysis addressed all tributary habitats located in the upper Nehalem River basin, defined as that portion of the basin on ODF lands upstream of the confluence of the Nehalem and Salmonberry rivers. The total area covered by this watershed analysis was 106,000 acres. The Upper Nehalem Watershed Project encompasses 13 distinct ODF management basins (Table 2-1) that serve as the unit of scale for much of the watershed analysis. A comprehensive watershed assessment of the entire Nehalem River basin was completed previously by Portland State University (Johnson and Maser 2000).

The Clatskanie River is located in Columbia County, Southeast of Clatskanie, Oregon. The Clatskanie River is one of three major rivers that comprise the Lower Columbia – Clatskanie Subbasin that encompasses 298 square miles. The ODF lands along the Clatskanie that were addressed by this watershed analysis were located near the town of Vernonia, Oregon and included portions of the headwaters of the Clatskanie, Little Clatskanie, Carcus Creek, and Oak Ranch Creek. This area of ODF lands covered 2,230 acres and was all contained within the Wilark management basin. A comprehensive watershed analysis of the entire Clatskanie River basin was completed previously by Portland State University (Rule 2001).

The Young's Bay watershed is located in the northwest corner of Clatsop County south of Astoria, OR and covers approximately 184 square miles. The ODF lands of concern in this watershed covered 716 acres along the upper South Fork Klaskanine River and were contained within the Hamilton management basin. A comprehensive watershed analysis of the entire Young's Bay watershed system was completed by the Young's Bay Watershed Council (E&S Environmental Chemistry and Young's Bay Watershed Council 2000).

Table 2-1. Administrative breakdown of lands in the Nehalem Watershed Analysis area.

Watershed	District	Management Basin	Area (acres)[1]
Nehalem River	Forest Grove	McGregor	10,618
Nehalem River	Forest Grove	Wheeler	15,613
Nehalem River	Astoria	Beneke	9,724
Nehalem River	Astoria	Buster	18,819
Nehalem River	Astoria	Crawford	4,212
Nehalem River	Astoria	Fishhawk	5,087
Nehalem River	Astoria	Hamilton	6,101[2]
Nehalem River	Astoria	Lousignot	4,555
Nehalem River	Astoria	Northrup	7,201
Nehalem River	Astoria	Quartz	8,582
Nehalem River	Astoria	Sager	10,257
Nehalem River	Astoria	Scattered	174
Clatskanie	Forest Grove	Wilark	4,596
Young's Bay/Klaskanine	Astoria	Klaskanine	716[2]

[1]Areas derived from GIS coverage provided by ODF.
[2]Hamilton management basin includes lands in the Nehalem River and Young's Bay watersheds.
[3] Wilark management basin includes lands in the upper Nehalem and Clatskanie watersheds.

2.1.1 Ecoregion

The Nehalem, Clatskanie and Young's Bay watersheds are located within the Coast Range Ecoregion (Pater et al. 1998), defined by highly productive, rain-dominated coniferous forests. Vegetation generally consists of a mosaic of western red cedar, western hemlock, and Douglas-fir. The Coast Range ecoregion has been further subdivided into Level IV ecoregions; lands evaluated for this analysis are located within the Volcanics ecoregion (1d) and the Astoria Basin (1f). The primary difference between these two Ecoregions is geology. Geology in the Volcanics Ecoregion consists of igneous rocks, including basalt flows and concreted basalt materials (Watershed Professionals Network 1999). These resistant parent materials commonly result in the formation of waterfalls, and a relatively low density of headwater streams that usually occupy steep, v-shaped channels. Shallow rapid landslides that propagate debris flows can be common. In contrast, geologic parent materials in the Willapa Hills Ecoregion consist primarily of easily weathered siltstone, mudstone and shale. Waterfalls are uncommon, and the stream density is high. Landslides occur as deep-seated earthflows, or less frequently, as shallow landslides that may trigger debris flows in steep headwater channels (Watershed Professionals Network 1999).

2.1.2 Geology

The parent rock and soils of the Oregon North Coast were formed through volcanic and depositional processes. The present Coast Range formation is the result of two historic upheavals, partial submergence, and subsequent erosion over time (Baldwin 1981).

The upper Nehalem River Project Area is located within the Tillamook Highlands, a geologic province of the north Coast Range that was formed in the Eocene age (35 to 55 million years ago) and is composed of both volcanic and sedimentary layers (Wells et al. 1994). Major formations in the study area include various sedimentary siltstone and sandstone formations to the north and northwest, and the Tillamook Volcanics to the south and southeast (Neim and Neim 1985; ODF 2003). The Tillamook volcanics formation extends under the siltstone and sandstone formations and was formed in the Eocene age approximately 40 million years ago. The formation consists of subaerial basalt flows and igneous rock interlaced with basaltic sandstones and conglomerates (Jackson 1983). This formation has been interpreted as the remains of an oceanic island from the Eocene (Wells et al. 1994). The more recent overlying sedimentary formations were formed mostly in the late Eocene, with some formed later in the Oligocene to lower Miocene age to approximately 20 million years ago (Neim and Neim 1985).

Predominant soil types in the northern Astoria District are deep, well-drained, colluvial soils with high clay content and high productivity (ODF 2003). Additionally there are soils with high rock content and lower productivity typical of mountainous terrain. The soil types within the southern Forest Grove District have been classified as “silty sand” and “plastic silt” with properties the result in long-term stability on slopes of less than 80% (ODF 2003). These properties reflect the siltstone and sandstone lithology to the north and basalt lithology to the south.

Geologic maps prepared by Neim and Neim (1985), Wells et al. (1994) indicate the following lithologies for each management basin, organized roughly from north to south:

- **Fishhawk Management Basin:** Predominantly Pittsburg Bluff formation in central and southern portions of basin, comprising of fine to medium grained sandstone with subordinate siltstone and claystone beds. Composed of bands of fine grained sandstone units in northern portion, including the Northrup Creek mudstone and sandstone formation.

- **Northrup Creek, Beneke, Lousignot, and Hamilton Management Basins:** Predominantly Northrup Creek and Pittsburg Bluff formations in northern and central portions of basins, respectively. Southern portion comprised of fine grained Sager Creek mudstone and interbedded sandstone formation. The Beneke and Hamilton basins also include a band, extending southwest to northeast through their central portions, of the fine grained Smuggler Cove claystone and siltstone formation.
- **Crawford Management Basin:** Composed almost exclusively of the fine grained Sager Creek mudstone and interbedded sandstone formation.
- **Sager Management Basin:** Composed predominantly of the fine grained Sager Creek mudstone and interbedded sandstone formation, with east-west running bands of the Keasey mudstone, Cowlitz sandstone, Hamlet mudstone and Sunset Highway sandstone formations in the southern portion of the basin.
- **Buster Management Basin:** In addition to large areas of east-west bands of the Keasey, Cowlitz, Hamlet, and Sunset Highway mudstone and sandstone formations in the northern half and western most portion of the basin, the southern half of the basin is composed of a large area of Tillamook Volcanics basalt.
- **Quartz and McGregor Management Basins:** Basins are composed of a heterogeneous mix of sedimentary and volcanic lithologies. Small distributed areas of the Cole Mountain, Tillamook Volcanics, and intrusive Grande Ronde basalt formations, found as invasive sills and dikes, lie surrounded by the Hamlet mudstone formation. The Quartz basin also includes areas of the Keasey mudstone formation in the western portion, whereas the McGregor basin contains areas of the Cowlitz formation in the eastern portion.
- **Wheeler Management Basin:** Basin is composed extensively of the Tillamook Volcanics basalt flow formation, and also areas of the Roy Creek basalt boulder and cobble conglomerate formation with overlying volcaniclastic sandstone, plus the Nestucca mudstone formation with sandstone interbedding.
- **Wilark Management Basin:** Less-detailed geologic setting map (U.S. Geological Survey websites - geology.wr.usgs.gov/wgmt/pacnw/100neh.html and geology.wr.usgs.gov/wgmt/pacnw/100ast.html) indicates presence of Miocene and Oligocene sedimentary and volcanic rocks.

2.1.3 Climate and Hydrology

The climate in the Oregon Coast Range is influenced by the maritime effects of the Pacific Ocean and topographic effects of the Cascade Mountains. Westerly winds blow inland from the Pacific Ocean and result in warm wet winters and cool summers. Annual precipitation is high, varying from approximately 80 inches in lower elevations to greater than 150 inches near the Coast Range divide (ODF 2003) and the majority of rain falls in winter months. Higher elevations in the watershed receive snow, but rain-on-snow events may occur. Cool marine air in summer also produces frequent fog in Northwestern part of the watershed. In contrast, forest lands east of the Coast Range experience extended periods of fair and dry summer weather.

There are no long-term stream gaging stations located within the analysis area. Thus the hydrology of the Nehalem River was best represented by Foss gage at RM 13.5. This gage shows that peak flows generally occur in December through February. A greater than 200-year recurrence interval flood occurred on the Nehalem River on February 8, 1996, as the result of a rain-on-snow event. Stream flows generally are lowest in August and September. The mean monthly flow for August was 147 cfs as recorded at the Foss gage.

2.1.4 Streams and Waterbodies

The analysis area included primarily headwater streams, as ODF managed lands do not include sections along the larger, lower gradient rivers. Drainage density varied with geology, and was highest in areas underlain by marine sedimentary rocks in the Willapa Hills Ecoregion (Watershed Professionals Network 1999). Historic cadastral survey maps and current USGS topographic maps suggested that small ponds and wetlands are common, although no digital data layers are currently available to quantify these features.

Oregon Department of Forestry utilizes a stream size classification system based on the estimated average annual stream flow. The system stratifies streams into three size classes: 1) large streams that have an estimated annual stream flow of more than 10 cfs; 2) medium-size streams that have an estimated annual flow of 2-10 cfs; and 3) small streams with an estimated annual flow of less than 2 cfs. The analysis area contained approximately 276 miles of fish bearing streams, the majority of which were classified as medium or large. Numerous additional small channels existed, including both perennial and intermittent streams. The length of small streams varied widely depending on the map coverage used and the extent to which cartographers extended stream lines or drainage features uphill. As a result, analyses conducted for this analysis focused on fish-bearing channels, and in some cases (riparian and sediment sources) on non-fish bearing headwater streams identified as being prone to debris flows.

Fish bearing streams on ODF lands were predominantly high gradient (>4%) and had moderately confined to confined channels. These channels were typically transport reaches, exporting both large wood and coarse sediment, potentially transmitting debris flows and responding to large wood inputs primarily by storing sediment and developing a step-pool bed morphology. Moderate gradient, low to moderately confined channels accounted for approximately 25 percent of the total length.

These stream channels store sediment and large wood, responding to increased inputs of both wood and sediment by forming a forced pool-riffle bed profile. Debris flows that are transmitted through steep, confined channels can deposit large amounts of large wood and sediment in moderate gradient channel types. Low gradient unconfined to moderately confined channels with associated floodplain deposits account for less than 15 percent of the stream length in the analysis area. These channels represent depositional areas that serve as long-term sediment storage sites. Large wood is recruited to low gradient unconfined channels primarily via bank erosion. Wood is stored as individual pieces in small channels, but may form large jams in large channels. Low gradient unconfined channels have pool-riffle bedforms and respond to large wood inputs by scour. Scour can form either deep pools, promote lateral migration, or initiate avulsions, which forms side channels.

2.2 BIOLOGICAL SETTING

2.2.1 Vegetation

The analysis area was located within the western hemlock zone (Franklin and Dryness 1988). Climax tree species included western hemlock (*Tsuga heterophylla*), western red cedar (*Thuja plicata*), and Sitka spruce (*Picea sitchensis*). Early seral forest typically consists of Douglas-fir (*Pseudotsuga menziesii)* and mixed stands of Douglas-fir and hemlock, red cedar or spruce.

Intensive timber harvest in the first half of the 20th Century, combined with a series of major fires that occurred in the 1930s and 1940s served to reset timber stands in the analysis area to early seral conditions. More than 58 percent of the Project Area consisted of timber stands that are less than 60 years old.

The OWEB Assessment Manual indicates that under natural conditions riparian stands would consist of a 25- to 50-foot wide inner zone consisting of dense, medium-sized mixed conifers and hardwoods (Watershed Professionals Network 1999). This stand type is considered to provide a moderate large wood recruitment potential (WFPB 1997). The remainder of the 100-foot wide riparian corridor (outer zone 25 to 75 feet wide depending on channel type) would generally support a stand of large (>24” dbh), dense conifers or mixed conifer/hardwoods with a high large wood recruitment potential. Approximately 28.7 miles of fish bearing streams are bordered by dense medium hardwood riparian stands. The Wheeler, Beneke and Hamilton management basins contain the highest proportion of this riparian type. There are currently no riparian areas that support dense large conifer or dense large mixed stand types. Approximately 103 miles of fish bearing streams are currently bordered by dense stands of medium-sized (12-24") conifer or mixed conifers and hardwoods that are on a trajectory to become dense large conifer or mixed stands with a high large wood recruitment potential over the next 50 years. The Fishhawk Management basin contains the highest proportion of dense medium conifers and dense medium mixed stands (69%) while the Northrup basin contains the lowest proportion of CMD and MMD stand types (15%).

2.2.2 Fish

Coho salmon, fall Chinook salmon, steelhead, coastal cutthroat trout, Pacific lamprey, and Western brook lamprey are fish species that have been documented in the upper Nehalem and Clatskanie rivers. Cutthroat trout and Western brook lamprey are thought to be present in the upper South Fork Klaskanine River. Populations of all of these species are native to these watersheds and with the exception of Western brook lamprey, all are thought to have declined from historic levels. However, only the Lower Columbia Chinook and coho salmon are currently listed under the federal ESA. Oregon Coast and Lower Columbia coho salmon are proposed for federal listing.

Fish habitat data were available for the upper Nehalem River (Kavanagh et al. 2005). In general the upper Nehalem within the Project Area performed similarly to Oregon Coast reference conditions and some stream reaches with excellent habitat characteristics were noted. However, many of the upper Nehalem survey sites had high levels of fine sediments in riffle areas and were lacking in large and very large riparian conifers. In addition, many of the survey sites had low level of key pieces of large wood or lacked this important habitat attribute altogether. No effects of splash damming were noted during any of the past aquatic habitat surveys.

2.2.3 Amphibians

A recent survey in Buster Creek documented the presence of both tailed frog and Columbia torrent salamander in the upper Nehalem River basin within the Project area. Based on the literature and available habitat conditions, both tailed frog and Columbia torrent salamanders are likely present in other locations within the Project Area. These species like steep, cool and wet habitat in and around mountain streams. Both species have distributions that cover the Oregon Coast Range and have been documented in nearby coastal basins, including the Miami and

Kilchis rivers. Survey indicated that torrent salamanders and tailed frogs occurred in most of ODF management basins within the Project Area.

2.3 SOCIAL CONTEXT

2.3.1 Population and Demographics

In 2000, the combined population of Clatsop, Columbia and Tillamook counties was 103,452 (U.S. Census Bureau 2005). The majority of the population was white (94%). The second largest group was Native Americans, representing approximately 1 percent of the population. Over the period from 1970 to 2002, annual population growth for these counties was around 1 percent. Except for Columbia county, the growth rate was generally less than the average annual growth rate for the state of Oregon or the United States as a whole, particularly in recent years (2000-2002). The median age of residents ranged from 38 (Columbia County) to 43.5 (Tillamook County). Most residents (around 85%) have a high school degree or higher education. Approximately 62 percent of the population 16 years old or older were in the labor force at the time of the 2000 census.

There were several small communities located in or near the analysis area, including Jewell, Jewell Junction, Vinemaple, Birkenfield, and Timber. The town of Vernonia (population 2,244) is located approximately 8 miles east of the main analysis area. The city of Portland, Oregon (population 529,000) was located approximately 50 miles southeast of the analysis area.

2.3.2 Economy

Traditional industries were agriculture (principally dairy), lumber/forestry, fishing and recreation/tourism. The 1980s and 1990s brought major declines in the wood products and fishing industries. Today, the area is working to diversify its economy and is experiencing growth in the service industries.

2.3.3 Transportation

Several state highways and railroads crossed the analysis area. State Route 202 ran south from Astoria then northeast up the Nehalem River Valley, across the northern part of the Project Area. US 26 (Sunset Highway) ran southeast from coastal Highway 101 across the center of the analysis area to Portland. The Port of Tillamook Bay Railroad crosses the extreme southern edge of the analysis area. Timber Road ran north and south between the main portion of the analysis area and the Clatskanie Parcel.

2.3.4 Recreation

Lands within the analysis area include parts of the Tillamook and Clatsop State Forests. The Tillamook State Forest is the largest block of public forest in the north Coast Range, and is used by campers, anglers, hunters, hikers, off-road vehicle (ORV) users, equestrians and other recreationists (ODF 2003). Similar uses are reported for the Clatsop State Forest (ODF 2003). There are two ODF campgrounds in the analysis area: Reehers Camp in the Wheeler Management basin, and Henry Rierson Spruce Run Campground in the Quartz Management basin. Lee Wood County Park is a small day-use area located within the Nehalem River watershed, but just outside of the Project Area.

2.4 FOREST MANAGEMENT

Forest harvest activities began in earnest in the early 19th Century in the Project Area. At the time, lands in the analysis area were primarily in private ownership. One logging practice during the 1930s and early 1940s was to cut timber, burn the slash to obtain state forestry releases, then simply stop paying property taxes. Eventually this led to foreclosure, and the lands reverted to the county. Major fires that occurred between 1933 and 1945 destroyed much valuable timber in and near the analysis area, and prompted legislation to change forest management practices and undertake a massive reforestation program (Fick and Martin 1992).

Lands in the analysis area were managed according to the Northwest Oregon State Forest Management Plan adopted by the Board of Forestry in 2001 (ODF 2001). The plan directed state forest districts to develop implementation plans that described the management approaches and activities each district will pursue. Those implementation plans were completed in March 2003, and describe proposed efforts for the ten-year period from July 2001 through June 2011 (ODF 2003).

Lands in the analysis area were contained within two state forests: the Tillamook State Forest and the Clatsop State Forest. Lands in the eastern one-third of the Tillamook Forest were managed by the Forest Grove District. Lands that are part of the Clatsop State Forest were generally managed by the Astoria District. However, state forest lands that were located in the southeastern corner of Clatsop County were administratively managed from the Forest Grove District. Management basins included in the Nehalem watershed analysis area are presented in Table 2-1.

The following descriptions provide a brief summary of existing conditions and proposed future management actions for each management basin as outlined in the district implementation plans

(ODF 2003). The reader is referred to the Implementation Plans for detailed information regarding each management basin.

2.4.1 Nehalem River Watershed

2.4.1.1 McGregor Management Basin

The McGregor Management basin encompasses an area of 10,618 acres and is managed by the Forest Grove District. The land area is drained primarily by North Fork Wolf Creek. Timber is generally between 45 and 60 years old, and consists primarily of the closed single canopy structure type. The desired future condition is to provide a range of stand structure types, including 26 percent older forest structure. Key resource considerations include protection of fish-bearing streams including areas in the Upper Rock Creek Salmon Anchor Habitat area, recreational resources including the Four Corners Trail and the Sunset Wayside interpretive loop, maintenance of visual resources along the Sunset Highway, and development of dispersal habitat for northern spotted owls.

2.4.1.2 Wheeler Management Basin

The Wheeler Management basin encompasses an area of 15,613 acres and is managed by the Forest Grove District. The land area is drained primarily by Wolf Creek, Lousignont Creek, Carlson Creek and the Nehalem River. Timber is generally between 50 and 70 years old, and consists primarily of the closed single canopy structure type that developed as natural regeneration after railroad logging in the 1930s. The desired future condition is to provide a range of stand structure types, including 32 percent older forest structure. Key resource considerations for the Wheeler Management basin include an 8,000-acre Northern Spotted Owl Cluster Area, protection of fish-bearing streams including areas in the Lousignont Salmon Anchor Habitat area, recreational resources including Reehers camp and a portion of the Gales Creek Trail, preservation of the historic Salem to Astoria Military Road, and protection of the water supply for the town of Timber.

2.4.1.3 Beneke Management Basin

The Beneke Management basin encompasses an area of 9,724 acres and is managed by the Astoria District. The land area is drained primarily by Beneke Creek and Sarajarvie Creek. Timber resources currently consist primarily of the closed single canopy structure type. The desired future condition is to provide a range of stand structure types, including 35 percent older forest structure. Key resource considerations for the Beneke Management Basin include a northern spotted owl cluster area, spotted owls and marbled murrelets, protection of fish-bearing streams, non-motorized recreational activities, preservation of remnants of railroad logging trestles, and ongoing studies at three research sites (SNC, Douglas-fir progeny and Douglas fir fertilization).

2.4.1.4 Buster Management Basin

The Buster Management basin encompasses an area of 18,819 acres and is managed by the Astoria District. The land area is drained primarily by Buster, Klines and Cow creeks, and includes areas adjacent to the mainstem Nehalem River. Timber resources currently consist primarily of the closed single canopy structure type. The desired future condition is to provide a range of stand structure types, including 36 percent older forest structure. Key resource considerations for the Buster Management Basin include a northern spotted owl cluster area, protection of fish-bearing streams including areas within the Buster Creek Salmon Anchor Habitat Area and Upper Rock Creek Salmon Anchor Habitat Area, non-motorized and dispersed recreational activities, preservation of Level 1 scenic resources along State Highway 26, ongoing studies at two research sites (Douglas-fir progeny site and stream temperature monitoring project on Stanley Creek), and the implications of a *Phellinus weirii* infection that is affecting Douglas-fir in portions of the basin.

2.4.1.5 Crawford Management Basin

The Crawford Management basin encompasses an area of 4,212 acres and is managed by the Astoria District. The land area is drained primarily by Squaw Creek and West Branch Squaw Creek. Timber resources currently consist primarily of the closed single canopy structure type. The desired future condition is to provide a range of stand structure types, including 65 percent older forest structure. Key resource considerations for the Crawford Management Basin include a northern spotted owl cluster area, protection of fish-bearing streams, non-motorized recreational activities, ongoing studies at three SNC research sites and preservation of remnants of railroad logging trestles.

2.4.1.6 Fishhawk Management Basin

The Fishhawk Management basin encompasses an area of 5,087 acres and is managed by the Astoria District. The land area is drained primarily by Fishhawk Creek. Timber resources currently consist primarily of the closed single canopy structure type. The desired future condition is to provide a range of stand structure types, including 35 percent understory, 19 percent layered and 14 percent older forest structure. Key resource considerations for the Fishhawk Management Basin are protection of fish-bearing streams including channels within a proposed Salmon Anchor Habitat, protection of Level 2 scenic resources near Fishhawk Lake located just east of the ODF lands, motorized recreational activities, maintenance of water quality in Fishhawk Creek, which serves as the drinking water source for the Fishhawk Lake community, and the implications of a *Phellinus weirii* infection that is affecting Douglas-fir in portions of the basin.

2.4.1.7 Hamilton Management Basin

The Hamilton Management basin encompasses an area of 6,817 acres and is managed by the Astoria District. Ninety percent of the management basin is located in the Nehalem River watershed. The remaining 10 percent drains to the Klaskanine River in the Young's Bay watershed. Portions of the Hamilton Management basin located in the Nehalem River watershed are drained primarily by Fishhawk Creek and Hamilton Creek. Timber resources currently consist primarily of the closed single canopy structure type. The desired future condition is to provide a range of stand structure types, including 31 percent older forest structure. Key resource considerations for the Hamilton Management Basin include a northern spotted owl cluster area, northern spotted owls and marbled murrelets, protection of fish-bearing streams, non-motorized recreational activities, and ongoing studies at one SNC research site.

2.4.1.8 Lousignot Management Basin

The Lousignot Management basin encompasses an area of 4,555 acres and is managed by the Astoria District. The land area is drained primarily by Lousignot Creek. Timber resources currently consist primarily of the closed single canopy structure type. The desired future condition is to provide a range of stand structure types, including 22 percent understory, 16 percent layered and 8 percent older forest structure. Key resource considerations for the Lousignot Management Basin are protection of fish-bearing streams including channels within the Fishhawk Lake Creek Salmon Anchor Habitat, designation of the basin for motorized recreational activities, ongoing studies at three research sites (SNC, Douglas-fir progeny and Underplanting), and the implications of a *Phellinus weirii* infection that is affecting Douglas-fir in portions of the basin.

2.4.1.9 Northrup Management Basin

The Northrup Management basin encompasses an area of 7,201 acres and is managed by the Astoria District. The land area is drained primarily by Northrup Creek. Timber resources currently consist primarily of the closed single canopy structure type. The desired future condition is to provide a range of stand structure types, including 36 percent layered and 25 percent older forest structure. Key resource considerations for the Northrup Management Basin are development of future spotted owl dispersal areas, protection of fish-bearing streams including channels within the Fishhawk Lake Creek Salmon Anchor Habitat, designation of the basin for non-motorized recreational activities and heavy dispersed recreational use, ongoing studies at one SNC research site, preservation of remnants of historic logging railroad trestles, and the implications of a *Phellinus weirii* infection that is affecting Douglas-fir in portions of the basin.

2.4.1.10 Quartz Management Basin

The Quartz Management basin encompasses an area of 8,582 acres and is managed by the Astoria District. The land area is drained primarily by tributaries to Quartz Creek and Rock Creek. Timber is generally between 35 and 50 years old, and consists primarily of the closed single canopy structure type that developed as natural regeneration after wildfires. The desired future condition is to provide a range of stand structure types, including 4 percent layered and 17 percent older forest structure. Key resource considerations for the Quartz Management Basin are Level 1 scenic resources along Highway 26, protection of fish-bearing streams including channels within the Upper Rock Creek Salmon Anchor Habitat, and designation of the basin for non-motorized recreational activities and heavy dispersed recreational use.

2.4.1.11 Sager Management Basin

The Sager Management basin encompasses an area of 10,257 acres and is managed by the Astoria District. The land area is drained primarily by Sager Creek. Timber is generally between 35 and 50 years old, and consists primarily of the closed single canopy structure type that developed as natural regeneration after wildfires. The desired future condition is to provide a range of stand structure types, including 4 percent layered and 17 percent older forest structure. Key Resource Considerations for the Sager Management Basin are a northern spotted owl cluster area, protection of fish-bearing streams including areas within the Buster Creek Salmon Anchor Habitat area, non-motorized recreational and dispersed recreational use, ongoing studies at seven research sites (3 SNC, 3 bear damage control, and 1 White Pine blister rust), and preservation of remnants of historic railroad logging trestles.

2.4.2 Clatskanie Watershed

2.4.2.1 Wilark Management Basin

The Wilark Management basin encompasses an area of 4,596 acres and is managed by the Forest Grove District. A 240-acre parcel owned by Columbia County, known as Camp Wilkerson, lies at the center of the state forest land. The land area is drained primarily by Oak Ranch Creek and the Little Clatskanie River. Approximately 60 percent of the basin has been clearcut within the past 25-years, and as a result the current stand structure consists primarily of regeneration and young closed single canopy structure types. The desired future condition is to provide a range of stand structure types, including 40 percent understory, 18 percent layered and 13 percent older forest structure. Key resource considerations for the Wilark basin include protection of fish-bearing streams and the Camp Wilkerson parcel, which is being managed for complex stand structures and provides an opportunity to develop a large interior habitat.

2.4.3 Young's Bay Watershed

2.4.3.1 Hamilton Management Basin

The Hamilton Management basin encompasses an area of 6,817 acres and is managed by the Astoria District. Ten percent of the management basin is located in the Young's Bay watershed. The remaining 90 percent drains to the Nehalem River. Portions of the Hamilton Management basin located in the Young's Bay watershed are drained by the Klaskanine River. Timber resources currently consist primarily of the closed single canopy structure type. The desired future condition is to provide a range of stand structure types, including 31 percent older forest structure. Key resource considerations for the Hamilton Management Basin include a northern spotted owl cluster area, northern spotted owls and marbled murrelets, protection of fish-bearing streams, non-motorized recreational activities, and ongoing studies at one SNC research site.

3. HISTORICAL OVERVIEW

Historical conditions were assessed as part of three previous watershed assessments conducted using the Oregon Watershed Enhancement Board (OWEB) assessment process. Each of the previous assessments contains a detailed timeline of historical events affecting the project area. Highlights of those assessments relevant to the Nehalem Watershed Analysis Area are summarized below. New information was derived through review of cadastral survey notes and historic maps and documents. In addition, a discussion of the natural disturbance regime is provided, based on information developed through modeling of other similar northwest landscapes. Information on the natural disturbance regime is critical for interpreting current watershed conditions and for developing sound management strategies.

3.1 HISTORICAL RESOURCES AND TRENDS

3.1.1 Natural Resources

The first EuroAmerican visitors to the upper Nehalem watershed area found a region rich in timber, fish and furs. Cadastral surveys to establish township and range boundaries, and evaluate the quality of land available for settlement were initiated in the vicinity of the Nehalem Project Area in the late 1840s (BLM 1982). Early surveyors generally described "considerable tracts of level, rich bottom lands (supporting) alder, ash and maple" adjacent to larger streams and rivers. These lowland areas were considered prime locations for agriculture and farming. The uplands were "heavily timbered with cedar, fir and hemlock." Indeed one surveyor noted in 1848 that the timber in Township 5 North Range 5 West was "heavy to clear and would no doubt stand undisturbed for years to come." The individual surveying Township 4 immediately to the east indicated: "I think the timber in this township is unsurpassed by any part of the Pacific Coast."

3.1.2 Early EuroAmerican Settlement

EuroAmerican exploration of the Pacific Northwest commenced in the late 18th Century, and settlement began in the mid-19th Century. No homes or settlements were marked on the earliest survey maps (circa 1848). However, the first settlers began arriving by the 1870s (Fulton 1997). Settlement was concentrated along rivers and streams, in particular the Nehalem River. A military wagon road from Astoria crossed the southern portion of the project area, from Cow Creek southeast across upper Rock Creek and south to the Salmonberry River. Within the project area, cabins or homesteads were noted along Walker Creek and Fishhawk Creek (mapped as Little Fishhawk Creek) and in the Buster Creek, Rock Creek and Upper Nehalem River valleys. A small village identified as the Voltaire Settlement was noted near the confluence of the Nehalem River and the unnamed tributary just east of Derby Creek in Township 3N Range

6W. In the Clatskanie River basin, a steamboat named the Novelty began making regular trips from Clatskanie to the Columbia River in 1878, carrying passengers, mail, lumber and supplies (Clatskanie Chamber of Commerce 2005).

Early settlers were primarily interested in clearing the land for agriculture. Notes on cadastral survey maps dating from the early 1890s frequently noted small areas of "slashing and burning" adjacent to many of the cabins or settlements. Timber harvest operations that did occur in the late 19th Century were small; large-scale logging did not begin in the Project Area until the early 19th Century. The history of timber management operations is described in detail in Section 3.3.

3.1.3 Fish Populations

Salmon runs in Oregon's rivers and streams have been reduced since the mid-1850s, but it is unclear by how much (Meengs and Lackey 2005). Little information on fish populations or distribution is available prior to the 1950s. Salmon and trout were known to inhabit many streams in the Project Area, and descriptions exist of fishing trips that resulted in the capture of hundreds of fish from local rivers in the Upper Nehalem basin near Vernonia (Fulton 1997). A recent study that estimated historic run sizes for a number of Oregon Coastal Rivers based on early cannery production suggests that as many as 44,000 Chinook salmon and 236,000 coho salmon returned to the Nehalem River system (Meengs and Lackey 2005).

3.1.4 Trends in Land Use and Management

Over the past 200 years, land use in the Nehalem basin and adjacent Clatskanie and Young's Bay watersheds has progressed from semi-nomadic hunting and gathering, through subsistence agriculture and family farms to large-scale commercial timber production. Lands evaluated for this analysis are currently managed by ODF to promote and enhance environmental, economic, and community sustainability. Current land use practices and watershed conditions are influenced by both historic anthropogenic activities described above as well as the natural disturbance regime.

3.2 NATURAL DISTURBANCE

Natural disturbances including fires, storms, floods, and landslides are an intrinsic property of landscapes in the north Oregon Coast Range. Disturbances such as fires and large storms deliver the majority of sediment, and a large proportion of woody debris, 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 basins such as the Nehalem during a watershed analysis, since 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.

The analysis of natural disturbance in the Nehalem Watershed Analysis consists of three components: (1) a brief overview covering the role of natural disturbances in humid temperate mountain landscapes; (2) a historical analysis using readily available information on forest fires, forest age patterns, and large storms and floods applicable to the Nehalem basin and surrounding areas; and (3) quantitative estimates of natural disturbance and the resultant natural variability based on existing regional simulation models. Simulation models are used to derive predictions for: (i) changing proportion of old growth versus younger forests over time; (ii) patterns of landslides and debris flows related to fires and large storms; (iii) role of debris flows in wood recruitment; and (iv) natural variation in wood recruitment and wood storage.

3.2.1 Role of Natural Disturbance in Humid Temperate Mountain Landscapes

Large scale, infrequent disturbance events are important for supplying sediment and large wood to streams within the Oregon Coast range and including the Nehalem River. These punctuated events that occur in the Oregon Coast range supply wood and sediment that are important for maintaining the geomorphic diversity within the stream channel and adjacent riparian areas. Examples include creation of spawning areas and rearing ponds, and side channel habitat. Creation of diverse habitat is not evenly dispersed throughout the stream but tend to be concentrated along valley floors, tributary confluences, along landslide deposits, canyons and bedrock outcrops. High geomorphic diversity leads to high habitat diversity for aquatic and riparian species. This, in turn can be expected to contribute to biological diversity within the stream system. While disturbance is generally beneficial when infrequent and natural, it may also destroy habitat and harm aquatic organisms. Such negative effects include burial of existing habitat, increased fine sediments, and direct mortality of organisms. More detail on the role of natural disturbance in maintaining riverine habitats is discussed in Appendix A.

3.2.2 Natural Disturbances of Fires, Storms, and Landslides

Computer simulation modeling of forest fires, storms, landslides, debris flows, sediment transport, and wood recruitment in a mountain drainage basin in southwest Washington is presented to provide insights into the role of natural disturbances in the Nehalem watershed project area. The full simulations and complete discussion is located in Appendix A. A brief summary is included here.

The modeling revealed that over a simulated period of thousands of years, old growth forests (greater than 250 years old) would dominate the forest age distribution, and comprise approximately 50 percent, of the forested area (Figure 3-1). Under the simulated conditions, forest stands aged 50-100 years of age would comprise approximately 16 percent of the area. Ridges and south facing hillslopes had the highest likelihood of forest fires (average fire recurrence interval of 175 years) while low gradient and wide valley floors had the lowest frequency of fires (average fire recurrence interval of 400 years).

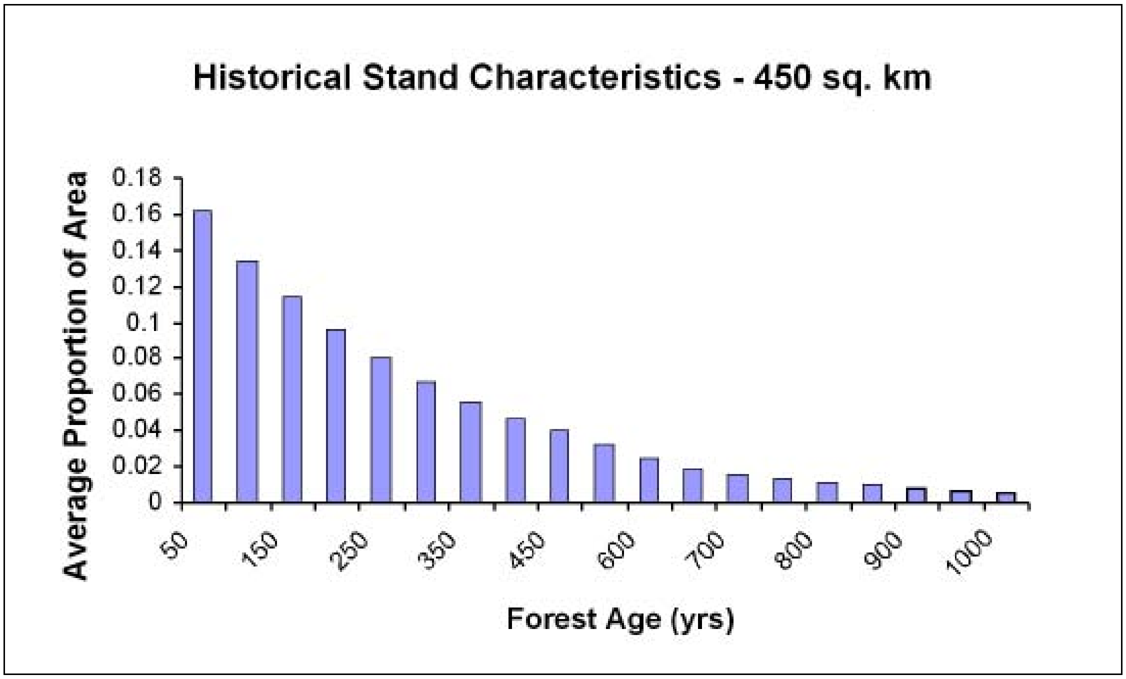


Figure 3-1. The predicted historical forest age distribution for the Nehalem watershed based on a forest fire simulation model developed for the central Oregon Coast Range (Benda and Dunne 1997a).

Forest fires and infrequent intense rainstorms triggered natural spates of landslides and debris flows in headwater streams. For instance, within a 200 km^2 watershed, dozens of landslides and debris flows would occur every few years to a decade and hundreds of landslide events would occur every 50 to 100 years in response to periodic wildfires followed by large storms.

Periodic spates of landslides and debris flows (includes stream side slides within inner gorges) would create local zones of channel sedimentation, particularly near tributary junctions. Moreover, debris flow deposits at confluences of headwater streams (with higher-order channels) resulted in locally high volumes of sediment and wood in channels at those locations. In some instances, migrating waves of sediment would be created that altered the channel morphology (frequency of pools) and channel width downstream from landslides.

In the simulated model, periodic disturbances were also important in wood recruitment to streams. For example, post fire toppling of fire-killed trees contributed approximately 50 percent of the total wood recruitment over thousands of years while chronic forest mortality contributed about 30 percent. Debris flows and stream side landslides contributed the remaining 20 percent of large wood.

Overall, the simulations predicted that natural disturbances, particularly wildfires and storms, supply much of the raw materials for the formation of aquatic habitats in temperate mountain drainage basins. Although only a small portion of the Nehalem study area is prone to shallow failures and debris flows (the southwest corner, see slope stability assessment), the study area is prone to periodic fires, deep-seated failures, inner gorge landslides, and intense rainstorms. Hence, natural disturbance is a naturally important agent in habitat formation and the simulation results (Appendix A) can be used as a general guide on this interaction. Perspectives on natural disturbance, both conceptual and quantitative, might be useful to help guide land management in the Nehalem study area.

Because landscape behavior is dynamic over a range of space and time scales, using single value targets for slope stability analyses, erosion rates, debris flows, wood recruitment, and storage rates are inappropriate. Both location and temporal variability should be considered when evaluating present-day channel conditions. Natural disturbance regimes and the natural range of variability in a watershed are most accurately represented by a range of values, specifically a distribution of values (Appendix A).

3.3 EARLY FOREST MANAGEMENT

Before 1900, the typical logging operation was family owned, consisting of eight to ten men who logged a small area, using oxen to drag the logs to the stream (Fulton 1997). Small sawmills were reportedly operated by Thomas Brown on Rock Creek, and by James Quick on the headwaters of Dairy Creek near Vernonia (Fulton 1997). Other mills were located at Pittsburg and Vernonia (Johnson and Maser 2000). A previous watershed assessment of the Nehalem watershed indicated that extensive log drives occurred on the Nehalem River from 1901 to 1926 (Johnson and Maser 2000). Although splash dams have been documented on the North Fork Nehalem River, the degree to which the practice was implemented in the Upper Nehalem Project Area is not known (Johnson and Maser 2000).

In 1920, the Southern Pacific Railroad from Tillamook to Portland was largely completed, and logging began in earnest using small privately constructed logging railroads. Although a number of companies owned and logged lands in the Project Area, early operations of the Oregon-American Company are particularly well documented by Kamholz et al. (2003). The following information is derived largely from their 2003 publication "The Oregon-American Lumber Company: Ain't No More" (Kamholz et al. 2003).

The Oregon American Company was formed following the purchase of the DuBois tract in 1917. The DuBois tract, located west of Vernonia, included portions of the Project Area in the Rock Creek, North Fork Rock Creek, Weed Creek drainages, as well as the headwaters of Quartz, Cow and Klines Creeks. Lumbermen at the time considered a stand of old-growth Douglas-fir timber exceptional if it carried more than 100,000 board-feet of timber per acre. Since the stand conditions vary widely, finding occasional stands that supported this volume of timber was not unusual; however, the average Douglas-fir forest in those days averaged around 55,000 board-feet per acre (Kamholz et al. 2003). The 22,000-acre DuBois Tract had no less than 10 sections (1 section = 640 acres) that averaged more than 100,000 board-feet per acre; at least 9,000 acres (over 40%) supported more than 100,000 board-feet per acre.

Logging of Oregon-American Company lands started along bottomlands in the Rock Creek drainage and then fanned out into the surrounding hills. Logs were hauled to local sawmills via railroad. Kamholz et al. (2003) provide maps of the early logging railroad network in and around the Oregon-American Company lands; the general location of those railroads was transferred onto a GIS layer of the Project Area and is presented in Chapter 7 (Sediment sources). Much of the current road and four-wheel drive network follows the path of those early logging railroads.

According to Kamholz et al. (2003), one logging method employed in those days was to "cut out and get out," in which landowners harvested timber, burned the slash to obtain state forestry releases, and then simply stopped paying property taxes. Eventually this led to foreclosure, and the lands reverted to the county.

Following WWII, use of contractors and trucks to haul logs out of the woods became more common (Kamholz et al. 2003). Inexpensive war surplus equipment plus the return of heavy equipment manufacturers to the commercial marketplace made use of logging trucks more economical. In addition, high lumber prices resulted in operators finding it more economical to salvage lower grades of logs that had previously been left on site. In 1957, the timber holdings of the Oregon American Company were largely exhausted. The Ginger Creek drainage, located in the Buster Management basin, was the last area to be logged by Oregon-American Company.

The majority of state forest lands in the upper Nehalem watershed were acquired by the State of Oregon during the 1930s, 40s and 50s (ODF 2003). These were lands that had been privately owned but reverted to the local counties due to delinquent tax payments after destructive fires that occurred between 1933 and 1945. Most of the timber on these lands had been harvested or burned and what remained was herbaceous vegetation or low value hardwoods. Thus, the counties deeded these lands to the state for reforestation and future management. The large scale devastation associated with the early fires had prompted Oregon state legislation to change forest management practices and undertake a massive reforestation program (Fick and Martin 1992). Over 325 square miles of the burned areas was replanted, including 117,800 acres via aerial re-seeding, and 110,000 acres by hand planting. Commercial harvest resumed in the 1950s in the Astoria District and 1960s in the Forest Grove District (ODF 2003) and continues under ODF management today.

4. STREAM CHANNEL

Channel morphology is a useful tool for classifying streams and rivers because it: (1) dictates habitat conditions used by the various life-history stages of salmonid species (Beechie and Sibley 1997); (2) directly influences the productive capacity of each habitat type (Vannote et al. 1980; Naiman et al. 1992; Paustian et al. 1992); and (3) varies in terms of sensitivity and response to changes in inputs of water, wood and sediment from natural or anthropogenic disturbances or from restoration activities (Paustian et al. 1992; Montgomery and Buffington 1993; Rosgen 1996). Watershed assessment conducted according to the OWEB methodology stratifies the stream network into Channel Habitat Types (CHTs) described in the Assessment Manual (Watershed Professionals Network 1999) and attempts to answer the following key questions regarding stream channels and historic channel modifications:

1. *What is the distribution of CHT's throughout the watershed?*
2. *What is the location of CHT's that are likely to provide specific aquatic habitat features?*
3. *What is the location of areas that may be the most sensitive to changes in the watershed condition?*
4. *Where are channel modifications located?*
5. *Where are historic channel disturbances located (for example: splash dams, stream cleaning)?*
6. *What CHT's have been impacted by channel modification?*

For this upper Nehalem Watershed Analysis, ODF also requested that supplementary information on habitat attributes and response potential for each channel type be provided to support an evaluation of various channel types in the context of habitat and restoration potential.

Specific methods used to complete the stream channel assessment are described in Section 4.1. Section 4.2 provides a discussion of channel sensitivity and specific habitat attributes typically associated with the various channel habitat types. The results of the CHT mapping and ground truthing are presented by management basin in Sections 4.3. Section 4.4 provides a brief discussion of the analyst's confidence in the data used to conduct this analysis, based on field and photo based ground truthing.

4.1 METHODS

Three previous OWEB watershed assessments have been completed covering portions of the current Upper Nehalem Project Area: the Nehalem River Watershed Assessment (Johnson and

Maser 2000), the Lower Columbia-Clatskanie Watershed Assessment (Rule 2001) and the Young's Bay Watershed Assessment (E&S Water Chemistry Inc. and Young's Bay watershed Council 2000). Those documents provide a narrative description of the morphologic characteristics of a set of Channel Habitat Types (CHTs) and 1:100,000 scale GIS layers depicting the channel confinement, channel sensitivity, and/or CHT distribution within each watershed.

The goal of the stream channel assessment portion of this watershed analysis was to build on existing CHT layers to support the more intensive analysis requested by ODF. To that end, CHT maps or GIS layers from the previous watershed analysis were obtained and "ground truthed." Ground truthing of CHT layers was a two-step process. First, the existing CHT layer that was overlain on the 1:12,000 scale stream layer and a 40-foot contour interval topography layer constructed using 10-meter Digital Elevation Model (DEM). For channels located on ODF lands within the Upper Nehalem Project Area, gradient and elevation classes used to stratify channel types for the OWEB analyses were verified against the more detailed stream and topography network. The CHT layer was updated where map-based gradient and confinement calls differed from those delineated in the earlier analysis. Mapping of CHT's was also extended to fish bearing channels that had not been evaluated at the coarser-scale used for earlier analyses.

The second phase of ground-truthing was to verify the updated CHT map and channel morphologic attributes using field data. Gradient, bankfull width and valley width were measured in one or more examples of the most common CHTs during field surveys. In addition, information was gathered to describe the following key morphologic attributes and geomorphic functions:

- Bedform
- Pool formative factors
- Large wood recruitment mechanism
- Large wood distribution and role in habitat formation
- Sediment storage
- Substrate mobility

Field data and geomorphic theory were used to develop a description of the sensitivity of each channel type to changing inputs of large wood, coarse sediment, fine sediment and peak flows. Geomorphic characteristics were then used to predict aquatic habitat attributes of each CHT, and to describe how those attributes would be affected by changing inputs of wood, sediment and water. Existing habitat conditions identified in Chapter 8, Fish Habitat, will be compared to predicted aquatic habitat conditions to support the identification of potential limiting factors conducted in the analysis phase of this project.

Channel modifications are defined as in-channel structures or activities that alter the physical character of streams (Watershed Professionals Network 1999). Common channel modifications include dams, dikes/levees, dredging, wood removal efforts, stream adjacent roads (rip-rap banks) or road crossing structures and in-channel gravel mines. In the 1960s and 1970s it was common practice in Oregon to remove downed wood from streams to improve fish habitat. The Oregon Department of Fish and Wildlife enlisted the assistance of Oregon Department of forestry in this stream cleaning effort. Thus, although it is not documented specifically, it is likely that some stream cleaning occurred in the Upper Nehalem watershed. As mentioned earlier in the disturbance discussion, five splash dams were documented in the Nehalem River watershed but specific location information was not available for this analysis.

Maps of channel modifications from previous watershed analyses (Johnson and Maser 2000; Rule 2001; E&S Water Chemistry Inc. and Young's Bay Watershed Council 2000) were used to identify the type and location of channel modifications in the project area. These materials were supplemented by analysis of USGS topographic maps, maps of historic logging railroads, and by field observations. A description of known existing or historic channel modifications within the analysis area is provided for each management basin in Section 4.3. Maps depicting the location of known channel modifications are provided in previous watershed analyses (Johnson and Maser 2000; Rule 2001; E&S Water Chemistry Inc. and Young's Bay Watershed Council 2000) and are not reproduced here. Stream adjacent roads or railroads were the most common channel modification identified in the Project Area; additional information on those features is provided in Chapter 6.

4.2 CHANNEL HABITAT ATTRIBUTES AND SENSITIVITY

Channel morphology varies in response to relatively static landform characteristics (gradient, valley width) as well as in response to changing inputs of wood, water and sediment. Table 4-1 summarizes key morphologic characteristics for each CHT based on general geomorphic theory. Habitat characteristics associated with each channel type were confirmed by data gathered during field surveys.

Table 4-1. Geomorphic characteristics of channel types delineated in the Upper Nehalem analysis area.

Channel Habitat Type		Gradient (%)	Confinement	Stream Size[1] (Width in feet)	Substrate	Bedform[2]	Associated landform	Fish Use[3]
Low Gradient Medium Floodplain	FP2	<1%	Unconfined	Medium to large	Sand to cobble	Dune-ripple to pool riffle	Alluvial valley	CH, PI, CK, SH
Low Gradient Small Floodplain	FP3	<2%	Unconfined	Small	Sand to gravel	Dune-ripple to pool riffle	Alluvial valley, headwater meadow	CH, PI, CO, CT
Low Gradient Moderately Confined	LM	<2%	Moderate	Variable	Sand to cobble	Pool-riffle	Alluvial valley, tributary valley	CH, PI, CO, CK, SH, CT
Low Gradient Confined	LC	<2%	Confined	Variable	Cobble to boulder	Pool-riffle	Canyon, alluvial terraces	CO, CK, SH, CT
Moderate Gradient Unconfined	MU	2-4%	Unconfined	Variable	Gravel to cobble	Forced pool riffle to plane bed	Alluvial valley; alluvial fan	PI, CO, CK, SH, CT
Moderate Gradient Moderately Confined	MM	2-4%	Moderate	Variable	Gravel to cobble	Forced pool riffle to plane bed	Alluvial fan, tributary valley	PI, CO, CK, SH, CT
Moderate Gradient Confined	MC	2-4%	Confined	Variable	Gravel to cobble	Step-pool	Tributary valley	PI, CO, CK, SH, CT
Moderate Gradient Headwater	MH	2-6%	Moderate to Confined	Small	Gravel to boulder	Forced pool riffle to plane bed to step pool	Headwater valley	PI, CO, CT, RT
Moderately	MV	4-8%	Confined	Small to	Cobble to	Step-pool	Headwater	CO, CK,

Table 4-1. Geomorphic characteristics of channel types delineated in the Upper Nehalem analysis area.

Channel Habitat Type		Gradient (%)	Confinement	Stream Size[1] (Width in feet)	Substrate	Bedform[2]	Associated landform	Fish Use[3]
Steep Narrow Valley				medium	boulder		valley/sideslope	SH, CT, RT
Steep Moderately Confined	SM	8-16%	Moderate	Small to medium	Cobble to boulder	Step-pool	Alluvial fan, Headwater Valley	SH, CT, RT
Steep Narrow Valley	SV	8-16%	Confined	Small to medium	Cobble to boulder	Step-pool	Headwater valley/sideslope	SH, CT, RT
Very Steep Headwater	VH	>16%	Confined	Small	Cobble to boulder	Step-pool to cascade	Headwater valley/sideslope	RT

1 Stream size derived from ODF classification maps. Small=mean annual flow < 2 cfs; Medium=mean annual flow 2-10 cfs; Large = mean annual flow > 10 cfs. Width data are derived from ODF channel surveys of streams within the Upper Nehalem Analysis area.

2 From Montgomery and Buffington 1993.

3 Predominant fish species using channel type, based on WDFW 2000 and Paustian et al. 1992. CH=Chum; PI=Pink; CO=Coho; CK=Chinook; SH=Steelhead; CT=Searun Cutthroat; RT=Resident trout (cutthroat and/or rainbow).

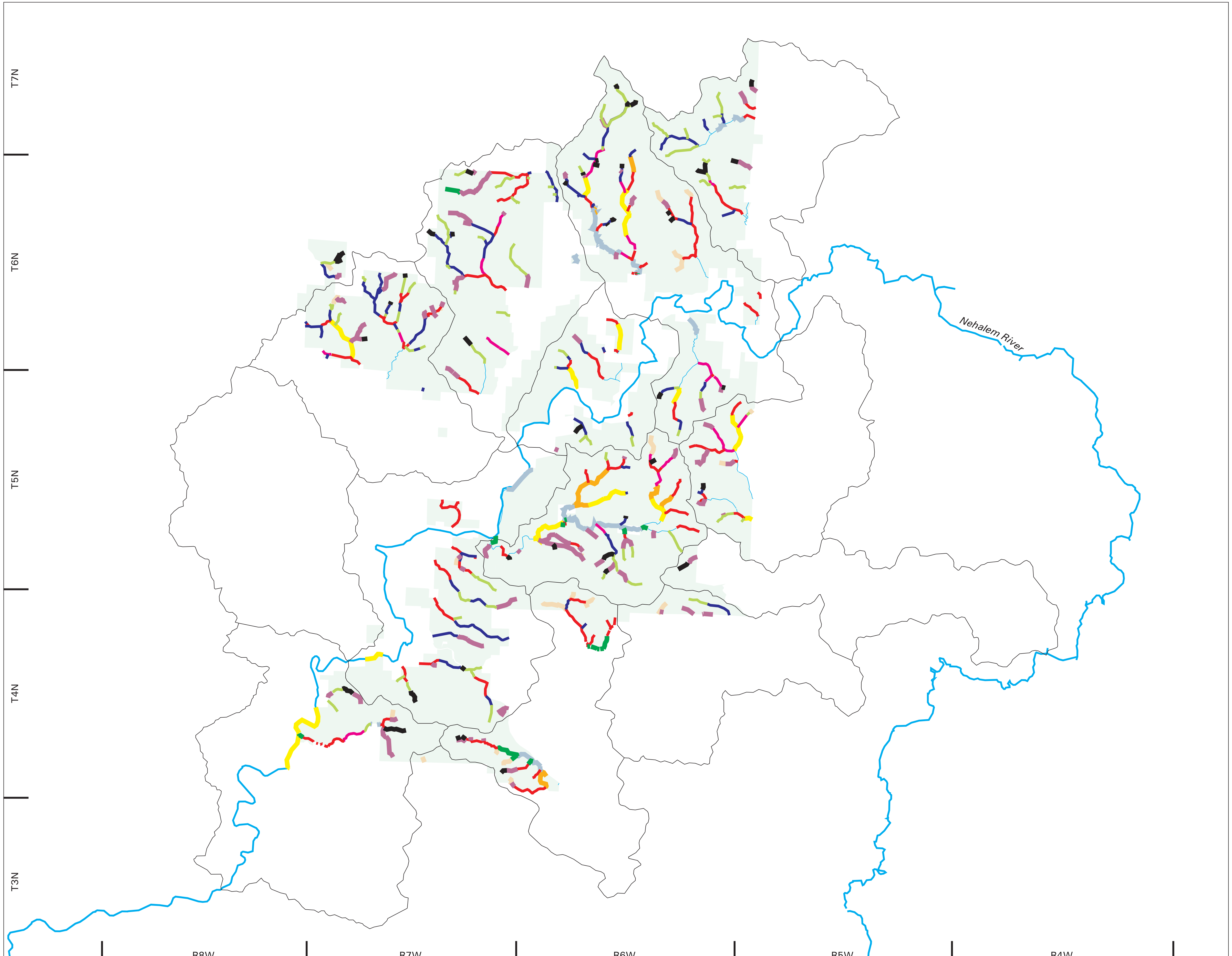
The OWEB Assessments designated the overall channel "sensitivity" to disturbance based on CHT morphologic characteristics. While such a stratification is a useful first step, it fails to recognize that channel types respond to inputs in different ways. For example, steep moderately confined channels may respond to increased large wood loads by forming vertical steps and storing sediment. In contrast, low gradient small floodplain channels respond to increased large wood inputs by increasing pool depth and frequency, forming side channels and eroding laterally. Both CHTs are sensitive to large wood inputs, but each respond differently to changes in the level of large wood inputs.

For this analysis each CHT was assigned a specific sensitivity to the following discrete inputs large wood, coarse sediment, fine sediment and peak flows. Sensitivity ratings are provided in Table 4-2. Specific sensitivity ratings for each input will be used to develop resource sensitivity maps in the analysis phase. The nature of channel response to varying levels of each input (resulting from either natural disturbances or anthropogenic activities) is summarized in Table 4-3.

Specific key aquatic habitat features provided by each CHT are identified in Table 4-4. Absence of a habitat feature for a given CHT implies only that it may be present in relatively low amounts, and does not constitute a significant habitat component. All CHT's provide unique habitat values for various aquatic species. Key aquatic habitat features for anadromous fish include adult holding habitat (i.e., pools > 1 m deep), off-channel rearing habitat (i.e., side channels), and spawning habitat (gravel to cobble size substrate). The intent of Table 4-4 is to help focus management and restoration efforts on areas that are important for the species of greatest concern, and that are most likely to contain habitat attributes that may limit fish production.

4.3 RESULTS BY MANAGEMENT BASIN

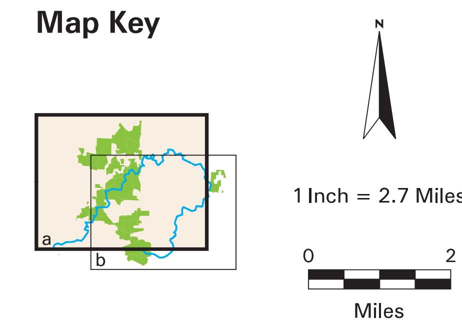
The distribution of channel types on fish bearing streams within the Upper Nehalem Project Area are depicted in Figure 4-1a,b and are summarized by management basin in Table 4-5. Channel habitat types and stream sections within each management basin that are likely to be most sensitive to geomorphic inputs are described below, in addition to the occurrence and location of known channel modifications and disturbances.



Legend

- Low Gradient Medium Floodplain
- Low Gradient Small Floodplain
- Low Gradient Moderately Confined
- Low Gradient Confined
- Moderate Gradient Unconfined
- Moderate Gradient Moderately Confined
- Moderate Gradient Confined
- Moderate Gradient Headwater
- Moderately Steep Narrow Valley
- Steep Moderately Confined
- Steep Narrow Valley
- Very Steep Headwater
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key



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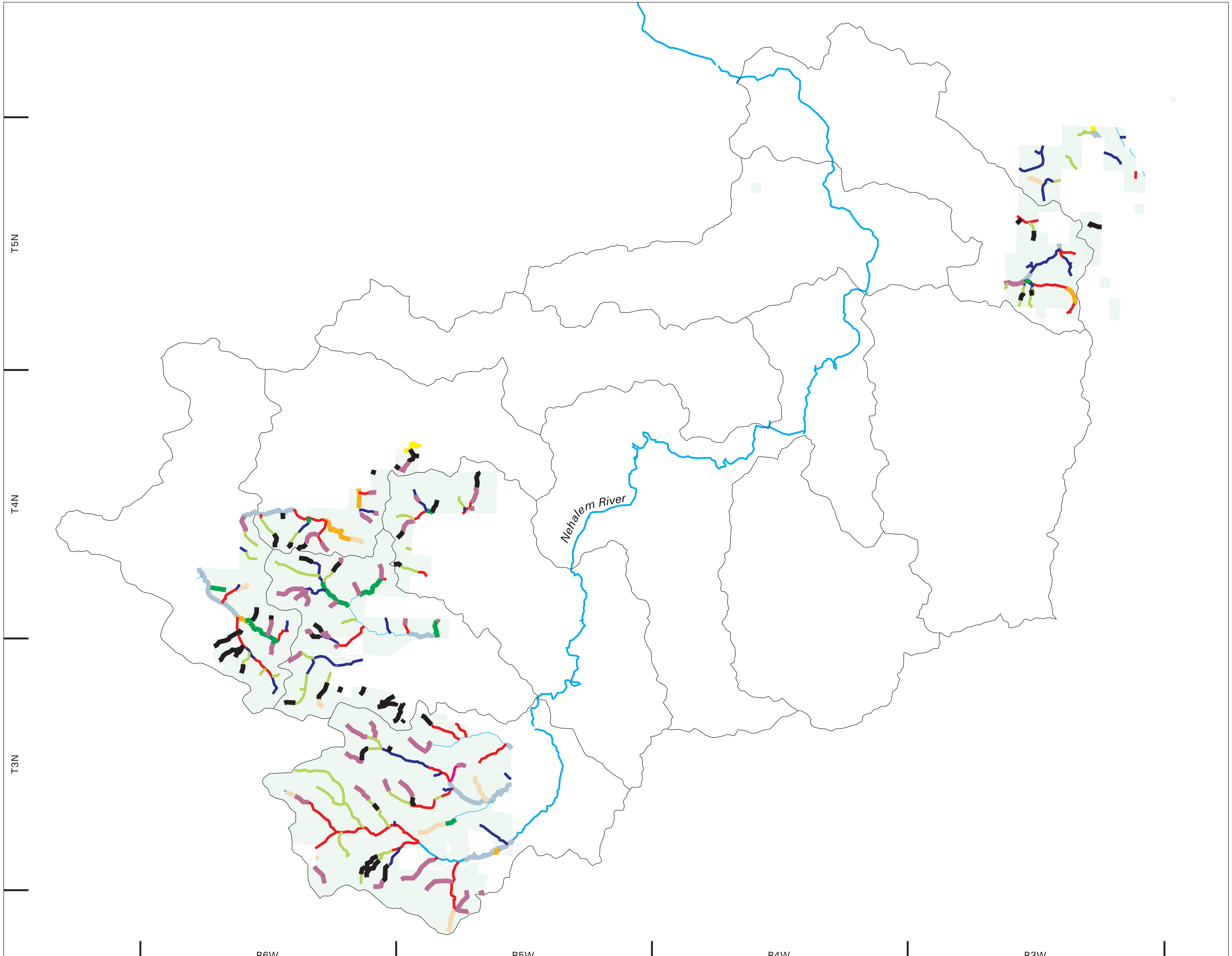
Oregon Department of Forestry
Upper Nehalem Watershed Analysis

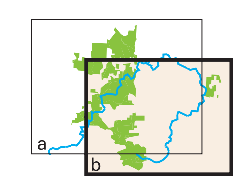
Figure 4-1(a)
Channel Types
Astoria District



Legend

- Low Gradient Medium Floodplain
- Low Gradient Small Floodplain
- Low Gradient Moderately Confined
- Low Gradient Confined
- Moderate Gradient Unconfined
- Moderate Gradient Moderately Confined
- Moderate Gradient Confined
- Moderate Gradient Headwater
- Moderately Steep Narrow Valley
- Steep Moderately Confined
- Steep Narrow Valley
- Very Steep Headwater
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key



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1 Inch = 2.3 Miles

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Miles

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Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 4-1(b)

Channel Types

Forest Grove District

Table 4-2. Physical responsiveness to geomorphic inputs for CHT's identified in the Nehalem Analysis Area.

Channel Type	Channel Type Code	Large Wood	Coarse Sediment	Fine Sediment	Peak Flows
Low Gradient Medium Floodplain	FP2	H	H	H	M
Low Gradient Small Floodplain	FP3	H	H	H	L
Low Gradient Moderately Confined	LM	H	H	H	M
Low Gradient Confined	LC	L	M	L	L
Moderate Gradient Unconfined	MU	H	H	M	H
Moderate Gradient Moderately Confined	MM	H	H	M	M
Moderate Gradient Confined	MC	L	M	L	M
Moderate Gradient Headwater	MH	M	M	M	M
Moderately Steep Narrow Valley	MV	M	M	L	M
Steep Moderately Confined	SM	M	M	L	L
Steep Narrow Valley	SV	M	L	L	L
Very Steep Headwater	VH	M	L	L	L

H=High M=Moderate L=Low

Table 4-3. Typical recruitment mechanism and response to changing levels of geomorphic inputs for CHTs identified in the Nehalem Watershed Analysis Area.

Channel Type	Large Wood	Coarse Sediment	Fine Sediment	Peak Flows
FP2	Recruited by bank erosion (key pieces) and fluvial transport Mobile except for key pieces; arranged in large jams associated with bedforms (meander, bar apex) Functions to form pools and off-channel habitats, provide cover	Recruited by bank erosion and fluvial transport Stored in bed, bars and floodplain Dominant substrate: Cobble to gravel (low to moderate supply); small gravel (high supply)	Recruited by bank erosion and fluvial transport Distributed throughout channel in sand lines, pools (high supply) or in hydraulically protected areas (low supply)	Bed and banks deformable, responds to increased peak flows by channel widening, incision
FP3	Recruited by bank erosion, mortality Only very small pieces are mobile; deposits as individual pieces (bridges, ramps) Functions to form pools, provide cover	Recruited by bank erosion Stored in bed, bars Dominant substrate: Small cobble to small gravel (low supply); small gravel to sand (high supply)	Recruited by bank erosion and fluvial transport Distributed throughout channel Accumulates under all supply conditions	Bed and banks deformable, may respond to increased peak flows by channel widening, incision, although propensity for overbank flow can counteract channel change.

Table 4-3. Typical recruitment mechanism and response to changing levels of geomorphic inputs for CHTs identified in the Nehalem Watershed Analysis Area.

Channel Type	Large Wood	Coarse Sediment	Fine Sediment	Peak Flows
LM	Recruited by bank erosion, mass wasting, fluvial transport Mobility depends on channel size; arranged as individual pieces or jams associated with bedforms (meander, bar apex) Functions to form pools, provide cover	Recruited by bank erosion, mass wasting, fluvial transport Stored in bed, bars Dominant substrate: Small cobble to small gravel (low supply); small gravel to sand (high supply)	Recruited by bank erosion, mass wasting, fluvial transport Accumulates in hydraulically protected areas (low supply), or as sand lines (high supply)	Bed and banks deformable, but relatively stable; may respond to increased peak flows by local scour, avulsion under high sediment supply conditions, may undergo bed armoring under low sediment supply.
LC	Recruited by mass wasting, fluvial transport General mobile; rapidly breaks up when deposited. Accumulates where pinned on bedrock/boulders. May form small jams Jams store sediment, provide cover	Recruited by mass wasting, fluvial transport Mobile sediments stored in pool tailouts, behind obstructions, areas of divergent flow. May fill pools under conditions of extreme high supply Dominant substrate: Boulder and bedrock (low supply); boulder to cobble (high supply)	Recruited by mass wasting, fluvial transport Accumulates predominantly along banks or in hydraulically protected areas Rare under all supply conditions	Bed and banks resist erosion. Channel configuration does not respond to peak flow increases. Increased peak flows in absence of high coarse sediment supply result in bed armoring

Table 4-3. Typical recruitment mechanism and response to changing levels of geomorphic inputs for CHTs identified in the Nehalem Watershed Analysis Area.

Channel Type	Large Wood	Coarse Sediment	Fine Sediment	Peak Flows
MM	Recruited by mass wasting, fluvial transport, bank erosion, debris flows Accumulates as individual pieces or small jams. Large jams may result from debris flow runout large wood forms pools, stores sediment, forms off-channel habitat, provides cover	Recruited by mass wasting, fluvial transport, bank erosion, debris flows Mobile sediments stored in association with large wood Dominant substrate: Plane bed composed of small boulder to large cobble (low sediment and LWD supply); forced pool riffle bed composed of cobble to gravel (high sediment and LWD supply)	Recruited by mass wasting, fluvial transport, bank erosion Accumulates predominantly as sand lines, in pools (high supply), or in hydraulically protected areas (low supply)	Bed and banks deformable; may respond to peak flows by channel widening, or by high flow side channel formation. Increased peak flows in absence of large wood can result in bed armoring. Loss of riparian vegetation can lead to channel wandering and braiding over alluvial deposits.
MC	Recruited by mass wasting, fluvial transport, debris flows General mobile; rapidly breaks up when deposited. Accumulates where pinned on bedrock/boulders. May form small jams Jams store sediment, provide cover	Recruited by mass wasting, fluvial transport Mobile sediments stored behind obstructions, areas of divergent flow. May fill pools under conditions of extreme high supply Dominant substrate: Plane bed composed of small boulder to large cobble (low supply of sediment and large wood); step pool composed of cobble to gravel (high supply of sediment and large wood).	Recruited by mass wasting, fluvial transport Accumulates predominantly along banks or in hydraulically protected areas Rare under all supply conditions	Bed and banks resist erosion. Channel configuration generally does not respond significantly to peak flow increases. Increased peak flows in absence of high coarse sediment supply result in bed armoring

Table 4-3. Typical recruitment mechanism and response to changing levels of geomorphic inputs for CHTs identified in the Nehalem Watershed Analysis Area.

Channel Type	Large Wood	Coarse Sediment	Fine Sediment	Peak Flows
MH	Recruited by bank erosion, mortality Only very small pieces are mobile; deposits as individual pieces (bridges, ramps) Functions to form pools, provide cover	Recruited by bank erosion Dominant substrate: Cobble to gravel plane bed (low sediment and large wood supply); forced pool-riffle gravel to sand (high sediment and large wood supply)	Recruited by bank erosion Distributed throughout channel Accumulates under all supply conditions	Bed and banks deformable, responds to increased peak flows by channel incision
MV	Recruited by mass wasting, fluvial transport, debris flows Accumulates as individual pieces, small jams. Debris flow transport/runout depends on gradient Stores sediment, forms plunge pools	Recruited by mass wasting, fluvial transport Mobile sediments stored behind obstructions, areas of divergent flow. May fill pools under conditions of extreme high supply Dominant substrate: Boulder to large cobble (low sediment and large wood supply); cobble to gravel step-pool (high sediment and large wood supply) Can scour to bedrock by debris flows	Recruited by mass wasting, fluvial transport Accumulates predominantly along banks or in hydraulically protected areas Rare under all supply conditions	Bed and banks resist erosion. Channel configuration does not respond significantly to peak flow increases. Increased peak flows in absence of high coarse sediment supply result in bed armoring

Table 4-3. Typical recruitment mechanism and response to changing levels of geomorphic inputs for CHTs identified in the Nehalem Watershed Analysis Area.

Channel Type	Large Wood	Coarse Sediment	Fine Sediment	Peak Flows
SM, SV, VH	Recruited by mass wasting, mortality Accumulates as individual pieces, small jams. Exported by debris flows Small and large wood store sediment, form plunge pools	Recruited by mass wasting Mobile sediments stored behind obstructions. May fill pools under conditions of extreme high supply Dominant substrate: Boulder to cobble (low sediment and large wood supply); cobble to gravel step pool (high sediment and large wood supply) Can scour to bedrock by debris flows	Recruited by mass wasting Accumulates predominantly along banks or in hydraulically protected areas Rare under all supply conditions	Bed and banks resist erosion. Channel configuration does not respond to peak flow increases.

Table 4-4. Specific habitat features associated with CHTs mapped within the Nehalem Analysis Area.

Channel Type	Adult Holding Habitat (pools>1m)	Off-Channel Rearing Habitat (side channels)	Spawning Habitat for Large Bodied Salmonids (CH, PI, CK, SH)	Spawning Habitat for Small Bodied Salmonids (CO, SH CT)	Spawning Habitat for Resident Trout
FP2	X	X	X	x	x
FP3		X		X	x
LM	X	x	X	x	x
LC	X		X	x	x
MU	X	X	X	x	x
MM	x	x	X	X	X
MC	x		X	X	X
MH				X	X
MV	x			x	X
SM					x
SV					x
VH					

X = abundant
x = common

The present day occurrence of large-scale channel modifications in the Upper Nehalem Project Area is not common. Historical records indicate that small-scale activities (i.e., instream dredging and flow diversions) that could have potentially modified stream channels likely occurred throughout the Nehalem watershed during the period of heavy logging and road building in the watershed in the late 1800s and early 1900s. Due to the lack of written records however, it is difficult to verify the extent of such historical channel modifications within the Upper Nehalem Project Area.

Common channel modifications within the Upper Nehalem Project Area include bridges and culverts placed at road crossings, and roads immediately adjacent to streams that can artificially constrain channel migration and floodplain connectivity. Bridges and culverts placed at stream crossings are not discussed in this section unless available information indicated that their mention was warranted. At locations in which road associated fill has potentially impacted the stream channel, ODF conducted field verifications to assess the presence or extent of such modifications. Roads and their impact within the Project Area are described further in Chapter 8.

Dams can affect channel processes by impeding sediment transport, movement of large wood, and by altering channel migration. Several small-scale dams were historically present within the Upper Nehalem Project Area. While most of the historic dams within the watershed have been removed, several small impoundments remain in the Wheeler and Fishhawk management basins and are described in greater detail below (Johnson and Maser 2000). Splash dams were reportedly used in several places within the Nehalem River watershed to transport timber in logging operations, however documentation of the extent of their use and their effect on stream channel morphology in the Project Area is not readily available. In addition, there were likely historic small-scale flow diversions in many parts of the basin, but the distribution and effect of such diversions is similarly not well documented.

Instream dredging has occurred historically in several locations in the Nehalem basin, primarily for road construction. Gravel was dredged from the mainstem Nehalem River for construction of Highway 26, however the specific locations of dredge sites were not available for this analysis. Permits for instream gravel removal and fill are held for sites near the Upper Nehalem Project Area (Johnson and Maser 2000), however the level of instream activity, or effects on stream channels from any instream activity that has resulted from such permits, is not well documented.

Diking and channelization inhibits channel connectivity and migration, and can increase streamflow velocity, which can affect the movement of sediment. The distribution of historic and recent diking in the Project Area was not available for this analysis, but it is thought to have been minimal in lower gradient channel types. No diking or channelizing related to agriculture or other activities are reported in the ODFW Aquatic Inventories for the Nehalem watershed (Johnson and Maser 2000).

Active removal of instream large wood occurred historically at various locations throughout the Nehalem watershed. Logs and stumps were often obstacles for fishermen, and as a result were removed from streams. A snagging association comprised mostly of fishermen regularly removed woody debris from streams in the Nehalem basin in the past (Johnson and Maser 2000). LWD was reportedly removed regularly from Rock Creek, and clearing was also conducted in the Upper Nehalem River in the 1960s.

Table 4-5. Miles of fish bearing stream by channel type on or adjacent to ODF lands in the Upper Nehalem watershed analysis area and contiguous parcels.

	FP2	FP3	LM	LC	MU	MM	MC	MH	MV	SM	SV	VH
Upper Nehalem												
Fishhawk Mgt. Basin												
HUC 171002020205[1]	0.8	0.0	1.7	0.0	0.0	1.5	0.2	0.0	2.0	1.0	4.2	0.9
Northrup Mgt. Basin												
HUC 171002020208	3.0	0.5	0.0	2.0	<0.1	2.1	2.1	0.0	3.8	1.0	3.8	1.1
HUC 171002020302	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Beneke Mgt. Basin												
HUC 171002020302	0.0	0.0	0.9	0.0	0.4	4.9	1.6	0.0	4.5	4.1	5.3	0.8
Lousignot Mgt. Basin												
HUC 171002020205	0.0	0.0	0.4	0.0	0.0	0.3	0.0	0.0	0.4	0.0	0.0	0.0
HUC 171002020208	0.0	0.0	1.1	0.0	0.0	3.4	0.0	1.4	0.4	0.3	0.0	0.3
Hamilton Mgt. Basin												
HUC 171002020303	0.0	0.0	1.2	1.3	0.0	3.6	0.5	0.4	5.3	2.5	2.5	0.3
Crawford Mgt. Basin												
HUC 171002020301	0.0	0.0	1.2	1.4	0.0	1.7	0.0	0.0	1.0	0.3	0.4	0.0
Sager Mgt. Basin												
HUC 171002020206	0.0	0.0	2.4	1.2	0.0	2.4	1.4	0.2	0.2	1.6	0.7	0.2
HUC 171002020208	0.5	0.0	1.9	0.5	0.0	0.6	1.2	0.0	1.0	0.5	0.5	0.2
HUC 171002020301	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	1.0	0.1	0.9	0.3
HUC 171002020305	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 4-5. Miles of fish bearing stream by channel type on or adjacent to ODF lands in the Upper Nehalem watershed analysis area and contiguous parcels.

	FP2	FP3	LM	LC	MU	MM	MC	MH	MV	SM	SV	VH
Buster Mgt. Basin												
HUC 171002020105	0.0	0.0	0.0	0.0	0.4	2.0	0.0	1.3	0.5	0.0	0.0	0.0
HUC 171002020106	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.7	0.7	0.5	0.0
HUC 171002020107	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3
HUC 171002020304	2.0	3.0	3.2	3.2	0.5	4.8	1.5	0.6	1.3	5.5	2.7	1.0
HUC 171002020305	0.0	0.0	0.2	0.0	0.1	4.0	0.0	0.2	4.1	1.6	2.4	0.0
Quartz Mgt. Basin												
HUC 171002020105	1.0	0.7	0.1	0.0	1.0	2.4	0.0	0.8	0.0	0.7	0.0	0.4
HUC 171002020305	0.0	0.0	0.0	0.1	0.0	1.1	0.0	0.0	1.0	0.7	1.0	0.5
HUC 171002020307	0.0	0.0	0.0	1.1	0.1	1.2	0.4	0.3	0.0	1.7	0.9	1.0
HUC 171002020402	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
McGregor Mgt. Basin												
HUC 171002020102	0.8	0.0	2.2	0.0	2.1	0.8	0.0	0.0	1.9	3.4	1.8	1.1
HUC 171002020103	0.0	0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.5	1.1	1.3	1.1
HUC 171002020105	0.5	0.0	0.1	0.0	0.4	0.8	0.0	0.3	0.6	0.7	0.8	0.4
HUC 171002020106	0.5	1.4	0.2	0.3	0.1	1.6	0.0	0.3	0.7	1.6	0.8	1.5
Wheeler Mgt. Basin												
HUC 171002020101	2.7	0.1	4.5	0.0	0.3	9.7	0.0	2.3	3.2	7.2	7.0	2.7
HUC 171002020102	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.3	0.4	1.5	2.5
HUC 171002020105	1.0	0.3	0.0	0.0	1.0	1.5	0.0	0.0	0.8	0.3	0.8	2.0

Table 4-5. Miles of fish bearing stream by channel type on or adjacent to ODF lands in the Upper Nehalem watershed analysis area and contiguous parcels.

	FP2	FP3	LM	LC	MU	MM	MC	MH	MV	SM	SV	VH
Wilark Mgt. Basin												
HUC 171002020203	0.4	0.5	0.0	0.0	0.2	2.3	0.0	0.0	2.2	0.5	1.2	0.7
Clatskanie												
Wilark Mgt. Basin												
Clatskanie	0.3	0.0	1.0	0.1	0.0	0.2	0.0	0.4	2.6	0.0	1.1	0.3
Young's Bay												
Hamilton Mgt. Basin												
Young's Bay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.4	0.7

[1] USGS Hydrologic Unit Code designating a 6th field subwatershed.

4.3.1 Nehalem Watershed

4.3.1.1 Fishhawk Management Basin

Channel Habitat Type Classification

The Fishhawk Management basin contains an estimated 12.4 miles of fish bearing stream channels. Approximately 50 percent of fish bearing channels in this management basin are moderately steep (MV) or steep narrow valley (SV) channels (Figure 4-1 Table 4-5). Highly responsive floodplain channel types (low gradient medium floodplain[FP2]) comprise approximately 6 percent of the channel network in the Fishhawk basin. Floodplain channels occur only on mainstem Fishhawk Creek (Figure 4-1). The Fishhawk management basin also contains 3.2 miles of moderately confined, low to moderate gradient channels that would be very responsive to changes in large wood, sediment supply and moderately responsive to peak flows (Table 4-3).

Channel Modification Assessment

Known existing channel modifications to streams within the Fishhawk Management Basin include a segment of old railroad trestle that is located in the stream bed on Warner Creek. A dam is currently present on Fishhawk Creek outside of the Project Area, approximately one half mile upstream of the confluence with Warner Creek. The dam forms Fishhawk Lake and was originally constructed for recreation purposes (Johnson and Maser 2000). Maintenance dredging of Fishhawk Lake is attempted every summer, conditions permitting, by the Fishhawk Lake Recreation Club (Johnson and Maser 2000). Habitat restoration projects were completed on Warner Creek in 2004 and on Fishhawk Creek.

4.3.1.2 Northrup Management Basin

Channel Habitat Type Classification

This basin contains an estimated 19.8 miles of fish bearing stream channels. Approximately half (49%) of fish bearing channels in this management basin are higher gradient channel types, including moderately steep narrow valley (MV), steep moderately confined (SM), steep narrow valley (SV) and very steep narrow valley (VH) channel habitat types (Figure 4-1, Table 4-5). Highly responsive floodplain channel types (low gradient medium floodplain and low gradient small floodplain) comprise 18 percent of the stream channel network in the Northrup Management basin (Table 4-3). Floodplain channels occur on lower Northrup Creek and in the headwaters of Cow Creek. Lower Northrup Creek flows through a small valley; the mainstem is classified as low gradient medium floodplain channel, and sections of small tributaries that flow across the narrow floodplain formed by Northrup Creek are classified as low gradient small floodplain channels. The Northrup Management basin also contains a short segment of Walker Creek that is classified as low gradient medium floodplain channel where it flows across ODF lands.

Channel Modification Assessment

Known existing channel modifications consist of a section of stream adjacent road along lower Cow Creek where the road occasionally impinges on the channel. The channel habitat type in this section is classified as moderate gradient confined. Large wood habitat improvement projects were completed in Cow and Northrup creeks in 2001 and in Northrup Creek in 2004.

4.3.1.3 Beneke Management Basin

Channel Habitat Type Classification

The Beneke Management basin contains 22.6 miles of fish bearing stream channels. The majority (62%) of fish bearing channels in this management basin are moderately steep narrow valley (MV), steep moderately confined (SM) and steep narrow valley (SV) channel habitat types (Figure 4-1, Table 4-5). No highly responsive low gradient floodplain channel types were identified. Approximately 4.9 miles of upper Walker Creek consists of moderate gradient, moderately confined channels that would be responsive to changes in large wood loading and coarse sediment delivery (Table 4-3).

Channel Modification Assessment

There are no known channel modifications in the Beneke Management Basin.

4.3.1.4 Lousignot Management Basin

Channel Habitat Type Classification

The Lousignot Management basin contains approximately 7.9 miles of fish bearing stream channels. The majority (65%) of fish bearing channels in this management basin are either low gradient moderately confined (LM) or moderate gradient moderately confined (MM) channel types. There were no highly responsive low gradient floodplain channel types identified (Figure 4-1, Table 4-5). Moderately confined, low to moderate gradient sections of Lousignot and Warner creeks would be responsive to changes in large wood loading and coarse sediment delivery (Table 4-3). Below the confluence with Warner Creek, Fishhawk Creek enters a wide low gradient valley. The area where Fishhawk Creek flows across ODF lands was determined to be transitional between a low gradient moderately confined and a low gradient small floodplain channel habitat type, and would likely be highly sensitive to changing levels of geomorphic inputs (Table 4-3).

Channel Modification Assessment

Habitat improvement projects were completed in Lousignot Creek in 2001 and in Warner Creek in 2004. Large wood clearing was known to occur on the Upper Nehalem River throughout the 1960s, however information regarding the specific location of such activities was not available for this analysis.

4.3.1.5 Hamilton Management Basin

Channel Habitat Type Classification

The Hamilton Management basin contains channels located in both the Nehalem watershed and the Young's Bay watershed. Channels located in the Young's Bay watershed are described in Section 4.3.2.2. The portion of the Hamilton Management basin located in the Nehalem River watershed contains an estimated 17.7 miles of fish bearing stream channels. Approximately 50 percent of fish bearing channels in this management basin are either moderate gradient moderately confined (MM) or moderately steep narrow valley (MV) channel types. There are no highly responsive low gradient floodplain channel types in this basin. The downstream ends of both Hamilton Creek and Fishhawk Creek consist of moderately confined, low to moderate gradient channels that would be responsive to changes in large wood loading and coarse sediment delivery (Table 4-3). Other moderate gradient, moderately confined channel types occur at tributary junctions (Figure 4-1).

Channel Modification Assessment

Known channel modifications in the Hamilton Management Basin include habitat enhancement projects on Fishhawk Creek and Hamilton Creek (Johnson and Maser 2000). A section of stream parallel road adjacent to Hamilton Creek is located on the valley bottom and may affect floodplain connectivity. The channel habitat type in this section of Hamilton Creek is low gradient moderately confined.

4.3.1.6 Crawford Management Basin

Channel Habitat Type Classification

The Crawford Management basin contains an estimated 5.9 miles of fish bearing stream channels. The majority (73%) of fish bearing channels in this management basin were low to moderate gradient channel types, including low gradient moderately confined (LM), low gradient confined (LC), and moderate gradient moderately confined (MM) channel habitat types (Figure 4-1, Table 4-5). There were no highly responsive low gradient floodplain channel types (low gradient medium floodplain and low gradient small floodplain) classified in this basin. Squaw Creek and West Branch Creek both include extensive sections of moderately confined, low to moderate gradient channels that would be responsive to changes in large wood loading and coarse sediment delivery (Table 4-3). The Nehalem River, which forms the southeast boundary of this management basin, consists of a low gradient moderately confined channel that is constrained by steep sideslopes to the north.

Channel Modification Assessment

There are no known channel modifications within the Crawford Management Basin. Large wood clearing was known to occur on the Upper Nehalem River throughout the 1960s; however, information regarding the specific location of such activities was not available for this analysis.

4.3.1.7 Sager Management Basin

Channel Habitat Type Classification

The Sager Management basin contains an estimated 20 miles of fish bearing stream channels. The majority (58%) of fish bearing channels in this management basin are low or moderate gradient types, including low gradient moderately confined (LM), moderate gradient moderately confined (MM), and moderate gradient confined (MC) channel types (Figure 4-1, Table 4-5). There are two sections classified as highly responsive low gradient floodplain channel types: (1) the downstream end of Sager Creek near the confluence with the Nehalem River and (2) the mainstem Nehalem River where it borders this management basin to the west (Figure 4-1). The Sager management basin also includes 7.8 miles of moderately confined, low to moderate gradient channels that would be responsive to changes in large wood loading and coarse sediment delivery (Table 4-3).

Channel Modification Assessment

Known channel modifications in the Sager Management Basin consist of a large wood habitat improvement project completed in Deep Creek in 2004. Large wood clearing was known to occur on the Upper Nehalem River throughout the 1960s, however information regarding the specific location of such activities was not available for this analysis.

4.3.1.8 Buster Management Basin

Channel Habitat Type Classification

The Buster Management basin contains an estimated 49.1 miles of fish bearing stream channels. There are extensive areas of highly responsive low gradient floodplain channel types in the Buster Management basin, including portions of Buster and Walker creeks (Figure 4-1, Table 4-3). Moderately confined moderate to low gradient channels that would be responsive to changes in large wood loading and coarse sediment delivery are also common in this management basin (Figure 4-1). Steep, relatively confined channels represent approximately 44% of the fish bearing stream network.

Channel Modification Assessment

Known channel modifications in the Buster Management Basin consist of two large wood placement projects completed on Buster Creek (Kavanagh et al. 2005).

A permit was issued to address an erosion/sediment control problem on North Fork Rock Creek at the southern edge of the management basin, however no information is currently available that indicates whether permitted activities have occurred and if so, the impact of such activities. Large wood clearing was known to occur on the Upper Nehalem River throughout the 1960s, however information regarding the specific location of such activities was not available for this analysis.

Review of early logging railroad maps indicated that most of the existing roads originated as railroad right of ways. The impacts of roads are discussed further in Chapter 8.0.

4.3.1.9 Quartz Management Basin

Channel Habitat Type Classification

The Quartz Management basin contains an estimated 18.3 miles of fish bearing stream channels. Approximately 44% of fish bearing channels in this management basin are low to moderate gradient channel types including low gradient medium floodplain (FP2), moderate gradient unconfined (MU), moderate gradient moderately confined (MM) (Figure 4-1 Table 4-5). Approximately 6.9 miles of fish bearing streams within the management basin are steep or very steep channel types (Table 4-5). Highly responsive low gradient floodplain channel types occur primarily in the Upper Rock Creek drainage on the east side of this management basin (Figure 4-1, Table 4-3). A small section of low gradient medium floodplain channel also exists in the headwaters of Spruce Run Creek near Spruce Run Lake. The floodplain and low to moderate gradient channels of low to moderate confinement in the Quartz Management basin would be responsive to changes in large wood loading and coarse sediment delivery (Figure 4-1, Table 4-3).

Channel Modification Assessment

Known existing channel modifications consist of a large wood habitat improvement project completed in the Quartz Management Basin in 2004. Large wood clearing was known to occur on the Upper Nehalem River throughout the 1960s, however information regarding the specific location of such activities was not available for this analysis.

Historic maps indicate that an artificial impoundment known as the Inman-Paulsen mill pond was located on Rock Creek, just east of the management basin, in the 1930s. This pond was used to stockpile logs near Inman-Paulsen's upper camp to guarantee a steady supply of timber for their Portland sawmill (Johnson and Maser 2000; Kamholz et al. 2003).

4.3.1.10 McGregor Management Basin

Channel Habitat Type Classification

The McGregor Management contains an estimated 32.9 miles of fish bearing stream channels. The majority (59%) of fish bearing channels in this management basin are moderately to very steep, relatively confined channel types including moderately steep narrow valley (MV), steep moderately confined (SM), steep narrow valley (SV), and very steep headwater (VH) types (Figure 4-1 Table 4-5). Highly responsive low gradient floodplain channel types are present on North Fork Wolf Creek, South Fork Rock Creek, Olson Creek and the Nehalem River (Figure 4-1, Table 4-3). The McGregor Management basin also contains almost 10 miles of moderately confined moderate to low gradient channels that would be responsive to changes in large wood loading and coarse sediment delivery (Figure 4-1, Table 4-3).

Channel Modification Assessment

Channel modifications identified in the McGregor Management Basin include a tributary to Olson Creek that has been diverted for a short distance down a section of road drainage ditch in the northern part of the management basin on Olson Road. Several habitat enhancement projects have been completed within the management basin including two large wood placement projects on both South Fork Rock Creek and the North Fork Wolf Creek. Enhancement projects were also undertaken on the mainstem Rock Creek and the North Fork Rock Creek just north of the McGregor Management Basin and on Bear Creek to the south.

Review of early logging railroad maps indicated that many of the existing roads originated as railroad right of ways. In the McGregor basin logging railroads were located primarily along ridgetops. Notable exceptions included lower Olson Creek, and the small tributary that entered

Rock Creek from the same side of the valley approximately 1.5 miles east of Rock Creek. Historical maps showed logging railroads along those streams, where no roads existed at the time of this assessment. The lingering effect of these old railroads on channel conditions is unknown. The impacts of roads are discussed further in Chapter 8.

Historic maps indicate an artificial impoundment known as the Inman-Paulsen mill pond was located on Rock Creek, just west of the management basin, in the 1930s. This pond was used to stockpile logs near Inman-Paulsen's upper camp to guarantee a steady supply of timber for their Portland sawmill (Johnson and Maser 2000; Kamholz et al. 2003).

4.3.1.11 Wheeler Management Basin

Channel Habitat Type Classification

The Wheeler Management Basin contains an estimated 53.6 miles of fish bearing stream channels. The majority (55%) of fish bearing channels in this management basin are moderately to very steep, relatively confined channels including moderately steep narrow valley (MV), steep moderately confined (SM), steep narrow valley (SV), and very steep headwater (HV) channel habitat types (Figure 4-1). Highly responsive low gradient floodplain channel types are present on the Nehalem River, Lousignont Creek and Bear Creek. The Wheeler Management basin also contains almost 17 miles of moderately confined moderate to low gradient channels that would be responsive to changes in large wood loading and coarse sediment delivery (Figure 4-1, Table 4-3).

Channel Modification Assessment

Known existing channel modifications within Wheeler Management Basin consist of several stream habitat enhancement projects completed on the South Fork Rock Creek, Lousignont Creek, and Bear Creek, which is a tributary to the South Fork Rock Creek.

The 2000 Nehalem Watershed Assessment indicates that several small dams currently exist in the Wheeler Management Basin. A map of historic channel modifications in the 2000 Assessment identifies an existing dam on Derby Creek, which is a tributary of Lousignont Creek, a mill pond and existing dam on Carlson Creek beneath a road, and two small dams on tributaries of the upper Nehalem River that are used for fire control on nearby railroads (Johnson and Maser 2000). Two dams were historically present on the mainstem Nehalem River, downstream of the management basin, and were removed in the 1930s (Johnson and Maser 2000). An artificial impoundment, known as the Cochran mill pond, is located on a tributary at the headwaters of the Nehalem River, just west of the Project Area (Johnson and Maser 2000). A reload pond was historically located downstream of the Cochran mill pond, immediately west of the management basin. The dam was removed in the 1980s (Johnson and Maser 2000).

4.3.1.12 Wilark Management Basin

Channel Habitat Type Classification

The Wilark Management Basin contains land within the Nehalem watershed and the Clatskanie watershed. Channels within the Clatskanie watershed are described in Section 4.3.2.1. Land within the Nehalem watershed in the Wilark Management Basin was estimated to contain approximately 8.0 miles of fish bearing stream channels. The majority (58%) of fish bearing channels in this management basin were moderate to very steep, confined channel types including moderately steep narrow valley (MV), steep moderately confined (SM), steep narrow valley (SV), and very steep headwater (VH) channel types (Figure 4-1, Table 4-5). Highly responsive low gradient channel types are present on Oak Ranch Creek. Approximately 2.5 miles of fish bearing streams within the management basin are of moderate gradient and moderately or unconfined that would be responsive to inputs of large wood and coarse sediment (Figure 4-1, Table 4-3).

Channel Modification Assessment.

There are no known channel modifications within the Wilark Management Basin.

4.3.2 Contiguous Parcels

4.3.2.1 Clatskanie

Wilark Management Basin

Channel Habitat Type Classification

The Wilark Management Basin contains land within the Nehalem watershed and the Clatskanie watershed, which drains north to the Columbia River (Figure 4-1). Channels within the Nehalem watershed are described in section 4.3.1.12. The portion of the Wilark Management basin in the Clatskanie watershed contains an estimated 6.0 miles of fish bearing stream channels. The majority (67%) of fish bearing channels in this management basin were moderate to very steep, confined channel types including moderately steep narrow valley (MV), steep narrow valley (SV), and very steep headwater (VH) channel types (Figure 4-1, Table 4-5). Highly responsive low gradient floodplain channel types are present on the Clatskanie River; however, the majority of low gradient medium floodplain channels in this drainage system flow across private lands. The Wilark Management basin also contains 1.2 miles of moderately confined moderate to low gradient channels that would be responsive to changes in large wood loading and coarse sediment delivery (Figure 4-1, Table 4-3).

Channel Modification Assessment

There are no known channel modifications within the Wilark Management Basin.

4.3.2.2 Young's Bay

Hamilton Management Basin

Channel Habitat Type Classification

The Hamilton Management basin contains land within the Nehalem and Young's Bay watersheds. Areas within the Nehalem watershed are described in Section 4.3.1.5. The portion of the Hamilton Management Basin within the Young's Bay watershed contains an estimated 1.8 miles of fish bearing stream channels. The majority (61%) of fish bearing channels in this area are steep narrow valley (SV) and very steep headwater (VH) channel habitat types. There are no highly responsive low gradient floodplain channel types in this management basin (Figure 4-1, Table 4-5).

Channel Modification Assessment

There are no known channel modifications within the Young's Bay Management Basin.

4.4 CONFIDENCE IN WORK PRODUCT

Two primary sources of error were encountered in conducting the stream channel assessment for this project: (1) errors in classification of stream gradient and confinement and (2) discrepancies in confinement between map calls and field measurement. The implications of each of these errors are described below.

1. Errors in classification of gradient and confinement

According to the OWEB manual, channel types are delineated based on a combination of gradient and confinement. Map layers of CHT's produced for previous watershed assessments delineated channel types using processes that appeared to vary slightly from the prescribed approach. The majority of the analysis area was covered by the Nehalem Watershed Assessment (Johnson and Maser 2000). Maps of channel sensitivity and confinement were included in the final report, but no map of CHTs was provided in this analysis document. Original CHT GIS data obtained from the Nehalem Watershed Council consisted of individual layers for each channel type. Channel Habitat Type map layers were grid cell analysis of 100 meter cells.

Analyses using this approach produced an estimated gradient/confinement of individual grid cells that cross the channel as opposed to defining the actual stream channel gradient /confinement. Because of this approach and the coarser base map scale used in the previous analysis, errors in classification were identified. Thus, in this channel assessment the CHTs from Johnson and Maser (2000) were compared to measurements of gradient and confinement derived from USGS topographic maps. The previous CHT classifications were corrected then to match the topographic analysis as needed to produce a single, consistent map layer that covered the entire Project Area.

2. Discrepancies in confinement between map calls and field measurement

A second source of error in classification of CHTs results from discrepancies between the gradient and confinement measured based on topographic maps versus field measurements. Channel confinement is particularly difficult to judge on topographic maps because it is a function of channel width. Map based confinement calls are made based on the shape of the contour line where it crosses the stream as follows:

1. v-shaped = confined
2. u-shaped = moderately confined
3. straight = unconfined.

The field assessment found that streams classified as "confined" were frequently "moderately confined," primarily due to the small channel width. For example, a channel with a bankfull width of 6-feet would qualify as moderately confined (Valley width = 2-4 x BFW) in any valley wider than 12 feet.

Discrepancies between map-based and field-based confinement calls were most frequent on small, steep channels. Since there is no systematic means of identifying the "correct" (i.e., field based) confinement call without visiting each stream segment, no adjustments were made to the map based classification. Differences in the geomorphic attributes and response potential of confined versus moderately confined, steep stream channels would be expected to be minor (see Section 4.2). Field-based estimates of gradient were found to be consistent with mapped classes.

In addition, there is considerable inherent uncertainty in analysis of hydrologic change and resulting effects on channel condition. The sensitivity calls in Table 4-2 reflect channel characteristics that cannot be discerned at the level of this analysis. The calls could be improved confidence-wise by visiting each basin and noting current site-specific conditions such as bed material, bank composition and structure, riparian vegetation type and condition, and field evidence of past channel instabilities.