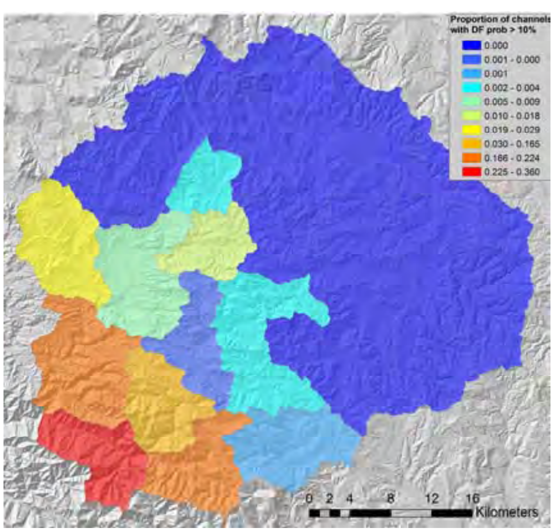
Upper Nehalem Watershed Analysis

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

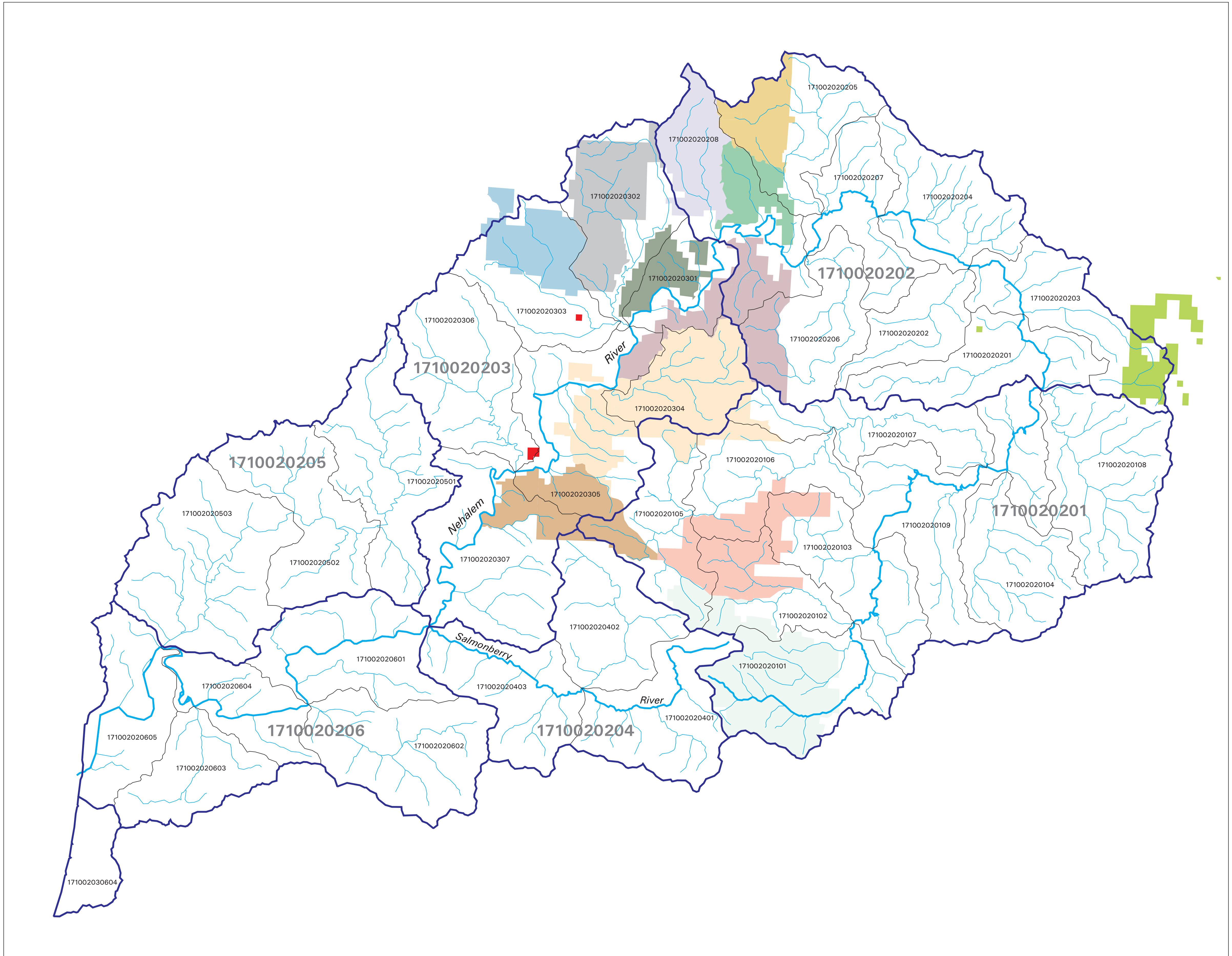
Oregon Administrative Rule (OAR 629-035-0020) and Oregon Revised Statute (ORS 530.050) directs ODF to manage BOF lands to provide the greatest permanent value to Oregonians including a full range of social, economic and environmental benefits that can be supported by managing for healthy, productive 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

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).

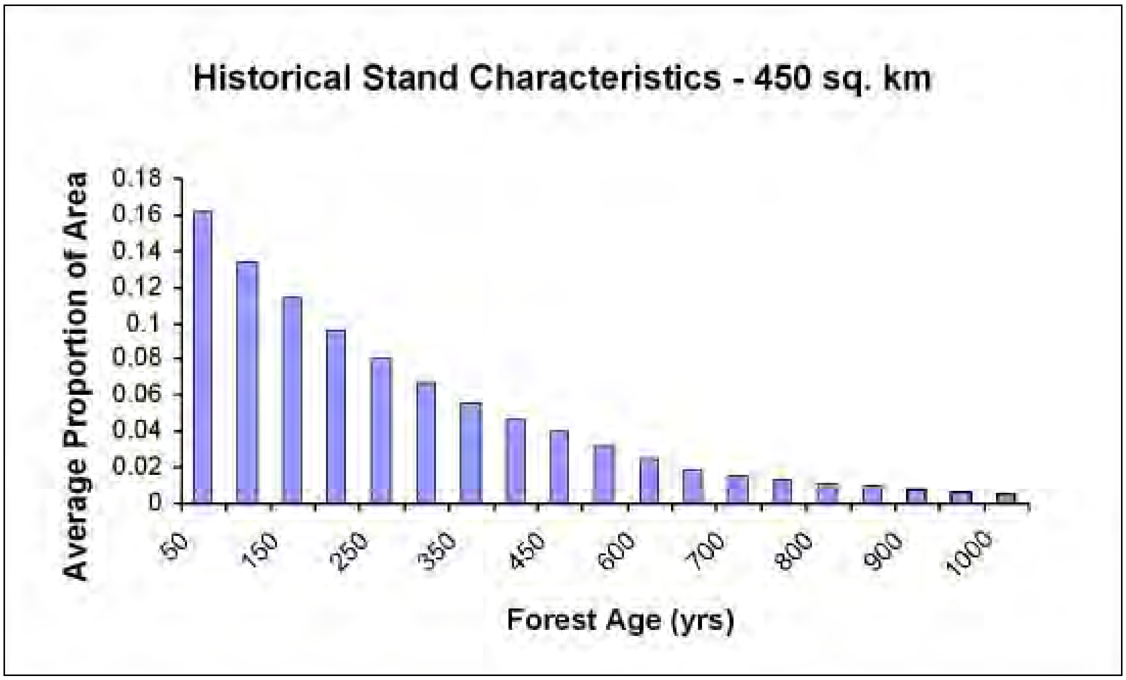


Figure 3-1. The predicted historical forest age distribution for the Nehalem watershed based on a forest fire simulation model developed for the central Oregon Coast Range (Benda and Dunne 1997a).

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).

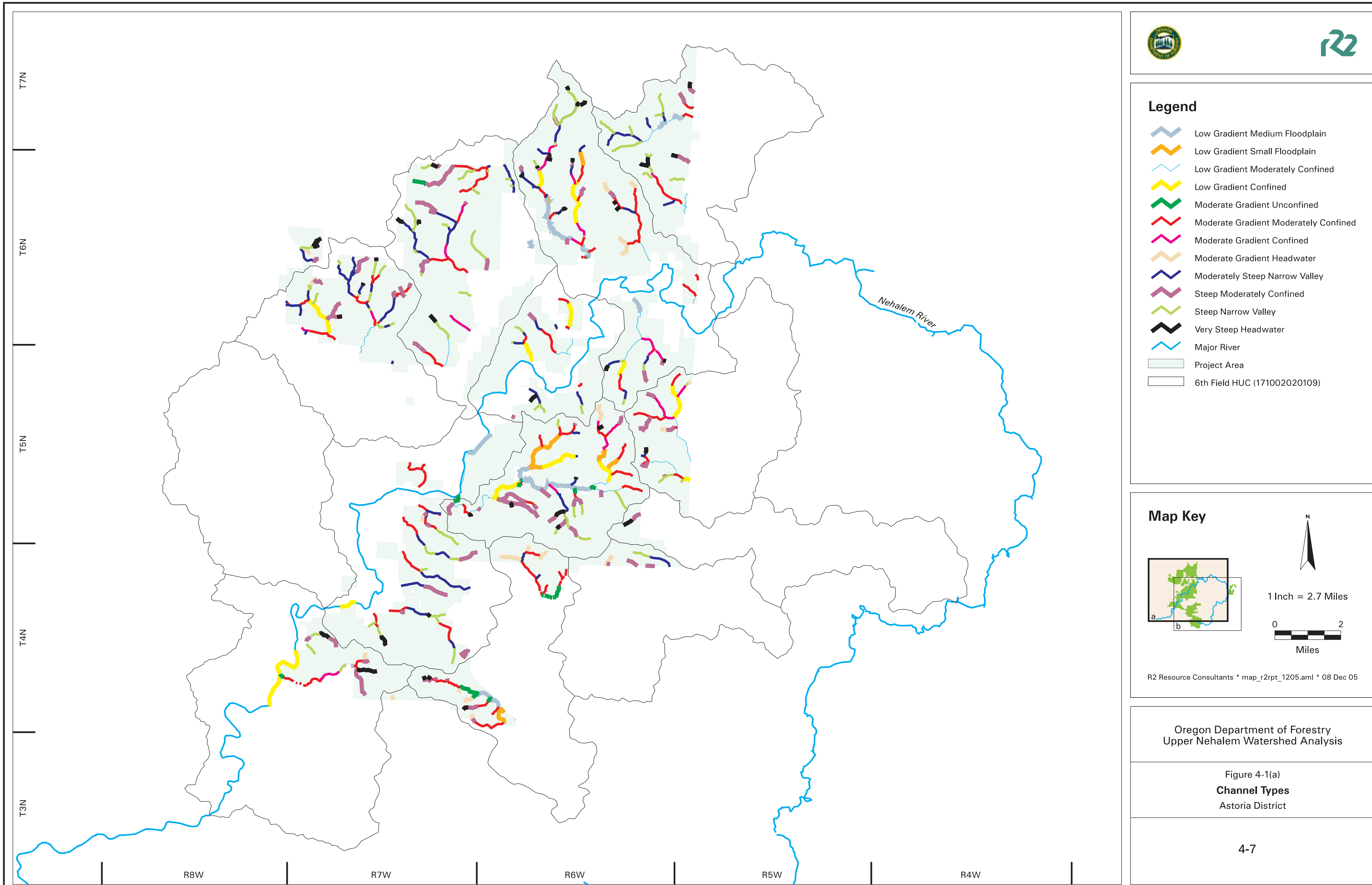
The OWEB Assessments designated the overall channel "sensitivity" to disturbance based on CHT morphologic characteristics. While such a stratification is a useful first step, it fails to recognize that channel types respond to inputs in different ways. For example, steep moderately confined channels 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.

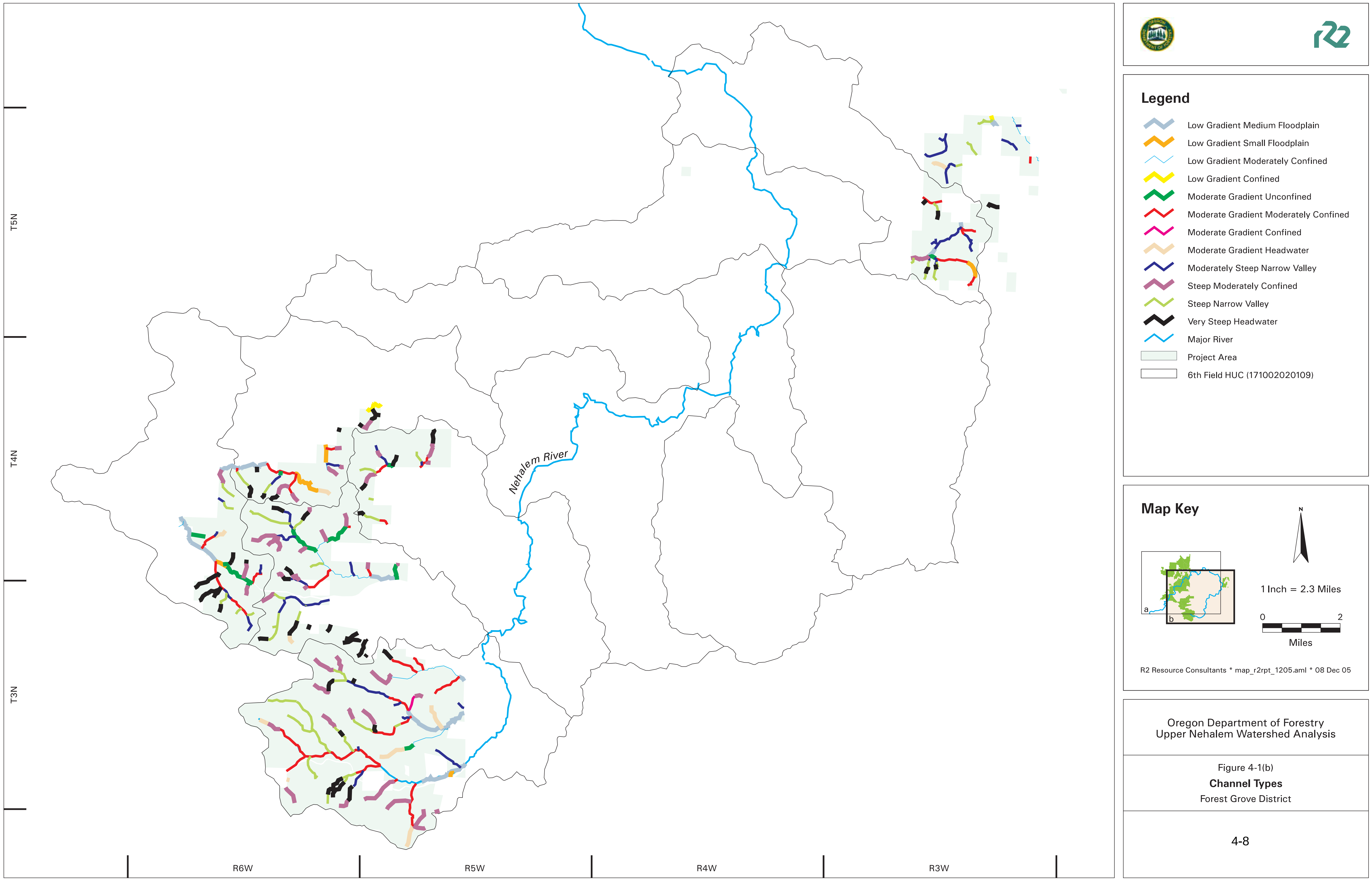
4.3 RESULTS BY MANAGEMENT BASIN

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.



Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 4-1(a)
Channel Types
Astoria District



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.

5. HYDROLOGY AND WATER USE

This section of the watershed analysis characterizes the hydrology and water uses within the ODF management areas. Where information is available, this section answers the four OWEB critical questions for hydrology and the seven critical questions for water use.

OWEB Hydrology Questions:

1. *What land uses are present in your watershed?*
2. *What is the flood history in your watershed?*
3. *Is there a probability that land uses in the basin have a significant effect on peak flows?*
4. *Is there a probability that land uses in the basin have a significant effect on low flows?*

OWEB Water Use Questions:

1. *For what beneficial use is water primarily used in your watershed?*
2. *Is water derived from a groundwater or surface-water source?*
3. *What type of storage has been constructed in the basin?*
4. *Are there any withdrawals of water for use in another basin (interbasin transfers)? Is any water being imported for use in the basin?*
5. *Are there any illegal uses of water occurring in the basin?*
6. *Do water uses in the basin have an effect on peak flows?*
7. *Do water uses in the basin have an effect on low flows?*

In the process of answering these questions, specific information is included describing streamflow characteristics, water yield and peak flows, instream water rights and low flows, consumptive water uses, and water withdrawals and storage. The hydrology and water use information for the project area are separated into two sections; the management basins located within the Upper Nehalem watershed and the Clatskanie and Young's Bay contiguous parcels.

5.1 NEHALEM MANAGEMENT BASINS

This section focuses on the hydrology and water use within the Nehalem watershed as a whole, but where applicable and information is available, the hydrologic assessment is described by the 13 ODF management basins. This assessment is based on information provided in the Nehalem River Watershed Assessment and some additional analysis performed using available GIS information.

The Nehalem River is one of the longest rivers in Oregon with a length of 118.5 miles and a drainage area of approximately 855 square miles. The headwaters of the Nehalem basin are on the eastern edge of the Coast Range. The Oregon Coast Range is relatively low, with peaks at 1,500 feet-3,300 feet in elevation. The Nehalem River circles around the northern tip of the mountains then heads in a southwesterly direction until it drains into the Nehalem Bay and then into the Pacific Ocean (Johnson and Maser 2000). The entire basin has the usual coastal type distribution with precipitation heavy in the fall and winter and light in the spring and summer (Young and Colbert 1965). The mean annual precipitation of the Nehalem Basin is approximately 113 inches. Annual precipitation ranges from 80 inches in the lower elevations to more than 150 inches in the higher elevations (ODF 2003). Because of the relatively low elevation, snowfall in the Coast Range is low, averaging 12-24 in annually (Johnson and Maser 2000).

The Oregon Coast range mountains do not collect sufficient snow to supplement spring and summer flows (Johnson and Maser 2000). Eighty percent of the precipitation falls between October and March with snowfall occurring only in the higher elevations (Broad 1996). As a result, peak stream discharges occur between December and February, the rainiest months, and low flows occur during the summer months. Snow that does accumulate is quickly washed away by winter rains. Rain-on-snow events that have the potential to increase peak flows occur infrequently, as in the February 1996 flood discussed in the streamflow section.

5.1.1 Streamflow Characteristics

Descriptions of streamflow for streams within the ODF management basins can not be provided as no tributary flow data is available. Thus, this summary of the hydrological characteristics relies on other data available within the Nehalem watershed. United States Geological Survey and Oregon Water Resources Department have operated several gages throughout the Nehalem watershed. These gages are summarized in Table 5-1. Only the Fishhawk Creek near Jewell gage is located within the project area. This gage was located within the Hamilton management basin and only measured peak flows. The peak flows for this gage are summarized in Table 5-2 along with the corresponding flow at the Nehalem River near Foss gage. The overall hydrology of the Nehalem watershed is best captured by the Nehalem River near Foss gage. This gage is located southwest of the project area on the Nehalem River at river mile 13.5. It has been in continuous operation since 1939 and captures the streamflow from a drainage area of 667 miles, almost 80 percent of the Nehalem watershed. The annual hydrograph for this gage is shown in Figure 5-1. As indicative of rain dominated systems, the hydrograph shows peaks during the rainy months of December through February and low flows during the mid to late summer. Streams located on the ODF management basins likely have a similar shape with variability in the magnitude of flow. However, to understand the specific hydrology of these smaller streams and ultimately how management of the surrounding forest impacts their hydrology more flow data would be needed.

Table 5-1. Summary of Gages within the Nehalem watershed.

Station Name	**Station Number**	**Period of Record**	**Drainage Area (mi^2)**	**Comments**
Nehalem River near Foss	14300100	1939-2003	667	
Nehalem River near Vernonia	14299800	2001-2003	70	
Jetty Creek near Brighton	14301250	1975-1995		
Fishhawk Creek near Jewell	14300400	1970-1976	0.71	Peak flows only
Oak Ranch Creek near Vernonia	14300200	1958-1969	11.6	Peak flows only

Table 5-2. Summary of Peak Flow Data for the Fishhawk Creek near Jewell Gage and corresponding Nehalem River near Foss gage data.

Date	**Fishhawk Creek Peak Flow (cfs)**	**Nehalem River Flow (cfs)**
1/17/1971	93	23,300
1/21/1972	1,920	38,200
12/21/1972	80	20,200
1/16/1974	131	37,800
3/18/1975	80	8,720
12/4/1975	93	29,000
11/15/1976	5.7	216

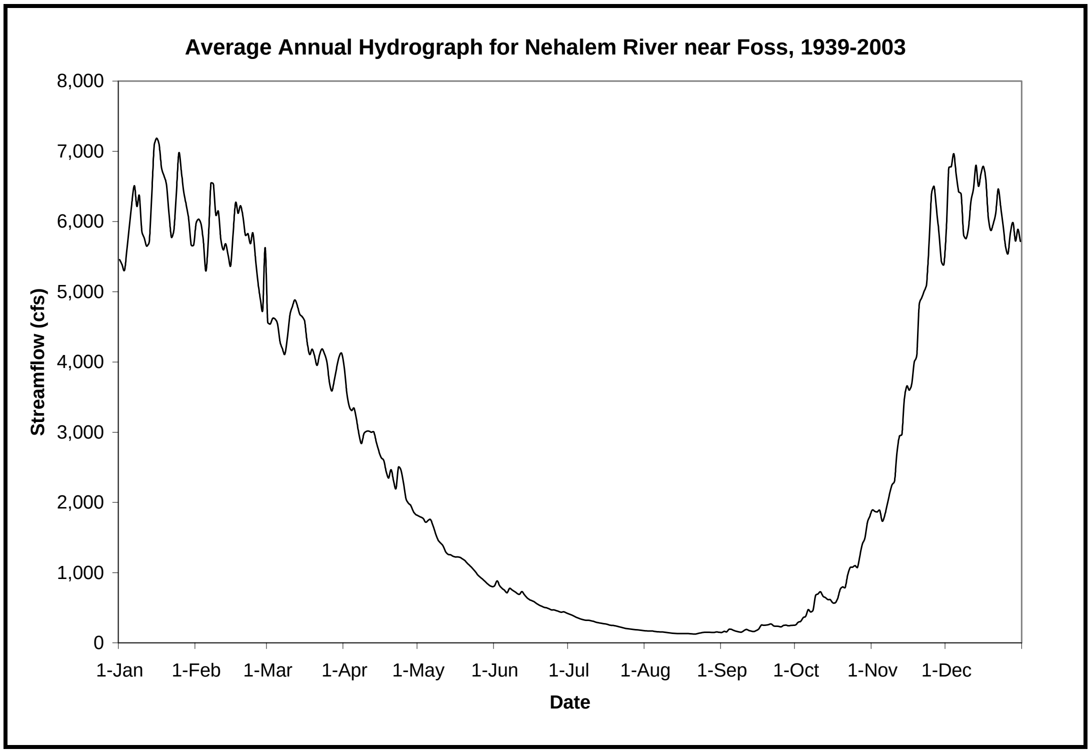


Figure 5-1. Annual Hydrograph for the Nehalem River near Foss, 1939-2003.

A greater than 200-year recurrence interval flood occurred on the Nehalem River in 1996. The Nehalem River near Foss gage read a maximum of 70,300 cfs on February 8, 1996. Other large floods were recorded in 1990, 1972 and 1964. The annual peak flows for the 1938-2003 period of record for Nehalem River near Foss gage are shown in Figure 5-2. Annual low flows for the same period recorded at the Foss gage are shown in Figure 5-3.

Land uses present in the four subwatersheds of the Nehalem watershed are detailed in Table 5-3. Forestry is the predominant land use in the project area. Given the paucity of flow data within the project area, we were unable to assess how specific ODF forestry practices have impacted the hydrology of the Nehalem River. Thus, in lieu of a project specific assessment, a brief and general discussion of how forestry practices can potentially affect stream hydrology is provided below.

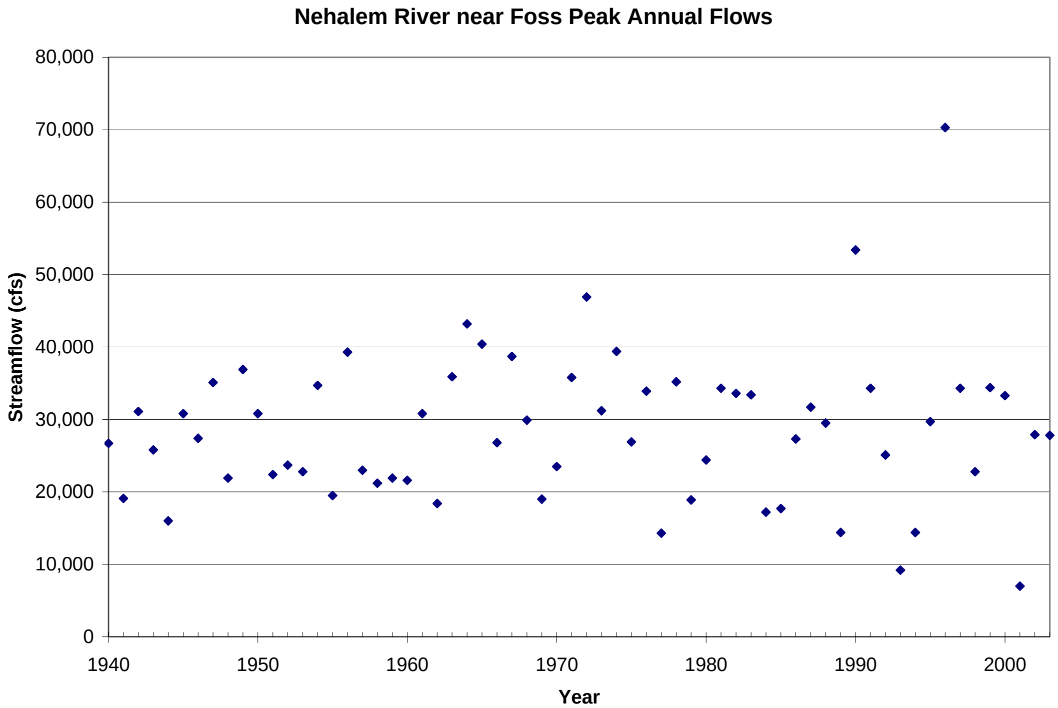


Figure 5-2. Annual Peak Flows for the Nehalem River near Foss Gage #14301000.

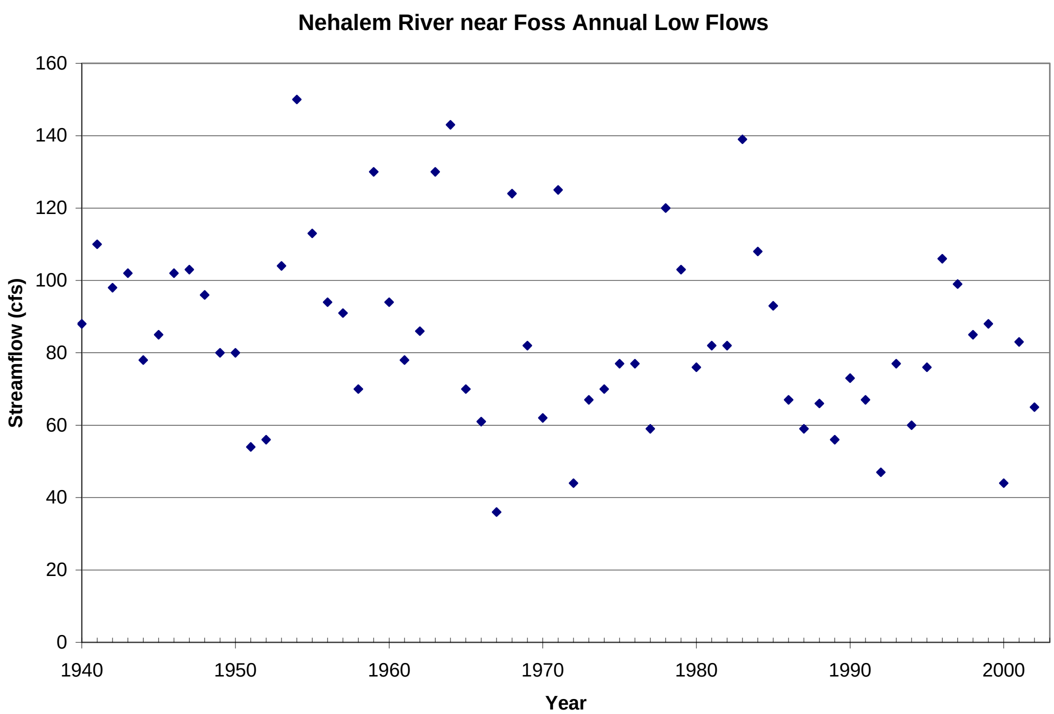


Figure 5-3. Annual Low Flows for the Nehalem River near Foss Gage #14301000.

Table 5-3. Summary of Land Uses for subwatersheds within the Nehalem watershed.

Watershed	Forestry	Ag/Rangeland	Ag/Rangeland/Forestry	Urban	Other[1]
Lower Nehalem River	90.7%	1.6%	4.9%	--	2.8%
Middle Nehalem River	95.8%	0.7%	2.7%	--	0.8%
Upper Nehalem River	95.1%	--	3.0%	0.7%	--
Entire Nehalem River	92.2%	1.7%	3.7%	0.5%	1.9%

[1] "Other" category includes natural resources, parks and recreation, rural industry, and rural residential
Source: PSU, 2000

The streamflow characteristics of a river system can be influenced by land use practices by altering both peak flows and low flows. Forestry practices can influence peak and low flows through several processes resulting from changes in vegetation and construction of new road networks (Johnson and Maser 2000). Loss of vegetative cover can potentially reduce rates of interception and evapotranspiration, and changes in canopy cover can alter streamflows by changing the snow accumulation and melt rate. This change has the most impact on systems that are rain-on-snow dominated and thus is not likely a significant factor in a rain dominated system like the Nehalem River. Forest road networks increase the impervious surface area and can potentially provide a more direct route for runoff into stream channels (Rule 2001). The impact of forest roads on peak and low flows in the Upper Nehalem Project Area is presumed to be insignificant, as the percentage of road per unit forest area and percentage of road drainage with hydrologic connection to streams are both low (see Chapter 8).

Specific data was not available to address if these potential hydrological effects are occurring in the Nehalem watershed. Site specific hydrologic data is lacking and is needed in order to understand any relationship between ODF management activities and Nehalem River hydrology.

5.1.2 Water Yield and Peak Flows

As described above, peak flows are potentially influenced by land uses within the watershed. The major land uses in the upper Nehalem River were evaluated to determine the potential impact on peak flows.

The largest land use in the four watersheds covering the management basins was forestry. Without additional hydrologic data is was not possible to assess forest management effect on flows. We were able to assess potential impact that forest roads may have on flows. A summary of the forest road areas within the three sub-watersheds is presented in Table 5-4. The data is presented by management basin in Table 5-5. The linear distance of roads within each management basin was calculated using the Roads Information Management System (RIMS) data set. According to the GWEB manual (1999), peak flow changes due to roads are small and statistically insignificant in watersheds where roads occupy less than 5 percent of the basin (Nehalem, Washington). A review of available information showed that the subwatersheds of interest and each of the ODF management basins have less than 5 percent of forest area in roads. Overall, the probability of peak flow enhancement from timber harvest in the Upper Nehalem Basin would be low due to the infrequency of rain-on-snow events and the small portion of forestry roads.

Table 5-4. Forest Road Area Summary for subwatersheds of the Nehalem watershed.

Subwatershed	Total Linear Distance of Forest Roads (miles)	Percent of Forested Area in Roads
Lower Nehalem River	344.04	0.98%
Middle Nehalem River	401.34	1.10%
Upper Nehalem River	443.1	0.93%

Source: PSU, 2000

Table 5-5. Forest Road Area Summary by Management Basin.

Management Basin	Total Linear Distance of Forest Roads (miles)	Percent of Forested Area in Roads
Beneke	48.7	1.5
Buster	106.3	1.7
Crawford	27.8	2.0
Fishhawk	32.8	2.0
Hamilton	37.7	1.9
Lousignot	27.5	1.8
Northrup	44.1	1.8
Quartz	55.3	1.9
Sager	69.4	2.1
McGregor	59.6	1.7
Wheeler	102	2.0
Wilark	16.8	2.2

A summary of the rural roads in the three subwatersheds is presented in Table 5-6. Rural road densities between 4 percent and 8 percent have a moderate risk potential of enhancing peak flow (GWEB 1999). The Middle Nehalem River subwatershed had 4.6 percent area in roads and thus, a moderate risk of enhancing peak flows. The Fishhawk, Lousignot, Northrup, and Sager management basins are located within the Middle Nehalem River subwatershed. All other subwatersheds would have a low potential for peak flow enhancement. The small percentage of agriculture/rangeland and urban area in the Nehalem watershed also had a low potential of enhancing peak flow.

Table 5-6. Rural Road Area Summary for subwatersheds of the Nehalem watershed.

Subwatershed	Total Linear Distance of Rural Roads (miles)	Percent Area in Roads	Relative Potential for Peak Flow Enhancement
Lower Nehalem River	50.5	4.6%	Moderate
Middle Nehalem River	18.89	3.42%	Low
Upper Nehalem River	16.07	3.16%	Low

Source: Johnson and Maser 2000

5.1.3 Consumptive Water Uses

Our research identified a total of eight ODF water rights within the management basins. These water rights are used for forest management and fire protection. The most common ODF forest management water uses included processing and compaction of forest roads, dust abatement, slash burning, and mixing with herbicides. Detailed information on ODF water rights within the project area including the permit number, water right type, use, maximum rate/size, specific restrictions, water source and tributary to, and the priority date is summarized in Table 5-7. As per Oregon Revised Statue requirements, some water uses by ODF do not require a permit. These water uses include the withdrawal of water for fire control in training or emergency fire fighting, and some forest management practices such as slash burning and mixing with herbicides. The quantity and timing of withdrawals for these exempt uses was unknown.

In addition to the ODF water rights, there were a total of fifteen private water rights located within the project area (Table 5-8). The data for Tables 5-7 and 5-8 were obtained by searching both the available water right GIS coverage within the identified project area and Oregon Water Resources Department (OWRD) Water Rights Information System for more recently approved water rights. There were a total of two reservoir permits and 21 surface water permits identified within the 11 management basins. We were unable to locate documentation that would allow us

Table 5-7. Summary of ODF Water Rights and Sources located within management basins.

Management Basin	Permit/ Application Number	Type	Use	Maximum Rate/Size	Restrictions	Source	Tributary To	Priority Date
Northrup	S52865	Surface	Forest management, fire protection	0.86 cfs	Jan 1 – May 31	Plympton Creek	Columbia River	12/9/1994
Beneke	S77250 S52852	Surface	Forest management, fire protection	0.86 cfs	Dec 1 – Mar 31, Not to exceed 100,000 gallons per year	Beneke Creek	Nehalem River	12/9/1994
	S52854 S77251	Surface	Forest management, fire protection	0.86 cfs	Dec 1 – Mar 31, Not to exceed 100,000 gallons per year	Bull Heifer Creek	Nehalem River	12/9/1994
Sager	R77249 70974[1]	Reservoir	Forest management, fire protection	2.9 ac-ft		Buster Creek, Plympton Creek, Sager Creek, Beneke Creek, Bull Heifer Creek		1/1/1993
	S52855 S77252	Surface	Forest management, fire protection	0.86 cfs	Nov 1 – Jul 31, Not to exceed 100,000 gallons per year	Sager Creek	Nehalem River	12/9/1994
	S52864 S77253	Surface	Forest management, fire protection	0.86 cfs	Nov 1 – Jul 31, Not to exceed 100,000 gallons per year	Sager Creek	Nehalem River	12/9/1994
Quartz	S52866 S77257	Surface	Forest management, fire protection	0.86 cfs	Nov 1- Jul 31, Not to exceed 100,000 gallons per year	Unnamed Stream	Nehalem River	12/9/1994
	R77248	Reservoir	Fire protection	0.3 ac-ft		Unnamed Stream/Reservoir		1/1/1993

[1] The place of use for this water right covers areas in Sager, Beneke, Fishhawk, Northrup, and Hamilton Management Basins

Table 5-8. Summary of Other (non-ODF) Water Rights and Sources in the ODF Management Basins.

Management Basin	Permit Number	Use	Maximum Rate (cfs) / Size (Acre-feet)	Source	Tributary To
Fishhawk	None				
Northrup	None				
Beneke	None				
Lousignot	S7135	Domestic	0.1	Nelson Creek	Nelson River
Hamilton	S26471	Domestic	0.01	Hamilton Creek	Fishhawk Creek
	S35238	Domestic	0.006	Hamilton Creek	Fishhawk Creek
Crawford	S43607	Domestic	0.005	A Spring	Nehalem River
Sager	S42756	Domestic	0.005	Sager Creek	Nehalem River
	S43757	Domestic expanded including non-commercial garden	0.005	Sager Creek	Nehalem River
Buster	S18269	Domestic including lawn and garden	0.01	Quartz Creek	Nehalem River
	S31735	Livestock	0.005	Unnamed Stream	Nehalem River
	S46988	Domestic, Stock	0.005	Nehalem River	Nehalem Bay
Quartz	S47566	Domestic	0	A Spring	Nehalem River
	S51894	Domestic expanded including non-commercial garden	0.01	A Spring	Nehalem
McGregor	S12432	Domestic	0.01	Unnamed Spring	South Fork Rock Creek
	S5670	Domestic	3	Rock Creek	Nehalem River
Wheeler	S12359	Municipal	0.15	Unnamed Stream	Nehalem River
	S5029	Fire protection	0.03	Unnamed Stream	Nehalem River
Wilark	None				

to determine if any illegal uses of water occurred within the project areas. We also failed to find any evidence of interbasin transfer or importation of water within the Project Area.

Within the entire Nehalem watershed, there were a total of 542 water rights with a potential diversion of 93.25 cfs (Johnson and Maser 2000). The quantities of water rights in each beneficial use category for the entire Nehalem watershed were: fish (33.3%), irrigation (25.8%), municipal (14.1%), geothermal manufacturing (8.8%), domestic (7.5%), fire protection (4.6%), and "other" (includes livestock, agriculture, recreation, wildlife, campground, dairy barn, and power (Johnson and Maser 2000).

5.1.4 Instream Water Rights and Water Availability

At the time of the report, instream water rights existed on eight rivers or streams located within or partially within the 11 ODF management basins. These instream water rights including the permit number, stream, range of flows, use, and priority date are summarized in Table 5-9. These water rights were granted to maintain flows within streams for the support of aquatic life or anadromous and resident fish rearing. These rights were granted to OWRD between 1989 and 1996, but have priority dates between 1973 and 1991. Like all water rights, water is first granted to those with more senior water rights. Many of the other water rights within the Nehalem basin have older priority dates. If all of these water rights are exercised, summer streamflows (low flows) could be significantly reduced.

The OWRD has identified 37 Water Availability Basins (WABs) for the entire Nehalem watershed that represent basins associated with tributaries of the Nehalem River. These WABs are used to identify areas with available or over appropriated water. A review of the 37 WABs in the Nehalem River basin at some point during the year showed that each of them had a potential water deficit. Potential channel dewatering can present problems for spawning and fish passage. Typically, the spawning period that coincides with the lowest flow starts in September and extends through October. Summer rearing habitat for fish also requires flow levels to be maintained.

There is insufficient streamflow data to support an assessment of the impact of forest practices on low flows within the project area. Hydrology data gaps identified include forest-specific streamflow data including low flows in managed and non-managed streams. However, the analysis of rights indicates that water uses in the basin have the potential to significantly impact low flows.

Table 5-9. Summary of Instream Water Rights Located in the ODF Management Basin Project Area.

Management Basin	Permit Number	Stream	Range of Flows (cfs)	Use	Priority Date
Fishhawk	IS71923	Fishhawk Creek	2.7-15	Anadromous and Resident Fish Rearing	10/11/1991
Northrup	IS71925	Northrup Creek	1.9-20	Anadromous and Resident Fish Rearing	10/11/1991
Beneke	None				
Lousignot	IS71923	Fishhawk Creek	2.7-25	Anadromous and Resident Fish Rearing	10/11/1991
Hamilton	None				
Crawford	MF40	Nehalem River	30-160	Supporting Aquatic Life	5/9/1973
Sager	MF39	Nehalem River	50-200	Supporting Aquatic Life	5/9/1973
Buster	IS71927	Buster Creek	3.5-51	Anadromous and Resident Fish Rearing	10/11/1991
	IS71928	Cow Creek	1-15	Anadromous and Resident Fish Rearing	10/11/1991
	MF39	Nehalem River	50-200	Supporting aquatic life	5/9/1973
Quartz	IS71929	Quartz Creek	1.7-30	Anadromous and Resident Fish Rearing	10/11/1991
McGregor	None				
Wheeler	IS71938	Nehalem River	6-40	Anadromous and Resident Fish Rearing	10/11/1991
Unnamed (next to Quartz)	IS71933	Spruce Run Creek	1-20	Anadromous and Resident Fish Rearing	10/11/1991
	MF38	Nehalem River	70-250	Supporting Aquatic Life	5/9/1973
	MF39	Nehalem River	50-200	Supporting Aquatic Life	5/9/1973
Wilark	IS 71921	Oak Ranch Creek	1.5-26	Anadromous and resident fish rearing	10/11/1991

5.1.5 Water Withdrawals and Storage

At the time of this report, the ODF water rights constituted a total of 84.4 million gallons of water withdrawn per year and a total storage capacity of 3.2 acre-feet. The majority of the water withdrawal was encompassed under the Plympton Creek water right that allows a maximum rate of 0.86 cfs withdrawn between January 1st and May 31st. If exercised completely, this water right would correspond to a withdrawal of 83.9 million gallons annually. None of the surface water rights owned by ODF allowed for withdrawals from August to October, the low flow months. However, ODF water uses exempted from water rights may be withdrawn. More detailed description of the types and quantities of ODF exempted water uses would be necessary to quantify the total amount of water withdrawn from ODF management basins.

At the time of this report, there were many other small reservoirs and off-channel ponds located throughout the entire Nehalem watershed. The total storage of water was 1273.6 acre feet. This water was used for recreation (77.5%), fish (15.4%), wildlife (5.2%), irrigation (1.4%), and "other" (fire protection, livestock, domestic/non-commercial). There was also an earth dam on Fishhawk Creek that forms Fishhawk Lake. The dam was privately owned by Fishhawk Lake Recreation Club, Inc. and holds 982 acre feet of water for recreational purposes (Johnson and Maser 2000)

5.2 CONTIGUOUS PARCELS

5.2.1 Clatskanie

A small parcel of the project area is contained within the Clatskanie River watershed, a subwatershed of the Lower Columbia-Clatskanie basin. The Clatskanie parcel is located within the Wilark management basin, is a total of 4,596 acres, with 2,366 acres within the Nehalem watershed and 2,230 acres within the Clatskanie River watershed. The portion within the Clatskanie River watershed covers only 3.7 percent of this watershed by area and is located within the higher elevation headwaters. There is relatively little information specific to the Clatskanie parcel of the project area and as a result, the hydrology and water use assessment was mainly based on information available for the entire Clatskanie River watershed. The majority of the information provided within was based on information provided in the Rule (2001) and some additional analysis performed using available GIS information. General characteristics of the Lower Columbia-Clatskanie watershed and the Clatskanie River subwatershed are summarized in Table 5-10.

Table 5-10. Summary of the Lower Columbia-Clatskanie Subwatershed Characteristics.

Watershed	Area (mi^2)	Mean Elevation (ft)	Minimum Elevation (ft)	Maximum Elevation (ft)	Mean Annual Precipitation (inches)
Lower Columbia-Clatskanie	298.3	654	0	3,008	57.2
Clatskanie River subwatershed	94.9	925	9	2,081	60

5.2.1.1 Streamflow Characteristics

There are several unnamed streams and Oak Ranch Creek within the Clatskanie parcel. No streamflow information existed for any of the streams within the Clatskanie parcel and even very little streamflow information exists for the Oregon portion of the Lower Columbia-Clatskanie watershed. There were no active stream gages and very little historical gage data identified. The historical gage data are summarized in Table 5-11 and the data is provided in Table 5-12. Table 5-13 summarizes the frequency and magnitude of floods for the Clatskanie River. The frequency and magnitude of flood events were calculated in the Lower Columbia-Clatskanie Watershed Assessment and were based on models developed by USGS. The predicted flows from the model were then compared to data from historic stream gage records for verification.

Table 5-11. Summary of streamflow data for the lower Columbia-Clatskanie subwatershed.

Gage Name	Gage Number	Period of Record	Data
Clatskanie River near Clatskanie, OR	14247000	1950-1954	Annual Peak Flows
Fall Creek near Clatskanie, OR	14247020	1972-1983	Annual Peak Flows
Merrill Creek at Deer Island, OR	14222905	1972-1976	Annual Peak Flows

Table 5-12. Summary of historical peak flows on record for the lower Columbia-Clatskanie subwatershed.

Clatskanie River		Fall Creek		Merrill Creek	
Date	**Flow (cfs)**	**Year**	**Flow (cfs)**	**Year**	**Flow (cfs)**
1/22/1950	795	1972	40	1972	480
2/15/1950	1,110	1973	99	1973	330
2/24/1950	2,000	1974	98	1974	560
3/5/1950	725	1975	73	1975	340
11/17/1950	935	1976	113	1976	450
1/25/1951	750	1978	135		
3/15/1951	970	1979	51		
12/5/1951	1,460	1980	108		
2/1/1952	920	1981	104		
1/20/1953	948	1982	144		
12/6/1953	1,130	1983	114		
12/9/1953	1,840	1984	56		
1/5/1954	1,600				
2/13/1954	1,600				

Source: Lower Columbia-Clatskanie Watershed Assessment, 1997

Table 5-13. Frequency and magnitude of floods in the Clatskanie River.

Frequency	Magnitude (cfs)
100-year	7,349
50-year	6,586
25-year	5,868
10-year	4,830
2-year	2,884

Source: Lower Columbia-Clatskanie Watershed Assessment, 1997

5.2.1.2 Water Yield and Peak Flows

As described in the management basin section, peak flows are potentially influenced by land uses within the watershed. Land use practices within the Lower Columbia-Clatskanie subwatershed are summarized in Table 5-14. These types of land uses were evaluated to determine the potential impact on peak flows.

Overall, the Clatskanie River subwatershed has a low risk of peak-flow enhancement due to associated land uses. At the time of this report, agriculture was limited with in the subwatershed and would, thus, have a low risk of peak enhancement. The largest percentage of land use within the Clatskanie parcel was forestry. Enhancement of peak flows is most problematic for forestry land uses during rain-on-snow events. The Clatskanie River watershed had 45 percent of its timber area in the snow zone (>=1000 ft), and historic crown closure of around 70 percent. This calculates to approximately 33 percent of forested area in the rain-on-snow zone that has less than 30 percent canopy closure (Rule 2001). Based on these statistics and the rain-on-snow rules outlined by OWEB, there was a low potential for peak flow enhancement due to timber land uses. Likewise, forest and rural roads in the Clatskanie River watershed represented less than 4 percent of the forest and rural areas and was therefore a low potential risk for peak flow enhancement. It was assumed that the assessment of the Clatskanie River subwatershed was also directly applicable to the ODF Clatskanie land parcel.

Table 5-14. Summary of land uses within the Clatskanie River subwatershed.

Watershed Area (Acres)	Urban Area (Acres)	Industrial Area (Acres)	Rural Residential Area (Acres)	Percent of Area Occupied by Land Uses (%)
60,724	712.5	67.3	973.6	2.9%

5.2.1.3 Consumptive Water Uses

Consumptive uses on the Clatskanie parcel should not have an impact on peak or low flows since no ODF water rights were identified within this portion of the project area and only one water right was found. This water right (S40755) was for a domestic use of a maximum diversion of 0.005 cfs. The source of the water was from Dribble Creek, a tributary to the Clatskanie River and outside of the Clatskanie parcel. It was difficult to discern from available GIS data, but it was suspected that this water was used outside of the Clatskanie parcel.

There were a total of 53 water rights identified within the entire Clatskanie River subwatershed (Rule 2001); nine were classified as reservoir water rights while the remaining 44 were classified as surface water rights. The reservoir water rights permits were used for recreation, wildlife, fire protection, livestock, and aesthetics, while the surface water rights permits were used for domestic, power, fish, irrigation, industrial/manufacturing, municipal, livestock, and recreation. All reservoir and surface water rights within the Clatskanie River watershed were derived from surface water sources. A measure of the consumptive use within the Clatskanie River water availability basin, as a percent of the natural streamflow at the 50 percent exceedance level for the Clatskanie River is summarized in Table 5-15.

We were unable to determine if any illegal uses of water occurred within either the Clatskanie parcel or the entire Clatskanie River subwatershed.

Table 5-15. Summary of the Consumptive use in the Clatskanie River Water Availability Basin as a percent of the Natural Streamflow.

Month	Percent
January	0%
February	0%
March	0%
April	0%
May	1%
June	1%
July	3%
August	3%
September	3%
October	4%
November	1%
December	0%

5.2.1.4 Instream Water Rights and Low Flows

Water availability using the 50 percent exceedance level streamflows from OWRD data had been identified for the Clatskanie River watershed and is summarized in Table 5-16. Negative net water availability occurred in the Clatskanie River watershed in the months of July, October, and November. During these months especially, water uses in the basin would be expected to have an effect on low flow.

Table 5-16. Summary of Water Availability within the Clatskanie River.

Month	Water Availability (cfs)
January	180
February	169
March	68.3
April	25.3
May	32.3
June	8.7
July	-0.04
August	0.06
September	0.28
October	-61.1
November	-26.2
December	91.3

5.2.1.5 Water Withdrawals and Storage

If exercised fully, the 0.005 cfs water right within the Clatskanie parcel could reach a withdrawal of 118 million gallons per year. However, this water right was for domestic use and generally a significant portion of the water withdrawn for domestic uses will reenter the system. There was currently no water storage allowed in the Clatskanie parcel. There were however, nine reservoir permit types issued within the Clatskanie River watershed. Three of the reservoir permits were issued for recreation, two for wildlife, one for livestock, two for fire protection, and one for aesthetics.

5.2.2 Young’s Bay

Seven hundred forty-two acres of the Hamilton management basin were located within the Young's Bay watershed. The majority of this parcel was located within the South Fork Klaskanine River subwatershed and a small portion in the Upper Young's River subwatershed. Due to the lack of available data for this small portion of land, the hydrology and water use assessment for this area was based on information provided in the Young’s Bay Watershed Assessment (E&S Water Chemistry, Inc. and Young's Bay Watershed Council 2000) for the entire watershed.

The general characteristics of the Young's Bay watershed and the two subwatersheds of interest are described in Table 5-17. Similar to the Clatskanie and Nehalem watersheds, the hydrology of the Young's Bay watershed is dominated by rain events. The majority of high flows and storm events occur between October to May, and the low flows occur during the summer.

Table 5-17. Summary of Young's Bay parcel subwatershed characteristics.

Watershed	Area (mi^2)	Mean Elevation (ft)	Minimum Elevation (ft)	Maximum Elevation (ft)	Mean Annual Precipitation (inches)
Young's Bay	186	415	0	3290	98
Upper Young's River subwatershed	37	780	0	3280	122
S Fork Klaskanine River subwatershed	23	880	0	2740	117

Source: E&S Water Chemistry, Inc. and Young's Bay Watershed Council 2000

5.2.2.1 Streamflow Characteristics

There were only a few perennial and intermittent streams located within the Young's Bay parcel and no active gages were located within the entire Young's Bay watershed. Historical gages within the Young's Bay basin are summarized in Table 5-18.

The only gage with a substantial period of record (30 years) was on the Young's River located near Astoria, Oregon. The annual hydrograph for the Young's River near Astoria gage was shown in Figure 5-4. Discharge patterns for the Young's River near Astoria gage was used as representative of hydrograph patterns for the area of interest. However, since the Young's Bay parcel was located much higher in the basin and had a much smaller area, streamflow characteristics on the ODF Young's Bay parcel would be slightly different. Annual peak flow events for the Young's River ranged between 2,000 and 4,000 cfs and are shown in Figure 5-5. The largest flood event on record reached 4,750 cfs, at the Young's River near Astoria and occurred on February 10, 1946.

Table 5-18. Summary of gages within the Young's Bay watershed.

Station Number	Station Name	Period of Record	Drainage Area (mi^2)	Comments
14251500	Young's River near Astoria, OR	1927-1958	40	Mean Daily Flow
14252000	NF Klaskanine River near Olney, OR	1950-1955	14	Annual Peak Flows

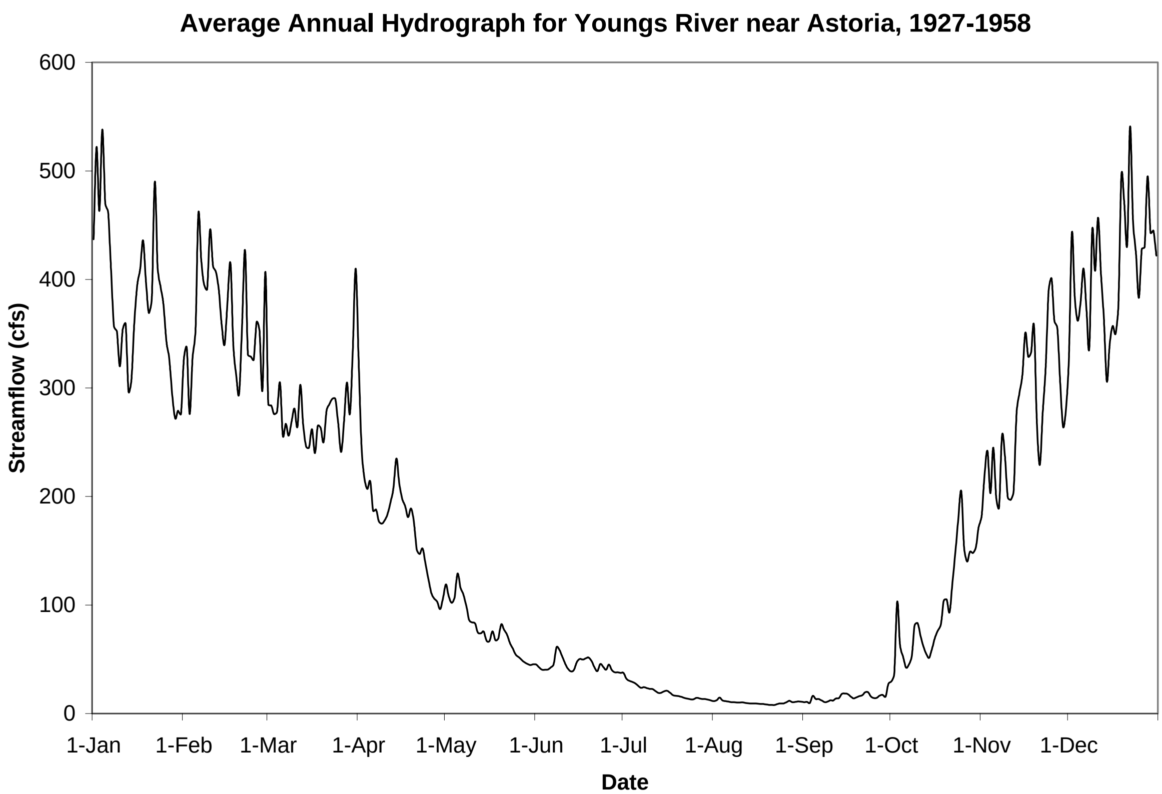


Figure 5-4. Annual Hydrograph for the Young's River near Astoria Gage.

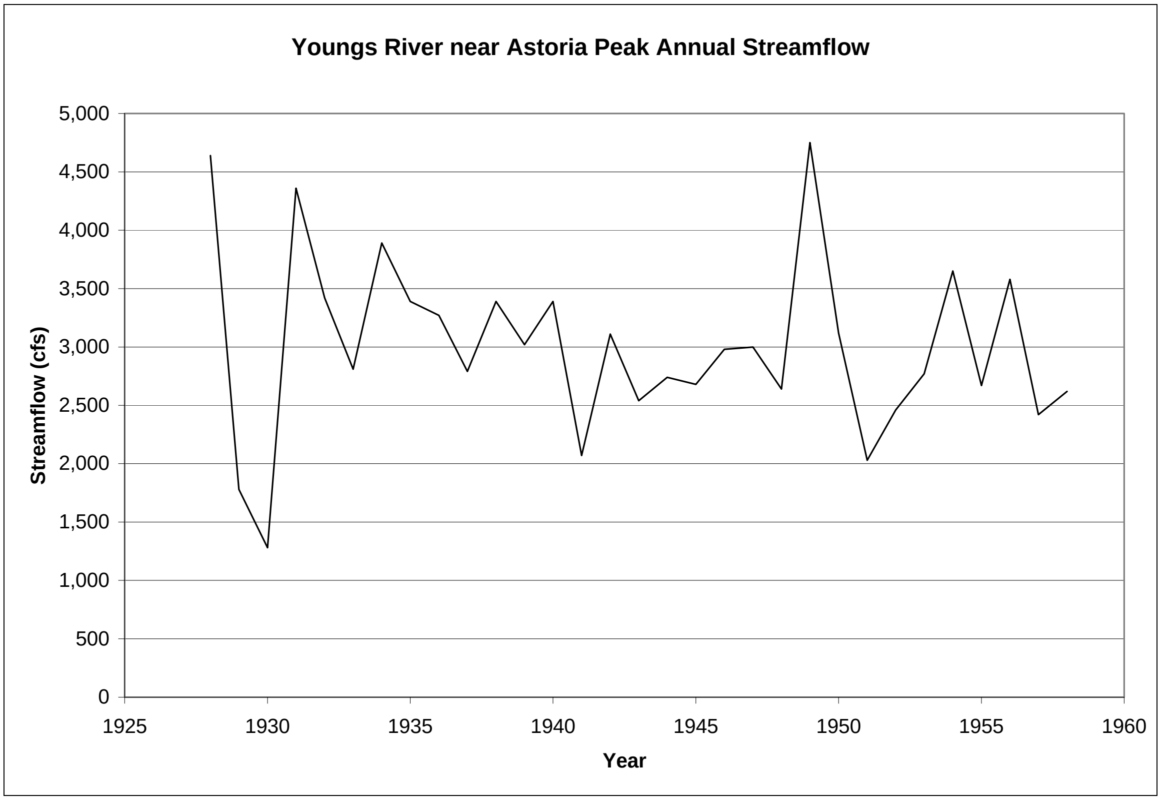


Figure 5-5. Young's River near Astoria Peak Annual Flows between 1927-1958

5.2.2.2 Water Yield and Peak Flows

There are four potential land use practices identified within the Young’s Bay watershed that can affect hydrology. These land uses include agriculture and rangeland, urban or rural residential development, forestry, and forest and rural roads. The practice of draining and diking of wetlands has had a large impact on the hydrology of the Young's Bay watershed. However, agricultural land use has been concentrated in the lower elevations of the Young's Bay watershed and has not occurred within the ODF Young’s Bay parcel. Urban and rural residential areas in the Young's Bay watershed were concentrated around the city of Astoria and also did not occur within the ODF Young’s Bay parcel. Rural road densities would have a moderate risk of peak flow enhancement in the South Fork Klaskanine River subwatershed with 4.1 percent of rural area in roads. There is a low risk of peak flow enhancement in the Upper Young's River subwatershed since only 1.6 percent of the rural area was road area.

The land use of interest within the ODF Young's Bay parcel is forestry. There was a low relative potential impact of timber harvesting on peak flow enhancement within the South Fork Klaskanine and Upper Young's River subwatersheds. The majority of timber related impacts were related to forest road construction. The percent forested area in roads in the South Fork Klaskanine River and Upper Young's River subwatersheds was 2.7 percent and 2.6 percent, respectively. Only watersheds with forest road areas greater than 4 percent would have a potential for increasing peak flows as a result of timber harvesting. It was assumed that the assessment of the South Fork Klaskanine and Upper Young's River subwatersheds are also directly applicable to the ODF Young's Bay land parcel. However, this assumption could not be verified without more detailed information specific to the parcel.

5.2.2.3 Consumptive Water Uses

Our review of existing consumptive uses within this portion of the project area indicated that these uses would not impact peak or low flows since there are no water rights located within the Young's Bay parcel.

The water rights located within the Upper Young's River and the South Fork Klaskanine River subwatersheds are summarized in Table 5-19. The South Fork Klaskanine River also had 16.7 cfs appropriated for a non-consumptive water use for a fish hatchery. This water right can only be exercised January through May and August and September and generally has reentered the stream quickly.

Table 5-19. Water Use and Storage in the South Fork Klaskanine and Young's River above Klaskanine River Water Availability Basins.

Watershed	Irrigation (cfs)	Municipal (cfs)	Domestic (cfs)	Fish/Wildlife (cfs)	Other (cfs)	Total (cfs)
SF Klaskanine River at Mouth	0.24	--	0.01	16.5	--	16.75
Young's River above Klaskanine River	--	27	2.01	--	2.02	31.03

5.2.2.4 Instream Water Rights and Low Flows

There was one instream water right identified for the South Fork Klaskanine River for anadromous and resident fish rearing, but this water right was not located within the ODF Young's Bay parcel.

OWRD has evaluated the impacts of consumptive uses on water availability that is summarized for the two subwatersheds of interest in Table 5-20. The dewatering potential was based on a 50 percent exceedance streamflow and was the percent of instream flows that are appropriated for consumptive use during the low flow months. This table shows a low dewatering potential for the South Fork Klaskanine River at the mouth, but a high potential for the Young's River above the Klaskanine River.

Table 5-20. Summary of dewatering potential in the South Fork Klaskanine and Young's River above Klaskanine Water Availability Basins.

	Dewatering Potential					Overall Dewatering Potential	
Water Availability Basin	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Average Percent Withdrawal**	**Potential**
SF Klaskanine River at Mouth	0.7	3.9	5.3	0.5	0.0	2.08	Low
Young's River above Klaskanine River	17.1	35.1	61.9	45.8	17.6	35.50	High

5.2.2.5 Water Withdrawals and Storage

There was only one storage water right identified within the South Fork Klaskanine and Young's River above Klaskanine subbasins. A water right for storage of 36,000 acre-feet was issued for the Young's River above Klaskanine River water availability basin. This storage water right was not located on the ODF Young's Bay parcel.

6. RIPARIAN/WETLANDS

This chapter consists of a remote assessment of riparian vegetation conditions along streams in the Upper Nehalem watershed. It also includes available information concerning the type, extent and location of wetlands and noxious weeds in the watershed. Within this assessment, vegetation information was compared between eleven management basins and two contiguous parcels falling within the Forest Grove and Astoria Districts of ODF. The water quality and fish habitat sections of this report (Chapters 9 and 10) discuss how resources may be influenced as a result of the current or future potential riparian conditions.

6.1 RIPARIAN ASSESSMENT

The purpose of the riparian assessment was to assess the current riparian situations in the watershed and determine how existing conditions compared to typical conditions present along various stream channel types for the ecoregions encompassing the watershed. From a starting point of the existing riparian stand conditions, ODF wished to forecast 50 to 100 years in the future and make an assessment of the potential feasibility of stands to provide reference riparian conditions in the future. An additional purpose was to organize the riparian areas in accordance with appropriate restoration/enhancement opportunities. The specific critical questions for the riparian assessment from the OWEB watershed assessment manual include the following:

1. *What are the current conditions of riparian areas in the watershed?*
2. *How do the current conditions compare to those potentially present or typically present for this ecoregion?*
3. *How can the current riparian areas be grouped within the watershed to increase the understanding of areas needing protection and the appropriate restoration or enhancement opportunities?*

ODF was interested in a little more detail than the standard OWEB approach. They requested the assessment address the following supplemental questions.

1. *What are the current riparian vegetation characteristics on state forest lands within the watershed?*
2. *What riparian areas currently have high, moderate, and low large wood input potential for key conifer pieces (>24-inch conifer)?*
3. *Which riparian areas will provide high large wood input potential for key conifer pieces under 50- and 100-year scenarios?*

6.1.1 Background

A watershed analysis was completed for the Nehalem watershed by Portland State University (PSU) in 2000 (Johnson and Maser 2000). This assessment performed an inventory of riparian conditions based on 1995 aerial photos. The inventory categorized the existing riparian conditions using width, continuity, and age along each reach as factors for determining whether the riparian area represented good, moderate or poor conditions as follows:

Good = mature and continuous

Moderate = mature and discontinuous, or young, narrow and continuous stands

Poor = young, narrow and discontinuous or absent vegetative stands

The existing conditions were subsequently used to determine the future potential for instream large wood as good, moderate or low contribution levels.

The PSU study determined the Upper Nehalem subwatershed (HUC #1710020201) had two reaches with poor riparian conditions; Weed Creek and South Fork Rock Creek. These reaches consisted of grass on both banks. A number of reaches supported narrow riparian buffers including East Fork Nehalem River, and Lower Rock, Beaver, Kist and Lousignont creeks. The balance of the Upper Nehalem typically supported continuous riparian buffers with young trees.

According to the PSU inventory approach there was a concentration of riparian buffer in poor condition in the Middle Nehalem subwatershed (HUC #1710020202) along Fishhawk and North Fork Fishhawk creeks. In addition, there were several small areas along tributaries of the mainstem Nehalem River in poor condition. The subwatershed generally consisted of young riparian trees typical of the entire watershed. Approximately 50 percent of the buffer strips were less than 30 feet wide and there were widespread interruptions and discontinuities in vegetation along the stream banks.

Existing instream levels of key piece-sized large wood in the Upper Nehalem were low (Kavanagh et al. 2005). Estimates of the future potential for recruiting large wood from riparian areas range from moderately high to low. The PSU inventory concluded poor and fair recruitment potential occurred along approximately 30 percent of the streams in both the Upper and Middle Nehalem subwatersheds. The Middle Nehalem basin consisted of a greater frequency of poor recruitment potentials compared to the Upper Nehalem basin (Johnson and Maser 2000).

The PSU approach representing good recruitment conditions included, among other categories, young and continuous, but narrow (>30 ft) riparian stands. As such, it may take many decades to achieve the potential recruitment levels of key piece-size wood from these stands.

The Nehalem River Watershed Assessment did not specifically address the OWEB critical questions, since the work was commissioned prior to completion of the OWEB protocols. As a consequence, this supplemental analysis addresses the aspects of the critical questions not previously covered.

The Upper Nehalem River Watershed Council (UNWC) subsequently developed detailed GIS coverage of existing riparian polygons of various condition codes based on species composition, average stand size (tree diameters) and relative level of density per the OWEB watershed manual guidelines (Watershed Professionals Network 1999) as shown below.

Riparian Species Composition

C = Conifer-dominated Stand (> 70% Conifer)
M= Mixed Stand (30 – 70% Conifer)
H = Hardwood Stand (<30% Conifer; > 70% Hardwood)

Relative Stand Size

Small = < 12" dbh
Medium = 12 – 24" dbh
Large = > 24" dbh

Relative Stand Density

Sparse = More than one-third of the ground is visible from aerial photos
Dense = Less than one third of the ground is visible from aerial photos

The existing photo-based inventory (UNWC, unpublished data) quantified current riparian conditions over 305 miles of ODF streams in the Nehalem watershed using 1995 aerial orthophotos. The results were electronically digitized into a GIS riparian data layer (UNWC, unpublished data).

6.1.2 Methods

6.1.2.1 Aerial Photo Interpretation

For this analysis, the existing UNWC GIS coverage was used as the base riparian layer for the watershed. The current riparian layer was projected onto a base map with 1:12,000 scale hydrography and the known fish-bearing streams. Aerial photo interpretation was performed on 1:12,000 scale using 2004 orthophotographs along areas extending 150 feet on either side of the centerline of fish-bearing channels not classified previously by UNWC. Locations of stream channels differed slightly between the original UNWC riparian GIS layer and the current 1:12,000 orthophotos, so photo interpreters used the channel location in the current orthophoto set to assess riparian area. A similar aerial photo assessment of the current riparian conditions occurred along streams identified as potentially prone to debris flows in Chapter 7: Sediment Sources. A new riparian data layer incorporating both the original UNWC polygons and the most recent photo assessment was created for this watershed analysis.

6.1.2.2 Field Verification

Riparian ground-truthing to confirm general riparian stand characteristics (i.e., stand composition, tree-size and density) as mapped on the existing riparian coverages or photo-based interpretation of additional stream segments occurred during March 2005. No attempt was made to verify the existing riparian polygon boundaries or conduct a detailed timber cruise, but stand characteristics and subplot data were collected from 19 locations in the watershed along various channel sizes and types. Survey sites for verification were selected based on the percent distribution of vegetative condition types in the watershed. Surveys were chosen for riparian stand codes comprising more than 10 percent of the stream mileage of fish-bearing streams in the basin. Vegetative condition types with high frequencies received correspondingly more field effort.

At each survey site, a lineal distance of approximately 20 times the bankfull channel width or 1,000 feet as measured with a laser range finder was assessed (Smith 1998). As a result of relatively small channel sizes, a typical survey length ranged between 400 and 800 feet. Within each survey reach, channel and riparian condition measurements and observations were recorded a minimum of four times at locations evenly distributed throughout the survey reach. Channel and riparian data were averaged for each reach. The channel measurements included (1) wetted width, (2) bankfull width and (3) valley width. Riparian measurements and observations included: (1) Angle and distance from mid-channel to the height of riparian vegetation providing shade; (2) inner riparian zone (RA1) width and composition (OWEB three-digit riparian condition code, see *Background*); (3) outer riparian zone (RA2) width and composition (OWEB three-digit riparian condition code, see *Background*) out to a distance of 150 feet on either side of the channel.

As a form of further verification, riparian tree species, density, diameters and heights were measured in a standard 30m x 30m (100 ft x 100 ft) sample plot. Plot surveys were based on

Riparian Stand Survey methods (Smith 1998). Plots were delineated using a compass and tape measure. Within the sample plot, the number of trees were enumerated by species and size class (4-8 in., 8-12 in., 12-16 in., 16-20 in., 20-24 in., 24-36 in.) using a standard diameter tape. A minimum of 5 trees of each species was measured to obtain an average tree height using a laser rangefinder when the visibility to tree crown allowed.

6.1.2.3 Assessment Procedures

Existing Stand Conditions

Riparian stands were categorized according to a three-digit alpha code identifying species composition, stand size and density according to the OWEB watershed assessment manual (Watershed Professionals Network 1999). The lineal distance of streams adjacent to various existing riparian polygons and the new photo-based interpretation was determined and summarized by HUC and management unit in the watershed. The existing stand characteristics were described for both an inner (disturbed; RA1) terrace zone and an outer riparian (more uniform, RA2) hillslope zone out to 100 feet from the channel. The existing stand characteristics were compared to the most likely vegetation condition found in these zones along channel habitat types in the eco-regions of the watershed (Table 6-1; adapted from the 1999 OWEB Manual). In developing the assessment protocol, OWEB assumed the vegetation likely to occur in a given riparian zone could be defined by the Channel Habitat type (CHT) and Ecoregion. A determination would be made whether or not the existing stands were consistent with potential riparian community composition based on site characteristics like soil types, moisture, elevation, aspect and natural disturbances. From a large wood recruitment perspective, if a stand was consistent with the historic site potential it would be assumed to offer riparian stand conditions for adequate large wood (key piece size) recruitment potential. The concept of maximum potential riparian stand characteristics was used to define the reference condition for this watershed analysis. However, wood recruitment to stream channels from these stands will occur at some point prior to achieving the reference condition for key piece size wood. Using the same three-digit riparian condition codes, the state of Washington in their guideline for conducting watershed analyses (WFPB 1997) suggest the following large wood recruitment potential:

Low Recruitment Potential

HSS, HSD, MSS, MSD, CSS, CSD, HMS, HLS

Moderate Recruitment Potential

HMD, MMS, CMS, HLD, MLS

High Recruitment Potential

CMD, MMD, MLD, CLD.

Table 6-1. Natural riparian conditions in the Upper Nehalem watershed according to ecoregions and channel types after Watershed Professionals Network 1999.

Ecoregion	Channel Confinement (code)	Riparian Area 1 Width (ft)	Riparian Area 1 Veg (code)	Riparian Area 2 Width (ft)	Riparian Area 2 Veg (code)
1 (d) Volcanics	C	0 - 25	HMD	25 - 100	CLD
	M	0 - 50	HMD	50 - 100	CLD
	U	0 - 75	HMD	75 - 100	CLD
1 (f) Willapa Hills	C	0 - 25	HMD	25 - 100	CLD
	M	0 - 50	HMD	50 - 100	CLD
	U	0 - 75	HMD	75 - 100	MLD

Riparian Area:
- RA1 = Inner riparian zone adjacent to streams along shallow terraces; often disturbed
- RA2 = Outer riparian zone along hillslopes adjacent to streams; often uniform growth

Confinement Codes:
- C = Confined
- M = Moderately Confined
- U = Unconfined

Riparian Vegetation Condition Codes:
- H = Hardwood
- C = Conifer
- M = Medium Stand Size
- L = Large Stand Size
- D = Dense Stand

Although short of the OWEB reference condition for the watershed, dense riparian stands of moderate-sized conifer and mixed species (CMD, MMD) should provide a high level of recruitable wood to the streams (WFPB 1997). For the Upper Nehalem Watershed Analysis, both (1) the OWEB reference condition concept for the inner and outer riparian zones according to channel habitat types and Ecoregions and (2) the WFPB potential wood recruitment situations were used to indicate possible trajectories to achieving the large wood recruitment reference conditions.

6.1.2.4 Forecasted Stand Conditions 50 to 100 Years in the Future

The existing riparian vegetation layer was used as the starting point to project conditions into the future under an assumption of no silvicultural riparian management. Each riparian condition code was qualitatively extrapolated to 50 years and 100 years assuming forest succession pathways typical of unmanaged growing conditions (WFPB 1997).

The future codes were assessed for: (1) potential large wood recruitment potential (using stand characteristics including species composition, mean stand diameter, and stand density) and (2) anticipated stream water temperatures using View-to-the-Sky (VTS) blocking angles represented by stand height and opacity (Water Quality Chapter 8). A determination was made whether or not the forecasted future stands were consistent with the potential riparian community composition for each CHT and Ecoregion.

6.1.3 Results

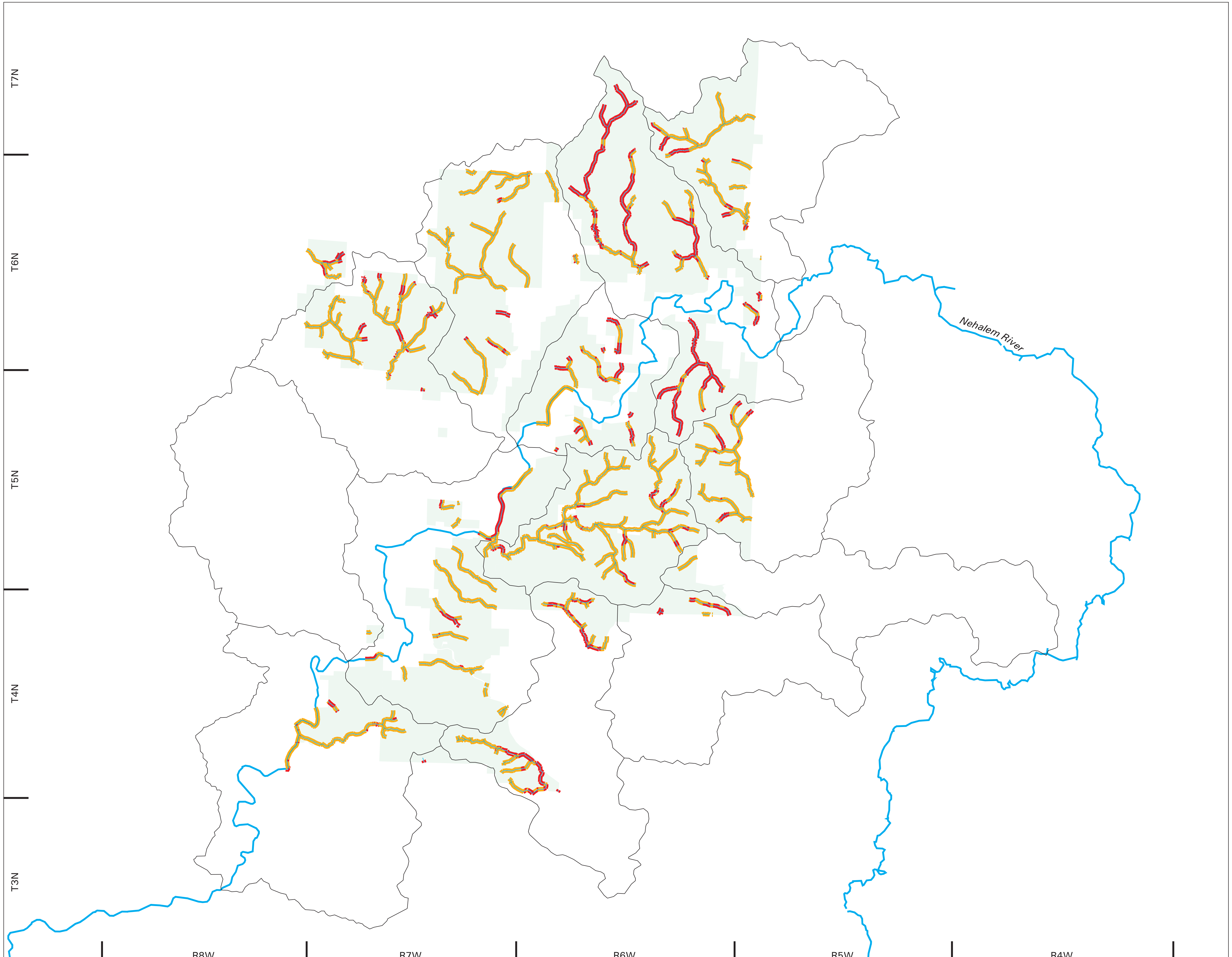
6.1.3.1 Existing Riparian Conditions.

Maps of the adequacy of the existing wood recruitment potential from stream adjacent stands are included as Figure 6-1a,b. The data are summarized by riparian stand characteristics for each of the ODF management basins within the upper Nehalem watershed in Table 6-2. Data are summarized by 6th field HUCs per Management Basin in Appendix B.

6.1.3.2 Field Verification

The results of the field verification occurring March 14-18, 2005 are provided in Appendix C including the overall reach assessment of stand characteristics as well as subplot measurements of individual trees, density in trees per acre (tpa), and measured diameters.

In general, the field verification along samples of small, medium and large channel sizes in the upper watershed indicated good agreement with riparian site conditions and the 1995 aerial photo assessment. The only exceptions were: (1) instances where tree growth in the riparian stand over the intervening 10-year period may have altered a call from a small diameter size class to an average overall medium size class, (2) where harvest since the 1995 photos may have reduced either the overall density or size class of the stand, (3) where a channel may have shifted or (4) stands considered dense as a result of closed canopies noted in the photo assessment may, in fact, have been sparse due to an underlying road. The instances where the field effort did not confirm the photo assessment were few (<10%). The watershed analysts were confident the original photo-based assessment was adequate to characterize the existing riparian conditions relative to their potential to contribute large wood to stream channels.



Legend

- Low Large Wood Recruitment Potential (Current)
- Moderate Large Wood Recruitment Potential (Current)
- Moderate/High Large Wood Recruitment Potential (Current)
- High Large Wood Recruitment Potential (Current)
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key

1 Inch = 2.7 Miles

0 2 Miles

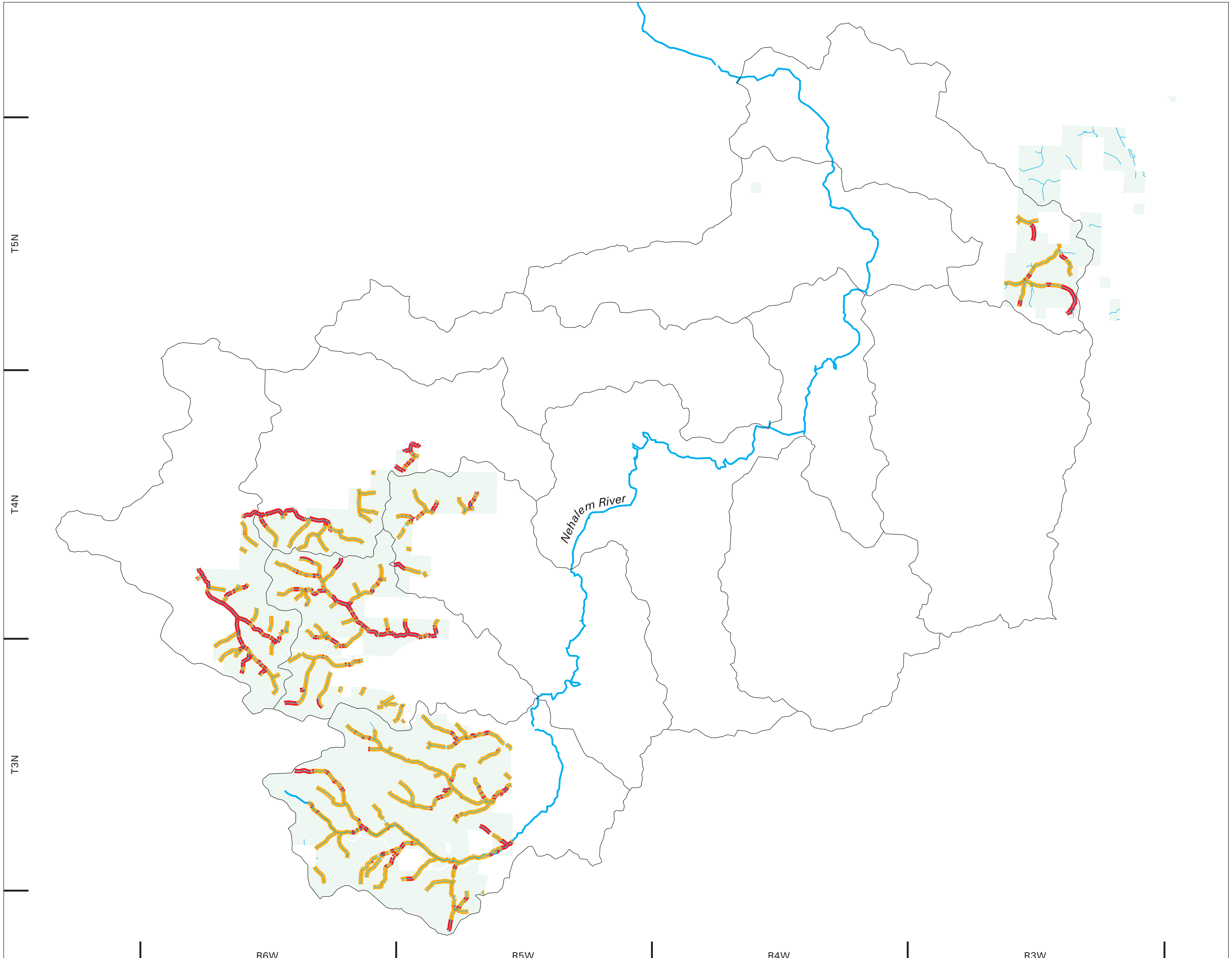
R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 6-1(a)

Current Large Wood Recruitment Potential

Astoria District



Legend

- Low Large Wood Recruitment Potential (Current)
- Moderate Large Wood Recruitment Potential (Current)
- Moderate/High Large Wood Recruitment Potential (Current)
- High Large Wood Recruitment Potential (Current)
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key

1 Inch = 2.3 Miles

0 2

Miles

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Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 6-1(b)

Current Large Wood Recruitment Potential

Forest Grove District

Table 6-2. Current riparian conditions and large wood recruitment potential adjacent to fish-bearing streams on ODF lands in various Management Basins.

						Forest Grove			Astoria								
Code[1/]	Recruitment Potential	Stream Length	ODF Lands	FG District	Astoria District	McGregor	Wheeler	Wilark	Beneke	Buster	Crawford	Fishhawk	Hamilton	Lousignot	Northrup	Quartz	Sager
		(ft)	(%)	(%)	(%)												
Water	L	0.3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	1%
Bareground	L	0.3	0%	0%	0%	0%	0%	0%	1%	0%	1%	0%	0%	0%	0%	0%	0%
Grass	L	1.4	1%	0%	1%	0%	0%	0%	1%	0%	0%	0%	0%	0%	1%	8%	0%
Shrub	L	3.5	1%	1%	1%	0%	2%	1%	1%	1%	0%	0%	0%	1%	1%	9%	0%
Road/RxR	L	0.1	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	1%	0%	0%	0%
CMD	H	64.9	27%	41%	19%	50%	36%	39%	3%	25%	2%	29%	3%	27%	8%	38%	27%
CMS	M	1.7	1%	2%	0%	3%	1%	2%	0%	0%	0%	2%	0%	0%	0%	0%	0%
CRD	L	9.5	4%	3%	4%	1%	2%	19%	0%	1%	20%	7%	2%	8%	2%	0%	17%
CRS	L	0.0	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
CSD	L	6.4	3%	0%	4%	0%	0%	5%	0%	1%	10%	1%	3%	18%	17%	0%	3%
CSS	L	1.0	0%	1%	0%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
HMD	M	38.7	16%	15%	17%	1%	24%	4%	39%	16%	2%	5%	39%	12%	6%	14%	2%
HMS	L	1.1	0%	0%	1%	0%	0%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%
HSD	L	24.9	10%	19%	6%	38%	8%	0%	0%	6%	3%	0%	3%	8%	11%	13%	8%
HSS	L	2.5	1%	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	5%	0%	10%
MMD	H	61.6	26%	12%	34%	4%	15%	24%	48%	40%	50%	45%	47%	11%	9%	17%	23%
MMS	M	5.2	2%	1%	3%	0%	1%	3%	4%	4%	2%	6%	0%	2%	8%	0%	0%
MSD	L	11.9	5%	4%	6%	1%	6%	1%	3%	2%	8%	2%	2%	9%	30%	1%	6%
MSS	L	2.6	1%	1%	1%	0%	1%	0%	0%	1%	0%	2%	2%	4%	1%	1%	2%
			100%	100%	100%	100%	99%	100%	100%	100%	99%	100%	100%	102%	99%	101%	99%
Distance (mi)			238.3	86.9	151.4	31.4	49.3	6.2	18.7	44.4	5.5	10.6	18.4	7.4	13.8	13.9	18.7
Percent (%)			100%	100%	100%	13%	21%	3%	8%	19%	2%	4%	8%	3%	6%	6%	8%

1) Three Digit Riparian Code (Species, Size, Density)

Riparian Species Composition

C = Conifer-dominated Stand (> 70% Conifer)
M = Mixed Stand (30 – 70% Conifer)
H = Hardwood Stand (<30% Conifer; > 70% Hrdwd)

Relative Stand Size

Regeneration = < 4" dbh
Small = 4 – 12" dbh
Medium = 12 – 24" dbh
Large = > 24" dbh

Relative Stand Density

Sparse = More than 1/3rd of the ground is visible from aerial photos
Dense = Less than 1/3rd of the ground is visible from aerial photos

6.1.3.3 Forecasted Stand Conditions 50 to 100 Years in the Future

The results for potential large wood recruitment are shown in a matrix of stand conditions along a trajectory of 50-yr increments in Table 6-3 and Figures 6-2a,b and 6-3a,b. The projection of future riparian stand conditions should be considered a coarse screen tool, given the broad range of conditions potentially occurring under each of the riparian condition codes and variations in site class condition across the landscape. The approach assumes a mean 100-yr site potential tree height equivalent to 150 feet (24-in. dbh) on average for conifer species and 99 feet (24-in. dbh) maximum for hardwood species in the upper Nehalem watershed. Although variability in site characteristics and disturbance regimes exists, these assumptions should prove accurate more times than not as a reference condition.

General Situations

Sparse Stands. In general, sparse stands need to develop either: (1) a closed coniferous canopy or (2) a second cohort underneath to develop into a dense stand capable of supporting a high recruitment potential rating over the 100-year time frame. For shade intolerant species like Douglas-fir, the canopy needs to be sufficiently open (RD <25) and understory conditions sufficient for seedling initiation to support ingrowth of a second cohort.

Except for conifer regeneration and small sparse stands (riparian condition codes: CRS/CSS), it is unlikely an existing sparse riparian stand can generate appropriate conditions for ingrowth of shade intolerant species. Current mature, but sparse stands, will likely grow without future ingrowth of a second cohort within 50 to 100 years. Some mixed stands could become conifer-dominated due to hardwood senescence but they will likely remain in an overall sparse condition.

Mixed Stands. In mixed stands, conifer trees are free to grow when they overtop the hardwood community. The overall stand heights between conifer and mixed stands are likely the same, but conifer density would likely be lower due to the low overall conifer abundance in mixed stands.

Inner Riparian Zones (RA1). Hardwood communities often dominate the riparian species composition on low terraces and areas of frequent flood or debris flow disturbance along stream channels. Red alder are the most prevalent disturbance species in the Upper Nehalem watershed. The OWEB manual suggests a typical species configuration for this zone is dense stands of moderate-sized hardwood species (HMD). The width of the RA1 zone varies in accordance with channel confinement from a narrow 25-feet strip along confined channel types upward to 75 feet along broad, unconfined floodplain type channels regardless of the designated Ecoregion in the watershed (Table 6-1). Growing conditions are not generally conducive to conifer establishment.

Table 6-3. Future Riparian Vegetation Conditions based on Forest Successional Pathways (after WFPB 1997).

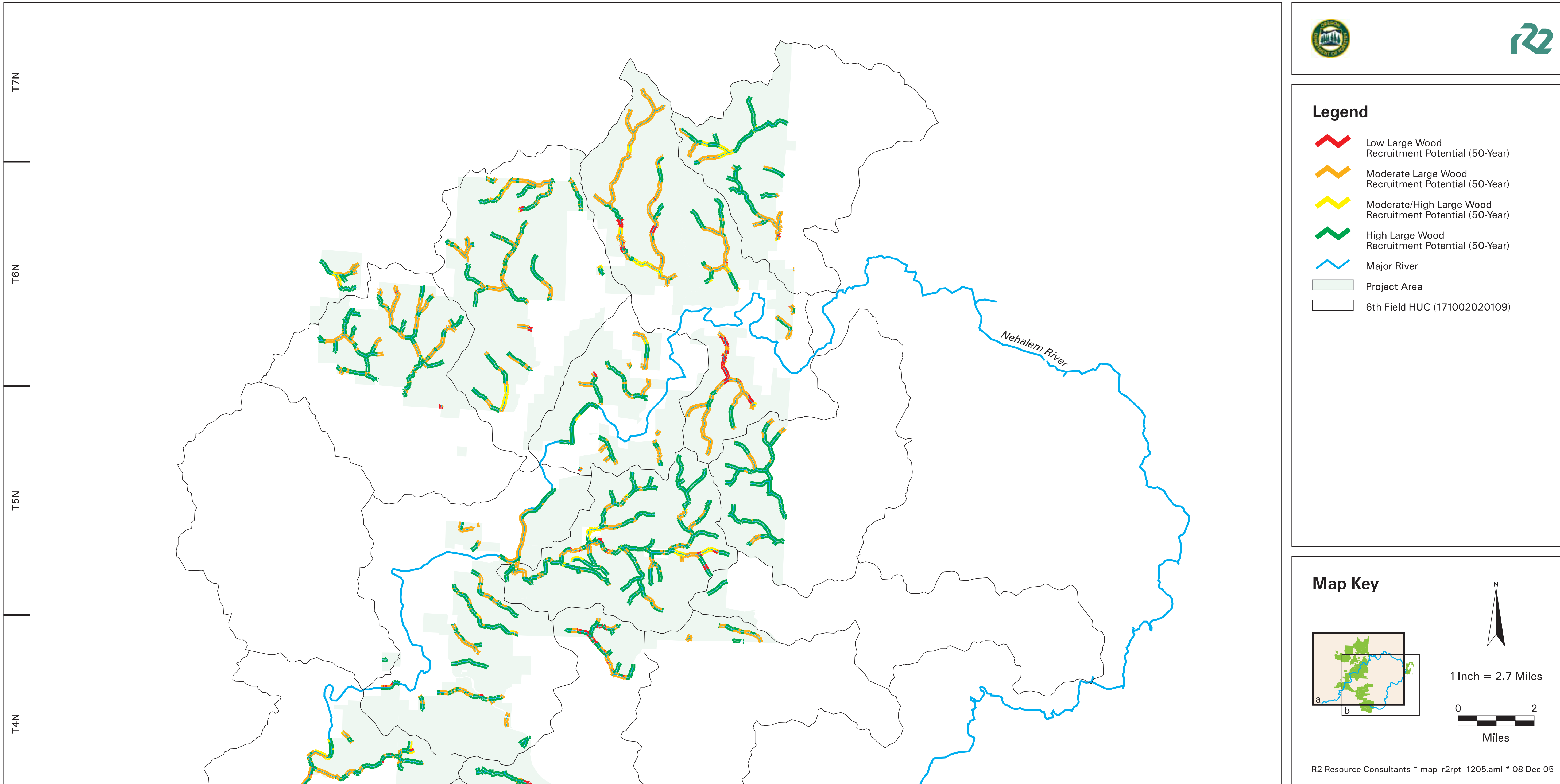
Riparian Characterization					
Code (Current)	**LW Cat.**	**Code 50 - Yr. (unmanaged)**	**LW Cat.**	**Code 100 - Yr. (unmanaged)**	**LW Cat.**
Water	L	Water	L	Water	L
Bare Ground	L	Bare Ground	L	Bare Ground	L
Grass	L	Grass	L	Forbs/STS	L
Shrub	L	Shrub	L	Shrub/STS	L
CRS	L	CMS/CMD	M	CLS/CLD	M/H
CRD	L	CMD	M	CLD	H
HSS	L	HMS	L	HMS/HLS	L
HSD	L	HMD	M	HMS/HLS	L
MSS	L	MMS/MMD	M	MLS/MLD	M/H
MSD	L	MMD	M	MLD/CLD	H
CSS	L	CMS/CMD	M	CLS/CLD	M/H
CSD	L	CMD	M	CLD	H
HMS	L	HLS/HMS	L	HLS/HMS	L
HLS	L	HLS	L	Shrub	L
HMD	M	HLD	M	HLS	L
MMS	M	MLS/MLD	M/H	MLS/CLS/MLD/CLD	M/H
CMS	M	CLS/CLD	M/H	CLS/CLD	M/H
CLS	M	CLS	M	CLD/STS	H
HLD	M	HLS	L	Shrub	L
MLS	M	MLS/CLS	M	CLS/STS	M/H
CMD	M	CLD	H	CLD	H
MMD	M	MLD/CLD	H	CLD	H
MLD	H	MLD/CLD	H	CLD	H
CLD	H	CLD	H	CLD	H

Species Composition
- STS = Shade Tolerant Species
- C = Conifer (>70% Conifer)
- M = Mixed (30 - 70% Conifer)
- H = Hardwood (>70% Hardwood)

Average Stand Size
- R = Regeneration(mean dbh < 4 “)
- S = Small (mean dbh 4 – 12")
- M = Medium (mean dbh 12 - 24")
- L = Large (mean dbh >24")

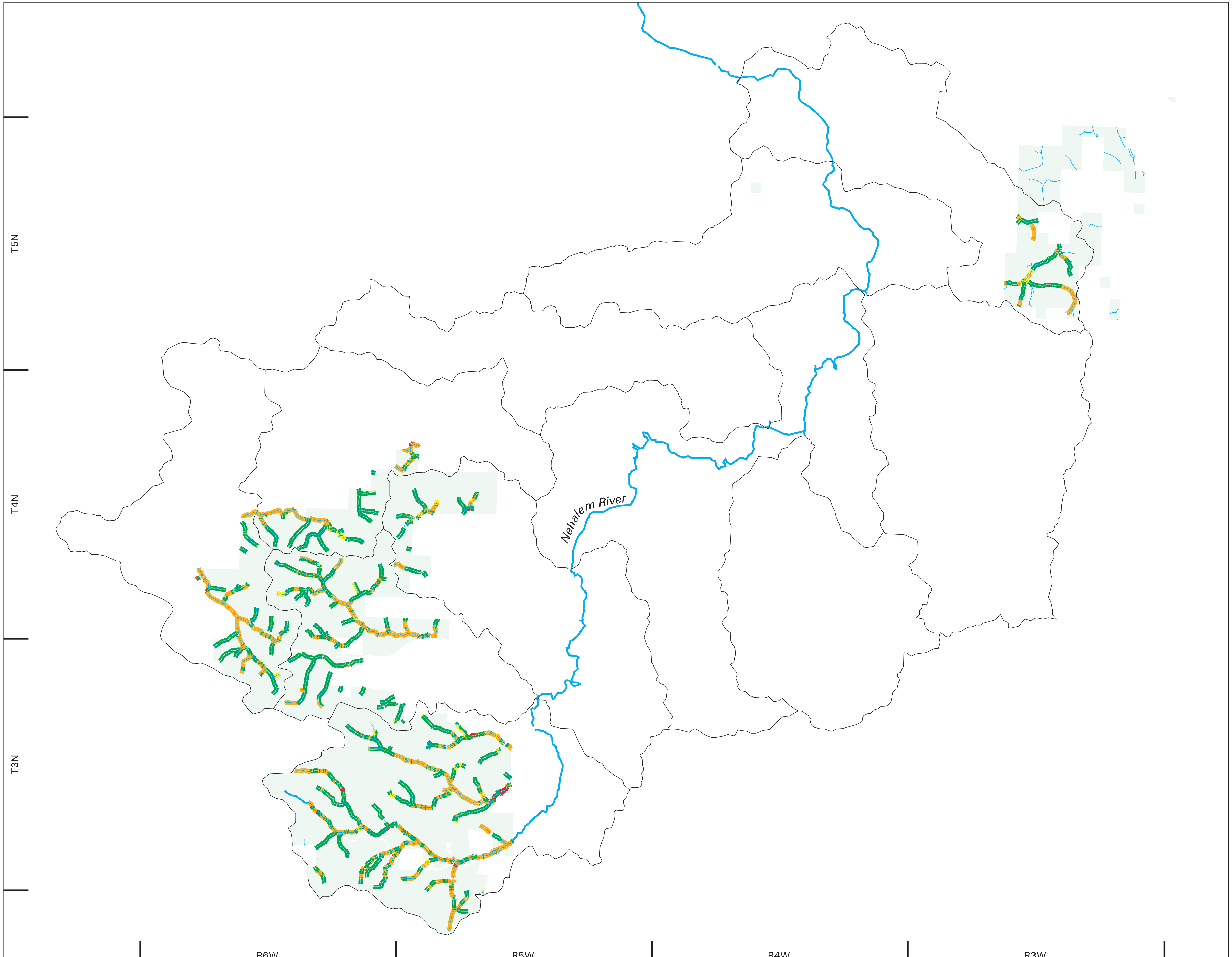
Stand Density
- S = Sparse (more than one-third of the ground visible on aerial photos)
- D = Dense (less than one-third of the ground visible on aerial photos)

LW Cat. = Large Wood Recruitment Potential Category
[H=high; M=moderate; L=low] for Key Pieces (> 24” dbh)



Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 6-2(a)
50-Year Large Wood Recruitment Potential
Astoria District



Legend

- Low Large Wood Recruitment Potential (50-Year)
- Moderate Large Wood Recruitment Potential (50-Year)
- Moderate/High Large Wood Recruitment Potential (50-Year)
- High Large Wood Recruitment Potential (50-Year)
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key

a
b

1 Inch = 2.3 Miles

0 2

Miles

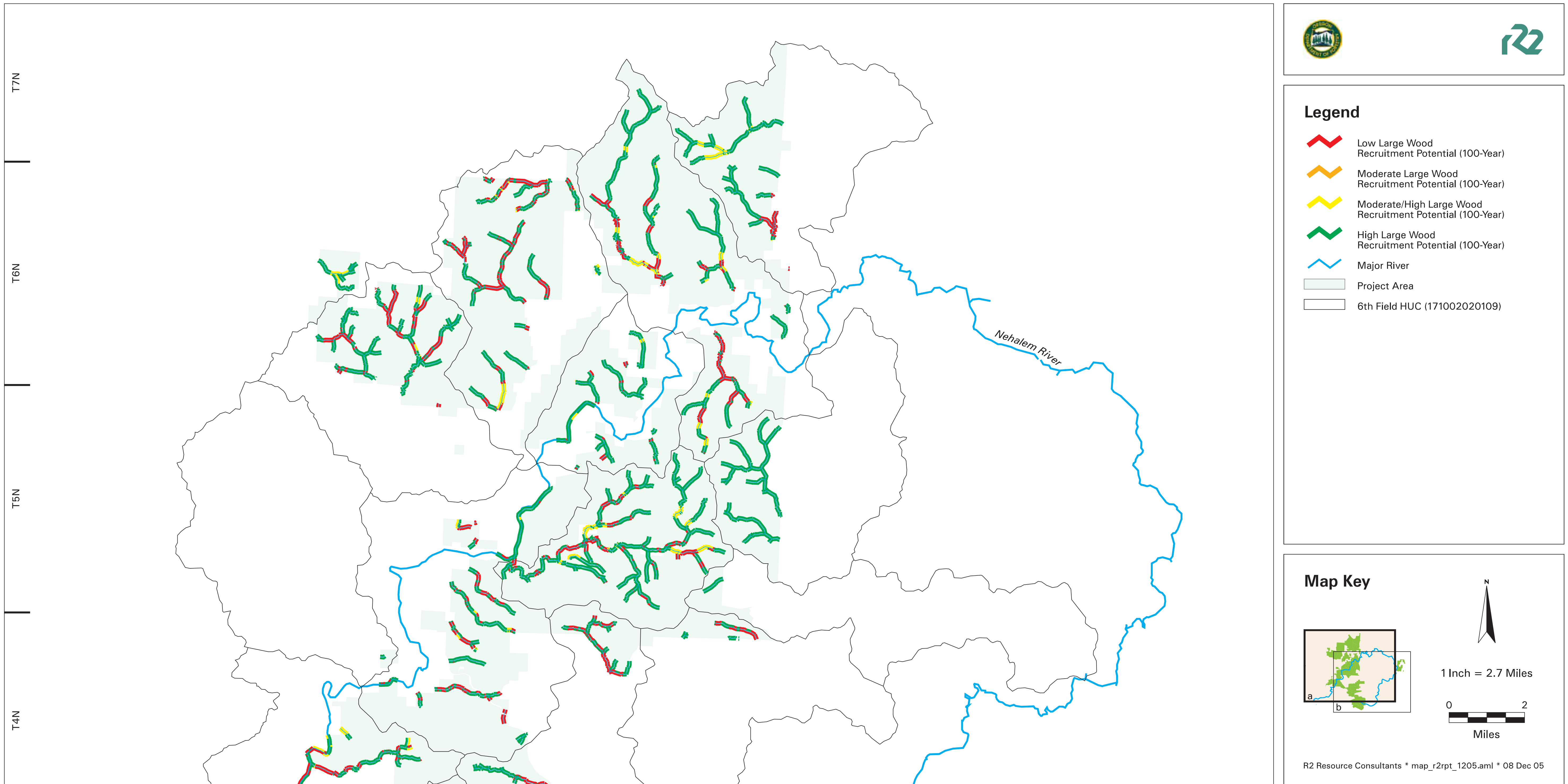
R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 6-2(b)

50-Year Large Wood Recruitment Potential

Forest Grove District

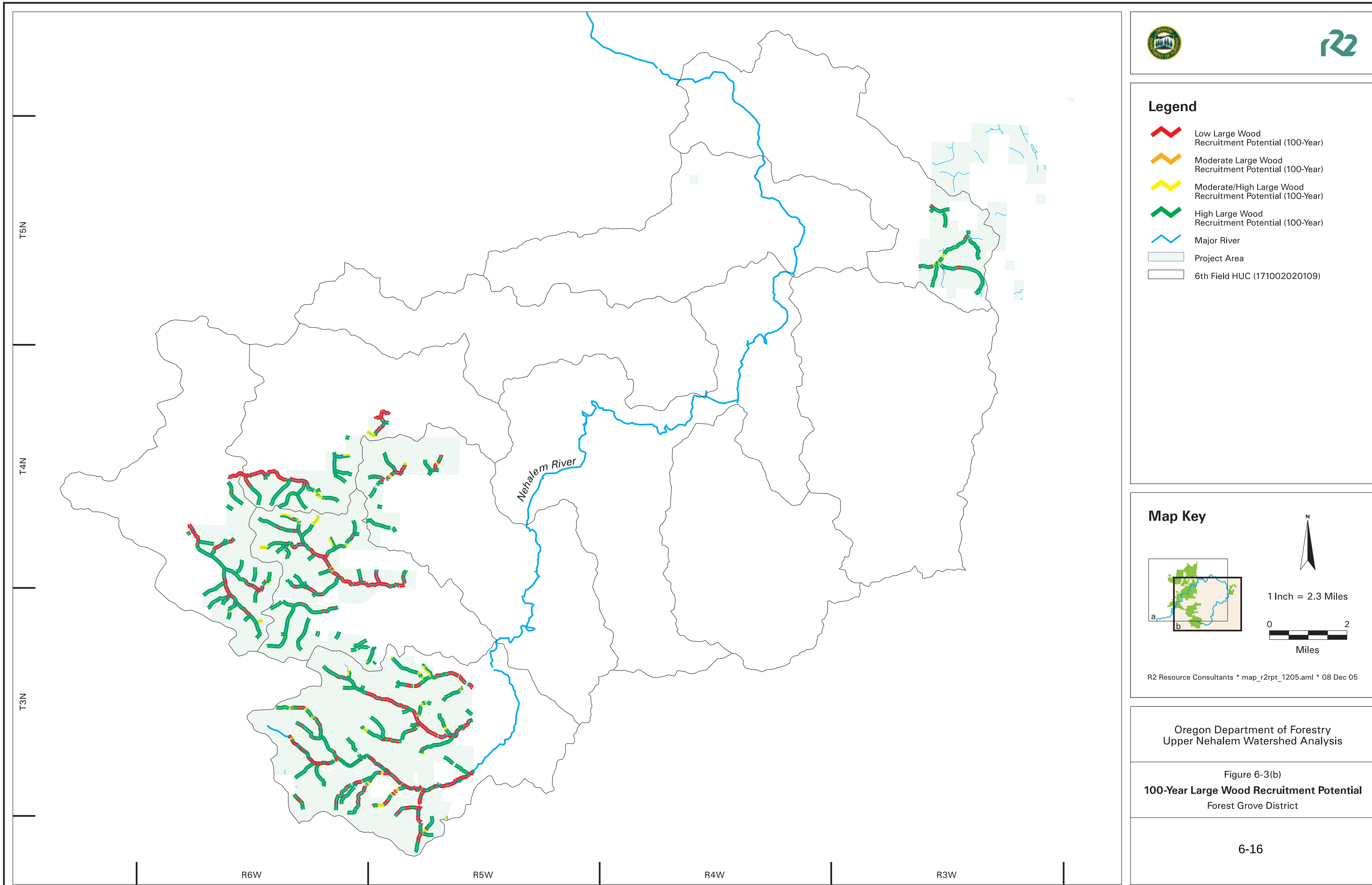


Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 6-3(a)

100-Year Large Wood Recruitment Potential

Astoria District



Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 6-3(b)

100-Year Large Wood Recruitment Potential

Forest Grove District

and these zones are not predicted to support conifer in the future. Repeated disturbances in this zone may keep the hardwood species in an early successional state. Without such disturbances, the hardwood species could mature and given their relatively short longevity could succeed to shrub-dominated vegetation communities in these zones. The natural disturbance regimes however are typically more frequent than the 100-year life cycle of some hardwood tree species

Outer Riparian Zones (RA2). Conifer or mixed species compositions typically dominate the riparian hillslope areas alongside streams where the soils are better drained than the low lying terraces. The OWEB manual suggests the typical species configuration for this zone are dense stands of large-sized conifer and mixed hardwood:conifer species (MLD, CLD). For the purposes of this assessment, the RA2 zone lies adjacent and upslope of the RA1 zone out to a distance of 100 feet on either side of the streams. The width of the RA2 zone subsequently varies in accordance with channel confinement and the width of the RA1 zone. The widest outer riparian areas are found along the confined channel types (Table 6-1).

Specific Situations

Specific assumptions and forecasts for each of the vegetation categories are summarized in this section.

Initial riparian stand conditions providing existing low large wood recruitment potential.

Water: For this analysis it is assumed a water body will not change in 100 years and the potential wood recruitment from this class would remain low throughout the entire period.

Bare Ground: This assessment assumed bare ground meant hard rock or other soil types incapable of growing a forest stand. As such, potential wood recruitment would remain low throughout the entire 100-year time period.

Grass: Grass as ground cover was assumed to preclude tree establishment; except for shade tolerant species (STS) that might initially develop in 100 years. These tree species would not be of sufficient size to contribute large wood in the 100-year time frame.

Shrubs: Shrubs were assumed to preclude tree establishment; except for STS that might initially develop in 100 years. Shrubs and developing STS tree species would not be of sufficient size to contribute large wood in the 100-year time frame.

Conifer Regeneration Sparse (CRS): This assessment assumed sparse conifer regeneration would add crown closure and could develop appropriate stand sizes and densities to offer a moderate and high large wood recruitment potential in 50 to 100 years, respectively. Depending upon the initial density, it is also possible stand conditions would remain sparse leaving the recruitment potential of large wood in the moderate category within 100-year time frame.

Conifer Regeneration Dense (CRD): It was assumed dense conifer regeneration would add crown closure, thin by stand suppression and develop appropriate stand densities in 100 years to offer high large wood recruitment potential.

Hardwood Small Sparse (HSS): Young hardwood stands (<12 in dbh) as a starting point were assumed to grow in excess of 12 in dbh in 50 years with an occasional large hardwood remaining in the stand at 100 years. However, the stand would not likely regenerate a second cohort so the density should remain sparse. Hardwood canopy and shrub understory was anticipated to preclude conifer regeneration. The large wood recruitment potential under this successional pathway will remain low throughout the 100-year time frame.

Hardwood Small Dense (HSD): This assessment assumed dense, young hardwood stands (<12 in dbh) would grow in excess of 12 in dbh in 50 years with an occasional large hardwood remaining in the stand at 100 years due to a short life span. The stand would not likely regenerate a second cohort, so the density at 100 years will become sparse. Hardwood canopy and shrub understory was anticipated to preclude conifer regeneration. Red alder would probably not mature to a large (> 24" dbh) category, but black cottonwood and broad leaf maple have the potential to exceed 24 inches in 100 years. The large wood recruitment potential under this successional pathway increases slightly to a moderate category in 50 years but deteriorates to low at 100 years due to hardwood senescence.

Mixed Small Sparse (MSS): Mixed sparse stands would likely grow from small to medium to large trees in 50 to 100 years, respectively. However, they would not likely develop a second cohort. Stands with sufficient numbers of conifers may become "dense" and could offer a moderate and high potential for large wood recruitment in 50 or 100 years, respectively. Depending upon the initial density, it is also possible stand conditions would remain sparse leaving the recruitment potential of large wood in the moderate category within 100-year time frame.

Mixed Small Dense (MSD): Mixed, dense stands were anticipated to grow from small to medium to large trees in 50 to 100 years, respectively. The hardwood component would begin to decrease in 100 years such that conifer might begin to dominate the stand composition. Ingrowth of a second cohort would likely include only STS. The stand conditions should offer a moderate level of large wood recruitment potential within 50 years and a high potential within the 100-year term.

Conifer Small Sparse (CSS): Depending upon the initial density, young, sparse conifer stands have the capacity to provide canopy closure and to mature into either dense or sparse stands for a moderate level of large wood recruitment potential in 50 and 100 years. It is also possible the dense stand conditions could offer a high degree of large wood recruitment potential in 100 years.

Conifer Small Dense (CSD): This assessment assumed young, dense conifer stands (4 - 12 dbh) would likely grow to greater then 12 in. dbh in 50 years and greater than 24 in. dbh in 100 years in unmanaged conditions, without a significant loss of overstory density. These conditions should offer a high level or wood recruitment potential for key pieces within 100 years.

Hardwood Medium Sparse (HMS): It was assumed medium-sized hardwood stands (12 - 24 in. dbh), as a starting point, would approach 24 in. dbh in 50 years with an occasional large hardwood remaining in the stand at 100 years. However, the stand would not likely regenerate a second cohort, so the density should remain sparse. Hardwood canopy and shrub understory was anticipated to preclude conifer regeneration. Red alder would probably not mature to the large (> 24 in. dbh) category, but black cottonwood and broad leaf maple have the potential to exceed 24 inches in diameter. As a result of sparse stand conditions, the recruitment potential would remain low for the duration of the 100-year time period.

Hardwood Large Sparse (HLS): Large-sized hardwood stands (>24 in. dbh), as a starting point, were anticipated to deteriorate with an occasional large hardwood remaining in the stand in 50 years and only shrubs at 100 years (WFPB 1997). The stand was not projected to regenerate a second cohort so the density remains sparse to none. Hardwood canopy and shrub understory was anticipated to preclude conifer regeneration. As a result of sparse stand conditions, the recruitment potential would remain low for the duration of the 100-year time period and beyond without either a stand disturbance event or silvicultural manipulation.

Initial riparian stand conditions providing existing moderate large wood recruitment potential.

Hardwood Medium Dense (HMD): Medium-sized hardwood stands (>12 in. dbh), as a starting point, likely would approach 24 in dbh in 50 years with an occasional large hardwood remaining in the stand at 100 years. The stand would likely remain dense for the first 50 years retaining its moderate large wood recruitment potential. However, due to hardwood senescence, tree densities should thin considerably in the subsequent 50-year period. Unmanaged, these hardwood stands are not anticipated to regenerate a second cohort so the density would remain sparse. Hardwood canopy and shrub understory was anticipated to preclude conifer regeneration. As a result of sparse stand conditions, the recruitment would deteriorate to a low potential at the 100-year time period and beyond without ongoing stand disturbances or silvicultural manipulation.

Mixed Medium Sparse (MMS): This assessment assumed medium-sized, sparse, mixed composition stands would grow medium to large trees in 50 years. It was anticipated the hardwood component would begin to decrease in 100 years such that conifer might dominate the stand composition. Ingrowth of STS as a second cohort would not likely contribute to the large wood potential until 150 to 200 years in the future. Stands at the upper limit of "sparse" may achieve "dense" conditions by 50 or 100 years offering this starting stand condition a number of different successional pathways. It is likely future stands would retain the moderate large wood recruitment potential and it is possible some combinations could provide a high level of recruitment as early as 50 years in the future.

Conifer Medium Sparse (CMS): Medium-sized, sparse, conifer stands would likely grow large trees in 50 years. Stands near the upper limit of the "sparse" category may reach "dense" stands by 50 or 100 years offering a high level of wood recruitment potential. Since, ingrowth of STS as a second cohort would not contribute to large wood potential until 150 years in the future, sparse stands near the lower limit of the category would retain a moderate wood recruitment potential during the 100-year term of this assessment.

Hardwood Large Dense (HLD): Large-sized hardwood stands (>24 in. dbh), as a starting point, would deteriorate with an occasional large hardwood remaining in the stand in 50 years and only shrubs at 100 years (WFPB 1997). The stand was not projected to regenerate a second cohort, so tree density should decrease over time. Hardwood canopy and shrub understory was anticipated to preclude conifer regeneration. The initial moderate large wood recruitment potential was anticipate to deteriorate to a low category by year 50 and remain low for the balance of the assessment period.

Mixed Large Sparse (MLS): Mixed, sparse stands greater than 24 inches dbh would remain large in size over the next 50 to 100 years. The hardwood component would likely deteriorate, giving way to a conifer dominated stand in 100 years, but conifers would not be able to reach "dense" level unless a second cohort of shade tolerant conifer species grows to sufficient size to contribute large wood in 100 years. The wood recruitment potential rating would likely remain moderate for the next 100 years. If an understory of STS develops, the recruitment rating could increase to a high potential in 100 years.

Mixed Medium Dense (MMD): Medium-sized, dense, mixed stands were assumed to grow large trees in 50 years. The hardwood should begin to decrease in 50 to 100 years, such that conifer dominate the stand composition. Ingrowth, with only STS as a second cohort, would not contribute to large wood potential until 150 to 200 years in the future. The large wood recruitment potential should remain high throughout the 100-year assessment period.

Conifer Medium Dense (CMD): This assessment assumes medium-sized, dense, conifer stands would grow from medium to large trees in 50 years and the stand would continue to offer large, dense conditions at 100 years. Ingrowth of STS as a second cohort would not likely contribute to the large wood recruitment potential until 150 years in the future. These conditions should maintain the high recruitment potential rating for the duration of the assessment period.

Initial riparian stand conditions providing existing high large wood recruitment potential:

Mixed Large Dense (MLD): Large-sized, dense, mixed stands were anticipated to retain their size in 100 years. The hardwood component would likely decrease in 50-100 years such that conifer dominate the stand composition. Ingrowth, with only STS as a second cohort, would not contribute to large wood potential until 150 to 200 years in the future. The large wood recruitment potential should remain high throughout the 100-year assessment period.

Conifer Large Dense (CLD): This assessment assumed large-sized, dense, conifer stands would retain their composition, size and density over the next 100 years. Ingrowth of STS, if any, as a second cohort may begin to contribute to the large wood recruitment potential in 100 years. The potential wood recruitment rating should remain high for the duration of the assessment period.

6.1.4 Discussion

6.1.4.1 Summary of Existing Riparian Conditions by Management Unit

Astoria District

Fishhawk Management Basin. The existing riparian situation in Fishhawk basin with respect to large wood recruitment was determined to be favorable. Nearly 73 percent of the streams in the management basin currently provide a high level of potential wood recruitment with an additional 14 percent in the moderate recruitment category. Approximately, 5 percent of the RA1 zone (0.6 stream miles) was currently in the reference condition, while none of the RA2 zone falls within its maximum potential. All of the current 13 percent of the stream length in low recruitment categories showed the potential to achieve moderate and high recruitment levels in 50 years. According to the vegetation succession model, the influence of natural hardwood stand thinning due to senescence in 100 years on the large wood recruitment potential is minor in this management basin. It was anticipated that 5 percent of the fish-bearing stream network (0.6 miles) would lie within the low recruitment category in 100 years.

Northrup Management Basin. Riparian conditions in the Northrup basin are currently in a relatively poor state with respect to potential wood recruitment. Only 6 percent of the RA1 zone (0.9 stream miles) complied with the reference condition and only 17 percent of the fish-bearing stream length offered high wood recruitment potential. Nearly 68 percent of the fish-bearing stream length falls within the low recruitment category. Approximately 90 percent of the low situations are predicted to achieve moderate and high recruitment levels in 50 years. According to the vegetation succession model, the influence of natural hardwood stand thinning due to senescence in 100 years on the large wood recruitment potential is substantial in this management basin. It is anticipated 24 percent of the fish-bearing stream network (3.3 miles) would lie within the low recruitment category in 100 years. Nevertheless, the predicted level of sparse stands remains consistent with the distribution of young age class stands under historic reference conditions (Benda and Dunne 1997).

Beneke Management Basin. Riparian conditions on ODF lands adjacent to fish-bearing streams in the Beneke basin offered 51, 43, and 6 percent of the stream mileage in high, moderate and low wood recruitment categories, respectively. Approximately 39 percent of the RA1 zone (7.8 stream miles) complied with the reference HMD condition, while none of the RA2 zone was mature enough to meet the OWEB reference condition. Half of the low recruitment situations should develop moderate and high recruitment levels in 50 years. According to the vegetation succession model, the influence of natural hardwood stand thinning due to senescence in 100 years on the large wood recruitment potential is considerable in this management basin. It is anticipated 42 percent of the fish-bearing stream network (7.8 miles) would lie within the low recruitment category in 100 years. The level of sparse stands is inconsistent with the distribution of young age class stands under historic reference conditions (Benda and Dunne 1997) and stand manipulation to achieve desired riparian conditions should be considered.

Lousignot Management Basin. Riparian conditions on ODF lands adjacent to fish-bearing streams in the Lousignot basin offered 38, 14, and 51 percent of the stream mileage in high, moderate and low wood recruitment categories, respectively. Approximately 13 percent of the RA1 zone (0.9 stream miles) complied with the reference HMD condition, while none of the RA2 zone was mature enough to meet the OWEB reference condition. Approximately 98 percent of the low recruitment situations should develop moderate and high recruitment levels in 50 years, respectively. According to the vegetation succession model, the influence of natural hardwood stand thinning due to senescence in 100 years on the large wood recruitment potential is substantial in this management basin. It is anticipated 24 percent of the fish-bearing stream network (1.7 miles) would lie within the low recruitment category in 100 years. Nevertheless, the predicted level of sparse stands remains consistent with the distribution of young age class stands under historic reference conditions (Benda and Dunne 1997).

Hamilton Management Basin. Riparian conditions on ODF lands adjacent to fish-bearing streams in the Hamilton basin offered 50, 39, and 11 percent of the stream mileage in high, moderate and low wood recruitment categories, respectively. Approximately 39 percent of the RA1 zone (7.2 stream miles) complied with the reference HMD condition, while none of the RA2 zone was mature enough to meet the OWEB reference condition. All of the low recruitment situations should develop moderate and high recruitment levels in 50 years. According to the vegetation succession model, the influence of natural hardwood stand thinning due to senescence in 100 years on the large wood recruitment potential is considerable in this management basin. It is anticipated 42 percent of the fish-bearing stream network (7.8 miles) would lie within the low recruitment category in 100 years. The level of sparse stands is inconsistent with the distribution of young age class stands under historic reference conditions (Benda and Dunne 1997) and stand manipulation to achieve desired riparian conditions should be considered.

Crawford Management Basin. Riparian conditions on ODF lands adjacent to fish-bearing streams in the Crawford basin offered 52, 4, and 43 percent of the stream mileage in high, moderate and low wood recruitment categories, respectively. Approximately 2 percent of the RA1 zone (0.1 stream miles) complied with the reference HMD condition, while none of the RA2 zone was mature enough to meet the OWEB reference condition. Ninety eight percent of the low recruitment situations should develop moderate and high recruitment levels in 50 years. According to the vegetation succession model, the influence of natural hardwood stand thinning due to senescence in 100 years on the large wood recruitment potential is minor in this management basin. It was anticipated that 6 percent of the fish-bearing stream network (0.3 miles) would lie within the low recruitment category in 100 years.

Sager Management Basin. Riparian conditions on ODF lands adjacent to fish-bearing streams in the Sager basin offered 50, 2, and 47 percent of the stream mileage in high, moderate and low wood recruitment categories, respectively. Approximately 2 percent of the RA1 zone (0.4 stream miles) complied with the reference HMD condition, while none of the RA2 zone was mature enough to meet the OWEB reference condition. More than three-fourths of the low recruitment situations should develop moderate and high recruitment levels in 50 years. According to the vegetation succession model, the influence of natural hardwood stand thinning due to senescence in 100 years on the large wood recruitment potential is substantial in this management basin. It is anticipated 21 percent of the fish-bearing stream network (3.9 miles) would lie within the low recruitment category in 100 years. Nevertheless, the predicted level of sparse stands remains consistent with the distribution of young age class stands under historic reference conditions (Benda and Dunne 1997).

Buster Management Basin. Riparian conditions on ODF lands adjacent to fish-bearing streams in the Buster basin offered 65, 19, and 16 percent of the stream mileage in high, moderate and low wood recruitment categories, respectively. Approximately 16 percent of the RA1 zone (7.0 stream miles) complied with the reference HMD condition, while none of the RA2 zone was mature enough to meet the OWEB reference condition. Seventy five percent of the current low recruitment situations should develop moderate and high recruitment levels in 50 years. According to the vegetation succession model, the influence of natural hardwood stand thinning due to senescence in 100 years on the large wood recruitment potential is substantial in this management basin. It is anticipated 25 percent of the fish-bearing stream network (11.2 miles) would lie within the low recruitment category in 100 years. Nevertheless, the predicted level of sparse stands remains consistent with the distribution of young age class stands under historic reference conditions (Benda and Dunne 1997).

Quartz Management Basin. Riparian conditions on ODF lands adjacent to fish-bearing streams in the Quartz basin offer 55, 14, and 32 percent of the stream mileage in high, moderate and low wood recruitment categories, respectively. Approximately 14 percent of the RA1 zone (2.0 stream miles) complied with the reference HMD condition, while none of the RA2 zone was mature enough to meet the OWEB reference condition. Approximately half of the current 32 percent of stream miles in the low recruitment category are predicted to develop moderate and high recruitment levels in 50 years. According to the vegetation succession model, the influence of natural hardwood stand thinning due to senescence in 100 years on the large wood recruitment potential is considerable in this management basin. It is anticipated 44 percent of the fish-bearing stream network (6.1 miles) would lie within the low recruitment category in 100 years. The level of sparse stands is inconsistent with the distribution of young age class stands under historic reference conditions (Benda and Dunne 1997) and stand manipulation to achieve desired riparian conditions should be considered.

Contiguous Parcels

Young's Bay. Portions of the Hamilton Management Basin extend into the headwater region of the Young's Bay watershed. Approximately 3 miles of small and medium-sized streams were included in this riparian assessment. More than half of the riparian situations consisted of stand condition code CMD. These existing stands are anticipated to provide a moderate potential for current inputs of large wood to channels. Given the overall small size of the streams, some wood from this stand class may be functioning as key pieces. Within 50 years, these stands are predicted to offer conifer trees in excess of 24 in. dbh. The balance of the riparian situations in the Young's Bay contiguous parcels offered a mosaic of conifer-dominated or mixed species compositions in relatively young, small size classes. These situations offered current low wood recruitment potential, but have the potential in 100 years to provide key-piece size wood to the streams.

Forest Grove District

McGregor Management Basin. Riparian conditions on ODF lands adjacent to fish-bearing streams in the McGregor basin offered 54, 4, and 42 percent of the stream mileage in high, moderate and low wood recruitment categories, respectively. Approximately 1 percent of the RA1 zone (0.3 stream miles) complied with the reference HMD condition, while none of the RA2 zone was mature enough to meet the OWEB reference condition. All of the low recruitment situations should develop moderate and high recruitment levels in 50 years. According to the vegetation succession model, the influence of natural hardwood stand thinning due to senescence in 100 years on the large wood recruitment potential is considerable in this management basin. It is anticipated 40 percent of the fish-bearing stream network (12.5 miles) would lie within the low recruitment category in 100 years. The level of sparse stands is inconsistent with the distribution of young age class stands under historic reference conditions (Benda and Dunne 1997) and stand manipulation to achieve desired riparian conditions should be considered.

Wheeler Management Basin. Riparian conditions on ODF lands adjacent to fish-bearing streams in the Wheeler basin offered 51, 27, and 21 percent of the stream mileage in high, moderate and low wood recruitment categories, respectively. Approximately 24 percent of the RA1 zone (12.0 stream miles) complied with the reference HMD condition, while none of the RA2 zone was mature enough to meet the OWEB reference condition. Ninety percent of the low recruitment situations should develop moderate and high recruitment levels in 50 and 100 years. According to the vegetation succession model, the influence of natural hardwood stand thinning due to senescence in 100 years on the large wood recruitment potential is considerable in this management basin. It is anticipated 35 percent of the fish-bearing stream network (17.2 miles) would lie within the low recruitment category in 100 years. The level of sparse stands is inconsistent with the distribution of young age class stands under historic reference conditions (Benda and Dunne 1997) and stand manipulation to achieve desired riparian conditions should be considered.

Wilark Management Basin. Riparian conditions on ODF lands adjacent to fish-bearing streams in the Wilark Management Basin offered 63, 9, and 28 percent of the stream mileage in high, moderate and low current wood recruitment situations, respectively. Approximately 4 percent of the RA1 zone (0.2 stream miles)] complied with the reference HMD condition, while none of the RA2 zone was mature enough to meet the OWEB reference condition. More than 90 percent of the low recruitment conditions were anticipated to develop moderate and high recruitment levels within 50 years. According to the vegetation succession model, the influence of natural hardwood stand thinning due to senescence in 100 years on the large wood recruitment potential is minor in this management basin. It was anticipated that 6 percent of the fish-bearing stream network (0.4 miles) would lie within the low recruitment category in 100 years.

Contiguous Parcels

Clatskanie. Portions of the Wilark Management Basin extend into headwater regions of the Clatskanie watershed. Approximately 14 miles of typed streams occurred on ODF lands in this area. Less than a mile of channel represented large streams, while approximately 3 miles consisted of medium-sized streams. As such, almost three-fourths of the typed waters on ODF lands in the Clatskanie were small streams. The riparian conditions along these channels were unknown and consist as a data gap in this watershed analysis.

6.2 WETLANDS ASSESSMENT

The purpose of the wetlands assessment was to assess the current locations and general characteristics of wetlands in the watershed and determine if opportunities exist to restore degraded wetland conditions. The specific critical questions for the wetlands assessment from the OWEB watershed assessment manual include:

6.2.1 Critical Questions

1. *Where are the wetlands in this watershed?*
2. *What are the general characteristics of wetlands within the watershed?*
3. *What opportunities exist to restore wetlands in the watershed?*

Existing literature and digital databases including: (1) the PSU watershed analysis, (2) subsequent Upper Nehalem River Watershed Council's update of the OWEB analysis, (3) National Wetlands Inventory maps and database as well as (4) ODF databases were reviewed. No information was located concerning the distribution of wetlands in the upper Nehalem River basin. Thus, the condition of forest wetlands is identified as a data gap in this watershed analysis.

6.3 NOXIOUS WEEDS ASSESSMENT

The purpose of the noxious weed assessment is to assess the current locations, type and extent of noxious weed communities based on ODF digital data. The OWEB watershed assessment manual does not include assessment guidelines for noxious weeds.

Very limited information is available for the noxious weed assessment in the upper Nehalem watershed. The distribution of Japanese knotweed *(Polygonum cuspidatum)* was obtained from the upper Nehalem Watershed Council (unpublished data). During the 2005 field verification of riparian habitat, R2 survey crews surveyed vegetation at 19 locations as described above in riparian methods. No noxious weeds, including communities of Japanese knotweed, were observed at any of the surveyed locations. A tally of noxious weed sites per HUC and ODF Management Basin is included in Table 6-4. While it is likely that the distribution of noxious weeds within the Upper Nehalem Project Area is more extensive than is outlined in Table 6-4, more survey effort will be required to determine the distribution of noxious weeds. The condition of noxious weeds is identified as a data gap in this watershed analysis.

A tally of noxious weed sites per HUC and ODF Management Basin is included in Table 6-4. Although 18 survey sites, from a total of more than 158 sites surveyed for Japanese knotweed in the upper watershed, occur within ODF Management Basin, only four of these sites (4) have positive identifications. Three occurrences of knotweed are found in the Quartz Management Basin on ODF lands in the Astoria District and one occurrence is located in the Wheeler Management Basin in Forest Grove. The observation of Japanese knotweed in the Wheeler basin is not located on ODF lands.

Table 6-4. Confirmed presence of Japanese knotweed *(Polygonum cuspidatum)* in various management basins in the Upper Nehalem Watershed. Data obtained from Upper Nehalem Watershed Council (comments from Weed Project 1-041305.xls database).

	Astoria		Forest Grove		
	Quartz		Wheeler		
	HUC 171002020208		HUC 171002020101		
Case	Size	Extent	Size	Extent	Comments
143	Large	30			Large spread patch next to campsite
144	Large	200			Everywhere, canes in water
145	Small	5			Small clump next to culvert opp. Nehalem
158			Large	30	4 clumps beaver presence

7. NON-ROAD SOURCES OF EROSION

7.1 CRITICAL QUESTIONS

The following five “critical questions,” created by Oregon Department of Forestry, were answered during the sediment source analysis in the Nehalem watershed analysis.

1. *What is the distribution of slopes prone to shallow, rapidly moving landslides on state forest lands within the watershed? Map high, moderate, and low hazard areas using the following criteria:*
    - *Low – Slopes below 60%*
    - *Moderate – Slopes 60-79%*
    - *High – Slopes above 79%*
2. *What is the distribution of debris flow-prone channels on state forest lands within the watershed? Map channels as: likely, uncertain, or unlikely to deliver wood to fish-bearing streams.*
3. *Are there locations with gullies or other active surface erosion areas in the watershed? Map any locations.*
4. *Are there deep-seated, active, or recently active moving landslides? Map any locations.*
5. *Are there any unusually prone soils on steep slopes (>79%) in the watershed: Map any locations.*

The five critical questions are intrinsically linked to one another. As such, this report is organized in a manner that integrates the discussion of the questions. The assessment component, as defined by the ODF, is contained within Sections 7.2 through 7.5 and the analysis component is contained within Section 13.

7.2 CRITICAL QUESTIONS REGARDING SHALLOW LANDSLIDING AND DEBRIS FLOWS

A landslide and debris flow model was applied to the Nehalem watershed to answer critical questions #2. Critical question #1 required development of a slope category map (i.e., Low <60%, Moderate 60 – 79%, and High >79%). The empirically calibrated landslide model included both slope and convergence and may be a more appropriate descriptor of slide potential on convergent as well as on planar slopes compared to slope maps alone.

7.2.1 Shallow Landslide and Debris Flow Modeling

There are a variety of models developed to predict shallow landslides and debris flows in humid temperate landscapes such as the Oregon Coast Range (Sidle 1987, 1992; Benda and Cundy 1990; Hungr et al. 1984; Fannin and Rollerson 1993; Montgomery and Dietrich 1994). Most of these models require information on hillslope topography, including network characteristics of headwater systems such as channel gradients and tributary junction angles. The shallow landslide models are more physically based (e.g., Sidle 1987, 1992; Montgomery and Dietrich 1994) while the debris flow models are more empirically based because of the lack of physics-based debris flow models (e.g., Benda and Cundy 1990).

7.2.1.1 An Empirical GIS-Based Model for Landslide Potential

A detailed discussion on the GIS-based model for landslide potential in the Upper Nehalem watershed is included in Appendix D. A summary description of the model is provided in this section.

The empirically-based shallow landslide and debris flow model used in the Nehalem Watershed Analysis was based on the most detailed field inventory of landslides and debris flows available in the Oregon Coast Range. Following the very large 1996 storm that triggered numerous landslides and debris flows in the Oregon Coast Range, the Oregon Department of Forestry (ODF) initiated a comprehensive landslide and debris flow inventory (Robison et al. 1999). To circumvent the limitations of using aerial photograph alone (i.e., many shallow slides and debris flows cannot be detected under forest canopy), ODF conducted a field-based inventory. Within the five study sites located in the Oregon Coast Range, landslides and debris flows were inventoried using field surveys of all channels and scour paths of landslides and debris flows. Information collected included hillside gradient, aspect, slope form, slide volume, soil characteristics, channel gradient, junction angles, etc. (see Appendix C in Robison et al. 1999 for further details on study design).

The empirical model used herein, was designed to use field or air-photo mapped landslide locations with digital elevation models (DEM) (refer to Miller et al. 2003, and Miller and Burnett in review). The model was intended for use over regional scales (10^2-10^4 km^2), and therefore must use readily available GIS data.

The empirical landslide model searched topography (using 10-m DEMs) for combinations of steep slopes and topographic convergence (based on the topography commonly associated with failures in the ODF 1999 inventory) (Figures D-1 and D-2 in Appendix D). Topographic convergence was defined as "spoon-shaped" depressions that concentrate the flow of groundwater during storms and also caused soils to thicken over century time periods. The role of forest vegetation was assessed in the model based on the ODF landslide inventories. Effect of vegetation in the landslide model was apparent from the variation in the relative landslide rates. The highest landslide density was associated with roads (i.e., 4.5 times the lowest landslide rate of forests categorized as either mature or old growth stands). The "open" category, that defines mostly recent clearcuts, had the second highest landslide rate of 3.7 times the Large Forest rate. The third highest rate 1.5 times the lowest rate was contained within "mixed" forests that generally encompassed second growth forests. Hence, from the empirical analysis, clearcuts and roads had high landslide rates compared to old forests. The high landslide rates associated with young forests (e.g., clearcuts) could have been due to some combination of low rooting strength and hydrological factors such as increased soil moisture due to reduced evapotranspiration.

In the landslide analysis for the Nehalem watershed analysis, present-day vegetation patterns included four different land-cover types in accordance with CLAMS vegetation mapping (Ohmann and Gregory 2002). These land-cover types included "OPEN" (non-forested areas and recent clear cuts [<10 years]), "MIXED" (hardwood stands, and mixed conifer and hardwood stands, and young to intermediate-aged stands (~10-80 years), and "large" (old, mixed hardwood and conifers, and old conifer stands [>80 years]). The Nehalem landslide analysis did not utilize a "road" land use category.

The landslide model did not include small streamside failures (often referred to as inner gorge landslides) in the ODF inventory because of the inability of 10-m DEMs to resolve inner gorge topography. Individual landslide sites in the ODF inventory were geo-spatially referenced on 10-m DEMs. Since the goal was to develop a model that utilized a digital database, the slope gradients associated with failure sites were derived from the DEM (and not from the field measurements). Since 10-m DEMs commonly underestimate slope gradients, the predicted locations of potential landslide sites as indexed by a variable landslide density may occur on lower DEM gradient areas compared to what may be found in the field. Hence, it is not appropriate to use a DEM-based slope gradient map with the predicted landslide density index to compare or contrast slide potential. A slope map can be used as a stand- alone measure of failure potential, with the understanding that 10-m DEMs underestimate slope gradients. Likewise, the 10-m DEM-based landslide density predictions are a stand-alone representation of failure potential. The DEM slope gradients associated with potential failures are likely less than the field gradients measured at those locations.

7.2.1.2 An Empirical GIS-Based Model for Debris Flow Potential

The debris flow component of the model employed four topographic factors: 1) channel slope, 2) valley width or confinement, 3) tributary junction angles, and 4) cumulative length of scour and deposition (i.e., rate of volume increase or decrease). In the model, debris flow runout was separated into zones of scour, transitional flow, and deposition, following the three classes identified in the field by ODF personnel. The functional relationships between debris flow scour and deposition and the four topographic factors were based on research illustrating the physical constraints of debris flow travel. For example, debris flow movement (1) declined with decreasing channel slope (Swanson and Lienkaemper 1978; Benda and Cundy 1990; Fannin and Rollerson 1993; Fannin and Wise 2001), (2) declined at sharp-angled tributary junctions (Benda and Cundy 1990), (3) was less in large forests, (4) was longer in clearcuts (Ketcheson and Froelich 1978; May 2002), and (5) increased with larger debris volumes (Benda and Cundy 1990).

The four vegetation types previously described for the CLAMS vegetation mapping (Ohmann and Gregory 2002) were evaluated in the debris flow model. Three specific study sites, the Elk Creek, Scottsburg, and Mapleton sites, from the ODF landslide study (Robison et al. 1999) were used in the analysis. Debris flow runout was sensitive to forest cover class, with higher probabilities of debris flows associated with OPEN cover classes compared to LARGE classes (Miller and Burnett in review). This result was likely due to the fact LARGE cover class was statistically associated with fewer field observations of debris flow scour, more deposition, and shorter runout paths than other cover classes. This finding was consistent with previous studies of debris flow movement in the Oregon Coast Range (Ketcheson and Froelich 1978, May 2002).

7.2.2 Wood Recruitment and the Importance of Debris Flows

Field surveys for this watershed analysis along 2.2 miles (3.6 km) of channels were used to estimate the types of wood recruitment sources in the Nehalem watershed. Of the 35 percent of total woody debris pieces that could be identified to a source, 66 percent originated from bank erosion, 30 percent from mortality, and 4 percent from streamside (inner gorge) landsliding (Figure D-3, Appendix D). Of the recruited wood to stream channels, 54 percent was deciduous and 46 percent was conifer (Figure D-3, Appendix D). Approximately 75 percent of all woody debris entered the channel from 60 feet from the stream bank and approximately 90 percent of all wood entered the channel within a distance of 85 feet.

Wood originating from debris flows is difficult to identify unless the debris flows are recent and logs can be linked to specific deposits. A field survey of woody debris was conducted along 1.4

miles (2.3 km) of a fourth-order channel with a high density of predicted debris flow-prone headwater streams. A series of old debris flow deposits were encountered along the study segment. The wood survey revealed the highest in-channel wood volume in apparent spatial association with the highest density of debris flow-prone headwater streams (Figure D-4, Appendix D). Statistical analysis of the spatial proximity of wood storage to headwater streams to verify the relationship between debris flows and wood loading was not accomplished for this analysis. Simulation modeling in landscapes similar to the Nehalem in the central Oregon Coast Range and in western Washington indicate debris flows can be locally significant in wood delivery to fish-bearing streams (Benda and Sias 2003, USFS 2002). Also refer to the section on Natural Disturbance, Section 3.2, for further information on the significance of debris flows in wood recruitment.

7.2.3 Spatial Probability Predictions

The debris flow model predictions represent spatial probabilities based on the 1996 ODF landslide inventory. Probabilities estimated by the model are based on the proportion of observed sites with similar attributes that have been similarly affected by debris flow occurrences based on field mapping. The model calculated probabilities based on spatial proportions within the study areas. For example, if one were to randomly select a site on a map containing landslide-initiation locations plotted as points, the model would estimate the probability that the selected site lands on a plotted initiation point. Likewise, if one were to randomly choose a point in the channel network, the model would estimate the probability of that point having been mapped with debris flow scour or deposition. Hence, modeled probabilities reflect the proportion of channels having similar topographic and forest cover attributes where debris flow impacts were mapped in the field following two very large storms in 1996 (Robison et al. 1999). A probability of 1 percent, for instance, indicated that of one hundred similar channel reaches, only one on average would have contained evidence of a debris flow after the 1996 storms. Low probabilities did not necessarily translate into small effects, but may translate to a low frequency of occurrence. In addition, the spatial probabilities were based on landslides and debris flows mapped in a single year. These data did not provide information on temporal patterns of landslides and debris flows. To obtain insights into temporal patterns of landslides and debris flows in landscapes such as the Nehalem watershed, refer to the video simulations in the USFS educational CD on landscape dynamics (USFS 2002).

7.2.4 Application of the Shallow Landslide-Debris Flow Model to the Nehalem Watershed

7.2.4.1 Landslide – Debris Flow Parameters

It is assumed for this analysis, the fish species of highest concern related to landslide and debris flow impacts in the Nehalem watershed include anadromous forms of coho, Chinook, and steelhead (see also Section 10, Fish, Fish Habitat, and Amphibians, of this report). Based on fish distribution analyses in the Nehalem and from other locations in the Oregon Coast Range, a channel threshold gradient of less than 12 percent was selected to define anadromous fish-bearing channels.

The model predictions take several forms that could be used to help manage landslide and debris flow risk in the Nehalem watershed. For more information on how field based methods can be integrated with model predictions for managing debris flow risk, see Benda et al. (2005). For each of the 13 ODF management basins, three model predictions were made (all at the 10-m DEM scale): 1) landslide density, 2) debris flow probability, and 3) debris flow wood recruitment corridors (i.e., along headwater streams) (Table 7-1). In addition, as required in critical question #1, a slope gradient map is included that categorizes hillslopes into three domains of high (>79%), moderate (60 – 79%), and low (<60%).

As described above, predictions of debris flows were sensitive to forest vegetation. The model applied to the Nehalem watershed utilized present-day vegetation types as contained in the CLAMS (satellite-based vegetation layer). No changes in forest cover due to forestry activities was included in the predictions, although they could be incorporated in the model and they may effect the debris flow predictions (and landslide density predictions). In addition, no road effects were included in the landslide analysis.

Table 7-1. Descriptions of the landslide – debris flow indices used in the Nehalem Watershed Analysis. See model description above for interpretation of "landslide density" and "debris flow probability."

Landslide – Debris Flow Indices	**Description**
1) Slope gradient.	According to ODF guidelines for the Nehalem Watershed Analysis, the management basins were mapped according to three slope gradient categories: Low (<60%), Moderate (60 – 79%), and High (>79%).
2) Landslide density.	Landslide density is the number of slides predicted per square kilometer (based on model calibration – see model description). Each pixel is assigned a landslide density based on local topographic attributes. Although the absolute values pertain only to the calibration area (see Miller and Burnett in review), the relative difference from point to point provides a quantitative measure of differences in landslide potential. *Nevertheless, because of the low resolution of digital topographic information, landslide density predictions are best used for large-scale screening. Field investigation is strongly encouraged (see Figure D-5).*
3) Average debris flow probability.	The potential for debris flow scour or deposition (average debris flow probability) is a function of slope gradient, channel confinement, tributary junction angles, and forest cover along the entire runout path. *This parameter provides information for determining the relative likelihood that a debris flow will flow through a channel given a slide potential.* Variation in the parameter value (probability) indicates the relative likelihood and runout of debris flows
4) Debris flow wood delivery corridors.	This index provides a relative probability that a pixel will be traversed by a debris flow from upslope that delivers to channels of less than 12%. The mapped wood delivery corridors (headwater streams only) can be used to identify those channels that are likely to deliver wood to lower gradient, fish-bearing streams.

7.2.4.2 Interpreting Model Results: Answering Critical Questions

Model predictions refer directly to the likelihood of shallow landsliding on planar and convergent slopes, and on the likelihood of debris flows to scour headwater channels and to deposit sediment and wood into fish bearing channels. Predictions are in terms of landslide density and probability of debris flows.

Interpreting model predictions in the context of forest management is dependent on the management and/or ecological perspective adopted. For example, landslides and debris flows can be assumed destructive to fish habitat in all cases. Conversely, debris flows provide sources of sediment and wood, and hence are sources of habitat development and heterogeneity over a long-term horizon. The scientific literature ranges across these two perspectives (refer to Section 3.2, Natural Disturbance, for an overview of the effects of debris flows on channel environments).

The slope gradient and landslide density maps provided herein, should be considered qualitative indices for landslide potential and hence, used primarily as a screening tool. This qualification is primarily related to the low resolution of the available digital topographic information (10-m DEMs). The landslide density maps likely over predict the slide hazard in some areas, although they may also under predict potential instability where bedrock hollows cannot be resolved with 10-m DEMs. When these indices are used in conjunction with aerial photographs and topographic maps, they can help indicate whether forestry activities can contribute to instability and whether additional field evaluation is necessary. If slope stability is not considered an issue, then the debris flow analysis and associated maps need not be consulted. However, when the screening tools and field-based stability analysis indicate shallow failures are a significant possibility, then the debris flow maps (see Items #3 and #4 in Table 7-1) can be used to help interpret the potential for debris flows to travel to fish-bearing streams. In addition, the debris flow-prone channels most likely to contribute wood to low gradient, fish-bearing streams can be estimated from the maps on wood recruitment.

ODF's critical question #2 requested a map of debris flow-prone channels "likely" or "unlikely" to deliver wood to fish-bearing streams. The average debris flow probability and debris flow wood delivery corridors can be arrayed according to "likely" through "unlikely" by having those categories span the predicted high – low range of probabilities. Refer to the flowchart in Figure D-5, Appendix D, that summarizes a procedure for managing landslide and debris flow risk. This flowchart provides guidance on how to use the four map products developed during this analysis.

7.2.4.3 Individual Forest Management Basins

The study area and legend for the slope stability and debris flow analysis are shown in Figures D-6 and D-7, respectively in, Appendix D and the legend is included in Figure 7-1, below. Results of the model predictions for: (1) slope gradient, (2) landslide density, (3) debris flow probability, and (4) debris flow wood recruitment corridors comprise 52 figures and can be found in Appendix D. We have selected representative figures to show a range of prediction results for each of the four parameters. These data are presented in Figures 7-2 to 7-5.

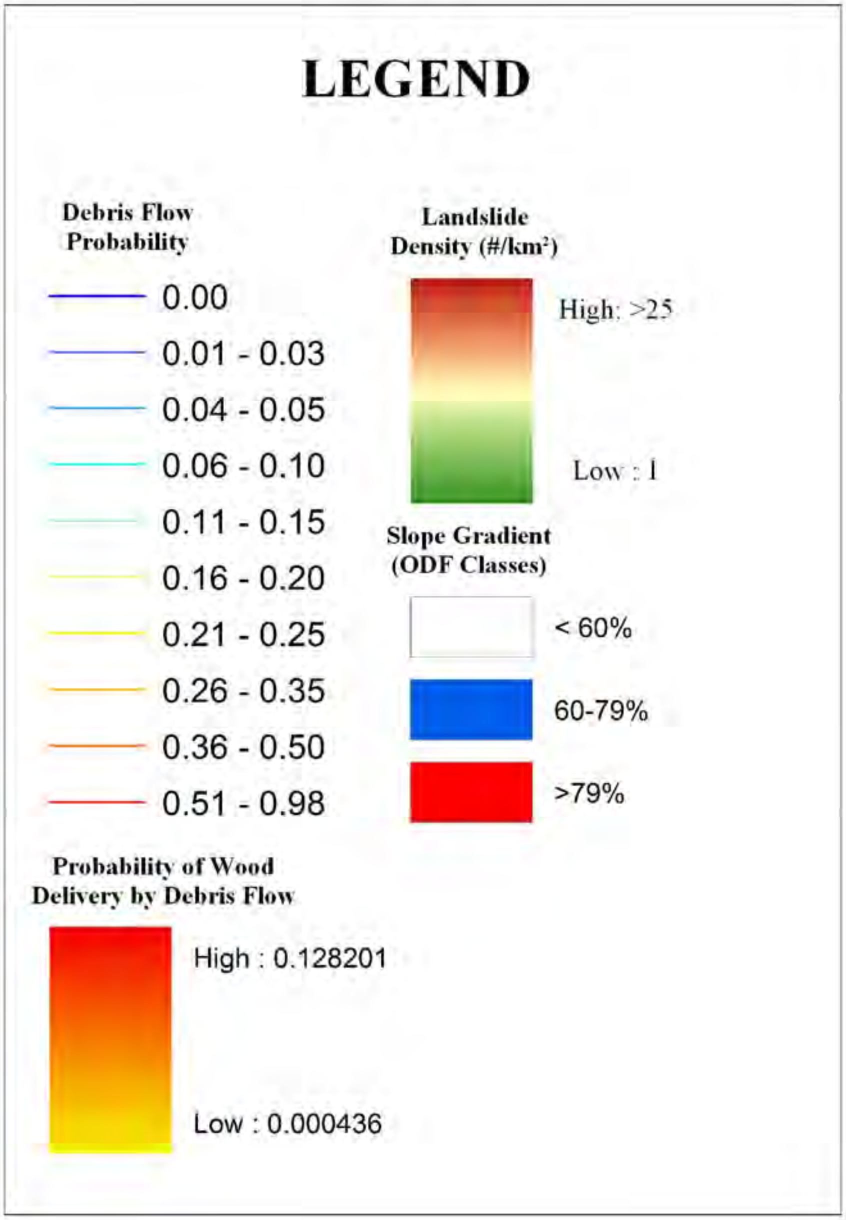


Figure 7-1. Legend for the four landslide and debris flow maps used in the Nehalem Watershed Analysis. Refer to Table 7-1 and discussion of models for more details.

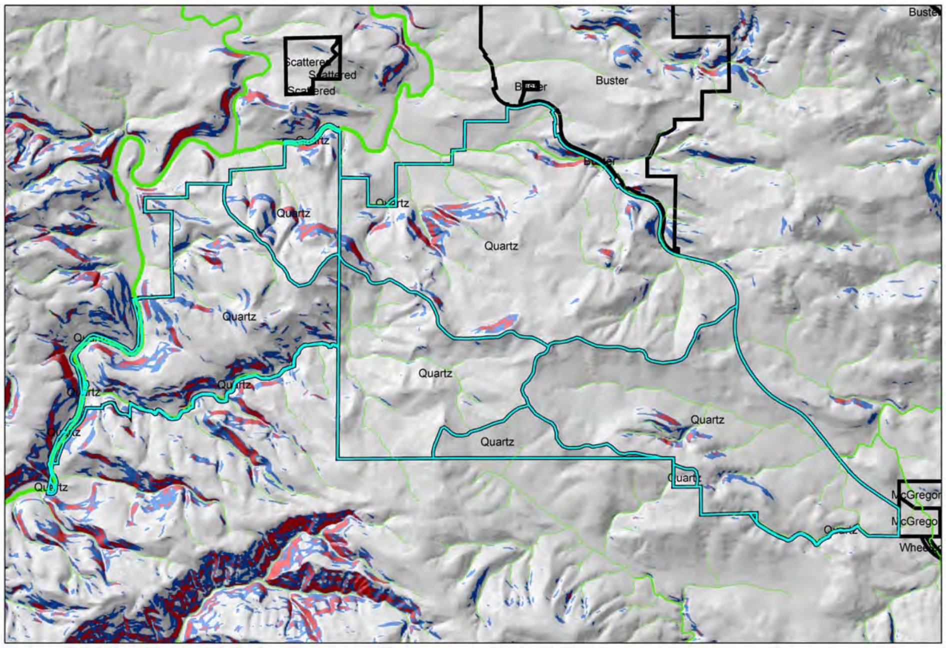


Figure 7-2. Slope gradient map for the Quartz Management Basin. Refer to the Legend in Figure 7-1.

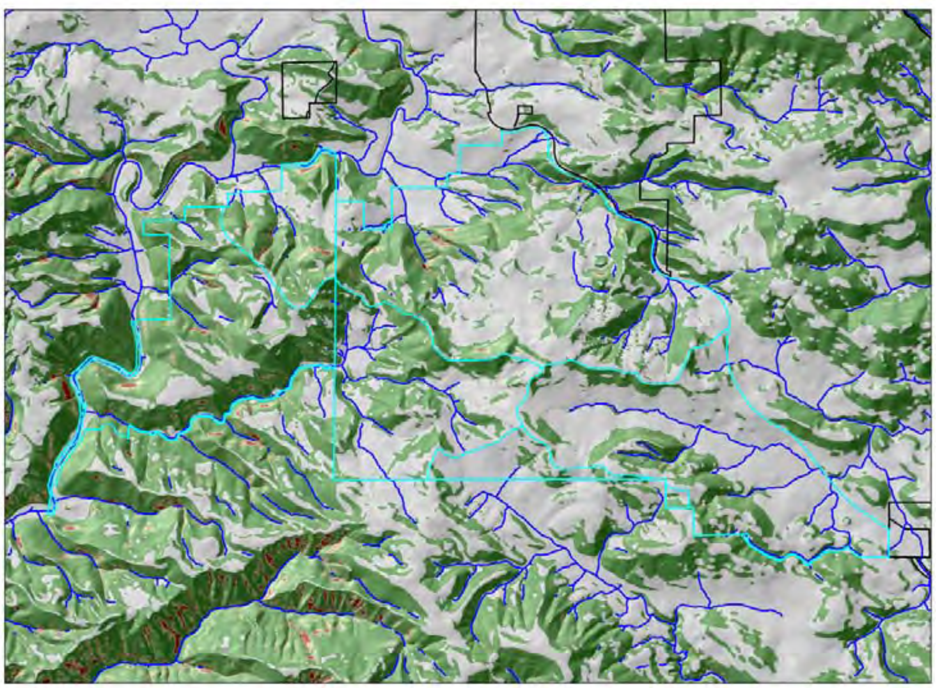


Figure 7-3. Predicted landslide density for the Quartz Management Basin. Refer to the Legend in Figure 7-1; the gray areas have no predicted landslide density.

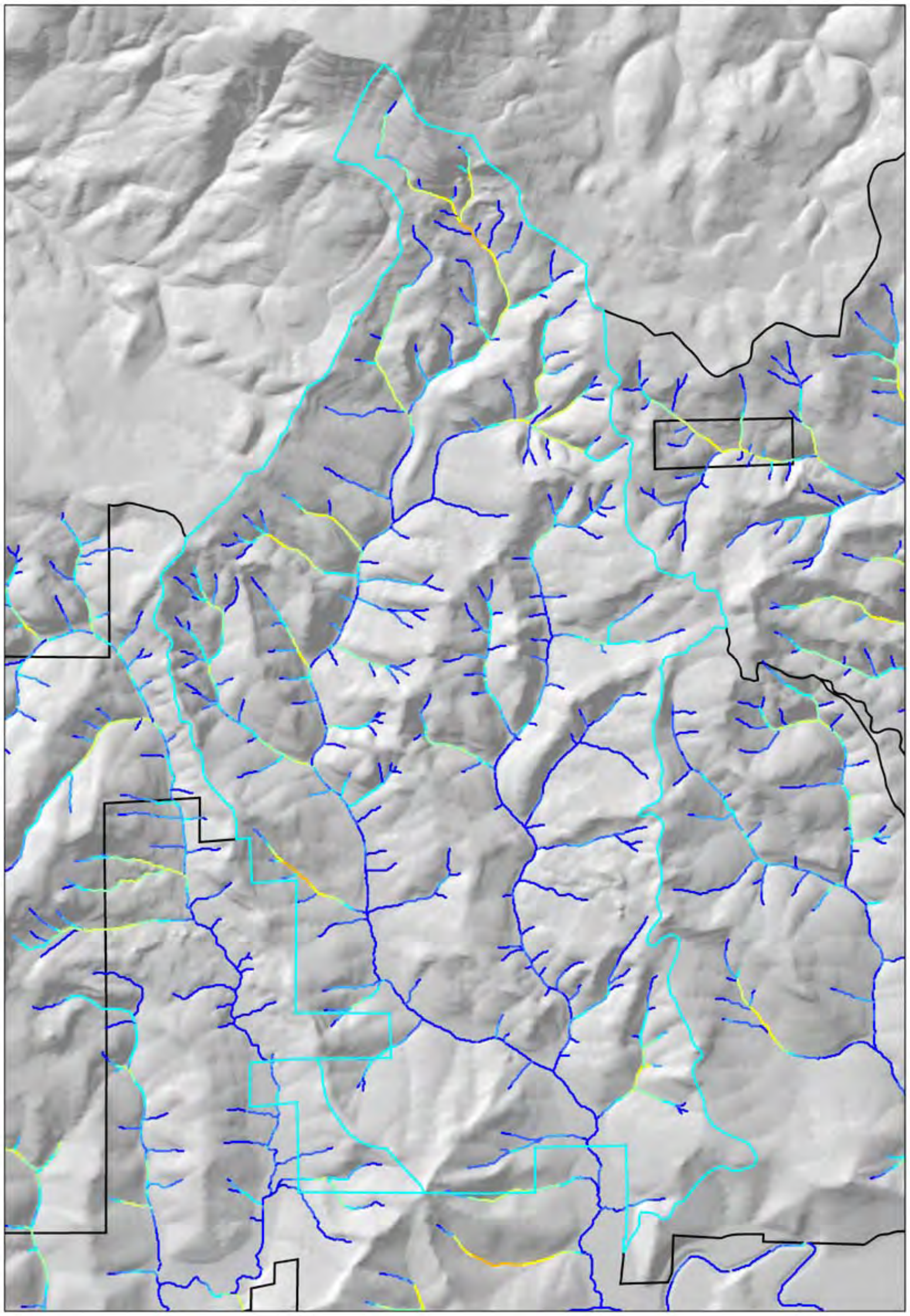


Figure 7-4. Predicted debris flow probability for the Northup Management Basin. Refer to the Legend in Figure 7-1. The predicted probabilities reflect cumulative landslide densities (that could trigger debris flows) and not individual pixel-based landslide potential shown in the landslide density map.

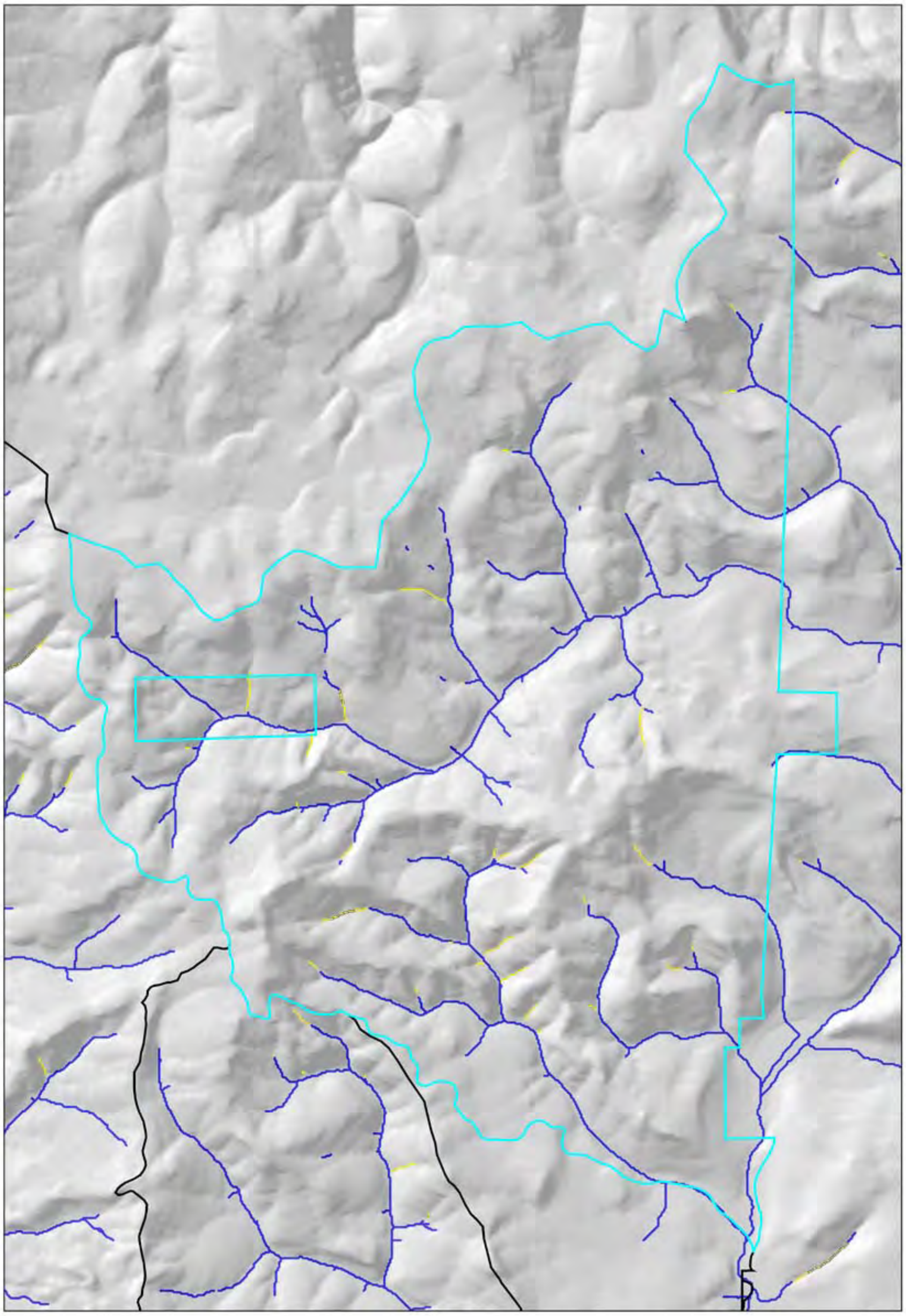


Figure 7-5. Headwater streams predicted to contribute wood to larger, fish-bearing streams in the Fishhawk Management Area. Refer to the Legend in Figure 7-1. The predicted probabilities reflect cumulative landslide densities (that could trigger debris flows) and not individual pixel-based landslide potential shown in the landslide density map.

7.2.4.4 Comparison Among Basins

There is significant variability across the Nehalem study area in predicted slope stability (as illustrated in the landslide density predictions) and debris flow potential. A plot of the cumulative distributions of debris flow probabilities illustrates the degree of variability at the HUC 6th field watersheds (Figure D-60, Appendix D). A visual display of this variability is shown in Figure D-61, Appendix D. The highest values (areas of the highest density of debris flow-prone channels) occur toward the western margin of the upper Nehalem watershed and decrease eastward.

It is important to stress the landslide modeling results indicated that the majority of the area encompassed by the Nehalem watershed analysis has a relatively low risk of landslides and debris flows. This result was due to the lack of very steep and highly convergent topography. Consequently, the risk posed by shallow landslides and debris flows to aquatic resources and water quality was low throughout much of the Nehalem study area. Fishhawk, Quartz, and Northup Management basins had the highest probabilities of shallow landslides and debris flows.

7.3 LOCATIONS OF GULLIES OR ACTIVE SURFACE EROSION

Critical question #3: "Are there any locations with gullies or other active surface erosion areas in the watershed (and map any locations)?

7.3.1 Overview

Active surface erosion can include gullies, small rills, and sheetwash. Active surface erosion in forested environments is generally associated with either direct runoff from roads, following fires on hydrophobic soils, or in areas cleared of vegetation (i.e., clearcuts). Gullies, rilling and sheetwash require overland flow, a process whereby infiltration capacity of the soil is less than rainfall intensity. This process is not common in forested humid landscapes where infiltration capacity is almost always higher than rainfall intensity. Based on 2005 road surveys of forest roads in the project area, gullies and other forms of surface erosion are not a significant issue in the Upper Nehalem. Road condition and drainage issues associated with roads are described in Chapter 8 – Road-Related Sediments.

7.4 DEEP-SEATED LANDSLIDES

Critical question #4: "Are there deep-seated, active or recently active moving landslides (map any locations)?

7.4.1 Overview

Deep-seated landslides may involve rapid displacement of large blocks or groups of blocks and the formation of debris flows. However, in other cases, movement may be slow or incremental (accelerated soil creep or strain). Subtle features, such as tension cracks and deformed trees, may characterize landslide activity. Some deep-seated landslides can contain both types of failures. Important environmental factors related to deep-seated landslides include soil and bedrock properties, soil depth, and both regional and local groundwater response to multi-year precipitation.

Deep rotational failures are typically triggered by the build up of pore water pressure in mechanically weak, and often clay rich rocks (Swanston 1974). Slumping involves the downward and backward rotation of a soil block or groups of blocks. The uppermost area of failure, where the soil breaks away from the slope, is often steep and generally bare of vegetation and the toe is hummocky or broken by individual slump blocks following the failure.

Deep-seated failures are often classified according to level of activity, such as active to recent, historical active, dormant young, and dormant mature (Cruden and Varnes 1996). Determining the potential effects of forestry activities on deep-seated failures often requires long-term detailed field monitoring (Swanston 1974) or a combination of aerial photographic interpretation and modeling (Miller 1995). In general, the role of forestry activities on deep-seated landslides in bedrock remains an open question. No general principles, such as the role of timber harvest on shallow failures in bedrock, exist.

7.4.2 Methods

Oregon Department of Forestry supplied the deep-seated landslide analysis that consisted of mapped landslides on GIS shape files (Figure D-62, Appendix D). The map shows the locations of deep-seated failures in bedrock and hence provides a general guide to this form of mass movement in the Nehalem watershed.

The following ODF methodology was used in the analysis of deep-seated failures for the Nehalem watershed analysis. Deep-seated, large-scale landslide landforms are often recognizable on topographic maps. With an understanding of scale and shape of large landslides, a geologist or other trained observer can recognize landforms that “might” be deep-seated, large-scale landslides. This type of mapping should be viewed much like a GIS screen, for possible areas of interest. This approach should not be considered highly accurate for including all possible large scale landslides (since the topographic map has limitations in accuracy). There is no way to tell from the topography if features truly are of landslide origins. Obviously, the level of failure activity cannot be determined solely from topography viewed from maps or from aerial photography. The set of shapes drawn in the GIS for the Upper Nehalem Watershed Assessment represents a first approximation that is fairly good at the scale of large landslides and fairly poor for smaller landslide features.

The methodology for producing the landslide maps examines topography Digital Raster Graph (DRG) and draws polygons where a shape of large-scale landslide features exists. Landslide features are detected using the following attributes:

- Steep sloped areas often somewhat uniquely located and limited in length.
- Often arcuate or curvilinear (curved in = spoon shaped) at the up-slope end.
- Gentle slopes below the up-sloped end, typically hummock shaped.
- Lower slope often curved out (fan shaped), often with youthful drainage dissection.
- Toe of slope might be pushing the stream out along a fan-shaped toe.

In addition, the latest geology maps that cover the Tillamook Highlands (Wells et al. 1995) and the Astoria Basin (Niem and Niem 1992) *were* used to further identify large landslides. The geology maps that include "landslide deposits" designations were available where watersheds fall in areas where fairly recent, quadrangle-scale geologic mapping has been published.
All landslide debris map units including the shape and location of these features that were not picked up in the earlier process, were added to the Nehalem maps. The shape files were sent to the Districts. District personnel provided local knowledge concerning recent activity and added unmapped areas known to have recent movement.

7.4.3 Additional Information Needs

No other additional information is required for the development of a large-scale screening tool. However, small deep-seated landslides can only be detected using field surveys. These features, when encountered in the field by geologists or foresters, should be used to update the landslide database in GIS.

7.5 UNUSUALLY EROSION PRONE SOILS ON STEEP SLOPES

Critical question #5: "Are there any unusually erosion-prone soils on steep slopes (>79%) in the watershed (and map any locations)?

7.5.1 Overview

Erosion in this context can refer to either mass wasting or surface erosion and gullying. Soil type is believed to play a minor role in shallow landsliding in humid temperate landscapes, such as the Nehalem. Indeed, none of the major shallow landslide models commonly used in the Pacific Northwest Region, or in the Oregon Coast Range specifically, include a parameter for soil type.

Soil type is likely more important in the process of surface erosion. However, as described in the answer to critical question # 3 ("Are there locations with gullies or other active surface erosion areas in the watershed?"), surface erosion, with the exception of road-related erosion, is anticipated to be uncommon in the Nehalem watershed. This assumption is because most forest soils have surface infiltration capacities that exceed rainfall intensities and consequently overland flow is rarely generated.

7.5.2 Additional Information Needs

Areas with slope gradients greater than 79 percent are limited to very local areas based on 10-m digital elevation models. In general, soil surveys are conducted at large scales and are generally not of a sufficiently fine detail to link local areas of very steep slopes (i.e., > 79%) with soil mapping units.

The issue of mapping scale has led to the following caveat found in the Oregon Soils Atlas: "*The general soil map[s]…shows broad areas that have distinctive patterns of soils, relief, and drainage…The general soil map can be used to compare the suitability of large areas for general land uses…Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure….*"

Detailed, site-specific field surveys of steep slopes in the Nehalem watershed would be required to determine the erosion potential (either landslide or surface erosion) and sediment delivery potential of particular areas. It is recommended that erosion potential surveys be conducted on a site-by-site basis during the normal application of timber harvest activities. Because of the very large areas involved, such surveys are impractical during coarse-scale analyses, such as the Nehalem watershed analysis.

8. ROAD RELATED SEDIMENT SOURCES

Erosion near streams and surrounding areas occurs through various natural and human-induced processes. The focus of this section is to identify portions of road networks that currently affect or are prone to affect stream channel morphology, fish habitat, and fish passage due to road position or delivery of fine sediment to streams. In particular, this section attempts to address the following ODF questions regarding road and trail conditions.

ODF Questions:

1. *What proportion of road length is within 100 feet of streams?*
2. *What proportion of road related drainage ditches are hydrologically connected to the stream network?*
3. *What roads are in critical locations?*
4. *What roads have road prism instability, including sidecast/fill landslides?*
5. *How many stream crossings are barriers to fish passage?*
6. *Are road washouts of stream crossing fills present in the project area?*
7. *Do recreation trails contribute to sediment or erosion problems?*
8. *What proportion of the project area is non-forested due to forest roads?*

8.1 METHODS

Three previously completed OWEB watershed assessments cover portions of the current Upper Nehalem Project Area: Nehalem River Watershed Assessment (Johnson and Maser 2000), Lower Columbia-Clatskanie Watershed Assessment (Rule 2001) and Young's Bay Watershed Assessment (E&S Water Chemistry Inc. and Young's Bay Watershed Council 2000). These documents provide additional descriptions of road location and condition within each watershed.

The ODF Roads Information Management System (RIMS) database was utilized in conjunction with available stream layers to address the questions provided. The RIMS data was collected in 2005 by ODF; surveys covered all accessible forest roads within the Upper Nehalem Project Area maintained by ODF.

For the purposes of this analysis, stream adjacent roads were defined as roads within 100 feet of a stream with an identifiable bed and banks. Stream adjacent roads were identified using RIMS critical road location and road crossing data. Critical road location types included streams paralleling road segments within 100 feet and road segments identified to have diverted streamflow in a roadside drainage ditch. Culvert and bridge crossings of streams recorded during the RIMS field surveys and the length of stream adjacent road associated with each crossing was estimated at 250 feet. Total stream adjacent road length within the Project Area was calculated by adding the stream adjacent road lengths associated with stream crossings with stream adjacent road lengths from the critical road location data layer. Percent road length adjacent to streams was calculated using the total length of roads surveyed during 2005 RIMS surveys. Stream adjacent road lengths were calculated by management basin and 6th Field HUC.

Hydrological connectivity of road drainage systems to stream systems was verified during RIMS field surveys and included in the RIMS road drainage data layer. Road sections in this data layer were sorted based on hydrologic connectivity, and the associated road length was tallied according to Management Basin and 6th Field HUC. Road drainage conditions were assessed in the project area during the 2005 RIMS surveys using Attention Priority (AP) codes, which rate the road drainage condition on a scale of 1 to 5, with a rating of 1 indicating highest priority for maintenance attention. Road drainage AP codes are described below. The percent of road length in the project area by AP code rating was calculated using the RIMS road drainage layer. The roads drainage analyses were completed based on the total length of road surveyed in the 2005 RIMS field surveys.

Road Drainage AP Codes

AP Code 1 – Road surface drainage is not controlled; surface water is causing severe erosion of road prism and needs immediate attention, unsafe to drive.

AP Code 2 – Road surface drainage is not controlled; surface water is causing moderate erosion of road, needs attention in next dry period.

AP Code 3 – Road surface drainage is poorly controlled, potential to cause erosion of road prism or weakness in road surface, needs attention before next wet season.

AP Code 4 – Road surface is not draining fully, however impairment is minor and does affect water quality or need immediate attention.

AP Code 5 – Surface drainage is functioning perfectly.

Road locations in the Upper Nehalem Project Area with inherent resource risk were identified during RIMS field surveys, and classified by stream-related, slope-related, and non-critical risk categories. Critical road locations were mapped by location type and the percent length of roads was calculated by critical location type using these data from the RIMS critical road location data layer. The RIMS critical locations are described below.

Stream-Related Critical Road Locations

Canyon fill. The road is in a steep, narrow canyon, with high cuts and fills crowding the stream in places.

Channel fill. Road is next to and sometimes crowding stream, however is in a generally stable location.

Stream in ditch. Stream has been diverted down a roadside ditch.

Stream parallel. Road generally parallel to stream and toe of fill averages within 100 feet of stream. No fill in channel.

Wetland adjacent. Road crosses a wetland.

Slope-Related Critical Road Locations

Sidecast/fill slides. Failures of both cut and steep sidecast slopes are present; difficult to stabilize road.

Fill slides. Sidecast slope failures are present along road segment, cutslope stable.

Deep Active Slide. Road prism has moved due to deep active slide.

Steep fill. Sidecast constructed road fill placed on natural slopes that are over 65 percent, with a resulting slope of over 75 percent. No significant slides are present.

Deep inactive slide. Road construction has cut toe of old, inactive slide.

Steep full-bench. Road constructed with full bench end haul (no fill) or effective pullback of roadside fill is apparent.

Non-Critical Road Locations

Non-critical. Any road not in one of the above locations. Slopes of road are stable and at least 100 feet from streams and do not cross wetlands, which is common for slopes less than 50 percent.

The stability of road prisms in the project area, including the presence of sidecast/fill and fill landslides was assessed using the RIMS road prism data layer. The percent length road located in sidecast/fill and fill slides was calculated based on the total length of forest roads surveyed. Road prism condition was assessed in the project area during the 2005 RIMS surveys using AP codes. The percent road length located in the project area by AP code rating was calculated using the RIMS road drainage data layer.

Road Prism AP Codes

AP Code 1 – Landslide involving most or all of road prism has closed road, geotechnical investigation and major reconstruction required to reopen road.

AP Code 2 – Arcuate cracks or other landslide has reduced road width; pullback and road widening may be necessary.

AP Code 3 – Road has serious surface erosion or minor cutback slump.

AP Code 4 – Minor surface erosion; bare soil slopes on a substantial minority of cutslope.

AP Code 5 – Road prism is vegetated, or rocked and is stable with little erosion.

The fish passage condition of stream crossings in the project area was summarized using RIMS stream crossings data. Stream crossings were surveyed for fish passage and were classified as adult barrier, juvenile barrier, or fully passable. Culvert passage condition and stream type data (i.e., known fish use, likely fish use, no fish use or unknown) at each crossing were summarized by management basin. Known fish presence determinations were based primarily on ODFW surveys or other direct observation. For streams in which fish presence has not been verified, presence was based on physical stream characteristics such as stream size and gradient. Fish presence will need to be validated in streams assessed to have likely and unknown fish presence.

Diversion and washout risk were evaluated during RIMS surveys and classified at each stream crossing as washed out or as high, moderate, or low risk of washout based on road and culvert conditions, including slope, culvert size, amount of road fill present, and presence of bank armoring. These two attributes were summarized using the stream crossings data layer.

Recreational hiking and all-terrain vehicle (ATV) trails are present within the project area but were not surveyed during 2005 RIMS surveys. Trail lengths and descriptions of locations by Management Basin and 6th Field HUC were completed using a data layer of the recreational trail distribution within the Project Area.

The non-forested area in the Upper Nehalem Project Area dedicated to roads (permanent non-forested) was calculated using measured road widths and lengths recorded for all surveyed road segments during 2005 RIMS surveys. Road width was obtained using sub-grade and cutslope widths. For the small proportion of forest roads not surveyed during the 2005 RIMS surveys, an average width was applied to the total length of unsurveyed roads obtained from the ODF GIS roads layer.

8.2 RESULTS

8.2.1 Stream Adjacent Roads

There are approximately 607 miles of active forest road managed by ODF within the project Area. Of this total length, approximately 53.8 miles (8.8%) are stream adjacent. The proportion of stream adjacent roads within the project area are presented by management basin and 6th field HUC in Tables 8-1 and 8-2, respectively.

Table 8-1. Length and percentage of forest roads within 100 feet of streams on ODF lands in the Upper Nehalem Watershed Analysis area, including stream type and size, by management basin.

Management Basin	Stream Type[1]	Stream Size	Road Length (mi)	Percentage of Total Road Length
Fishhawk	Fish	Large	0.1	0.2%
	Fish	Medium	0.2	0.6%
	Non-fish	Unknown	<0.1	0.2%
	Unknown	Unknown	1.0	3.0%
Total			***1.3***	***4.1%***
Northrup	Fish	Large	0.8	2.0%
	Unknown	Unknown	1.0	2.7%
Total			***1.8***	***5.6%***
Beneke	Fish	Medium	0.4	0.8%
	Fish	Unknown	0.1	0.2%
	Non-fish	Unknown	<0.1	0.1%
	Unknown	Unknown	3.7	8.0%
Total			***4.2***	***9.1%***
Lousignot	Fish	Large	<0.1	<0.1%
	Fish	Medium	0.2	0.9%
	Fish	Unknown	0.1	0.5%
	Non-fish	Unknown	0.6	2.3%
	Unknown	Unknown	1.2	4.5%
Total			***2.3***	***8.4%***

Table 8-1. Length and percentage of forest roads within 100 feet of streams on ODF lands in the Upper Nehalem Watershed Analysis area, including stream type and size, by management basin.

Management Basin	Stream Type[1]	Stream Size	Road Length (mi)	Percentage of Total Road Length
Hamilton	Fish	Large	0.8	2.1%
	Fish	Medium	0.1	0.4%
	Fish	Small	0.2	0.5%
	Fish	Unknown	0.7	1.8%
	Non-fish	Unknown	0.4	1.2%
	Unknown	Unknown	6.0	16.0%
Total			***8.2***	***22.0%***
Crawford	Fish	Medium	0.2	1.0%
	Unknown	Unknown	1.9	7.5%
Total			***2.1***	***8.3%***
Sager	Fish	Large	0.1	0.1%
	Fish	Medium	0.4	0.6%
	Fish	Unknown	0.1	0.2%
	Non-fish	Unknown	0.2	0.3%
	Unknown	Unknown	2.7	4.1%
Total			***3.5***	***5.3%***
Buster	Fish	Large	1.8	1.8%
	Fish	Medium	0.6	0.6%
	Fish	Small	<0.1	<0.1%
	Fish	Unknown	0.3	0.3%
	Non-fish	Unknown	0.5	0.4%
	Unknown	Unknown	4.9	4.7%
Total			***8.2***	***7.9%***
Quartz	Fish	Medium	0.3	0.6%
	Fish	Small	<0.1	0.1%
	Fish	Unknown	0.3	0.5%
	Non-fish	Unknown	0.5	1.0%
	Unknown	Unknown	3.1	6.1%
Total			***4.2***	***8.2%***
McGregor	Fish	Large	0.1	0.2%
	Fish	Medium	<0.1	0.1%
	Fish	Small	0.9	1.5%
	Non-fish	Medium	0.1	0.2%
	Non-fish	Small	3.2	5.4%
	Non-fish	Unknown	0.1	0.2%
	Unknown	Unknown	0.2	0.4%
Total			***4.7***	***8.0%***

Table 8-1. Length and percentage of forest roads within 100 feet of streams on ODF lands in the Upper Nehalem Watershed Analysis area, including stream type and size, by management basin.

Management Basin	**Stream Type[1]**	**Stream Size**	**Road Length (mi)**	**Percentage of Total Road Length**
Wheeler	Fish	Large	1.6	1.7%
	Fish	Medium	1.7	1.8%
	Fish	Small	1.6	1.7%
	Non-fish	Small	5.4	5.8%
	Unknown	Unknown	0.8	0.8%
Total			***11.0***	***11.9%***
Wilark	Fish	Medium	0.2	0.7%
	Fish	Small	1.5	5.3%
	Non-fish	Small	0.4	1.3%
	Unknown	Unknown	0.2	0.8%
Total			***2.3***	***8.1%***
Project Total			***53.8***	***8.8%***

1 Stream types include fish bearing (Fish), non-fish bearing (Non-Fish), and unknown fish presence (Unknown)

Table 8-2. Length and percentage of forest roads within 100 feet of streams on ODF lands in the Upper Nehalem Watershed Analysis area, including stream type and size, by 6th Field HUC[1].

Sixth Field HUC[1]	Stream Type[2]	Stream Size	Road Length (mi)	Percentage of Total Road Length in HUC
HUC 171002020101	Fish	Large	1.2	1.7%
	Fish	Medium	1.3	1.8%
	Fish	Small	1.4	1.9%
	Non-fish	Small	3.8	5.3%
	Unknown	Unknown	0.5	0.8%
Total			***8.2***	***11.6%***
HUC 171002020102	Fish	Large	0.1	0.5%
	Fish	Medium	0.1	0.3%
	Fish	Small	0.3	1.0%
	Non-fish	Small	1.0	3.2%
	Unknown	Unknown	0.2	0.8%
Total			***1.8***	***5.8%***
HUC 171002020103	Fish	Medium	<0.1	0.2%
	Fish	Small	0.1	0.6%
	Non-fish	Medium	0.1	0.6%
	Non-fish	Small	1.7	10.5%
	Unknown	Unknown	0.1	0.5%
Total			***1.9***	***12.3%***
HUC 171002020105	Fish	Large	0.4	0.9%
	Fish	Medium	0.6	1.3%
	Fish	Small	0.3	0.7%
	Fish	Unknown	0.1	0.2%
	Non-fish	Small	1.7	3.8%
	Non-fish	Unknown	0.1	0.2%
	Unknown	Unknown	1.5	3.4%
Total			***4.8***	***10.5%***
HUC 171002020106	Fish	Small	0.4	2.1%
	Non-fish	Small	0.4	2.0%
	Unknown	Unknown	0.3	1.3%
Total			***1.0***	***5.4%***
HUC 171002020107	Unknown	Unknown	0.3	6.1%
HUC 171002020203	Fish	Medium	0.2	1.1%
	Fish	Small	0.7	4.2%
	Non-fish	Small	0.3	1.7%
	Unknown	Unknown	0.2	1.4%

Table 8-2. Length and percentage of forest roads within 100 feet of streams on ODF lands in the Upper Nehalem Watershed Analysis area, including stream type and size, by 6th Field HUC[1].

Sixth Field HUC[1]	Stream Type[2]	Stream Size	Road Length (mi)	Percentage of Total Road Length in HUC
Total			***1.4***	***8.5%***
HUC 171002020205	Fish	Large	0.1	0.2%
	Fish	Medium	0.3	0.8%
	Non-fish	Unknown	<0.1	0.1%
	Unknown	Unknown	1.3	3.2%
Total			***1.8***	***4.4%***
HUC 171002020206	Fish	Medium	0.2	0.9%
	Fish	Unknown	0.1	0.6%
	Unknown	Unknown	0.6	2.7%
Total			***1.0***	***4.2%***
HUC 171002020208	Fish	Large	0.9	1.0%
	Fish	Medium	0.3	0.4%
	Fish	Unknown	<0.1	0.2%
	Non-fish	Unknown	0.7	0.9%
	Unknown	Unknown	2.6	3.2%
Total			***4.7***	***5.7%***
HUC 171002020301	Fish	Medium	0.2	0.9%
	Non-fish	Unknown	<0.1	0.2%
	Unknown	Unknown	1.5	5.3%
Total			***1.8***	***6.4%***
HUC 171002020302	Fish	Medium	0.4	0.7%
	Fish	Unknown	0.1	0.2%
	Non-fish	Unknown	<0.1	0.1%
	Unknown	Unknown	4.8	9.0%
Total			***5.3***	***9.9%***
HUC 171002020303	Fish	Large	0.8	2.2%
	Fish	Medium	0.1	0.4%
	Fish	Small	0.1	0.4%
	Fish	Unknown	0.6	1.7%
	Non-fish	Unknown	0.4	1.2%
	Unknown	Unknown	5.6	16.2%
Total			***7.7***	***22.1%***

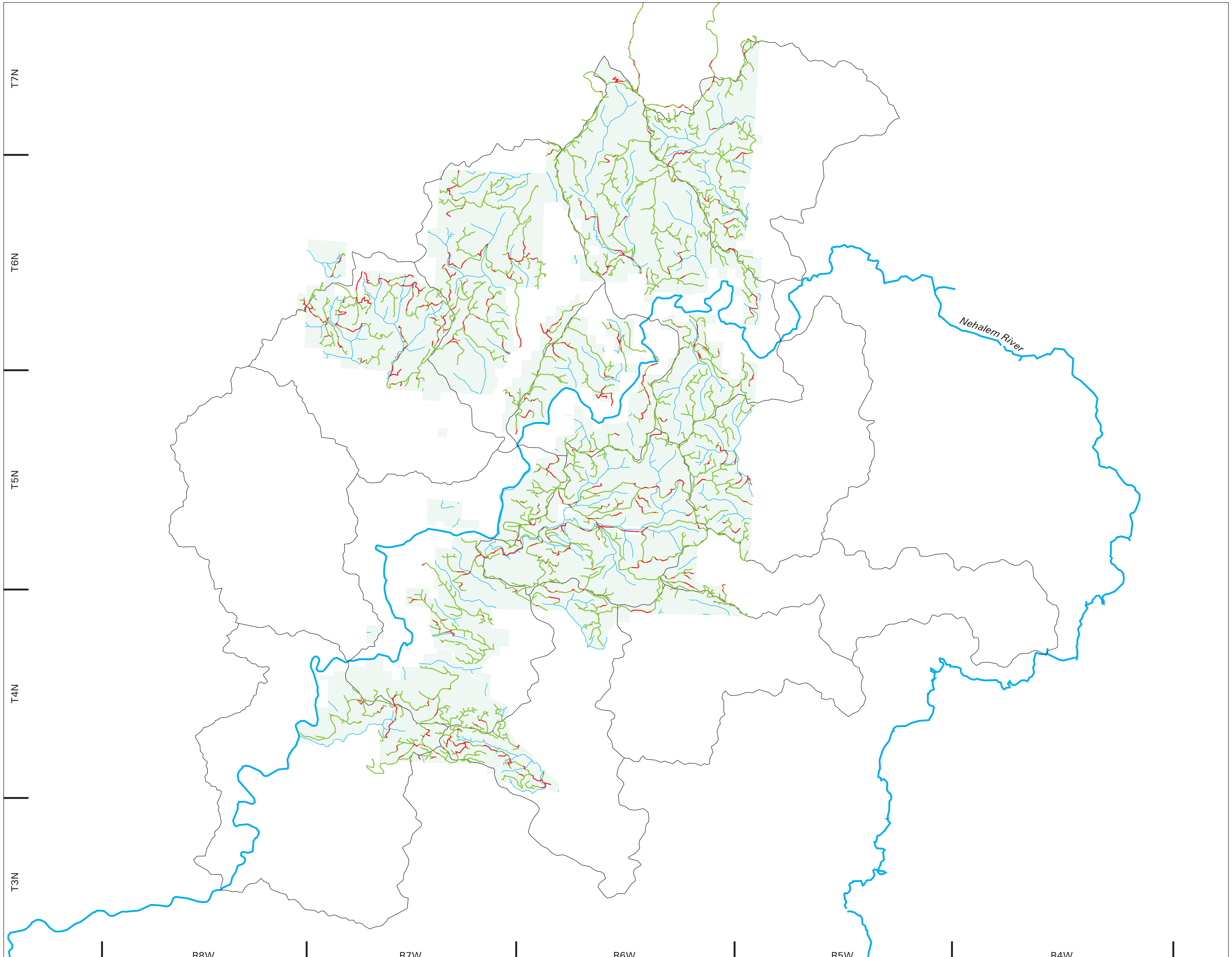
Table 8-2. Length and percentage of forest roads within 100 feet of streams on ODF lands in the Upper Nehalem Watershed Analysis area, including stream type and size, by 6th Field HUC[1].

Sixth Field HUC[1]	Stream Type[2]	Stream Size	Road Length (mi)	Percentage of Total Road Length in HUC
HUC 171002020304	Fish	Large	1.8	3.0%
	Fish	Medium	0.4	0.6%
	Fish	Small	<0.1	<0.1%
	Fish	Unknown	0.3	0.5%
	Non-fish	Unknown	0.5	0.7%
	Unknown	Unknown	2.8	4.7%
Total			***5.8***	***9.6%***
HUC 171002020305	Fish	Medium	0.3	0.5%
	Fish	Small	<0.1	0.1%
	Non-fish	Unknown	0.3	0.7%
	Unknown	Unknown	2.8	5.6%
Total			***3.4***	***7.0%***
HUC 171002020307	Fish	Medium	<0.1	0.3%
	Fish	Unknown	0.2	1.0%
	Non-fish	Unknown	0.1	0.9%
	Unknown	Unknown	1.0	6.6%
Total			***1.4***	***8.7%***
HUC 171002020402	Unknown	Unknown	0.2	6.9%
Clatskanie Watershed	Fish	Small	0.8	6.8%
	Non-Fish	Small	0.1	0.8%
Total			***0.9***	***7.7%***
Young's Bay Watershed	Fish	Small	<0.1	2.0%
	Fish	Unknown	0.1	3.2%
	Unknown	Unknown	0.3	13.2%
Total			***0.4***	***17.9%***
Project Total			***53.8***	***8.8%***

1 6th field HUC is a USGS Hydrologic Unit Code designating a subwatershed.
2 Stream types include fish bearing (Fish), non-fish bearing (Non-Fish), and unknown fish presence (Unknown)

8.2.2 Road Drainage

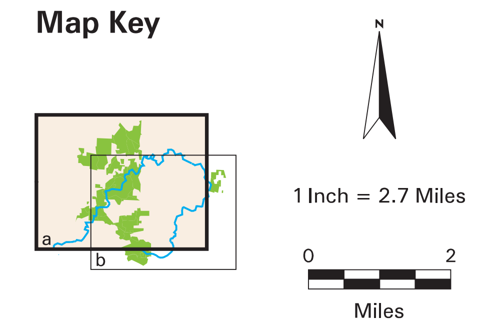
There are approximately 607 miles of forest road in the project area. Drainage for approximately 96 miles (15.8%) of forest road within the project area was assessed to have direct hydrologic connection to streams. Hydrologic connectivity of road drainage is summarized in Figure 8-1a,b



Legend

- Hydrologically Connected Road Segment
- Unconnected Road
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key



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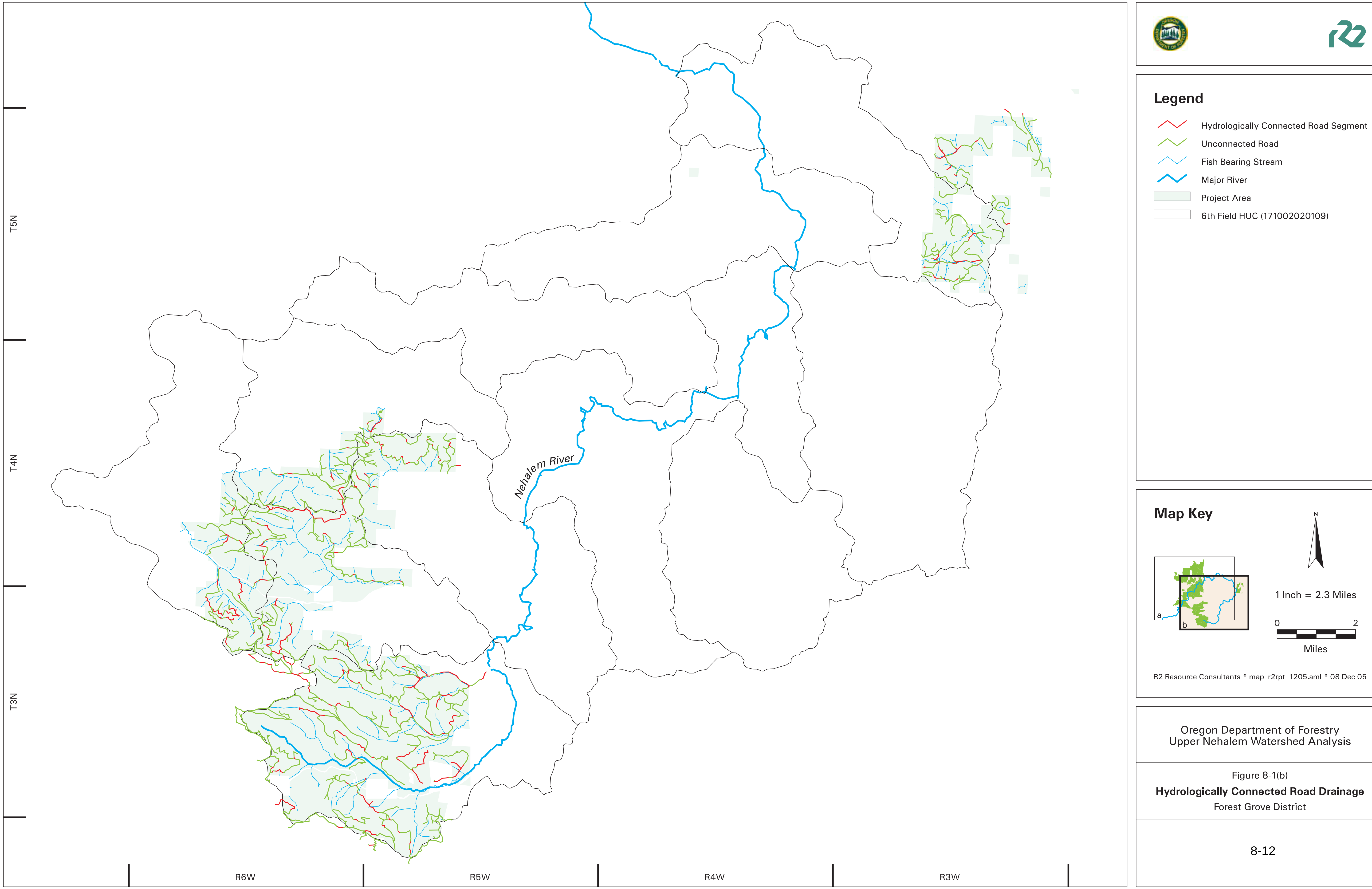
Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 8-1(a)
Hydrologically Connected Road Drainage
Astoria District



Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 8-1(b)
Hydrologically Connected Road Drainage
Forest Grove District

and Tables 8-3 and 8-4. The majority (67.4%) of forest roads in the project area were identified to have drainage AP code 5, indicating perfectly functioning road drainage (Table 8-5).

Table 8-3. Length and percentage of forest roads on ODF lands in the Upper Nehalem Watershed Analysis area in which the drainage system is directly connected to streams, by management basin.

Management Basin	Road Length (mi)	Percentage of Total Road Length
Fishhawk	2.6	8.2%
Northrup	3.9	10.3%
Beneke	7.6	16.4%
Lousignot	2.6	9.5%
Hamilton	11.3	30.4%
Crawford	5.3	20.9%
Sager	8.0	12.1%
Buster	16.1	15.6%
Quartz	8.5	16.6%
McGregor	8.5	14.5%
Wheeler	18.2	19.6%
Wilark	3.4	11.9%
Project Area Total	***96.0***	***15.8%***

Table 8-4. Length and percentage of forest roads on ODF lands in the Upper Nehalem Watershed Analysis area in which the drainage system is directly connected to streams, by 6th Field HUC.[1]

Sixth Field HUC[1]	Road Length (mi)	Percentage of Total Road Length
HUC 171002020101	12.9	18.3%
HUC 171002020102	6.3	20.5%
HUC 171002020103	1.6	10.0%
HUC 171002020105	9.5	20.8%
HUC 171002020106	2.4	12.6%
HUC 171002020107	1.0	20.3%
HUC 171002020203	1.8	11.0%
HUC 171002020205	3.6	8.9%
HUC 171002020206	2.6	11.3%
HUC 171002020208	7.9	9.7%
HUC 171002020301	5.4	19.5%
HUC 171002020302	9.1	17.1%
HUC 171002020303	10.6	30.4%
HUC 171002020304	11.4	18.8%
HUC 171002020305	4.8	9.8%
HUC 171002020307	2.4	15.5%
HUC 171002020402	0.3	10.9%
Clatskanie Watershed	1.5	13.0%
Young's Bay Watershed	0.7	30.2%
Project Area Total	***96.0***	***15.8%***

1 Sixth field HUC is a USGS Hydrologic Unit Code designating a subwatershed.

Table 8-5. Length and percentage of road associated with each road drainage AP code in the Upper Nehalem Project Area.

Road Drainage AP Code	Road Length (Mi)	Percentage of Total Roads
AP Code 1	0.3	<0.1%
AP Code 2	2.0	0.3%
AP Code 3	10.5	1.6%
AP Code 4	203.7	30.7%
AP Code 5	448.0	67.4%

8.2.3 Critical Road Locations

Critical road locations identified within the project area included roads with sidecast/fill slides, fill slides, stream in ditch, stream parallel roads, wetland adjacent roads, roads with steep fill, and roads with steep full-bench. Canyon fill, channel fill, deep active slide and deep inactive slide road types were not observed in the project area. The total length of critical roads identified in the project area is 33.6 miles, or approximately 5.5 percent of the total road length (Table 8-6). The vast majority of roads (94.4%) in the project area were designated non-critical during 2005 RIMS surveys. The roads with the greatest length of road in critical location are BU Road in the Buster Management Basin, which has 1.75 miles of stream parallel road, and NLOU Road in the Wheeler Management Basin, with 1.36 miles of stream parallel and steep fill roads. The types and locations of critical roads within the Upper Nehalem project area are identified in Figure 8-2a,b.

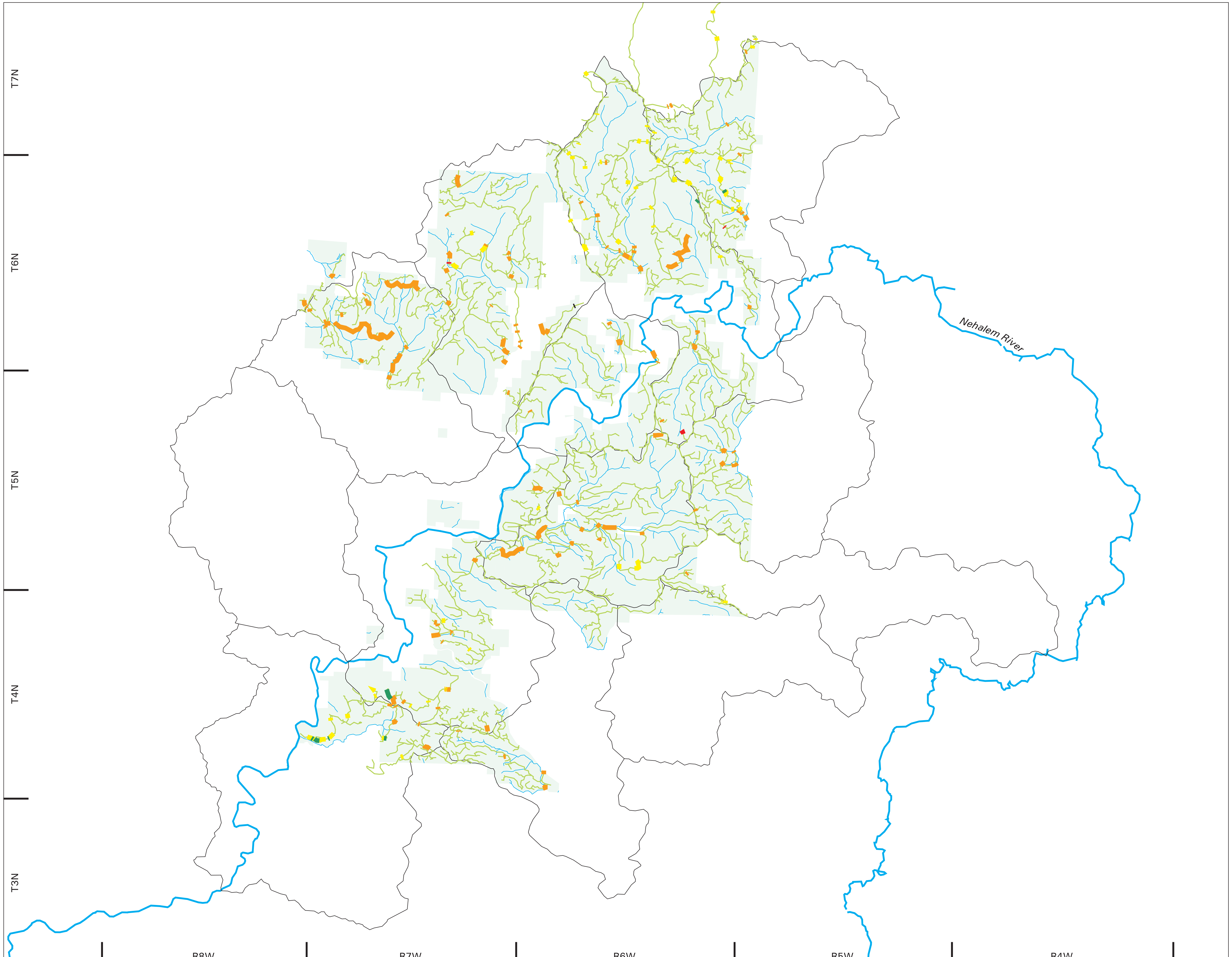
Table 8-6. Length and percentage of road associated with each critical and non-critical road location type in the Upper Nehalem Project Area.

Road Location Type	Road Length (Mi)	Percentage of Total Roads
Critical Roads		
Sidecast/Fill Slide	0.11	<0.1%
Fill Slide	0.16	<0.1%
Stream in ditch	0.01	<0.1%
Stream parallel[1]	25.12	4.1%
Wetland adjacent	0.09	<0.1%
Steep fill	7.16	1.2%
Steep full-bench	0.98	0.2%
Total Critical Roads	*33.6*	*5.5%*
Non-Critical Roads	573.3	94.4%

[1] Stream adjacent roads considered in Section 8.2.1 include mileage associated with stream parallel roads and stream crossings.

8.2.4 Road Prism Stability

A total of five road sections in the Upper Nehalem Project Area, totaling approximately 0.26 mile, are located in sidecast/fill or fill slides (Table 8-7). Approximately 67 percent of road prisms in the project area were assessed to be stable, with a road prism AP Code 5, and an



Legend

- Cut/Fill Slide
- Fill Slide
- Stream in Ditch
- Stream Parallel
- Wetland
- Steep Fill
- Steep Full-Bench
- Non-Critical Road
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key

a
b

N

1 Inch = 2.7 Miles

0 2

Miles

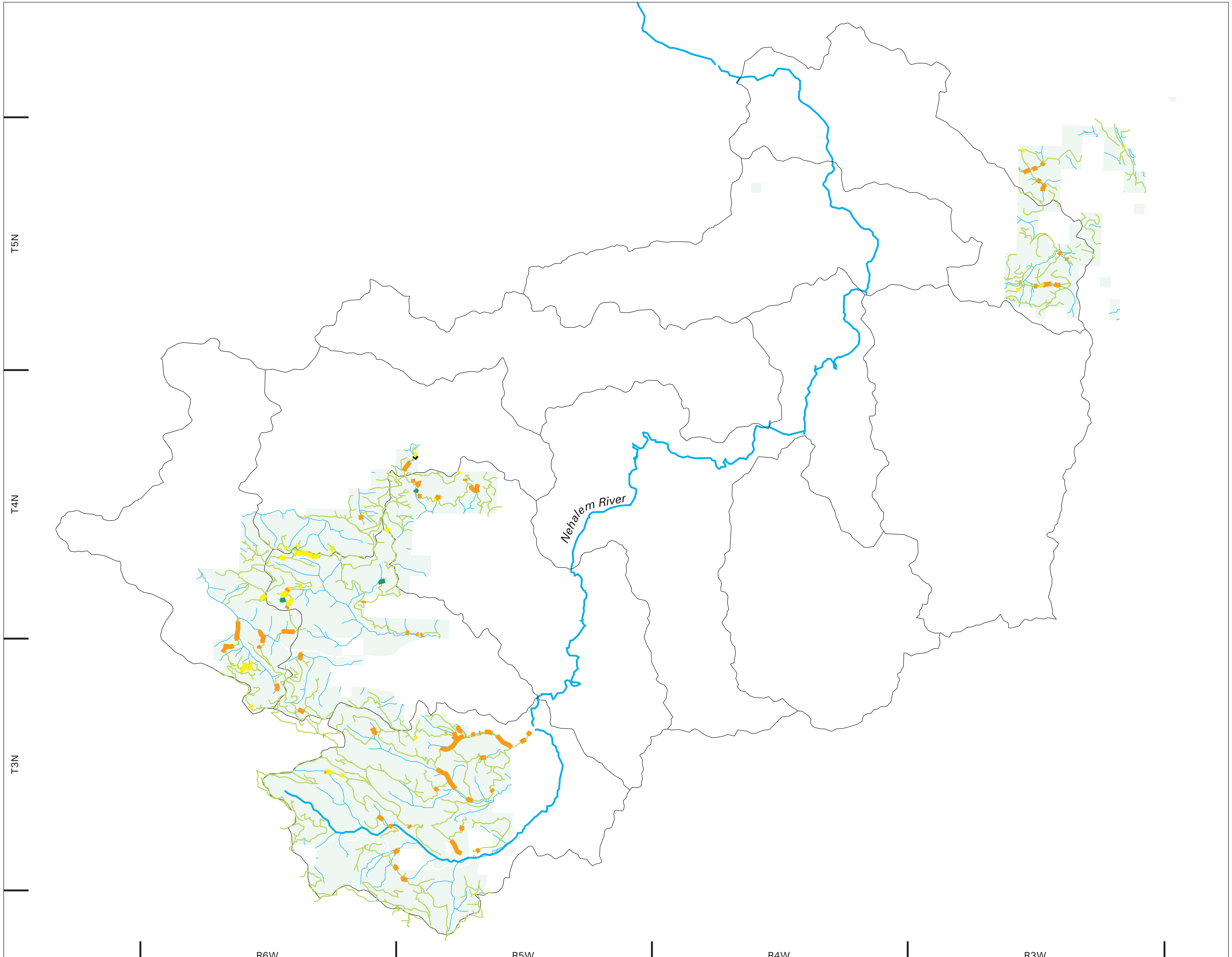
R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 8-2(a)

Critical Road Types and Locations

Astoria District



Legend

- Cut/Fill Slide
- Fill Slide
- Stream in Ditch
- Stream Parallel
- Wetland
- Steep Fill
- Steep Full-Bench
- Non-Critical Road
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key

1 Inch = 2.3 Miles

0 2

Miles

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Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 8-2(b)

Critical Road Types and Locations

Forest Grove District

additional 30 percent was identified to have only minor bare soil exposure on the cutslope only (Table 8-8).

Table 8-7. Location and length of critical road sections in the Upper Nehalem Project Area with sidecast/fill and fill slide conditions.

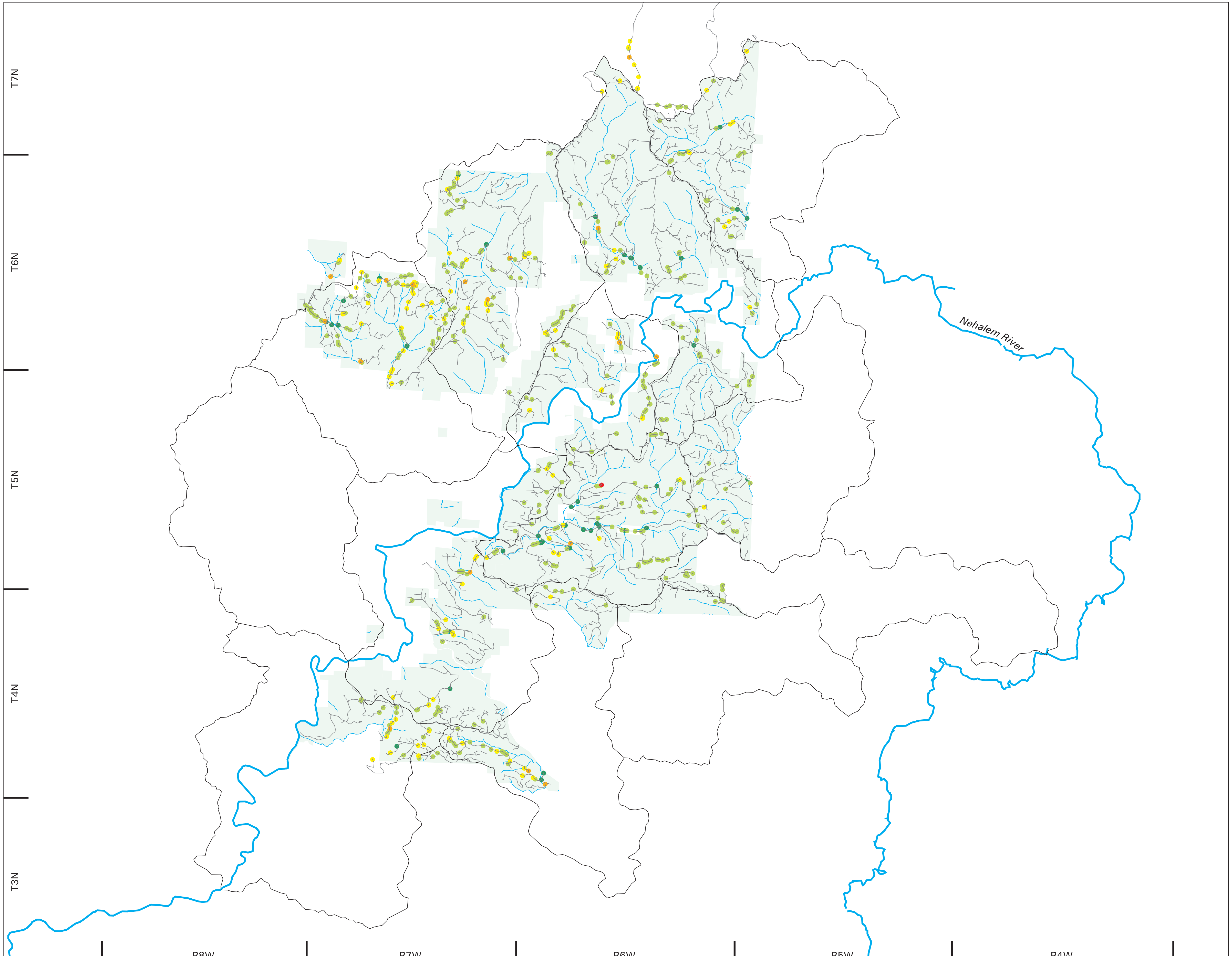
Management Basin	Road Name	Road Location (Road Mile)	Road Length (Mi)	Critical Road Type
McGregor	Lower Rock Creek	0.54	0.09	Sidecast/fill slide
Crawford	Crawford Ridge 14010	1.21	0.02	Sidecast/fill slide
Sager	East Sager Vacated 3	0.23	0.10	Fill slide
Beneke	Beneke Vacated 1	0.45	0.03	Fill slide
Lousignot	Vesper Spur 16850	0.08	0.02	Fill slide

Table 8-8. Length and percentage of road associated with each road prism stability AP code in the Upper Nehalem Project Area.

Road Drainage AP Code	Road Length (Mi)	Percentage of Total Roads
AP Code 1	n/a	n/a
AP Code 2	0.2	0.1%
AP Code 3	16.7	2.5%
AP Code 4	200.8	30.2%
AP Code 5	446.3	67.2%

8.2.5 Stream Crossings

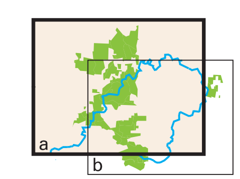
A total of 720 stream crossings were identified within the Upper Nehalem Project Area. Of this total, three stream crossings identified as barriers occur on known fish bearing streams, while 559 crossings were assessed to have no fish passage restriction. A summary of fish passage at stream crossings within the project area is provided in Figure 8-3a,b and Table 8-9.



Legend

- Known Fish Passage Barrier
- Likely Fish Passage Barrier
- Possible Fish Passage Barrier
- Known Fish Absence
- Full Fish Passage
- RIMS Road Network
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key



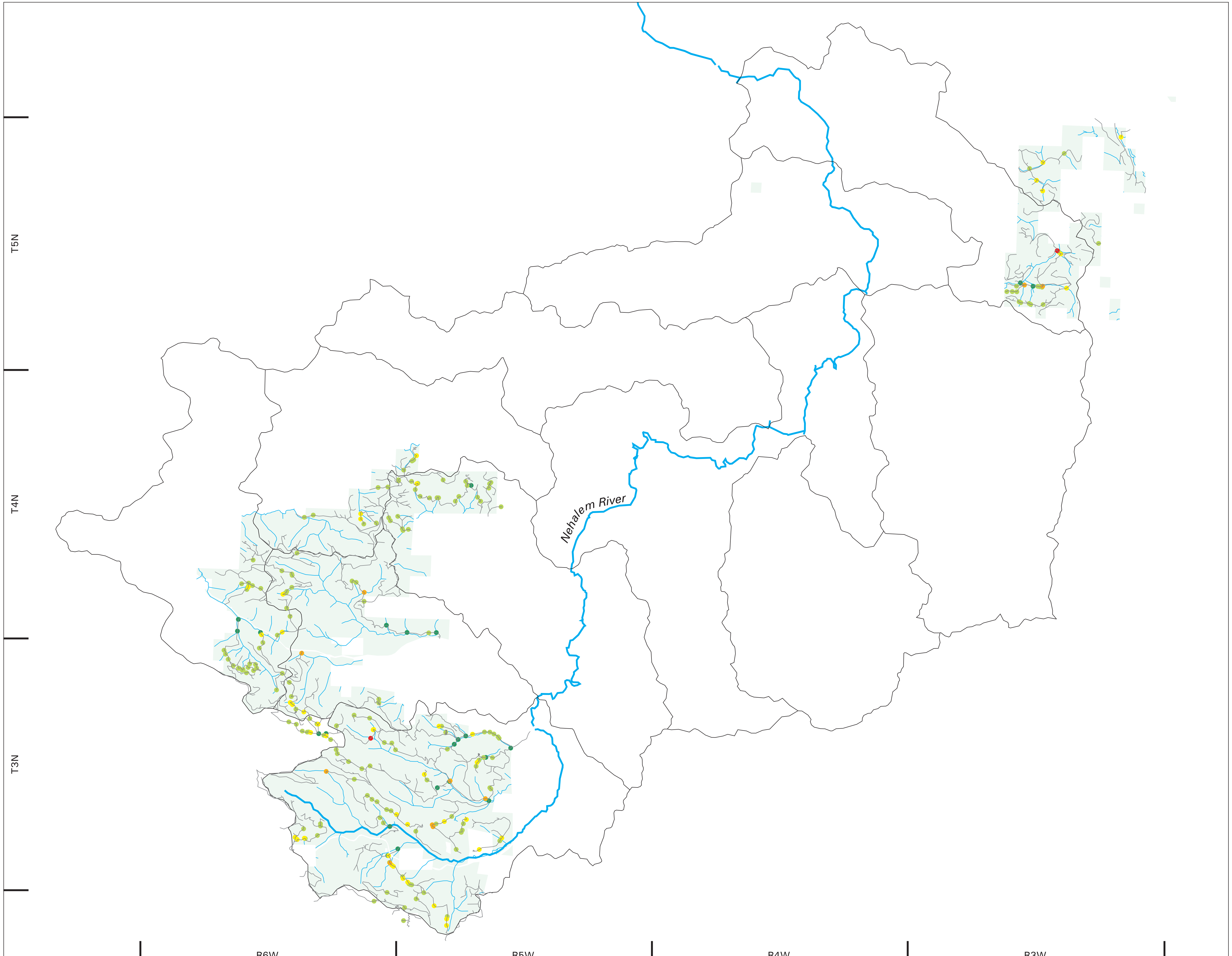
1 Inch = 2.7 Miles

0 2
Miles

R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 8-3(a)
Fish Passage Condition
Astoria District



Legend

- Known Fish Passage Barrier
- Likely Fish Passage Barrier
- Possible Fish Passage Barrier
- Known Fish Absence
- Full Fish Passage
- RIMS Road Network
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key

1 Inch = 2.3 Miles

0 2

Miles

R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 8-3(b)

Fish Passage Condition

Forest Grove District

Table 8-9. Number and type of fish passage barriers at stream crossings within the project area by management basin.

Fish Presence Condition	**Barrier Type[1]**			
	Known Barriers	**Likely Barriers**	**Possible Barriers**	**No Passage Restriction[2]**
Fishhawk Mgt Basin				
Adult and Juvenile	0	0	1	2
Juvenile Only	0	0	4	-
No fish	-	-	-	13
Total	***0***	***0***	***5***	***15***
Northrup Mgt Basin				
Adult and Juvenile	0	0	1	5
Juvenile Only	0	1	3	-
No fish	-	-	-	15
Total	***0***	***1***	***4***	***20***
Beneke Mgt Basin				
Adult and Juvenile	0	0	4	2
Juvenile Only	0	3	8	-
No fish	-	-	-	42
Total	***0***	***3***	***12***	***44***
Lousignot Mgt Basin				
Adult and Juvenile	0	0	2	2
Juvenile Only	0	0	1	-
No fish	-	-	-	16
Total	***0***	***0***	***3***	***18***
Hamilton Mgt Basin				
Adult and Juvenile	0	4	10	7
Juvenile Only	0	1	13	-
No fish	-	-	-	50
Total	***0***	***5***	***23***	***57***
Crawford Mgt Basin				
Adult and Juvenile	0	1	5	0
Juvenile Only	0	0	5	-
No fish	-	-	-	22
Total	***0***	***1***	***10***	***22***
Sager Mgt Basin				
Adult and Juvenile	0	0	2	2
Juvenile Only	0	0	2	-
No fish	-	-	-	48
Total	***0***	***0***	***4***	***50***

Table 8-9. Number and type of fish passage barriers at stream crossings within the project area by management basin.

Fish Presence Condition	Barrier Type[1] Known Barriers	Likely Barriers	Possible Barriers	No Passage Restriction[2]
Buster Mgt Basin				
Adult and Juvenile	0	1	10	16
Juvenile Only	1	1	5	-
No fish	-	-	-	100
Total	***1***	***2***	***15***	***116***
Quartz Mgt Basin				
Adult and Juvenile	0	1	4	5
Juvenile Only	0	2	14	-
No fish	-	-	-	41
Total	***0***	***3***	***18***	***46***
McGregor Mgt Basin				
Adult and Juvenile	0	0	5	4
Juvenile Only	0	1	2	-
No fish	-	-	-	55
Total	***0***	***1***	***7***	***59***
Wheeler Mgt Basin				
Adult and Juvenile	0	3	12	14
Juvenile Only	1	4	14	-
No fish	-	-	-	80
Total	***1***	***7***	***26***	***94***
Wilark Mgt Basin				
Adult and Juvenile	0	0	4	2
Juvenile Only	1	2	2	-
No fish	-	-	-	16
Total	***1***	***2***	***6***	***18***
Project Total	***3***	***25***	***133***	***559***

1 Known barriers represent barriers on known fish bearing streams.
Likely barriers represent barriers on likely fish bearing streams.
Possible barriers represent barriers on streams of unknown fish presence.
On streams with known fish absence, fish passage is not applicable

2 No passage restrictions represent crossings that do not impede fish movement, including crossings that allow full fish passage on known, likely, and unknown fish bearing streams and all crossings on streams with known fish absence.

Of the 720 stream crossings within the project area, eight were determined to be at high risk of washout while 484 were assessed to be at low risk of washout. No washouts were recorded at stream crossing assessed during RIMS surveys. A summary of washout risk at stream crossings within the project area is provided in Table 8-10.

Table 8-10. Diversion and washout risk ratings at road stream crossings on ODF lands in the Upper Nehalem watershed analysis area, by management basin.

	Diversion/Washout Risk			
Management Basin	**Low**	**Moderate**	**High**	**Total**
Fishhawk	19	1	0	20
Northrup	15	10	0	25
Beneke	39	19	1	59
Lousignot	14	6	1	21
Hamilton	50	34	1	85
Crawford	7	26	0	33
Sager	32	20	2	54
Buster	98	34	2	134
Quartz	54	13	0	67
McGregor	57	10	0	67
Wheeler	80	48	0	128
Wilark	19	7	1	27
Project Area Total	***484***	***228***	***8***	***720***

8.2.6 Recreational Trails

There were approximately 14.6 miles of recreational trails in the project area. Recreational trails on ODF lands included approximately 8.8 miles of ATV trails in Northrup and Fishhawk management basins and 5.8 miles of hiking trails in Quartz, McGregor, and Wheeler management basins. Based on mapped distributions, sections of ATV trail were adjacent to Northrup and Fishhawk creeks however information on trail condition and impact of the trail on adjacent streams were not available for this analysis. Sections of hiking trails also appeared to be stream adjacent, however the erosion related impacts of these portions of trails on adjacent streams were likely minimal and were not identified in this analysis.

8.2.7 Non-Forested Area Due to Roads

The total land area dedicated to roads (permanent non-forested) in the Upper Nehalem Project Area is 1,998 acres, or is approximately 2 percent of the total project area. The total non-forested area was calculated based on the total mileage of all active and inactive forest roads. The total length of active and inactive roads in the project area is 643 miles, which include approximately 36 miles of inactive or inaccessible roads that were not assessed during 2005 RIMS surveys.

8.3 SUMMARY

1. *What proportion of road length is within 100 feet of streams?*

   Of 607 total miles of forest road in the project area, 53.8 (8.8%) are steam adjacent.

2. *What proportion of road related drainage ditches are directly connected to the stream network?*

   Approximately 96 miles, or 15.8 percent, of the total road system has direct hydrological connection to the stream network.

3. *What roads are in critical locations?*

   A total of 33.6 miles, or 5.5 percent of forest roads are in critical locations. The roads with greatest in critical location are Buster Creek Road in the Buster Management Basin, which has 1.76 miles of stream parallel road, and North Lousignont Road in the Wheeler Management Basin, with 1.36 miles of stream parallel and steep fill roads.

4. *What roads have road prism instability, including sidecast/fill landslides?*

   No roads in the project area were identified to have prism AP Code 1. Two road sections are located on sidecast/fill slides: Lower Rock Creek Road and Crawford Ridge 14010. Three road sections are located on fill slides: East Sager Vacated 3, Beneke Vacated 1, and Vesper Spur 16850.

5. *How many stream crossings are barriers to fish passage?*

   A total of three stream crossings are barriers to juvenile fish and occur on known fish bearing streams.

6. *Are road washouts of stream crossing fills present in the project area?*

No washouts are present in the project area.

7. *Do recreation trails contribute to sediment or erosion problems?*

   The 14.6 miles of hiking and ATV trails in the project area likely to have minimal erosion related impacts.

8. *What proportion of the project area is non-forested due to forest roads?*

   The total land area dedicated to roads (permanent non-forested) is 1,998 acres, which is approximately 2 percent of the total project area.

8.4 CONFICENCE IN WORK PRODUCT

The analysis in this section was based predominantly on data recorded during the 2005 RIMS roads surveys of the Upper Nehalem Project Area. Data gathered during these surveys was considered to be preferable to GIS derived estimates based on the level of visual field verification of road and stream features inherent in the RIMS surveys. For this reason there is high confidence in the summaries of road locations and characteristics provided in this analysis.

9. WATER QUALITY

This Chapter consists of a water quality assessment along fish-bearing streams in the upper Nehalem watershed. It should be regarded as supplemental to the PSU water quality assessment prepared by Johnson and Maser (2000). The primary purpose of this effort was to perform a remote assessment of riparian vegetation conditions to estimate the radiation-blocking angles along stream corridors and to make projections of potential stream temperatures based on current, historical and future riparian conditions. Within this assessment, vegetation heights, topographic blocking elements and reasonably achievable surface water temperatures are estimated for eleven management basins and two contiguous parcels falling within the ODF Forest Grove and Astoria Districts. The assessment also includes an update of other key water quality parameters to augment the PSU watershed analysis.

9.1 SURFACE WATER TEMPERATURE ASSESSMENT

The purpose of the riparian assessment was to assess the conditions in the watershed and determine how the current conditions compare to riparian characteristics typically present along various stream channel types for the ecoregions encompassing the watershed. In addition, ODF wished to forecast 50 to 100 years in the future and make an assessment of the potential feasibility of stands to provide appropriate conditions to maintain surface water temperatures.

9.1.1 Background

A watershed analysis was completed for the Nehalem watershed by Portland State University (Johnson and Maser 2000). This analysis provided a screening level assessment of water quality parameters in the watershed in accordance with the Oregon watershed assessment manual (Watershed Professionals Network 1999). Critical water quality questions addressed under the OWEB process included:

OWEB Critical Questions

1. *What are the designated beneficial uses of water for the stream segments?*
2. *What are the water quality criteria that apply to the stream reaches?*
3. *Are stream reaches identified as water quality limited on the 303(d) list by the state?*
4. *Are any stream reaches identified as high-quality waters or Outstanding Resource Waters?*
5. *Do water quality studies or evaluations indicate that water quality has been degraded or is limiting the beneficial uses?*

Water quality information was collected for beneficial stream uses, for 303(d) listed reaches, and for outstanding resource waters and available water quality data collected by ODEQ, Upper and Lower Nehalem Watershed Councils and the Isaak Walton League of America were summarized. Beneficial uses in the Nehalem River included those necessary to maintain salmonid habitat and aquatic life, domestic water supply, livestock watering, recreation and industrial water supply (Johnson and Maser 2000). Water quality impairments of particular parameters (temperature, dissolved oxygen, pH, nutrients, bacteria, turbidity and macroinvertebrate communities) based on current water quality standards (or benthic indices of biological integrity for macroinvertebrates) for the stream reaches and beneficial uses in question were identified according to the following OWEB protocol:

Not Impaired	=	< 15% of samples exceed the state water quality standard
Moderately Impaired	=	15 to 50% of samples exceed the water quality standard
Impaired	=	> 50% of samples exceed the water quality standard

Although water quality sampling was limited in the basin, the PSU analysis found no impairments for dissolved oxygen (D.O.), pH, bacteria (as represented by *E. coli*), phosphate, turbidity or contaminants during their data review in 1998 and 1999 in the middle and upper Nehalem Subbasins (Johnson and Maser 2000). The analysis noted elevated levels of nutrients, primarily nitrate, in the fall, winter and spring. The impairments were attributed to heavy rainfall which may have eroded organic materials from stream banks, hillslopes and fields. A macro-invertebrate analysis conducted in 1998 by the Nehalem Watershed Councils indicated clear evidence of stream disturbance as highlighted in the Index of Biotic Integrity (IBI) downstream of Fishhawk dam. Other sites were considered either slightly impaired or not impaired compared to reference sites in the region.

The PSU watershed analysis included a riparian shade assessment based on 1995 aerial photos as well as a water quality temperature assessment of current temperature monitoring data. The riparian inventory categorized the existing shade conditions using the size of the stream and the vegetation continuity and age along each reach as factors for determining whether the riparian areas represented high, moderate or low shade conditions as follows:

High	=	Shade > 70% (stream surface on aerial photos not visible or visible in patches)
Moderate	=	Shade 40 – 70% (stream surface on aerial photos is visible, but banks are not visible)

Low = Shade < 40% (stream surface and banks are visible on aerial photos)

The PSU assessment indicated that the mainstem river and large stream reaches in the Lower, (HUC #1710020203), Middle (HUC #1710020202) and Upper Nehalem River (HUC #1710020201) subwatersheds received a moderate amount of riparian shade and the small stream reaches generally received a high degree of shade. A few exceptions occurred in the subwatersheds where vegetation was lacking due to land use practices (Refer to Figure 7-5 of the PSU watershed analysis).

At the time of the PSU report, water temperatures along the mainstem Nehalem River were seasonally high. Multiple water bodies, including the mainstem Nehalem River from its mouth to Rock Creek was listed (on 303(d) list) as water quality limited due to elevated summer water temperatures. DEQ defined the designated fish use in the Upper Nehalem watershed as “core, cold-water habitat.” The seven-day-average maximum temperature (7-Dmax) for core, cold-water habitat use may not exceed 16.0ºC (60.8ºF) (OAR 340-041). Temperature data reviewed indicated that peak summer water temperatures routinely exceeded this standard along the mainstem river upstream to the confluence of Rock Creek near Vernonia, in the EF Nehalem River and in Fishhawk, Little Fishhawk, Beneke, Deep and Rock creeks (Johnson and Maser 2000). Historic water temperature data prior to land use activities in the upper watershed were not available.

The information presented in the PSU watershed analysis was sufficient to answer the OWEB critical questions and will not be further evaluated herein. The assessment included in this chapter should be considered supplemental to the PSU watershed analysis and it specifically addresses the ODF additional questions concerning surface water temperatures of stream reaches adjacent to ODF lands in the Upper Nehalem Watershed as itemized below:

ODF Supplemental Questions for Water Quality

1. *What stream temperatures are reasonably achievable on State Forests?*
2. *How do the current shade levels along streams compare to historic levels by sub-watershed and stream size?*
3. *How do the current stream temperature levels compare to historic levels by sub-watershed and stream size?*
4. *How do water temperatures compare to other nearby basins with similar flows and geology?*

The assessment also updated other key water quality parameters monitored in the basin since publication of the PSU Nehalem Watershed Analysis (Section 9.2).

9.1.2 Methods

The range and variability of historic temperature conditions in the watershed were unknown. However, with a few assumptions historical conditions were estimated. The state of Washington guidelines for conducting watershed analysis provide a View-to-the-Sky (VTS) methodology that is appropriate for addressing the ODF supplemental questions (Washington Forest Practices Board 1997). A description of this methodology is provided in Appendix E. The VTS temperature approach estimates the potential maximum surface water temperatures based on channel size, elevation and riparian canopy closure, following the Washington state temperature/elevation screen (Sullivan et al. 1990).

The VTS methodology is a geometric expression of the relationship between vegetation height and stream channel width. It is a measure of the fraction of a hemisphere centered over the stream that is unobstructed by either vegetation or topography. These factors control the relative openness of a channel and the amount of incoming and outgoing solar radiation. A waterbody's openness to the sky (often regarded as the opposite of shade or canopy closure) is a major factor influencing stream temperature, especially as it relates to the blockage of direct incoming and outgoing solar radiation. The proportion of the sky effectively blocked by streamside vegetation and topography determines the relative degree water temperatures will be depressed below ambient air temperatures. Coupled with a temperature elevation screen (Sullivan et al. 1990), VTS calculations can be used to estimate potential stream temperatures (Washington Forest Practices Board (WFPB) 1997). Campbell and Kvam (2003) found the VTS calculations produced a good representation of measured stream temperatures, unless streams exhibit strong thermal responses to either groundwater influx or wetland/ponded water runoff.

Sullivan et al. (1990) also suggested that a relationship exists between the ability of shade to influence water temperatures and the distance from the watershed divide. When stream channels become sufficiently wide and deep, shade no longer has an effect on moderating stream temperatures. Sullivan et al. (1990) referred to this point as a "threshold" distance where the mean daily water temperatures equilibrate primarily to local air temperatures. They implied that under normal channel conditions the "threshold" distance would typically lie 31 to 37 miles from the divide where water temperature equilibrate to ambient air temperatures regardless of shade. Shade reductions caused by land use processes were assumed to have little influence on water temperatures at low elevations in watersheds. Sullivan et al. (1990) referred to this point as the "threshold distance" from the stream origin where water temperature was determined by air temperature. Upstream of this “threshold” elevation, shade could have a pronounced effect on surface water temperatures and could influence the degree that stream temperatures are depressed below ambient average air temperatures as well as the range of daily fluctuations.

Input factors and the specific approach taken in developing a VTS temperature model for the upper Nehalem watershed are described in Appendix F.

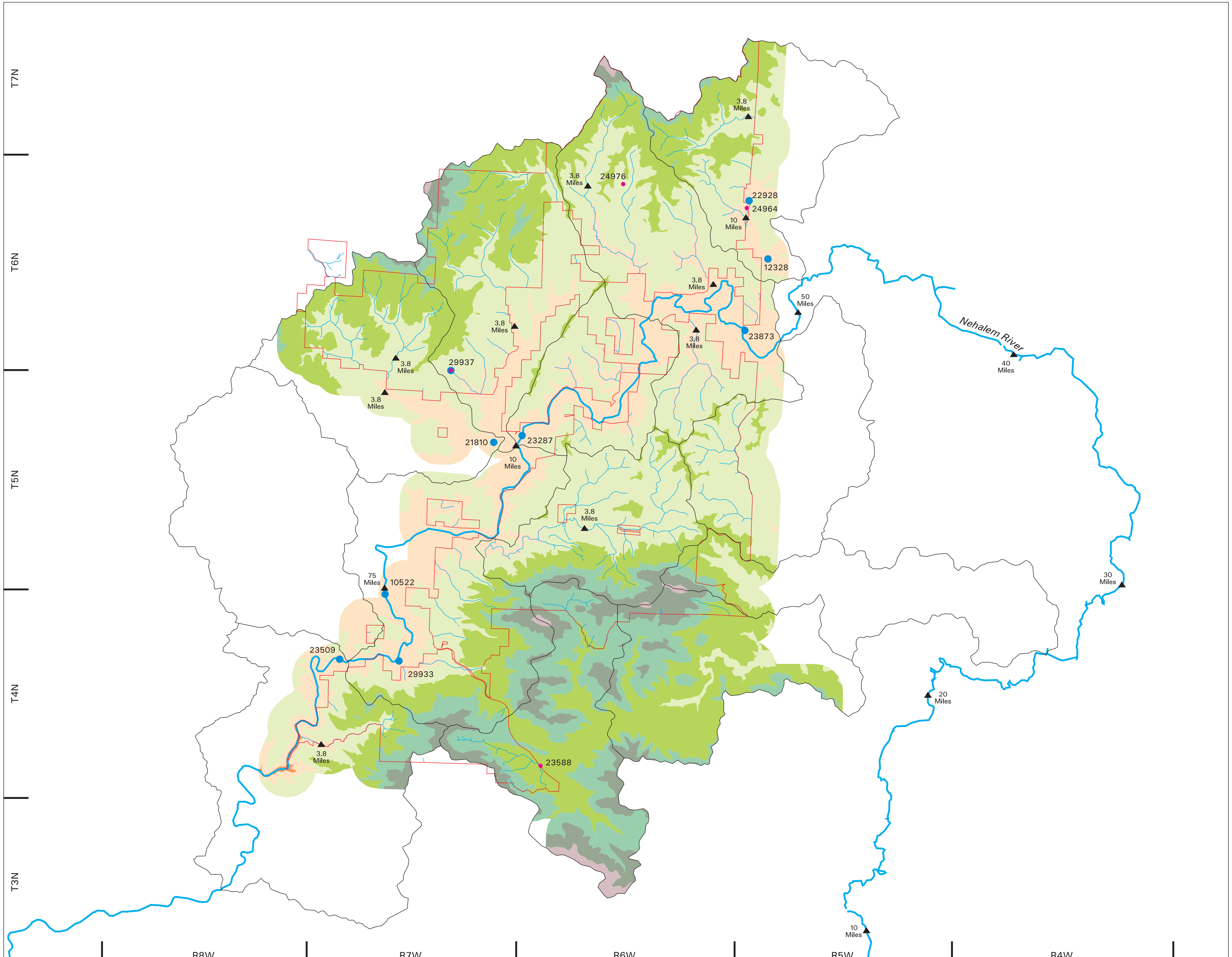
9.1.3 Results

9.1.3.1 Reference Riparian Conditions

Reference surface water temperatures for the upper Nehalem watershed based on channel size, channel confinement and elevation bands are shown as ranges in Table 9-1 and are included in Table 9-3. The low end of the range represents the expected surface water temperatures under assumptions of mature timber, either conifer or hardwood species, growing immediately adjacent to the channels. The upper end of the range represents the expected water temperatures with an estimate of 20 percent openings in an otherwise mature hardwood forest canopy.

According to the VTS model, ODF stream channels in the Forest Grove and Astoria Districts prior to European influence likely supported 7-Dmax summer water temperatures between 12.7ºC and 17.5ºC, depending upon channel size and elevation. Fish-bearing waters on ODF lands encompass a wide range of elevations and channel sizes from a low of 300 feet msl along the mainstem Nehalem River in the Quartz Management Unit (Astoria District) to a high of 2,700 feet msl on a small, unnamed tributary to the SF of Rock Creek in the Wheeler Management Unit (Forest Grove District). A brief summary of reference temperatures as a function of channel size, elevation and reference riparian tree heights is provided in Table 9-1 (Figures 9-1a,b).

According to the model, streams wider than 50 feet BFW in the watershed downstream of 680 feet msl in elevation were not anticipated to achieve the summer core, cold-water temperature standard of 16ºC under mature coniferous forest canopy. The height of radiation blocking elements would need to be on the order of 181 feet to achieve the temperature standard compliance for a 50-feet bankfull channel at the downstream end of the ODF assessment area (~ 300 ft msl). Similarly, the average large-size stream in the watershed of 40 feet was anticipated to naturally exceed the state core, cold-water standard downstream of 540 feet msl elevation in hardwood-dominated situations and downstream of 320 feet msl elevation in conifer-dominated situations. The balance of stream channels in the watershed under a mature riparian canopy should have the potential to comply with the current state standards.



Legend

- 2400 to 2960 feet msl
- 1960 to 2400 feet msl
- 1640 to 1960 feet msl
- 1160 to 1640 feet msl
- 680 to 1160 feet msl
- 320 to 680 feet msl
- < 320 feet msl
- Water Temperature Station
- Water Quality Station
- Distance from Watershed Divide
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key

N

a
b

1 Inch = 2.7 Miles

0 2

Miles

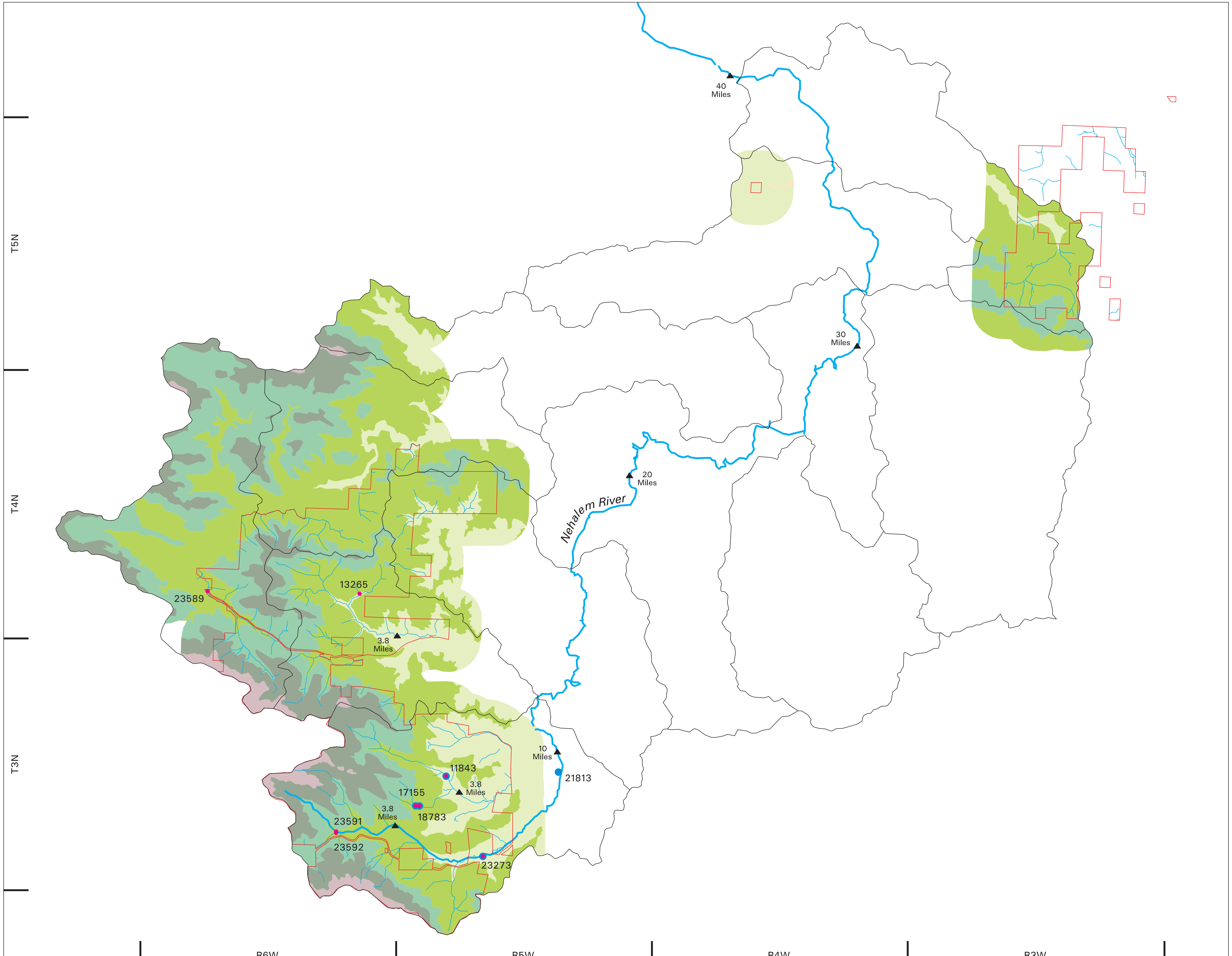
R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 9-1(a)

Elevation and Distance Zones for Reference Temperatures

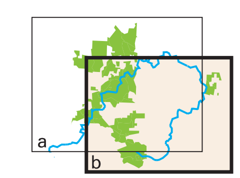
Astoria District



Legend

- 2400 to 2960 feet msl
- 1960 to 2400 feet msl
- 1640 to 1960 feet msl
- 1160 to 1640 feet msl
- 680 to 1160 feet msl
- 320 to 680 feet msl
- < 320 feet msl
- Water Temperature Station
- Water Quality Station
- Distance from Watershed Divide
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key



1 Inch = 2.3 Miles

0 2

Miles

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Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 9-1(b)

Elevation and Distance Zones for Reference Temperatures

Forest Grove District

9.1.3.2 Existing Riparian Conditions

Existing riparian condition codes from stream adjacent stands included in Table 6-1 were used to approximate the current stand heights as shown in Table 9-2. VTS estimates of the range of existing surface water temperatures are shown in Figures 9-2a,b to 9-4a,b and are summarized in Table F-1, (Appendix F). The data were organized by riparian stand characteristics for each of the ODF management basins and 6th field HUCs within the upper Nehalem watershed in Table 9-3.

Table 9-1. Lookup Table for Reference Temperature Codes in the Upper Nehalem Watershed.

Reference Temperature Codes

Conifer-Dominated andf Mixed Stands (150-ft mature tree height)

Elevation Bands for 16C	Stream Type = Small; BFW = 10'			Stream Type = Medium; BFW = 20'			Stream Type = Large; BFW = 40'		
	Potential View-to-Sky (V%)	Maximum Allowable View - to the - Sky[1] (S%)	Reference Temp. (T^oC)	Potential View-to-Sky (V%)	Maximum Allowable View - to the - Sky[1] (S%)	Reference Temp. (T^oC)	Potential View-to-Sky (V%)	Maximum Allowable View - to the - Sky[1] (S%)	Reference Temp. (T^oC)
>3920	2.1	100	9.0	4.2	100	9.2	8.4	100	9.5
3600	2.1	90-99	9.8	4.2	90-99	9.9	8.4	90-99	10.2
3280	2.1	80-90	10.5	4.2	80-90	10.7	8.4	80-90	11.0
2960	2.1	70-80	11.2	4.2	70-80	11.4	8.4	70-80	11.7
2400	2.1	60-70	12.0	4.2	60-70	12.1	8.4	60-70	12.5
1960	2.1	50-60	12.7	4.2	50-60	12.9	8.4	50-60	13.2
1640	2.1	40-50	13.5	4.2	40-50	13.6	8.4	40-50	13.9
1160	2.1	30-40	14.2	4.2	30-40	14.4	8.4	30-40	14.7
680	2.1	20-30	15.0	4.2	20-30	15.1	8.4	20-30	15.4
<200	2.1	10-20	15.7	4.2	10-20	15.9	8.4	10-20	16.2

Hardwood-Dominated Stands in Unconfined Channel Types (99-ft mature tree height)

Elevation Bands for 16C	Stream Type = Small; BFW = 10'			Stream Type = Medium; BFW = 20'			Stream Type = Large; BFW = 40'		
	Potential View-to-Sky (V%)	Maximum Allowable View - to the - Sky[1] (S%)	Reference Temp. (T^oC)	Potential View-to-Sky (V%)	Maximum Allowable View - to the - Sky[1] (S%)	Reference Temp. (T^oC)	Potential View-to-Sky (V%)	Maximum Allowable View - to the - Sky[1] (S%)	Reference Temp. (T^oC)
>3920	3.2	100	9.1	6.4	100	9.3	12.7	100	9.8
3600	3.2	90-99	9.8	6.4	90-99	10.1	12.7	90-99	10.5
3280	3.2	80-90	10.6	6.4	80-90	10.8	12.7	80-90	11.3
2960	3.2	70-80	11.3	6.4	70-80	11.6	12.7	70-80	12.0
2400	3.2	60-70	12.1	6.4	60-70	12.3	12.7	60-70	12.8
1960	3.2	50-60	12.8	6.4	50-60	13.1	12.7	50-60	13.5
1640	3.2	40-50	13.6	6.4	40-50	13.8	12.7	40-50	14.3
1160	3.2	30-40	14.3	6.4	30-40	14.5	12.7	30-40	15.0
680	3.2	20-30	15.1	6.4	20-30	15.3	12.7	20-30	15.8
<200	3.2	10-20	15.8	6.4	10-20	16.0	12.7	10-20	16.5

V% = Potential View-to-Sky under mature riparian forest conditions (tree height; conifer = 150 ft; hardwood = 99 ft).
S% = Target View-to-Sky range for ODEQ core cold-water fish habitat = 7-Dmax 16C).
Ref. T^oC = Reference highest 7-day average of the maximum temperatures (7-Dmax) under mature riparian forest conditions.
BFW = Bank-full Channel Width.

Table 9-2. Existing and Future Riparian Vegetation Heights based on Forest Successional Pathways (WFPB 1997).

	Riparian Characterization Code (Current)	Tree Ht.	Riparian Characterization Code 50 - Yr. (unmanaged)	Tree Ht.	Riparian Characterization Code 100 - Yr. (unmanaged)	Tree Ht.
	Water	0	Water	0	Water	0
	Bareground	0	Bareground	0	Bareground	0
	Grass	<3	Grass	<3	Forbs/STS	<3
	Shrub	<15	Shrub	<15	Shrub/STS	<15
	CRS	<15	CMS/CMD	83 - 150	CLS/CLD	>150
	CRD	<15	CMD	83 - 150	CLD	>150
	HSS	<74	HMS	74 - 99	HMS/HLS	74 - >99
	HSD	<74	HMD	74 - 99	HMS/HLS	74 - >99
	MSS	<83	MMS/MMD	83 - 150	MLS/MLD	>150
	MSD	<83	MMD	83 - 150	MLD/CLD	>150
	CSS	<83	CMS/CMD	83 - 150	CLS/CLD	>150
	CSD	<83	CMD	83 - 150	CLD	>150
	HMS	74 - 99	HLS/HMS	>99	HLS/HMS	74 - >99
	HLS	>99	HLS	>99	Shrub	<15
	HMD	74 - 99	HLD	>99	HLS	>99
	MMS	83 - 150	MLS/MLD	>150	MLS/CLS/MLD/CLD	>150
	CMS	83 - 150	CLS/CLD	>150	CLS/CLD	>150
	CLS	>150	CLS	>150	CLD/STS	>150
	HLD	>99	HLS	>99	Shrub	<15
	MLS	>150	MLS/CLS	>150	CLS/STS	>150
	CMD	83 - 150	CLD	>150	CLD	>150
	MMD	83 - 150	MLD/CLD	>150	CLD	>150
	MLD	>150	MLD/CLD	>150	CLD	>150
	CLD	>150	CLD	>150	CLD	>150

Species Composition

C = Conifer (>70% Conifer)
M = Mixed (30 - 70 % Conifer)
H = Hardwood (>70% Hardwood)

Average Stand Size

R = Regen
S = Small (mean dbh < 12 ")
M = Medium (mean dbh 12 - 24")
L = Large (mean dbh >24")

Stand Density

S = Sparse (more than 1/3rd of the ground visible on aerial photos)
D = Dense (less than 1/3rd of the ground visible on aerial photos)

Table 9-3a. Predicted range of existing surface water temperatures in 6th field HUCs in ODF Management Basins in the Astoria District.

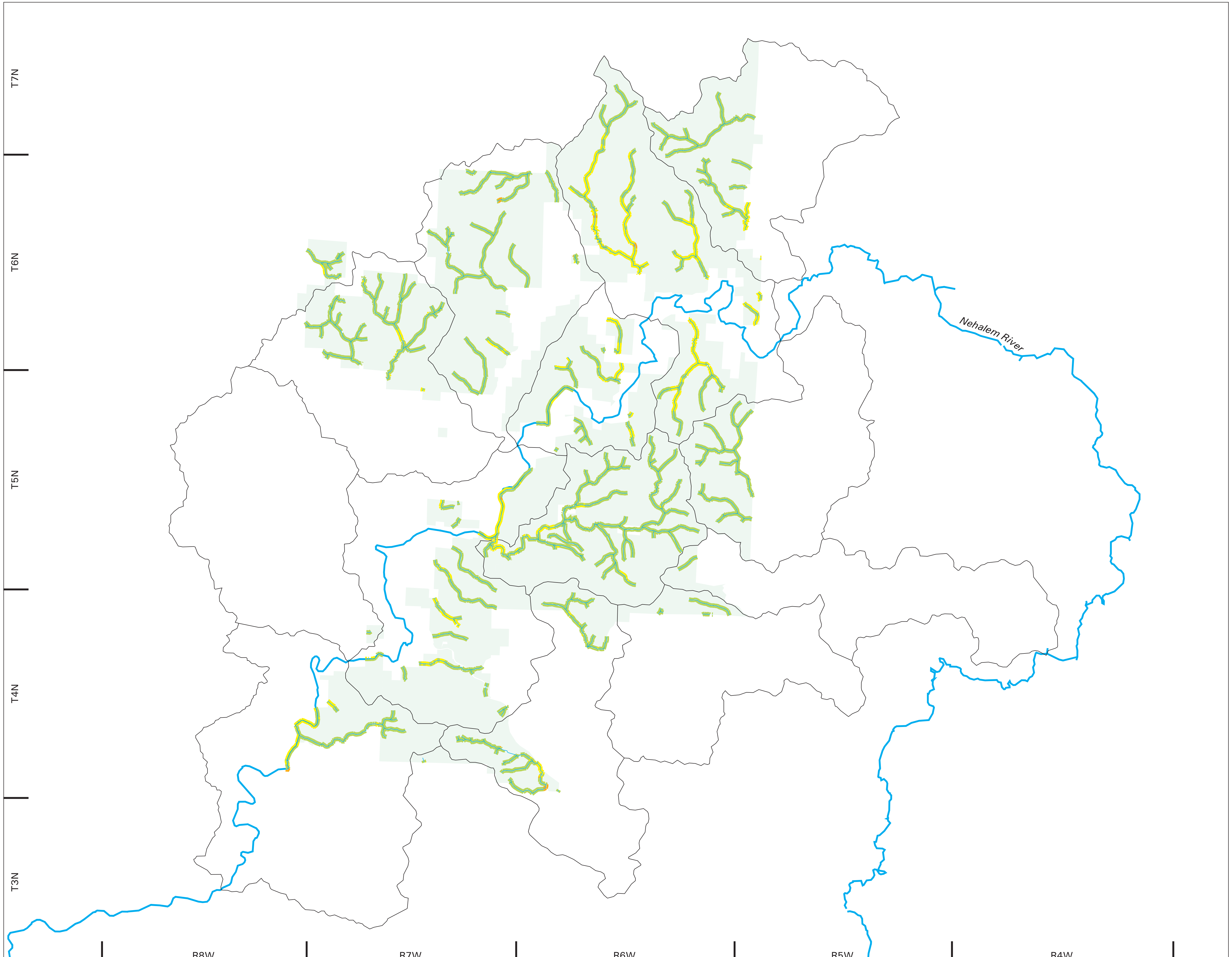
	ODF Management Basins in Astoria District									
	Beneke	Buster						Crawford		
Temp Range	Total	171002020105	171002020106	171002020107	171002020304	171002020305	Total	171002020301	171002020302	Total
12.1C to 16.0C	97%	97%	100%	100%	93%	87%	92%	64%	100%	65%
16.1C to 18.0C	2%	3%	-	-	7%	13%	7%	35%	-	33%
18.1C to 20.0C	1%	-	-	-	-	-	-	-	-	-
>20.0C	1%	-	-	-	0.3%	0.1%	0.2%	1%	-	1%
Stream Length (mi)	37.4	7.1	3.5	1.3	60.0	16.9	88.8	10.6	0.4	11.0

	ODF Management Basins in Astoria District									
	Fishhawk	Hamilton			Louisignot			Northrup		
	Total	171002020303	Young's Bay	Total	171002020205	171002020208	Total	171002020208	171002020302	Total
12.1C to 16.0C	91%	95%	100%	96%	70%	50%	54%	43%	78%	44%
16.1C to 18.0C	8%	4%	-	4%	29%	49%	46%	52%	14%	51%
18.1C to 20.0C	0.3%	0%	-	0%	-	-	0%	2%	8%	2%
>20.0C	0.0%	0%	-	0%	1%	0.4%	1%	2%	-	2%
Stream Length (mi)	21.2	33.4	3.3	36.7	2.5	12.3	14.8	26.9	0.7	27.6

	ODF Management Basins in Astoria District									
	Quartz					Sager				Scattered
	171002020105	171002020305	171002020307	171002020402	Total	171002020206	171002020208	171002020301	Total	Total
12.1C to 16.0C	79%	80%	83%	82%	70%	99%	45%	84%	77%	44%
16.1C to 18.0C	9%	19%	16%	18%	29%	0.5%	53%	16%	23%	51%
18.1C to 20.0C	2.8%	-	-	-	-	-	0.2%	-	0.1%	2%
>20.0C	9.3%	1%	1%	-	1%	0.1%	1%	-	1%	2%
Stream Length (mi)	12.3	5.4	9.8	0.1	27.6	18.2	14.3	4.9	37.4	0.3

Table 9-3b. Estimated range of existing surface water temperatures in 6th Field HUCs in ODF Management Basins – Forest Grove District.

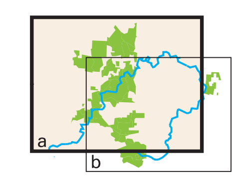
Current Temperature Range	ODF Management Basins in Forest Grove District									
	McGregor					Wheeler				Wilark
	171002020102	171002020103	171002020105	171002020106	Total	171002020101	171002020102	171002020105	Total	Total
<12C	-	-	-	-	-	0.3%	-	-	0.2%	-
12.1C to 16.0C	79%	100%	100%	97%	89.8%	96%	100%	79%	93.8%	95.9%
16.1C to 18.0C	21%	0.3%	0.0%	2.4%	10.0%	2.4%	0.0%	21%	5.1%	3.3%
18.1C to 20.0C	0%	0.0%	0.1%	0.0%	0.1%	1.2%	0.2%	0.1%	0.9%	0.0%
>20.0C	0%	0.0%	0.2%	0.2%	0.1%	0.3%	0.0%	0.2%	0.2%	0.8%
Stream Length (mi)	13.9	4.2	4.2	9.2	31.4	35.7	5.8	7.8	49.3	6.2



Legend

- < 12.0C
- 12.1C to 16.0C
- 16.1C to 18.0C
- 18.1C to 20.0C
- > 20C
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key



N

1 Inch = 2.7 Miles

0 2

Miles

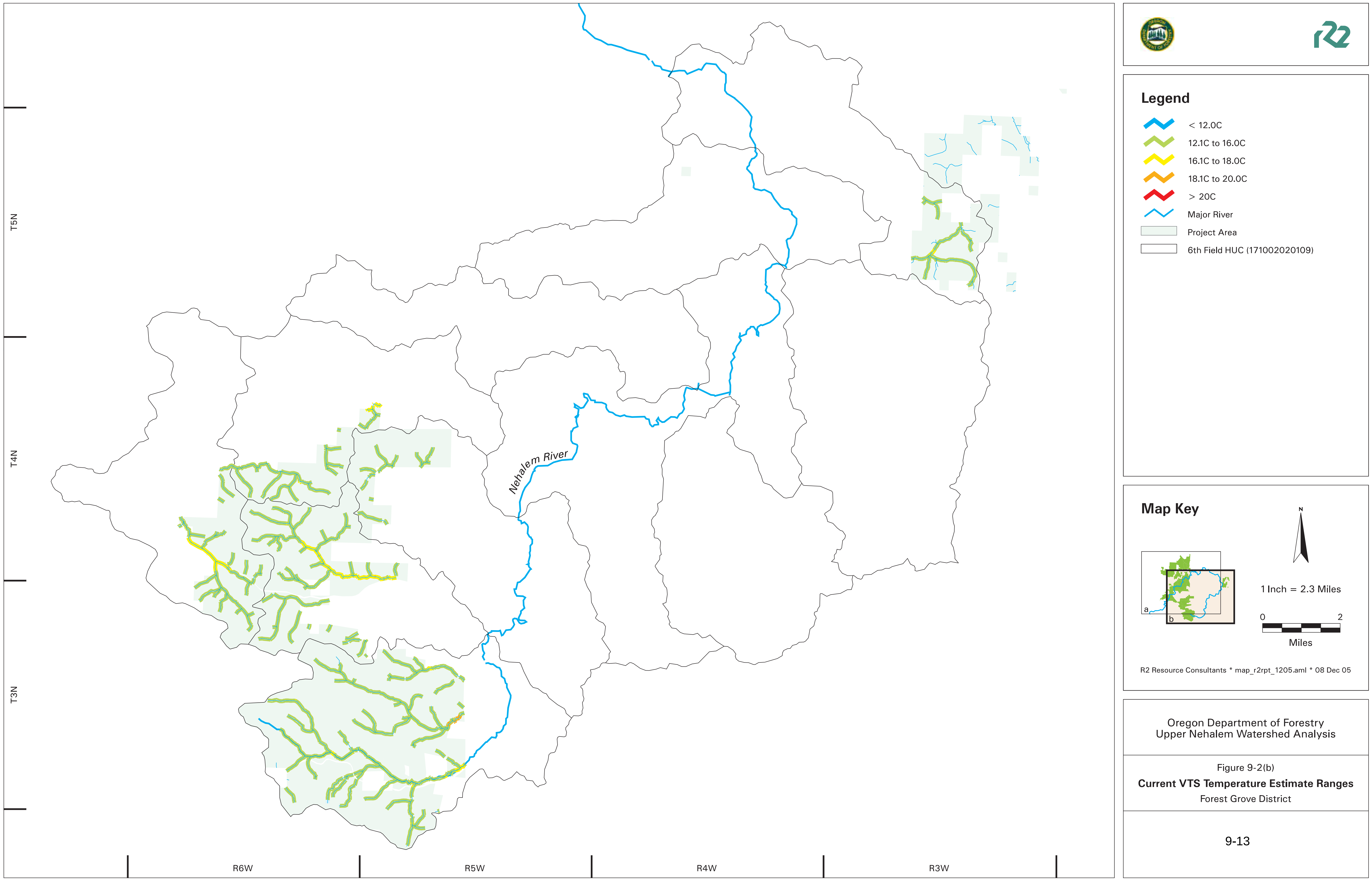
R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 9-2(a)

Current VTS Temperature Estimate Ranges

Astoria District

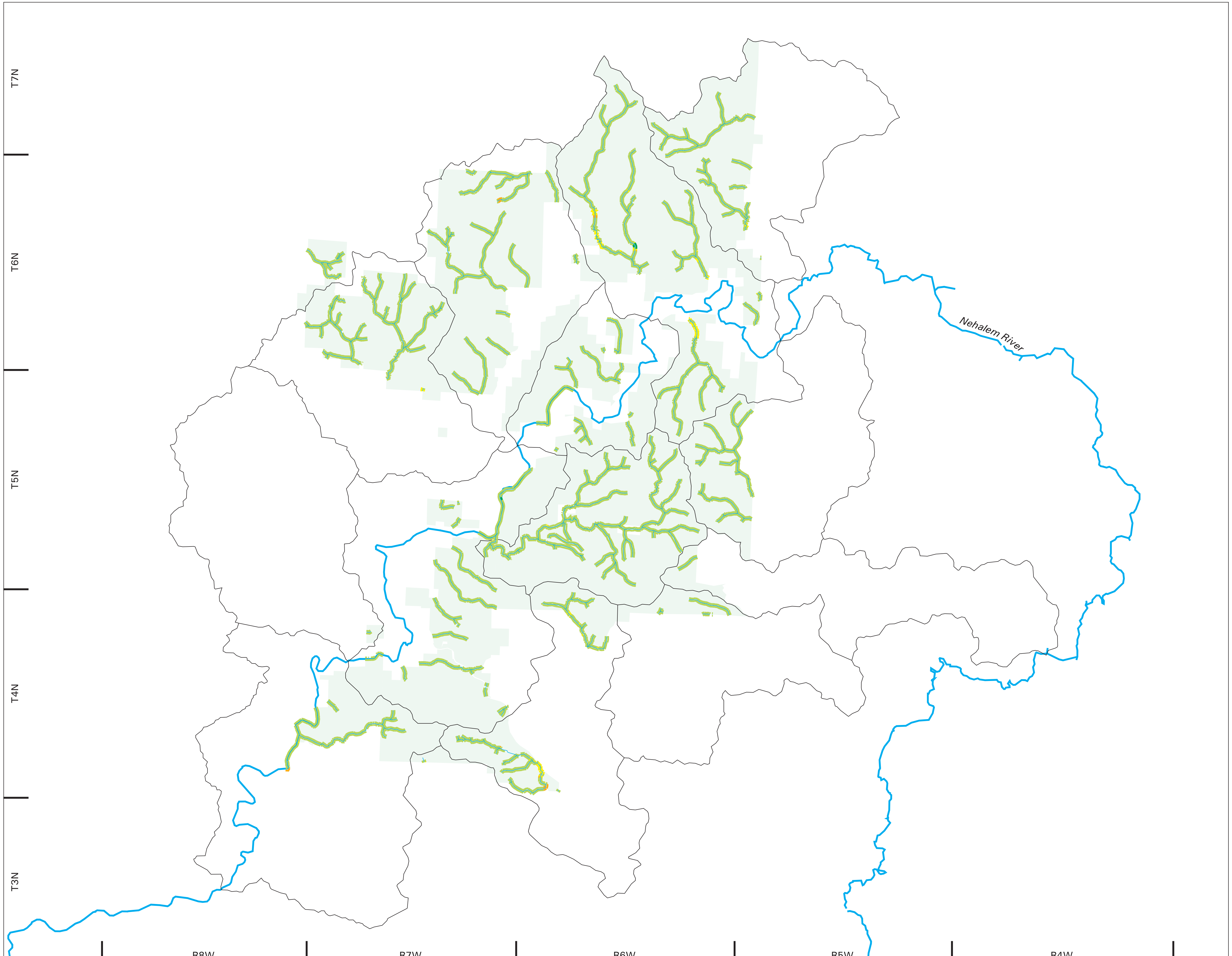


Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 9-2(b)

Current VTS Temperature Estimate Ranges

Forest Grove District



Legend

- < 12.0C
- 12.1C to 16.0C
- 16.1C to 18.0C
- 18.1C to 20.0C
- > 20C
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key

1 Inch = 2.7 Miles

0 2

Miles

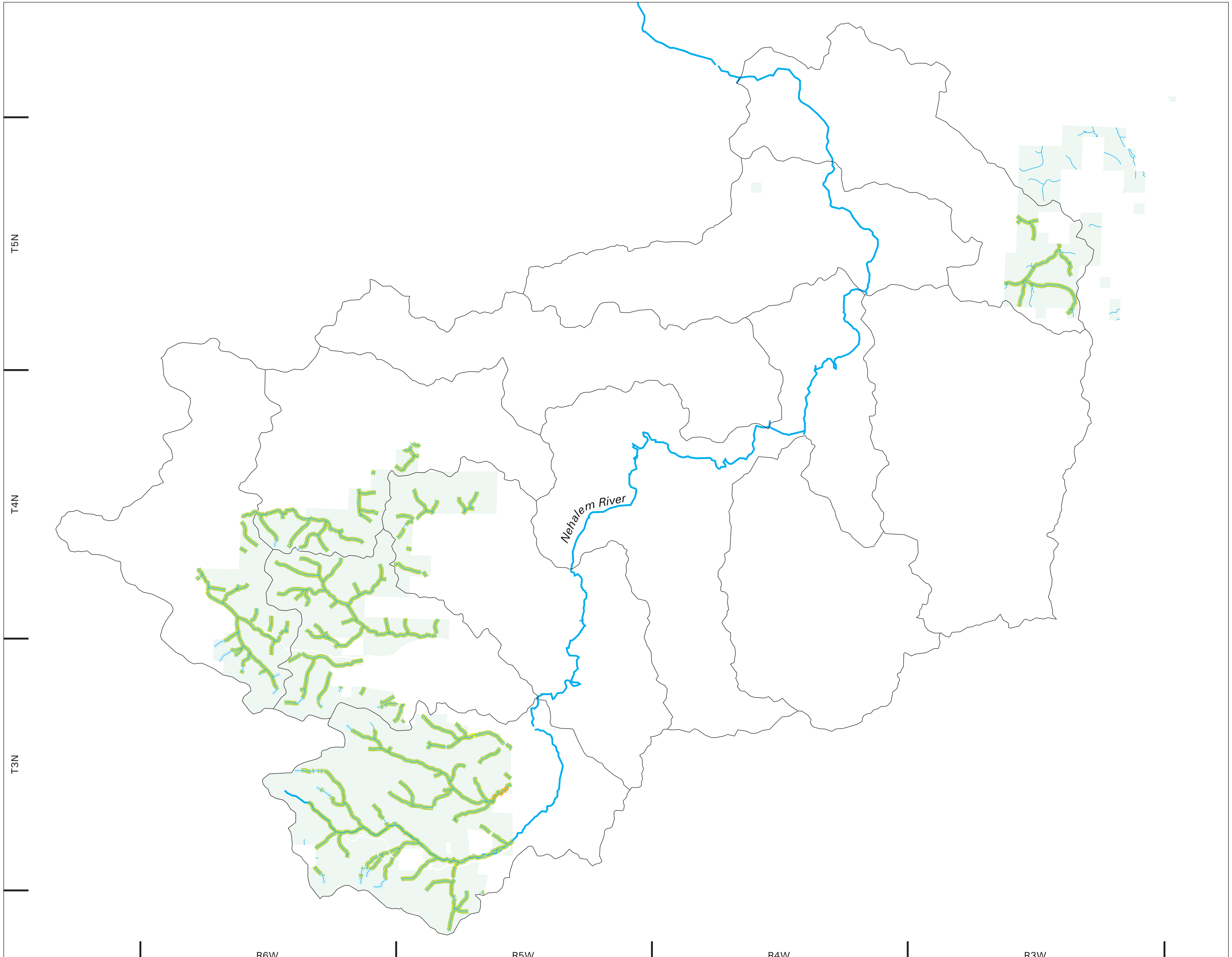
R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 9-3(a)

50-Year VTS Temperature Estimate Ranges

Astoria District



Legend

- < 12.0C
- 12.1C to 16.0C
- 16.1C to 18.0C
- 18.1C to 20.0C
- > 20C
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key

1 Inch = 2.3 Miles

0 2

Miles

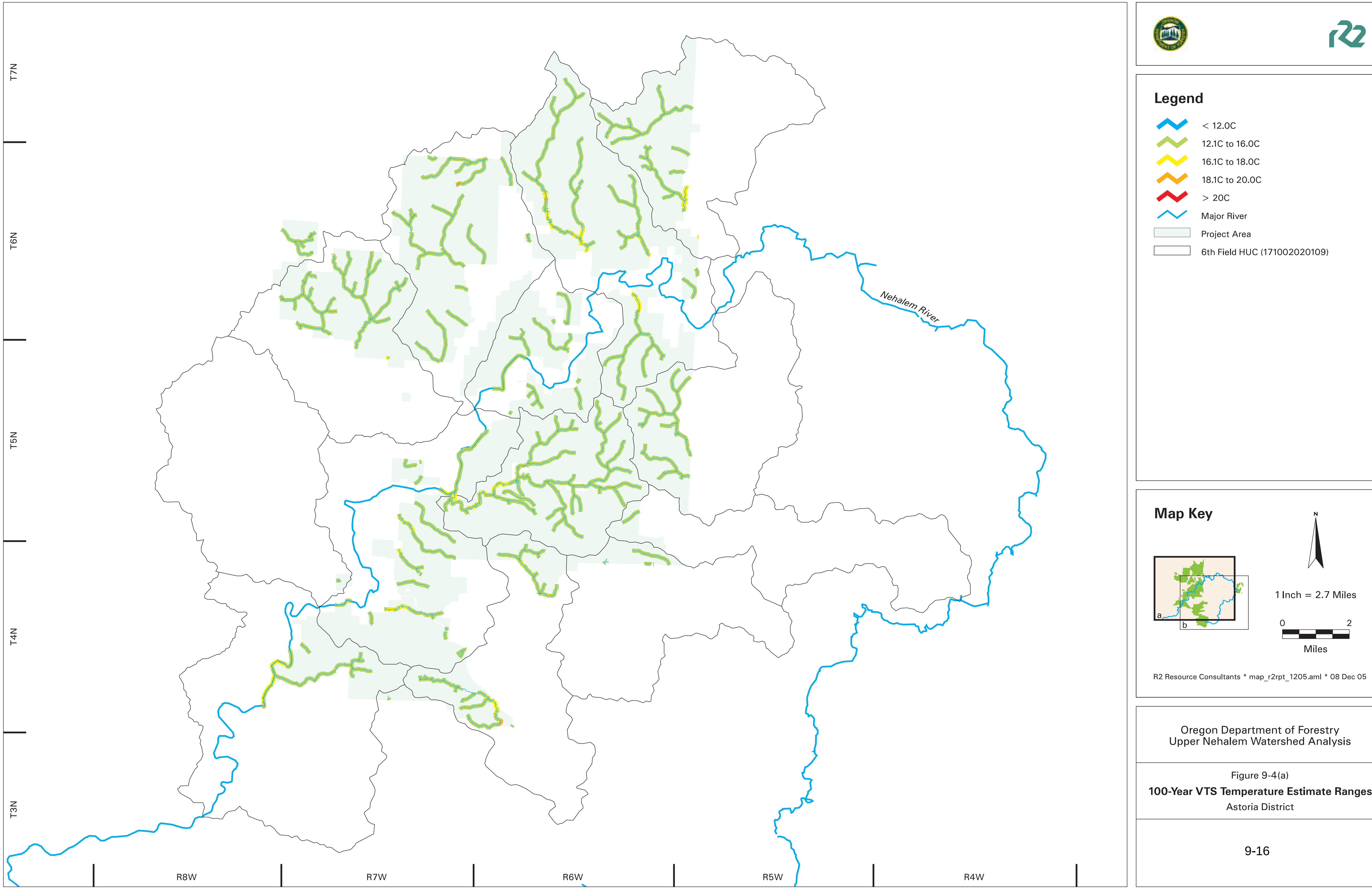
R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 9-3(b)

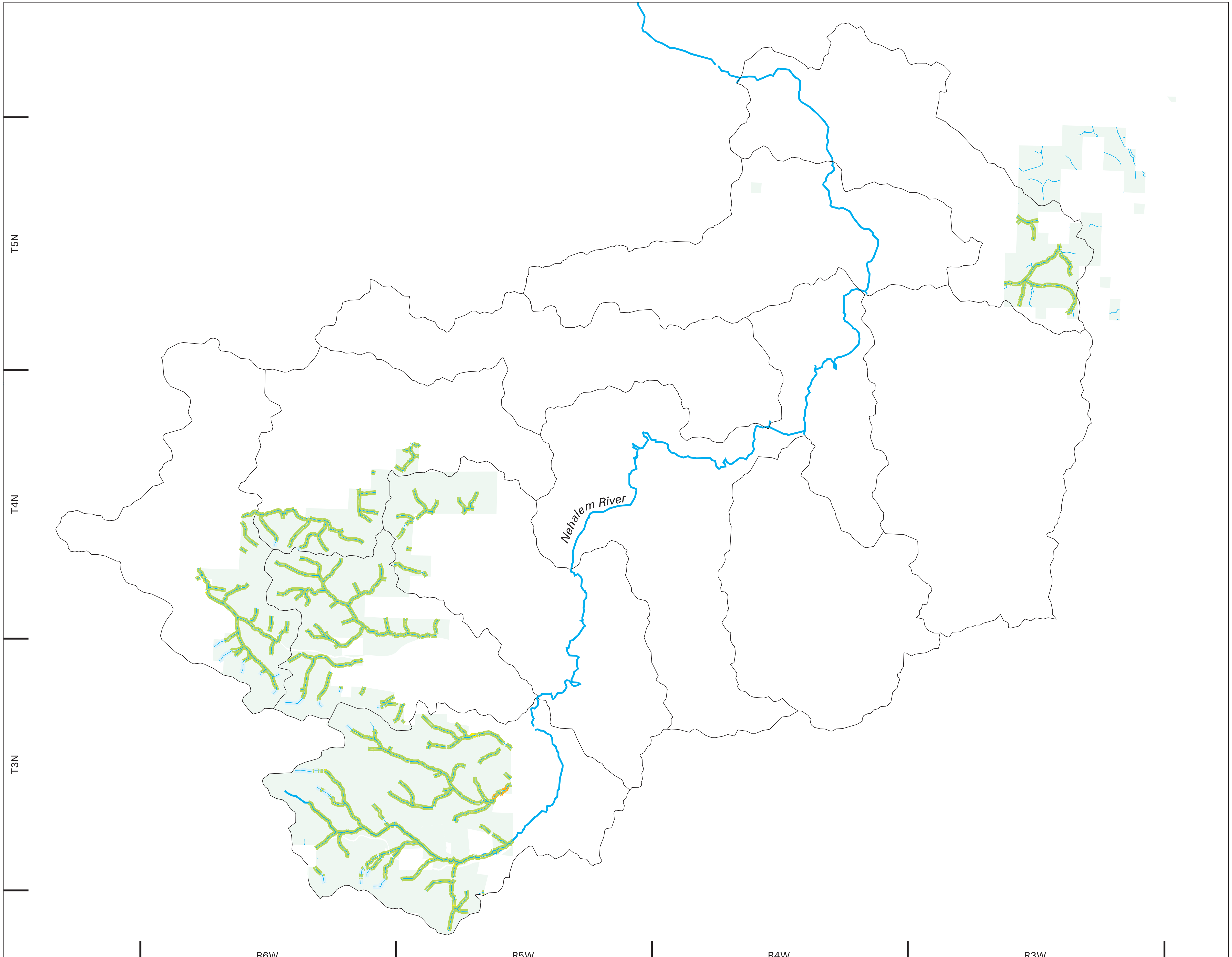
50-Year VTS Temperature Estimate Ranges

Forest Grove District



Oregon Department of Forestry
Upper Nehalem Watershed Analysis

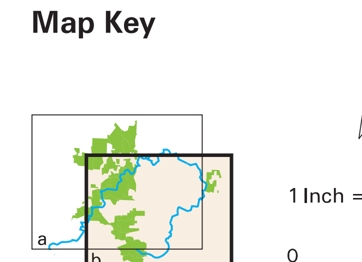
Figure 9-4(a)
100-Year VTS Temperature Estimate Ranges
Astoria District



Legend

- < 12.0C
- 12.1C to 16.0C
- 16.1C to 18.0C
- 18.1C to 20.0C
- > 20C
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key



1 Inch = 2.3 Miles

0 2
Miles

R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 9-4(b)
100-Year VTS Temperature Estimate Ranges
Forest Grove District

9.1.3.3 Field Verification

The results of the field verification occurring March 14-18, 2005 were used to estimate the average effective stand height. The field verification along samples of small, medium and large channel sizes in the upper watershed indicated good agreement with riparian site conditions and the 1995 aerial photo assessment. The instances when the field effort did not confirm the photo assessment were few (<10%) as previously described in Section 6.1.3.2. Although small shifts in the existing riparian conditions may exist on the ground, the watershed analysts were confident the original photo-based assessment was adequate to characterize the existing riparian conditions relative to their potential to block radiation to stream channels.

9.1.3.4 Forecasted Stand Conditions 50 to 100 Years in the Future

The results for future tree heights are shown in a matrix of stand conditions along a trajectory of 50-yr increments in Table 9-2. The projection of future riparian stand conditions should be considered a coarse screen tool, given the broad range of conditions potentially occurring under each of the riparian condition codes and variations in site class condition across the landscape. The approach assumes a mean 100-yr site potential tree height equivalent to 150 feet (24-in. dbh) on average for conifer species and 99 feet (24-in. dbh) maximum for hardwood species in the upper Nehalem watershed. Although variability in site characteristics and disturbance regimes exists, these assumptions should be representative of a general reference stand condition.

General Situations

Sparse Stands. In general, sparse stands need to develop either: (1) a closed coniferous canopy or (2) a second cohort underneath to develop into a dense stand capable of supporting a high VTS blocking potential over the 100-yr time frame. For shade intolerant species like Douglas-fir; the canopy needs to be open (RD <25) and understory conditions sufficient for seedling initiation to support ingrowth of a second cohort.

It is unlikely an existing sparse, riparian stand could generate appropriate conditions for ingrowth of shade intolerant species, with the exception of stands beginning as conifer regeneration and/or small, sparse stands (riparian condition codes: CRS/CSS). Current mature, but sparse stands, would likely grow without future ingrowth of a second cohort within 50 to 100 years. Some mixed stands could become conifer-dominated due to hardwood senescence, but they would likely remain in an overall sparse condition.

Mixed Stands. In mixed stands, conifer trees are free to grow when they overtop the hardwood community. The overall stand heights between conifer and mixed stands are likely the same, but conifer density may be lower due to the lower overall conifer abundance in mixed stands. The degree of openings in mixed stands may influence the radiation blocking potential of the riparian zone.

Inner Riparian Zones (RA1). Hardwood communities often dominate the riparian species composition on low terraces and areas of frequent flood or debris flow disturbance along stream channels. Red alder (*Alnus rubra) w*ere the most prevalent disturbance species in the Upper Nehalem watershed. The typical species configuration and target riparian condition for this zone was dense stands of moderate-sized hardwood species (HMD). The width of the RA1 zone varied in accordance with channel confinement from a narrow 25-feet strip along confined channel types upward to 75 feet along broad, unconfined floodplain type channels, regardless of the designated Ecoregion in the watershed (Table 6-1). Growing conditions were not generally conducive to conifer establishment and these zones were not predicted to support conifer in the future. Repeated disturbances in this zone may keep the hardwood species in an early successional state. Without such disturbances, the hardwood species could mature and, given their relatively short longevity, could succeed to shrub-dominated vegetation communities in these zones (WFPB 1997). However, it is unlikely this situation would develop in the inner riparian zone, since natural disturbance regimes are typically more frequent than the 100-year life cycle of some hardwood tree species.

Outer Riparian Zones (RA2). Conifer or mixed species compositions typically dominate the riparian hillslope areas alongside streams where the soils are better drained than the low-lying terraces. The typical species configuration and target riparian conditions for this zone are dense stands of large-sized conifer and mixed hardwood:conifer species (MLD, CLD). For the purposes of this assessment, the RA2 zone lies adjacent and upslope of the RA1 zone out to a distance of 100 feet on either side of the streams. The width of the RA2 zone subsequently varies in accordance with channel confinement and the width of the RA1 zone. The widest outer riparian areas are found along the confined channel types (Table 6-1).

The inner riparian zone (RA1) immediately adjacent to the stream channels has a more direct influence on radiation blocking angles, and hence stream temperatures, than areas further away. Even moderate-size alder (> 12 inches dbh, >74 ft in height) provide narrower VTS angles than mature conifer (> 24 inches dbh, > 150 ft in height) located in outer riparian zone (RA2), for any of the channel habitat types (CHTs). The only exception occurs when the local topography in the outer zone rises sharply above the channel. Mature conifers on steep ground add additional blocking angles to vegetation in RA1.

Specific Situations

Specific assumptions and forecasts for each of the vegetation categories leading to low, moderate or high predictions of the current, 50-year and 100-year VTS blocking potentials are summarized in Appendix F.

9.1.3.5 Summary of Existing Riparian Conditions by Management Unit

Astoria District

Fishhawk Management Basin. A total of 21.2 miles of fish-bearing channels occur on ODF lands in the Fishhawk Management Basin. These streams lie between 528 feet and 1,503 feet msl. The distribution of historical reference temperature conditions based on cumulative stream miles in the Basin likely fell between 13.7ºC and 16.3ºC.

Predicted Temperature Range (TºC)	Reference Conditions (%)	Current Conditions (%)	50-Year Conditions (%)	100-Year Conditions (%)
<12ºC		0.0		
12.1 to 16.0ºC	97.4	91.0	94.7	94.7
16.1 to 18.0ºC	2.6	8.0	5.3	5.3
18.1 to 20.0ºC		0.3		
> 20.0ºC		0.0		

The riparian situation in the Fishhawk Basin with respect to stream shading was determined to be favorable at the time of this assessment. Approximately 91 percent of the fish-bearing stream length in the management basin provided sufficient riparian blocking height to maintain water temperatures below 16ºC. The riparian situations along 95 percent of the streams have the potential for maintaining temperatures less than 16ºC in 50 and 100 years. Approximately 1.1 miles (5.3%) are estimated to remain in a low shade situation. This distribution of temperatures is consistent with the range of temperatures under reference conditions.

Northrup Management Basin. A total of 13.8 miles of fish-bearing channels occur on ODF lands in the Northrup Management Basin. These streams lie between 518 feet and 1,811 feet msl. The distribution of historical reference temperature conditions based on cumulative stream miles in the Basin likely fell between 13.3ºC and 16.3ºC.

Predicted Temperature Range (TºC)	**Reference Conditions (%)**	**Current Conditions (%)**	**50-Year Conditions (%)**	**100-Year Conditions (%)**
<12ºC		0.0		
12.1 to 16.0ºC	86.2	44.0	84.0	89.0
16.1 to 18.0ºC	13.8	51.0	13.0	8.0
18.1 to 20.0ºC		2.0	1.0	0.9
> 20.0ºC		2.0	2.0	2.2

Riparian conditions in the Northrup basin were generally open with respect to the degree of channel exposure. The VTS model predicted approximately 44 percent of the fish-bearing stream length in the basin offered sufficiently high VTS blocking potential to maintain water temperatures below 16ºC. Of the balance of streams currently predicted to exceed the 7-Dmax of 16ºC, 2 percent were predicted to exceed 18ºC, and 2 percent were predicted to exceed 20ºC, based on the existing level of channel openness, channel width, and elevation across the management basin. Approximately 84 percent of the fish-bearing stream network was predicted to provide peak summer temperatures less than 16ºC in 50 years and 89 percent would likely achieve such levels in 100 years. Approximately 3.1 percent or 0.4 miles of the fish-bearing stream network were estimated to exceed 16.3ºC in 100 years, without some form of silvicultural management, due to the lack of existing trees in riparian communities dominated by grasses and shrubs.

Beneke Management Basin. A total of 18.7 miles of fish-bearing channels occur on ODF lands in the Beneke Management Basin. These streams lie between 541 feet and 1,549 feet msl. The distribution of historical reference temperature conditions based on cumulative stream miles in the Basin likely fell between 13.6ºC and 15.6ºC.

Predicted Temperature Range (TºC)	Reference Conditions (%)	Current Conditions (%)	50-Year Conditions (%)	100-Year Conditions (%)
<12ºC		0.0		
12.1 to 16.0ºC	100.0	96.7	98.4	98.4
16.1 to 18.0ºC		1.6	0.1	0.1
18.1 to 20.0ºC		0.8	0.7	0.7
> 20.0ºC		0.9	0.9	0.9

The riparian situation in the Beneke basin with respect to stream shading was found to be one of the most favorable of the management basins in both Astoria and Forest Grove districts. Riparian conditions on ODF lands adjacent to fish-bearing streams in the Beneke basin offered sufficiently high VTS blocking potential to maintain water temperatures below 16ºC along 97 percent of the stream distance. All but 2 percent (0.6 miles) of the current low canopy closure situations should develop sufficient characteristics to achieve 16ºC or less in 50 years. Riparian conditions along the stream miles not anticipated to comply with 16ºC in 50 years would require stand manipulation to achieve the desired conditions due to the presence of bare ground, grass, or shrub-dominated stands. More than 40 percent of the riparian stands along fish-bearing waters in the Beneke Management Basin are hardwood-dominated forests. According to the VTS model, the influence of natural hardwood stand thinning in 100 years due to senescence on water temperatures is very small. Although deciduous stands may become more sparse than at the 50-year time frame, subsequent tree growth is anticipated to offset the thermal effect of thinning such that the “effective” radiation blocking tree height and view-to-the-sky angles remain similar between 50 and 100 years. The only change in achieving PFC for water temperature due to hardwood senescence in this management basin is forecasted to occur in large stream channels downstream of 680 ft msl.

Lousignot Management Basin. A total of 7.4 miles of fish-bearing channels occur on ODF lands in the Lousignot Management Basin. These streams lie between 515 feet and 988 feet msl.

The distribution of historical reference temperature conditions based on cumulative stream miles in the Basin likely fell between 14.6ºC and 16.3ºC.

Predicted Temperature Range (TºC)	Reference Conditions (%)	Current Conditions (%)	50-Year Conditions (%)	100-Year Conditions (%)
<12ºC		0.0		
12.1 to 16.0ºC	92.8	54.0	97.2	93.8
16.1 to 18.0ºC	7.2	46.0		5.7
18.1 to 20.0ºC		0.0	2.2	0.0
> 20.0ºC		1.0	0.5	0.5

Riparian conditions on ODF lands adjacent to fish-bearing streams in the Lousignot basin indicated that 54 percent of the stream mileage is likely to maintain peak summer water temperatures below 16ºC. Nearly ninety seven percent of the fish-bearing stream network should develop appropriate stand height and closure to maintain water temperatures below 16ºC in 50 years. According to the VTS model, the situation was anticipated to deteriorate slightly in 100 years due to senescence of mature hardwood stands. Nevertheless, the stream temperature situation at 100 years nearly mimics the reference conditions. Less than 0.1 stream miles (0.5%) of fish-bearing waters would require stand manipulation to achieve the desired conditions in 100 years along these stream reaches due to either the existence of roadways, or shrubs influencing vegetative stand development.

Hamilton Management Basin. A total of 18.4 miles of fish-bearing channels occur on ODF lands in the Hamilton Management Basin. These streams lie between 666 feet and 1,683 feet msl. The distribution of historical reference temperature conditions based on cumulative stream miles in the Basin likely fell between 13.4ºC and 16.0ºC.

Predicted Temperature Range (TºC)	**Reference Conditions (%)**	**Current Conditions (%)**	**50-Year Conditions (%)**	**100-Year Conditions (%)**
<12ºC		0.0		
12.1 to 16.0ºC	100.0	95.2	99.1	99.2
16.1 to 18.0ºC		4.0	0.4	0.4
18.1 to 20.0ºC		0.3		
> 20.0ºC		0.5	0.5	0.4

Riparian conditions on ODF lands adjacent to fish-bearing streams in the Hamilton basin offered sufficiently high VTS blocking potential to maintain water temperatures below 16ºC along 95 percent of the stream mileage. With the exception of 0.2 stream miles of young conifer reproduction, mixed species and hardwood forests, nearly all of the existing low canopy closure situations should develop appropriate stand characteristics to achieve 16ºC or less in 50 years. More than 40 percent of the riparian stands along fish-bearing waters in the Hamilton Management Basin are hardwood-dominated forests. According to the VTS model, the influence of natural hardwood stand thinning in 100 years due to senescence on water temperatures is very small. Although deciduous stands may become more sparse than at the 50-year time frame, subsequent tree growth is anticipated to offset the thermal effect of thinning such that the "effective" radiation blocking tree height and view-to-the-sky angles remain similar between 50 and 100 years. The only change in achieving PFC for water temperature due to hardwood senescence in this management basin is forecasted to occur in large stream channels downstream of 680 ft msl.

Crawford Management Basin. A total of 5.5 miles of fish-bearing channels occur on ODF lands in the Crawford Management Basin. These streams lie between 472 feet and 679 feet msl. The distribution of historical reference temperature conditions based on cumulative stream miles in the Basin likely fell between 15.0ºC and 15.5ºC.

Predicted Temperature Range (TºC)	**Reference Conditions (%)**	**Current Conditions (%)**	**50-Year Conditions (%)**	**100-Year Conditions (%)**
<12ºC		0.0		
12.1 to 16.0ºC	100.0	65.2	98.6	98.6
16.1 to 18.0ºC		33.4		
18.1 to 20.0ºC		0.0		
> 20.0ºC		1.4	1.4	1.4

Riparian conditions on ODF lands adjacent to fish-bearing streams in the Crawford basin offered sufficient canopy closure to maintain water temperatures below 16ºC along 65 percent of the stream mileage. Ninety nine percent of the fish-bearing stream miles should develop sufficient canopy closure in 50 and 100 years to meet 16ºC. Slightly more than 1 percent of the existing riparian situations (0.05 stream miles) offered bare ground and may require some form of soil manipulation to achieve tree growth. The distribution of surface water temperatures in this management basin is consistent with expected levels under reference conditions.

Sager Management Basin. A total of 18.7 miles of fish-bearing channels occur on ODF lands in the Sager Management Basin. These streams lie between 495 feet and 1,024 feet msl. The distribution of historical reference temperature conditions based on cumulative stream miles in the Basin with a provision for 20 percent openings in the canopy likely fell between 14.5ºC and 16.3ºC depending upon elevation and channel size.

Predicted Temperature Range (TºC)	Reference Conditions (%)	Current Conditions (%)	50-Year Conditions (%)	100-Year Conditions (%)
<12ºC		0.0		
12.1 to 16.0ºC	98.2	76.5	96.3	96.3
16.1 to 18.0ºC	1.8	22.9	3.1	3.1
18.1 to 20.0ºC		0.1		
> 20.0ºC		0.6	0.6	0.6

Riparian conditions on ODF lands adjacent to fish-bearing streams in the Sager basin offered sufficiently high VTS blocking potential to maintain water temperatures below 16ºC along 77 percent of the stream mileage. Ninety six percent of the stream mileage should develop moderate and high shade levels sufficient to achieve a 7-day maximum temperature of 16ºC in 50 and 100 years. Approximately 0.4 stream miles (1.9%) are estimated to remain in a low shade situation in 100 years compared to the distribution of stream temperatures under reference conditions.

Buster Management Basin. A total of 44.4 miles of fish-bearing channels occur on ODF lands in the Buster Management Basin. These streams lie between 423 feet and 1,982 feet msl. The distribution of historical reference temperature conditions based on cumulative stream miles in the Basin likely fell between 12.7ºC and 16.5ºC.

Predicted Temperature Range (TºC)	Reference Conditions (%)	Current Conditions (%)	50-Year Conditions (%)	100-Year Conditions (%)
<12ºC		0.0		0.4
12.1 to 16.0ºC	95.3	92.4	99.4	95.8
16.1 to 18.0ºC	4.7	7.4	0.4	3.6
18.1 to 20.0ºC		0.0		
> 20.0ºC		0.2	0.2	0.2

Riparian conditions on ODF lands adjacent to fish-bearing streams in the Buster basin offered sufficiently high VTS blocking potential to maintain water temperatures below 16ºC along 92 percent of the stream mileage. More than 99 percent of the stream miles should develop moderate and high shade levels to achieve 7-day maximum surface water temperatures of 16.5ºC or less in 50 years. Less than 0.1 stream miles (0.2%) of the fish-bearing stream network was projected to exceed reference conditions in this management basin due to riparian conditions dominated by shrubs and sparse hardwood conditions. Approximately 3.5 fish-bearing stream miles (3.8%) in the basin are estimated to remain in a low shade situation in 100 years. This level is consistent with the distribution of stream temperatures under reference conditions.

Quartz Management Basin. A total of 13.8 miles of fish-bearing channels occur on ODF lands in the Quartz Management Basin. These streams lie between 300 feet and 1,923 feet msl. The distribution of historical reference temperature conditions based on cumulative stream miles in the Basin likely fell between 12.8ºC and 16.0ºC. The exception is the mainstem Nehalem River in the Quartz Management Basin. This wide portion of the river (~ 100 ft active channel width), situated at approximately 300 feet msl and more than 90 miles downstream from the watershed divide, was likely naturally warm. Under a canopy of mature timber, the VTS model predicts summer 7-Dmax. surface water temperatures would have been historically near 17.5ºC.

Predicted Temperature Range (TºC)	Reference Conditions (%)	Current Conditions (%)	50-Year Conditions (%)	100-Year Conditions (%)
<12ºC		0.0		
12.1 to 16.0ºC	96.0	80.5	89.9	84.0
16.1 to 18.0ºC	4.0	13.6	4.2	10.0
18.1 to 20.0ºC		1.2	1.2	1.2
> 20.0ºC		4.7	4.7	4.7

The current riparian conditions on ODF lands adjacent to fish-bearing streams in the Quartz basin offered sufficiently high VTS blocking potential to maintain water temperatures below 16ºC along 80 percent of the stream mileage. Ninety three percent of the stream miles should develop moderate and high levels in 50 years sufficient to achieve a distribution of temperatures consistent with reference conditions. Although senescence of hardwood species was anticipated in 100 years, the distribution of surface water temperatures was predicted to be similar to the 50-year time frame. Approximately 0.8 stream miles (5.9%) will likely remain in a low shade situation throughout the 100-year assessment period. If appropriate, stand manipulation may be needed to achieve the desired temperature conditions along these reaches.

Contiguous Parcels

Young's Bay. A total of 1.7 stream miles of fish-bearing streams adjacent to ODF lands in the headwaters of the Young's Bay watershed lie in the Hamilton Management basin. Based on the elevation, channel width and degree of canopy closure, all of these streams were projected to maintain water temperatures below 16ºC now and in the future.

Forest Grove District

McGregor Management Basin. A total of 31.4 miles of fish-bearing channels occur on ODF lands in the McGregor Management Basin. These streams lie between 883 feet and 2,221 feet msl. The distribution of historical reference temperature conditions based on cumulative stream miles in the Basin likely fell between 12.3ºC and 15.7ºC.

Predicted Temperature Range (TºC)	Reference Conditions (%)	Current Conditions (%)	50-Year Conditions (%)	100-Year Conditions (%)
<12ºC		0.0	0.6	0.6
12.1 to 16.0ºC	100.0	89.8	99.0	99.0
16.1 to 18.0ºC		10.0	0.1	0.1
18.1 to 20.0ºC		0.1	0.1	0.1
> 20.0ºC		0.1	0.1	0.1

Riparian conditions on ODF lands adjacent to fish-bearing streams in the McGregor basin offered sufficiently high VTS blocking potential to maintain water temperatures below 16ºC along 90 percent of the stream mileage. More than 99 percent of the stream miles have the potential to develop moderate and high riparian shade levels in 50 and 100 years. Approximately 0.1 stream miles (0.3%) are estimated to remain in low shade situations. The distribution of surface water temperatures in this management basin were predicted to be consistent with reference water temperatures.

Wheeler Management Basin. A total of 49.3 miles of fish-bearing channels occur on ODF lands in the Wheeler Management Basin. These streams lie between 833 feet and 2,681 feet msl. The distribution of historical reference temperature conditions based on cumulative stream miles in the basin likely fell between 11.6ºC and 15.7ºC.

Predicted Temperature Range (TºC)	Reference Conditions (%)	Current Conditions (%)	50-Year Conditions (%)	100-Year Conditions (%)
<12ºC	4.8	0.2	7.4	9.3
12.1 to 16.0ºC	95.2	93.8	90.8	88.9
16.1 to 18.0ºC		5.1	0.7	0.7
18.1 to 20.0ºC		0.9	0.9	0.9
> 20.0ºC		0.2	0.2	0.2

Riparian conditions on ODF lands adjacent to fish-bearing streams in the Wheeler basin offered sufficiently high VTS blocking potential to maintain water temperatures below 16ºC along 94 percent of the stream mileage distance. Ninety eight percent of the stream miles have the potential to develop moderate and high riparian shade levels in 50 and 100 years. Approximately 0.9 stream miles (1.8%) were estimated to remain in low shade situations throughout the 100-year time frame. If appropriate, stand manipulation may be required to achieve the desired temperature conditions along these stream reaches.

Wilark Management Basin. A total of 6.2 miles of fish-bearing channels occur on ODF lands in the Wilark Management Basin. These streams lie between 764 feet and 1,660 feet msl. The distribution of historical reference temperature conditions based on cumulative stream miles in the Basin likely fell between 13.4ºC and 15.9ºC.

Predicted Temperature Range (TºC)	Reference Conditions (%)	Current Conditions (%)	50-Year Conditions (%)	100-Year Conditions (%)
<12ºC		0.0		
12.1 to 16.0ºC	100.0	95.9	99.2	99.2
16.1 to 18.0ºC		3.3		
18.1 to 20.0ºC		0.0		
> 20.0ºC		0.8	0.8	0.8

The riparian situations in the Wilark Management Basin were determined to be favorable with respect to canopy closures and water temperatures. Riparian conditions on ODF lands adjacent to fish-bearing streams in the Wilark basin offered sufficiently high VTS blocking potential to maintain water temperatures below 16ºC along 96 percent of the stream mileage distance. On the order of 0.2 stream miles were currently projected to exceed 16ºC with 0.05 miles predicted to exceed 20ºC. Ninety nine percent of the stream miles have the potential to develop moderate and high riparian shade levels sufficient to achieve a 7-day maximum of 16ºC in 50 and 100 years. Approximately 0.05 stream miles (0.8%) are estimated to remain in a low shade situation due to the prevalence of riparian shrubs and stream parallel roads. The distribution of surface water temperatures in this management basin were predicted to be consistent with reference water temperatures. If appropriate, stand manipulation could be considered to achieve the desired temperature conditions along the short reaches, predicted to exceed 20ºC but the overall effect on the management basin would be small.

Contiguous Parcels

Clatskine. There was a current lack of riparian habitat data along ODF lands in this watershed. At this point, the Clatskine basin remains a data gap with respect to riparian conditions and projections of water temperature data.

9.1.3.6 Summary of Existing Water Temperature Data

DEQ water temperature data from the Laboratory Analytical Storage and Retrieval (LASAR) database included an extensive array of temperature records and stations throughout the Upper Nehalem watershed (http://deq12.deq.state.or.us/wq/lasar). Many of these measurements occurred in response to the Nehalem Basin Temperature TMDL and as a result of the Oregon Salmon Plan. Some of the records were solitary spot measurements of temperature at a given point and time, while others included continuous monitoring gauges such that the 7-day running average of the daily maximum values could be calculated. A comparison of VTS predicted peak summer temperatures and measured temperatures is shown in Appendix G. The comparison provides an indication of the appropriateness VTS current condition temperature estimates and which stations appear to be good approximations for reference stream conditions.

Data indicate that the VTS model provided an accurate assessment of water temperatures in the portion of the basin within a threshold distance from the watershed divide, where riparian vegetation was predicted to have a thermal influence on surface waters (Sullivan et al. 1990; BioSystems et al. 2003). Various threshold distances are shown in each of the Management Basins in Figure 9-1a,b. Conversely, the VTS model underpredicted surface water temperatures where streams became too wide and too deep for the moderating effects of riparian canopy (Table 9-4).

Table 9-4. Comparison of the predictive capability of the VTS model in relation to the threshold distance from the watershed divide

	Distance from the Watershed Divide			
Temperature Comparison	**< 3.8 Miles**	**>3.8 Miles**	**>10.0 Miles**	**>30.0 Miles**
Much Cooler (groundwater influence)	5			
Slightly Cooler	1			
Within Range	6		1	
Slightly Warmer		6		1
Much Warmer		4	3	4
Lake Influence			2	
Total	12	10	6	5

Data were considered "within range" if the predicted and measured summer peak values were within ± 5 percent of each other. "Slightly cooler or warmer" meant the measured values were within ± 10 percent of the predicted temperatures. "Much cooler or warmer" categories included temperatures that exceeded a 10 percent difference.

Excluding stations reflecting a high incidence of groundwater influence, the VTS model predicted summer temperatures within 5 percent of measured values in 86 percent of the cases where monitoring stations were located within 3.8 miles of the watershed divide. Most of the ODF forest lands were located upstream of this distance in each of the management basin. The model was less effective in regions where the thermal influence of riparian vegetation diminishes. As shown in Table 9-4, this finding was evident when site conditions like lake water runoff (Fishhawk Lake) influenced downstream water temperatures or in the Mainstem Nehalem River when the distance from the divide exceed 30 miles.

Regional Environmental Monitoring and Assessment Program (REMAP) sites in the Nehalem watershed # 1710020205, on the NF Nehalem River at RM 13.1 (Station ID 12514; STORET ID 405276) and E. Foley Creek at RM 2.5 (STORET ID 11844; 404533) have received bio-monitoring reference condition status for macroinvertebrate communities (Canale 1999; Drake 1999). Water temperature data from these undisturbed sites were considered as logical estimates of reasonably achievable surface water temperatures within the basin.

The North Fork Nehalem River site at RM 13.1 was large channel located at elevation 315 feet msl. Surface water temperatures from spot measurements of North Fork Nehalem River at RM 13.1 sampled between July 29 and September 20, 1995 and 1996 ranged between 13.5ºC and 14.5ºC (DEQ LASAR and STORET Legacy Data Retrieval). These temperatures are below: (1) the VTS reference conditions of 16.0ºC for this site elevation and channel size and (2) the current prediction of 16.6ºC based on the existing vegetation characteristics. The data collected to date either imply the site was groundwater influenced or that the sampling effort did not represent the full range of summer temperature extremes. Using these data as a temperature reference site was considered inappropriate.

The E. Foley Creek macroinvertebrate reference site was a large channel located at an elevation of 217 feet msl. Temperatures from spot measurements in E. Foley Creek at RM 2.5 in late August 1994 and early September 1992 ranged between 12.0ºC and 12.5ºC. These temperatures were less than the VTS reference conditions of 16.3ºC for the site elevation and channel size and a current temperature prediction of 18.0ºC based on existing vegetation characteristics. Similarly, the data either did not represent the mid-summer maximum temperature levels or groundwater has a considerable effect on surface water temperatures.

As a consequence, monitoring records from the two macroinvertebrate reference stations may not have reflected achievable water temperatures based on riparian canopy closure levels and they thus, would not make good temperature reference stations for the upper Nehalem basin. Individual site characteristics of elevation, stream flow, ground or ponded water influence and sampling limitations, made establishment of any reference sites within the basin or in adjacent basins for estimating reasonably achievable temperatures problematic. Use of the VTS model for this purpose was a reliable approach within an estimated 3.8 miles of the watershed divide.

9.2 SURFACE WATER QUALITY ASSESSMENT

9.2.1 Methods

Data for other key water quality parameters were accessed via ODEQ's LASAR database for the Nehalem River Basin. The database included a compilation from various entities collecting information in the basin. Key water quality parameters for this assessment included: dissolved oxygen levels and percent saturation, pH, conductivity, turbidity, total suspended solids, nutrients, and bacteria (fecal coliforms; *E. coli*).

9.2.2 Results

Water quality data collected in the upper watershed to date were limited. I*n-situ* water quality measurements for the key parameters have been collected in the upper Nehalem watershed intermittently since 1998 at fourteen stations located on or immediately downstream of ODF lands. Only four of the 14 stations was located within streams bordering ODF lands; three (3) in Lousignot Creek (Wheeler Management Basin) and one (1) in Gilmore Creek (Beneke Management Basin). A summary table of the water quality results from various stations on or near ODF lands in the basin is included in Appendix H. Station locations are shown in Figure 9-1a,b. The ranges of available data from the four ODF sampling sites were in line with reasonably achievable levels for all of the parameters in forested mountain streams. Overall, water quality data from the sampled waters were rated good for summer fish rearing and they were consistent with biological use criteria.

The water quality data in the watershed varied between stations and through time. Variation between stations reflected influences such as elevation, land use, groundwater input, wetland or lake outflow, and riparian canopy cover. Variation through time reflected influences such as annual weather conditions (e.g., air temperature, streamflow, and snow pack volume) and the occurrence of disturbances such as floods and debris flows. Variation in each of the major parameters is discussed below:

Dissolved Oxygen (DO)

Dissolved oxygen levels in streams were not generally a concern due to high re-aeration rates in turbulent flowing water. Dissolved oxygen concentrations in streams may be adversely influenced under special cases where the decomposition of high levels of organic matter results in high oxygen demand; in areas supporting very warm stream temperatures; in shallow, slow-moving stream environments (<1% gradient); at the junction of a wetland discharges to streams or during the low streamflow season when groundwater contributions are high relative to surface water volumes.

Measured DO concentrations in the upper Nehalem watershed ranged between 7.8 and 11.5 mg/l. The DO saturation levels were between 84 to 103 percent. The DO standard for Cold Waters of the state is a 30-day average of 8.0 mg O_2/L or greater with an absolute minimum value of 6.0 mg O_2/L. In lieu of long-term measurements the oxygen levels should exceed 90 percent saturation at all times. Approximately 26 percent of the DO saturation measurements fell slightly below this saturation level. The exceedances were of low magnitude with the lowest saturation measured during the months of July through September at 80 percent in Fishhawk Creek (Sta #12328), downstream of both Lousignot and Fishhawk Management Basins. Most of the exceedances in the watershed occurred during the low stream flow period of the year. In general, the low flow period has less re-aeration capacity, warmer surface water and a greater relative contribution of groundwater to base stream flows than during the balance of the year. The recorded DO levels were not of sufficient magnitude to have a deleterious effect upon summer rearing life stages of fish species present in the watershed. The lowest DO levels were recorded in the late summer and early fall after the incubation period for salmonid fish species. Incubation represents the most sensitive life history stage for salmonid fishes that requires DO to be near saturation. The incubation periods for salmon and trout occur during the winter and spring months, respectively.

In summary, DO levels in the surface waters of the watershed were expected to comply with the state standard throughout the stream network except for local areas of quiescent waters that exhibit low re-aeration rates and/or high level of groundwater contribution during the late summer or early fall low streamflow period.

Hydrogen Ion Activity (pH):

The pH of sampled waters in the WAU ranged from 5.7 to 7.8 pH units. Twenty-eight of 196 (14%) values fell below the water quality criterion of pH 6.5, indicating slightly acidic waters. Slightly acidic waters are normal for forested headwater streams in western Washington that share similar conditions to streams in the Project Area. The pH values below or near 6.5 were infrequent and isolated in nature and lacking any specific pattern in the watershed and they remain above a pH level of 5.0, the minimum requirement for fish survival (U.S. Environmental Protection Agency 1986).

Hydrogen Ion Activity (pH)

The pH of flowing waters was generally not influenced by forest management practices. The buffering capacity of the soil precludes forest practices from materially affecting stream pH (Stottlemeyer 1987; MacDonald et al. 1991). Water quality standards for pH consists of water between 6.5 to 8.5 +/- 0.5 pH units.

Spot measurements of pH in the watershed indicated neutral waters (6.6 to 7.7 pH units). All readings represented natural conditions. The pH levels were very stable throughout the channel network indicative of a well-buffered system. This assessment concluded the waters within the Upper Nehalem watershed offer neutral acidity, were well-buffered, and remained within water quality standards. The pH levels were not necessarily sensitive to inputs from forest practices in the stream network.

In summary, pH levels in the surface waters of the watershed were expected to comply with the state standard throughout the stream network. The pH levels monitored to date were not anticipated to have an adverse affect upon aquatic biota in the watershed.

Ammonia

Ammonia nitrogen (NH_3-N) is a chief end product of nitrogen metabolism in most aquatic animals and it is a by-product of organic decomposition. In flowing waters high levels of ammonia can be toxic to aquatic biota. Under normal stream pH levels, ammonia is typically bound in ammonium salt (NH_4OH) and unavailable for biological uptake. Un-ionized ammonia is the available and highly toxic form of ammonia, but at the pH levels measured in the upper watershed more than 98% of the ammonia nitrogen would be in the bound rather than the un-ionized form. A safe level of un-ionized ammonia in streams is 0.02 mg/l, while ammonia-nitrogen is recommended to remain below 0.5 mg/l (USEPA, Water Quality Criteria 1986). All of the reported results on and near ODF lands in the watershed for ammonia-nitrogen and un-ionized ammonia remained within recommended concentrations for aquatic life.

Stream Nutrients

The prior PSU watershed analysis (Johnson and Maser 2000) indicated a concern for nitrate-nitrogen levels in the watershed. However, data from the upper basin indicate a low level of nitrates, suggesting the nutrient concern was more likely an issue in the lower portions of the basin. Forested mountain streams in the Pacific Northwest are generally very low in both nitrogen and phosphorus and primary productivity is often naturally low. Nitrogen levels often peak in autumn during leaf fall. As a nitrogen-fixing plant, the presence of alder can increase levels of nitrate in streams. Forest management practices generally do not have a considerable influence on nutrient concentrations in surface waters. Although harvesting and burning can increase nitrate levels, the inputs remain relatively low (Bisson et al. 1992; Fredricksen et al. 1975).

Nutrients are generally assessed relative to the likelihood of increasing nuisance aquatic plant growth and potentially adverse effects on dissolved oxygen levels in surface waters. The typical objective is to exclude management-induced nutrient contributions from elevating stream and lakes to a higher trophic status. Nitrogen concentrations in streams of less than 0.30 mg NO_3 – N / L will generally prevent downstream eutrophication (WFPB 1997).

Nitrogen concentrations collected to date ranged between 0.005 and 0.410 mg/l, suggesting the waters are generally low in dissolved levels of nitrate. The low N:P ratio (10:1) indicated nitrogen is likely limiting plant growth in the upper Nehalem watershed. This finding was consistent with the observation that forested mountain streams are most often N-limited (Gessel et al. 1979; Salminen and Beschta 1991; MacDonald et al. 1991; and Wolf 1992). The data suggest changes in nitrogen, rather than phosphate, inputs to streams are likely to have a direct influence on aquatic productivity.

Eighteen of nineteen measurements (95%) in the watershed indicate nitrate levels represented a low risk to increased plant growth. The highest single measurement of 0.410 mg /L occurred in one sample collected in Quartz Creek downstream of the ODF Quartz Management Basin in June, 2003. This result may have represented an unnatural source of nitrate, possible via groundwater influx as suggested by the relatively high levels of mineralization (conductivity). Dissolved oxygen saturation levels, ranging between 95 and 101 percent, did not suggest deleterious levels of algal production in Quartz Creek. More detailed information is needed to assess the effects of nitrate-nitrogen levels in Quartz Creek.

A review of the PSU assessment indicates nitrogen concentrations increased in the downstream direction with more intensive land uses compared to the nature of lands in the headwater regions. Based on available literature and the longitudinal trends in the nearby data collected to date, nitrates were assumed to be low (<0.05 mg/L) in the headwater streams. Because there was a general low level of nitrogen contribution from forest practices, headwater streams in the watershed contributing to streams in the valley floor were assumed have a low level of nitrogen input.

Phosphate levels recorded in the watershed were relatively low, ranging from < 0.01 to 0.04 mg/L. These levels were within natural ranges found in forested mountain streams and they did not imply an unnatural source of nutrient enrichment.

Turbidity/Total Suspended Solids

Turbidity and total suspended solids (TSS) are two related measures of water clarity that typically have a high degree of correlation between each other. High levels of either turbidity or TSS may indicate a source of fine sediment inputs to streams. Forest management practices through harvesting and road construction, maintenance and use can influence the loading of fine sediments to surface waters. Other landuses in the watershed also have the potential to contribute fine sediments to the channel network.

Turbidity measurements in the watershed ranged from <1 to 8 NTU. These levels were low, but likely did not represent the full range of turbidity levels throughout the year. Water quality sampling rarely occurs during peak storm events or high seasonal stream flows. The highest recorded turbidity levels were recorded in March, 1997 on Fishhawk Creek (Sta #12328), downstream of both Lousignot and Fishhawk Management Basins.

Similarly, TSS values ranged from <1 to 54 mg/L in the fourteen monitoring stations in the upper Nehalem watershed. Approximately 75 percent of the observations were below 10 mg/L and 98 percent of the measurements were recorded below 18 mg/L. The single highest recording of 54 mg/l occurred in the mainstem Nehalem River at Vesper (Sta # 23873) on March 28, 2001. The highest recorded TSS value was typical of a spring storm event. The remaining values were characteristic of TSS levels during dry periods or low level rainfall events in the watershed.

10. AQUATIC RESOURCES AND THEIR HABITATS

10.1 INTRODUCTION

This habitat section describes the aquatic environment within the upper Nehalem watershed and ODF contiguous parcels and how that environment affects the distribution and abundance of aquatic resources in the watershed. Although other species exist within the watershed, the focus of this Chapter will be on seven anadromous fish species and two amphibian species. By exploring the following key questions we can begin to understand the connection between forest management practice and aquatic species and habitats in the target watersheds.

Key Questions:

1. *What fish species are documented in the watershed? Are any of these currently state or federally listed as endangered, threatened or candidate species? Are there any fish species that historically occurred in the watershed that no longer occur there?*
2. *What is the distribution, relative abundance and population status of salmonid species in the watershed? What is the distribution of fish species, by life stage, in the watershed?*
3. *Which salmonid species are native to the watershed, and which have been introduced into the watershed?*
4. *Are there potential interactions between native and introduced species?*
5. *What is the condition of the fish habitat in the watershed (by subbasin) according to existing habitat data?*
6. *Where are the potential barriers to fish passage? How many miles of fish-bearing streams are blocked by culverts?*
7. *What stream reaches have high, moderate, and low level of key pieces of large wood (> 24 inch conifer) in the channel?*
8. *Did any splash damming occur in the watershed? Where did this splash damming occur? Are the effects still apparent?*
9. *Are the tailed frog and Columbia torrent salamander potential present in the watershed? What are the habitat needs of these species?*

10.2 METHODS

The information obtained in this chapter was compiled from a review of the existing literature and data including existing watershed assessments and ODFW Aquatic Inventory Reports and ODFW and ODF data. Our task was to review and summarize the available information relative to the questions stated above and with respect to ODF management basins. Existing data for fish habitat was available only at the 5th field HUC level and not the level of ODF management basins. Figure 10-1 shows the relationship between the three relevant 5th field HUC and ODF management basins.

10.3 RESULTS

10.3.1 Fish Species in the Upper Nehalem River Basin

Table 10-1 lists some fish species documented in the upper Nehalem River and their current management status. All of these species are native to the Oregon coastal rivers. Warm water fish species have been introduced to Fishhawk Lake, near the Fishhawk Management Basin, and it is likely that rainbow trout from stocks outside the Nehalem River watershed have been planted in the basin. No information was available on the interactions between native and introduced fish. No information was available to document the extirpation of any native fish species from the Nehalem River basin.

Table 10-1. The management status of fish species documented in the upper Nehalem River.

Species	Life Histories Strategy	Management Status
Coho salmon *Oncorhynchus kisutch*	Anadromous	Proposed as threatened under federal ESA, as part of Oregon Coast ESU. State sensitive with critical status
Chinook salmon *O. tshawytscha*	Anadromous	Not currently listed
Steelhead *O. mykiss*	Anadromous	Candidate for listing under federal ESA. State sensitive with vulnerable status
Coastal cutthroat trout *O. clarki clarki*	Anadromous and Resident	Federal species of Concern State sensitive with vulnerable status
Pacific lamprey *Lampetra tridentata*	Anadromous	Federal species of Concern State sensitive with vulnerable status
Western Brook lamprey *L. richardsoni*	Resident	Not currently listed

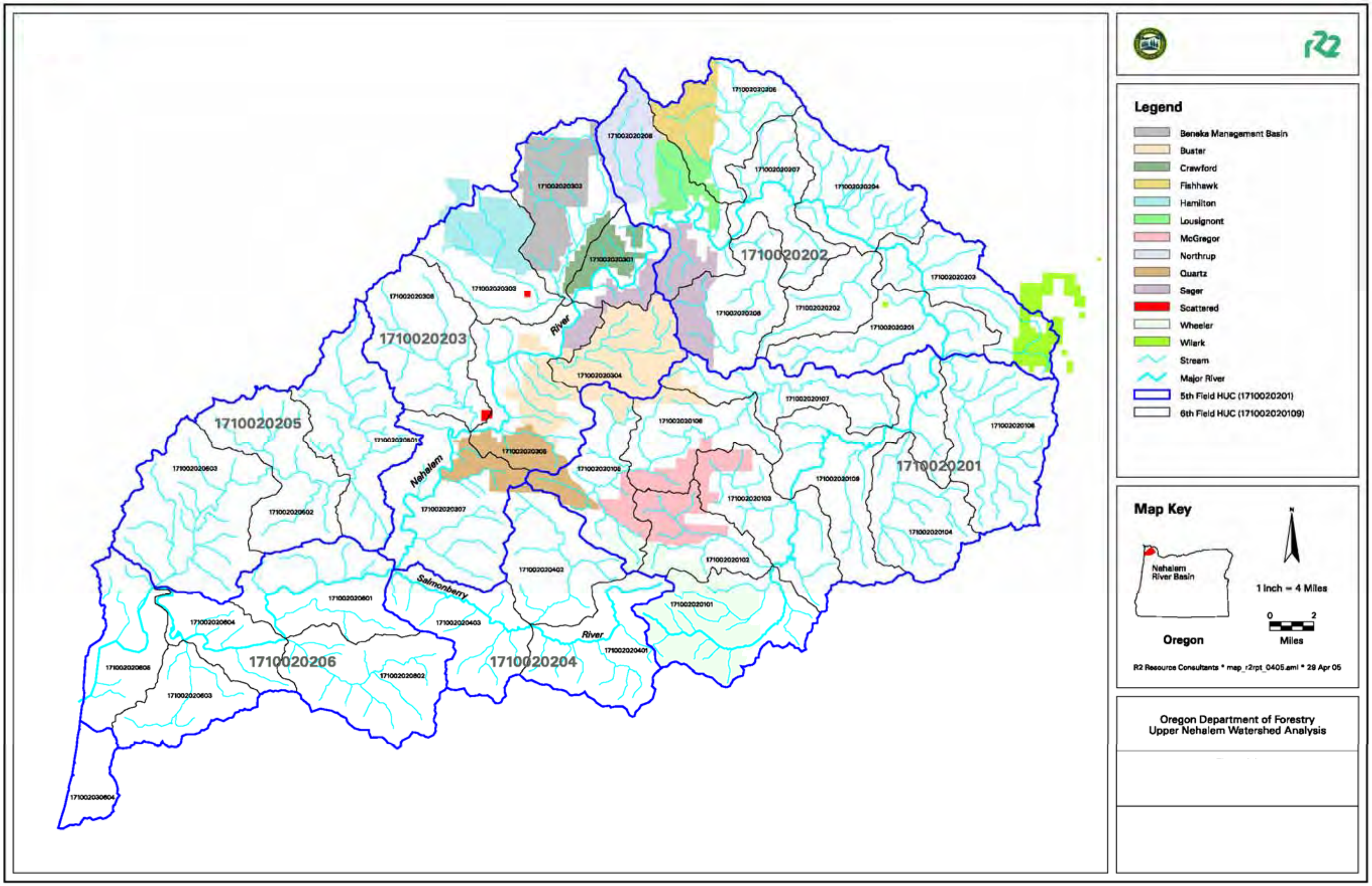


Figure 10-1. Project Area 5th and 6th Field HUCs.

10.3.1.1 Fish Distribution, Abundance, Status in the Upper Nehalem

Coho Salmon, *Oncorhynchus kisutch*

Distribution. Coho salmon are endemic to coastal rivers and streams of Oregon at the time of this assessment. They were widely distributed throughout the mainstem and larger tributaries of upper Nehalem River (Figure 10-2).

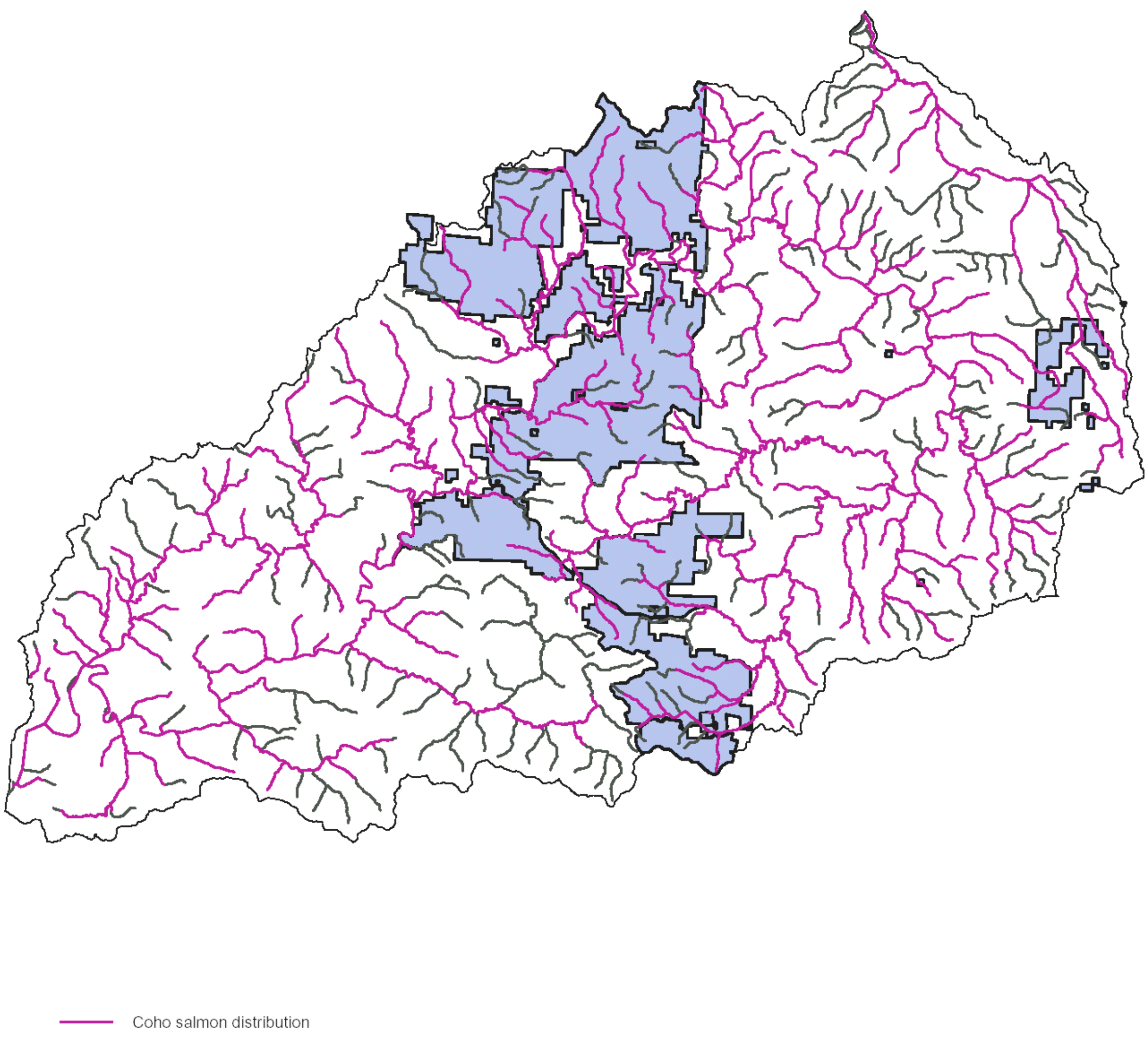


Figure 10-2. Coho salmon distribution in the Nehalem River basin.

Status. The coho salmon within the upper Nehalem are part of the Oregon Coast Evolutionary Significant Unit (ESU). The Oregon Coast ESU of coho salmon is a declining population and is currently proposed for listing under the federal Endangered Species Act. Estimates of abundance suggest that this ESU is currently at a level of 5 to 10 percent of historical abundance (Weitkamp et al. 1995).

Several factors have been identified as likely contributing to the population decline of coho salmon. These factors of decline include habitat destruction, overfishing, artificial propagation, and poor ocean conditions (Weitkamp et al. 1995). As in-channel habitat complexity, structure, and abundance of pool habitats are important for freshwater survival of coho salmon, reduction of these habitat characteristics may limit coho production (Nickelson et al. 1992).

Abundance. ODFW conducted coho salmon spawning surveys in the Nehalem River from 1998 to 2003. In general, densities of spawners increased from 1 to 5 wild adult coho per mile in 1998 to more than 200 per mile in 2002 and 2003 (Kavanagh et al. 2005).

Chinook Salmon, *O. tshawytscha*

Distribution. Within the Project Area, fall Chinook salmon were distributed in upper mainstem Nehalem River and the lower reaches of six tributaries (Figures 10-3 and 10-4) (Kavanagh et al. 2005).

Status. Chinook salmon in the Nehalem River basin are part of the Oregon Coast ESU. Chinook salmon in this ESU do not currently hold any special status at the state or federal level. Forty-five populations have been identified within this ESU (Kostow 1995). In the Oregon Coast ESU, habitat loss and degradation have been associated with human activities such as dam construction, water withdrawal, logging, and agriculture. Logging and agricultural practices were identified as resulting in modifications to stream structure and reduction of riparian habitat (Myers et al. 1998).

Abundance. A 5-year mean spawning escapement for the Oregon Coast ESU was estimated at 136,000 Chinook salmon and the long term trend has been determined to be stable or increasing (Myers et al. 1998). ODFW survey data show counts of spawning fall Chinook salmon to be 140 fish total in the Nehalem River (Kavanagh et al. 2005).

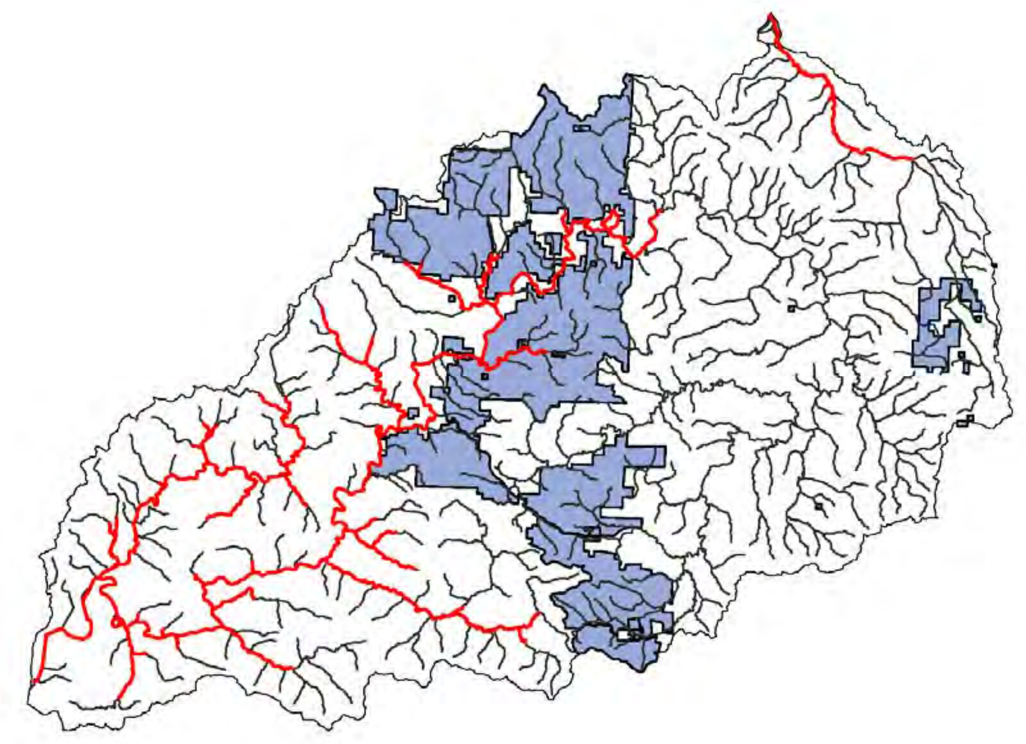


Figure 10-3. Fall Chinook salmon distribution in the Nehalem River basin.

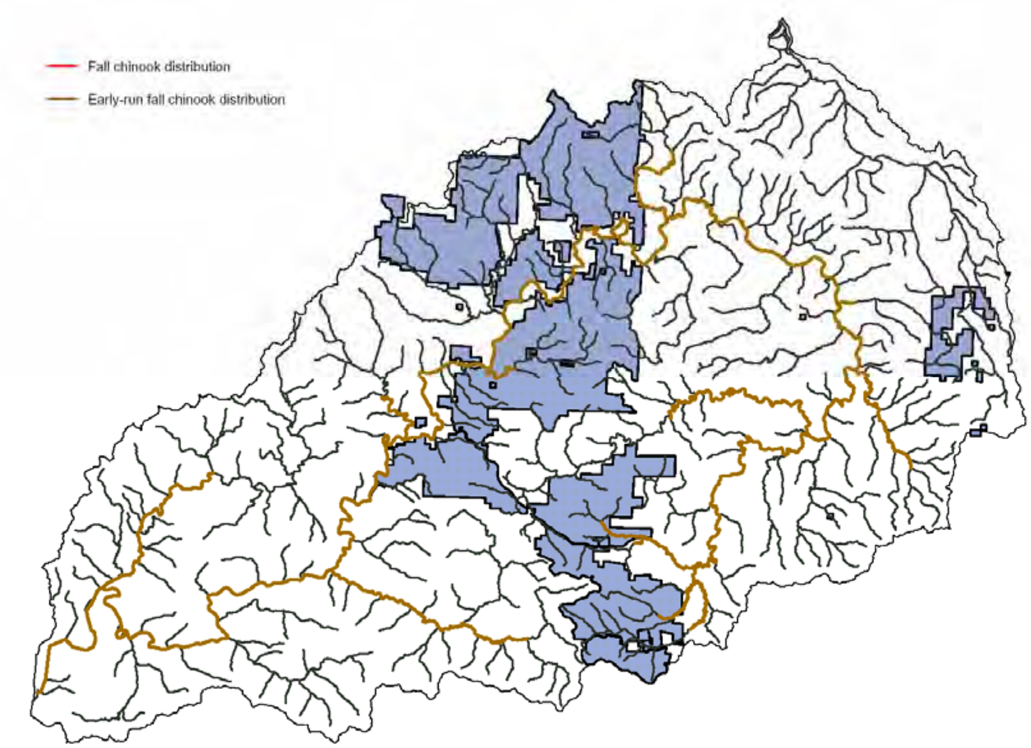


Figure 10-4. Early run fall Chinook salmon distribution in the Nehalem River basin.

Steelhead, *Oncorhynchus mykiss irideus*

Distribution. Winter steelhead were found throughout the mainstem Nehalem and larger tributaries (Figure 10-5) (Kavanagh et al. 2005). These authors also reported that steelhead have access to all historic habitat in the upper Nehalem basin.

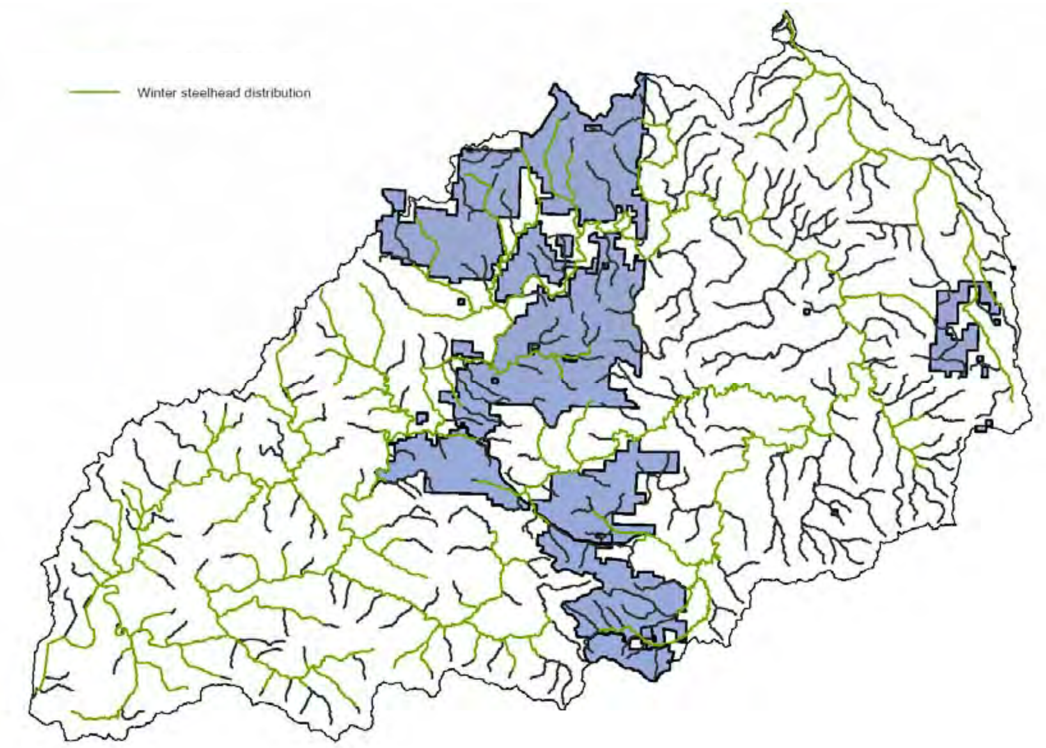


Figure 10-5. Steelhead distribution in the Nehalem River basin.

Status. The Oregon Coast ESU of steelhead is a candidate for federal listing under the ESA. Past run size and escapement estimates have been based on expansions of angler catch using assumed harvest rates. Total 5-year mean escapement for major streams in the Oregon ESU was 96,000 steelhead (82,000 winter, 14,000 summer). These totals did not include all streams in the ESU, and thus were thought to be an underestimate. Due to concerns with the method of escapement estimation, NOAA Fisheries conducted a trend analysis for 42 independent stocks within the Oregon Coast ESU (Busby et al. 1996). Thirty-six stocks were found to have a declining trend and 6 exhibited increases evident during the available data series.

Kostow (1995) reported the habitat degradation has impacted steelhead populations in the mid-Oregon coastal streams. She notes specifically siltation, loss of structural complexity, and loss of riparian habitat from road building and logging. Additional threats include channelization, water withdrawals, and development. Busby et al. (1996) reported similar threats to coastal salmonid populations and added concerns regarding streamflow and temperature in areas where there are significant water withdrawals or removal of streamside vegetation had occurred.

Abundance. ODFW recently (2003 and 2004) conducted steelhead surveys in the mainstem Nehalem and Rock Creek. Data varied over time and survey location, but average redd densities that ranged from 2.2 to 20.7 redds per mile (Kavanagh et al. 2005).

Coastal Cutthroat Trout, *Oncorhynchus clarki*

Distribution. Cutthroat trout were widely distributed throughout the upper Nehalem River basin (Figure 10-6) (Kavanagh et al. 2005).

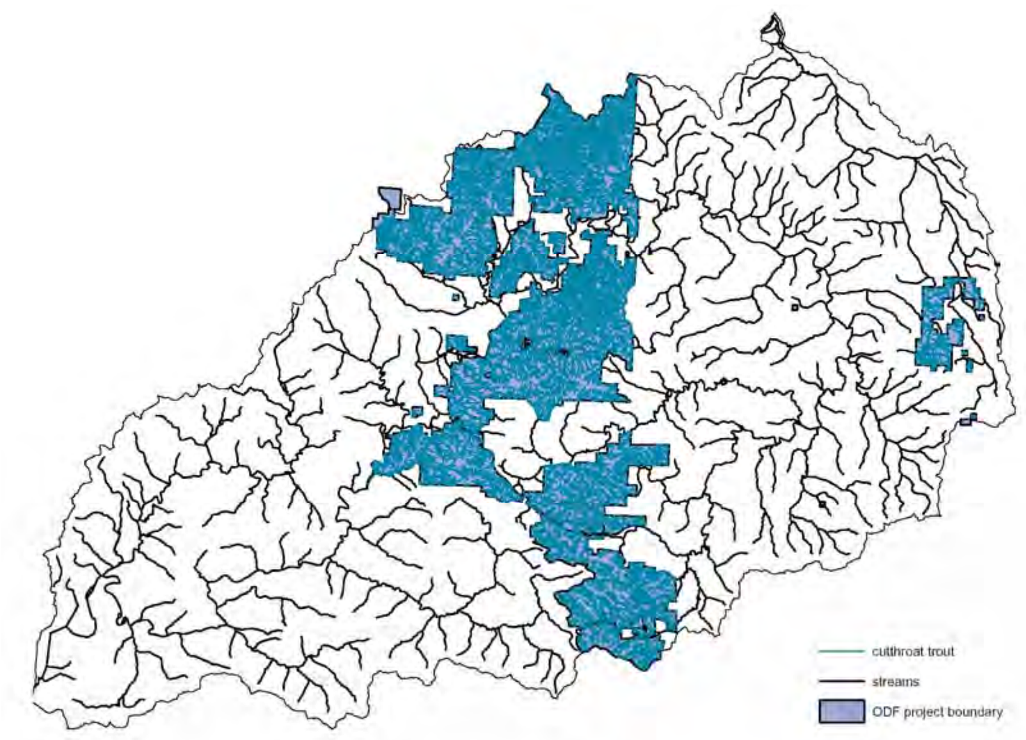


Figure 10-6. Cutthroat trout distribution in the Nehalem River basin.

Status. Coastal cutthroat trout in the Nehalem River Basin are part of the Oregon Coast ESU. Data on adult abundance in this ESU were available for only a few streams and would not be indicative of the status of the ESU as a whole. Thus, NOAA Fisheries used other available information to evaluate population trends for this ESU in 1999 (Johnson 1999). An analysis of recreational harvest data indicated that the numbers of larger fish have been declining; however trends in juvenile abundance have been stable or positive in most locations (Johnson et al. 1999). Additional information compiled by ODFW indicates that declining trends were evident for wild populations of anadromous cutthroat trout based on recreational fisheries data (Johnson et al. 1999). Resident populations however, were reported to be relatively stable (Johnson et al. 1999).

Habitat degradation appears to be the prime concern regarding the future status of coastal cutthroat trout populations. Habitat degradation and increases in stream temperatures have been noted in many small tributaries in the Oregon coastal region (Kostow 1995). More specifically, Johnson et al. (1999) reported that logging practices have been shown to decrease instream habitat quality due to increases in water temperature and siltation, removal of large wood, changes in river basin hydrology, and placement of culverts. The increased culvert numbers in coastal cutthroat trout streams was noted as a serious threat because of their effectiveness in compromising fish migrations (Johnson et al. 1999). The reduction in habitat connections among streams has been described as a potentially significant threat to coastal cutthroat trout populations (Johnson et al. 1999).

Abundance. No data was available on the abundance of cutthroat trout in the upper Nehalem River.

Pacific Lamprey, *Lampetra tridentata*

Distribution. Pacific lamprey were distributed throughout coastal rivers and stream in Oregon and throughout the Columbia River basin (Kostow 2002). Pacific lamprey were present in the Nehalem River basin (Kavanagh et al. 2005) although their exact distribution was not known.

Status. Pacific lamprey were petitioned for listing under the federal ESA but the listing was determined not warranted. However, available count data from two Columbia River dams and two dams on the Oregon Coast all indicated that this species may have declined from levels detected in 1970 (Kostow 2002). Freshwater habitat degradation was likely the most significant threat to Pacific lamprey populations. Potential habitat issues were reviewed in Kostow (2002). Habitat issues that potential impact lamprey ammocoetes include siltation, water pollution, hydrologic modifications, and development in or above rearing areas. Migrating adult lamprey have difficulty negotiating fish ladders, thus dams and perched culverts could eliminate access to spawning habitats.

Abundance. Lamprey redds were counted on 2003 and 2004 ODFW steelhead surveys in the Nehalem River. Counts averaged from 14 to 30 redds per mile (Kavanagh et al. 2005).

Western Brook Lamprey, *Lampetra richardsoni*

Distribution. Western brook lamprey was distributed throughout coastal rivers and streams in Oregon and are present in the Nehalem River basin (Kostow 2002) although their exact distribution was not known.

Status. Western Brook lamprey were petitioned for listing under the federal ESA but the listing was determined not warranted. Freshwater habitat degradation is likely the most significant threat to lamprey populations. Potential habitat issues were reviewed in Kostow (2002). Habitat issues that potential impact lamprey ammocoetes include, siltation, water pollution, hydrologic modifications, and development in or above rearing areas.

Abundance. No data were available on the abundance of Western Brook lamprey in the upper Nehalem River.

10.3.2 Fish Habitat in the Upper Nehalem River

Data on the habitat condition in the upper Nehalem River was obtained from Kavanagh et al. (2005). In the Nehalem River basin, ODFW Aquatic Inventory Habitat surveys were conducted from 1992 to 2004. Within the Project Area, surveys were restricted to tributary habitats and covered approximately 288 km of stream habitat (Kavanagh et al. 2005). During these surveys data were collected to describe the stream channel morphology, riparian characteristics and instream habitat features during low flow conditions. Details on the specific methods used can be found in Moore et al. (1999). Summary data on the habitat conditions for upper Nehalem streams was taken from Kavanagh et al. (2005) and can be found in Table 10-2. Overall these streams were reported to have habitat in fair to good condition (Kavanagh et al. 2005).

Kavanagh et al. (2005) analyzed the survey data collected and reported on the health of the upper Nehalem streams by comparing survey data to reference stream conditions. Reference stream conditions were obtained from 124 sites that were located in Oregon Coastal streams and were deemed to have experienced only low impact from human activities, such as sites within roadless areas, wilderness sites, or sites within late-successional or mature forests (Kavanagh et al. 2005). Fifteen habitat attributes were averaged for the three 5th field HUCs that overlap with the Project Area and compared with reference values for those same variables. The following results are summarized from Figures 1 through 6 of Kavanagh et al. (2005).

The results of the comparison showed the upper Nehalem streams had fewer high gradient reaches and more reaches with a narrower active channel width than Reference streams. The Upper Nehalem streams showed similar habitat ratings for 6 attributes including: percent gravel in riffles, percent bedrock, density of deep pools, percent pool habitat, percent secondary channel

Table 10-2. Upper Nehalem River Habitat Summaries by 5th Field HUC. Data obtained from Kavanagh et al. (2005).

ODF NEHALEM PROJECT AREA: HUC 1710020203
REACH SUMMARY

STREAM	SURVEY DATE	REACH LENGTH (m)	% AREA IN SIDE CHANNELS	GRADIENT	VWI	*VALLEY FORM	*CHANNEL FORM	*LAND USE DOM	*LAND USE SUB-DOM	SHADE %	BEDROCK %	FINES IN RIFFLES %	GRAVEL IN RIFFLES %	LARGE BOULDERS #/100m
BENEKE CR	7/7/1999	1065	5.9	4.7	3.3	CT	CA	YT		86	11	40	14	0.3
BENEKE CREEK	7/19/2001	6774	6.0	0.3	38.2	CT	CT	LG	AG	73	11	9	39	3.2
BENEKE CREEK	7/29/2001	2056	8.5	2.2	24.1	CT	CA	ST	AG	76	8	7	40	19.8
BENEKE CREEK	8/1/2001	2536	5.1	2	7	MT	CA	ST	YT	84	9	10	27	49.6
BENEKE CREEK	8/7/2001	1981	4.2	3.3	3.7	MT	CA	ST	LT	91	23	13	41	50.8
BENEKE CREEK	8/9/2001	1225	12.7	5	2.8	MT	CT	ST	YT	98	6	19	24	83.8
BENEKE CREEK	8/14/2001	1300	8.7	10.1	7.5	MT	CA	PT	ST	92	2	46	51	51.8
BENEKE CREEK	8/15/2001	633	10.7	18.4	1.2	SV	CH	PT	LT	85	0	95	5	19.3
BENEKE CREEK	8/24/1993	3049	4.4	0.4	20	CT	CT	AG		86	20	8	42	6.0
BENEKE CREEK	8/26/1993	6584	7.2	0.5	16.8	MT	CA	AG		87	8	9	55	4.8
BENEKE CREEK	9/10/1993	3349	13.6	0.7	7.5	MT	CT	TH		82	6	12	44	21.1
BULL HEIFER CREEK	6/22/1998	535	8.7	2.7	6.5	MT	CA	ST		90	5	32	22	6.4
BULL HEIFER CREEK	8/20/2001	1007	11.1	2.8	6	MT	CA	ST	LT	91	6	25	25	104.9
BULL HEIFER CREEK	8/22/2001	1564	3.3	7.3	2.8	MT	CA	LT	ST	94	2	58	21	74.7
BULL HEIFER CREEK TRIB A	8/27/2001	2227	8.1	4.7	5.5	MT	CT	ST	LT	95	7	34	24	150.4
BUSTER CR	8/16/1999	967	5.5	0.9	10.8	CT	CT	YT		84	2	37	33	0.0
BUSTER CR TRIB	8/20/2001	848	0.0	0.8	12.9	MT	US	ST		64	0	87	13	0.0
BUSTER CREEK	8/7/1997	1192	9.1	1.3	1.9	MV	CH	ST		93	4	8	60	8.2
BUSTER CREEK	8/11/1997	1668	4.6	1.4	1	MV	CH	ST		92	15	5	39	27.6
BUSTER CREEK	8/11/1997	524	15.9	1.5	6.2	CT	CA	ST		93	10	5	48	8.6
BUSTER CREEK	8/12/1997	772	45.0	2.2	5	MT	UA	YT	ST	91	1	9	53	18.1
BUSTER CREEK	8/14/1997	1473	8.6	1.2	2.4	CT	CA	ST	YT	89	3	18	57	39.0
BUSTER CREEK	8/14/1997	934	2.4	0.3	8.5	CT	CT	ST	YT	91	0	9	92	0.2
BUSTER CREEK	8/18/1997	1802	3.4	0.7	9.8	MT	US	ST	YT	88	0	9	85	0.7
BUSTER CREEK	8/19/1997	1053	3.7	0.7	9.2	MT	US	ST	YT	95	1	9	86	0.8
BUSTER CREEK	8/19/1997	1307	8.4	0.9	6.4	CT	CT	YT	ST	92	5	10	78	0.1
BUSTER CREEK	8/21/1997	306	13.7	1.1	7.5	MT	US	ST		94	5	7	78	0.0
BUSTER CREEK	8/21/1997	1944	3.1	1.6	11.2	CT	CT	ST		91	1	39	55	2.4
BUSTER CREEK TRIB (NC-2390)	8/12/2002	885	2.9	1.2	8.5	MT	US	ST		88	0	94	6	0.0
BUSTER CREEK TRIB A	6/25/1998	562	1.8	0.6	6.2	MT	CA	ST		90	0			0.0
BUSTER CREEK TRIB C (NC-2356)	8/14/2002	496	3.1	7.5	2	MV	CH	YT		100	2	0	50	0.4
BUSTER CREEK TRIBUTARY A1	6/11/2002	1237	3.2	5.7	4.3	CT	CA	LT	ST	100	9	55	38	0.0
BUSTER CREEK TRIBUTARY A3	6/10/2002	545	0.3	2.5	3.2	MT	US	MT	ST	99	1	64	36	0.0
BUSTER CREEK TRIBUTARY A3	6/10/2002	652	4.8	8.5	2.1	SV	CH	MT	ST	99	12	65	25	0.0
COW CR	8/23/2000	583	5.9	6.1	2.9	CT	CT	ST		91	19	9	22	2.4
COW CREEK	8/1/1995	2999	11.4	1.4	6.2	CT	CT	RR		80	0	14	48	3.4
COW CREEK	8/7/1995	1949	8.1	2.7	3.1	CT	CA	TH	ST	85	5	13	47	8.0
COW CREEK	8/9/1995	3656	7.0	6.1	1.2	MV	CH	TH	ST	94	24	18	43	24.8
COW CREEK (NC-1149)	8/20/2003	1000	8.7	5.1	2.4	CA	CT	ST		85	21	13	34	81.0
CRAWFORD CR	8/23/2001	952	0.3	2.2	3.9	CT	CA	ST	MT	85	0	68	23	0.7
FISHHAWK CREEK (JEWEL)	10/4/1995	3464	2.4	1.5	4.9	WF	US	ST	LT	85	7	23	29	1.7
FISHHAWK CREEK (JEWEL)	10/4/1995	843	1.9	5.5	1.8	MV	CH	LT	ST	92	0	16	30	0.2
FISHHAWK CREEK TRIB A	10/10/1995	823	0.8	2.5	3	CT	CA	LT	ST	88	9	18	31	0.7
FISHHAWK CREEK TRIB A	10/10/1995	1603	0.9	4	2.2	MV	CH	YT	TH	75	2	21	35	0.0
GILMORE CR	8/24/2000	650	3.4	3.3	2.5	CT	CA	ST		91	2	15	15	0.0
GILMORE CREEK	9/11/2001	1616	7.4	3.2	6.1	CT	CA	ST		88	3	48	36	2.2
GILMORE CREEK	9/17/2001	700	6.3	10	1.7	MV	CH	ST		91	6	53	40	3.3
GILMORE CREEK (NC-2154)	8/19/2003	1004	5.4	4.5	3.4	CT	CA	ST		92	11	40	40	6.9
GILMORE CREEK TRIB A	9/18/2001	2001	0.0	2.5	5.5	MT	CT	ST		87	1	40	43	0.2
GILMORE CREEK TRIB A	9/19/2001	1022	3.5	9.4	1.8	MV	CH	ST		93	8	22	65	5.5
HAMILTON CREEK	9/14/1993	1095	8.0	1.3	6.6	MT	CT	TH	YT	86	10	20	30	2.8
HAMILTON CREEK	9/14/1993	2540	5.5	2.3	2.7	MT	CA	TH	YT	89	5	20	34	8.6
HAMILTON CREEK	9/16/1993	2019	7.5	3.4	2.1	MV	CH	TH		99	9	22	19	11.6

Table 10-2. (cont) Upper Nehalem River Habitat Summaries by 5th Field HUC. Data obtained from Kavanagh et al. (2005).

ODF NEHALEM PROJECT AREA: HUC 1710020203
REACH SUMMARY

STREAM	SURVEY DATE	REACH LENGTH (m)	% AREA IN SIDE CHANNELS	GRADIENT	VWI	*VALLEY FORM	*CHANNEL FORM	*LAND USE DOM	*LAND USE SUB-DOM	SHADE %	BEDROCK %	FINES IN RIFFLES %	GRAVEL IN RIFFLES %	LARGE BOULDER #/100m
HAMILTON CREEK TRIB A	9/23/1996	783	2.5	3.4	3.8	MT	US	LT		98	16	17	26	8.6
HAMILTON CREEK TRIB A	9/25/1996	1364	7.7	4.5	2.1	MV	CH	YT	LT	90	7	15	32	14.9
HAMILTON CREEK TRIB A	9/25/1996	326	5.4	9.4	1.5	MV	CH	LT		98	7	15	22	5.2
HAMILTON CREEK TRIB A1	9/23/1996	1070	4.8	6.9	2.5	MV	CH	LT		99	6	19	63	9.3
HAMILTON CREEK TRIB B	9/24/1996	405	15.0	8.9	1.2	MV	CH	ST	LT	96	2	10	30	51.9
HAMILTON CREEK TRIB B	9/24/1996	621	3.5	5.2	2.1	MV	CH	YT	ST	79	5	15	28	12.9
HAMILTON CREEK TRIB B	9/24/1996	963	2.6	8.6	1.6	MV	CH	YT	LT	99	6	15	30	9.6
KLINES CREEK	7/19/1995	2613	3.9	2	6.8	CT	CT	LG		79	0	20	65	1.5
KLINES CREEK	7/24/1995	3836	19.9	6.8	1.8	MV	CH	LT		90	1	16	61	11.0
KLINES CREEK	7/31/1995	1172	4.7	6.8	1.9	MV	CH	ST		88	0	0	0	0.0
MOORES CREEK	7/12/1995	1415	5.1	2.6	4.2	MT	UA	YT		82	0	29	46	0.3
MOORES CREEK	7/17/1995	2193	3.0	7	1.9	MV	CH	ST		89	0	23	49	3.1
NETTLE CREEK	6/20/2000	395	24.6	6.4	10.7	MT	US	ST		95	0	29	37	0.0
NETTLE CREEK	6/21/2000	297	2.6	10.7	5.7	MT	US	YT	ST	85	2	27	57	0.0
NETTLE CREEK	6/26/2000	734	1.0	12.9	1.8	MV	CH	YT		79	1	27	38	0.0
NETTLE CREEK	6/28/2000	1406	1.9	9.2	2.2	MV	CH	ST		95	0	22	53	1.5
NORTH FORK QUARTZ CREEK	7/22/1996	1159	13.6	5.5	1.6	MV	CH	ST		99	5	30	43	19.8
NORTH FORK WALKER CREEK	7/13/1994	2063	7.8	9	1.8	MV	CH	ST		100		7	31	7.6
OSWEG CREEK	7/13/1998	520	8.6	16.1	5	CT	CA	ST	MT	96	0	86	13	9.2
OSWEG CREEK	8/21/1995	1680	27.4	9.4	1.2	MV	CH	YT		94	0	22	63	16.5
OSWEG CREEK	8/22/1995	1028	1.3	8.9	1.1	MV	CH	ST		94	0	30	65	1.8
QUARTZ CREEK, SURVEYED AS NF	7/16/1996	2090	8.9	3.1	4.1	MT	CA	RR		82	2	21	33	3.8
QUARTZ CREEK, SURVEYED AS NF	7/17/1996	995	9.9	5.4	1.8	MV	CH	ST		86	1	22	31	34.2
QUARTZ CREEK, SURVEYED AS NF	7/18/1996	572	2.3	12.7	1	SV	CH	ST		84	19	38	37	55.8
SLAUGHTERS CREEK	7/27/1997	548	1.7	2.6	1	MV	CH	MT		97		36	55	11.1
SLAUGHTERS CREEK	7/28/1997	594	6.0	2.7	1.4	MV	CH	MT	YT	89		22	66	0.5
SOUTH FORK QUARTZ CREEK	7/23/1996	373	0.0	12.7	2.7	MV	CH	SR		94	9	7	33	193.8
SOUTH FORK QUARTZ CREEK	7/24/1996	870	2.4	3	3.6	MT	CA	ST		97	5	28	45	47.8
SOUTH FORK WALKER CREEK	7/18/1994	285	1.1	5.9	1	MV	CH	ST		98	13	9	42	15.1
STANLEY CREEK	9/4/1997	582	4.4	3.1	7.2	MT	US	ST		98	7	5	58	27.7
STANLEY CREEK	9/8/1997	281	1.9	3.9	1.8	MV	CH	ST		95	14	10	62	26.0
STANLEY CREEK	9/8/1997	542	15.7	2.5	2.5	MT	US	ST		100	17	37	45	56.5
STANLEY CREEK	9/9/1997	1466	4.2	8.6	2	SV	CH	ST		95	14	6	51	116.2
STANLEY CREEK	9/11/1997	519	12.0	6.3	3.4	MT	US	YT	ST	90	1	15	53	9.2
TRAILOVER CREEK	9/24/2001	2026	2.4	2.9	9.2	CT	CT	ST		85	6	22	48	0.1
TRAILOVER CREEK	8/30/1994	1425	4.0	2.8	5.8	CT	CA	LT		92	1	30	34	0.1
TRAILOVER CREEK	5/13/1997	2870	1.8	7.8	1.3	MV	CH	YT	ST	90		27	53	4.8
WALKER CREEK	6/20/1994	8013	2.9	0.6	14.6	CT	CA	YT		89	14	9	63	1.6
WALKER CREEK	6/23/1994	2182	11.9	1.1	13.4	MT	CA	YT		76	6	11	47	2.3
WALKER CREEK	6/30/1994	2269	7.7	1.6	2.6	MT	CA	LT	ST	91	25	6	42	8.8
WALKER CREEK	7/5/1994	270	0.0	1.4	2	MV	CH	ST		97	6	3	28	15.9
WALKER CREEK	7/5/1994	688	5.3	2	2.9	MT	CA	YT		86	23	5	31	11.5
WALKER CREEK	7/6/1994	2104	13.6	3	1.4	SV	CH	ST		97	20	12	35	5.9
WALKER CREEK	8/29/1997	1994	0.7	0.6	12.4	CT	CT	YT		77	0	55	43	0.1
WALKER CREEK	9/1/1997	3288	2.0	0.6	4.2	CT	CA	ST		95	3	16	81	1.6
WALKER CREEK (NC-2130)	8/7/2002	1009	0.5	0.7	6	CT	CA	ST		73	1	17	77	5.2

Table 10-2. (cont) Upper Nehalem River Habitat Summaries by 5th Field HUC. Data obtained from Kavanagh et al. (2005).

ODF NEHALEM PROJECT AREA: HUC 1710020203
REACH SUMMARY

STREAM	REACH LENGTH (m)	ACTIVE CHANNEL WIDTH (m)	CHANNEL WIDTHS/ POOL	PERCENT POOLS	PERCENT SLACKWATER POOLS	POOLS >1m DEEP/km	RESIDUAL POOL DEPTH (m)	WOOD DEBRIS PIECES #/100m	WOOD DEBRIS VOLUME (m3)/100m	KEY PIECES #/100m	CONIFER TREES TOTAL/1000ft	RIPARIAN CONIFERS #>20in dbh /1000ft	RIPARIAN CONIFERS #>35in dbh /1000ft
BENEKE CR	1065	5.2	57.9	3.3	0.4	0.8	0.53	14	46	3.2	650	0	0
BENEKE CREEK	6774	14.8	4.2	74.0	2.4	8.2	0.9	10	14	0.3	75	27	7
BENEKE CREEK	2056	9.7	2.7	65.4	3.2	13.1	0.72	18	20	0.6	102	20	0
BENEKE CREEK	2536	10.5	3.6	44.1	7.7	5.4	0.62	29	29	0.9	329	49	12
BENEKE CREEK	1981	7.6	5.1	34.3	11.2	0.5	0.39	34	46	1	219	98	12
BENEKE CREEK	1225	6.3	6.1	16.9	1.7	0.6	0.29	20	54	1.9	549	46	0
BENEKE CREEK	1300	3	9.3	9.4	0.3	0	0.23	30	79	3.8	442	168	0
BENEKE CREEK	633	2.5	144.7	0.3	0.0	0	0.19	14	37	1.9	914	427	0
BENEKE CREEK	3049	19.9	4.9	39.8	0.4	3.7	0.7	14	12	0.5	0	0	0
BENEKE CREEK	6584	16.3	7	26.6	1.6	4.2	0.8	30	28	1	18	6	6
BENEKE CREEK	3349	14.2	2.9	40.8	10.9	2.6	0.6	49	50	1.2	163	42	6
BULL HEIFER CREEK	535	8.8	4	27.9	12.4	3	0.53	28	49	2.6	163	0	0
BULL HEIFER CREEK	1007	7.5	3.8	28.4	0.1	0.8	0.38	29	41	1.9	142	0	0
BULL HEIFER CREEK	1564	4.2	5.5	44.8	38.4	1.2	0.44	21	55	1.2	599	295	51
BULL HEIFER CREEK TRIB A	2227	6.3	4.5	30.0	14.6	1.5	0.44	26	49	1.1	183	52	0
BUSTER CR	967	13	2.4	74.1	0.4	6.7	0.58	28	37	2.3	61	20	20
BUSTER CR TRIB	848	4.7	8.2	94.8	91.5	1.2	0.62	11	11	0.2	1097	0	0
BUSTER CREEK	1192	15.7	3.1	49.6	0.0	6.1	0.6	18	41	1.8	549	61	0
BUSTER CREEK	1668	16.6	3.4	47.8	0.2	5.7	0.8	14	21	0.5	168	30	0
BUSTER CREEK	524	12.5	3.1	65.6	1.7	2.7	0.6	17	32	1	30	0	0
BUSTER CREEK	772	20.8	2.8	32.8	0.0	1.8	0.5	26	26	0.4	274	0	0
BUSTER CREEK	1473	12.7	3.8	62.0	14.2	5.8	0.6	21	26	0.6	224	20	0
BUSTER CREEK	934	11.5	5.3	91.6	30.0	9.3	0.7	15	17	0.6	0	0	0
BUSTER CREEK	1802	11.2	2.9	80.5	1.8	7.6	0.7	16	19	0.3	198	15	15
BUSTER CREEK	1053	8.9	3.7	83.1	2.2	7.3	0.7	18	19	0.2	508	81	20
BUSTER CREEK	1307	8.4	3.5	85.6	1.3	2.7	0.6	15	23	0.7	325	20	0
BUSTER CREEK	306	7.1	4.5	76.7	0.0	2.8	0.5	24	42	0.7	183	0	0
BUSTER CREEK	1944	3.7	5	78.8	20.7	0.5	0.3	18	30	1.3	137	15	0
BUSTER CREEK TRIB (NC-2390)	885	3.4	6.9	64.6	14.0	0	0.29	23	40	1.6	264	0	0
BUSTER CREEK TRIB A	562	5.2	6.4	73.0	73.0	21.4	0.34	45	259	4.8	264	102	0
BUSTER CREEK TRIB C (NC-2356)	496	3.9	22.4	2.4	0.0	0	0.05	16	35	1.6	0	0	0
BUSTER CREEK TRIBUTARY A1	1237	2.1	10.3	40.6	9.3	0.7	0.36	26	44	1.1	500	85	0
BUSTER CREEK TRIBUTARY A3	545	3	6.5	64.7	1.3	0	0.47	29	97	1.3	945	244	0
BUSTER CREEK TRIBUTARY A3	652	2.7	10.9	48.7	3.1	0	0.38	16	40	0.6	1006	213	0
COW CR	583	6.8	13.7	11.9	0.0	1.5	0.53	22	7	0	122	41	0
COW CREEK	2999	11.1	3.3	35.1	11.7	0.3	0.4	4	3	0.1	70	0	0
COW CREEK	1949	7.8	11.8	9.4	0.2	0.4	0.3	23	19	0.5	41	0	0
COW CREEK	3656	6.4	9.3	11.9	0.1	0.2	0.4	21	42	1.4	504	28	0
COW CREEK (NC-1149)	1000	7.7	6.8	14.0	0.0	1.7	0.53	35	38	0.5	81	0	0
CRAWFORD CR	952	5.1	6.3	77.1	67.8	1.1	0.58	17	18	0.2	406	0	0
FISHHAWK CREEK (JEWEL)	3464	8.4	5.7	44.5	5.9	7.6	0.7	19	36	0.7	139	52	17
FISHHAWK CREEK (JEWEL)	843	3	20.7	22.4	4.6	0	0.3	18	57	1.4	305	122	0
FISHHAWK CREEK TRIB A	823	5.1	9.2	32.5	5.5	0	0.5	21	50	2.2	305	30	0
FISHHAWK CREEK TRIB A	1603	4.9	15.9	22.1	4.7	1.2	0.5	25	57	1.6	305	30	0
GILMORE CR	650	4.8	11.5	32.7	16.4	1.4	0.52	20	10	0	183	20	20
GILMORE CREEK	1616	5.8	4.2	72.4	44.1	2.8	0.45	28	19	0.2	207	0	0
GILMORE CREEK	700	3.9	32.3	12.7	0.0	0	0.21	41	23	0.1	366	0	0
GILMORE CREEK (NC-2154)	1004	10.7	8.7	34.3	28.3	0	0.35	24	28	0.3	61	0	0
GILMORE CREEK TRIB A	2001	5	7	89.2	84.6	2.4	0.55	27	23	0.2	134	0	0
GILMORE CREEK TRIB A	1022	3.6	16.5	24.9	0.0	0	0.27	37	28	0.2	625	46	0
HAMILTON CREEK	1095	10	3.6	50.1	4.6	3.3	0.5	13	15	0.3	91	0	0
HAMILTON CREEK	2540	7.5	6.2	29.4	3.0	1.4	0.5	15	22	0.3	326	60	12
HAMILTON CREEK	2019	5.8	7.6	17.7	0.3	0	0.4	23	31	0.8	229	48	24

Table 10-2. (cont) Upper Nehalem River Habitat Summaries by 5th Field HUC. Data obtained from Kavanagh et al. (2005).

ODF NEHALEM PROJECT AREA: HUC 1710020203
REACH SUMMARY

STREAM	REACH LENGTH (m)	ACTIVE CHANNEL WIDTH (m)	CHANNEL WIDTHS/ POOL	PERCENT POOLS	PERCENT SLACKWATER POOLS	POOLS >1m DEEP/km	RESIDUAL POOL DEPTH (m)	WOOD DEBRIS PIECES #/100m	WOOD DEBRIS VOLUME (m3)/100m	KEY PIECES #/100m	CONIFER TREES TOTAL/1000ft	RIPARIAN CONIFERS #>20in dbh /1000ft	RIPARIAN CONIFERS #>35in dbh /1000ft
HAMILTON CREEK TRIB A	783	7.4	4.6	30.3	1.5	1.2	0.5	18	32	0.1	0	0	0
HAMILTON CREEK TRIB A	1364	5.8	6.8	32.8	4.2	0.6	0.4	27	69	2.4	305	20	0
HAMILTON CREEK TRIB A	326	2.2	148.2	4.8	0.0	0	0.3	17	26	0.6	853	0	0
HAMILTON CREEK TRIB A1	1070	2.4	18.6	21.7	0.0	0	0.3	17	47	1.6	213	0	0
HAMILTON CREEK TRIB B	405	8.2	9.9	8.0	0.4	0	0.4	17	48	1	792	61	0
HAMILTON CREEK TRIB B	621	5.9	10.5	16.6	0.0	1.5	0.5	35	63	2.3	305	0	0
HAMILTON CREEK TRIB B	963	6.4	7.9	14.7	0.6	0	0.4	25	55	1.3	213	30	0
KLINES CREEK	2613	4.9	7.6	45.2	15.0	0.7	0.3	2	3	0.2	30	30	10
KLINES CREEK	3836	3.8	24.1	30.0	21.9	0	0.3	18	37	1.9	433	47	0
KLINES CREEK	1172	4.7	254	2.9	3.0	0	0.4	19	55	3.3	305	61	0
MOORES CREEK	1415	4.3	16.7	12.2	0.6	0	0.2	8	15	0.9	142	81	20
MOORES CREEK	2193	3.2	122.7	1.2	0.0	0	0.3	19	32	1	1097	30	0
NETTLE CREEK	395	4.1	20.5	13.4	0.0	0	0.28	9	4	0	61	61	0
NETTLE CREEK	297	4.1	6.5	6.5	0.0	0	0.23	32	23	0	91	61	0
NETTLE CREEK	734	3.4	27.5	2.2	0.0	0	0.28	38	31	0.8	366	61	0
NETTLE CREEK	1406	3.5	72.2	1.5	0.0	0	0.35	21	41	1	1768	305	122
NORTH FORK QUARTZ CREEK	1159	6.6	8.5	17.2	0.8	0.7	0.43	36	67	2.6	0	0	0
NORTH FORK WALKER CREEK	2063	5.4	22.4	6.1		0	0.3	35	82	1.3	739	8	8
OSWEG CREEK	520	1.8	83.9	1.4	0.3	0	0.15	29	81	3.1	284	81	0
OSWEG CREEK	1680	3.9	30.1	6.1	1.1	0	0.3	23	27	1	112	20	0
OSWEG CREEK	1028	2.1	0	0.0	0.0	0	0	15	16	0.6	61	0	0
QUARTZ CREEK, SURVEYED AS NF	2090	12.6	8.9	6.8	0.0	1.3	0.5	20	14	0	406	0	0
QUARTZ CREEK, SURVEYED AS NF	995	12.3	6.8	6.9	0.0	2.8	0.52	34	36	0.7	30	30	0
QUARTZ CREEK, SURVEYED AS NF	572	8.5	5.9	25.9	0.0	11.7	0.92	51	60	0.7	122	0	0
SLAUGHTERS CREEK	548	3.4	9.6	28.5		0	0.2	30	76	3.6	30	30	0
SLAUGHTERS CREEK	594	3.1	7.9	34.5		0	0.2	30	63	1.5	447	122	20
SOUTH FORK QUARTZ CREEK	373	7.5	7.1	10.5	0.0	0	0.42	34	32	0.3	183	0	0
SOUTH FORK QUARTZ CREEK	870	3.7	17.3	16.0	0.1	1.1	0.55	5	2	0	183	0	0
SOUTH FORK WALKER CREEK	285	6	4.9	19.4	0.0	0	0.3	56	112	4.2	61	0	0
STANLEY CREEK	582	6.7	3.8	26.6	0.7	0	0.2	11	19	0.7	91	0	0
STANLEY CREEK	281	8.6	2.7	32.9	1.9	0	0.2	26	28	0.4	244	0	0
STANLEY CREEK	542	8.4	3.4	31.1	0.0	1.5	0.3	27	92	0.7	386	102	0
STANLEY CREEK	1466	7.1	4.3	25.7	0.5	0.6	0.3	40	67	1.2	549	61	0
STANLEY CREEK	519	6.3	4.3	22.4	0.2	0	0.3	43	54	1.3	152	0	0
TRAILOVER CREEK	2026	5.6	4	74.3	55.9	2.8	0.41	45	22	0.1	96	35	9
TRAILOVER CREEK	1425	4.9	300.1	2.8	2.8	0	0	43	57	1.7	163	18	0
TRAILOVER CREEK	2870	3.8	26	10.3		0		36	33	1	305	12	0
WALKER CREEK	8013	9.9	4.9	54.0	1.9	8.3	0.6	12	8	0	146	20	0
WALKER CREEK	2182	6.7	8.2	42.9	20.7	4	0.6	15	13	0.6	268	0	0
WALKER CREEK	2269	10	5.1	27.2	2.4	0.4	0.6	19	32	1.2	98	61	12
WALKER CREEK	270	10.5	4.3	44.8	0.0	0	0.5	13	12	0	305	244	0
WALKER CREEK	688	8.6	6	24.8	1.1	0	0.5	22	52	2.5	61	0	0
WALKER CREEK	2104	8.4	6.7	16.4	5.7	0.4	0.4	45	92	2.1	76	15	0
WALKER CREEK	1994	5	11	96.4	56.4	7.3	0.5	14	20	0.6	98	12	0
WALKER CREEK	3288	3.7	6.7	91.4	11.9	0.6	0.4	23	50	2	523	122	5
WALKER CREEK (NC-2130)	1009	4.6	7.7	93.8	72.5	7.9	0.67	11	9	0	81	0	0

Table 10-2. (cont) Upper Nehalem River Habitat Summaries by 5th Field HUC. Data obtained from Kavanagh et al. (2005).

ODF NEHALEM PROJECT AREA: HUC 1710020202
REACH SUMMARY

STREAM	SURVEY DATE	REACH LENGTH (m)	% AREA IN SIDE CHANNELS	GRADIENT	VWI	*VALLEY FORM	*CHANNEL FORM	*LAND USE DOM	*LAND USE SUB-DOM	SHADE %	BEDROCK %	FINES IN RIFFLES %	GRAVEL IN RIFFLES %	LARGE BOULDERS #/100m
COW CREEK	8/7/2000	2769	4.1	2.6	5.3	CT	CA	ST		92	14	16	26	3.3
COW CREEK	8/9/2000	2854	3.5	2.2	6.5	CT	CA	ST		87	4	49	41	0.1
COW CREEK	8/15/2000	783	1.0	13.4	1.3	SV	CH	ST		90	1	22	67	0.0
DEEP CREEK	8/8/1994	13932	0.3	0.4	17.8	CT	CT	YT	TH	87	5	45	46	0.3
DEEP CREEK	8/9/1994	4108	0.8	0.8	11.2	CT	CT	TH	MT	87	2	34	58	0.9
DEEP CREEK	8/15/1994	3599	0.9	0.9	8.5	CT	CT	TH	YT	88	17	33	48	2.4
DEEP CREEK	7/27/1999	1991	1.0	0.5	3.6	CT	CA	ST		85	21	23	33	0.7
DEEP CREEK	7/28/1999	472	0.8	0.9	1	OV	CH	ST		89	7	23	35	11.9
DEEP CREEK	7/28/1999	245	1.9	0.3	5	CT	CA	ST		90	1	35	40	0.0
DEEP CREEK (TRIB)	7/28/1999	310	4.0	0.5	3	CT	CA	ST		87	3	23	35	0.3
DEEP CREEK (TRIB)	7/29/1999	893	2.4	2.7	3	CT	CT	ST		91	12	21	35	0.0
DEEP CREEK (TRIB)	7/29/1999	385	1.6	3.8	1.3	MV	CH	ST		90	10	28	33	0.0
DEEP CREEK (TRIB)	9/9/1999	357	0.0	0.3	8	CT	CT	ST		92	0			0.0
DEEP CREEK SURVEYED AS TRIB A	9/13/1999	498	0.0	1.8	2.8	CT	CT	ST	YT	90	6	60	36	4.6
FISHHAWK CR (NC-2308)	9/8/2004	532	0.0	3.2	6.4	CT	CT	ST	YT	70	10	24	33	
FISHHAWK CREEK (ABOVE LAKE)	7/31/1996	2158	3.4	1.7	1.5	MV	CH	YT	ST	96	15	30	33	2.5
FISHHAWK CREEK (ABOVE LAKE)	8/1/1996	1576	4.8	0.3	3.8	CT	CT	ST		84	7	62	28	0.0
FISHHAWK CREEK (ABOVE LAKE)	8/28/1996	1422	4.0	2.3	3	MT	CA	YT		54	7	36	40	0.2
FISHHAWK CREEK (ABOVE LAKE)	8/28/1996	1035	5.9	4.3	1.6	MV	CH	YT	ST	69	3	33	50	3.0
LOUISGNONT CR	8/22/2000	877	0.9	0.6	4.5	CT	CT	ST	YT	94	2	38	47	0.0
LOUSIGNONT CREEK	8/16/2000	2605	3.8	1.5	4.7	CT	CT	YT	ST	90	4	22	60	0.1
LOUSIGNONT CREEK	8/23/2000	2202	5.6	5.8	8.4	CT	CT	YT	ST	93	7	13	26	0.0
LOUSIGNONT CREEK	8/29/2000	1166	2.8	7.7	4.4	CT	CT	YT	ST	92	3	62	34	0.3
NORTHRUP CR	9/10/2001	1090	7.8	1.3	5.4	MT	CA	ST		93	17	10	46	0.4
NORTHRUP CREEK	7/5/2000	831	5.3	0.8	12.9	CT	CT	ST		77	6	15	39	0.4
NORTHRUP CREEK	7/6/2000	4170	1.7	1.1	8.1	CT	CT	ST		74	9	26	59	0.8
NORTHRUP CREEK	7/18/2000	2440	8.6	1.6	4.9	CT	CA	ST		82	19	16	39	4.1
NORTHRUP CREEK	7/24/2000	3489	7.1	7.8	2	MV	CH	ST		86	9	20	41	2.4
NORTHRUP CREEK	7/31/2000	932	0.8	13.9	1.1	MV	CH	ST		98	10	19	26	1.3
NORTHRUP CREEK TRIBUTARY A	8/2/2000	2219	6.6	1.5	4.2	CT	CA	ST		83	3	24	58	1.8
NORTHRUP CREEK TRIBUTARY A	8/3/2000	556	3.3	27	2	MV	CH	ST		85	17	41	35	0.0
OAK RANCH CREEK	7/31/1995	2845	2.1	1.4	3.4	CT	CA	ST	TH	87	1	16	36	12.5
SAGER CR	8/9/2000	1073	5.4	3.2	1.3	OV	CH	ST		60	0	71	17	3.2
SAGER CREEK	9/14/1995	2625	0.0	0.8	2.4	CT	CT	LT	ST	84	5	64	23	2.4
SAGER CREEK	10/2/1995	3709	0.4	1.9	1.9	MV	CH	ST	YT	73	2	86	10	0.6
SAGER CREEK (NC-2365)	8/21/2003	1075	1.1	5.1	1.5	MV	CH	ST	TH	86	5	0	0	5.5
TRESTLE CREEK	8/14/1997	823	0.5	1.6	3.9	MT	US	LT		91	0	97	2	2.8
TRESTLE CREEK	8/14/1997	296	1.3	8.5	1	MV	CH	LT		94	0	65	30	0.0
WARNER CREEK	9/9/1996	827	3.9	2.7	4.8	CT	CA	YT	ST	87	16	17	46	3.3
WARNER CREEK	9/9/1996	606	4.5	2.2	1	MV	CH	YT	ST	82	8	43	43	4.5
WARNER CREEK	9/10/1996	1070	4.0	2	2.4	CT	CA	YT	ST	89	0	30	66	0.3
WARNER CREEK	9/10/1996	1282	2.7	5.1	1.2	MV	CH	ST	YT	91	1	28	58	1.3
WARNER CREEK TRIB A	9/12/1996	524	0.7	7.7	1.9	MV	CH	ST		92	16	20	30	3.1
WARNER CREEK TRIB B	9/11/1996	399	0.0	8.1	1	MV	CH	YT	ST	88	1	35	33	4.5
WARNER CREEK TRIB C	9/11/1996	226	0.0	13.3	1	MV	CH	YT	ST	75	1	34	52	0.0

Table 10-2. (cont) Upper Nehalem River Habitat Summaries by 5th Field HUC. Data obtained from Kavanagh et al. (2005).

ODF NEHALEM PROJECT AREA: HUC 1710020202
REACH SUMMARY

STREAM	REACH LENGTH (m)	ACTIVE CHANNEL WIDTH (m)	CHANNEL WIDTHS/ POOL	PERCENT POOLS	PERCENT SLACKWATER POOLS	POOLS >1m DEEP/km	RESIDUAL POOL DEPTH (m)	WOOD DEBRIS PIECES #/100m	WOOD DEBRIS VOLUME (m3)/100m	KEY PIECES #/100m	CONIFER TREES TOTAL/1000ft	RIPARIAN CONIFERS #>20in dbh /1000ft	RIPARIAN CONIFERS #>35in dbh /1000ft
COW CREEK	2769	6.7	6	30.2	1.0	0.3	0.43	25	27	1	163	20	10
COW CREEK	2854	4.7	14.1	44.5	0.8	0.3	0.49	38	65	2.6	61	20	0
COW CREEK	783	3	55.3	73.0	73.0	2.4	0.77	23	47	3.4	427	122	61
DEEP CREEK	13932	9.8	7.2	68.5	11.5	5.3	0.6	10	19	0.7	230	0	0
DEEP CREEK	4108	11	9.4	47.2	17.4	3.8	0.8	6	16	0.9	610	0	0
DEEP CREEK	3599	14.4	10.7	13.3	25.8	1.1	0.6	5	16	0.6	508	0	0
DEEP CREEK	1991	6.3	7.9	46.3	0.8	0	0.48	53	115	7.4	716	30	0
DEEP CREEK	472	7.5	4.2	66.0	0.9	0	0.39	77	192	9.5	853	183	0
DEEP CREEK	245	5.1	4.5	94.4	9.6	3.9	0.51	28	56	3.7	549	61	0
DEEP CREEK (TRIB)	310	5	2.6	82.7	2.0	0	0.43	62	116	5.2	61	0	0
DEEP CREEK (TRIB)	893	3.9	26.6	46.9	2.2	0	0.4	6	12	0.7	183	0	0
DEEP CREEK (TRIB)	385	2.8	7.8	71.6	5.0	5.2	0.5	65	155	9.9	427	0	0
DEEP CREEK (TRIB)	357	3.8	18.8	95.0	95.0	0	0.26	21	14	0.3	183	183	0
DEEP CREEK SURVEYED AS TRIB A	498	4.7	11.8	71.0	0.0	0	0.3	17	35	2.8	549	366	0
FISHHAWK CR (NC-2308)	532	5	5.1		16.6	0	0.31	21	22	0.6	264	81	0
FISHHAWK CREEK (ABOVE LAKE)	2158	9.2	4.4	58.5	2.9	9.5	0.8	36	59	1.9	61	30	15
FISHHAWK CREEK (ABOVE LAKE)	1576	6.2	5.9	71.8	10.8	14.6	0.8	14	21	0.8	122	30	0
FISHHAWK CREEK (ABOVE LAKE)	1422	8	3.6	66.4	46.2	4.5	0.5	31	56	3.4	533	46	0
FISHHAWK CREEK (ABOVE LAKE)	1035	5.8	4	47.0	7.9	0	0.4	33	106	5.7	508	61	41
LOUISGNONT CR	877	6.4	3.7	79.7	18.1	1.1	0.44	25	25	0.9	1630	20	20
LOUSIGNONT CREEK	2605	6.7	3.9	64.5	14.9	1.1	0.52	23	33	1.7	70	26	9
LOUSIGNONT CREEK	2202	4.1	20.1	13.8	0.7	0	0.35	23	39	2	122	61	0
LOUSIGNONT CREEK	1166	1.9	128.3	5.7	0.0	0	0.53	25	29	0.6	366	0	0
NORTHRUP CR	1090	10.5	3.1	69.9	13.7	0	0.41	20	7	0.1	0	0	0
NORTHRUP CREEK	831	12.3	2.2	63.8	1.1	12.8	0.68	21	20	0.7	0	0	0
NORTHRUP CREEK	4170	8.1	3.6	66.9	2.2	10.5	0.7	22	16	0.6	73	12	0
NORTHRUP CREEK	2440	8.7	5.4	29.7	1.1	0.3	0.47	29	27	0.4	0	0	0
NORTHRUP CREEK	3489	6.8	19.8	7.2	0.5	0.8	0.57	29	43	0.7	198	15	0
NORTHRUP CREEK	932	2.5	0	0.0	0.0	0	0	14	30	0.9			
NORTHRUP CREEK TRIBUTARY A	2219	4.7	13.2	28.7	10.7	0	0.45	28	53	2.3	61	20	0
NORTHRUP CREEK TRIBUTARY A	556	3.3	0	0.0	0.0	0	0	34	34	0.2	488	0	0
OAK RANCH CREEK	2845	6.6	6.5	47.3	17.4	1.7	0.4	9	15	0.8	44	0	0
SAGER CR	1073	5.1	14.6	66.0	62.6	5.4	0.65	19	52	3.9	284	81	0
SAGER CREEK	2625	6.8	10.7	74.2	20.2	1.9	0.6	11	22	0.5	102	0	0
SAGER CREEK	3709	4.1	11.5	80.4	54.5	2.7	0.4	17	50	1.6	200	0	0
SAGER CREEK (NC-2365)	1075	4.2	29.1	17.7	3.6	0	0.45	17	35	0.7	325	20	20
TRESTLE CREEK	823	3.5	59.4	10.5	0.0	0	0.4	24	44	2.1	610	0	0
TRESTLE CREEK	296	2.3	0	0.0	0.0	0	0	32	80	3	0	0	0
WARNER CREEK	827	8.2	3.9	49.7	16.3	3.4	0.4	22	22	0.7	30	0	0
WARNER CREEK	606	7.6	4.4	39.7	0.2	3.1	0.6	46	44	1.7	152	0	0
WARNER CREEK	1070	6	5.1	50.3	9.4	2.6	0.6	28	25	0.5	274	0	0
WARNER CREEK	1282	5	7.1	31.9	0.6	0.7	0.5	37	42	1.5	203	0	0
WARNER CREEK TRIB A	524	4	8.7	22.3		0	0.4	31	34	0.8	427	0	0
WARNER CREEK TRIB B	399	4.3	13.3	13.5		0	0.4	35	60	3	61	0	0
WARNER CREEK TRIB C	226	2.3	19.7	20.2		0	0.4	64	103	6.6	183	0	0

Table 10-2. (cont) Upper Nehalem River Habitat Summaries by 5th Field HUC. Data obtained from Kavanagh et al. (2005).

ODF NEHALEM PROJECT AREA: HUC 1710020201
REACH SUMMARY

STREAM	SURVEY DATE	REACH LENGTH (m)	% AREA IN SIDE CHANNELS	GRADIENT	VWI	*VALLEY FORM	*CHANNEL FORM	*LAND USE DOM	*LAND USE SUB-DOM	SHADE %	BEDROCK %	FINES IN RIFFLES %	GRAVEL IN RIFFLES %	LARGE BOULDERS #/100m
BEAR CREEK	5/26/1997	853	2.2	1.9	4.5	MT	CA	ST		93	3	31	38	0.9
BEAR CREEK	5/26/1997	989	2.1	1.9	1.1	MV	CH	LT		92	6	56	32	1.2
BEAR CREEK	5/27/1997	822	1.0	2.6	2.7	MT	CA	ST	LT	88	5	67	31	0.6
CARLSON CREEK	8/29/1995	2968	0.1	2.8	1.8	OV	CH	ST	LT	87	2	60	20	0.5
CLEAR CREEK	7/7/1994	1691	4.1	2.4	5.6	CT	CA	TH	YT	90	0	55	35	0.1
DELL CREEK	7/11/1994	1302	3.8	1.7	2.4	OV	CH	ST		92	1	1	62	0.4
DELL CREEK	7/13/1994	457	1.8	2	5.8	MT	CT	ST		80	0	5	48	0.0
DERBY CREEK	9/22/1998	530	23.7	5.7	4.2	MT	US	ST	LT	90	0	33	26	149.6
LOUISIGNONT CREEK	8/18/1993	2600	9.7	0.9	6.1	CT	CA	LT	YT	93	6	32	58	1.1
LOUISIGNONT CREEK	8/24/1993	2911	19.4	1.7	4.9	MT	UA	LT	MT	98	0	37	49	0.0
LOUISIGNONT CREEK	8/26/1993	3420	7.4	4.8	1.7	SV	CH	LT	MT	97	6	40	38	4.8
LOUSIGNONT CR	6/30/1999	397	3.6	3.4	1.3	SV	CH	ST		79	0	44	29	0.0
LOUSIGNONT CREEK (NC-1268)	7/2/2002	442	10.3	6.1	3.9	MT	US	LT		90	0	10	48	0.7
N. FK. LOUSIGNONT CR (NC-1289)	8/12/2004	872		0.9	5.5	CT	CT	ST		76	0	63	35	
NORTH FORK ROCK CREEK	7/15/1993	1387	7.8	1.1	4.1	CT	CA	ST	ST	96		3	47	13.2
NORTH FORK ROCK CREEK	7/19/1993	1553	40.3	1	9.6	WF	US	ST	ST	94		9	50	4.0
NORTH FORK ROCK CREEK	7/21/1993	453	0.6	4.8	3.3	MV	CH	ST	ST	94		4	29	22.5
NORTH FORK WOLF CREEK	8/24/1992	1293	0.8	1.2	14.9	CT	CA	ST		87	29	24	43	3.9
NORTH FORK WOLF CREEK	8/24/1992	1514	1.3	1.7	2.6	SV	CH	ST		87	23	23	43	3.8
NORTH FORK WOLF CREEK	8/31/1992	1454	4.2	2.4	2	SV	CH	ST		87	13	26	65	2.7
NORTH FORK WOLF CREEK	9/1/1992	722	4.5	1.5	6.2	WF	US	ST		88	0	26	59	0.0
NORTH FORK WOLF CREEK	9/2/1992	1172	6.2	3.6	1.8	MV	CH	ST		98	2	44	46	1.3
OLSON CR (NC-1046)	9/1/2004	1053		0.8	2.1	MV	CH	ST		73	0	62	39	
ROCK CREEK	7/1/1993	582	6.8	0.6	3	CT	CT	TH	ST	99	7	8	32	75.4
ROCK CREEK	8/11/1993	669	4.4	2.9	1.5	MV	CH	ST		95	3	5	20	323.5
ROCK CREEK	8/12/1993	794	2.7	0.9	13.3	WF	US	ST		69	1	1	36	0.1
SOUTH FORK NEHALEM RIVER	9/12/1995	1396	2.3	4.3	1.3	MV	CA	ST	LT	94	1	30	47	3.8
SOUTH FORK NEHALEM RIVER	9/13/1995	1877	4.2	15	1.2	MV	CH	ST	LT	94	13	23	28	7.2
SOUTH FORK ROCK CREEK	8/3/1993	4670	1.8	2.3	12.1	MT	CT	ST	ST	95		2	35	14.9
SOUTH FORK ROCK CREEK	8/4/1993	188	0.0	7.5	1	SV	CH	ST	ST	99		0	67	58.5
SOUTH FORK ROCK CREEK	8/4/1993	490	0.0	3.1	7.8	CT	CT	ST	ST	97		4	66	0.8
SOUTH FORK ROCK CREEK	8/5/1993	2756	0.3	5.1	2.4	SV	CH	ST	TH	90		2	47	17.8
UPPER NEHALEM RIVER	8/31/1995	6079	4.5	2.3	2.6	CT	CA	LT		96	6	29	36	7.8
UPPER NEHALEM RIVER	9/11/1995	3517	3.1	9.1	1.9	MV	CH	LT		97	12	61	25	1.7
WOLF CREEK	7/15/1997	1690	5.0	3.5	1.2	MV	CH	LT		88	15	15	34	3.8
WOLF CREEK	7/15/1997	2455	2.2	6.3	1	SV	CH	MT		85	14	11	34	7.8
WOLF CREEK	7/16/1997	905	0.4	10.8	1	SV	CH	YT	LT	63	27	15	55	11.5

Table 10-2. (cont) Upper Nehalem River Habitat Summaries by 5th Field HUC. Data obtained from Kavanagh et al. (2005).

ODF NEHALEM PROJECT AREA: HUC 1710020201
REACH SUMMARY

STREAM	REACH LENGTH (m)	ACTIVE CHANNEL WIDTH (m)	CHANNEL WIDTHS/ POOL	PERCENT POOLS	PERCENT SLACKWATER POOLS	POOLS >1m DEEP/km	RESIDUAL POOL DEPTH (m)	WOOD DEBRIS PIECES #/100m	WOOD DEBRIS VOLUME (m3)/100m	KEY PIECES #/100m	CONIFER TREES TOTAL/1000ft	RIPARIAN CONIFERS #>20in dbh /1000ft	RIPARIAN CONIFERS #>35in dbh /1000ft
BEAR CREEK	853	5.8	7.7	47.2	8.5	5.6	0.6	35	28	0.8	213	0	0
BEAR CREEK	989	6.8	9.5	48.4	6.8	2.9	0.6	38	31	0.6	671	0	0
BEAR CREEK	822	2.5	10.4	89.4	88.3	3.3	0.5	31	22	0.5	396	30	0
CARLSON CREEK	2968	11.5	8.1	53.8	42.5	0.7	0.5	15	23	0.4	1240	203	20
CLEAR CREEK	1691	5.3	6.1	47.4	1.2	2.3	0.5	22	65	1.1	213	0	0
DELL CREEK	1302	5	5.5	60.3	12.8	0	0.4	44	34	0.5	290	12	0
DELL CREEK	457	2.9	16.5	18.5	6.5	0	0.4	32	28	0	701	0	0
DERBY CREEK	530	3.6	10	18.9	0.9	0	0.39	23	15	0.2	691	41	0
LOUISIGNONT CREEK	2600	10.3	3	65.4	2.0	2.5	0.6	23	16	0.2	260	30	0
LOUISIGNONT CREEK	2911	10	3	38.4	4.4	0.2	0.5	23	21	0.6	253	79	12
LOUISIGNONT CREEK	3420	6.9	6.8	25.8	0.6	0.9	0.4	41	59	1.5	441	121	0
LOUSIGNONT CR	397	3.7	8.3	15.3	2.5	0	0.43	39	82	4.3	1321	0	0
LOUSIGNONT CREEK (NC-1268)	442	4.7	5.4	16.6	0.8	0	0.3	23	29	0.5	325	122	0
N. FK. LOUSIGNONT CR (NC-1289)	872	7.3	5.2		87.2	0	0.41	20	17	0.7	467	41	0
NORTH FORK ROCK CREEK	1387	7.7	3.5	49.9			0.5	54	155		670	0	0
NORTH FORK ROCK CREEK	1553	3.5	7.9	59.8			0.4	39	78		483	0	0
NORTH FORK ROCK CREEK	453	3.5	10.8	25.9			0.4	51	91		1116	121	0
NORTH FORK WOLF CREEK	1293	9.1	3.8	61.8	9.3	3	0.4	7	7	0.2		0	0
NORTH FORK WOLF CREEK	1514	7.7	5.5	33.0	0.1	4.5	0.4	16	13	0.3		0	0
NORTH FORK WOLF CREEK	1454	6.7	5.4	46.0	0.2	2.5	0.5	29	29	1.5		0	0
NORTH FORK WOLF CREEK	722	4.3	6	55.9	0.7	0	0.5	22	44	2.8		0	0
NORTH FORK WOLF CREEK	1172	6.9	3.8	40.9	1.7	0.8	0.4	31	54	3.9		0	0
OLSON CR (NC-1046)	1053	10.1	7.5		88.2	1.9	0.48	21	33	0.6	1138	0	0
ROCK CREEK	582	17	8.6	9.8	1.2	3	0.6	6	12	0.4		0	0
ROCK CREEK	669	8.5	19.7	26.2	18.6	4.2	0.8	11	35	2.4	845	60	0
ROCK CREEK	794	8.2	9.7	38.6	10.5	7.8	1	9	14	0.4	0	0	0
SOUTH FORK NEHALEM RIVER	1396	9.6	15.1	12.1	0.0	1.4	0.7	28	38	0.7	610	122	0
SOUTH FORK NEHALEM RIVER	1877	11	89.9	1.2	0.0	0	0.4	23	44	0.9	549	122	0
SOUTH FORK ROCK CREEK	4670	7.1	8.3	27.6			0.6	20	28		338	48	0
SOUTH FORK ROCK CREEK	188	4	11.8	20.7			0.5	54	86		1448	241	0
SOUTH FORK ROCK CREEK	490	6.3	5.2	52.0			0.5	19	22		1207	91	30
SOUTH FORK ROCK CREEK	2756	4	19.1	14.8			0.4	31	65		748	133	42
UPPER NEHALEM RIVER	6079	14	9.5	15.8	0.0	2.9	0.7	15	18	0.4	315	91	0
UPPER NEHALEM RIVER	3517	10	34.4	17.7	3.3	0	0.5	26	59	2.2	549	213	30
WOLF CREEK	1690	7	11	16.3	1.3	4.7	0.7	30	16	0.1	366	0	0
WOLF CREEK	2455	6.9	24.4	8.2	0.6	0	0.5	22	28	0.9	701	0	0
WOLF CREEK	905	2.4	190.7	2.1	0.0	0	0.6	19	39	1.4	549	0	0

area, percent channel shading. According to Kavanagh et al (2005), dissimilarities between the upper Nehalem and reference conditions were evident for percent fine sediments and riparian attributes. The upper Nehalem streams had greater amount of fine sediments in riffle habitat compared to reference sites. Seventy five percent of the surveyed reaches had greater than 8 percent fines in riffle. With respect to the six wood attributes, the Nehalem streams were lower in terms of density of wood pieces, density of wood volume, key wood pieces, as well as in all three densities of riparian conifers. In addition, although channel shading in upper Nehalem was similar to reference stream condition this shading was provided by predominantly hardwood species as indicated by the lower number of large and very large riparian conifers in upper Nehalem reaches. The counts of large and very large riparian conifers were zero in 37 percent and 72 percent respectively of the upper Nehalem reaches surveyed. These findings are not surprising given that the Project area is managed for forestry where as the reference stream are located within unmanaged and relatively unimpacted systems.

When individual reach data were compared to reference conditions it was clear that there are reaches within these upper Nehalem streams that support excellent habitat conditions (Kavanagh et al. 2005). These reaches were identified by five or more attributes that were similar to or better than conditions in reference reaches. Table 10-3 identifies these reaches and their high quality habitat parameters by 5th Field HUC.

10.3.3 Fish Passage Barriers

Fish passage barriers at stream crossings were identified during 2005 road information management system (RIMS) surveys of all forest roads within the project area. Based on the RIMS database, a total of three passage barriers on known fish bearing streams exist in the project area as a result of road crossings. All three barriers were assessed to restrict passage of juvenile fish only. A description of fish barriers at stream crossings is provided in Section 8.2.5 and in Table 8-9.

10.3.4 Key Large Wood

Kavanagh et al. (2005) reported that large wood was relatively rare in upper Nehalem streams. According to the ODFW reference criteria, more than 3 pieces of large wood constitutes a high level, less than 0.5 pieces constitutes a low level, and from 0.51 to 2.9 pieces constitutes a moderate level. The data on large wood from Table 10-2 indicated that 61 percent of upper Nehalem surveyed stream reaches a moderate amount of key large wood. Twelve percent of the reaches had high levels of key large wood while 27 percent had low levels. It is important to not that the following streams had surveyed reaches that were lacking any key large wood: Cow Creek, Gilmore Creek, Nettle Creek (2 reaches), Osweg Creek, South Fork Quartz Creek, Walker Creek (3 reaches), Dell Creek. Table 10-4 denotes levels of key pieces of large wood for stream reaches by management basin.

Table 10-3. Excellent quality reach habitats within the upper Nehalem as defined in Kavanagh et al. (2005).

Management Basin	Stream Name	High quality habitat characteristics
Wheeler	South Fork Rock Creek	0% fines in riffles, >60% gravel in riffles, large wood >50 pieces/100m, >200 large riparian conifers
Sager	Deep Creek	~ 66% pools, large wood >75 pieces/100m, wood volume >192, ~9 key pieces large wood/ 100m, 183 large riparian conifers
	Tributary to Deep Creek	~72% pools, ~ 5% deep pools, large wood >65 pieces/100m, wood volume >155, ~10 key pieces large wood/ 100m, 183 large riparian conifers
Fishhawk	Fishhawk Creek	47% pools, ~ 8% deep pools, large wood >33 pieces/100m, wood volume >105, ~6 key pieces large wood/ 100m, ~6% secondary channel area
Beneke	Beneke Creek	large wood >29 pieces/100m, wood volume >79, ~4 key pieces large wood/ 100m, 168 large riparian conifers, ~6% secondary channel area
Buster	Buster Creek	8% fines in riffles, 60% gravel in riffles, ~ 50% pools, ~6% deep, 9% secondary channel area
	Buster Creek	7% fines in riffles, 78% gravel in riffles, ~ 76% pools, ~6% >23 pieces large wood/100 m, ~14% secondary channel area
	Buster Creek	57% gravel in riffles, ~ 62% pools, ~14% slack water, ~6% deep, 21 pieces large wood/100 m, ~9% secondary channel area
	Tributary to Buster Creek	73% pools, 73% slack water, >21% deep pools, large wood >45 pieces/100m, wood volume >259, ~5 key pieces large wood/ 100m,
	Cow Creek	67% gravel in riffles, 73% pools, 73% slack water, >22 pieces large wood, 3.4 key pieces large wood
	North Fork Rock Creek	3% fines in riffles, ~ 50% pools, large wood >50 pieces/100m and >154 volume, 7.8% area of secondary channels

Table 10-4. Streams with high, medium and low levels of key pieces of large wood. The number of reaches in parentheses for stream with more than one reach per category.

	Level of Key Pieces of Large Wood		
Management Basin	**High (>3 pieces/100 m)**	**Medium (0.6 – 3 pieces/100 m)**	**Low (<0.5 pieces/ 100 m)**
Wheeler		Bear Creek (2)	Bear Creek Carlson Creek
			Derby Creek
	Lousignont Creek	Lousignont Creek (2)	Lousignont Creek (2)
		N. Fork Lousignont Creek	
		S Fork Nehalem River	
		Upper Nehalem River	Upper Nehalem River
		Wolf Creek (2)	Wolf Creek
McGregor		Clear Creek	
	N. Fork Wolf Creek	N. Fork Wolf Creek	N. Fork Wolf Creek (2)
		Olson Creek	
		Rock Creek	Rock Creek (2)
Sager	Sager Creek	Sager Creek (3)	
	Deep Creek (3)	Deep Creek (3)	
	Deep Creek Tributary (2)	Deep Creek Tributary (2)	Deep Creek Tributary
	Slaughter's Creek	Slaughter's Creek	
Lousignot		Lousignot Creek	
Fishhawk	Fishhawk Creek (above lake) (2)	Fishhawk Creek (above lake) (2)	
		Fishhawk Creek	
	Trestle Creek	Trestle Creek (2)	
		Warner Creek (3)	Warner Creek
	Warner Creek Tributaries (3)	Warner Creek Tributary	
Northrup	Cow Creek	Cow Creek	
		Northrup Creek (4)	Northrup (2)
		Northrup Creek Tributary	Northrup Creek Tributary
Quartz		Quartz Creek	 S. Fork Quartz Creek (2)
Buster		Buster Creek (6)	Buster Creek (6)
	Buster Creek Tributary	Buster Creek Tributaries (5)	Buster Creek Tributary
	Cow Creek	Cow Creek (2)	Cow Creek (2)
			Crawford Creek
	Klines Creek	Klines Creek (2)	Klines Creek
		Moores Creek (2)	
		Nettle Creek (2)	Nettle Creek (2)
	Osweg Creek	Osweg Creek (2)	

Table 10-4. Streams with high, medium and low levels of key pieces of large wood. The number of reaches in parentheses for stream with more than one reach per category.

Management Basin	Level of Key Pieces of Large Wood High (>3 pieces/100 m)	Medium (0.6 – 3 pieces/100 m)	Low (<0.5 pieces/ 100 m)
		N. Fork Quartz Creek (2)	N. Fork Quartz Creek
		Stanley Creek (3)	Stanley Creek
	S. Fork Walker Creek		
Hamilton		Fishhawk Creek (Jewel) (2)	
		Fishhawk Creek Tributary (2)	
		Hamilton Creek Tributaries (6)	Hamilton Creek Tributary
		Hamilton Creek	Hamilton Creek (2)
Beneke	Beneke Creek (2)	Beneke Creek (7)	Beneke Creek (2)
		Bull Heifer Creek (3)	
		Bull Heifer Creek Tributary	
			Gilmore Creek (3)
			Gilmore Creek Tributary (2)
		Trailover (2)	Trailover
		N. Fork Walker Creek	
			S. Fork Walker Creek
		Walker Creek (6)	Walker Creek (2)
Wilark			Dell Creek
			Derby Creek
		Oak Ranch Creek	

10.3.5 Splash Dams

There is little documentation that splash damming occurred in and around the Project Area. The location of 11 permanent splash dams located in western Oregon rivers were documented in Hobbs et al. (2002). Three of these dams appeared to be in the upper Nehalem watershed, but there was insufficient detail to determine if they were located within the Project Area. In addition, no residual effects of splash dams were noted during ODFW Aquatic Inventory habitat surveys (Kavanagh et al. 2005).

10.3.6 Fish Habitat in Contiguous Lands

10.3.6.1 Clatskanie River Basin

Fish Species in the Upper Clatskanie River Basin.

Table 10-5 lists the fish species documented in the upper Nehalem River and their current management status. All of these species are native to the Oregon coastal rivers. Although additional resident and migratory fishes were undoubtedly present in the system, no documentation of those species was available. No information was available on introductions or presence of non-native species in the upper Clatskanie River, nor on their interactions with native species. No information was available to document the extirpation of any native fish species from the upper Clatskanie River basin.

Table 10-5. The management status of fish species distributed in the upper Clatskanie River within the Project area.

Species	Life histories strategy	Management Status
Coho salmon *Oncorhynchus kisutch*	Anadromous	Proposed as threatened under federal ESA as part of the Lower Columbia River ESU. State Endangered.
Chinook salmon *O. tshawytscha*	Anadromous, fall race	Listed as Threatened under federal ESA as part of the Lower Columbia River ESU. State sensitive species with critical status.
Steelhead *O. mykiss*	Anadromous, winter race	No special status
Coastal cutthroat trout *O. clarki clarki*	Anadromous and Resident	Federal species of Concern State sensitive with vulnerable status
Pacific lamprey *Lampetra tridentata*	Anadromous	Federal species of Concern State sensitive with vulnerable status
Western Brook lamprey *L. richardsoni*	Resident	No Special Status

The regional distribution, status and abundance of fish species is described in Section 10.3.1. The little information available that pertains specifically to these fishes in the Project Area is summarized below.

Coho salmon and winter steelhead have been observed spawning in the sections of the Little Clatskanie and Clatskanie rivers that flow through the Project area (Kavanagh et al. 2005). Coho salmon spawning was observed from mid November to early January while steelhead spawning was observed from mid-March to mid-April. Pacific lamprey have been observed in the Clatskanie River upstream of Carcus Creek (Kavanagh et al. 2005). Pacific lamprey redds were documented in April and May.

Oregon Department of Fish and Wildlife conducted spawning ground surveys for coho salmon in the Clatskanie River from 1948 to 1997. These data suggested that the abundance of spawning coho salmon decline considerably in the 1960s and 1970s (Rule 2001). Very few coho salmon are thought to return to the Clatskanie River today (Kavanagh et al. 2005). No population information was available for others fish species in the Clatskanie River basin Project Area.

Fish Habitat in the Upper Clatskanie River

Data on fish habitat in the Clatskanie River basin is presented in Rule (2001). This data was not presented in sufficient detail to separate out the reach that flows through ODF land. In general, the Clatskanie River habitat was rated good for pools, fair to poor for riffles, poor for large wood, poor for abundance of conifers and good for shade. Rule (2001) noted that the Clatskanie River had undesirably low levels of wood that there were few large riparian conifers, and that fine sediments were generally high within riffle habitats.

Fish Passage Barriers

Fish passage barriers at stream crossings were identified during 2005 road information management system (RIMS) surveys of all forest roads within the project area. Based on the RIMS database, no fish barriers existed on contiguous lands in the Upper Clatskanie River. A description of fish barriers at stream crossings is provided in Section 8.2.5 and in Table 8-9.

Key Large Wood

Data on key large wood is presented in Table 10-4.

Splash Dams

There is little documentation that splash damming occurred in and around the Project Area. The location of 11 permanent splash dams located in western Oregon rivers were documented in Hobbs et al. (2002). One of these dams appeared to be in the vicinity of the Clatskanie River, but there was insufficient detail to determine if it was located within the Project Area. In addition, no residual effects of splash dams were noted during ODFW Aquatic Inventory habitat surveys (Kavanagh et al. 2005).

10.3.6.2 Young's Bay Watershed

Fish Species in the Upper South Fork of the Klaskanine River

Due to the presence of a 25-foot waterfall on the lower South Fork of the Klaskanine River (E&S Environmental Chemistry and Young's Watershed Council 2000) no anadromous fish species are likely present in the Project Area. Based on their regional distribution, resident cutthroat trout and western brook lamprey most likely are present (Table 10-6). These species are native to the Oregon coastal rivers. Although additional resident and migratory fishes are undoubtedly present in the system. No documentation of those species was available. No information was available on introductions or presence of non-native species in the upper South Fork Klaskanine River, nor on their interactions with native species. No information was available to document the extirpation of any native fish species from the upper South Fork Klaskanine River basin.

Table 10-6. The management status of fish species distributed in the upper South Fork of the Klaskanine River within the Project area.

Species	Life Histories Strategy	Management Status
Coastal cutthroat trout *O. clarki clarki*	Anadromous and Resident	Federal species of Concern State sensitive with vulnerable status
Western Brook lamprey *L. richardsoni*	Resident	No Special Status

The ecology and regional distribution of the fish species present in the Project area are described in Section 10.3. No information was available that pertained specifically to these fishes in the Project Area.

Fish Habitat in the Upper South Fork of the Klaskanine River

No data were available on fish habitat in upper South Fork Klaskanine River within the Project Area. Oregon Department of Fish and Wildlife Aquatic inventory Habitat surveys were conducted in habitats downstream in the South Fork Klaskanine River in 1992 (E&S Environmental Chemistry 2000). The data from these surveys are summarized below. The South Fork Klaskanine survey reaches generally had moderate to good frequency of pools, moderate gravel in riffles, but lacked large wood both in terms of pieces and volume.

Fish Passage Barriers

Fish passage barriers at stream crossings were identified during 2005 road information management system (RIMS) surveys of all forest roads within the project area. Based on the

RIMS database, no fish barriers existed on known fish bearing streams in the Upper South Fork Klaskanine River as a result of road crossings. A description of fish barriers at stream crossings is provided in Section 8.2.5 and in Table 8-9.

Key Large Wood

No data were available on key pieces of large wood for the upper South Fork of the Klaskanine River within the Project Area. Data from habitat surveys downstream showed that all of the surveyed reaches in the South Fork completely lacked key pieces of large wood (E&S Environmental Chemistry 2000).

Splash Dams

Although there is some documentation that splash damming occurred in and around the Project Area historically, no documentation of splash dams in the South Fork Klaskanine River was found.

10.4 AMPHIBIANS IN THE UPPER NEHALEM RIVER

10.4.1 Columbia Torrent Salamander

10.4.1.1 Species Distribution and Status

The Columbia torrent salamander is one of four species (*Rhyacotriton olympicus, R. cascadae, R. variegatus*, and *R. kezeri*) in the genus Rhyacotriton. Until 1992, the genus was considered to be a single species, all of which were formally known as *R. olympicus*. The geographic ranges of the four species are almost entirely isolated from one another—the single exception being a possible area of overlapping ranges of *R. kezeri* and *R. variegatus* in southern Tillamook County, Oregon (Csuti et al. 1997). The Columbia torrent salamander occurs north of the Little Nestucca River and south of the Chehalis River in the Coast Range of Oregon and Washington (Good and Wake 1992).

The Columbia torrent salamander (*R. kezeri*), also commonly known as the Columbia seep salamander, is classified by the Oregon Department of Fish and Wildlife (ODFW) as “Sensitive-Critical.” The species has Natural Heritage Network ranks of Global-3 and State-3 (ORNIC 2004).

10.4.1.2 Natural History

The four species of *Rhyacotriton* are morphologically very similar, but can be differentiated based on pigmentation features, minor variation among some life history characteristics (Good and Wake 1992), and genetics (Good et al. 1987). There is apparently little variation in habitat selection among the four species of *Rhyacotriton* (Good and Wake 1992).

Torrent salamanders are usually found along the wetted edge of steep streams, seeps, and waterfall splash zones. Diller and Wallace (1996) reported that the average slope of stream reaches occupied by torrent salamanders was 17.6 percent. Torrent salamanders prefer cold environments and begin to exhibit signs of stress at relatively low temperatures (63°F) compared to other salamanders (Brattstrom 1963). The highest abundances of torrent salamanders are observed in water temperatures of 46.4-55.4°F (Welsh and Lind 1996). Adult torrent salamanders are occasionally found in moist, riparian environments as well. However, they are extremely vulnerable to desiccation in terrestrial environments. Ray (1958) demonstrated experimentally that torrent salamanders become physically incapacitated when subjected to more than a 7.4 percent loss of body water, a much lower threshold for water loss than any other salamander tested. Not surprisingly, torrent salamanders are only able to persist out of water in closed-canopy forests (Good and Wake 1992). Welsh and Lind (1996) suggested that torrent salamanders are dependent on the microclimate and habitat structure associated with late-successional forests. Diller and Wallace (1996) concluded that highly suitable microhabitats are most likely to exist in late-successional forests, but torrent salamanders are widespread in other habitat types.

Given its low tolerance for warm, dry environments, it would seem likely that torrent salamanders would prefer sites on northerly aspects. Diller and Wallace (1996) found evidence that torrent salamanders were more likely to occur in streams on northern slopes than other aspects when aspect measurements were averaged at a landscape-scale using a geographic information system (GIS). But the same study failed to produce evidence of habitat selection for aspect at a microsite scale (i.e., measured at the point of capture). This is not particularly surprising because stream water temperature (and presumably torrent salamander abundance) is more strongly affected by upstream conditions than aspect or other conditions at the point of temperature measurement. Another California study (Welsh and Lind 1996) tested, but failed to find a significant association between torrent salamander abundance and landscape-scale aspect.

Torrent salamanders reportedly are most abundant in streambed substrates composed of coarse gravel and cobble (Good and Wake 1992; Diller and Wallace 1996; Welsh and Lind 1996). The interstitial spaces among streambed particles are used as oviposition sites and hiding cover by adults and larvae. Good and Wake (1992) report that adult salamanders tend to be found among rocks, while larvae tend to use coarse gravel. Welsh and Lind (1996) suggest that stream reaches having a variety of particle sizes provides the most suitable torrent salamander habitat for hiding, feeding, and reproduction. However, habitat is degraded where interstitial spaces become filled with sand or fine sediment. Lowell and Diller (1996) found that consolidated geological formations (vs. unconsolidated sedimentary formations) and stream gradient were among the best predictors of torrent salamander occurrence. The authors believed the relationship could be explained by the relatively large streambed particles that result from the decomposition of consolidated bedrock, and the downstream transport of fine particles caused by fast water moving down steep slopes.

10.4.2 Tailed Frog

10.4.2.1 Species Distribution and Status

In Oregon, tailed frogs are distributed throughout the Coast Range, Siskiyou region, western Cascades, and the Blue Mountains (Csuti et al. 1997).

The tailed frog (*Ascaphus truei*) is classified by ODFW as "Sensitive-Vulnerable" and has Natural Heritage Network ranks of Global-4 and State-3 (ORNIC 2004). The U.S. Fish and Wildlife Service (USFWS) considers the tailed frog a Species of Concern in Oregon (USFWS 2004). Neither the torrent salamander nor tailed frog has been determined to be Threatened or Endangered under the federal Endangered Species Act.

10.4.2.2 Life History

Tailed frogs are almost always associated with cold, mountain streams. Unlike most other frogs in the Pacific Northwest, the species does not use lakes or wetlands. deVlaming and Bury (1970) reported that first year tailed frog tadpoles tend to prefer water temperatures <50°F, while older tadpoles prefer temperatures 50-71.6°F. In a stream amphibian survey conducted in the Kilchis River basin (Tillamook Co., OR), water temperatures where tailed frogs were captured averaged 52.2°F (Pacific Wildlife Research, unpublished data).

Tailed frogs appear to select microhabitats depending upon their developmental stage. Adult frogs and more mature larvae tend to occur more often upstream, in steeper and faster waters than less developed larvae (Hayes et al. 2003; Wahbe and Bunnell 2003). Hayes et al. (2003) hypothesize that adult tailed frogs lay eggs in lower reaches where they are more likely to remain submerged during low flow. As larvae mature, they may move upstream to reaches that are unoccupied by fish, which are significant predators of tailed frogs.

Adult tailed frogs are also found outside of stream channels in riparian and upslope forests (Gomez and Anthony 1996; McComb et al. 1993). However, research on tailed frogs does not clearly describe a relationship between forest conditions and tailed frog occurrence or abundance. Blaustein et al. (1995) suggested that tailed frogs are among the amphibian species most sensitive to the loss of old-growth forests in the Pacific Northwest. Furthermore, Gomez and Anthony (1993) found tailed frogs to be more abundant in large conifer and old-growth forests than in younger forest types in the Oregon Coast Range. In contrast, Bull and Carter (1996) did not find evidence of a relationship between tailed frog abundance and timber harvest intensity in northeastern Oregon. Wahbe and Bunnell (2003) concluded tailed frog abundance was more strongly affected by stream microhabitat features than the logging history of a site.

Cobbles and large rocks in stream channels are important habitat elements for tailed frogs. Tailed frog tadpoles use a specialized oral disk to attach themselves to cobbles and boulders while feeding on diatoms and periphyton (Altig and Brodie 1972; Bull and Carter 1996). The interstitial spaces between rocks are used as oviposition sites and as hiding cover by tadpoles and adults.

10.4.3 Population Distributions in the Nehalem Watershed

The Project Area is within the reported geographic ranges of the Columbia torrent salamander and the tailed frog (Csuti et al. 1997; Corkran and Thoms 1996). A review of scientific literature, state and federal agency reports, and watershed analyses for the Nehalem River basin revealed just one stream amphibian survey conducted in the Project Area. Researchers from Oregon State University Department of Forest Science collected data on stream amphibians in Buster Creek, a tributary to the Nehalem River, in 2004 as part of amphibian monitoring methods study (Hayes and Stoddard 2004). These researchers found both torrent salamanders and tailed frogs present in Buster Creek. Tailed frogs have also been observed to the south of the Nehalem watershed during fish surveys in the Miami River and tributaries (D. Plawman, ODFW, pers. comm.) and both amphibian species were found to be widespread during a 1998 stream amphibian survey in the Kilchis River watershed (Pacific Wildlife Research, unpublished data). To better understand the distribution of the two focal species, the Columbia torrent salamander and coastal tailed frog for this 2005 Watershed Analysis, an extensive reconnaissance survey was conducted across Oregon state forestlands within the upper Nehalem watershed.

10.4.3.1 Survey and Analytical Methods

Prior to fieldwork, potential survey sites were selected in the watershed using a GIS and spatially-explicit data from ODF (GIS coverages on management basin boundaries, streams, and roads). The selection of particular sites was guided by three principles:

- The number of survey sites allocated to a single ODF management basin was approximately proportional to the land area of the management basin relative to the total land area of all ODF state forestlands in the watershed.
- Approximately 75 percent of the survey sites were to be allocated to streams categorized as "Small" on the ODF streams coverage so as to focus most of the sampling effort in headwater streams where torrent salamanders and tailed frogs tend to be most numerous. The remainder of the sites were allocated to streams categorized as "Medium." Tailed frogs (particularly the larval stage) are known to occur in these mid-order streams and torrent salamanders are sometimes detected in springs and seeps associated with these larger streams.
- Survey sites were located within 200 m of road crossings to minimize walk-in times to the sites, thus maximizing the time available for amphibian searches. All ODF management basins in the watershed are well-roaded and no gaps in coverage were apparent during the GIS survey site selection process.

Based on these selection principles, 100 potential locations were identified and their latitude/longitude coordinates loaded into a GPS for the amphibian surveyor.

Amphibian surveys were conducted from August 16 to August 26, 2005. Searches were conducted by a single surveyor along a 20-m stream transect located at each site. As the surveyor approached each transect, he was observant for adult tailed frogs along the stream margins. The wetted channel was then searched systematically from the downstream end, working upstream. Amphibians were captured in riffles and slides by holding a bait net 200-500 cm downstream of rocks that were overturned by the surveyor, allowing the current to sweep amphibians, fish, and invertebrates into the net. Pools and shallows were searched by visual inspection. Seeps and springs flowing into the main channel were carefully searched for torrent salamanders. Each survey site was searched for a total of 15 minutes. All captured amphibians were released on the transect following the search. Habitat characteristics were recorded at many of the transects visited during the survey. Measurements included stream temperature, active channel width, and a classification of dominant and secondary substrate size classes (silt, sand, gravel, cobble, boulders, or bedrock) on the transect. A digital photograph was also taken of most transects.

A number of survey sites selected prior to fieldwork were inaccessible due to logging or road construction, had no wetted channel when they were visited, or were erroneously selected (no stream channel at the GPS coordinates). Most of these survey sits were replaced by other streams found during the course of fieldwork in the same management basin. However, extensive road building and logging activities occurring prevented the surveyor from reaching many of the major streams in Fishhawk, Louisignot and Northrup Basins.

Because each transect was searched for amphibians only briefly, it is likely that many torrent salamanders and tailed frogs went undetected on transects having suitable habitat. To better understand which transects have conditions favorable for torrent salamanders and tailed frogs, habitat characteristics summarized from sites where each species was detected were reviewed and formulated into simple habitat mapping rules. These rules were implemented as GIS query statements to identify transects having suitable habitat attributes, and where each species would be most likely to occur, even if they were undetected during this reconnaissance survey. The mapping rule used to identify transects that have suitable habitat for torrent salamander is as follows:

Habitat: Stream Temp <10C° and Dominant Substrate = "Cobble" or "Gravel"

The stream temperature criterion (<10.3C°) was set to include streams within one standard deviation of the mean temperature recorded at transects where torrent salamanders were detected. Observations from the survey, as well as research studies, indicate that the species most often inhabits coarse gravel and cobble substrates.

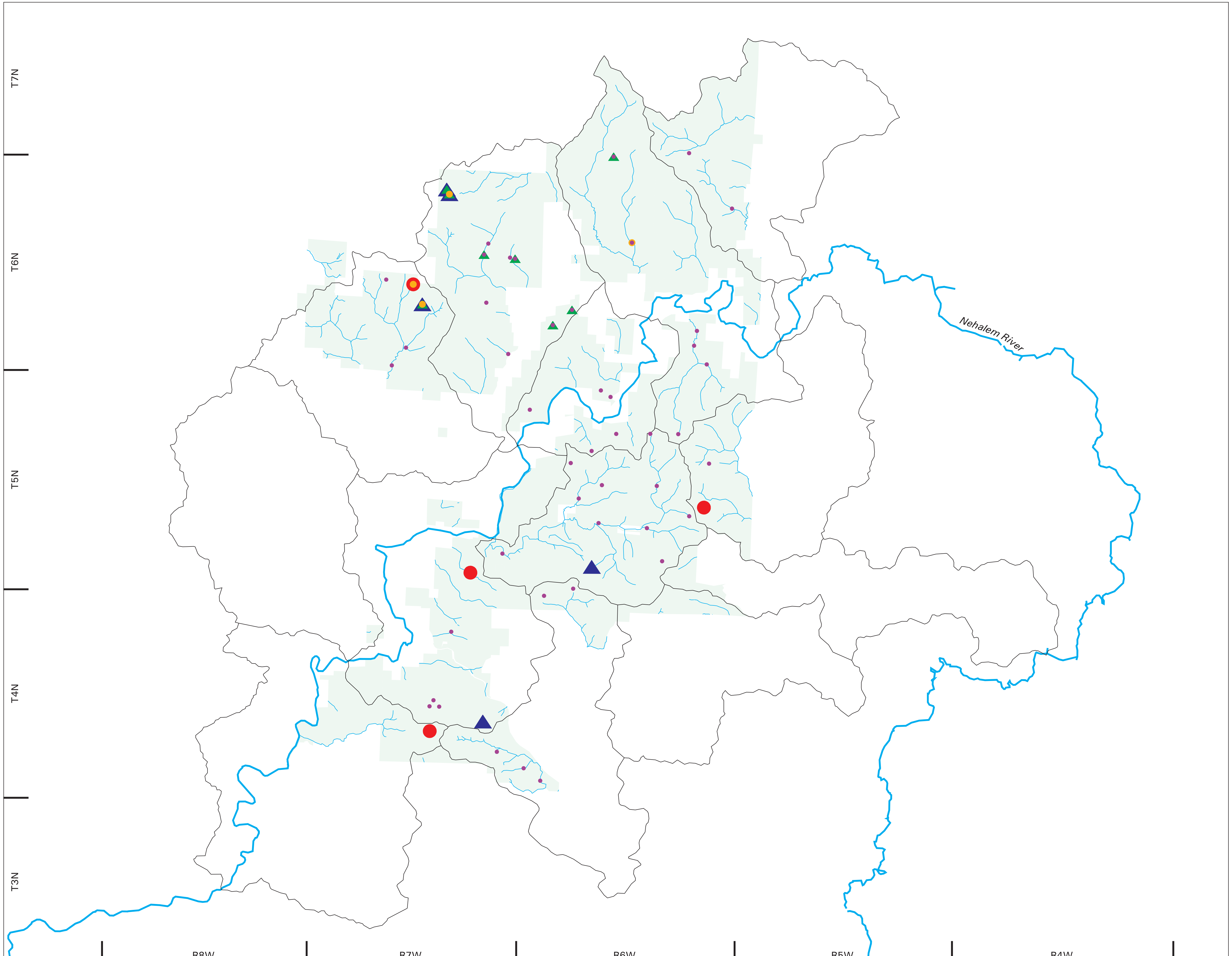
The mapping rule used to identify transects that have suitable habitat for tailed frogs is as follows:

Habitat: Stream Temp <12.7 and Dominant Substrate = "Cobble"

Similar to the torrent salamander rule, the tailed frog rule is based on the assumption that stream temperature and streambed substrate composition are the most limiting factors to tailed frog populations. Both rules were used to filter out records from the survey GIS database and identify transects that are potentially suitable habitat for the two focal species.

10.4.4 Results

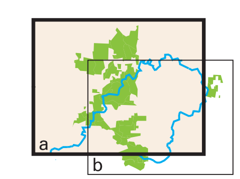
Ninety-one different sites were sampled during the course of the survey. Columbia torrent salamanders were detected at eight sites and coastal tailed frogs were detected at 10 sites (Figure 10-7a,b). Other amphibians observed during the survey included Cope's giant salamander, (*Dicamptodon copei*), Pacific giant salamander (*Dicamptodon tenebrosus*), rough-skinned newt (Taricha granulosa), Pacific treefrog (*Hyla regilla*), and red-legged frog (*Rana aurora*).



Legend

- Columbia Torrent Salamander Sighting
- Columbia Torrent Salamander Habitat
- Tailed Frog Sighting
- Tailed Frog Habitat
- Amphibian Sample Site
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key



1 Inch = 2.7 Miles

0 2

Miles

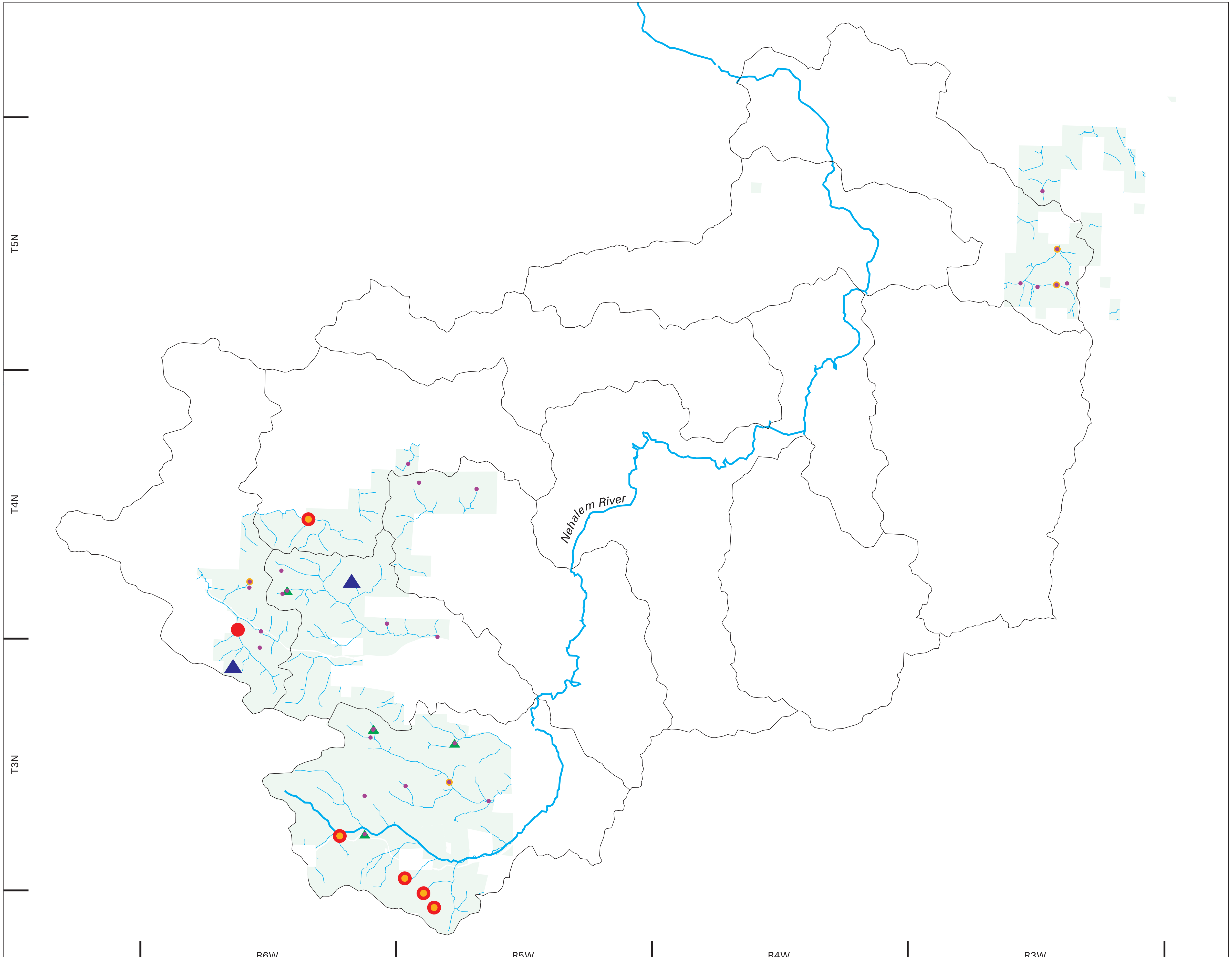
R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 10-7(a)

Amphibian Sightings and Habitat

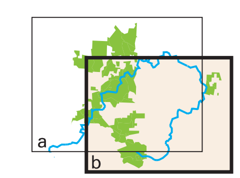
Astoria District



Legend

- Columbia Torrent Salamander Sighting
- Columbia Torrent Salamander Habitat
- Tailed Frog Sighting
- Tailed Frog Habitat
- Amphibian Sample Site
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key



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1 Inch = 2.3 Miles

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Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 10-7(b)
Amphibian Sightings and Habitat
Forest Grove District

Table 10-7 summarizes habitat characteristics at sites where torrent salamanders and tailed frogs were detected, and among all sites where habitat data were collected. These results indicate that Columbia torrent salamanders were most often found in the coldest streams of the watershed. The species was usually detected in small, headwater streams where streambed substrates were dominated by cobble (diameter 2.5-10.0 in.). However, the surveyor noted that torrent salamanders were most often uncovered in small deposits of gravel (diameter 3/4-2.5 in.) imbedded among the cobbles. Using a GIS mapping rule based on habitat measurement and observations made during the survey, a total of 13 transects visited during the survey were determined to have suitable habitat for torrent salamanders. Eight our of 11 ODF management basins in the analysis area had at least one transect having suitable conditions for torrent salamanders (Figure 10-7a,b).

Table 10-7. A comparison of stream habitat characteristics measured or observed at sites where Columbia torrent salamanders and coastal tailed frogs were detected, and among all sites visited during the survey

Measurement/ Classification	**Torrent Salamander Sites**	**Tailed Frog Sites**	**All Survey Sites**
Number of sites	8	10	91
Mean (standard deviation) stream temperature, C°	9.1 (1.2)	11.6 (1.1)	11.9 (1.9)
Maximum stream temperature, C°	11.0	13.0	16.7
Mean active channel width, meters	1.3	1.9	2.4
Most frequent dominant substrate class	Cobble	Cobble	Cobble
Most frequent secondary substrate class	Cobble	Cobble	Gravel

Tailed frogs were typically found in larger and warmer streams than torrent salamanders, but were excluded from streams where water temperatures exceeded 13.0C° (Table 10-7). Adult and larval tailed frogs were only found in streams where substrates were dominated by cobbles. Using the tailed frog habitat mapping rule, a total of 13 transects visited during the survey were determined to have suitable habitat for the species. Eight our of 11 ODF management basins in the analysis area had at least one transect having suitable conditions for tailed frogs (Figure 10-7a,b).

10.5 CONCLUSIONS

The findings of this reconnaissance survey indicate that torrent salamanders and tailed frogs occur in most of ODF management basins within the Nehalem watershed. Habitat data collected at transects occupied by torrent salamanders and tailed frogs supported results of earlier research studies showing that the two species are most frequently found in streams having coarse streambed substrates and cold water temperatures.

REFERENCES

Altig, R.G., and E.D. Brodie. 1972. Laboratory behavior of *Ascaphus truei* tadpoles. J. Herpetology 6:21-24.

Baldwin, E.M. 1981. Geology of Oregon. Kendall/Hunt. Dubuque, Iowa.

Beechie, T.J. and T.H. Sibley. 1997. Relationships between channel characteristics, woody debris and fish habitat in northwestern Washington streams. Trans. Amer. Fish. Soc. 126: 217-229.

Benda, L. 1990. The influence of debris flows on channels and valley floors in the Oregon coast range, U.S.A. Earth Surface Processes and Landforms 15:457-466.

Benda, L. and T. Dunne. 1987. Sediment routing by debris flow. Pages 213-223 *in* Erosion and Sediment Transport in Pacific Rim Steeplands. IAHS, Christchurch.

Benda, L., and T. Dunne. 1997a. Stochastic forcing of sediment supply to channel networks from landsliding and debris flow. Water Resources Research 33:2849-2863.

Benda, L. and T. Dunne. 1997b. Stochastic forcing of sediment routing and storage in channel networks, Water Resources Research, Vol. 33, No. 12 2865-2880.

Benda, L., C. Veldhuisen, and J. Black. 2003. Debris flows as agents of morphological heterogeneity at low-order confluences, Olympic Mountains, Washington. Geological Society of America Bulletin 115:1110-1121.

Benda, L., D. Miller, D. Michaels, and G. Reeves. In preparation. Managing landslide and debris flow risk in the Oregon Coast Range.

Benda, L., D. Miller, P. Bigelow, and K. Andrus. 2003. Effects of post-wildfire erosion on channel environments, Boise River, Idaho. Journal of Forest Ecology and Management 178:105-119.

Benda, L.E., and J.C. Sias. 2003. A quantitative framework for evaluating the mass balance of in-stream organic debris. Forest Ecology and Management 172:1-6.

Benda, L.E., and T.W. Cundy. 1990. Predicting deposition of debris flows in mountain channels. Canadian Geotechnical Journal 27:409-417.

Benda, L.E., D.J. Miller, T. Dunne, G. Reeves, and J. Agee. 1998. Dynamic Landscape Systems. Pages 261-288 *in* R.J. Naiman and R.E. Bilby, editors. River Ecology and Management. Springer-Verlag, New York.

Beschta, R.L. 1984. River Channel Response to Accelerated Mass Soil Erosion. Pages 155-163 *in* Symposium on the Effects of Forest Land Use on Erosion and Slope Stability, Honolulu, Hawaii.

Biosystems, Water Work Consulting, Coos Watershed Association, Alsea Geospatial, Inc., and Karen Bahus Technical Writing 2003. Elliot State Forest Watershed Analysis. Final Report to Oregon Department of Forestry. Salem, Oregon.

Bisson, P.B., G.G. Ice, C.J. Perrin, and R.E. Bilby. 1992. Effects of forest fertilization on water quality and aquatic resources in the Douglas-fir region. Pages 179-193 in Chappell, H.N., G.F. Weetman, and R.E. Miller, editors. Forest Fertilization: Sustaining and Improving Nutrition and Growth of Western Forests, Institute of Forest Resource Contrib. 72, University of Washington, Seattle, Washington.

Blaustein, A.R., J.J. Beatty, D. Olson and R.M. Storm. 1995. The biology of amphibians and reptiles in old-growth forests in the Pacific Northwest. U.S. Forest Service General Technical Report PNW-GTR-337.

Brattstrom, B. H. 1963. A preliminary review of the thermal requirements of amphibians. Ecology 44:238-255.

Broad, Tyson and Collins, Charles. 1996. U.S. Geological Survey, Water-Resources Investigations Report 96-4080. "Estimated Water Use and General Hydrologic Conditions for Oregon, 1985 and 1990. Prepared in cooperation with Oregon Water Resources Department and Oregon State Health Division. Portland, Oregon.

Bull, E.L. and B.E. Carter. 1996. Tailed frogs: distribution, ecology, and association with timber harvest in northeastern Oregon. USDA Forest Service, Pacific Northwest Research Station. Research Paper PNW-RP-497. Portland, Oregon.

Bureau of Land Management (BLM). 1982. Cadastral survey field notes and plats for Oregon and Washington. U.S. Department of Interior, Bureau of Land Management. Denver, Colorado.

Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Oregon, and California. National Oceanic and Atmospheric Administration (NOAA). Technical Memorandum NMFS-NWFSC-27, Seattle, Washington.

Campbell R.F. and E.B. Kvam. 2003. Riparian, Fish and Water Quality Conditions on the Mineral tree Farm. *In* Ten-year review of the West Fork Timber Co, LLC Mineral Tree Farm HCP and Amendment. Paper presented at the HCP Review Meeting Symposium, Sheraton Inn, Tacoma, Washington, December 15, 2003.

Canale, G. 1999. Oregon Coast Range macroinvertebrate analysis and monitoring status; 1991-1997. Oregon Department of Environmental Quality, Laboratory Division, Biomonitoring Section, Portland, OR.

Clatskanie Chamber of Commerce. 2005. Clatskanie's History. Article posted on Clatskanie Chamber of Commerce website http://www.clatskanie.com/chamber/history.html Downloaded March 30, 2005.

Corkran, C.C., and C. Thoms. 1996. Amphibians of Oregon, Washington, and British Columbia. Lone Pine Publishing. Edmonton, Alberta.

Cross, J. 2003. Measuring the impact of harvest intensity on riparian forest functionality in terms of shade production and large woody debris recruitment potential: two models. MS Thesis, College of Forest Resource, University of Washington, Seattle, Washington. 72 p.

Cruden, D.M., and D.J. Varnes. 1996. Landslide types and processes: Chapter 3 *in* Landslides: Investigations and Mitigation, Turner, A.K. and R.L. Schuster, editors. Transportation Research Board, Special Report 247, 36-71.

Csuti, B., A.J. Kimerling, T.A. O'Neil, M.M. O'Shaughnessy, E.P. Gaines, M.M.P. Huso. 1997. Atlas of Oregon wildlife: distribution, habitat, and natural history. Oregon State University Press. Corvallis, Oregon.

deVlaming, V.L. and R.B. Bury. 1970. Thermal selection in tadpoles of the tailed-frog, *Ascaphus truei*. Journal of Herpetology. 4:179-189.

Dietrich, W.E. and T. Dunne. 1978. Sediment budget for a small catchment in mountainous terrain. Zietshrift für Geomorphologie Suppl. Bd. 29:191-206.

Diller, L.V. and R.L. Wallace. 1996. Distribution and habitat of *Rhyacotriton variegatus* in managed, young growth forests in north coastal California. Journal of Herpetology 30:184-191.

Drake, D. 1999. Oregon Coast Range REMAP study. Stream habitat index development and site results; 1994 – 1996. Tech. Rept. No. BIO98-06. Oregon Department of Environmental Quality, Laboratory Division, Biomonitoring Section, Portland, OR. March 1999.

Drew, T.J. and J.W. Flewelling. 1979. Stand density management: an alternative approach and its applications to Douglas-fir plantations. For. Sci. 25:518-532.

E&S Environmental Chemistry and Young's Bay Watershed Council. 2000. Youngs Bay Watershed Assessment. Report prepared for the Young's Bay Watershed Council. Astoria, Oregon. August 2000.

Edwards, R.T. 1998. The hyporheic zone. Pages 399-429 *in* R. Naiman and R.E. Bilby, editors. River ecology and management: lessons from the Pacific coastal ecosystem. Springer, New York.

Elliot, F.A. 1914. State Forestry Board Map. Oregon.

Everest, F.H. and W. Meehan. 1981. Forest management and anadromous fish habitat productivity. Transactions of the North American Wildlife and Natural Resources Conference 46:521-530.

Everest, F.H., R. Beschta, J.C. Scrivener, K.V. Koski, J.R. Sedell, and C.J. Cederholm. 1987. Fine Sediment and Salmonid Production: A Paradox. Pages 98-142 *in* E.O. Salo and T.W. Cundy, editors. Streamside Management: Forestry and Fishery Interactions. College of Forest Resources, University of Washington, Seattle, Washington, USA.

Fick, L. and G. Martin. 1992. The Tillamook Burn: Rehabilitation and reforestation. Oregon Department of Forestry, Forest Grove Oregon.

Fisher, S.G., J. Schade, and J. Henry. 2002. Landscape challenges to ecosystem thinking: creative flood and drought in the American Southwest. Scientia Marina 65:181-192.

Franklin, J.L. and C.T. Dryness. 1988. Natural vegetation of Oregon and Washington. Oregon State University Press. Corvallis, Oregon.

Fredricksen, R., D. Moore, and L. Norris. 1975. The impact of timber harvest, fertilization and herbicide treatment on stream water quality in western Oregon and Washington. Pages 288-313 *in* B. Bernier and C. Winget, editors. Forest Soils and Land Management. Laval University Press, Quebec, Canada.

Fulton, A. 1997. Vernonia, a pocket in the woods. Self-published. Oregon.

Gessel, S.P., E.C. Steinbrenner, and R.E. Miller. 1979. Response of Northwest forests to elements other than nitrogen. Pages 29-36 *in* S.P. Gesell et al., editors. Forest Fertilization Conference. College of Forest Resources, University of Washington, Seattle, WA.

Gomez, D.M. and R.G. Anthony. 1996. Amphibian and reptile abundance in riparian and upslope areas of five forest types in western Oregon. Northwest Science 70: 109-118.

Good, D.A and D.B. Wake. 1992. Geographic variation and speciation in the torrent salamanders of the genus *Rhyacotriton* (Caudata: Rhyacotritonidae). Zoology 126:1-91.

Good, D.A., G.Z. Wurst, and D.B. Wake. 1987. Patterns of genetic variation in allozymes of the Olympic salamander, Rhyacotriton olympicus (Caudata: Dicamptodontidae). Fieldiana, Zoology, New Series (32): iii+1-15.

Governors Watershed Enhancement Board. 1999. Oregon watershed assessment of aquatic resources draft manual

Hayes, J.P. and M. Stoddard. 2004. Estimating site occupancy from repeated presence-absence counts: implications for a potential monitoring strategy for stream amphibians on Oregon State Forest Lands. Final report submitted to Oregon Department of Fish and Wildlife. Dated July 30, 2004.

Hayes, M.P., T. Quinn, D.J. Dugger, and T.L. Hicks. 2003. Pacific tailed frog (*Ascaphus truei*) distribution in headwater streams. Presented at the 2003 Annual Meeting of the Geological Society of America, November 2-5, 2003, Seattle, Washington.

Healey, M.C. 1991. Life history of chinook salmon (*Oncorhynchus tshawytscha*). Pages 313-396 *in* C. Groot and L. Margolis, editors. Pacific salmon life histories. University of British Columbia Press, Vancouver, Canada.

Hobbs, S.D., J.P. Hayes, R.L. Johnson, G.H. Reeves, T.H. Spies, J.C. Tappeiner II, and G.E. Wells. 2002. Forest and Stream Management in the Oregon Coast Range. Oregon State University Press, Corvallis, OR.

Hogan, D.L., S.A. Bird, and S. Rice. 1998. Stream channel morphology and recovery processes. Pages 77-96 *in* D.L. Hogan, P.J. Tschaplinski, and S. Chatwin, editors. Carnation Creek and Queen Charlotte Islands Fish/Forestry Workshop: Applying 20 Years of Coast Research to Management Solutions. Land management handbook 41. Crown Publications, Inc., Victoria, B.C.

Hupp, C.R. and W.R. Osterkamp. 1985. Bottomland vegetation distribution along Passage Creek, Virginia, in relation to fluvial landforms. Ecology 66:670-681.

Jackson, M. 1983. Stratigraphic Relationships of the Tillamook Volcanics and the Cowlitz Formation in the Upper Nehalem River-Wolf Creek Area, Northwestern Oregon. Master's Thesis, Department of Geology, Portland State University.

Johnson, J. and J. Maser. 2000. Nehalem River Watershed Assessment. Report prepared by Portland State University for the Upper and Lower Nehalem Watershed Councils under a Governor's Watershed Enhancement Board (GWEB) grant. May 2000. 169 p. + app.

Johnson, O. W., M.H. Ruckelhaus, W.S. Grant, F.W. Waknitz, A.M. Garrett, G.J. Bryant, K. Neely, and J.J. Hard. 1999. Status review of coastal cutthroat trout from Washington, Oregon, and California. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-37, 292p.

Kalliola, R. and M. Puharta. 1988. River dynamics and vegetation mosaicism: a case study of the River Kamajohka, northernmost Finland. Journal of Biogeography 15:703-719.

Kamholz, E.J., J. Blain and G. Kamholz. 2003. The Oregon-American Lumber Company: Ain't no more. Stanford University Press. Stanford, California.

Kavanagh, P., K. Jones, C. Stein, and P. Jacobsen. 2005. Fish habitat assessment in the Oregon Department of Forestry mid-Nehalem and Clatskanie study area. Report prepared by the Oregon Department of Fish and Wildlife, Aquatic Inventories Project, Corvallis, Oregon. April 3, 2005. 22 p. + Tables, Figures and Maps.

Kostow, K. 1995. Biennial report on the status of wild fish in Oregon. Oregon Department of Fish and Wildlife. Portland, Oregon.

Kostow. K. 2002. Oregon lampreys: Natural history status and problem analysis. Oregon Department of Fish and Wildlife. Salem, Oregon. 112 p.

Long, C.J., C. Whitlock, P.J. Bartlein, and S.H. Millspaugh. 1998. A 9000-Year Fire History from the Oregon Coast Range, Based on a High-Resolution Charcoal Study. Canadian Journal of Forest Resources 28:774-787.

MacDonald, L.H., A.W. Smart, and R.C. Wissmar. 1991. Monitoring guidelines to evaluate effects of forestry. Activities on streams in the Pacific Northwest and Alaska. EPA 910/9-91-001. 166p.

Mallory, V.S. 1959. Lower Tertiary biostratigraphy of the California Coast Ranges: Tulsa, OK, American Association of Petroleum Geologists, 416 p.

May, C.L. 2002. Debris Flows through Different Forest Age Classes in the Central Oregon Coast Range. Journal of the American Water Resources Association 38:1097-1113.

May, C.L. and R.E. Gresswell. 2003a. Spatial and temporal patterns of debris-flow deposition in the Oregon Coast Range, USA. Geomorphology 1362:1-15.

McComb, W.C., K. McGarigal, and R.G. Anthony. 1993. Small mammal and amphibian abundance in streamside and upslope habitats of mature Douglas-fir stands, western Oregon. Northwest Science 67:7-15.

Meade, R.H. 1985. Wavelike movement of bedload sediment, East Fork River, Wyoming. Environ. Geol. Water Sci. 7:215-225.

Meengs, C.L. and R.T. Lackey. 2005. Estimating the size of historical Oregon salmon runs. Reviews in Fisheries Science 13:51-666.

Miller, D. and K. Burnett. In Review. An empirical model to characterize debris flow delivery to stream channels.

Miller, D. and L. Benda. 2000. Effects of mass wasting on channel morphology and sediment transport: South Fork Gate Creek, Oregon. Bulletin of the Geological Society of America:1814-1824.

Miller, D., K. Burnett, and K. Christiansen. In Review. River Ecosystems in a dynamic landscape: debris flows in the Oregon Coast Range (Ecosystems, spec. ed).

Miller, D.J. 1995. Coupling GIS with physical models to assess deep-seated landslide hazards. Environmental & Engineering Geoscience 1:263-276.

Miller, D.J., C.H. Luce, and L.E. Benda. 2003. Time, space, and episodicity of physical disturbance in streams. Forest Ecology and Management 178:121-140.

Montgomery, D.R. and J.M. Buffington. 1993. Channel classification, prediction of channel response, and assessment of channel condition. Timber Fish and Wildlife Report TFW-SH10-93-002. 84 pp.

Montgomery, D.R., and W.E. Dietrich. 1994. A physically based model for the topographic control on shallow landsliding. Water Resources Research 30:1153-1171.

Moore, K., K. Jones, J. Dambacher. 1999. Methods for stream habitat surveys. Oregon Department of Fish and Wildlife. Portland, Oregon.

Morrison, P.H., and F.J. Swanson. 1990. Fire History and Pattern in a Cascade Range Landscape. General Technical Report PNW-GTR-254, USDA Forest Service, Portland, Oregon.

Mosley, M.P. 1978. Bed material transport in the Tamaki River near Dannevirke, North Island, New Zealand. N.Z. J. of Science 21:619-626.

Naiman, R.J., T. Beechie, L.E. Benda, D.R. Berg, P.A. Bisson, L.H. MacDonald, M.D. O'Connor, P.L. Olsen, and E.A. Steele. 1992. Fundamental elements of ecologically healthy watersheds in the Pacific Northwest Coastal Ecoregion. Pages 127-188 *in* R.J. Naiman, editor. Watershed management: balancing sustainability and environmental change. Springer-Verlag, New York.

Nakamura, F. 1986. Chronological study on the torrential channel bed by the age distribution of deposits. Research Bulletin Coll. Exp. For. Hokkaido University 43:1-26.

National Marine Fisheries Service (NMFS). 1996. Position paper on the Oregon Forest Practices Act. May 13, 1996. http://www.umpqua-watersheds.org/local/nmfs_on_ofpa.html#3.

Nickelson, T., J.D. Rodgers, S.L. Johnson, and M. Solazzi. 1992. Seasonal changes in habitat use by juvenile coho salmon (*Oncorhynchus kisutch*) in Oregon coastal streams. Canadian Journal of Fisheries and Aquatic Sciences 49: 783-789.

Niem, A.R., and W.A. Niem. 1985. Geologic map of the Astoria Basin, Clatsop and northernmost Tillamook Counties, northwest Oregon: Oregon Department of Geology and Mineral Industries Oil and Gas Investigations 14, scale 1:100,000.

Niem, W.A. and A.R. Niem. 1992. Ages of rocks in southwestern Washington and northwestern Oregon as indicated by paleontological and isotopic dates: U.S. Geological Survey Open-File Report 92-344, 115 p. + 2 plates.

Ohmann, J.L., and M.J. Gregory. 2002. Predictive mapping of forest composition and structure with direct gradient analysis and nearest neighbor imputation in coastal Oregon, USA. Canadian Journal of Forest Resources 32:725-741.

Oregon Climate Service (OCS). 2005. Data downloaded from Oregon Climate Service website Service http://www.ocs.oregonstate.edu/ March 11, 2005.

Oregon Department of Forestry (ODF). 2001. Northwest Oregon State Forests Management Plan. Oregon Department of Forestry, Salem, Oregon. January 2001

Oregon Department of Forestry (ODF). 2003. Implementation plans for Northwest and Southwest Oregon State Forests Management Plan. Oregon Department of Forestry, Salem Oregon. March 2003.

Oregon Department of Forestry. 1993. Elliot State Forest Watershed Analysis. Report prepared for Oregon Department of Forestry by Biosystems, Water Work Consulting, Coos Watershed Association, Alsea Geospatial Inc. and Karen Bahus Technical Writing. Oregon Department of Forestry.

Oregon Natural Heritage Information Center (ORNIC). 2004. Rare, Threatened and Endangered Species of Oregon. Oregon Natural Heritage Information Center, Oregon State University, Portland, Oregon. 105 pp.

OWEB Manual. 1999. (See: Watershed Professionals Network 1999).

Pater, D.E., S.A. Bryce, T.D. Thorson, J. Kagan, C. Chappel, J. Omernik, S,H, Azevedo and A.J. Woods. 1998. Ecoregions of western Washington and Oregon. Map. U.S. Environmental Protection Agency. Corvallis, Oregon.

Paustain, S.J., K. Anderson, D. Blanchet, S. Brady, M. Cropley, J. Edgington, J. Fryxell, G. Johnejack, D. Kelliher, M. Kuehn, S. Maki, R. Olson, J. Seesz and M. Wolanek. 1992. A channel type users guide for the Tongass National Forest, Southeast Alaska. U.S. Forest Service, Alaska Region R10-TP-26. 179 pp.

Piegay, H., T.A. and A. Citterio. 1999. Input, storage and distribution of large woody debris along a mountain river continuum, the Drome River, France. Catena 35:19-39.

Pike, R.G. and R. Scherer. 2003. "Overview of the potential effects of forest management on low flows in snowmelt-dominated hydrologic regimes" BC journal of Ecosystems and Management. Vol 3. No 1.

Ray, C. 1958. Vital limits and rates of desiccation in salamanders. Ecology 39:75-83.

Reeves, G.H., P.A. Bisson, and J.M. Dambacher. 1998. Fish Communities. Pages 200-234 *in* R.J. Naiman and R.E. Bilby, editors. River ecology and management: lessons from the Pacific coastal ecosystem. Springer, New York.

Roberts, R.G. and M. Church. 1986. The sediment budget in severely disturbed watersheds, Queen Charlotte Ranges, British Columbia. Canadian Journal of Forest Research 16:1092-1106.

Robison, G.E., K.A. Mills, J. Paul, L. Dent, and A. Skaugset. 1999. Storm Impacts and Landslides of 1996: Final Report. Forest Practices Technical Report 4, Oregon Department of Forestry, Salem, OR.

Roghair, C.N., C.A. Dolloff, and M.K. Underwood. 2002. Response of a Brook Trout Population and Instream Habitat to a Catastrophic Flood and Debris Flow. Transactions of the American Fisheries Society 131:718-730.

Rosgen. D. 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, CO.

Rule, G. 2001. Watershed Assessment of the Lower Columbia-Clatskanie Subbasin of Oregon. Master's Thesis of Environmental Management degree at Portland State University. Portland, Oregon.

Salminen, E.M., and R.L. Beschta. 1991. Phosphorus and forest streams: the effects of environmental conditions and management activities. Oregon State University, Department of Forest Engineering. Corvallis, OR. 185p.

Scrivener, J.C. and M.J. Brownlee. 1989. Effects of Forest Harvesting on Spawning Gravel and Incubation Survival of Chum (*Oncorhynchus keta*) and Coho Salmon (*O. kisutch*) in Carnation Creek, British Columbia (Bigelow). Canadian Journal of Fisheries and Aquatic Sciences 46:681-696.

Sedell, J.R and C. N. Dahm. 1984. Catastrophic disturbances to stream ecosystems: volcanism and clear-cut logging. Pages 531-539 *in* M.J. Klug and C.A. Reddy, editors. Current perspectives in microbial ecology. Michigan State University, East Lansing and American Society of Microbiology, Washington, D.C.

Sidle, R.C. 1987. A dynamic model of slope stability in zero-order basins. IAHS Publ. 165:101-110.

Sidle, R.C. 1992. A theoretical model of the effects of timber harvesting on slope stability. Water Resources Research 28:1897-1910.

Smith, D. 1998. Riparian Stand Survey. TFW Effectiveness Monitoring and Evaluation Program. Northwest Indian Fish Commission. September 1998. 11 p. + app.

Snavely, P.D., Jr., and H.F. Vokes. 1949. Geology of coastal area between Cape Kiwanda and Cape Foulweather, Oregon: U.S. Geological Survey Oil and Gas Investigational Preliminary Map 97, scale 1:62,500.

Snavely, P.D., Jr., N.S. MacLeod, and D.L. Minasian. 1990. Preliminary map of the Nestucca Bay Quadrangle, Tillamook County, Oregon: U.S. Geological Survey Open-File Report 90-202, scale 1:24,000.

Stottlemeyer, R. 1987. Natural and anthropic factors as determinants of long-term streamwater chemistry. Pages 86-94 *in* C.A. Troendle, M.R. Kaufmann, R.H. Hamre, and R.P. Winokur (tech. coord.). Proceedings of a Technical Conference: Management of Subalpine Forests: Building on 50 Years of Research, Silver Creek, CO. July 6-9, 1987. USDS Forest Service, General Tech. Report RM-149. 253 p.

Sugden, B., and Others. 1998. Technical Appendix to the Native Fish HCP. Report prepared by Plum Creek Timber Company, Montana; presented to the Federal Services (US Department of Interior, US Fish and Wildlife Service and US Department of Commerce, NOAA Fisheries) in support of an Incidental Take Permit under ESA Section 10. 1998.

Sullivan, K., J. Tooley, K. Doughty, J.E. Caldwell and P. Knudsen. 1990. Evaluation of prediction models and characterization of stream temperature regimes in Washington. Timber/Fish/Wildlife Rep. No. TFW-WQ3-90-006. Washington Department of Natural Resources, Olympia, Washington.

Swales, S., and C.D. Levings. 1989. Role of off-channel ponds in the life cycle of juvenile coho salmon (*Oncorhynchus kisutch*) and other juvenile salmonids in the Coldwater River, British Columbia. Canadian Journal of Fisheries and Aquatic Sciences 46:222-242.

Swanson, F.J. 1981. Fire and geomorphic processes. General Technical Report WO-26:401-420.

Swanson, F.J., and G.W. Lienkaemper. 1978. Physical consequences of large organic debris in pacific northwest streams. General Technical Report PNW-69, USDA Forest Service, Portland, Oregon.

Swanston, D.N. 1974. Slope stability problems associated with timber harvesting in mountainous regions of the western United States. USDA Forest Service General Technical Report U.S. Department of Agriculture, Portland, Oregon.

Taylor, G. 1995. The Big Storm—December 12, 1995. Article posted on website of Oregon Climate Service http://www.ocs.oregonstate.edu/index.html. Downloaded March 11, 2005.

Taylor, G.H. and R.R. Hatton. 1999. The Oregon weather book: a state of extremes. Oregon State University Press, Corvallis, Oregon.

Teensma, P.D.A. 1987. Fire history and fire regimes of the central western Cascades of Oregon. Ph.D. University of Oregon, Eugene, Oregon.

UNWC. (unpublished data). GIS data layer transmittal of the Upper Nehalem Watershed Council concerning riparian characterization from 1995 aerial photographs.

U.S. Fish and Wildlife Service (USFWS). 2004. Species of Concern in Oregon. Report dated April 21, 2004. Oregon Fish and Wildlife Office. Portland, Oregon. Accessed on the WWW February 2, 2005 at http://oregonfwo.fws.gov/EndSpp/Documents/SOC.pdf

Umpqua Resource Area, Coos Bay District, and Bureau of Land Management. 2001. South Fork Coos Watershed Analysis. March 31, 2001.

United Sates Census Bureau. 2005. Fact sheets for Tillamook, Clatsop and Columbia Counties. Information downloaded from U.S. Census web site http://factfinder.census.gov April 26, 2005.

U.S. Environmental Protection Agency. 1986. Water quality criteria for 1986. U.S. Environmental Protection Agency, Washington D.C.

United States Forest Service (USFS). 2002. Landscape Dynamics and Forest Management: Educational CD-ROM. General Technical Report, RMRS-GTR-101CD, USDA, Rocky Mountain Research Station/Earth Systems Institute.

Vannote, R.L, G.W. Minshall, K.W. Cummins, J.R. Sedell, and C.E. Cushing. 1980. The river continuum concept. Canadian Journal of Fisheries and Aquatic Sciences 37:130-137.

Wahbe, T.R. and F.L. Bunnell. 2003. Relations among larval tailed frogs, forest harvesting, stream microhabitat, and site parameters in southwestern British Columbia. Canadian Journal of Forest Research 33(7): 1256-1266.

Warren, W.C., H. Norbisrath, and R.M. Grivetti. 1945. Geology of northwestern Oregon west of Willamette River and north of latitude 45°15': U.S. Geological Survey Oil and Gas Investigations Preliminary Map OM-42, scale 1:145,728.

Washington Department of Fish and Wildlife (WDFW). 2000. Fish passage barrier and surface water diversion screening assessment and prioritization manual. Washington Department of Fish and Wildlife Habitat Program-Environmental Restoration Division. Olympia, Washington. August 2000.

Washington Forest Practices Board (WFPB). 1997. Standard methodology for conducting watershed analysis, Version 4.0. Washington Forest Practices Board Manual, prepared by the Washington Department of Natural Resources. Olympia, Washington. November 1997.

Watershed Professionals Network. 1999. Oregon Watershed Assessment Manual. Developed for the Governor's Watershed Enhancement Board. Salem, Oregon.

Weitkamp, L.A., T.C. Wainwright, G.J. Bryant, G.B. Milner, D.J. Teel R.G. Kope and R.S. Waples. 1995. NOAA-NWFSC Tech Memo-24: Status review of coho salmon from Washington, Oregon, and California. National Marine Fisheries Service, US Department of Commerce. Seattle, Washington.

Wells, R.E., P.D. Snavely, Jr., N.S. Macleod, M.M. Kelly, M.J. Parker, Fenton, Johanna, and Felger, Tracey. 1995. Geologic map of the Tillamook Highlands, Northwest Oregon Coast Range-a digital database: U.S. Geological Survey Open-File Report 95-670.

Welsh, H.H. and A.J. Lind. 1996. Habitat correlates of the southern torrent salamander, *Rhyacotriton variegatus* (Caudata: Rhyacotritonidae), in northwestern California. Journal of Herpetology. 30:385-398.

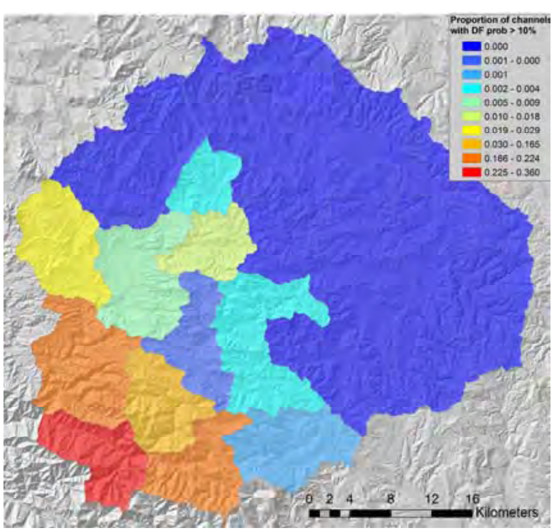
Wimberly, M.C., T.A. Spies, C.J. Long, and C. Whitlock. 2000. Simulating historical variability in the amount of old forests in the Oregon Coast Range. Conservation Biology 14:167-180.

Wolf, D.W. 1992. A literature review: Land use and nonpoint phosphorus pollution in the Tualatin Basin, OR. Oregon State University Extension Service and Oregon Water Resources Research Institute. Corvallis, OR. Special Report No. 898. 63p.

Young, L.L. and J.L. Colbert. 1965. Waterpower Resources in Nehalem River Basin Oregon. U.S. Geological Survey Water-supply Paper 1610-C.

Ziemer, R.R. 1981. Roots and the stability of forested slopes. I.A.H.S. Publ. 132:343-357

Upper Nehalem Watershed Analysis
Part II - Analysis



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FIGURES

TABLES

Part II – WATERSHED ANALYSIS

The Analysis portion of the document addressed habitat conditions described in the assessment phase (Part I) as they relate to the utility and quality of aquatic and riparian habitat and it subsequently addressed forest management considerations to facilitate attaining desired future habitat conditions in a timely fashion. The Analysis Section is organized: (1) to identify areas where resource conditions are consistent with the range of variation typically found under natural disturbance regimes for the watershed (defined in the Northwest Oregon Forest Management Plan [NW FMP; ODF 2001] as properly functioning habitat conditions (PFC); (2) to anticipate where conditions in the basin are on a likely trajectory to achieve PFC in a timely fashion under future FMP or SAH management scenarios; and (3) to assess what factors or physical processes in the basin may be limiting the ability to readily achieve PFC.

Four primary topics including: limiting factors, alternative vegetative management, slope stability and road management, were assessed to determine if aquatic and riparian resources were functioning properly. A set of Key Questions are specifically addressed and a report chapter is dedicated to each topic as follows.

Chapter 11 – Limiting Factors evaluates in-channel habitat values for large wood, sediment accumulations and surface water temperatures as they relate to the range of natural variation found in monitoring data from unmanaged reference sites along the Oregon North Coast Range. Areas where functions were impaired or limited represent potential management opportunities to enhance and promote PFC in the long-term.

Chapter 12 – Alternative Vegetation Management considers areas in the basin where riparian zones are consistent with or on a trajectory to achieve PFC for riparian functions of wood recruitment and shade under current management programs. Alternative management measures for specific areas in the watershed not on a timely PFC-trajectory are discussed to facilitate achieving desired conditions more quickly than under either the NW FMP or SAH measures.

Chapter 13 – Slope Stability addresses the potential for hillslope failures to pose a high risk to either downstream sediment accumulations or channel scour and the potential for management activities to influence slope failure rates. Both sediment and large wood sources were evaluated and ranked in accordance to their delivery potential to the channel network and fish-bearing waters.

Chapter 14 – Road Management assesses road conditions in the transportation network in relation to which ones need repair, vacation, relocation and which stream crossings should be considered for replacement. Recommended specific locations in the road network are prioritized for management actions.

Finally, the Analysis Section includes Chapter 15 – Summary that provides a synthesis of individual scientific disciplines and watershed processes used to help rate recommended management considerations in accordance with prospective habitat benefits. A prioritized list of potential sites for management activities on ODF lands in the upper Nehalem Watershed is included. A review of the critical question responses and a list of data gaps are also included in the summary.

11. LIMITING FACTORS

Identification of habitat factors limiting fish populations can not be determined without documenting a change in a factor and a subsequent increase in population size. Given the complexity of natural systems and the anadromous life history of many salmonid populations, the ecological concepts of limiting factors and population release are rarely empirically demonstrated. As a surrogate method, fish scientists often measure physical habitat characteristics in a target system and compare these measurements to values deemed suitable for fish. Caution must be exercised with this surrogate approach since there is no single value that can accurately characterize “healthy” fish habitat. Fish populations have adapted to a range of habitat conditions that occur naturally, including conditions under natural disturbance regimes.

For the purposes of this analysis, properly functioning aquatic habitat conditions (PFCs) for ODF lands in the upper Nehalem watershed were determined by comparing critical habitat attributes in surveyed stream reaches with reference values. Reference values were derived from available data collected on unmanaged lands in the region and accepted standards established for salmonid fishes in Pacific Northwest rivers. The following sources were used in generating reference conditions: Oregon Department of Fish and Wildlife’s Aquatic Inventory Project (ODFW AIP) data; US Forest Service natural range of variation data from Sandy River OR (USFS 1996); Fox (2001) data from unmanaged streams in SW Washington; FWS/NOAA Fisheries Table of Population Indicators for Use in the Northwest Forest Plan Area (USFWS 1998; NMFS 1999).

Two comparisons were made for the analysis of limiting factors. The first was a watershed-to-watershed comparison of wood and substrate habitat indicators. For this comparison the statistical distributions of the upper Nehalem River data, the Oregon AIP reference data sets and other reference values were evaluated where applicable. The second comparison was a performed on a reach-specific basis.

The reference values used in the watershed-to-watershed comparison are summarized in Table 11-2. Data are presented with descriptive statistics to help quantify the variation inherent in habitat data. A habitat attribute from the Nehalem habitat assessment was determined to be a potential limiting factor if it fell outside the range of reference values. In this analysis, we assume fish in the Nehalem River have adapted to a range of natural conditions represented by the referenced values and that fish productivity would improve the closer Nehalem habitat conditions emulate channel data from unmanaged streams. Based on our professional opinion, we assume forestry management actions that move limiting habitat attributes closer to, and ultimately within, the range of variation identified for reference conditions will support aquatic habitat PFCs in the upper Nehalem River. Comparisons of upper Nehalem River wood and substrate indicators from various reaches in the watershed with regional reference values can be found in Tables 11-2 and 11-3. Table 11-2 summaries the distribution of the data for the entire watershed while Table 11-3 show the distribution of the data by 5th Field HUC.

The most applicable data for the reach comparison was the ODFW AIP reference stream data set. This data set is composed of 124 surveyed reaches from Oregon Coast Range streams (Table 10-2). It includes a subset of data from 15 surveyed reaches in the North Oregon Coast Ecoregion and 2 surveyed reaches in the Nehalem River basin. The Oregon Coast data set was the largest and most complete data set available for unmanaged forest streams in Oregon and the data was obtained from the closest geographic river systems including many within the same Ecoregion as the Nehalem River. In addition, the reference reaches were morphologically similar to those surveyed for the Nehalem River Assessment (Table 11-1). Thus, we used Oregon Coast reference values for reach comparisons of wood loading in the upper Nehalem. Given the distinct sedimentary geology of the upper Nehalem River basin, we have concluded this system is likely to have higher naturally occurring levels of fine sediments than most nearby North Coast streams. Thus, for reach-specific substrate analysis we used a 30 percent cut off for acceptable levels of fine sediment (<2mm) in riffle gravels. This value approximates the highest substrate level observed in Nehalem River unmanaged stream reaches as well as the volume of fines sufficient to fill the pore spaces of riffle gravels.

Table 11-1. A comparison of morphological characteristics in ODFW AIP reference and assessment reaches (ODFW unpublished data).

Data Set	Number of Reaches	Median Reach Length and Range (km)	Median Active Channel Width and Range (m)	Median Gradient and Range (%)
Oregon Coast Reference Reaches	124	971 174 - 6,776	7.2 1.5 - 31.5	2.3 0.5 – 19.2
North Coast Reference Reaches	15a	702 393 - 2,960	7.5 2.6 – 31.5	1.3 0.6 – 7.4
Nehalem Reference Reaches	2	515 512 - 517	7.1 5.3 - 8.8	3.1 1.8 - 4.4
Nehalem Habitat Assessment	182	1,075 188 – 13,932	6.3 1.8 - 20.8	2.7 0.3 – 27.0

Table 11-2. Reference Values for assessing limiting factors associated with substrates and large wood and a comparison of Upper Nehalem Reach data.

		ODFW AIP Reference Data				**FWS/NOAA Fisheries Habitat Indicators**	**SW Washington Streams (Fox 2001)**	**Sandy River, OR Natural Range of Variation (USFS 1996)**
Parameter	**Definition**	**Upper Nehalem River Assessment N = 182**	**Oregon Coast Data N= 124**	**North Oregon Coast Data N= 15**	**Nehalem River Data N = 2**	**Literature**	**N = 78**	
		25th -75th quartiles; median	25th -75th quartiles; median	25th -75th quartiles; median	Range		25th -75th quartiles; median	Range (mean ± 1 St. Dev.; median)
Pieces large wood	Number of wood pieces (>5cm diameter x 3 m) length per 100m stream	**16.9-31, 22.7**	8.2-22.6, 14.0	2.6-16.9, 14.5	29.9-35	NA	7.9-19.2, 20.2* *>10 cm diameter and 2 m length	NA
Volume large wood	m^3 of wood (>15 cm diameter x 3m length / 100 m stream	**20.7-52.4, 32.7**	17.1–57.7 31.3	12.4-44.7, 28.4	21.2-46.2	NA	NA	NA

Table 11-2. Reference Values for assessing limiting factors associated with substrates and large wood and a comparison of Upper Nehalem Reach data.

		ODFW AIP Reference Data				**FWS/NOAA Fisheries Habitat Indicators**	**SW Washington Streams (Fox 2001)**	**Sandy River, OR Natural Range of Variation (USFS 1996)**
Parameter	**Definition**	**Upper Nehalem River Assessment N = 182**	**Oregon Coast Data N= 124**	**North Oregon Coast Data N= 15**	**Nehalem River Data N = 2**	**Literature**	**N = 78**	
Key pieces of wood	Number of wood pieces > 60 cm diameter and > 12 m long/100 m stream	**0.5-1.8, 0.8**	0.5- 2.8, 1.4	0.1-1.4, 0.9	0.0-1.4	>5.0 key pieces per 100m (>61cm diameter and > 15 m length)	0.3 – 2.6, 0.7* (*>61cm diameter and 15 m length per 100 m	0.0-4.0; 0.6 (* >91 cm diameter and 15 m length per 100 m
Percent fines in riffles	Visual estimate (%) of substrate of particles less than 2 mm diameter	**11-36, 22**	8-22,13	13-23, 20	13-29	If fines are dominant, substrate is not properly functioning condition	NA	NA
Percent gravel in riffles	Visual estimate (%) of substrate of particles between 2 and 64 mm diameter	**31-51, 39**	27 – 53, 38	27 – 33, 29	53-66	Gravel or cobble substrate with clear interstitial spaces is properly functioning condition	NA	NA

Table 11-2. Reference Values for assessing limiting factors associated with substrates and large wood and a comparison of Upper Nehalem Reach data.

		ODFW AIP Reference Data				FWS/NOAA Fisheries Habitat Indicators	SW Washington Streams (Fox 2001)	Sandy River, OR Natural Range of Variation (USFS 1996)
Parameter	**Definition**	**Upper Nehalem River Assessment N = 182**	**Oregon Coast Data N= 124**	**North Oregon Coast Data N= 15**	**Nehalem River Data N = 2**	**Literature**	**N = 78**	
Percent bedrock in stream	Visual estimate (%) of substrate composed of solid bedrock	**1-9, 5**	1-13, 5	0-11, 5	0-6	If bedrock is dominant, substrate is not properly functioning condition	NA	NA

Table 11-3. Distribution of data for critical substrate and wood habitat indicators by 5th Field HUC

5th Field HUC	Habitat Indicator	Total Range	Interquartile Range (25th-75th)	Median
1710020201	Percent fines in riffles	0-67	5-40	24
	Percent gravel in riffles	20-67	32-48	38
	Pieces large wood/100m stream	56-54	20-32	23
	Volume large wood (m^3/ 100 m)	7-155	21-54	29
	Key pieces large wood/100 m	0-4.3	0.4-31.2	0.6
1710020202	Percent fines in riffles	0-97	21-42	29
	Percent gravel in riffles	0-67	32-36	36
	Pieces large wood/100m stream	5-77	18-33	24
	Volume large wood (m^3/100 m)	7-192	22-56	35
	Key pieces large wood/100 m	0.1-9.9	0.7-3.0	1
1710020203	Percent fines in riffles	0-95	10-30	19
	Percent gravel in riffles	0-92	30-46	40
	Pieces large wood/100m stream	2-56	17-30	22
	Volume large wood (m3/100 m)	2.1-259.2	19.95-49.7	32.4
	Key pieces large wood/100 m	0-4.8	0.3-1.6	0.9

The following questions were addressed to help identify habitat factors that may limit achievement of (PFC).

1. Are *there sub-watersheds where the current level of in-stream wood is a limiting factor for achieving properly functioning aquatic systems?*
2. *Are there sub-watersheds were stream sediment deposition (associated with hillslopes and/or erosion) is a limiting factor for achieving properly function aquatic systems?*
3. *Given the stream temperatures that are reasonably achievable, what is the likelihood (rate as high, moderate, low, or unknown) that stream temperatures and/or shade conditions are a limiting factor for achieving properly functioning aquatic systems?*
4. *Are there any other conditions limiting the achievement of PFCs?*

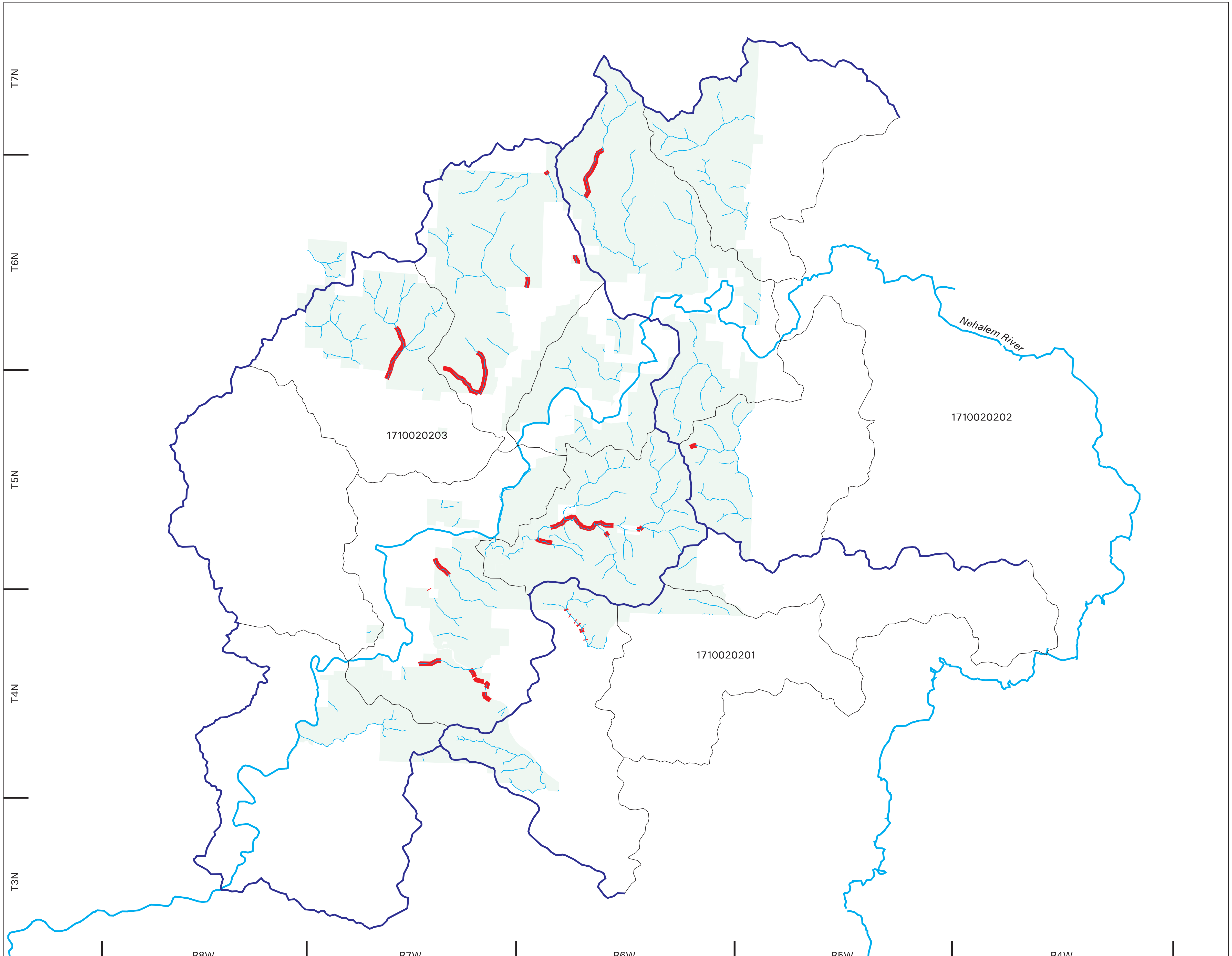
11.1 INSTREAM WOOD LOADING OF LARGE WOOD

In-stream wood is a critical habitat component for freshwater fishes and freshwater life stages of anadromous fishes as it contribute to habitat complexity. Wood also provides cover and nutrients and interacts with river flow to trap sediment or create new habitat types such as pools, off-channel habitat, and undercut banks. Coho salmon juveniles will use slower water habitats with complex structure as a refuge from high winter flows (Nickelson et al. 1992) as well as during the summer low-flow period (Grette and Salo 1986). Adult steelhead require holding and resting sites during their upstream migration (Spence et al. 1996). Large in-stream wood, boulders, and other structures create the necessary slow water and pool habitat needed for resting and cover for adult steelhead during their upstream migration as well as for juveniles rearing in freshwater (Spence et al. 1996). Similar associations with in-stream structure have been documented for other species of fish including cutthroat trout and Chinook salmon.

A comparison of the statistical distributions of the ODFW AIP reach data (Tables 11-2, 11-3) indicated that the upper Nehalem River Project Area streams were similar in character to unmanaged references streams and conditions with respect to in-stream wood levels. The interquartile range and median values for pieces, key pieces and volume of large wood in the upper Nehalem assessment reaches were equal to or greater than most reference values. One exception was the median value of key pieces of large wood (0.8 key pieces per 100 m) was slightly more than half of the median value of key pieces for the Oregon Coast reference streams (1.4 kp/100m). From a watershed perspective, the wood levels in the upper Nehalem appeared to be within the natural variation of unmanaged systems, and thus all subwatersheds were classified as functioning within PFC. However, there remains room for improvements to key piece-size large wood levels in specific reaches within the Project Area (Figure 11-1a,b).

Kavanagh et al. (2005) provided reach specific information on levels of wood in Project area streams. There were 11 reaches where the levels of three critical wood indicators fall within the upper quartile range for the Oregon Coast reference streams exceeding 23 pieces, 57.7 m^3, and 2.8 key pieces, per 100 m stream (Table 11-4). A list of 13 reaches where two of three key indicators were similar to Oregon Coast reference values in the upper quartile (75th to 100th percentile) is also included in Table 11-4. These levels of wood are consistently high compared to various reference conditions, and thus, we presume they can be regarded as the most suitable wood habitats in the upper Nehalem watershed.

There were also 41 reaches where key pieces of wood were less than 0.5 pieces per 100m stream (Table 11-5) representing low levels of wood compared to reference values (Figure 11-1a,b).

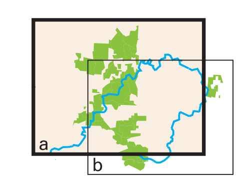


Legend

- Low Key Piece Size Large Wood (less than 0.5 pieces/100 meters)
- Fish Bearing Stream
- Major River
- Project Area
- 5th Field HUC (1710020201)
- 6th Field HUC (171002020109)

Note: Key piece wood size is greater than 60cm in diameter and greater than 12m in length.

Map Key



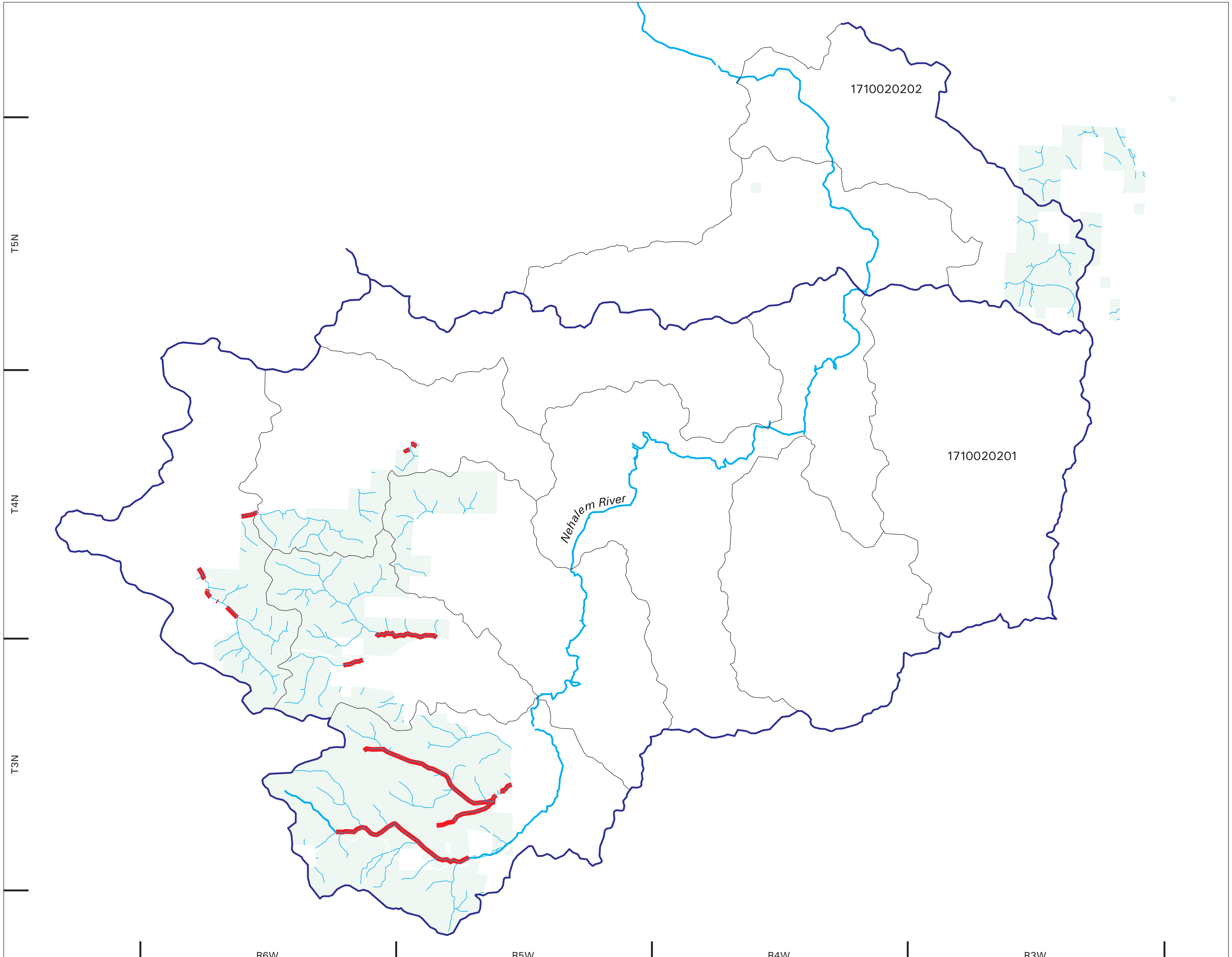
1 Inch = 2.7 Miles

0 2
Miles

R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 11-1(a)
Low In-Stream Wood Levels
Astoria District



Legend

- Low Key Piece Size Large Wood (less than 0.5 pieces/100 meters)
- Fish Bearing Stream
- Major River
- Project Area
- 5th Field HUC (1710020201)
- 6th Field HUC (171002020109)

Note: Key piece wood size is greater than 60cm in diameter and greater than 12m in length.

Map Key

1 Inch = 2.3 Miles

0 2

Miles

R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

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Upper Nehalem Watershed Analysis

Figure 11-1(b)

Low In-Stream Wood Levels

Forest Grove District

Included in Table 11-5 and as noted earlier in Section 9.3.4, the following 11 stream reaches were lacking key pieces of large wood: Cow Creek, Gilmore Creek, Nettle Creek (2 reaches), Osweg Creek, Quartz Creek, South Fork Quartz Creek, Walker Creek (3 reaches), and Dell Creek (Kavanagh et al. 2005). It is our professional opinion these reaches would benefit from management actions that improve instream levels of wood loading.

Table 11-4. Stream reaches with the highest levels of wood loading by 5th field HUC. (At least two of three indicator wood levels exceed the Oregon Coast reference upper quartile values of 22.6 pieces, 57.7 m^3, and 2.8 key pieces, per 100 m stream).

5th Field HUC	Stream	Pieces large wood	Volume large wood	Key pieces large wood
1710020201	Lousignont Creek	39.1	81.5	4.3
	North Fork Rock Creek	51.4	90.6	ND
	South Fork Rock Creek	53.6	86.0	ND
	North Fork Wolf Creek	31.0	54.4	3.9
	Lousignont Creek	40.7	58.5	1.5
1710020202	Fishhawk Creek	31.2	56.3	3.4
	Fishhawk Creek	33.2	105.9	5.7
	Trestle Creek	32.1	79.7	3.0
	Warner Creek Tributary C	64.2	103.4	6.6
	Deep Creek	52.6	115.4	7.4
	Deep Creek	77.4	192.1	9.5
	Deep Creek	28.2	55.9	3.7
	Deep Creek Tributary	61.9	116.3	5.2
	Deep Creek Tributary	65.3	155.4	9.9
	Cow Creek	38.4	64.5	2.6
1710020203	Gilmore Creek	30.3	76.1	3.6
	Walker Creek	45.3	92.4	2.1
	South Fork Walker Creek	56.1	112.0	4.2
	North Fork Walker Creek	35.3	81.9	1.3
	Slaughters Creek	22.0	66.0	
	Beneke Creek	29.9	79.2	3.8
	Hamilton Creek Tributary A	27.4	68.5	2.4
	Hamilton Creek Tributary B	34.8	63.0	2.3
	Buster Creek Tributary A	45.4	259.2	4.8
	Stanley Creek	40.4	67.3	1.2
	Kline's Creek	36.3	67.2	2.6
	Quartz Creek	50.5	59.8	0.7

Table 11-5. Stream reaches with low levels of key pieces of large wood (<0.5 pieces/ 100m).

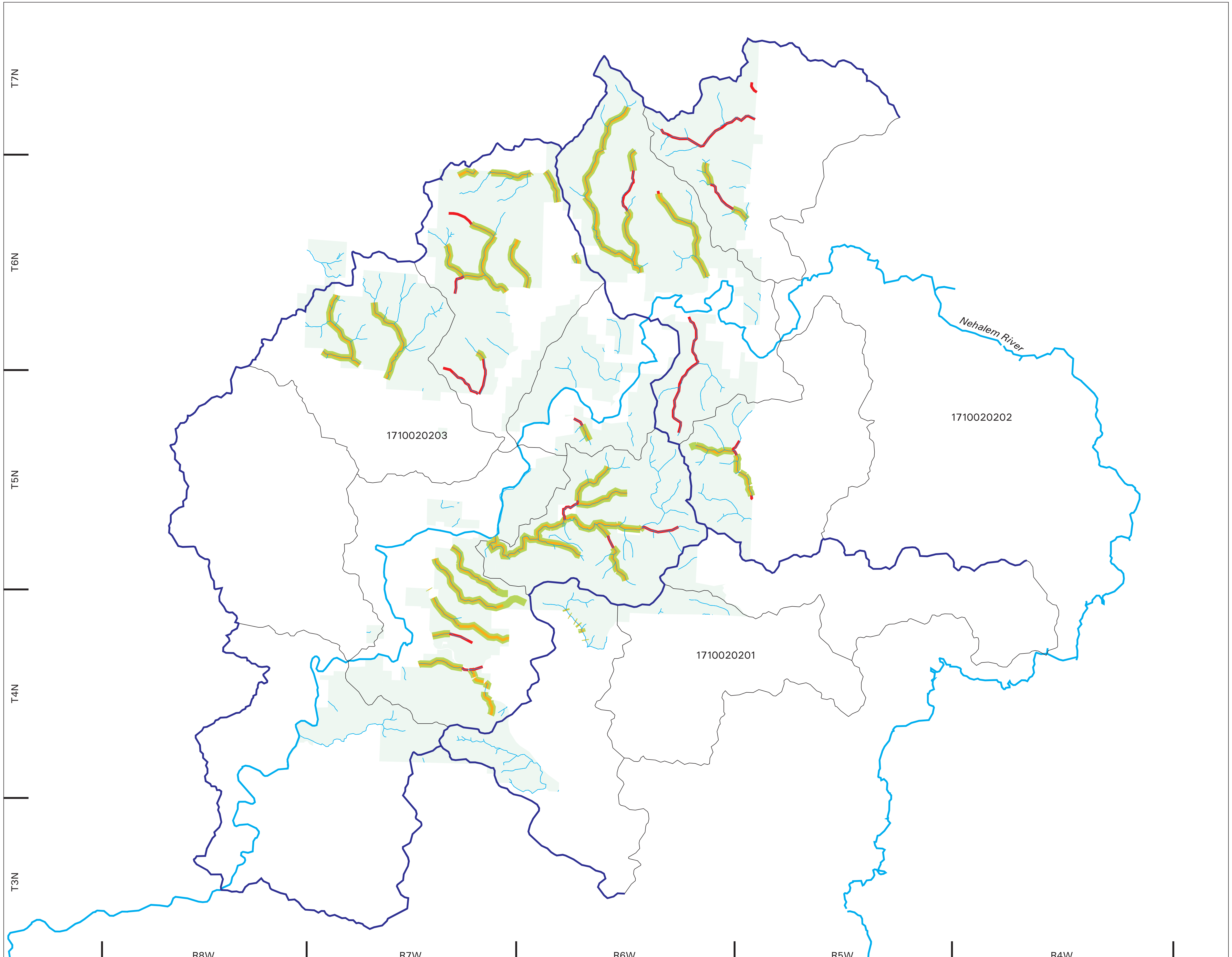
1710020101		1710020102		1710020103	
Stream	**Key Pieces Large Wood**	**Stream**	**Key Pieces Large Wood**	**Stream**	**Key Pieces Large Wood**
Derby Creek	0.02	Northrup Creek	0.1	Hamilton Creek	0.3
Dell Creek	0.0	Northrup Creek Tributary A	0.2	Hamilton Creek	0.3
North Fork Wolf Creek	0.2	Northrup Creek	0.4		
North Fork Wolf Creek	0.3	Deep Creek	0.3	Hamilton Creek Tributary A	0.1
Rock Creek	0.4			Buster Creek	0.4
Rock Creek	0.4			Buster Creek	0.4
Wolf Creek	0.1			Buster Creek	0.2
Upper Nehalem River	0.4			Nettle Creek	0.0
Lousignont Creek	0.2			Nettle Creek	0.0
				Stanley Creek	0.4
				Cow Creek	0.1
				Cow Creek	0.0
				Kline’s Creek	0.2
				Quartz Creek	0.0
				South Fork Quartz Creek	0.3
				South Fork Quartz Creek	0.0
				Gilmore Creek	0.0
				Gilmore Creek	0.3
				Gilmore Creek	0.2
				Gilmore Creek	0.1
				Gilmore Creek Tributary A	0.2
				Gilmore Creek Tributary A	0.2
				Beneke Creek	0.3
				Trailover Creek	0.1
				Walker Creek	0.0

11.2 SEDIMENT DEPOSITION

Sediment composition is also a critical habitat variable for properly functioning aquatic systems. High amounts of gravels and cobbles typically are considered healthy since they provide substrates for incubation of fish embryos, and support diverse macroinvertebrate communities. High levels of bedrock throughout a stream can indicate a deficiency in coarse sediment input, or scouring of the stream bed and downstream movement of sediment. When levels of fine sediments in the substrate are high, intergravel spaces and flow of water and oxygen to incubating eggs can be reduced. Over time, fines can build up cementing gravels into the streambed and reducing their utility for invertebrate habitat and fish spawning habitat. Thus, stream gravels need to be relatively free of fine sediments for proper function.

A comparison of the statistical distributions of the reach data (Table 11.2) indicated that the ODF streams in the upper Nehalem River Project Area were similar to unmanaged references streams and conditions with respect to substrate composition. The interquartile range and median values for percent fines, gravels, and riffles in the upper Nehalem assessment reaches were similar to reference conditions. One exception was the range and median value of percent fines (<2mm) in the upper Nehalem (11-36, 22%) was greater than the range and median for the Oregon Coast reference streams (8-22, 13%), and the range was more extensive than the range for fines in North Oregon Coast Reference Streams (13-23%). However, when considering the fines levels in the unmanaged upper Nehalem reaches (13–29%), it appeared that the underlying geology naturally supports higher amounts of fines than other Oregon coast streams. From a watershed perspective, the substrate composition in the upper Nehalem appeared to be within the natural variation of unmanaged streams, given the geology of the watershed. Thus, it is our opinion, all of the 5th field subwatersheds remain within PFC. Similar to wood loading, there were specific stream reaches with large variations of substrate composition including reaches with high quality substrates and reaches that could benefit from substrate improvements (Figure 11-2a,b).

Kavanagh et al. (2005) provided reach specific information on substrate composition in riffle habitats within Project area streams. Riffle reaches with an approximate 5 percent gradient, relatively low levels of fines and high levels of gravels are listed in Table 11-6. These reaches represent potentially suitable habitat for spawning salmonid fishes, given the high quality of substrate observed. Additional field verification would be needed to verify low levels of embeddedness and or appropriate distributions of gravels to support spawning.

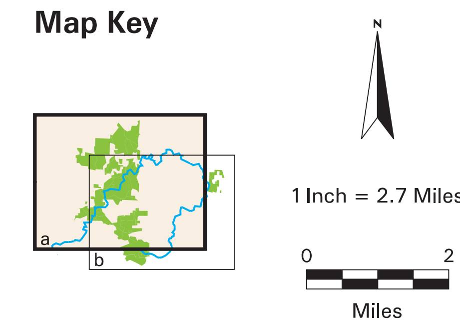


Legend

- Low Fine Sediment Deposition (fines < 30%)
- Potentially Good Spawning Habitat (fines < 30% and gravel > 15%)
- High Fine Sediment Deposition (fines > 30%)
- Fish Bearing Stream
- Major River
- Project Area
- 5th Field HUC (1710020201)
- 6th Field HUC (171002020109)

Note: Sediment-size fractions less than 2mm.

Map Key



1 Inch = 2.7 Miles

R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

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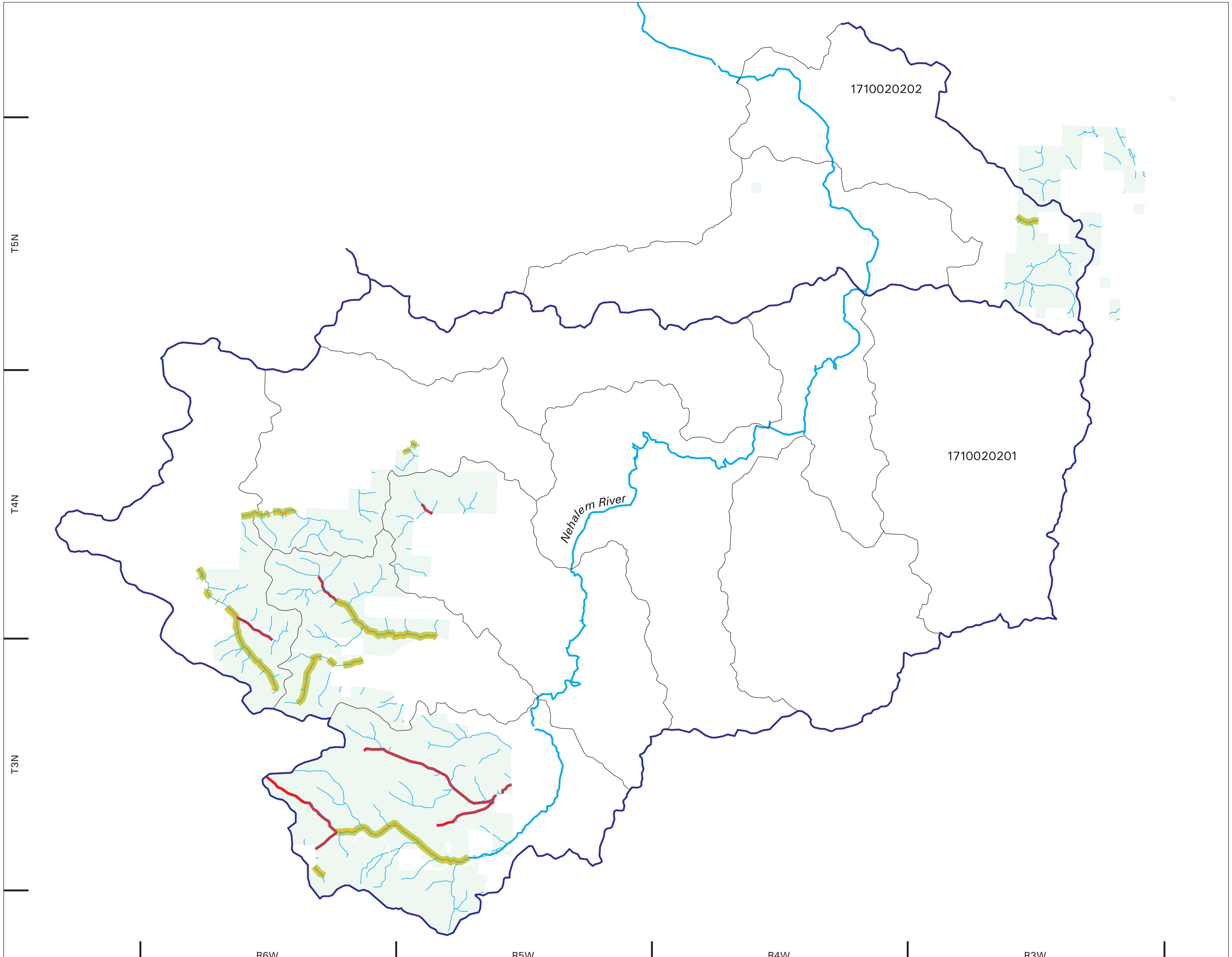
Upper Nehalem Watershed Analysis

Figure 11-2(a)

In-Stream Sediment Deposition in Riffle Habitat

Astoria District

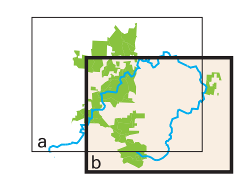


Legend

- Low Fine Sediment Deposition (fines < 30%)
- Potentially Good Spawning Habitat (fines < 30% and gravel > 15%)
- High Fine Sediment Deposition (fines > 30%)
- Fish Bearing Stream
- Major River
- Project Area
- 5th Field HUC (1710020201)
- 6th Field HUC (171002020109)

Note: Sediment-size fractions less than 2mm.

Map Key



1 Inch = 2.3 Miles

0 2

Miles

R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 11-2(b)
In-Stream Sediment Deposition in Riffle Habitat
Forest Grove District

In addition, there are 58 reaches with high levels of fines that could be affecting the habitat value to native fishes. These reaches have more than 30 percent fines in riffles and represent sufficient amounts of fine sediments by volume to fill the pore spaces in riffle gravels and diminish the suitability of these substrates for salmonid fish spawning. Reaches consisting of heavy fine sediment loads within the upper Nehalem are listed in Table 11-7 and shown in Figure 11-2a,b. It is our professional opinion these reaches would benefit from enhancement actions that reduce fine sediment inputs into the stream channels.

Table 11-6. Potential good spawning reaches by 5th field HUC. [These reaches have less than 30% fines and gradients of 5% or less. Actual quality of spawning habitat would require additional field assessment of embeddedness and gravel distribution].

5th Field HUC	Stream	Percent Fines	Percent Gravels
1710020201	Dell Creek	1	62
	Dell Creek	5	48
	Rock Creek	8	32
	Rock Creek	5	20
	Rock Creek	1	36
	South Fork Rock Creek	3	47
	South Fork Rock Creek	9	50
	South Fork Rock Creek	4	29
	South Fork Rock Creek	2	35
	South Fork Rock Creek	0	67
	North Fork Wolf Creek	24	43
	North Fork Wolf Creek	23	43
	North Fork Wolf Creek	26	65
	North Fork Wolf Creek	26	59
	Wolf Creek	15	34
	Wolf Creek	11	34
	Wolf Creek	15	55
	South Fork Nehalem River	23	28
	Upper Nehalem River	29	36
1710020202	Northrup Creek	10	46
	Northrup Creek	15	39
	Northrup Creek	26	59

Table 11-6. Potential good spawning reaches by 5th field HUC. [These reaches have less than 30% fines and gradients of 5% or less. Actual quality of spawning habitat would require additional field assessment of embeddedness and gravel distribution].

5th Field HUC	Stream	Percent Fines	Percent Gravels
	Northrup Creek	16	39
	Northrup Creek Tributary A	24	58
	Warner Creek	17	46
	Deep Creek	23	33
	Deep Creek	21	35
	Deep Creek Tributary	23	35
	Deep Creek Tributary	21	35
	Deep Creek Tributary	28	33
	Oak Ranch Creek	16	36
	Cow Creek	16	26
1710020203	Gilmore Creek	15	15
	Walker Creek	17	77
	Cow Creek	13	34
	Slaughters Creek	22	66
	Fishhawk Creek	23	29
	Fishhawk Creek	16	30
	Fishhawk Creek Tributary A	18	31
	Fishhawk Creek Tributary A	21	35
	Beneke Creek	9	39
	Beneke Creek	7	40
	Beneke Creek	10	27
	Beneke Creek	13	41
	Beneke Creek	19	24
	Beneke Creek	8	42
	Beneke Creek	9	55
	Beneke Creek	12	44
	Bull heifer Creek	25	25
	Trailover Creek	22	48
	Walker Creek	9	63
	Walker Creek	11	47

Table 11-6. Potential good spawning reaches by 5th field HUC. [These reaches have less than 30% fines and gradients of 5% or less. Actual quality of spawning habitat would require additional field assessment of embeddedness and gravel distribution].

5th Field HUC	Stream	Percent Fines	Percent Gravels
	Walker Creek	6	42
	Walker Creek	3	28
	Walker Creek	5	31
	Walker Creek	12	35
	Hamilton Creek	20	30
	Hamilton Creek	20	34
	Hamilton Creek	22	19
	Hamilton Creek Tributary A	17	26
	Hamilton Creek Tributary A	15	32
	Hamilton Creek Tributary A	15	22
	Buster Creek	5	39
	Buster Creek	5	48
	Buster Creek	9	53
	Buster Creek	18	57
	Buster Creek	9	92
	Buster Creek	9	85
	Buster Creek	9	86
	Buster Creek	10	78
	Buster Creek	7	78
	South Fork Walker Creek	9	42
	Stanley Creek	5	58
	Stanley Creek	10	62
	Cow Creek	14	48
	Cow Creek	13	47
	Klines Creek	20	65
	Moores Creek	29	46
	Quartz Creek	21	33
	South Fork Quartz Creek	28	45

Table 11-7. Reaches supporting high sediment loads in the upper Nehalem by 5th field HUC.

1710020101		1710020102		1710020103	
Stream	**Percent Fines**	**Stream**	**Percent Fines**	**Stream**	**Percent Fines**
Derby Creek	33	Lousignont Creek	38	Bull Heifer Creek	32
Lousignont Creek	44	Lousignont Creek	62	Bull Heifer Creek	58
North Fork Lousignont Creek	63	Sager Creek	71	Bull Heifer Creek Tributary A	34
Olson Creek	62	Sager Creek	64	Osweg Creek	86
Clear Creek	55	Sager Creek	86	Buster Creek	37
Bear Creek	31	Fishhawk Creek (above lake)	30	Buster Creek	39
Bear Creek	56	Fishhawk Creek (above lake)	62	Buster Creek Tributary	87
Bear Creek	67	Fishhawk Creek (above lake)	36	Buster Creek Tributary	94
North Fork Wolf Creek	44	Fishhawk Creek (above lake)	33	Buster Creek Tributary	55
South Fork Nehalem River	60	Northrup Creek Tributary A	41	Buster Creek Tributary	64
Upper Nehalem River	61	Trestle Creek	97	Buster Creek Tributary	65
Lousignont Creek	32	Trestle Creek	65	Beneke Creek	40
Lousignont Creek	37	Warner Creek	43	Beneke Creek	40
Lousignont Creek	40	Warner Creek Tributary B	35	Beneke Creek	95
		Warner Creek Tributary C	34	Crawford Creek	68
		Deep Creek	45	Gilmore Creek	53
		Deep Creek	34	Gilmore Creek	48
		Deep Creek	33	Gilmore Creek Tributary A	40
		Deep Creek Tributary	36	Slaughters Creek	40
		Deep Creek Tributary	60	Slaughters Creek	36
		Cow Creek	49	Stanley Creek	37
				Walker Creek	55
				Quartz Creek	38

11.3 SURFACE WATER STREAM TEMPERATURES

Maximum 7-day surface water temperatures under historical reference conditions for the upper Nehalem watershed were modeled based on an assumption of mature forest conditions (MFC) growing adjacent to various stream channel sizes and elevation zones using the View-to-the-Sky (VTS) model as discussed in Appendix 9-2. Reference conifer, mixed and hardwood tree heights were modeled using 100-year site potential tree growth for the ecoregions encompassing the watershed.

As shown in Figure 3-1, Benda and Dunne (1997) predicted the historical forest age-class distribution for the Nehalem watershed based on natural disturbance regimes (fire, landslides, debris flows, etc.). Over thousands of years, they estimated an average of 16 percent of the area would have consisted of forests less than 50 years old and 30 percent would have been less than 100 years old. Mature forest conditions (MFCs) are generally regarded to initially develop around 80 years. Based on the Benda and Dunne (1997) assessment, one could assume MFC and older stands were likely prevalent across approximately 75 percent of the watershed area, on average, over time.

Openings in the riparian canopy and the influence of varying vegetation ages to simulate the effect of occasional disturbance regimes, were modeled using the effective tree height option in the VTS model to account for a reduction in stand opacity. This approach was included to provide potential variability and ranges to surface water temperatures that may have occurred historically. The resulting thermal regimes were assumed to represent reasonably achievable surface water temperatures consistent with historical conditions under occasional disturbances in mature forest conditions (Chapter 9 and summarized in Table 11-9). Given the adaptation of aquatic biota over time to local thermal conditions, the aforementioned reference conditions were regarded as properly functioning conditions (PFC) for streams on ODF lands in the upper Nehalem watershed.

Modeled stream temperatures based on current riparian conditions were also estimated using the VTS model and compared to the reference conditions. The likelihood of exceeding PFC was ranked on relative probability basis as discussed below. Actual stream temperature monitoring data in the watershed were used to verify the model was performing within expected ranges.

Water temperatures were recorded at 12 stations on large and medium stream channels adjoining ODF lands in the Upper Nehalem watershed (DEQ LASAR database). Continuous temperature monitors were installed at eight (8) of the 12 stations where a peak summer 7-day maximum average could be calculated. The remaining four stations were field spot measurements of surface water temperatures. The monitoring data, specific to ODF lands, are shown in Table 11-8. These data are compared in the table with predicted summer surface water temperatures based on current channel size, elevation and riparian canopy closure levels and reasonably achievable surface water temperatures based on mature riparian timber growing along the water courses (as developed in Assessment Chapter 9, Water Quality).

The recorded 7-day maximum temperatures ranged typically between 12.9ºC and 16.4ºC. The only exception was a 7-day maximum level of 23.9ºC recorded in Fishhawk Creek, 275m (300 yd) downstream of Fishhawk Lake (Sta # 24964 in the Fishhawk Management Basin) during the summer of 2000. The Fishhawk Creek station showed the effect of the shallow reservoir impoundment on downstream water temperatures, which overshadowed the influence of riparian shade. Without the reservoir temperature predictions for this reach, based on the distance from divide (9.8 miles), indicated the reach in Fishhawk Creek along ODF lands had the capability to reasonably achieve 17.7ºC. The current water temperature situation in Fishhawk Creek, downstream of Fishhawk Lake to the confluence with the Nehalem River, was regarded as limiting the ability of aquatic habitats to achieve properly functioning conditions for aquatic habitats.

Summer spot measurements of water temperature at four stations on ODF lands in the watershed, including Lousignont Creek in the Forest Grove District and Gilmore Creek in the Astoria District, ranged between 10.6ºC and 13.1ºC (Table 11-8). These measurements did not represent the full range of summer temperatures experienced in the creeks and were not used in the analysis.

In lieu of monitoring data, the water temperature assessment used current riparian stand characteristics (Part 1: Assessment, Chapter 6, Riparian/Wetlands), channel size, elevation and distance from the divide to predict anticipated stream temperatures on a reach by reach basis. The existing temperature predictions for ODF lands were mapped (Figure 9-2).

Table 11-8. Measured versus predicted surface water temperatures on ODF lands in the Upper Nehalem Watershed.

DEQ:LASAR Monitoring Stations List (Parameter: Surface Water Temperature).

Station ID	Location Description	Latitude	Longitude	ODF Lands (Y/N)	Elev. (ft. msl)	Water Type (L,M,S)	Est. Mean BFW (ft)	Riparian Code[1/]	Est. VTS (%)	Summer Temperature Stations: Grab Samples (N)	Temp. Range (°C)	Temp. Mean (°C)	7-day Max (°C)	VTS[2/] Pred. Temp. (°C)
Upper Nehalem														
Wheeler Management Basin														
11843	Lousignont Creek @ RM 7.0	45.7340	123.3388	Y	1040	L	40	HMD	16.8	1	11.0	11.0		15.5
18783	Lousignont Creek Tributary w/in Landslide	45.7236	123.3511	Y	1375	M	20	HMD	8.6	1	13.1	13.1		14.4
17155	Lousignont Creek Tributary upstream of Landslide	45.7236	123.3530	Y	1398	M	20	HMD	8.6	1	11.2	11.2		14.4
23592	Nehalem River - SF Nehalem @ Cochran Rd.	45.7135	123.3910	Y	1503	M	20	MMD	7.6	4393	8.0 - 13.2	10.7	12.9	14.1
23591	Nehalem River just upstream of SF Nehalem River	45.7140	123.3910	Y	1496	L	40	HMD	16.8	4007	8.4 - 14.5	11.3	14.1	14.8
23273	Nehalem River @ Cochran Rd. Bdg 1393	45.7073	123.3197	Y	1014	L	40	HMD	16.8	4093	9.2 - 17.2	12.8	16.4	16.9[3/]
McGregor Management Basin														
23589	Rock Creek - SF Rock Creek @ HWY 26	45.7938	123.4572	Y	1434	L	40	MMD	15.1	4009	8.3 - 14.3	11.1	13.7	14.8
13265	Tributary to NF Wolf Creek @ RM 0.45	45.7947	123.3837	Y	1139	M	20	CMD	7.6	1128	10.1- 15.5	12.4	14.7	14.7
Quartz Management Basin														
23588	Rock Creek @ HWY 26 upstream of SF Rock Creek	45.8044	123.4737	Y	1381	L	40	CMD/SHR	37.1	4009	8.4 - 17.2	12.8	16.3	16.5
Middle Nehalem														
Fishhawk Management Basin														
24964	Fishhawk Cr. 300 yds downstream of Fishhawk Lake	46.0288	123.3677	Y	538	L	40	HMD	16.8	1880	15.9 - 25.2	19.6	23.9	17.7[3/]
Northrup Management Basin														
24976	Northrup Cr. At Headwaters	46.0366	123.4386	Y	850	M	20	CSD/CRD	26.9	2179	7.0 - 17.1	12.5	16.3	16.6
Lower Nehalem														
Beneke Management Basin														
29937	Gilmore Cr. Tr.	45.9601	123.5329	Y	768	M	20	MMD	7.6	1	10.6	10.6		15.2

1) Riparian Code defined in Table 6-2.
2) VTS = View-to-the-Sky Temperature Assessment Model (WFPB 1997)
3) Predicted per distance from divide temperature regression (Biosystems et al. 2003)

ODF Temperature Prediction Summary

Frequency	Percent	Comment
2	29%	Slightly cooler; within - 10% of measured mean temperature (1434 - 1500 ft msl)
5	71%	Predicted temperatures fall within ± 5% of measured mean (850 to 1496 ft msl)
0	0%	Slightly warmer; within + 10% of measaured mean temperature
0	0%	Much warmer; > 10% of measured mean tempreature
1		Lake Outflow; reservoir influence

The likelihood of water temperatures limiting the ability of a stream reach to achieve PFC was assessed based upon reasonably achievable temperatures modeled under MFC for low elevation streams in each management basin (Table 11-9).

Table 11-9. Reasonably Achievable Water Temperatures at the lowest stream elevation in each Management Basin on ODF lands.

Basin	Elevation (ft, msl)	Channel Size	Distance from Divide (mi)	Reasonably Achievable Temperature ºC
Astoria				
Beneke	541	Moderate	< 3.8	<16.0
Buster	423	Large	7.0	17.1
Crawford	472	Moderate	< 3.8	<16.0
Fishhawk	528	Large	9.8	17.7
Hamilton	666	Large	4.0	16.1
Lousignot	515	Large	< 3.8	16.0
Northrup	518	Large	7.0	17.1
Quartz	315	Moderate	4.3	16.4
Sager	495	Large	4.0	16.1
Forest Grove				
McGregor	883	Large	4.3	16.3
Wheeler	833	Large	10.2	17.8
Wilark	764	Large	< 3.8	<16.0

The current riparian conditions were then compared to reasonably achievable temperatures (PFC) and the likelihood of exceeding PFC was ranked on a low, moderate and high level of probability. Summer 7-day maximum temperatures predicted to exceed 20ºC were rated as a high likelihood to limit the ability of a stream reach to achieve PFCs. Temperatures predicted to comply with the reasonably achievable temperatures in each basin were rated with a low likelihood to be limiting. Intermediate situations were rated with a moderate temperature limitation (Table 11-10).

11.3.1 Astoria District

Approximately 90 percent of the fish-bearing stream miles on Astoria District lands in the study area were rated with low temperature probability to be limiting aquatic life (Figure 11-4). A total of 9 and 1 percent of the fish-bearing stream miles were rated with moderate and high probabilities to be limiting, respectively. As shown in assessment Figures 9-2a,b through 9-4a,b and Table 11-10, Beneke, Buster, Fishhawk, Hamilton and the Northrup Management Basins all comprised greater than 95 percent of the stream miles in the low probability category. The Lousignot Management Basin currently supports the lowest percentage (54%) of fish-bearing stream miles in the low probability category, offering 46 percent of the stream miles in the moderate probability category. Compared to the other basins in the Astoria District, the Quartz Management Basin had the greatest percentage (5%) of stream miles (0.7 miles) in the high probability category (Figure 11-3a,b).

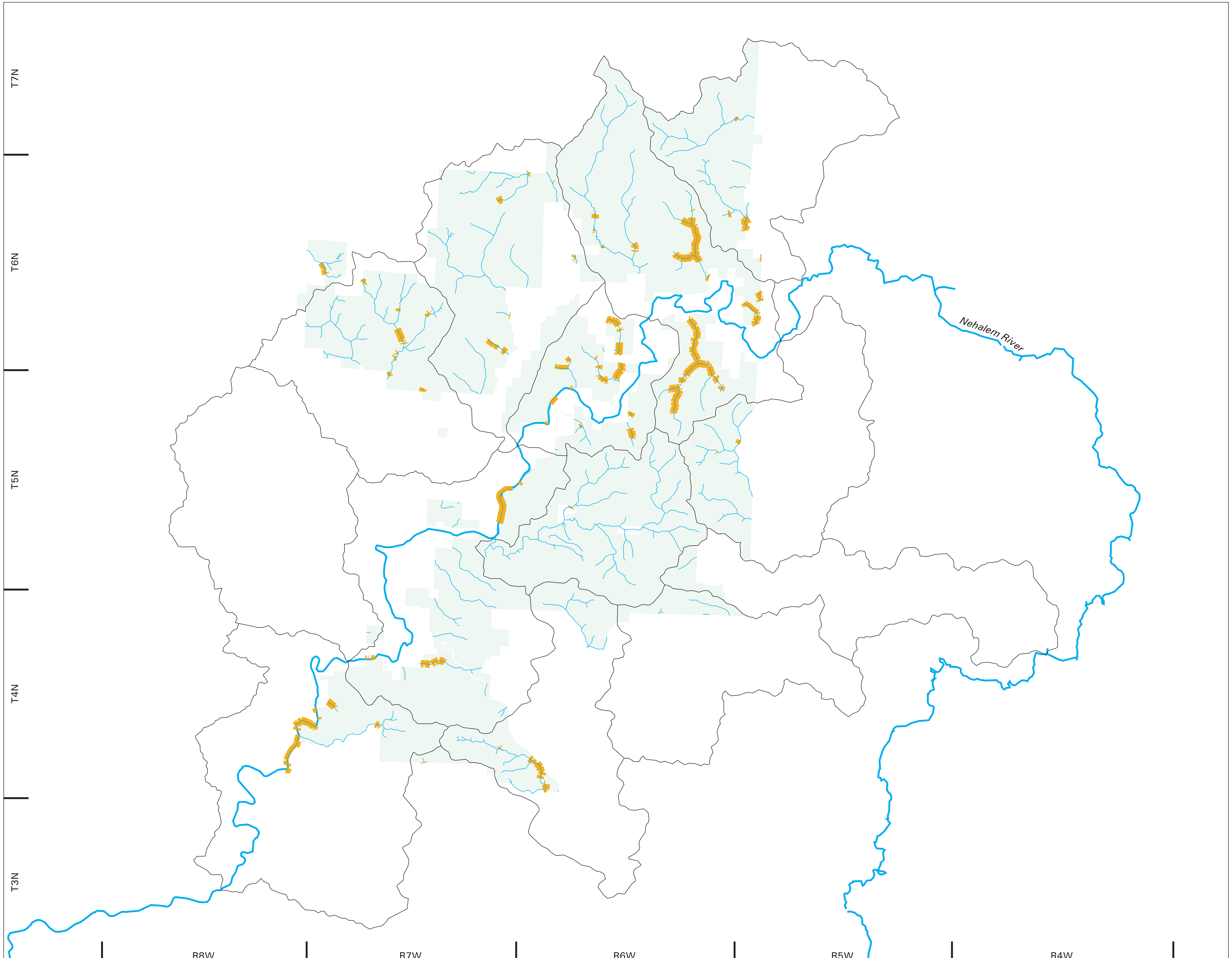
11.3.2 Forest Grove District

Approximately 96 percent of the fish-bearing stream miles on Forest Grove lands in the study area, are currently rated with low probability, while 4 percent were rated with a moderate probability that water temperatures are limiting the ability of a stream reach to achieve properly functioning conditions (Figure 11-5). A total of 0.4 stream miles (0%) were rated in the high probability category. As shown in Figure 11-3a,b and Table 11-4, McGregor, Wheeler and the Wilark Management Basins all comprised greater than 90 percent of the stream miles in the low probability category. The McGregor Management Basin currently supports the highest percentage (10%) of fish-bearing stream miles (6.3 miles) in the moderate probability category, compared to the other basins in the District.

11.3.3 Stream Temperature Conclusion

Stream reach-level water temperatures were estimated for ODF lands in the upper Nehalem Watershed based on various channel sizes, elevations, riparian stand conditions and distances from the topographic divide in each subbasin. Properly functioning habitat conditions (PFC) for water temperature were assessed in accordance with reasonably achievable water temperatures based on mature forest conditions and an allowance for openings in riparian canopies as a function of typical historical channel disturbance regimes (Benda and Dunne 1997).

The current riparian situations on ODF lands in the watershed are anticipated to meet PFC along 93 percent of the fish-bearing streams in the watershed. Approximately 17 miles and 2 miles of ODF fish-bearing streams are anticipated to have a moderate and high risk of limiting the achievement of PFC, respectively.

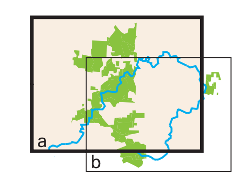


Legend

- Moderate Probability
- High Probability
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Note: Probability that riparian conditions limit the potential for surface water temperatures to achieve properly functioning conditions.

Map Key



N

1 Inch = 2.7 Miles

0 2

Miles

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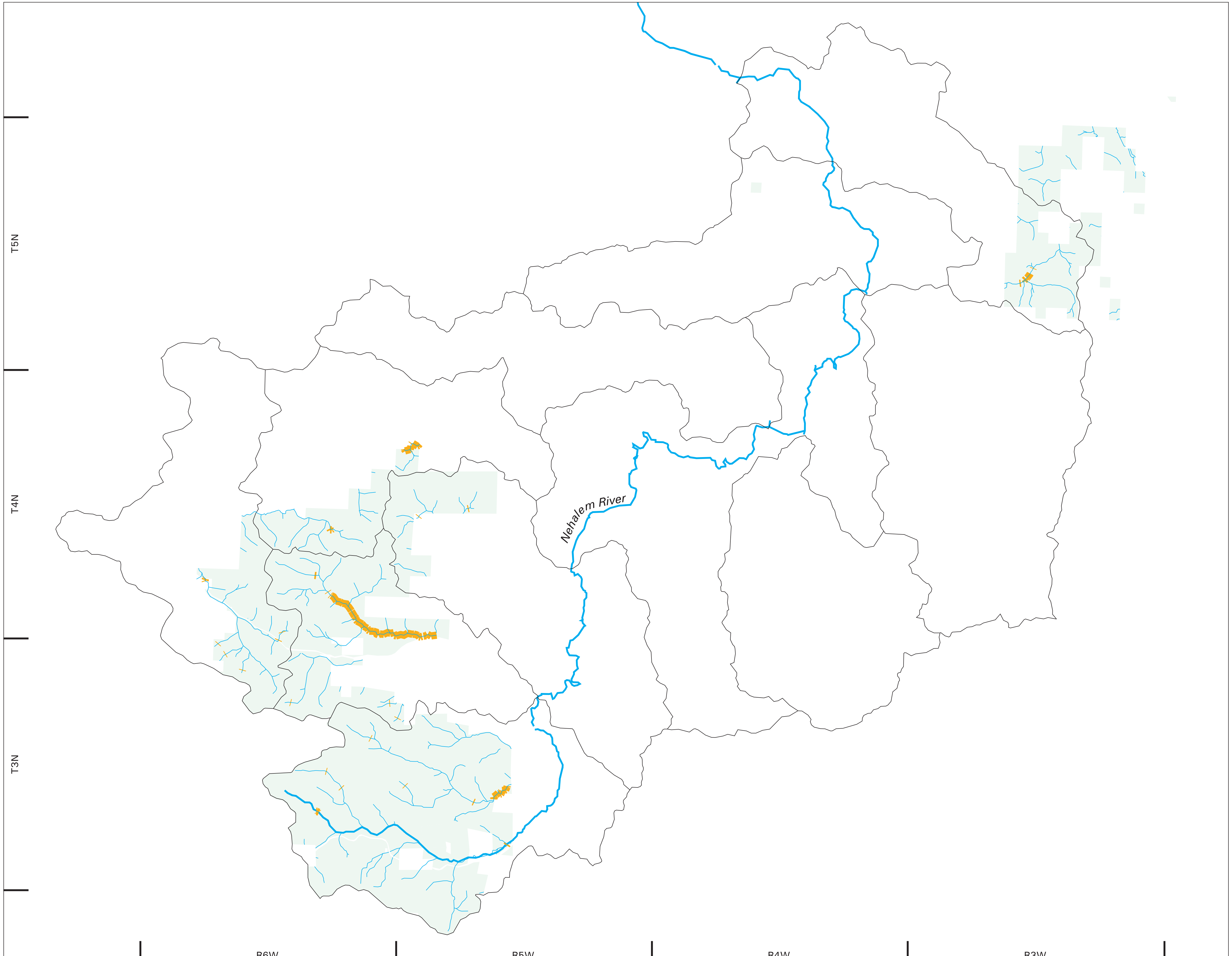
Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 11-3(a)

Predicted Risk to Achieving PFC for Water Temperature

Astoria District

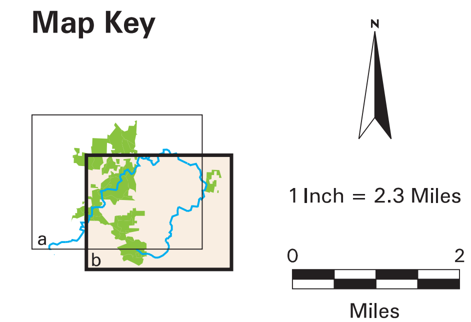


Legend

- Moderate Probability
- High Probability
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Note: Probability that riparian conditions limit the potential for surface water temperatures to achieve properly functioning conditions.

Map Key



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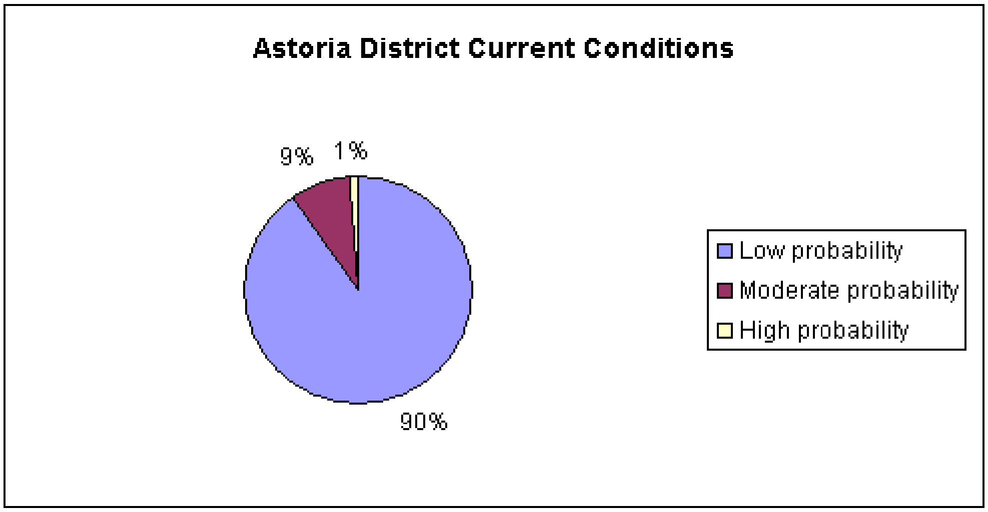
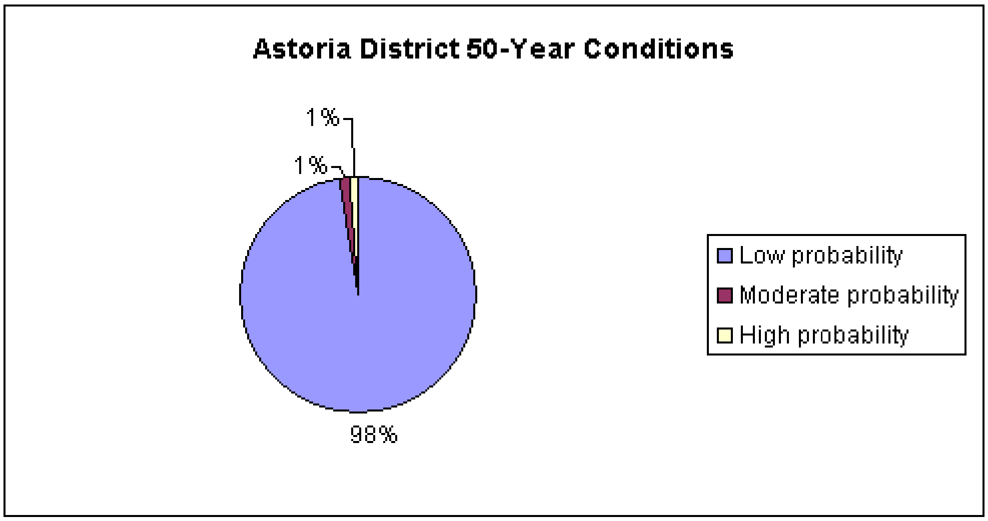
Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 11-3(b)

Predicted Risk to Achieving PFC for Water Temperature

Forest Grove District





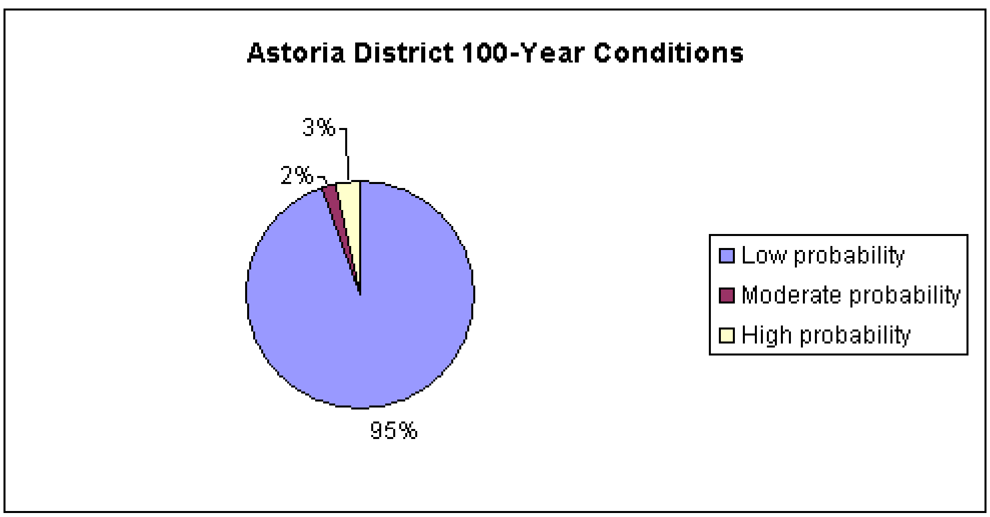
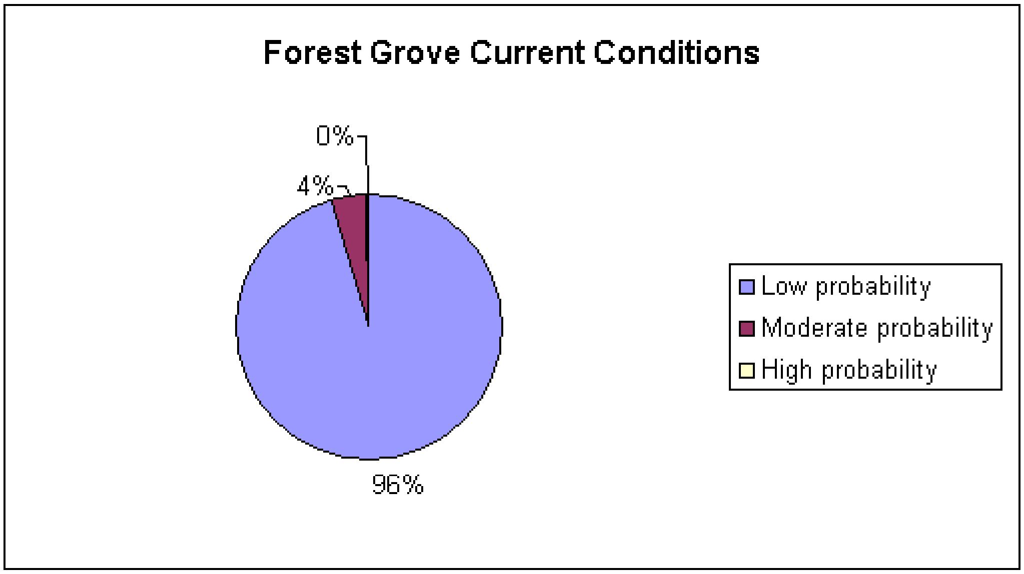


Figure 11-4. Likely probability that riparian shade conditions limit the potential for water temperatures to achieve properly functioning levels along fish-bearing streams on Astoria District lands in the upper Nehalem Watershed



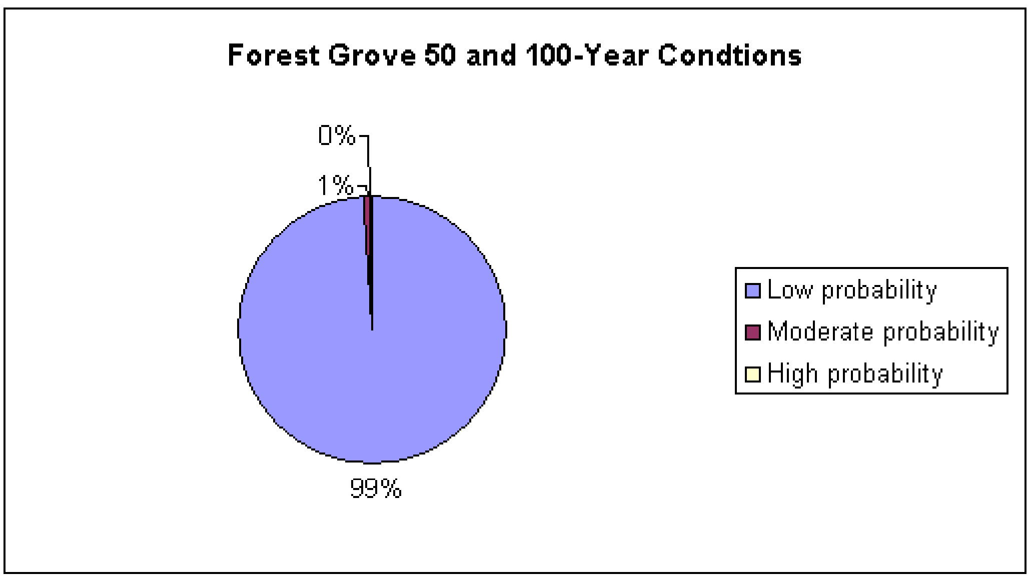


Figure 11-5. Likely probability of riparian shade conditions to limit the potential for water temperatures to achieve properly functioning levels along fish-bearing streams on Forest Grove District lands in the upper Nehalem Watershed.

The most amount of stream miles per subbasin with either a moderate or a high risk of limiting habitat conditions for aquatic life were determined as follows:

Management Basin	Stream Miles	Percent of Subbasin
Sager	4.5	24%
McGregor	3.5	10%
Lousignot	3.4	47%
Quartz	2.8	20%
Crawford	1.9	34%

Of these five basins, only the Lousignot and Crawford Management Basins exceeded, and the Sager Management Basin approaches, a predicted forest-age distribution of stands less than 80 years old (<25%) based on typical Oregon coast range disturbance regimes (Benda and Dunne 1997). It was assumed at any one point in time, riparian stands younger than a mature forest condition would pose a risk to achieving PFC.

11.4 OTHER LIMITING FACTORS

No other conditions related to forest management practices were identified in the assessment with the potential to limit the achievement of properly functioning aquatic habitat conditions on ODF lands in the Upper Nehalem Watershed.

Table 11-10. Likely probability existing surface water temperatures in ODF Management Basins are limiting the ability of a stream reach to achieve properly functioning aquatic habitat conditions.

Limiting Condition Probability	ODF Management Basins in Forest Grove District									
	McGregor					Wheeler				Wilark
	171002020102	171002020103	171002020105	171002020106	Total	171002020101	171002020102	171002020105	Total	Total
Low ≤ pfc	79%	100%	100%	97%	89.8%	98%	100%	100%	99.0%	99.0%
Moderate	21%	0.3%	0.1%	2.4%	10.1%	1.2%	0.2%	0.1%	0.9%	0.0%
High > 20C	0%	0.0%	0.2%	0.2%	0.1%	0.3%	0.0%	0.2%	0.2%	0.8%
Stream Length (mi)	13.9	4.2	4.2	9.2	31.4	35.7	5.8	7.8	49.3	6.2

	ODF Management Basins in Astoria District									
	Beneke	Buster						Crawford		
	Total	171002020105	171002020106	171002020107	171002020304	171002020305	Total	171002020301	171002020302	Total
Low ≤ pfc	97%	100%	100%	100%	100%	100%	100%	64%	100%	65%
Moderate	3%	0%	-	-	0%	0%	0%	35%	-	33%
High > 20C	1%	-	-	-	0.3%	0.1%	0.2%	1%	-	1%
Stream Length (mi)	18.7	3.6	1.8	0.7	30.0	8.5	44.4	5.3	0.2	5.5

	ODF Management Basins in Astoria District									
	Fishhawk	Hamilton			Lousignot			Northrup		
	Total	171002020303	Young's Bay	Total	171002020205	171002020208	Total	171002020208	171002020302	Total
Low ≤ pfc	99%	95%	100%	96%	70%	50%	54%	95%	92%	95%
Moderate	0.3%	4%	-	4%	29%	49%	46%	2%	8%	2%
High > 20C	0%	0.5%	-	0.5%	1%	0.4%	0.5%	2%	-	2%
Stream Length (mi)	10.6	16.7	1.7	18.4	1.3	6.2	7.4	13.5	0.4	13.8

	ODF Management Basins in Astoria District									
	Quartz					Sager				Scattered
	171002020105	171002020305	171002020307	171002020402	Total	171002020206	171002020208	171002020301	Total	Total
Low ≤ pfc	79%	80%	83%	82%	80%	99%	45%	84%	77%	44%
Moderate	12%	19%	16%	18%	15%	0.5%	53%	16%	23%	53%
High > 20C	9%	1%	1%	-	5%	0.1%	1%	-	1%	2%
Stream Length (mi)	6.2	2.7	4.9	0.1	13.8	9.1	7.2	2.5	18.7	0.2

12. ALTERNATIVE VEGETATIVE MANAGEMENT

The following questions were addressed in this chapter to help identify where management standards are likely or unlikely to achieve properly functioning aquatic habitat conditions (PFC). If suitable riparian conditions were not likely to be met in a timely fashion, alternative vegetative management were suggested to achieve PFC.

1. *Given current management strategies, which sub-watersheds have aquatic and riparian conditions that have already achieved the PFC?*
2. *Which sub-watersheds have aquatic and riparian conditions suitable for the development of the PFC in a 50-yr timeframe? In 100-yr timeframe? Longer than a 100-year timeframe?*
3. *For those sub-watersheds where it will take longer than 100 years to develop the PFC, prioritize by stream reach (and map) for alternative vegetation management to achieve the PFC.*

PFC was evaluated for two discrete habitat attributes related to riparian stand conditions; (1) large wood recruitment potential and (2) shade/water temperature in the following sections. All three of the key alternative vegetation management questions were addressed below for both the large wood recruitment and shade attributes.

12.1 LARGE WOOD RECRUITMENT POTENTIAL

The objective for defining PFC for the potential wood recruitment from riparian management stands to stream channels is to achieve reasonable stand conditions comparable to unmanaged lands under late-successional, mature forest conditions (MFC; 80 to 200 years). The earliest a fully-stocked, unmanaged stand would generally achieve an average relative conifer stand size of 24 in. mean dbh on high level site class soils (Site Index 190) is around 100 years from stand initiation (McArdle et al. 1949). Under less productive site indices for the area, it could take 150 to 200 years to achieve a mean conifer stand diameter of 24 inches dbh. The variability of site conditions along riparian areas in the upper Nehalem watershed make generalizations difficult; however, it is possible some of the low elevation riparian soil conditions would not naturally produce the OWEB reference vegetation condition of CLD or MLD (greater than 24 in. DBH) within 80 to 100 years without silvicultural management.

In establishing reference conditions for wood recruitment potential, it is also important to emphasize the typical riparian conditions under natural Oregon Coast Range disturbance regimes. Over the long-term, the historic forest was estimated to support forest stand-age class conditions of less than 80 years old across 25 percent of the Nehalem watershed area at any point in time (refer to Chapters 3 and 7 after Benda and Dunne 1997).

Therefore, two separate techniques for evaluating PFC for wood recruitment potential were used herein:

1. the frequency of stand conditions consistent with OWEB (1999) reference criteria for RA1 of hardwood, mature, dense stands (HMD) and for RA2 of either conifer or mixed-species, large, dense stands (CLD or MLD), and
2. WFPB (1997) guidelines for potential wood recruitment levels.

Both techniques are described below:

(1) OWEB (1999). Riparian areas comprised of HMD vegetation conditions represent densely-stocked stands dominated by deciduous species (< 30% conifer composition) between 12 to 24 inches in diameter that range in age between approximately 50 and 99 years. The hardwood species may dominate the low level terrace zone adjacent to stream channels (RA1) due to the prevalence of saturated soil conditions and highly disturbed nature of channel processes. These stand conditions were deemed the normal reference situation for the Ecoregions in the watershed. Although hardwood-dominated stands were prevalent along the riparian edges, and accounted for 27 percent of the length along stream channels adjacent to ODF lands in the watershed. Only 16 percent of the stands were sufficiently large and dense to be consistent with the OWEB reference condition of HMD. This situation was similar among both the Astoria and Forest Grove Forest Districts. The Beneke and Hamilton Management Basins in the Astoria District supported the highest frequency of stream miles (39% each) consistent with HMD riparian conditions.

Densely stocked conifer-dominated or mixed species stands in excess of mean stand diameters of 24 inch dbh (CLD, MLD) represented the OWEB reference conditions for the riparian hillslope areas (RA2) where soil conditions were drier and the influence of channel disturbances were less than in the terraces areas. These stands represented densely-stocked mixed and conifer-dominated species compositions that ranged under unmanaged conditions between 100 and 200 years in stand age depending upon soil productivity. Silvicultural thinning regimes can produce mean conifer or mixed-species stand diameters of 24 in. in perhaps 80 years on the best site classes.

None of the HUCs or Management Basins currently support mean stand sizes of large wood in excess of 24 inch dbh. Sufficient time has not occurred since legacy harvests and fires altered the overall stand age distributions in the watershed. However, many existing stands were approaching this size class as discussed below.

(2) (WFPB 1997). Washington state guidelines for conducting watershed analyses accept a broader range of riparian stand conditions appropriate for in-channel wood loading than the OWEB approach. The difference is based on the direct relationship between functional wood sizes and channel size. Using literature data for functional wood piece diameters for variable sized channels (Bibly and Ward 1989; Beechie and Sibley 1997; Beechie 1998; and Kennard et al. 1999; Table 12-1), the WFPB (1997) concluded riparian code conditions CLD, MLD, CMD and MMD provided a high level and CMS, MMS and HMD provide a moderate level of wood recruitment potential for channels the size of small, medium and large streams in the upper Nehalem watershed.

For this watershed analysis, the OWEB guidelines were used to represent "*reference riparian stand conditions*" and the WFPB guidelines were used to represent the near-term large wood "*recruitment potential*." The anticipated distribution of these specific riparian conditions across the landscape were assumed based on the disturbance history work of Benda and Dunne (1997) as shown in Table 12-2. The current riparian stand data are also summarized in Table 12-2 to provide an indication of riparian stand conditions that have met the reference conditions and/or are likely providing a current level of high, medium and low wood recruitment potential to local streams.

12.1.1 Sub-Watersheds That have Achieved PFC for Large Wood.

Overall the current riparian conditions on ODF lands in the Upper Nehalem watershed offered 53, 19, 28 percent of the total stream miles in high, moderate and low wood recruitment categories, respectively (Table 12-2). Approximately, 16 percent of the inner riparian terrace (RA1) zone (38.7 stream miles) was consistent with the OWEB reference "Hardwood Mature Dense" (HMD) condition, while none of the outer riparian hillslope (RA2) zone was mature enough to meet the "Conifer or Mixed-Species Large Dense" (CLD or MLD) reference condition. The situation in RA2 was a result of legacy harvests in this zone and insufficient time to

Table 12-1. Review of available literature regarding functional wood diameters in various channel sizes.

Channel Class	Channel Size[1/]		Beechie (1998) Minimum Diameter		Beechie-Sibley (1997) Minimum Diameter		Bilby-Ward (1989) Min. Mid-point Diam.		Kennard et al. (1999) Min. DBH Diameter		Range of Estimates
	mean (acw) (m)	(ft)	LWD (cm)	LWD (in)	LWD (cm)	LWD (in)	LWD (cm)	LWD (in)	LWD (cm)	LWD (in)	LWD (in)
Mainstem	23.0	75	187.5	73.8	210.6	8.0	75.7[3/]	29.8[3/]	251.6	17.1	23 - 36
Large	9.1	40	100.0	39.4	112.6	3.3	112.0	12.7	144.5	12.0	9 - 23
Medium	6.1	20	50.0	19.7	56.6	2.3	69.2	12.0	83.3	10.9	6 - 16
Small	2.5	10	10.0[2/]	4.0[2/]	10.0[2/]	4.0[2/]	31.8[3/]	13.0[3/]	52.7	9.6	4 - 13

1) = approximate average of ODFW surveyed AIP data from streams in the upper Nehalem watershed.

2) = Minimum LWD diameter size defined as a 10 cm (4 inch) diameter log.

3) = Extrapolated beyond range of field data

Beechie and Sibley (1997)

Min. LWD $\text{diameter}_{(cm)} = 2.8(CW_m) + 0.57$

Min. LWD $\text{diameter}_{(in)} = 0.336(\text{CW ft})+0.2244$

Beechie (1998)

Min. LWD $\text{diameter}_{(cm)} = 2.5(CW_m)$

Min. LWD $\text{diameter}_{(in)} = 0.3(\text{CW ft})$

Bilby and Ward (1989)

Min. LWD $\text{diameter}_{(cm)} = 2.14(CW_m) +26.43$

Min. LWD $\text{diameter}_{(in)} = 0.2568(\text{CW ft})+10.406$

Kennard et al. (1999)

Min. LWD $\text{diameter}_{(cm)} = 3.06(CW_m) +22.1$

Min. LWD $\text{diameter}_{(in)} = 0.367(\text{CW ft}) + 8.7$

Table 12-2. Projected frequencies of riparian recruitment categories 50 and 100-yr. in the future adjusted for long-term likelihood of channel disturbances.

		Current			**50-Yr.**			**100 - Yr.**			**Reference**
Reference Stand Condition (OWEB 1999)											
Riparian Zone	Riparian Code	ODF Lands	Astoria District	Forest Gr. District	ODF Lands	Astoria District	Forest Gr. District	ODF Lands	Astoria District	Forest Gr. District	Stand with Natural Disturbances[1/]
RA1	HMD	16%	15%	17%	27%	33%	23%	16%	16%	16%	43%
RA2	CLD, MLD	0%	0%	0%	42%	48%	38%	67%	63%	70%	70%
Large Wood Recruitment Potential (WFPB 1997)											
Recruit. Potential	Riparian Code	ODF Lands	Astoria District	Forest Gr. District	ODF Lands	Astoria District	Forest Gr. District	ODF Lands	Astoria District	Forest Gr. District	
High	CLD, MLD, CMD, MMD	53%	53%	53%	60%	56%	63%	67%	63%	70%	70%
Moderate	CMS, MMS, HMD	19%	18%	20%	26%	32%	22%	18%	18%	18%	14%
Low	All other riparian codes:	28%	29%	27%	14%	12%	15%	15%	19%	12%	16%

1) after disturbance rates developed in Benda and Dunne (1997) for western Oregon Coast Range watersheds the size of the upper Nehalem by correlating riparian codes and forest age-classes.

grow trees where the average stand size exceeded 24 in dbh. The Wolf Creek fire may have contributed to the intermediate-aged riparian stand conditions in the Quartz and McGregor Management Basins.

12.1.1.1 Current Conditions

None of the 6th field HUCs or Management Basins currently supported riparian conditions that offer relative stand sizes of large wood in excess of 24 in. DBH. These results are consistent with the general finding of limited wood levels in ODF streams (Kavanagh et al. (2005) and the abundance of reaches where in-stream loading of key piece-sized wood were low (Figure 11-1a,b). Nevertheless, the current potential for wood recruitment was rated high along more than 60 percent of the fish-bearing waters in the Fishhawk, Buster and Wilark Management basins, since a number of dense conifer or mixed stands were approaching the large wood size category. More than 94 percent of the stream reaches in the Beneke Management basin were rated with either a high or moderate recruitment potential. Based on the estimated natural historic distribution of stand characteristics supporting high, moderate, and low recruitment potential for large wood, the fishhawk management basin in the project area is currently consistent with PFC. Basins with the least amount of either a high or a moderate recruitment potential included Northrup, Sager, Crawford and McGregor.

12.1.2 Sub-Watersheds with Suitable Conditions for the Development of PFC for Large Wood in 50, 100 and More Than 100 Years in the Future

12.1.2.1 50-Year Time Frame

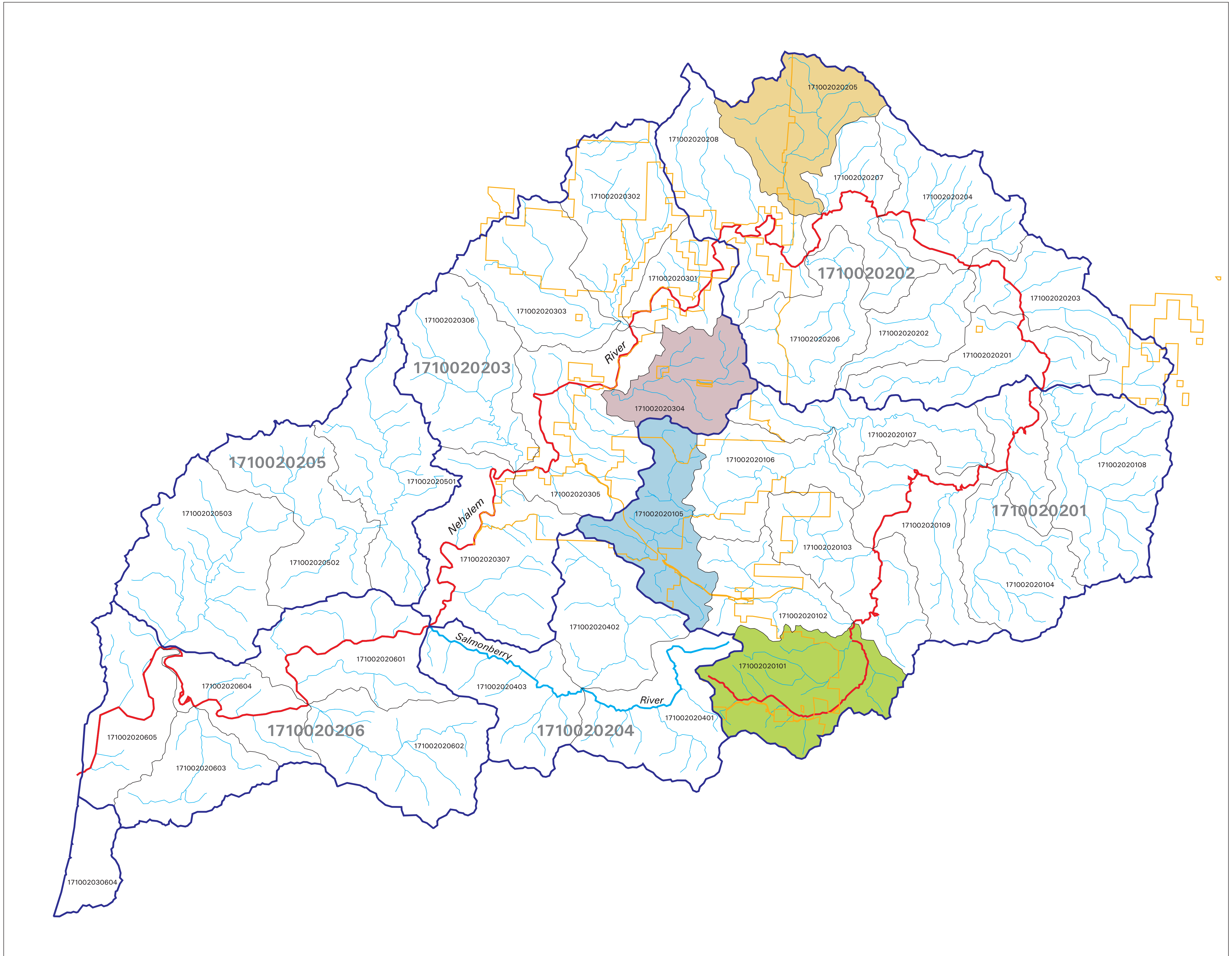
Many of the riparian zones adjacent to fish-bearing waters in the watershed appeared to be on a trajectory to PFC and should achieve such conditions within a 50-year time frame under proposed management strategies for aquatic and riparian areas. The two principal riparian management strategies include the *Northwest Oregon State Forest Management Plan (NW FMP)* and the “Salmon Anchor Habitats (SAHs) Strategy for Northwest Oregon State Forests” (ODF 2003). The NW FMP specifies for all fish-bearing streams: (1) no-harvest within the 0 - 25 ft streambank zone and (2) silvicultural management within the inner 25- to 100 ft-zone to achieve mature forest condition (MFC) equivalent to stand ages of 80 to 100 years or greater with stand structure targets of 220 ft^2/acre conifer basal area, a stand density index of greater than 25% SDI; and at least 50 TPA with 40 – 45 conifer TPA > 32 in. DBH (ODF 2001).

The NW FMP also identified specific SAH strategies for managing core watershed areas potentially representing metapopulations of salmonid fish species. The SAH strategy is intended to represent lower short-term risk to populations of key salmonid species (metapopulations; core-areas) on state forests than the NW FMP for a period of 10-years, until June 30, 2013.

ODF has designated the mainstem Nehalem River and four HUCs in the upper Nehalem Watershed area as SAHs (Figure 12-1) as follows:

Buster Cr.	#171002020304
Fishhawk Cr.	#171002020205
Lousignont Cr.	#171002020101
Upper Rock Cr.	#171002020105

Differences between management operations in the NW FMP and in the SAHs are highlighted in Table 12-3. There are differences with respect to riparian forest management in NW FMP Strategies 2, 3, and 4; to sediment delivery in both Strategy 6 “Slope Stability” and Strategy 7 “Forest Roads Management” of the FMP. The primary difference with respect to riparian areas for fish-bearing streams is the SAHs specify a 100 ft no-harvest zone (NHZ) throughout the entire inner riparian zone.



Legend

- Buster Creek (SAH)
- Fishhawk Creek (SAH)
- Lousignont Creek (SAH)
- Upper Rock Creek (SAH)
- Nehalem River Mainstem
- Stream
- Major River
- Project Area
- 5th Field HUC (1710020201)
- 6th Field HUC (171002020109)

Map Key

Nehalem River Basin

Oregon

1 Inch = 4 Miles

0 2

Miles

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Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 12-1
Salmon Anchor Habitats
Nehalem River Basin

Table 12-3. Management measures for specific SAHs in the upper Nehalem Watershed

Strategy 2; Aquatic and Riparian Areas

<u>Fish-bearing and Large and Medium Non-Fish bearing streams:</u>

- All harvest activity

    0 - 100 ft. No-harvest zone (NHZ)

    No more than 10% vegetation disturbance in RMAs for cable corridors or felling impacts

<u>Small, Non-Fish bearing, perennial streams:</u>

- Partial cuts retaining > 25% SDI:

    0 - 50 ft. (Ground-based) ELZ

- Any harvest activity reducing density < 25% SDI:

    0 - 50 ft. NHZ

    50 – 100 ft. 15 – 25 TPA conifer tree or snag retention

- No more than 25% vegetation disturbance in RMAs for cable corridors or felling impacts

<u>Small, Non-Fish bearing, seasonal streams:</u>

- Partial cuts retaining > 25% SDI:

    0 - 50 ft. (Ground-based) ELZ

- Any harvest activity reducing density < 25% SDI:

    0 - 50 ft. (Ground-based) ELZ

    0 - 50 ft. 15 – 25 TPA conifer tree or snag retention

- High Energy Reaches and Potential Debris Flow Track Reaches that are direct tributaries to Fish-bearing streams

    0 – 50 ft. NHZ

- No more than 25% vegetation disturbance in RMAs for cable corridors or felling impacts

<u>Debris Torrent Fans</u>

- No harvest on the fan

Strategy 3, Restore Aquatic Habitats

- SAH watersheds within the District that have been determined to have high restoration potential will be a high priority for implementation
- This aspect will help us set priorities for management actions.

Strategy 4, Alternative Vegetation Treatment

- Use alternative vegetation treatments only where, through analysis, ODF in consultation with ODFW determine the risk to species using the stream in question are less than without the alternative.

Table 12-3. (cont)

Strategy 6, Slope Stability

- Reduce the likelihood of sediment delivery to streams from management-related landslides through closer scrutiny by geotechnical specialists.
- All new road construction in an SAH will be reviewed by a Geotech. For HLHLs and high risks to streams
- Avoid harvest operations and road construction in HLHL that pose a high risk to streams
- Report landslides through inventory procedures and apply adaptive management

Strategy 7, Forest Roads Management

- SAHs priority basins for completing District Transportation plans
- Identify existing and legacy roads needing formal abandonment
- New road construction minimized to lower level of harvest activities
- New road construction limited to upper portions of slopes away from streams
- New road construction designed to avoid perennial stream crossings
- Dry weather construction only
- SAHs high priority for conducting needed road network repairs including unstable sidecast, road drainage, fish passage barriers identified through road inventories
- Correct all problem areas within 10 years
- Existing roads are a high priority for maintenance and improvement to minimize potential sediment delivery to streams
- Dry weather hauling unless prior approval and close monitoring of road surface and drainage systems

Specific SAH Limitations on Timber Harvest Activities

<u>Buster/Lousignont HUCs</u>

- Max. 20% of state forest related to commercial thinning (CT), regeneration harvests (clearcuts) or other timber harvest activity during the 10-year period.
- Of this total, clearcut harvesting shall not exceed 5% of the total acreage in the HUC.
- Clearcut harvesting will not be allowed where the percent of stands ≤ 15 years would exceed 15% of the ODF acreage in the HUC as a result of harvest.

<u>Fishhawk/Upper Rock HUCs</u>

Major waterfalls create natural barriers to fish passage near the state ownerships and fish use is primarily limited to downstream areas from state forests. The primary benefits of state forests shall be to provide downstream effects related to sources of large wood and good water quality.

- No thinning acreage limit
- Clearcut harvesting shall not exceed 7% of the total state forest acreage in the HUC during the 10-year period.
- Clearcut harvesting will not be allowed where the percent of stands ≤ 15 years would exceed 15 % of the ODF acreage in the HUC as a result of harvest.

Reference Stand Conditions: Nearly 42 percent of the fish-bearing stream miles on ODF lands in the upper Nehalem Watershed (100 miles) were projected to develop sufficient riparian stand characteristics in the next 50 years to generate reference conifer/mixed stand conditions in RA2 for large diameter wood (> 24 in.) in 50 years. Similarly, 27 percent of the ODF fish-bearing stream miles were projected to support riparian conditions consistent with OWEB reference hardwood condition for RA1.

Wood Recruitment Potential*:* With respect to potential wood recruitment in 50 years, approximately 60, 26 and 14 percent of the riparian situations along ODF forest lands adjacent to fish-bearing waters were anticipated under NW FMP and SAHs strategies to offer high, medium and low recruitment potential (WFPB 1997). These trends were similar among both the Astoria and Forest Grove Forest Districts. The McGregor, Wheeler, and Wilark Management Basins in the Forest Grove District and Beneke, Buster, Crawford, Fishhawk, Hamilton, and Lousignot Management Basins in the Astoria District supported the highest frequency of stream miles (86% to 90%) consistent with high and medium potential large wood recruitment conditions. Similarly, Wheeler, Buster and McGregor provided the most total miles in the high recruitment category compared to all twelve of the Management Basins. All of the basins were anticipated to develop more than 84 percent of the stream miles in either high or moderate recruitment categories consistent with the historic frequency of forest age-classes with the exception of Quartz, Sager and Northrup Management Basins in the Astoria District. These basins were anticipated to offer high and medium recruitment potential for large wood along 74 to 82 percent of the fish-bearing waters.

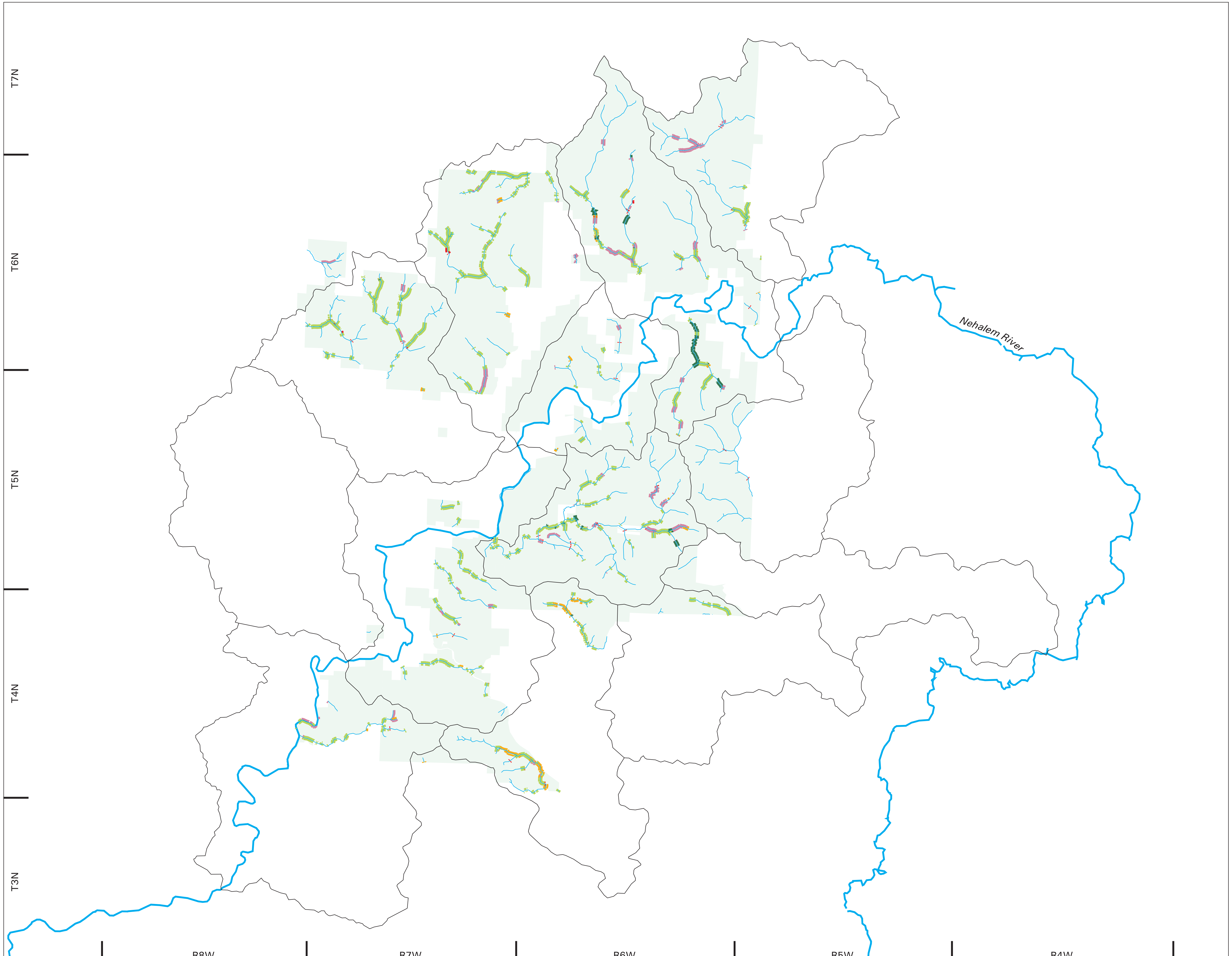
Only 14 percent of the streams adjacent to ODF lands in both Management Districts (34 miles) were projected to remain in a low recruitment potential category in the 50-year time frame. These situations are the primary result of understory conditions precluding the establishment of a second cohort, low densities of some hardwood stands and the influence of ongoing channel disturbances. The Quartz Management Basin was anticipated to have the most stream miles of the Management Basins remaining in a low recruitment category (27%; 3.8 miles).

The riparian situation in a 50-year time frame was projected to offer a distribution of vegetative conditions consistent with natural disturbance regimes along western Oregon coast range streams (Benda and Dunne 1997) for most of the management basins. Low recruitment potential in the Northrup, Sager and Quartz Management Basins along 17 to 27 percent of the fish-bearing stream length in each basin was slightly greater than the anticipated natural variation in frequencies of young forested age-classes (< 50 years) of 16 percent.

12.1.2.2 100-Year Time Frame

Reference Stand Conditions: Approximately 67 percent of the fish-bearing stream miles on ODF lands in the upper Nehalem Watershed (160 miles) were anticipated to develop sufficient riparian stand characteristics in 100 years to generate PFC for large diameter wood (> 24 in.) in both RA1 and RA2 where mixed and conifer-dominated stands prevail. However, the medium-sized (12 – 24 in.), dense, hardwood-dominated stands (HMD) prevalent in riparian zone RA1 should thin considerably in the subsequent 50-year period due to natural senescence of hardwood trees. These hardwood stands were anticipated to become sparse (HMS or HLS) in 100 years. Unmanaged, hardwood-dominated stands were not anticipated to regenerate a second cohort and both hardwood canopy and shrub understory are anticipated to preclude conifer regeneration within 100 years. Only by means of anticipated future natural stand disturbances, will the existing HMD stands in the RA1 zone maintain some of the OWEB reference condition at 100-years. Based on historic rates of natural disturbance, we anticipated approximately 16 percent of fish-bearing stream length on ODF lands in the upper Nehalem watershed could become disturbed and grow sufficiently to meet reference conditions for RA1.

***Wood Recruitment Potential**:* With respect to potential wood recruitment in 100 years, approximately 67, 18 and 15 percent of the riparian situations along ODF forest lands adjacent to fish-bearing waters were anticipated under NW FMP and SAHs strategies to offer high, medium and low recruitment potential (WFPB 1997). These trends were similar among both the Astoria and Forest Grove Forest Districts. The Wilark Management Basin in the Forest Grove District and Fishhawk, and Crawford Management Basins in the Astoria District supported the highest frequency of stream miles (93% to 94%) consistent with high and medium potential large wood recruitment conditions. All of the basins were anticipated to develop more than 84 percent of the stream miles in either high or moderate recruitment categories with the exception of Quartz, Hamilton, and Beneke Management Basins in the Astoria District and McGregor and Wheeler Management Basins in the Forest Grove District. These basins were anticipated to offer low recruitment potential for large wood to fish-bearing waters along 19 to 26 percent of the fish-bearing waters, slightly higher than historic frequencies that likely occurred under natural disturbance regimes. The locations of reaches supporting low wood recruitment potential are shown in Figure 12-2a,b and the areas are prioritized for alternative vegetative management actions in Chapter 16.

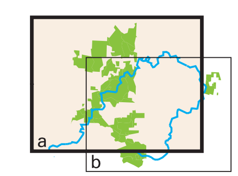


Legend

- 1 - Vegetation Composition
- 2 - Development
- 3a - Sparse Hardwood Species
- 3b - Sparse Conifer and Mixed Species
- 4 - Hardwood Senescence
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Note: Numbers 1-4 indicate recommended alternative vegetation management scenarios.

Map Key



N

1 Inch = 2.7 Miles

0 2

Miles

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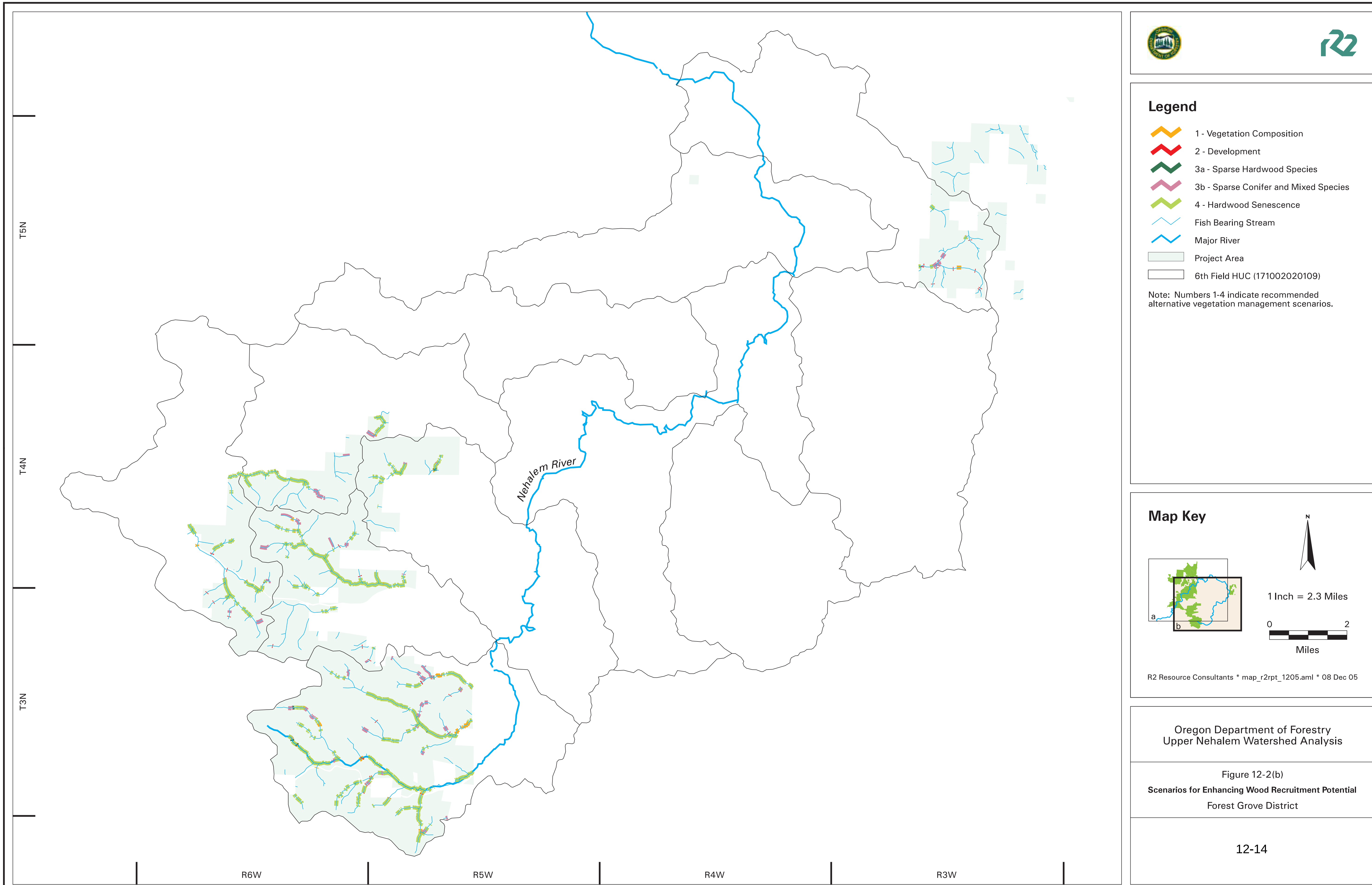
Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 12-2(a)

Scenarios for Enhancing Wood Recruitment Potential

Astoria District



Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 12-2(b)
Scenarios for Enhancing Wood Recruitment Potential
Forest Grove District

The similar frequencies of the low recruitment potential categories at the 100-year compared to the 50-year time period was principally a result of the ongoing dynamic between stand growth and riparian losses due to hardwood senescence and channel disturbances developing sparse stand conditions.

Benda and Dunne (1997) predicted 16 percent of forests across the landscape the size of the upper Nehalem watershed would be less than 50 years old and 30 percent would be less than 100 years old. Disturbances occur episodically rather than at a constant rate, but over a long period of thousand's of years, the overall long-term average level of natural disturbance equates to 0.3 percent of the forest per year.

Disturbance regimes capable of altering the riparian vegetation character along the streambank zone include stand-replacing fires, wind-throw and major channel forming events like floods and debris flows. Assuming disturbances in the riparian zone are similar to the total landscape disturbance rate, one can anticipate 16 percent of the riparian forest along the streambank (RA1) zone would be modified in the first 50 years. This assumption is likely in the appropriate range since riparian zones experience more channel-related disturbances but less fire-related disturbances than upland forests.

A new hardwood stand requires approximately 50 years of growth to: (1) comply with the OWEB reference stand (HMD with medium-sized trees 12 to 24 in. in diameter) and (2) to provide a moderate potential rating for recruitment of large wood to channels (WFPB 1997). As such, a disturbed deciduous stand needs to be re-initiated prior to or exactly at year 50 to contribute to mature PFC in RA1 in a 100-year time frame. Depending upon when the channel disturbance occurred, it is possible some of the low recruitment potentials (perhaps upward to 15 percent) modeled in Chapter 6 could offer moderate recruitment capabilities within a 100-year time frame.

The watershed analyst team was less confident of the predicted wood recruitment results at 100 years than at 50 years. This confidence level was a result of: (1) multiple possible vegetation successional pathways from a given starting condition, (2) the assumption of no stand-replacing disturbance events and (3) the extended time frame.

12.1.2.3 Longer Than 100-Year Time Frame

Development of shade tolerant conifer species as a second cohort was anticipated to occur under many of the existing hardwood and grass/shrub stands (Assessment Table 6-3). Some of these stands were predicted to provide moderate and high levels of wood recruitment in 150 to 200 years. Nevertheless, given stand replacement disturbance events and ongoing hardwood senescence, it is likely a mosaic of stand ages and wood sizes will prevail on the landscape. A component of the riparian zone will remain in either a young age class or in sparse densities offering low wood recruitment potentials. It was not possible to anticipate the dynamics involved with any degree of confidence to quantify the influence. Under natural disturbance regimes in the Nehalem Watershed (Benda and Dunne 1997), it was estimated approximately 16 percent of the entire area basin would have forests in age classes less than 50 years old with 30 percent less than 100 years old (Assessment Figure 3-1, based on the work of Benda and Dunne [1997a] for the Oregon Coast Range).

12.1.3 Alternative Vegetation Management to Achieve the PFC for Large Wood

Anticipated future management strategies including NW FMP and SAHs are not anticipated to hinder achievement of PFC for large wood in 100 years. However, the existing conditions within some riparian stands will have an ongoing influence on the ability to achieve PFC in the future. Recommendations for alternative vegetation management to achieve the wood recruitment potential for stands remaining low in 100 years vary by the specific group of situations in each stand. The followings current conditions were anticipated to inhibit development of PFC in a 100-year time frame under the proposed management scenarios (Figure 12-2a,b).

1. ***Vegetation Composition:*** Riparian zones dominated by bare ground, grasses, shrubs.
2. ***Riparian Structures/Development:*** Encroachment of road and rail line structures within the 100-ft riparian zone.
3. ***Sparse Levels of Stocking in Stands:*** Sparse hardwood, mixed species and conifer stands that hinder development of a second cohort.
4. ***Hardwood Senescence:*** Dense hardwood stands (HMD and HSD) that become sparse, yet hinder development of a second cohort.

Alternative management scenarios for each of the four groups of situations are discussed below.

12.1.3.1 Vegetation Composition (Bare Ground, Grasses, and Shrubs).

A total of 5.8 miles of riparian areas along fish-bearing waters (2.4% of ODF lands in both Management Districts) in the Upper Nehalem Watershed were within this category. Conditions within 100 years were not forecasted to provide sufficient wood diameters to qualify as large (> 24 in.) wood. A total of 0.4 miles in the riparian zones was comprised of bare ground. It was assumed bare ground implied the presence of surfaces, such as exposed hard rock, that would not support development of a riparian vegetation stand.

The recommended alternative forest management practice for locations where grasses and shrubs exist in riparian areas include:

1-1. For locations where site conditions are conducive for conifer tree establishment, perform active silvicultural management by means of vegetation removal, site preparation and replanting with appropriate conifer species. Verify the replanted stand becomes established within the first 15 years.

12.1.3.2 Riparian Structures

The frequency of roads or railroads in the riparian zone appeared to be low (Chapter 8). The RIMS database categorized approximately 15 miles of stream-adjacent roads (road prisms within 100 ft of a fish-bearing channel). This distance corresponds to 6 percent of the fish-bearing stream network in both Management Districts. However, only 0.4 scattered miles of the riparian polygons identified in the aerial photographic assessment indicated the dominating presence of either roads or rail lines. The discrepancy between the on-ground survey (RIMS database) and the aerial photographic assessment was likely due to the lack of road observation through the riparian canopy on the photos. Regardless, the level of road surface encroachment in the riparian zone was small with respect to the overall wood recruitment potential along ODF stream reaches.

The recommended alternative forest management practice for riparian locations with stream-adjacent roads includes:

2-1. Consider road relocation when and where feasible per the guidelines and prioritization established in Chapter 14 (Road Management).

12.1.3.3 Sparse Stands

Hardwood Species: Approximately 3.6 discontinuous stream miles adjacent to ODF lands (1.5%) in the upper Nehalem Watershed were identified in a current sparse hardwood condition. Vegetative growth and succession within 100 years were not forecasted to provide sufficient wood diameters to qualify as large (> 24 in.) wood.

The recommended alternative forest management practice for riparian locations supporting sparse hardwood stands include:

3-1. *For locations where site conditions are conducive for conifer tree establishment, perform hardwood conversion by completely removing hardwoods between 25 and 100 ft from the stream bank, and actively planting with an appropriate conifer species for the site conditions. Verify the new stand becomes established within the first 15 years.*

Conifer and Mixed Species: Depending upon the understory and site conditions and the initial stand density, some of the mixed and coniferous sparse stands were predicted to remain in a sparse condition, developing only a moderate level of wood recruitment potential within 100 years. A total of 10.5 stream miles (4.4%) of the fish-bearing channel network currently supported sparse stands of either coniferous or mixed species. The recommended alternative forest management practice for riparian locations supporting sparse, mixed or coniferous stands include:

3-2. *Where sparse overstory conditions and soil conditions allow the establishment of a coniferous stand, underplant with appropriate coniferous species and verify an understory stand becomes developed within the first 15 years.*

3-3. *Consider removal of the hardwood component between 25 and 100 ft from the stream channel to allow an improved chance of conifer establishment and free-to-grow conditions.*

12.1.3.4 Hardwood Senescence

Many of the dense hardwood stands were anticipated to become sparse due to mortality within the 100-year time frame. Development of a second stand cohort of any species in the understory was also assumed to be difficult without some form of stand manipulation or disturbance. Sparse conditions would not likely offer a sufficient level of wood recruitment within 100 years. A total of 52.3 stream miles (22%) of the fish-bearing channel network currently supported dense hardwood stands that might be vulnerable to senescence.

Rather than early, pro-active stand manipulation, the alternative management recommendation for this riparian situation follows:

4-1. Assess the future level of site-specific riparian disturbances in the watershed.

- *a. If channel and riparian disturbances are creating a mixture of stand composition and age class conditions, especially in the inner (RA1) zone, then no management activity is needed.*
- *b. If, however, a dense hardwood riparian stand matures to the point of imminent mortality, consider hardwood conversion per alternative vegetation management recommendation #3-1 above.*

12.2 RIPARIAN SHADE/WATER TEMPERATURES

12.2.1 Sub-Watersheds that have Achieved PFC for water temperature

Many of the 6th field HUCs and Management Basins are currently predicted to offer riparian conditions characteristic of PFC for shade and surface water temperatures. These results are consistent with the water temperature measurements in ODF streams (Table 11-9).

More than 90 percent of the fish-bearing stream lengths on ODF lands are estimated to currently support PFC water temperatures based on the level of canopy closure and height of riparian vegetation in sub-watersheds located in Beneke, Buster, Fishhawk, Hamilton, Northrup, McGregor, Wheeler and Wilark Management Basins (Table 11-10). In general, the watershed assessment estimated the Forest Grove District has 96 percent (83 miles) and the Astoria District 90 percent (136 miles) of the fish-bearing streams in properly functioning shade conditions to maintain surface water temperatures (Chapter 9).

Sub-watersheds in the Crawford, Lousignot, Quartz, and Sager Management Basins and in scattered lands offered 80 percent or less of the fish-bearing stream miles in riparian conditions considered suitable for achieving PFC for water temperatures. Riparian conditions in these sub-watersheds were regarded as likely more open than conditions prior to European influence, especially in headwater regions of the subbasins. Many of these riparian zones were determined to be on a trajectory to PFC and should achieve such conditions within a 50-year time frame as described below.

12.2.2 Sub-Watersheds with Suitable Conditions for the Development of PFC, for Water Temperature in 50, 100 and More Than 100 Years in the Future

Predictions of canopy closure and water temperatures based on riparian conditions 50, 100 and more years in the future were made by projecting existing stand conditions adjacent to fish-bearing channels on ODF lands in the watershed with vegetation succession projections. Effective vegetation heights predicted from the future stand characteristics were subsequently included in a VTS assessment of the radiation blocking elements along streams as a function of channel width and elevation to estimate surface water temperatures. Assumptions for forest management included stand characteristics resulting from the Salmon Anchor Habitat strategy (SAHs) along fish-bearing streams in the Buster, Fishhawk, Lousignot, and the Upper Rock Cr. HUCs [0-100 ft no-harvest zone] and the NW FMP strategies elsewhere on ODF lands in the watershed [0-25 ft no-harvest streambank zone; 25-100 ft Mature Forest Condition (MFC) inner zone]. The VTS temperature model incorporated an option of lowering the effective tree height to accommodate the concept of created openings in the riparian stand as a result of disturbance conditions. For proper context, the results were compared to reference conditions anticipated under natural disturbance regimes for western Oregon Coast range forests after Benda and Dunne (1997).

12.2.2.1 50-Year Time Frame

Ninety eight percent of the fish-bearing stream miles on ODF lands in the upper Nehalem Watershed (234 miles) were anticipated to develop sufficient riparian stand characteristics to generate PFC for shade and water temperature in the next 50 years. All of the Management Basins were predicted to exceed 96 percent of the stream miles in conditions consistent with PFC, with the exception of Quartz. The Quartz Management Basin was anticipated to support 90 percent of the stream miles with a high probability of achieving PFC. This frequency is likely consistent with, or exceeds, historic riparian stand conditions under natural disturbance regimes.

Only 2.6 miles (1.1%) and 1.7 miles (0.7%) of the stream lengths adjacent to ODF lands in both Management Districts were predicted to have a moderate and high risk, respectively, of not achieving PFC in 50 years. The riparian situations generating some degree of risk to achieving

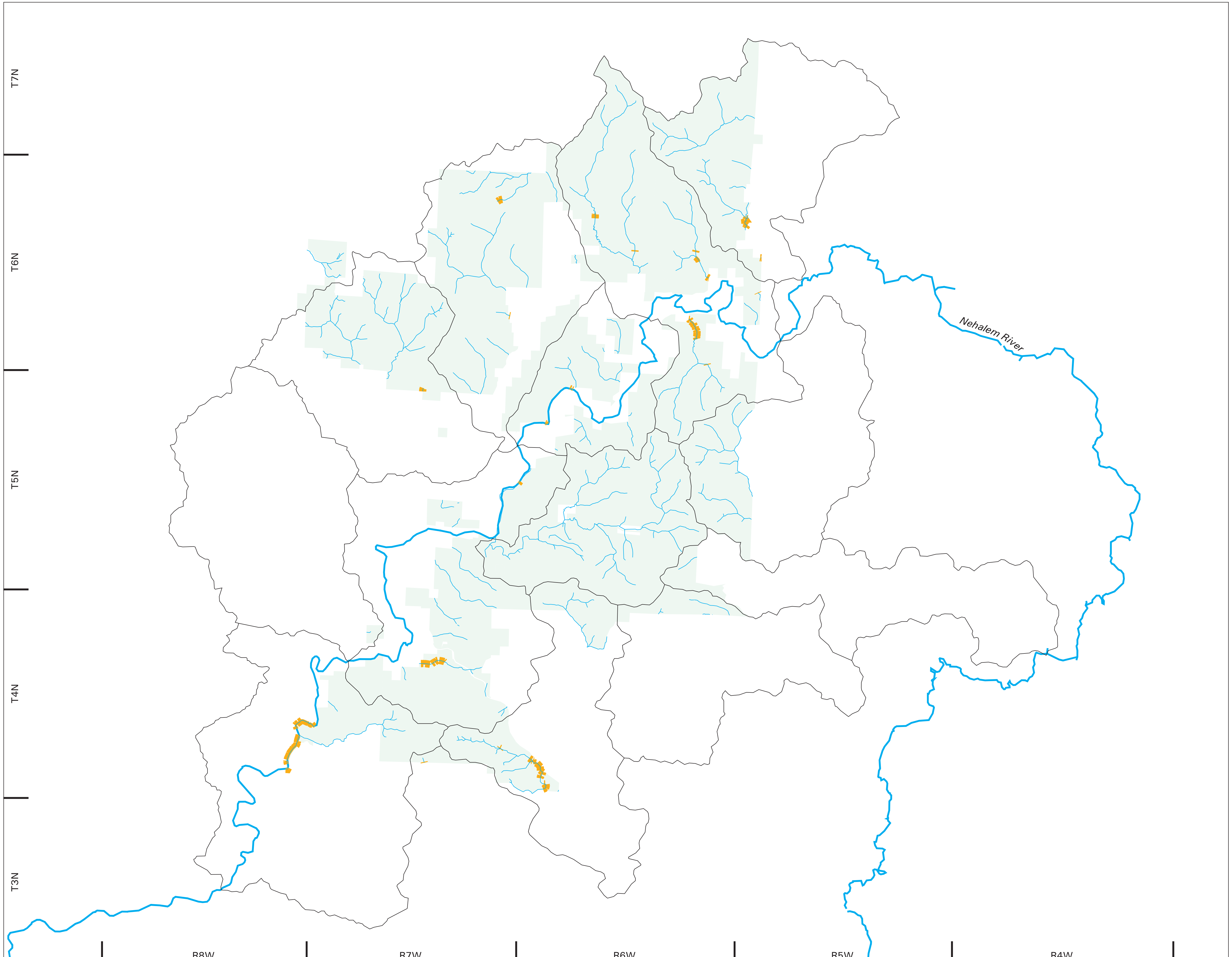
PFC were the primary result of understory vegetation conditions precluding the establishment of a second cohort and low densities of some hardwood stands.

12.2.2.2 100-Year Time Frame

Very little difference was predicted in the probability of achieving PFC related to shade and water temperature between the 50- and 100-year time frames. Nearly ninety seven (97%) percent of the fish-bearing stream miles on ODF lands in the upper Nehalem Watershed (230 miles) were anticipated to retain sufficient riparian stand characteristics to generate PFC in 100 years. A minor amount (1%) of riparian canopy was anticipated to open sufficiently compared to 50-year time frame to potentially increase surface water temperatures as a result of hardwood senescence. Approximately 3.3 miles (1.4%) and 5.2 miles (2.2 percent) adjacent to ODF lands in both Management Districts were predicted to have a moderate and high risk, respectively, of not achieving PFC in 100 years (Figure 12-3a,b). The principal anticipated differences between the 50- and 100-year time frames were in both the Quartz and Lousignot Management Basins where abundant hardwood stands were anticipated to become sparse through senescence. As shown in Figure 11-4, the increase in the distribution of fish-bearing waters exceeding PFC changed from 1 to 3 percent between 50 and 100 years in the Astoria Forest District and remained unchanged in the Forest Grove District. The degree of channel openness predicted in both Districts remained consistent with historic riparian stand conditions under natural disturbance regimes.

12.2.2.3 Longer Than 100-Year Time Frame

Development of shade tolerant conifer species as a second cohort was anticipated to occur under many of the existing hardwood and grass/shrub stands (Appendix F). Some of these stands were predicted to provide high levels of shade in 150 to 200 years. Nevertheless, with stand replacement disturbance events and ongoing hardwood senescence, it was likely a mosaic of stand ages and shade levels would prevail on the landscape. A component of the riparian zone would remain in either a young age class or in sparse densities offering low radiation-blocking potentials compared to the channel sizes. It was not possible to anticipate the dynamics involved with any degree of confidence to quantify the influence. Under natural disturbance regimes in the Nehalem Watershed (Benda and Dunne 1997), it was estimated approximately 16 percent of the entire area basin would have forests in age classes less than 50 years old (Assessment Figure 3-1, based on the work of Benda and Dunne (1997) for the Oregon Coast Range).



Legend

- Moderate Probability
- High Probability
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Note: Probability that riparian conditions limit the potential for surface water temperatures to achieve properly functioning conditions.

Map Key

a
b
N
1 Inch = 2.7 Miles
0 2
Miles

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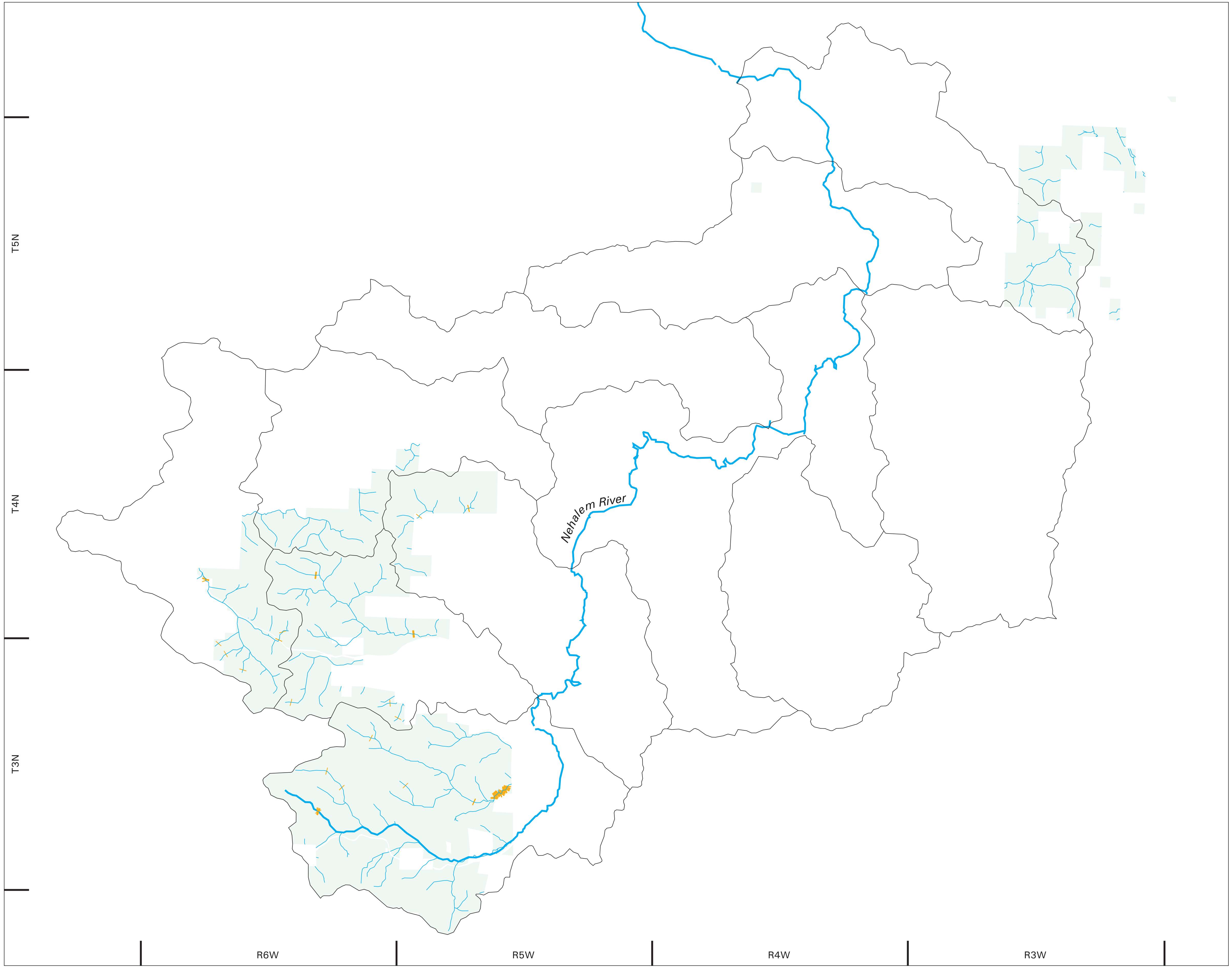
Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 12-3(a)

Predicted Risk to Achieving PFC for Water Temp. in 100 Years

Astoria District

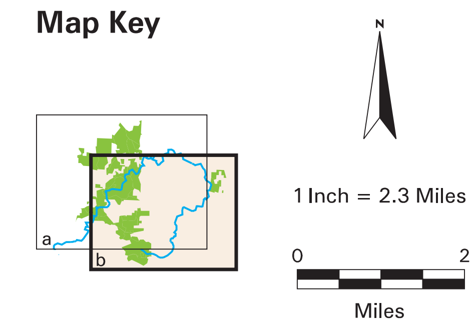


Legend

- Moderate Probability
- High Probability
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Note: Probability that riparian conditions limit the potential for surface water temperatures to achieve properly functioning conditions.

Map Key



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Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 12-3(b)

Predicted Risk to Achieving PFC for Water Temp. in 100 Years

Forest Grove District

12.2.3 Alternative Vegetation Management to Achieve the PFC

PFC for water temperature not only varies by the amount of canopy coverage based on natural growing conditions for riparian stands and natural disturbances, but by channel size and location in the watershed (elevation and distance from the watershed divide). PFC for water temperatures was determined for each of the ODF Management Basins in the watershed in Assessment Chapter 9 based on an evaluation of reasonably achievable water temperatures. PFC ranged between 11.6 and 17.8°C for various channel sizes, elevations, and distance from divide across the twelve management basins (Table 11-9). The distribution of reasonably achievable reference temperatures integrating the frequency of channel sizes, elevations and natural disturbances for discrete thermal classes on fish-bearing streams on all ODF lands in the watershed was as follows.

Thermal Class	Predicted Historic Frequency
< 12°C	1%
< 16°C	96%
< 18°C	3%
> 18°C	0%

The reference temperature distributions differed slightly between the two Management Districts since the Astoria District encompasses lower elevation lands than the Forest Grove district. The reference, current, and projected 50- and 100-year temperature distributions are summarized in Table 12-4. Most (90%) of the fish-bearing streams were currently consistent with reference water temperatures in each basin. Nearly all of the fish-bearing waters (98% and 97%) were anticipated to be consistent with reference temperatures at the 50-year and 100-year time frames, respectively. Only, 2.8 stream miles (1.2%) of the total ODF lands in the watershed were not anticipated to achieve PFC in 100 years. Most of the stream miles anticipated to exceed PFC were located in Quartz, Wheeler, Northrup, and the Beneke Management Basins (see Figure 12-3a,b).

Achieving PFC in the riparian zone was more difficult for generating the large wood recruitment potential in the Upper Nehalem Watershed than it was for generating proper conditions to maintain surface water temperatures. Recommendations for alternative vegetation management to address specific low wood recruitment potential issues will provide a corollary benefit to surface water temperatures. Based on the watershed assessment, there are no additional recommendations for alternative management scenarios for achieving properly functioning shade conditions.

Table 12-4. Distribution of forecasted water temperatures on fish-bearing streams on ODF lands in the upper Nehalem Watershed

	Surface Water Temperature Class				**Probability of Exceeding PFC**		
	<12^{o}C	12 – 16^{o}C	16 – 18^{o}C	>18^{o}C	Low	Moderate	High
ODF Lands							
Reference	1%	96%	3%	0%	100%	-	-
Current	0%	86%	6%	9%	92%	7%	1%
50-Yr	2%	95%	3%	0%	98%	1%	1%
100-Yr	2%	94%	3%	1%	98%	2%	1%
Forest Grove District							
Reference	3%	97%	0%	0%	100%	-	-
Current	0%	92%	7%	1%	96%	4%	0%
50-Yr	4%	95%	0%	1%	99%	1%	0%
100-Yr	5%	94%	0%	1%	99%	1%	0%
Astoria District							
Reference	0%	95%	5%	0%	100%	-	-
Current	0%	82%	5%	13%	90%	9%	1%
50-Yr	0%	95%	5%	0%	98%	1%	1%
100-Yr	0%	94%	5%	1%	97%	2%	1%

13. KEY ANALYSIS QUESTIONS FOR SLOPE STABILITY

The following questions were addressed to help identify areas in the watershed where landslides may occur and may impact stream habitat.

1. *Are there landslide-prone hillslopes that pose a high risk of downstream sediment or scour impacts? If so, identify the specific hillslopes and stream reaches, describe why they pose a high risk to streams, and describe how management will affect possible stream sediment or scour impacts?*
2. *Which of the mechanisms (shallow landslides, deep-seated landslides, and soil creep) provide a substantial source of sediment to streams?*
3. *Which steep slopes will likely provide future in-stream key pieces of large wood to debris flow prone channels?*

13.1 LANDSLIDE-PRONE HILLSLOPES THAT POSE A HIGH RISK OF DOWNSTREAM SEDIMENT OR SCOUR IMPACTS

Landslide-prone hillslopes that pose a high risk of downstream sediment or scour impacts can be identified based on the slope gradient, landslide density, and debris flow probability maps provided in this section for each of ODF's management areas (see Table 7-1 and Appendix D, Figures D-9 to D-59). The specific stream reaches likely to be impacted can also be identified using the debris flow probability maps (both scour along the predicted paths and deposition at the downstream end of the predicted path). However, additional site-specific information is required to evaluate the risk posed by debris flows to fish-bearing channels (see below). Evaluating how forest management will affect debris flow risk and ultimately the conditions of channels will require information on rates and spatial patterns of timber harvest, information only available from ODF planning staff. Understanding how channel conditions can be affected by debris flows can be enhanced by referring to the discussion of disturbance in the Nehalem watershed analysis.

13.1.1 Additional Information Needs

Critical information is needed on why landslide-prone hillslopes (or debris flows) pose a high risk to streams and how management will affect stream sediment or scour impacts. As mentioned in Section 3.2, the ecological effects of landslides and debris flows is a complex issue. Detailed analysis of channel conditions could be used to understand whether landslides and debris flows pose a high risk to streams and hence how forest management can affect that risk at any particular location. Hence, an additional information need includes detailed field surveys in landslide and debris flow deposition zones to estimate how mass wasting would alter channel and valley floor morphology. In the absence of detailed field measurements, however, it can be assumed that landslides and debris flows pose a high risk. The assumption of high risk could lead to certain types of ODF forest management policy decisions, such as no or limited road building or harvest prescriptions. Such prescriptions may be overly conservative. Therefore, it may be important to create additional environmental context from which to understand effects of debris flows using both models or field data on channel conditions, or a combination of both.

Field information could be used to determine whether landslides and debris flows are “properly functioning.” “Properly functioning” refers to the behavior of mass wasting that contributes to habitat formation through the introduction of sediment and large wood that ultimately creates aquatic habitats. Properly functioning could be defined in terms of composition (i.e., in their respective proportions of wood and sediment in landslide and debris flow deposits) and whether landslides and debris flows in managed forests are occurring at rates in space and time in the same order of magnitude as in natural systems. Riparian buffer strips along debris flow-prone headwater streams could be used as a strategy to ensure future mass wasting wood is transported to low-gradient, fish-bearing streams (i.e., maintaining a natural level of debris flows as a wood recruitment agent). Other types of analyses could be used to investigate the spatial and temporal patterns of mass wasting in managed versus unmanaged systems.

13.2 SEDIMENT SOURCE ANALYSIS

The Oregon Department of Forestry requested an evaluation of the relative importance of sediment sources in the Nehalem watershed (i.e., question #2 above). This information would be useful in understanding if and how forest management might be contributing to increased sedimentation in streams. For example, if landslides and debris flows are major sources of sediment, and timber harvest is linked to increased landslide and debris flow rates, then forest management may lead to increased rates of sediment to stream channels. However, the ecological ramifications of landslides and debris flows is more complex than simply constructing sediment budgets; see the discussion of natural disturbance in the Nehalem Watershed Analysis. A thorough understanding of sedimentation mechanisms in the upper Nehalem Watershed would require the construction of a sediment budget or at least a partial budget focused on the principle erosion processes, specifically mass wasting and soil creep. Development of a quantitative sediment budget would require an aerial photograph and field-based assessment of the various forms of erosion in the Nehalem watershed, including shallow landslides in bedrock hollows, shallow landslides in inner gorges, debris flows in first- and second-order streams, soil creep along channels of all orders but in particular headwater streams, and soil creep or shallow landsliding from deep-seated landslides. Historical aerial photography can be used to develop a time series of certain types of erosion (visible from air photos) such as debris flows. Refer to Dietrich and Dunne (1978) and Reid and Dunne (1996) for more complete discussions on creating sediment budgets. Erosion from logging roads was not evaluated in this analysis since the sediment source budget outlined below is primarily qualitative. A separate roads analysis is contained in Chapter 14.

13.2.1 Qualitative Comparative Analysis

It was feasible to infer the relative importance of the four different soil erosion mechanisms from information available in the Nehalem watershed as well as from other studies in the Oregon Coast Range. In the discussion that follows, sediment supply was considered for large, high-order channels (third- and higher-order channels) since the focus of the analysis was on the supply, storage, and routing of sediment and wood in fish-bearing streams. In the relatively steep terrain of the North Coast Range central Oregon Coast Range, sediment budgets have indicated the overwhelming importance of shallow landslides and debris flows in supplying sediment to the higher-order channel network (Dietrich and Dunne 1978; Reneau and Dietrich 1991; Benda and Dunne 1997). The dominance of shallow landslides and debris flows in the sediment budget would occur discontinuously in the Nehalem watershed because of the spatial variation in the predicted landslide and debris flow potential (e.g., Figure D-61). Shallow landslides and debris flows may dominate the sediment sources primarily in the western portion of the study area and locally in other areas predicted to have relatively high landslide and debris flow potential.

The ODF mapping of large, deep-seated landslides (Figure D-62, Appendix D) suggests this form of mass failure is a relatively insignificant contributor to sediment supply in the study area. Moreover, because of the low temporal frequency of such large and deep failures, the majority is presumed to be old and hence, should not represent a significant contribution to the sediment budget. Undoubtedly, small deep-seated failures exist in the Nehalem watershed that were not mapped because of dense forest cover. It is possible deep-seated slides, including small ones that border many headwater streams, may locally be a significant component of the sediment budget. If improved methods of mapping reveal additional deep seated failures, such large slides may become a significant source of sediment. However, the relative importance of deep-seated failures likely depends on the subbasin of interest. For example, the landslide and debris flow models that were run in the Nehalem watershed show a pronounced gradient characterized by a high potential of debris flows in the southwestern section of the study area with declining potential towards the northeast (see Figure 59 in the Slope Stability Assessment Sections). Consequently, the relative importance of deep-seated failures may follow this gradient, but in reverse. The highest relative importance of deep-seated slides may occur in the northeast with declining potential towards the southwest.

Soil creep, a process that can comprise rheological soil creep, animal burrowing, and tree throw, has been estimated to vary from approximately 1 mm/yr to 1 cm/yr in various parts of the central Oregon Coast Range (Dietrich and Dunne 1978, Reneau and Dietrich 1991, Benda and Dunne 1997). Although these values come from steep hollow topography, the values provide a rough order of magnitude bracket for soil creek. The values do not apply to toes of deep-seated slides which may have higher rates of soil creep. Even with such soil creep rates, sediment budgets in the central Oregon Coast Range concluded shallow failures and debris flows dominate the erosion regime (in steep, mass wasting prone landscapes). One reason for this finding is sediment introduced by soil creep into first- and second-order channels (comprising 70% to 80% of the entire network) is subsequently removed by debris flow and hence becomes part of the debris flow component of the sediment budget. Thus, the sediment source analysis concentrates on large, fish-bearing channels (i.e., third- and higher-order channels) since the focus is on impacts to high quality aquatic habitats. In areas where small headwater streams are not prone to debris flows (in significant areas of the Nehalem study area, see Appendix D, Figures D-8 to D-59), soil creep may become significantly more important and approach 10 percent or more of the total sediment supply to large channels.

Shallow failures in inner gorges may also be a dominant component of the sediment budget in some areas of the Nehalem where steep slopes abut channels, particularly along headwater streams that comprise approximately 70-80% of the cumulative channel length. In addition to post-fire accelerated landsliding in the Oregon Coast Range (Benda and Dunne 1997), increased surface erosion following fire may account for at least 50% of the long-term sediment yield (Roering and Gerber 2005). The process of wildfire erosion was not investigated during the Nehalem watershed analysis since it would require sophisticated computer simulation modeling and recent fires were limited to Quartz and McGregor management areas.

In summary, in certain portions of the study area, such as along the western margin, shallow landslides and debris flows likely dominate the supply of sediment to large fish-bearing streams and rivers. Inner gorge slides are also likely important in certain areas. Soil creep is probably minimal. In other, less highly dissected and lower gradient portions of the Nehalem Project Area (northern and eastern portions), the role of shallow slides and debris flows is probably diminished (< 50%) with soil creep becoming more important. Over the entire area, post fire erosion is probably significant and may dominate the erosion regime in the form of landslides, debris flows, inner gorge failures, surface erosion, and gullying over the long term (i.e., centuries). All of the erosion processes mentioned contain both coarse and fine sediments. Analysis of colluvium in the central Oregon Coast Range indicates that fine sediment (sand size and less) can comprise up to 30 to 40% (by weight) of samples (Benda and Dunne 1997). Moreover, the attrition of gravel during fluvial transport will also generate large volumes of fine sediments.

13.2.2 Additional Information Needs

The sediment budget for the Nehalem watershed, and hence the comparative analysis of different sediment sources, can only be inferred from terrain information (i.e., slope, landslide, and debris flow predictions) and from other erosion studies conduced in the Oregon Coast Range. To obtain a more quantitative and accurate estimate of the various rates of erosion in the Nehalem watershed would require additional aerial photograph interpretation and field surveys. For example, historical aerial photograph analysis could be used to estimate landslide and debris flow rates (#/time/area). Field surveys could estimate the average volume of sediment associated with landslides and debris flows. Field surveys should also be used to document the spatial frequency and size of streamside landslides. Surveys of channels could be used to measure bank erosion over some elapsed time period. To obtain estimates of the erosion regime in the Nehalem watershed over a large temporal scale (centuries), computer simulation models could be used to estimate landslides and debris flows associated with periodic fires and large storms.

13.3 STEEP SLOPES LIKELY TO PROVIDE FUTURE IN-STREAM KEY PIECES OF LARGE WOOD TO DEBRIS FLOW PRONE CHANNELS

An empirically-calibrated debris flow model was used to investigate which hillslopes would likely provide future in-stream large wood to debris flow prone channels; see Appendix D, Figures D-8 to D–59 for each of the 13 management basins, organized by HUC 6th-field watersheds. The mapped debris flow corridors are those predicted to deliver to fish-bearing streams, defined as channels less than 12%. The debris flow model, including the prediction of wood delivery to fish-bearing channels, is explained in detail in the Assessment Section and in associated Appendix D (that describes the model in greater detail). The 12% cutoff is based empirically on the comprehensive landslide and debris flow inventory in the central Oregon Coast Range (Robison et al. 1995). In general, most of the Nehalem watershed has a limited ability to deliver wood to fish-bearing channels by debris flow because of the overall low potential for shallow failures and debris flows. The highest potential for wood delivery from debris flows exists in the southwest corner of the study area.

14. ROAD MANAGEMENT

The following questions were addressed to help identify road related factors that may limit PFC's in the Upper Nehalem Project Area:

1. *Which roads need review by ODF for repair and why? What are the specific locations of the road issues?*
2. *What road segments should be considered by ODF for vacation or relocation and why?*
3. *Which stream crossings identified in the assessment phase, including fish passage barriers and crossings in poor condition, should be considered for replacement?*

14.1 ROAD CONDITION

Road condition in the Upper Nehalem Project Area was in overall good condition, with few isolated problems. Road drainage, prism condition, and critical location of roads in the project area were all assessed to be in good condition based on the 2005 RIMS surveys. Approximately 98% of road drainage was functioning properly or has only minor impairment, while 97% of road prisms were in proper condition or had only minor surface erosion (Chapter 8). In addition, the vast majority of roads (94%) were identified to be in non-critical location, with no inherent resource risk (Chapter 8). A limited number of isolated road sections identified to be in need of repair are described below.

Based on surveys of stream sediment composition by Kavanagh et al. (2005), overall levels of fine sediment in the project area rate fair to good in comparison to unmanaged reference reaches (see Section11.2). However, several streams within the project area were identified to have high fine sediment levels in need of improvement. These stream reaches with sediment concern are described in Section 11.2. The high levels of fine sediment in stream reaches in the project area are likely due in part to the influence of underlying sedimentary material in the study area (see Section 2.12). Given the level of fine sediments present naturally in stream channels, it is assumed additional inputs from roads should be avoided.

The level of sediment delivery to the stream from roads in the project area was presumed to be relatively low based on the present condition of forest roads (see Chapter 8). Based on road surveys conducted in 2005 (RIMS), the percentage of road length that is stream adjacent (9%)

and hydrologically connected to the stream network (16%) in the project area was low. In addition, minimal road length (0.26 mile) was identified to be in sidecast/fill and fill slide condition during the 2005 road surveys.

Road segments in the project area in need of repair and vacation or relocation were identified based primarily on road drainage condition, road prism condition, hydrologic connectivity of the road drainage to the stream network, critical road location and proximity to streams with sediment level concerns. Roads were secondarily sorted based on the location of the segment within Salmon Anchor Habitat (SAH). Based on the SAH strategy, roads in SAH were high priority for repair and improvement to minimize potential sediment delivery to streams. Salmon Anchor Habitat within the project area includes HUC's #171002020205 (Fishhawk Creek), #171002020304 (Buster Creek), and #171002020101 (Lousignont Creek).

14.1.1 Road Repair

A total of 85 road segments in the project area were identified and prioritized for on-site review for possible repair projects (Table 14-1). Road segments in need of repair were prioritized into three categories based on the following criteria:

1a – Road segments with prism Attention Priority (AP) code 1, sidecast/fill or fill slides, or stream in ditch critical location and hydrologic connectivity to the stream network.

1b – Roads with drainage AP code 1 and hydrologic connectivity.

1c – Road segments with prism AP code 2 and hydrologic connectivity.

1d – Roads with drainage AP code 2 and hydrologic connectivity.

2a – Roads with prism AP code 3 and hydrologic connectivity.

2b – Roads greater than 0.25 mile in length with hydrologic connectivity, and proximal to streams with sediment concerns.

2c – Roads greater than 0.50 mile in length with hydrologic connectivity.

3a – Roads with prism AP code 1, sidecast/fill or fill slides, or stream in ditch critical location and hydrologically disconnected.

3b – Roads with drainage AP code 1 and hydrologically disconnected.

3c – Roads with prism AP code 2 and hydrologically disconnected.

3d – Roads with drainage AP code 2 and hydrologically disconnected.

No roads with prism AP code 1 were identified in the project area.

Table 14-1. Road sections in the Upper Nehalem project area prioritized for repair based on road drainage and prism Attention Priority (AP) codes, hydrologic connection of road drainage, road critical location, location within Salmon Anchor Habitat (SAH), and proximity to streams with sediment concern.

Management Basin	Road Name	Segment Location (Road Mile)	Segment Length (Mi)	Drainage AP Code[1]	Prism AP Code[2]	Critical Location[3]	Hydrologic Connection	SAH[4]	Sediment Concern
Lousignot	Vesper Spur 16850[5]	0.08	0.02	-	2	FS	Y	Y	N
Beneke	Beneke Vacated 1	0.45	0.03	-	-	FS	Y	N	N
McGregor	Lower Rock Creek	0.54	0.11	-	3	CT	Y	N	N
McGregor	Olson	1.49	0.03	-	-	SD	Y	N	N
Wheeler	South Lousignont	2.32	0.25	1	-	-	Y	Y	Y
Wilark	Little Clatskanie[5]	0.38	0.01	1	-	-	Y	N	N
Wheeler	Shields Spur 1.57 Mile	0.93	0.31	2	3	-	Y	Y	N
Quartz	Sterling Ranch 1005	0	0.17	2	-	-	Y	Y	N
Buster	Osweg 2010	0	0.08	2	-	-	Y	N	N
Wheeler	Shields Spur 1.57 Mile	1.40	0.31	-	3	-	Y	Y	N
Wheeler	BC 1.95	1.22	0.22	-	3	-	Y	Y	N
Wheeler	Shields Spur 1.72 Mile	0.48	0.20	-	3	-	Y	Y	N
Wheeler	Shields Spur 1.72 Mile	0.25	0.10	-	3	-	Y	Y	N
Quartz	Sterling Ranch 9010	0	0.07	-	3	-	Y	Y	N
Hamilton	Tidewater Loop 120	0	0.86	-	3	SP	Y	N	N
Beneke	Tidewater Loop 20	0.71	0.19	-	3	SP	Y	N	N

Table 14-1. Road sections in the Upper Nehalem project area prioritized for repair based on road drainage and prism Attention Priority (AP) codes, hydrologic connection of road drainage, road critical location, location within Salmon Anchor Habitat (SAH), and proximity to streams with sediment concern.

Management Basin	Road Name	Segment Location (Road Mile)	Segment Length (Mi)	Drainage AP Code[1]	Prism AP Code[2]	Critical Location[3]	Hydrologic Connection	SAH[4]	Sediment Concern
Buster	Osweg 20	0.03	0.12	-	3	-	Y	N	Y
Hamilton	Ebsen 10	0.86	0.09	-	3	SP	Y	N	N
Hamilton	Fishhawk Creek 05	0	0.09	-	3	-	Y	N	N
Hamilton	Tidewater Loop 135	0.63	0.09	-	3	-	Y	N	N
Hamilton	Tidewater Loop 135	0.96	0.06	-	3	SP	Y	N	N
Northrup	Northrup Creek 20	0.35	0.05	-	3	-	Y	N	N
Hamilton	Tidewater Loop	0.36	0.54	-	3	-	Y	N	N
Beneke	Wild Goose Ridge 60	0.96	0.22	-	3	-	Y	N	N
Hamilton	Fishhawk Creek 1020	0	0.13	-	3	-	Y	N	N
Northrup	Foster 300	0.13	0.13	-	3	-	Y	N	N
McGregro	No Fo	2.89	0.12	-	3	SF	Y	N	N
Sager	Jones 10	0.59	0.10	-	3	-	Y	N	N
Quartz	Lost Lake	3.33	0.10	-	3	-	Y	N	N
Hamilton	Tidewater Loop 110[5]	0.85	0.09	-	3	-	Y	N	N
Beneke	Wild Goose Ridge 60	0.81	0.08	-	3	-	Y	N	N
Quartz	Lost Lake	4.47	0.06	-	3	-	Y	N	N

Table 14-1. Road sections in the Upper Nehalem project area prioritized for repair based on road drainage and prism Attention Priority (AP) codes, hydrologic connection of road drainage, road critical location, location within Salmon Anchor Habitat (SAH), and proximity to streams with sediment concern.

Management Basin	Road Name	Segment Location (Road Mile)	Segment Length (Mi)	Drainage AP Code[1]	Prism AP Code[2]	Critical Location[3]	Hydrologic Connection	SAH[4]	Sediment Concern
Buster	Green Mountain	5.11	0.06	-	3	-	Y	N	N
Quartz	August Fire	3.02	0.06	-	3	-	Y	N	N
Beneke	Wild Goose Ridge 60	0.64	0.05	-	3	-	Y	N	N
Hamilton	Tidewater Loop	0.98	0.05	-	3	-	Y	N	N
Beneke	Foster 16010	0.40	0.04	-	3	-	Y	N	N
Quartz	Sterling Ridge 60	0.53	0.04	-	3	-	Y	N	N
McGregor	Music	1.69	0.03	-	3	SF	Y	N	N
Buster	Osweg 3010	0.04	0.03	-	3	SF	Y	N	N
Wheeler	Clarkson Cr Spur 0.44 mi.	0.21	0.73	-	-	SP	Y	Y	Y
Fishhawk	Fishhawk Loop	3.33	0.69	-	-	-	Y	Y	Y
Wheeler	Section 10	0	0.52	-	-	SP	Y	Y	Y
Wheeler	Marshall	0.03	0.51	-	-	SP	Y	Y	Y
Wheeler	Clarkson Creek	0	0.45	-	-	SP	Y	Y	N
Wheeler	Clarkson Creek	1.02	0.41	-	-	-	Y	Y	Y
Beneke	Wild Goose Ridge 20[5]	1.81	0.31	-	-	-	Y	Y	N
Wheeler	Voltaire	0	0.30	-	-	-	Y	Y	N

Table 14-1. Road sections in the Upper Nehalem project area prioritized for repair based on road drainage and prism Attention Priority (AP) codes, hydrologic connection of road drainage, road critical location, location within Salmon Anchor Habitat (SAH), and proximity to streams with sediment concern.

Management Basin	Road Name	Segment Location (Road Mile)	Segment Length (Mi)	Drainage AP Code[1]	Prism AP Code[2]	Critical Location[3]	Hydrologic Connection	SAH[4]	Sediment Concern
Wheeler	Derby Ridge	0.96	0.28	-	-	SP	Y	Y	N
Buster	Nettle Creek 30	0	0.26	-	-	-	Y	Y	N
Buster	Buster Creek	6.13	0.50	-	-	-	Y	N	N
Hamilton	Ebsen 1010	0	0.46	-	-	-	Y	N	N
Northrup	Northrup Creek	1.78	0.45	-	-	-	Y	N	N
Buster	Buster Creek	5.50	0.41	-	-	SP	Y	N	N
Sager	Deep Creek Relocated	0.98	0.40	-	-	SP	Y	N	N
Beneke	Beneke Vacated 1[5]	0.14	0.39	-	-	SF	Y	N	N
Buster	Grasslands 20	0.21	0.34	-	-	-	Y	N	N
Northrup	Northrup Creek	0.77	0.34	-	-	-	Y	N	N
Hamilton	Ebsen 10	0.37	0.33	-	-	SP	Y	N	N
Sager	Sager Creek	0.38	0.28	-	-	SP	Y	N	Y
Buster	Soak Alley	0.38	0.25	-	-	-	Y	N	N
Northrup	Northrup Creek	0.44	0.24	-	-	SP	Y	N	N
Buster	Buster Creek	6.70	0.24	-	-	-	Y	N	Y
Beneke	Beneke Vacated 1	0.56	0.23	-	-	SP	Y	N	N

Table 14-1. Road sections in the Upper Nehalem project area prioritized for repair based on road drainage and prism Attention Priority (AP) codes, hydrologic connection of road drainage, road critical location, location within Salmon Anchor Habitat (SAH), and proximity to streams with sediment concern.

Management Basin	Road Name	Segment Location (Road Mile)	Segment Length (Mi)	Drainage AP Code[1]	Prism AP Code[2]	Critical Location[3]	Hydrologic Connection	SAH[4]	Sediment Concern
Buster	Wage[5]	2.64	0.17	-	-	SP	Y	N	N
Buster	Stanley Creek	0	0.12	-	-	-	Y	N	Y
Buster	Buster Creek	1.71	0.88	-	-	SP	Y	Y	N
Hamilton	Tidewater Loop 80[5]	0	0.55	-	-	SP	Y	N	N
Hamilton	Tidewater Loop	2.10	0.83	-	-	SP	Y	N	N
Wheeler	SB 0.13	0	1.05	-	-	-	N	N	N
Wheeler	Ingersol Spur 1.64 mile	0	0.08	-	2	-	N	Y	N
Sager	East Sager Vacated 3	0.23	0.10	-	-	FS	N	N	Y
Crawford	Crawford Ridge 14010[5]	1.21	0.02	-	-	CT	N	N	N
McGregor	Music[5]	1.91	0.05	-	2	SP, SF	N	N	N
McGregor	McGregor	6.15	0.02	-	-	-	N	N	N
Quartz	Lost Lake 12020	0	0.03	-	-	-	N	N	N
Sager	Walker Ridge 40	0	0.15	2	-	-	N	Y	N
Wheeler	Morgan Cr. Spur 0.67 mi.	0.38	0.09	2	-	-	N	Y	N
Quartz	Lost Lake 180	0.05	0.21	2	3	SF	N	N	N
Buster	Walker Ridge 10	0	0.13	2	-	-	N	N	N

Table 14-1. Road sections in the Upper Nehalem project area prioritized for repair based on road drainage and prism Attention Priority (AP) codes, hydrologic connection of road drainage, road critical location, location within Salmon Anchor Habitat (SAH), and proximity to streams with sediment concern.

Management Basin	Road Name	Segment Location (Road Mile)	Segment Length (Mi)	Drainage AP Code[1]	Prism AP Code[2]	Critical Location[3]	Hydrologic Connection	SAH[4]	Sediment Concern
Northrup	Foster 50	0.04	0.22	2	-	-	N	N	N
Northrup	Bovine 160	0.10	0.26	2	-	-	N	N	N
Quartz	Lost Lake 140	0.27	0.03	2	-	-	N	N	N
Quartz	Lost Lake 110	0.05	0.06	2	-	-	N	N	N
Quartz	Lost Lake 10	0	0.27	2	-	-	N	N	N

1 Only Drainage AP codes 1 and 2 are considered in this prioritization; AP codes 3-5 are not identified.

AP Code 1 indicates surface water is causing severe erosion of road prism and needs immediate attention.

AP Code 2 indicates surface water is causing moderate erosion of road or onto steep fill

2 Only Prism AP codes 1-3 are considered in this prioritization; AP codes 4 and 5 are not identified.

AP Code 1 does not exist in the project area.

AP Code 2 indicates arcuate cracks or other landslide is present reducing road width and drop on outside edge of road.

AP Code 3 indicates serious surface erosion or minor cutback slump.

3 Critical road locations identified include sidecast/fill slides (CT), fill slides (FS), stream in ditch (SD), stream parallel (SP), and steep fill (SF).

4 Salmon Anchor Habitats in the project area include HUC's #171002020304 (Buster Cr.), #171002020205 (Fishhawk Cr.), #171002020101 (Lousignont Cr.), and #171002020105 (Upper Rock Cr.)

5 Road segment also contains culvert in need of replacement or repair.

Traffic intensity on forest roads within the project area was not considered in the road repair analysis. Traffic intensity can potentially have a significant impact on road condition and subsequent fine sediment delivery to streams. However, it can be difficult to quantify, as the level of travel on individual road segments fluctuates greatly due to forest harvest and management practices. Monitoring of traffic levels on roads segments identified as higher priority for repair may be warranted in order to prevent sediment delivery to streams.

14.1.2 Road Vacation

In order to identify roads in need of vacation or relocation, roads were analyzed using the same set of criteria described in Section 1.4.1.1. Road segments with multiple poor condition factors were considered for vacation and relocation. No road segments in need of vacation or relocation were observed in the Upper Nehalem Project Area.

14.2 STREAM CROSSING CONDITION

Maintaining proper stream crossing condition is critical to maintaining fish passage and preserving road fill condition at the crossing site. Based on 2005 RIMS surveys, present condition of stream crossings on the Upper Nehalem Project Area was good (see Chapter 8). A total of 720 stream crossings exist in the Upper Nehalem Project Area, of which only three were identified to be barriers on known fish bearing streams (Table 8-9). No washouts of stream crossings were identified during the 2005 surveys, however eight sites were determined to be at high risk of washout (Table 8-10).

Stream crossings were prioritized for replacement and repair based on fish passage restrictions in known fish bearing streams, crossing AP code, and washout hazard rating. Crossings were secondarily sorted based on location of the crossing within SAH and proximity of the crossing to streams with sediment concern.

Crossings with fish passage restrictions on streams with likely fish presence were identified so that fish presence surveys can be conducted to verify fish presence. Streams with likely fish presence include streams with habitat suitable for fish presence, but for which no fish presence survey has been conducted.

14.2.1 Stream Crossing Replacement

A total of five stream crossings were identified for consideration of replacement within the project area (Table 14-2). While it is likely most of the crossings identified will require replacement, it is recommended that further field assessment of these crossings is conducted, as it is possible that a portion may only require retrofitting. Stream crossings to be considered for replacement were prioritized based on the following criteria:

1 – Crossings that restrict adult fish passage on known fish bearing streams.

2 – Crossings with AP Code 1 and high washout risk.

3 – Crossings with AP Code 2 and high washout risk.

No adult fish passage barriers on known fish bearing streams exist in the project area.

Table 14-2. Streams crossings in the Upper Nehalem project area prioritized for replacement based on crossing Attention Priority (AP) code, washout hazard rating, location in Salmon Anchor Habitats (SAH), and proximity to streams with sediment concern.

Management Basin	Road Name	Crossing Location (Road Mile)	AP Code[1]	Washout Hazard Rating	SAH[2]	Sediment Concern
Buster	Grasslands	4.50	1	H	Y	N
Wilark	Little Clatskanie	0.38	1	H	N	N
Buster	Osweg 10	0.28	2	H	N	N
Sager	Grand Rapids 601030	0.19	2	H	N	N
Hamilton	Tidewater Loop	3.49	2	H	N	N

1 Only AP codes 1 or 2 are considered in this prioritization; AP codes 3-5 are not identified.
AP code 1 indicates the crossing is in failure
AP code 2 indicates the crossing is nearing failure.

2 Salmon Anchor Habitats in the project area include HUC's #171002020304 (Buster Cr.), #171002020205 (Fishhawk Cr.), #171002020101 (Lousignont Cr.), and #171002020105 (Upper Rock Cr.).

14.2.2 Stream Crossing Repair

A total of 27 stream crossings were prioritized for repair in the project area, and will likely require retrofitting in order to function properly (Table 14-3). Prioritization of stream crossing repair was based on the following criteria:

1 – Crossings that restrict juvenile fish passage on known fish bearing streams.

2 – Crossings with high washout risk.

3 – Crossings with AP code 1 and moderate washout risk.

4 – Crossings with AP code 2 and moderate washout risk.

5 – Crossings with AP code 1 and low washout risk.

6 – Crossings with AP code 2 and low washout risk.

Table 14-3. Streams crossings in the Upper Nehalem project area prioritized for repair based on fish passage condition, crossing Attention Priority (AP) code, washout hazard rating, location in Salmon Anchor Habitats (SAH), and proximity to streams with sediment concern.

			Fish Passage					
Management Basin	**Road Name**	**Crossing Location (Road Mile)**	**Known Juvenile Barrier**	**Stream Length Upstream of Barrier (Mi)[1]**	**AP Code[2]**	**Washout Hazard Rating**	**SAH[3]**	**Sediment Concern**
Wilark	Oak Ranch	0.12	Y	14.41	-	L	N	N
Wheeler	North Lousignont	4.41	Y	3.7	-	L	Y	Y
Buster	Grasslands 20	0.49	Y	0.5	-	L	Y	N
Lousignot	Vesper Spur 16850	0.09	-	-	-	H	Y	N
Beneke	Beneke Vacated 1	0.30	-	-	-	H	Y	N
Sager	Deep Creek	0.21	-	-	-	H	N	N
Hamilton	Tidewater Loop Spur A	0.56	-	-	1	M	N	N
Hamilton	Tidewater Loop 80	0.25	-	-	1	M	N	N
Wheeler	Section 10	1.53	-	-	2	M	Y	N
Buster	Grand Rapids	1.53	-	-	2	M	Y	N
Hamilton	Ebsen	0.19	-	-	2	M	Y	N
Hamilton	Wooden	0.07	-	-	2	M	Y	N
Northrup	Foster 2010	0.47	-	-	2	M	Y	N
Lousignot	Vesper Spur 16850	0.44	-	-	2	M	N	N
Buster	Osweg 1010	0.04	-	-	2	M	N	N
Beneke	Sarajarvie Creek	0.33	-	-	2	M	N	N
Buster	Osweg 10	0.37	-	-	2	M	N	N
Crawford	Crawford Ridge 14010	0.75	-	-	2	M	N	N

Table 14-3. Streams crossings in the Upper Nehalem project area prioritized for repair based on fish passage condition, crossing Attention Priority (AP) code, washout hazard rating, location in Salmon Anchor Habitats (SAH), and proximity to streams with sediment concern.

			Fish Passage					
Management Basin	**Road Name**	**Crossing Location (Road Mile)**	**Known Juvenile Barrier**	**Stream Length Upstream of Barrier (Mi)[1]**	**AP Code[2]**	**Washout Hazard Rating**	**SAH[3]**	**Sediment Concern**
Hamilton	Fishhawk Creek 1010	0.03	-	-	2	M	N	N
Hamilton	Tidewater Loop 110	0.79	-	-	2	M	N	N
Hamilton	Tidewater Loop 80	0.18	-	-	2	M	N	N
Hamilton	West Tidewater	0.72	-	-	2	M	N	N
McGregor	Music	2.03	-	-	2	M	N	N
Buster	Wage 90 Vacated	0.14	-	-	2	L	Y	N
McGregor	Pit	0.97	-	-	2	L	Y	N
Sager	Walker Ridge	1.96	-	-	2	L	Y	N
Sager	West Sager Creek 120	0.17	-	-	2	L	N	N

1 The stream length upstream of barriers represents stream mileage up to the current upstream extent of passage on each stream.

2 Only AP codes 1 or 2 are considered in this prioritization; AP codes 3-5 are not identified.
AP code 1 indicates the crossing is in failure
AP code 2 indicates the crossing is nearing failure.

3 Salmon Anchor Habitats in the project area include HUC's #171002020304 (Buster Cr.), #171002020205 (Fishhawk Cr.), #171002020101 (Lousignont Cr.), and #171002020105 (Upper Rock Cr.).

14.2.3 Fish Presence Verification

A total of 25 stream crossings were identified to restrict adult and juvenile fish passage on streams with likely fish presence (Table 14-4). Likely fish presence indicates that a stream exhibits habitat conditions determined likely to support fish populations, but fish presence surveys have not yet been conducted on the stream. Likely barrier crossings were not prioritized other than by passage restriction type.

Table 14-4. Streams crossings in the Upper Nehalem project area identified as adult and juvenile barriers on streams with likely fish presence and their presence in Salmon Anchor Habitats (SAH).

Management Basin	Road Name	Crossing Location (Road Mile)	Likely Fish Barrier Type	SAH[1]
Wheeler	Clarkson Creek	0.96	Adult/Juvenile	Y
Wheeler	Fire Road 1	1.19	Adult/Juvenile	Y
Wheeler	Salmonberry	0.07	Adult/Juvenile	N
Quartz	August Fire	3.48	Adult/Juvenile	N
Buster	Soak Alley 20	0.42	Adult/Juvenile	N
Crawford	Squaw Creek	1.29	Adult/Juvenile	N
Hamilton	Tidewater Loop	2.57	Adult/Juvenile	N
Hamilton	Tidewater Loop	3.49	Adult/Juvenile	N
Hamilton	Wooden 10	0.02	Adult/Juvenile	N
Hamilton	West Tidewater	0.01	Adult/Juvenile	N
Wheeler	Clarkson Creek	1.02	Juvenile	Y
Wheeler	Marshall	0.03	Juvenile	Y
Wheeler	South Lousignont	2.98	Juvenile	Y
Wheeler	Round Top	0.57	Juvenile	Y
Quartz	Sterling Ranch	0.79	Juvenile	Y
Quartz	Sterling Ranch 10	0.18	Juvenile	Y
Buster	Nettle Creek	1.06	Juvenile	Y

Table 14-4. Streams crossings in the Upper Nehalem project area identified as adult and juvenile barriers on streams with likely fish presence and their presence in Salmon Anchor Habitats (SAH).

Management Basin	Road Name	Crossing Location (Road Mile)	Likely Fish Barrier Type	SAH[1]
McGregor	North Fork Wolf Creek	3.16	Juvenile	N
Hamilton	Fishhawk 10	0.06	Juvenile	N
Beneke	Sarajarvie Creek 40	0.70	Juvenile	N
Beneke	Sarajarvie Creek 40	.028	Juvenile	N
Beneke	Wild Goose Ridge 20	2.27	Juvenile	N
Northrup	Northrup Creek	1.92	Juvenile	N
Wilark	Beaver Home	0.05	Juvenile	N
Wilark	Beaver Home	0.52	Juvenile	N

1 The stream length upstream of barriers represents stream mileage up to the current upstream extent of passage on each stream.

2 Only AP codes 1 or 2 are considered in this prioritization; AP codes 3-5 are not identified.

AP code 1 indicates the crossing is in failure

AP code 2 indicates the crossing is nearing failure.

3 Salmon Anchor Habitats in the project area include HUC's #171002020304 (Buster Cr.), #171002020205 (Fishhawk Cr.), #171002020101 (Lousignont Cr.), and #171002020105 (Upper Rock Cr.).

15. SUMMARY/SYNTHESIS

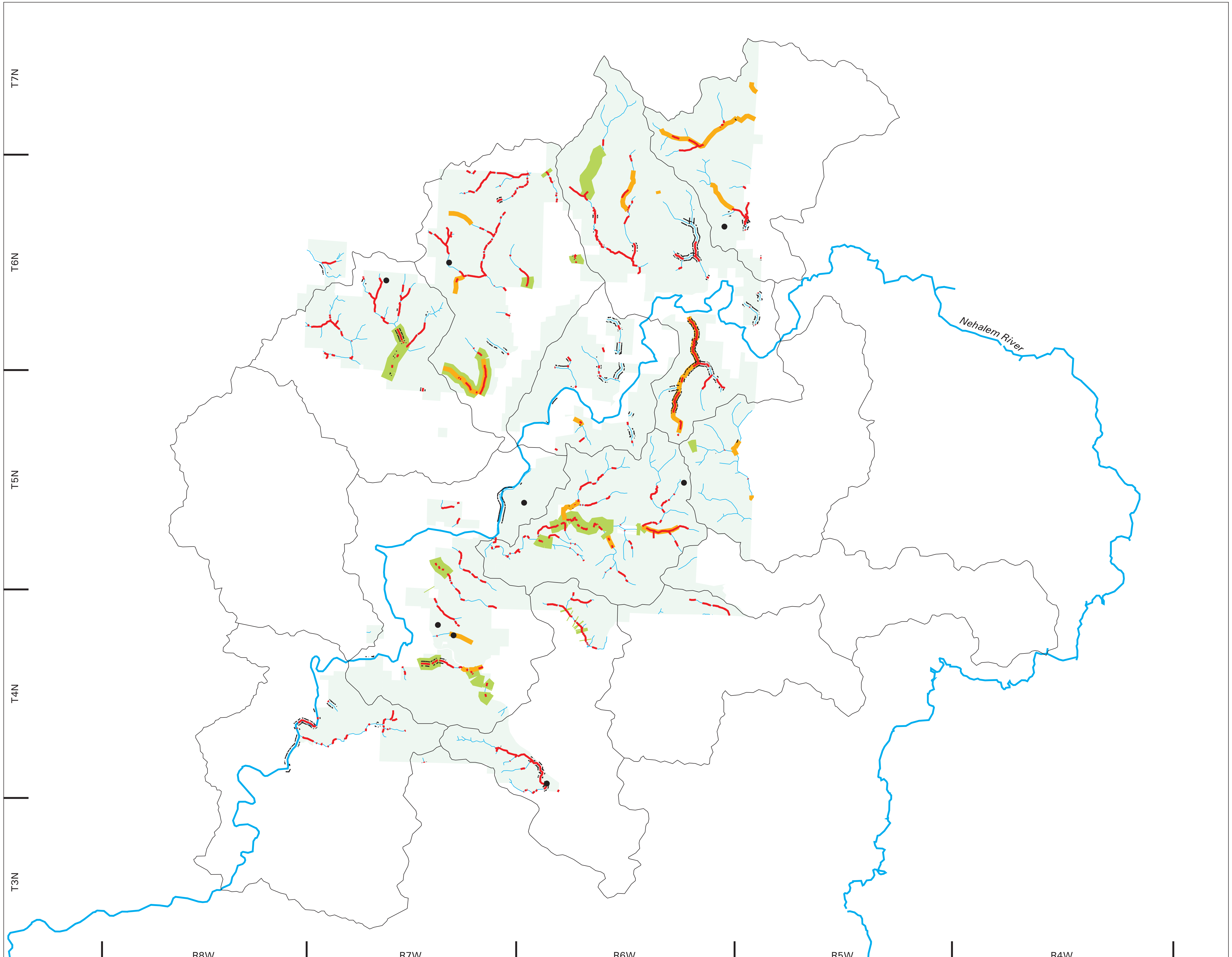
The summary portion of the Watershed Analysis document addresses habitat conditions described in the assessment and analysis phases (Parts I and II) as they relate to the utility and quality of aquatic and riparian habitat. This chapter subsequently addresses forest management considerations to facilitate attaining desired future habitat conditions in a timely fashion. The Summary Section is organized: (1) to identify areas where resource conditions were consistent with the range of variation typically found under natural disturbance regimes for the watershed (defined in the Northwest Oregon Forest Management Plan [NW FMP; ODF 2001] as properly functioning habitat conditions (PFC); (2) to anticipate where conditions in the basin were on a likely trajectory to achieve PFC in a timely fashion under future FMP or SAH management scenarios; and (3) to assess what factors or physical processes in the basin may be limiting the ability to readily achieve PFC.

The information generated within the individual disciplines (e.g., sediment sources, water quality, fish habitat, etc.) was combined to synthesize how management projects to improve habitat conditions should be prioritized. Conclusions for each of the scientific disciplines have been provided in the individual Chapters in the Assessment and Analysis including Hydrology (Chapter 5), Riparian (Chapter 6), Non-road sediment sources (Chapter 7), Road sediment sources (Chapter 8), Water Quality (Chapter 9) and Fish Habitat (Chapter 10). Analyses and a discussion of watershed processes affecting fish habitat are summarized in Limiting Factors (Chapter 11).

Deliverability of input variables (including fine and coarse sediment, heat, and large wood) to the stream channel network and public resources was evaluated to determine if the resource situation was expected to differ from representative conditions under natural disturbance regimes for the watershed (PFC). Specific reach locations where conditions were identified as needing improvement or potentially limiting achievement of PFC were identified as an area of resource sensitivity (ARS) if a link from management activities on the hillslope to aquatic resources in the channel network could be delineated (Figures 15-1a,b).

15.1 MANAGEMENT CONSIDERATIONS

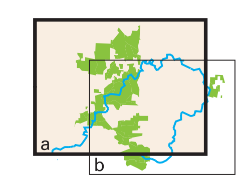
Overall, ODF lands in the upper Nehalem watershed are being managed effectively to address key issues affecting water quality and aquatic life. ODF has a well-designed road system and most human-induced fish barriers have been addressed. Where timber harvest occurs, wide riparian management areas are left along all fish-bearing and perennial flowing streams in



Legend

- ● Road Repair
- Low Key Piece Size Large Wood (less than 0.5 pieces/100 meters)
- High Fine Sediment Deposition (fines > 30%)
- Moderate to High Probability Risk of Achieving PFC for Water Temperature
- Low Wood Recruitment Potential
- Fish Bearing Stream
- Major River
- Project Area
- 6th Field HUC (171002020109)

Map Key



1 Inch = 2.7 Miles

0 2

Miles

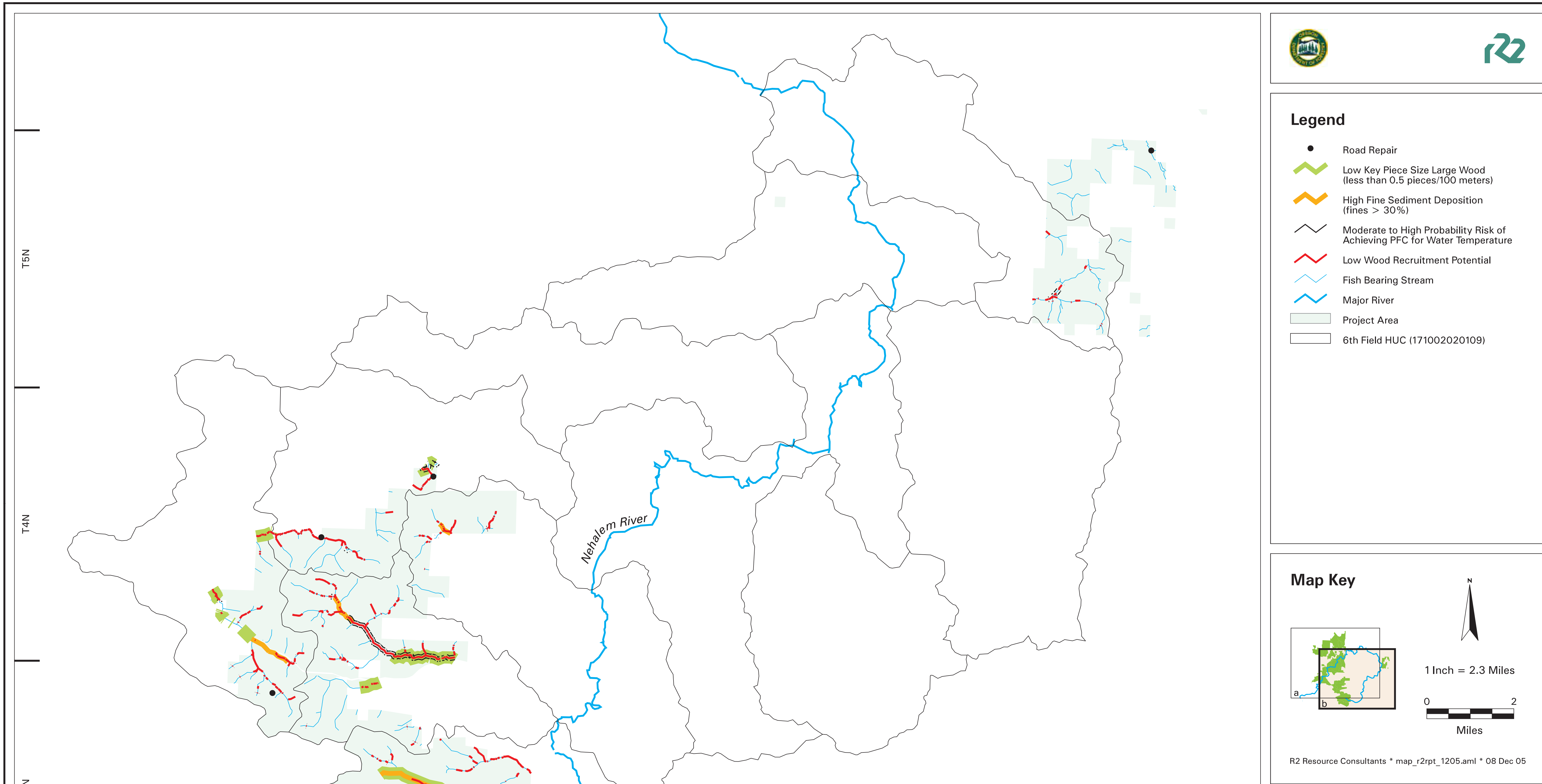
R2 Resource Consultants * map_r2rpt_1205.aml * 08 Dec 05

Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 15-1(a)

Areas of Resource Sensitivity

Astoria District



Oregon Department of Forestry
Upper Nehalem Watershed Analysis

Figure 15-1(b)

Areas of Resource Sensitivity

Forest Grove District

accordance with NW FMP and SAH strategies. Prior forest practices have adversely influenced water quality and aquatic life. Information from this analysis provides a framework for understanding both positive and negative aspects of current management on the landscape. It also helps identify opportunities to protect and improve stream and riparian habitats.

The discussion under "Management Considerations" addresses the suite of recommendations for alternative measures and prioritizes the actions with respect to the greatest perceived potential influence on aquatic and riparian resources in the upper Nehalem watershed (Table 15-1). The priority scheme includes numeric codes from 1 to 4 representing the highest to lowest priority. Each of the watershed analysts has independently designed an appropriate priority system specific to evaluate the habitat factor of interest. In this section, the priorities are combined and based on our professional opinion we have integrated the independent scales to generate the effort resulting in the likely greatest benefit to the resources. Where priorities are equal, we gave greater weighting to recommended measures along streams located in SAH sub-watersheds, since they have been designed to protect critical anadromous salmonid habitats with an objective of improving habitat conditions in a 10-year period.

The following management considerations represent strategies to achieve and maintain PFC for aquatic and riparian resources that are not anticipated to occur under the current management strategies for the NW FMP and for SAHs.

15.1.1 In-Channel Habitat Conditions:

Channel habitat data collected under ODFW's aquatic inventory project (AIP) indicated site-specific reaches: (1) lacking key piece-size large wood (> 24 in. diameter) and (2) where fine sediment levels exceeded an estimate of historic sediment loading under routine channel conditions (Figure 15-1a,b). Although sources and management considerations for sediment and wood in the watershed are discussed separately below, they work cooperatively together in the channel to form or modify aquatic habitats.

Large Wood: Areas shown on Figure 15-1a,b where in-channel wood was currently low, combined with riparian characteristics that offered low long-term recruitment potential represent locations in the watershed where opportunities exist for the addition of log structures or boulder clusters to enhance habitat complexity. Specific areas were identified where both ARS features overlapped and short-term and long-term restoration recommendations based on specific riparian stand situations [**#1 Vegetation Composition**: Riparian zone dominated by bare ground, grasses, shrubs; **#2 Riparian Structures/Development**: Encroachment of road and rail line

Table 15-1. Potential sites for management activities in the Upper Nehalem Watershed ranked according to priority level.

Management						
District	**Basin**	**Stream**	**Resource Factor**	**Reach Location**	**Priority**	**Issue to Address**
Astoria						
	Beneke					
		Beneke Cr.	Stream Crossing	Beneke Vacated 1 @ 0.30	1	High washout hazard
		Gilmore Cr.	Large Wood		2	Low in-stream wood; low recruitment potential scenario #3b, 4.
		Gilmore Cr. Tributary A	Large Wood		2	Low in-stream wood; low recruitment potential scenario #3b, 4.
	Buster	Unnamed Trib to Walker Cr.	Fish Passage Barrier	RM 0.2; Grasslands 20 @ mile 0.49	1	Juvenile barrier blocking 0.5 miles; replacement; sediment concern; SAH
		Buster Creek	Large Wood		1	Low in-stream wood; low recruitment potential scenario #3a, 3b, 4; SAH
		Osweg Cr.	Stream Crossing	Osweg 10 @ mile 0.28	3	AP code 2 with high washout hazard; low sediment concern
	Fishhawk	Fishhawk Cr.	Water Temperature	Fishhawk Lake to Confluence	4	Shallow reservoir heating; not forest management related.
		Warner Cr.	Water Temperature	Warner Creek Confluence	2	Based on stream length influenced; Riparian Restoration Strategy #4
	Hamilton	Hamilton Cr.	Large Wood		3	Low in-stream wood; low recruitment potential scenario #3b, 4.
			Stream Crossing	Tidewater Loop @ mile 3.49	2	AP code 2 with high washout hazard; low sediment concern
	Lousignot		Stream Crossing	Vesper Spur 16850 @ mile 0.09	1	High washout hazard; sediment concern

Table 15-1. Potential sites for management activities in the Upper Nehalem Watershed ranked according to priority level.

District	Management Basin	Stream	Resource Factor	Reach Location	Priority	Issue to Address
	Northrup	Northrup Cr.	Large Wood	RM 4.0	3	Low in-stream wood; low recruitment potential scenario #4 - hardwood; headwater location
		Cow Cr.	Fine Sediment	ODFW Reach 28	4	1.6 mi., (high fines, but no obvious management sources)
	Quartz	Rock Cr.	Water Temperature	RM 26.5 - 27.0	1	0.5 mi. Riparian Restoration Scenarios #1, 2, 4; SAH
		Klines Cr.	Large Wood	0.6 mi.	3	Low in-stream wood; low recruitment potential scenario #4 - hardwood
		Quartz Cr.	Large Wood		3	Low in-stream wood; low recruitment potential scenario #4 - hardwood
		Quartz Cr.	Water Temperature		2	0.8 mi. Riparian restoration strategy #4.
		Mainstem Nehalem River	Water Temperature	Near Spruce Run Cr. Confluence	4	2.0 mi. Riparian restoration strategy #3b, 4
	Sager	Sager Creek	Fine Sediment	Sager Cr. Road @ mile 0.38	2	0.28 mi. parallel road, hydrological connection; sediment sources
		Sager Creek	Water Temperature		2	0.5 mi. Riparian Restoration Scenarios #3a – Sparse Hardwood;
		Deep Creek	Stream Crossing	Deep Creek @ mile 0.21	1	High washout hazard
			Stream Crossing	Grand Rapids 601030 @ mile 0.19	3	AP code 2 with high washout hazard; low sediment concern
Forest Grove						
	McGregor	NF Wolf Cr.	Large Wood		2	Low in-stream wood; low recruitment

Table 15-1. Potential sites for management activities in the Upper Nehalem Watershed ranked according to priority level.

Management						
District	**Basin**	**Stream**	**Resource Factor**	**Reach Location**	**Priority**	**Issue to Address**
						potential scenario #4 - hardwood
		Bear Creek Trib to SF Rock Cr.	Fine Sediment	Section 10 Road @ mile 3.33	2	0.52 mi. Stream parallel road; hydrological connection sediment sources; SAH
		SF Rock Creek	Large Wood		1	Low in-stream wood; low recruitment potential scenario #4 - hardwood; SAH
	Wheeler	Unnamed Trib. to Lousignont Cr.	Fish Passage Barrier	RM 0.5; North Lousignont @ 4.4	1	Juvenile barrier blocking 3.7 miles; sediment concern; SAH
		Lousignont Cr.	Water Temperature		1	0.4 mi. riparian restoration scenario #1; SAH
		Lousignont Cr.	Large Wood		1	Low in-stream wood; low recruitment potential scenario #1, 2, 4; SAH
		Lousignont Cr.	Fine Sediment	Marshall Road mile 0.03	2	0.51 mi. Stream parallel road; hydrological connection sediment sources; SAH
		Carlson Cr. trib to Lousignont Cr.	Fine Sediment	Clarkson Creek road mile 1.02; Clarkson Cr. Spur 0.44 mi at road mile 0.21	2	1.14 mi. Stream parallel roads; hydrological connection; sediment sources; SAH
		Doty Cr.	Water Temperature		2	0.1 mi. riparian restoration scenario #4; SAH but small stream length influenced
		Upper Nehalem River	Large Wood		1	Low in-stream wood; low recruitment potential scenario #1, 3b, 4; SAH
		SF Nehalem River	Fine Sediment	ODFW Reach 154	4	0.5 mi. (Fines); SAH: but no obvious management sources
	Wilark	Oak Ranch Cr.	Fish Passage Barrier	RM 7.0; Oak Ranch @	1	Juvenile barrier blocking 14.4 miles

Table 15-1. Potential sites for management activities in the Upper Nehalem Watershed ranked according to priority level.

Management						
District	**Basin**	**Stream**	**Resource Factor**	**Reach Location**	**Priority**	**Issue to Address**
				0.12 mi.		
		Little Clatskanie River	Stream Crossing	Little Clatskanie @ 0.38 mi.	2	AP code 1 with high washout hazard; low sediment concern

structures within the 100-ft riparian zone; **#3 Sparse Levels of Stocking in Stands**: Sparse hardwood, mixed species and conifer stands that preclude development of a second cohort; and **#4 Hardwood Senescence**: Dense hardwood stands (HMD and HSD) that become sparse due to future mortality, yet preclude development of a second cohort] were identified (Figure 12-2). Streams with riparian restoration recommendations are listed below.

1) Headwaters of Nehalem River
    a. Short-term: Wood placement
    b. Long-term: Riparian Restoration Scenarios #1, 3b, 4
    c. Priority: (1) based on SAH sub-watershed

2) Buster Creek
    a. Short-term: Wood placement
    b. Long-term: Riparian Restoration Scenarios #3a, 3b, 4
    c. Priority: (1) based on SAH sub-watershed

3) SF Rock Creek
    a. Short-term: Wood placement
    b. Long-term: Riparian Restoration Scenarios #4
    c. Priority: (1) based on SAH sub-watershed

4) Lousignont Creek
    a. Short-term: Wood placement
    b. Long-term: Riparian Restoration Scenarios #1, 2, 4
    c. Priority: (1) based on SAH sub-watershed

5) Gilmore Creek and Gilmore Tributary A
    a. Short-term: Wood placement
    b. Long-term: Riparian Restoration Scenarios #3b, 4
    c. Priority: (2) based on length of channels in low condition

6) NF Wolf Creek
    a. Short-term: Wood placement
    b. Long-term: Riparian Restoration Scenarios #4
    c. Priority: (2) based on length of channel in low condition

7) Mainstem Hamilton Creek:
    a. Short-term: Wood placement
    b. Long-term: Riparian Restoration Scenarios #3b, 4
    c. Priority: (3) based on small area influenced

8) Northrup Creek
    a. Short-term: Wood placement
    b. Long-term: Riparian Restoration Scenarios #4
    c. Priority: (3) based on small area influenced

9) Klines Creek
    a. Short-term: Wood placement
    b. Long-term: Riparian Restoration Scenarios #4
    c. Priority: (3) based on small area influenced

10) Quartz Creek
    a. Short-term: Wood placement
    b. Long-term: Riparian Restoration Scenarios #4
    c. Priority: (3) based on small area influenced

ODF and ODFW have a long history of cooperatively performing in-stream enhancement projects to improve habitat complexity. The working procedures from both agencies should be used to facilitate such projects based on the priority status included above.

Fine Sediment: Specific channel reaches shown on Figure 15-1a,b where instream fine sediment levels (> 2mm size fractions) exceeded estimates of historic sediment loading in combination with ODF hydrologically-connected roads that offered a potential sediment concern (Table 14-1) represent locations in the watershed where opportunities exist for source reductions from road surfaces. Specific areas where both ARS features overlap and potential restoration recommendations have been identified and prioritized in Chapter 14 and are summarized below. All of these situations, with the exception of Sager Creek, are included in Salmon Anchor Habitat sub-watersheds and received a top priority for road attention.

1) Bear Creek (Tributary to SF Rock Creek)
    a. Road Name: Section 10
    b. Segment length: 0.52 mi., stream parallel
    c. Priority: 2 – based on segment length, hydrological connection, and proximity to sediment concern and SAH location

2) Lousignont Creek
    a. Road Name: Marshall
    b. Segment length: 0.51 mi., stream parallel
    c. Priority: 2 – based on segment length, hydrological connection, and proximity to sediment concern and SAH location

3) Carlson Creek (Tributary to Lousignont Creek)
    a. Road Name: Clarkson Creek Spur 0.44 mi.
    b. Segment length: 0.73 mi., stream parallel
    c. Priority: 2 – based on segment length, hydrological connection, and proximity to sediment concern and SAH location

4) Carlson Creek (Tributary to Lousignont Creek)
    a. Road Name: Clarkson Creek
    b. Segment length: 0.41 mi.
    c. Priority: 2 – based on segment length, hydrological connection, and proximity to sediment concern and SAH location

5) Sager Creek
    a. Road Name: Sager Creek
    b. Segment length: 0.28 mi., stream parallel
    c. Priority: 2 – based on segment length, hydrological connection, and proximity to sediment concern

ODF should also consider implementing restoration opportunities listed in the ODFW habitat survey report (as cited in Kavanagh et al. 2005) as per the reaches in Table 15-2.

15.1.2 Alternative Vegetation Management

The following alternative vegetation management strategies were discussed in Chapter 12 to address specific riparian stand characteristics that were not anticipated to achieve PFC in a 100-year time frame.

The recommendations for alternative vegetation management were specific to stand situations predicted to inhibit development of PFC under the proposed management scenarios (Figure 12-2a,b).

Vegetation Composition: Riparian zone dominated by bare ground, grasses, shrubs.

Riparian Structures/Development: Encroachment of road and rail line structures within the 100-ft riparian zone.

Table 15-2. Potential enhancement sites for the Upper Nehalem Watershed ranked according to ODFW habitat priority level.

Stream Name	Length (m)	Length (ft)	Channel Size	Priority	Access	Habitat Survey	Field Verified	ODF District	Potential Project Extent: From	To	Resource Concern	Miles Affected
South Fork Rock Creek	2200	7216	Medium	1	H	yes	X	FG	HWY 26	Shields Rd	Large wood	0.8
South Fork Rock Creek	1780	5840	Medium	1	H	yes	X	FG	Mouth	HWY 26		
Olson Creek	1274	4178	Medium	2	M		X	FG	Rock Creek	End of Coho		
Rock Creek	1832	6010	Large	2	M	yes	X	FG	North Fork Rock Creek	TJ/		
Rock Creek Trib C	401	1317	Medium	2	M		X	AST	Rock Creek	End of Coho	Replaced culverts	1.5
Wolf Creek	5200	17057	Large	2	H		X	FG	Nehalem River	North Fork Wolf Creek		
Wolf Creek	1429	4867	Medium	2	M		X	FG	North Fork Wolf Creek	Wolf Creek Falls		
North Fork Wolf Creek	4213	13820	Medium	2	M	yes	X	FG	Wolf Creek	End of Coho	Large wood	1.0
North Fork Wolf South Trib	1602	5253	Medium	2	U			FG	North Fork Wolf Creek	Endo of Coho		
North Fork Wolf Creek Trib B	1375	4512	Medium	2	M			FG	North Fork Wolf Creek	End of Coho		
North Fork Wolf Creek Trib B	86	281	Medium	2	M			FG	North Fork Wolf Creek	End of Coho		
Lousignont Creek (Timber)	1998	6555	Medium	2	M	yes	X	FG	Carlson Creek	End of Coho	Large wood	2.0
Lousignont Creek (Timber)	1704	5588	Medium	2	H	yes	X	FG	Carlson Creek	End of Coho	Large wood	
North Fork Lousignont Creek	3402	11159	Medium	2	M		X	FG	Lousignont Creek	Endo of Coho		
South Fork Lousignont Trib A	1104	3622	Medium	2	U			FG	South Fork Lousignont Creek	End of Coho		
Nehalem River	2158	7077	Medium	2	M	yes	X	FG	Hans Creek	End of Coho		
South Fork Nehalem River	1343	4405	Medium	2	M	yes	X	FG	Hans Creek	End of Coho		
Step Creek	536	1758	Medium	2	M		X	FG	Nehalem River	End of Coho		
Nehalem River	422	1385	Medium	3	L	yes	X	FG	Hans Creek	Endo of Coho (Doty Pond?)		

Table 15-2. Potential enhancement sites for the Upper Nehalem Watershed ranked according to ODFW habitat priority level.

									Potential Project Extent			
Stream Name	Length (m)	Length (ft)	Channel Size	Priority	Access	Habitat Survey	Field Verified	ODF District	From	To	Resource Concern	Miles Affected
Upper Nehalem River Trib B	598	1963	Medium	3	L			FG	Nehalem River	End of Coho		
Selder Creek	1859	6099	Medium	4	N			AST	Rock Creek	End of Coho		
Olson Creek	832	2730	Medium	4	N		X	FG	Rock Creek	End of Coho		
North Fork Rock Creek	1950	6395	Medium	4	N	yes	X	AST	Large TJ/	End of Coho		
North Fork Rock Creek Trib B	1096	3596	Medium	4	N			AST	Mouth	Endo of Coho		
South Fork Rock Creek	1001	3284	Medium	4	N	yes	X	FG	Above Shields Rd	End of Coho		
Bear Creek (Rock Creek)	1622	5319	Medium	4	H	yes	X	FG	South Fork Rock Creek	End of Coho		
North Fork Wolf Creek	1429	4688	Medium	4	N	yes	X	FG	Wolf Creek	End of Coho		
Lousignont Creek (Timber)	1528	5013	Medium	4	N	yes	X	FG	North Fork Lousignont Creek	Carlson Creek		
Carlson Creek	1567	5138	Medium	4	M	yes	X	FG	South Fork Lousignont Creek	End of Coho		
Carlson Creek	914	2999	Medium	4	N	yes	X	FG	South Fork Lousignont Creek	End of Coho		
Nehalem River	6869	22530	Large	4	U			FG	Castor Creek	Step Creek		
Nehalem River	756	2480	Large	4	M	yes	X	FG	Step Creek	Hans Creek		
Nehalem River	972	3189	Large	4	M	yes	X	FG	Step Creek	Hans Creek		
Nehalem River	1500	4918	Medium	4	N	yes	X	FG	Step Creek	Hans Creek		
Nehalem River	875	2869	Medium	4	N	yes	X	FG	Hans Creek	End of Coho (Doty Pond?)		
Step Creek	972	3189	Medium	4	N			FG	Nehalem river	End of Coho		
Derby Creek	280	917	Medium	4	N			FG	Nehalem River	End of Coho		
East Humbug Creek	3428	11245	Medium	1	H		X	AST	1st Rd X-ing	End of Road Access		
Buster Creek	1789	5866	Medium	1	H		X	AST	Walker Creek	Stanley Creek		
Buster Creek	3280	10758	Medium	1	H		X	AST	Stanley Creek	End of Road Access		
Walker Creek	5892	19326	Medium	1	H	yes	X	AST	2nd Walker CR RD X-ing	End of Road Access	Culvert replaced	0.1
East Humbug Creek	1738	5699	Medium	2	U			AST	End of Road Access	End of Coho		
Quartz Creek	1985	6511	Medium	2	U	yes		AST	Nehalem River	High Gradient Reach		

Table 15-2. Potential enhancement sites for the Upper Nehalem Watershed ranked according to ODFW habitat priority level.

									Potential Project Extent			
Stream Name	Length (m)	Length (ft)	Channel Size	Priority	Access	Habitat Survey	Field Verified	ODF District	From	To	Resource Concern	Miles Affected
										Below S FK		
SF Quartz Creek			Medium									
Moores Creek	655	2150	Medium	2	H	yes			Nehalem River	End of Coho	Culv. Removed, road vacated	0.2
Buster Creek	888	2914	Medium	2	M		X	AST	End of Lower Rd Access	End of Coho	Culvert replaced	1.0
Walker Creek (Buster Creek)	1253	4111	Medium	2	M		X	AST	Buster Creek	TJ Upstream of Wage Rd		
Stanley Creek	1259	4131	Medium	2	U			AST	Buster Creek	End of Coho		
Hamilton Creek	3399	11149	Medium	2	M	yes	X	AST	Fishhawk Creek	End of Road Access	Culvert replaced	1.9
Grub Creek	950	3115	Medium	2	U			AST	Nehalem River	End of Coho		
Squaw Creek	4495	14745	Medium	2	U			AST	Nehalem River	End of Coho	Culvert removed	1.1
West Branch Squaw Creek	1248	4095	Medium	2	U			AST	Squaw Creek	End of Coho		
Northrup Creek	709	2324	Medium	2	H		X	AST	ODF Boundary	Cow Creek	Culvert replaced	0.2
Northrup Creek	5912	19391	Medium	2	M		X	AST	Cow Creek	End of Coho	Large wood	1.5
Sager Creek	2513	8241	Medium	2	M	yes	X	AST	Nehalem River	East Sager Creek		
East Sager Creek	1696	5564	Medium	2	M		X	AST	Sager Creek	End of Coho	Culv. Removed, road vacated	1.0
Deep Creek	403	1322	Medium	2	U		X	AST	TJ AT T6N-R6W-12	End of Coho		
Deep Creek	3099	10165	Medium	2	U	yes		AST	TJ/ AT T5N-R5W 19NW	TJ at End of Deep Creek Rd		
Deep Creek Trib C	402	1319	Medium	2	U			AST	TJ AT T6N-R6W-12	End of Coho		

Table 15-2. Potential enhancement sites for the Upper Nehalem Watershed ranked according to ODFW habitat priority level.

									Potential Project Extent			
Stream Name	Length (m)	Length (ft)	Channel Size	Priority	Access	Habitat Survey	Field Verified	ODF District	From	To	Resource Concern	Miles Affected
Warner Creek	1515	4970	Medium	2	U	yes		AST	Fishhawk Creek	End of Coho	Culvert replaced	2.5
Buster Creek Trib A	167	547	Medium	3	H			AST	Buster Creek	End of Coho	Culver replaced	0.3
Beneke Creek	1609	5279	Medium	3	L		X	AST	Bull Heifer Creek	TJ AT T6N-R7W-11C		
Cow Creek	2908	9537	Medium	3	H		X	AST	Northrup Creek	200M above Cow Cr Road	Culverts replaced	3.9
Cow Creek (Vinemaple)	1383	4537	Medium	4	N	yes	X	AST	End of Road Access	End of Coho (falls)		
Klines Creek (South)	1107	3630	Medium	4	N	yes	X	AST	Nehalem River	End of Coho		
Buster Creek	3844	12607	Large	4	U		X	AST	Nehalem River	/TJ AT T5N-R6W-30NW		
Buster Creek	2783	9128	Medium	4	N		X	AST	End of Lower Rd Access	End of Coho		
Buster Creek Trib B	1908	6257	Medium	4	N			AST	Buster Creek	End of Coho		
Buster Creek Trib C	1077	3532	Medium	4	N			AST	Buster Creek	End of Coho (below Rd x-ing)		
Walker Creek (Buster Creek)	2014	6606	Medium	4	N		X	AST	Walker Creek	End of Coho		
Walker Creek (Buster Creek) Trib	1473	4832	Medium	4	N		X	AST	Walker Creek	End of Coho		
Hamilton Creek	2302	7551	Medium	4	N	yes	X	AST	End of Road Access	End of Coho		
Beneke Creek	5163	16934	Large	4	H	yes	X	AST	Gilmore Creek	Walker Creek		
Beneke Creek	1600	5249	Medium	4	N			AST	End of Road Access	Bull Heifer Creek		
Bull Heifer Creek	500	1640	Medium	4	N			AST	Beneke Creek	End of Coho		
Beneke Creek	222	729	Medium	4	N			AST	Bull Heifer Creek	TJ AT T6N-R7W-11C		
Gilmore Creek			Medium									
Gilmore Creek Trib A	1929	6326	Medium	4	N			AST	Gilmore Creek	End of Coho		
Trailover Creek	1645	5395	Medium	4	N	yes		AST	Walker Creek	End of Coho		
Walker Creek	2712	8896	Medium	4	N			AST	/TJ AT T5N-R6W-20	End of Coho		
Walker Creek	6001	19682	Medium	4	N	yes	X	AST	End of Road Access	End of Coho		

Table 15-2. Potential enhancement sites for the Upper Nehalem Watershed ranked according to ODFW habitat priority level.

Stream Name	Length (m)	Length (ft)	Channel Size	Priority	Access	Habitat Survey	Field Verified	ODF District	Potential Project Extent: From	Potential Project Extent: To	Resource Concern	Miles Affected
Crawford Creek	1343	4403	Medium	4	N			AST	Nehalem River	End of Coho		
Grub Creek	1336	4383	Medium	4	N			AST	Nehalem River	End of Coho		
Nehalem River Trib B	756	2478	Medium	4	N			AST	Nehalem River	End of Coho		
Northrup Creek	576	1889	Medium	4	N		X	AST	Cow Creek	End of Coho		
Cow Creek	1907	6256	Medium	4	N		X	AST	200M above Cow Cr Rd	End of Coho		
Sager Creek	2854	9360	Medium	4	N	yes	X	AST	East Sager Creek	End of Coho		
Lousignont Creek (Birkenfeld)	4233	13884	Medium	4	N			AST	Nehalem River	End of Coho		
Deep Creek	1287	4223	Medium	4	N			AST	TJ AT T6N-R6W-12	End of Coho		
Deep Creek Trib B	3179	10427	Medium	4	N			AST	Deep Creek	End of Coho		
Deep Creek Trib C	804	2638	Medium	4	N			AST	TJ AT T6N-R6W-12	End of Coho		
Fishhawk Creek (Birkenfeld)	3116	10222	Large	4	H		X	AST	End of Ag Land Use	Fishhawk Lake	Off Channel, Riparian, Culvert	0.4
Warner Creek	680	2232	Medium	4	N	yes		AST	Fishhawk Creek	End of Coho		
Slaughters Creek	1536	5039	Medium	4	U			AST	Nehalem River	End of Coho		
West Branch Squaw Creek	635	2083	Medium	4	N			AST	Squaw Creek	End of Coho		
Oak Ranch Creek	3287	10781	Medium	1	H	yes	X	FG	Rock Pit above Apiary Rd X	Camp Wilkerson		
Oak Ranch Creek	2502	8207	Medium	2	U	yes	X	FG	Camp Wilkerson	TJ AT T5N-R3W-21NW		
Oak Ranch Creek	1518	4979	Medium	2	U			FG	TJ AT T5N-R3W-21NW	End of Coho		
Oak Ranch Creek	902	2957	Medium	4	N		X	FG	Camp Wilkerson	TJ AT T5N-R3W-21NW		
Pebble Creek	2162	7091	Medium	4	N		X	FG	West Fork Pebble Creek	End of Coho		
Dell Creek	1810	5936	Medium	4	N	yes		FG	Pebble Creek	End of Coho		
Nettle Creek												
Osweg Creek												

Sparse Levels of Stocking in Stands: Sparse hardwood, mixed species and conifer stands that preclude development of a second cohort.

Hardwood Senescence: Dense hardwood stands (Riparian codes HMD and HSD) that become sparse due to future mortality, yet preclude development of a second cohort.

Large Wood: Areas shown on Figure 15-1a,b where in-channel wood was low in combination with riparian characteristics that offered low wood recruitment potential were addressed in Section 15.1.1 above.

Shade/Water Temperature: Locations on ODF lands in the watershed where opportunities exist for the alternative vegetation measures to address a moderate to high probability of not achieving PFC for water temperature in 100 years are shown on Figures 12-3a,b. Long-term restoration recommendations for key areas based on stream length and specific riparian stand situations are listed below and in Table 15-1. The recommendations of appropriate management actions per riparian stand scenario have been outlined in Section 12.1.3.

1) Doty Creek (Tributary to upper Nehalem River)
    a. Long-term: Riparian Restoration Scenarios #4 – Hardwood
    b. Priority: (1) based on SAH sub-watershed

2) Lousignont Creek (downstream of Carlson Creek)
    a. Long-term: Riparian Restoration Scenarios #1 – Shrub, grasses
    b. Priority: (1) based on SAH sub-watershed

3) Upper Rock Creek
    a. Long-term: Riparian Restoration Scenarios #1, 2, 4
    b. Priority: (1) based on SAH sub-watershed

4) Sager Creek
    a. Long-term: Riparian Restoration Scenarios #3a – Sparse Hardwood
    b. Priority: (2) based on stream length influenced

5) Warner Creek (Tributary to Fishhawk Cr.)
    a. Long-term: Riparian Restoration Scenarios #4 - Hardwood
    b. Priority: (2) based on stream length influenced

6) Quartz Creek
    a. Long-term: Riparian Restoration Scenarios #4 - Hardwood
    b. Priority: (2) based on stream length influenced

7) Mainstem Nehalem River (near confluence of Spruce Run Cr.)
   a. Long-term: Riparian Restoration Scenarios #3b, 4
   b. Priority: (4) channel width, elevation and distance from divide make alternative riparian restoration measures unlikely to modify stream temperatures at this location

Other scattered sections of stream reaches with moderate or high probability of not achieving PFC for water temperature in the 100-year time frame exist throughout the ODF land as shown in Figure 12-3a,b. However, the reaches are of small magnitude and overall they represent a low probability for a measurable influence on aquatic resources in the watershed. Alternative vegetation management measures for these areas are rated with a low priority (4).

Road Management Considerations

ODF road improvements to minimize potential road-related risks to aquatic and riparian resources in the upper Nehalem watershed have been discussed in Chapter 14. A total of 85 road segments, 25 road crossings and 3 fish passage barriers have been prioritized for future management actions. Management actions were prioritized based on ODF road drainage and prism “attention priority” (AP) codes, hydrologic connection of road drainages, critical road locations, proximity to high in-channel sediment loads, stream crossing hazard ratings, washout hazard ratings and fish passage concerns. The highest priority road-related projects have been integrated with other areas of resource sensitivity in Table 15-1.

15.2 CRITICAL QUESTION RESPONSE SUMMARY

OWEB Critical and ODF Supplemental Questions

This Chapter provides a brief summary to the questions used to develop the upper Nehalem Watershed Assessment where feasible. For detailed or lengthy answers, the location within the document where answers can be found is provided.

Historical Assessment

OWEB Critical Questions

1. What were the characteristics of the watershed’s resources at the time of European exploration/settlement?

A discussion of the watershed at the time of European settlement can be found in Section 3.1.1.

2. What are the historical trends and locations of land use and other management impacts in the watershed?
Historic trends in land use and management are discussed in 3.1.4.

3. What are the historical accounts of fish populations and distribution?
An historic account of fish populations can be found in Section 3.1.3

4. Where are the locations of historic floodplain, riparian area, channel, and wetland modifications, and what was the type and extent of the disturbance?
A discussion of historic floodplain and channel modifications can be found in Section 4.3.1. A discussion of historic land clearing for agriculture, timber management can be found in Sections 3.1.2.

ODF Supplemental Questions

1. What are the natural disturbances and their impacts on the aquatic ecosystem prior to and shortly after European Settlement, as well as through recent times?
A discussion of the natural disturbance regime for floods, fires and landslides in the Nehalem River can be found in Section 3.2 and Appendix A.

2. What is the early management history of the forestland in the watershed (this would include things like description of salvage logging or replanting of burned areas?
A discussion of early forest management can be found in Section 3.3.

Stream Channels

OWEB Critical Questions

1. What is the distribution of CHT's throughout the watershed?
Twelve distinct channel habitat types were identified within the upper Nehalem Project Area. These channel Types are depicted in Table 4-1. The distribution of channel types on fish bearing streams within the Upper Nehalem Project Area are depicted in Figure 4-1, Appendix I, and are summarized by management basin in Table 4-5.

2. What is the location of CHT's that are likely to provide specific aquatic habitat features?
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).

3. What is the location of areas that may be the most sensitive to changes in the watershed condition?
Channel habitat types and stream sections within each management basin that are likely to be most sensitive to geomorphic inputs are described in Section 4.3.1.

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4. Where are channel modifications located?
Locations of channel modification are described by management basin in Section 4.3.1.

5. Where are historic channel disturbances located (for example: splash dams, stream cleaning)?
Locations of channel modification are described by management basin in Section 4.3.1.

6. What CHT's have been impacted by channel modification?
Channel habitat types that have been impacted by channel modification are described by management basin in Section 4.3.1.

Hydrology and Water Use

OWEB Critical Questions

1. What land uses are present in your watershed?
Land uses present in the four subwatersheds of the Nehalem watershed are detailed in Table 5-3. Forestry is the predominant land use in the project area.

2. What is the flood history in your watershed?
A greater than 200-year recurrence interval flood occurred on the Nehalem River in 1996. The Nehalem River near Foss gage read a maximum of 70,300 cfs on February 8, 1996. Other large floods were recorded in 1990, 1972 and 1964.

3. Is there a probability that land uses in the basin have a significant effect on peak flows?
Based on literature review addressing the relationship between forestry practices and peak flows, some probability exists that land management activities in the Nehalem basin have affected peak flows. Given the paucity of flow data within the project area, we were unable to assess how specific land uses, including ODF forestry practices, may have impacted the hydrology of the Nehalem River.

4. Is there a probability that land uses in the basin have a significant effect on low flows?
Based on literature review addressing the relationship between forestry practices and low flows, some probability exists that land management activities in the Nehalem basin have affected peak flows. Given the paucity of flow data within the project area, we were unable to assess how specific land uses, including ODF forestry practices, may have impacted the hydrology of the Nehalem River.

5. For what beneficial use is water primarily used in your watershed?
Our research identified a total of eight ODF water rights within the management basins that are used for forest management and fire protection and fifteen private water rights for domestic and livestock water supply located within the project area.

6*. Is water derived from a groundwater or surface-water source?*
The majority of water used is derived from surface sources (Table 5-7, 5-8) with the exception of two water rights that identify a spring source.

7. What type of storage has been constructed in the basin?
At the time of this report, there were many other small reservoirs and off-channel ponds located throughout the entire Nehalem watershed. The total storage of water was 1273.6 acre feet. This water was used for recreation (77.5%), fish (15.4%), wildlife (5.2%), irrigation (1.4%), and "other" (fire protection, livestock, domestic/non-commercial). There was also an earth dam on Fishhawk Creek that forms Fishhawk Lake. The dam was privately owned by Fishhawk Lake Recreation Club, Inc. and holds 982 acre feet of water for recreational purposes (Johnson and Maser 2000)

8. Are there any withdrawals of water for use in another basin (interbasin transfers)? Is any water being imported for use in the basin?
We were unable to find any evidence of inter-basin transfer or importation of water within the Project Area.

9. Are there any illegal uses of water occurring in the basin?
We were unable to locate documentation that would allow a determination if illegal uses of water occurred within the project areas.

10. Do water uses in the basin have an effect on peak flows?
The small percentage of agriculture/rangeland and urban area in the Nehalem watershed had a low potential of increasing peak stream flows.

11. Do water uses in the basin have an effect on low flows?
The analysis of water rights indicates that water uses in the basin have the potential to significantly impact low flows.

Riparian Conditions and Wetland

OWEB Critical Questions

1. What are the current conditions of riparian areas in the watershed?
A watershed analysis was completed for the Nehalem watershed by Portland State University (PSU) in 2000 (Johnson and Maser 2000). This assessment performed an inventory of riparian conditions based on 1995 aerial photos. The PSU study determined the Upper Nehalem subwatershed (HUC #1710020201) had two reaches with poor riparian conditions; Weed Creek and South Fork Rock Creek. A number of reaches supported narrow riparian buffers including East Fork Nehalem River, and Lower Rock, Beaver, Kist and Lousignont creeks. The balance of the Upper Nehalem typically supported continuous riparian buffers with young trees. According to the PSU inventory, there were concentrations of riparian buffer in poor condition in the Middle Nehalem subwatershed (HUC #1710020202) along Fishhawk and North Fork Fishhawk creeks and along tributaries of the mainstem Nehalem River. The remainder of the subwatershed consisted primarily of young riparian trees, with approximately 50 percent of the buffer strips less than 30 feet wide and widespread interruptions and discontinuities in vegetation along the stream banks. The PSU inventory concluded poor and fair recruitment potential occurred along approximately 30 percent of the streams in both the Upper and Middle Nehalem subwatersheds.

The Upper Nehalem River Watershed Council (UNWC) subsequently developed detailed GIS coverage of existing riparian polygons of various condition codes based on species composition, average stand size (tree diameters) and relative level of density per the OWEB watershed manual guidelines (Watershed Professionals Network 1999). The existing photo-based inventory quantified current riparian conditions over 305 miles of ODF streams in the Nehalem watershed using 1995 aerial orthophotos. The results were specifically used herein to address the key watershed questions. Current riparian conditions have been summarized for their potential to contribute large wood and shade in Sections 6.1.3 and 6.1.4.

2. How do the current conditions compare to those potentially present or typically present for this ecoregion?
A description of current condition by management basin is presented in Section 6.1.4.1 that compares riparian stand to typical conditions for the ecoregions in the watershed.

3. How can the current riparian areas be grouped within the watershed to increase the understanding of areas needing protection and the appropriate restoration or enhancement opportunities?
Stream reaches needing riparian protection and restoration and enhancement were identified in groups of various stand situations in Chapter 12, as highlighted in Figure 12-2.

4. What is the location and extent of noxious weeds on state forest lands within the watershed?
A discussion of noxious weeds is located in section 6.3.

ODF Supplemental Questions

1. What are the current riparian vegetation characteristics on state forest lands within the watershed?
The data are summarized by riparian stand characteristics for each of the ODF management basins within the upper Nehalem watershed in Section 6.1.4.1 and in Table 6-2. Data are summarized by 6th field HUCs per Management Basin in Appendix B.

2. What riparian areas currently have high, moderate, and low large wood input potential for key conifer pieces (>24-inch conifer)?
Maps of the adequacy of the existing wood recruitment potential from stream adjacent stands are included as Figure 6-1, Appendix I. Specific reaches with low forecasted wood recruitment potential have been identified in Figure 16-1.

3. Which riparian areas will provide high large wood input potential for key conifer pieces under 50- and 100-year scenarios?
The results for potential large wood recruitment are shown in a matrix of stand conditions along a trajectory of 50-yr increments in Table 6-3 and Figures 6-2 and 6-3, Appendix I.

Non-Roads Sediment Sources

ODF Supplemental Questions

1. What is the distribution of slopes prone to shallow, rapidly moving landslides on state forest lands within the watershed?
A detailed discussion on the GIS-based model for landslide potential in the Upper Nehalem watershed is included in Appendix D. A summary description of the model is provided in Section 7.2.1.1. Model predictions referred directly to the likelihood of shallow landsliding on planar and convergent slopes, and on the likelihood of debris flows to scour headwater channels and to deposit sediment and wood into fish bearing channels. Predictions were in terms of landslide density and probability of debris flows.

Maps of the study area and legend for the slope stability and debris flow analysis are shown in Appendix D, Figures D-6 and D-7. The legend is included in Figure 7-1, below. Results of the model predictions for: (1) slope gradient, (2) landslide density, (3) debris flow probability, and (4) debris flow wood recruitment corridors comprise 52 figures and can be found in Appendix D. We selected representative figures to show a range of prediction results. For landslides these data are presented in Figures 7-2 and 7-3.

2. What is the distribution of debris flow-prone channels on state forest lands within the watershed?
The average debris flow probability and debris flow wood delivery corridors can be arrayed according to “likely” through “unlikely” by having those categories span the predicted high – low range of probabilities. Refer to the flowchart in Figure D-5, Appendix D, summarizes a procedure for managing landslide and debris flow risk. This flowchart provides guidance on how to use the four map products developed during this analysis. The maps depicting debris flow-prone channels are shown by management basin in Appendix D. We selected representative figures to show a range of prediction results. For debris flow-prone channels these data are presented in Figure 7-4.

3. Are there locations with gullies or other active surface erosion areas in the watershed?
Based on 2005 road surveys of forest roads in the project area, gullies and other forms of surface erosion was not a significant issue in the Upper Nehalem. Road condition and drainage issues associated with roads are described in Chapter 8, Road-Related Sediments.

4. Are there deep-seated, active, or recently active moving landslides?
The map showing the locations of deep-seated failures in bedrock and hence providing a general guide to this form of mass movement in the Nehalem watershed is Figure D-62 in Appendix D.

5. Are there any unusually prone soils on steep slopes (>79%) in the watershed?
Soil type is likely more important in the process of surface erosion and surface erosion is anticipated to be uncommon in the Nehalem watershed. This assumption is because most forest soils have surface infiltration capacities that exceed rainfall intensities and consequently overland flow is rarely generated.

Road-Related Sediment Sources

ODF Supplemental Questions

1. What proportion of road length is within 100 feet of streams?
Of 607 total miles of forest road in the project area, 53.8 (8.8%) were stream adjacent (Tables 8-1 and 8-2).

2. What proportion of road related drainage ditches are directly connected to the stream network?
Approximately 96 miles, or 15.8 percent, of the total road system had direct hydrological connection to the stream network (Figure 8-1, Appendix I, and Tables 8-3 and 8-4).

3. What roads are in critical locations?
A total of 33.6 miles, or 5.5 percent of forest roads were in critical locations (Table 8-6). The roads with greatest in critical location were Buster Creek Road in the Buster Management Basin, which has 1.76 miles of stream parallel road, and North Lousignont Road in the Wheeler Management Basin, with 1.36 miles of stream parallel and steep fill roads.

4. What roads have road prism instability, including sidecast/fill landslides?
No roads in the project area were identified to have prism AP Code 1. Two road sections are located on sidecast/fill slides: Lower Rock Creek Road and Crawford Ridge 14010. Three road sections were located on fill slides: East Sager Vacated 3, Beneke Vacated 1, and Vesper Spur 16850. See Tables 8-7 and 8-8.

5. How many stream crossings are barriers to fish passage?

A total of three stream crossings were identified as barriers to juvenile fish and occur on known fish bearing streams (Figure 8-3, Appendix I, and Table 8-9).

6. Are road washouts of stream crossing fills present in the project area?
No washouts were present in the project area. A summary of washout risk at stream crossings within the project area is provided in Table 8-10.

7. Do recreation trails contribute to sediment or erosion problems?
The 14.6 miles of hiking and ATV trails in the project area were likely to have minimal erosion related impacts.

8. What proportion of the project area is non-forested due to forest roads?
The total land area dedicated to roads (permanent non-forested) was 1,998 acres, which was approximately 2 percent of the total project area.

Water Quality

OWEB Critical Questions

1. What are the designated beneficial uses of water for the stream segments?
Beneficial uses in the Nehalem River included those necessary to maintain salmonid habitat and aquatic life, domestic water supply, livestock watering, recreation and industrial water supply (Johnson and Maser 2000).

2. What are the water quality criteria that apply to the stream reaches?
Water quality constituents of concerns included temperature, dissolved oxygen, pH, nutrients, bacteria, turbidity and macroinvertebrate communities based on current water quality standards (or benthic indices of biological integrity for macroinvertebrates) for all upper Nehalem stream reaches. See Johnson and Maser 2000 for a detailed water quality analysis. DEQ defined the designated fish use in the Upper Nehalem watershed as “core, cold-water habitat.” Under this designation, the seven-day average maximum temperature (7-Dmax) may not exceed 16.0ºC [60.8ºF]

3. Are stream reaches identified as water quality limited on the 303(d) list by the state?
The mainstem Nehalem River from its mouth to its confluence with Rock Creek near Vernonia, OR was listed as 303(d) water quality limited due to elevated summer water temperatures.

4. Are any stream reaches identified as high-quality waters or Outstanding Resource Waters?
Fish-bearing waters in four 6th field HUCs including Fishhawk, Buster, Upper Rock and Lousignont Creeks have been designated as Salmonid Anchor Habitats (SAHs). Approximately 90 percent of the fish-bearing waters adjacent to ODF lands in the upper Nehalem Watershed currently comply with thermal Properly Functioning Conditions (PFC) defined as reasonably achievable water temperatures given channel locations in the watershed and predicted thermal conditions under natural disturbance regimes.

5. Do water quality studies or evaluations indicate that water quality has been degraded or is limiting the beneficial uses?
Although water quality sampling was limited in the basin, the PSU analysis found no impairments for dissolved oxygen (D.O.), pH, bacteria (as represented by *E. coli*), phosphate, turbidity or contaminants during their data review in 1998 and 1999 in the middle and upper Nehalem Subbasins (Johnson and Maser 2000). The analysis noted elevated levels of nutrients, primarily nitrate, in the fall, winter and spring. However, recent data from the upper basin indicate a low level of nitrates suggesting the nutrient concern is more likely an issue in the lower portions of the basin.

The ranges of available data from the various sites are in line with reasonably achievable levels for all of the parameters in forested mountain streams. The data indicate water quality conditions on ODF lands are good and in accordance with biological use criteria.

ODF Supplemental Questions

1. What stream temperatures are reasonably achievable on State Forests?
Maximum 7-day surface water temperatures under historical reference conditions for the upper Nehalem watershed were modeled based on an assumption of mature forest conditions (MFC) growing adjacent to various stream channel sizes, elevation zones and distances from topographic divides in each subbasin, using the View-to-the-Sky (VTS) model (Appendix 9-2). Reference conifer, mixed and hardwood tree heights were modeled using 100-year site potential tree heights for the ecoregions and soil conditions encompassing the watershed. A VTS sub-routine was used that simulated openings in the riparian forest canopy to account for natural channel disturbances. This approach was included to provide potential variability and ranges to surface water temperatures that may have occurred historically. The resulting thermal regimes were assumed to represent reasonably achievable surface water temperatures consistent with historical conditions under occasional disturbances in mature forest conditions. Results are summarized in Table 11-9 for the lowest elevation stream on ODF lands in each sub-basin.

2. How do the current shade levels along streams compare to historic levels by sub-watershed and stream size?
Comparisons of riparian conditions by management basin per estimates of the historic setting are presented in Section 9.1.3.5. Extrapolations of shade, or the corollary view-to-sky, to water temperature have been made as summarized in Figures 11-4 and 11-5 and in Table 12-4. More than 92 percent of the current riparian shade conditions along fish-bearing waters adjacent to ODF lands offer a low probability of exceeding estimates of historic conditions.

3. How do the current stream temperature levels compare to historic levels by sub-watershed and stream size?
Comparisons of stream temperature by management basin are presented in Section 9.1.3.5. More than 92 percent of the predicted water temperature conditions along fish-bearing waters adjacent to ODF lands offer a low probability of exceeding estimates of historic conditions.

4. How do water temperatures compare to other nearby basins with similar flows and geology?
Water temperatures from nearby basins with comparable elevation, geologies and stream flows including streams in the Wilson and Kilchis River basins as well as streams in unmanaged portions of Nehalem watershed sub-basins are similar to surface water temperature conditions along ODF lands in the Upper Nehalem River (http://deq12.deq. state.or.us/wq/lasar). However, given the inherent variability in site conditions and monitoring records, use of data from nearby unmanaged basins or sub-basins as reference conditions to estimate reasonably achievable surface water temperatures for this watershed analysis was deemed less accurate than use of the VTS model to predict site-specific conditions (Section 9.1.4.2). Use of the VTS model for this purpose was determined to be a reliable approach within the zone where riparian stand characteristics have an influence on surface water temperatures.

Aquatic Resources and Their Habitats

1. What fish species are documented in the watershed? Are any of these currently state or federally listed as endangered, threatened or candidate species? Are there any fish species that historically occurred in the watershed that no longer occur there?
Table 10-1 lists fish species documented in the upper Nehalem River and their current management status. Warm water fish species have been introduced to Fishhawk Lake, near the Fishhawk Management Basin, and it is likely that rainbow trout from stocks outside the Nehalem River watershed have been planted in the basin.

2. What is the distribution, relative abundance and population status of salmonid species in the watershed? What is the distribution of fish species, by life stage, in the watershed?
Information on distribution, abundance, and population status of salmonids is presented in Section 10.3.1.1.

3. Which salmonid species are native to the watershed, and which have been introduced into the watershed?
All of the salmonid species present are native to the watershed. It is likely that rainbow trout from stocks outside the Nehalem River watershed have been planted in the basin.

4. Are there potential interactions between native and introduced species?
No information was available on the interactions between native and introduced fish.

5. What is the condition of the fish habitat in the watershed (by subbasin) according to existing habitat data?
Fish habitat conditions are described in Section 10.3.2.

6. Where are the potential barriers to fish passage? How many miles of fish-bearing streams are blocked by culverts?
A total of three passage barriers were identified on known fish bearing streams in the project area as a result of road crossings

7. What stream reaches have high, moderate, and low level of key pieces of large wood (> 24 inch conifer) in the channel?
The data on large wood are presented in Table 10-2. These data indicated that 61 percent of upper Nehalem surveyed stream reaches had a moderate amount of key large wood, twelve percent of the reaches had high levels of key large wood, and 27 percent had low levels.

8. Did any splash damming occur in the watershed? Where did this splash damming occur? Are the effects still apparent?
There is little documentation that splash damming occurred in and around the Project Area. The location of 11 permanent splash dams located in western Oregon rivers were documented in Hobbs et al. (2002). Three of these dams appeared to be in the upper Nehalem watershed, but there was insufficient detail to determine if they were located within the Project Area.

9. Are the tailed frog and Columbia torrent salamander potential present in the watershed? What are the habitat needs of these species?
Tailed frogs and Columbia torrent salamanders have been documented in the watershed. The findings of this reconnaissance survey indicate that torrent salamanders and tailed frogs occur in most of ODF management basins within the Nehalem watershed. The habitat needs of these species are presented in Sections 10.4.1.2 and 10.4.2.2 and in Table 10-7.

Limiting Factors

ODF Questions

1. Are there sub-watersheds where the current level of in-stream wood is a limiting factor for achieving properly functioning aquatic systems?
The available data on the upper Nehalem River critical wood habitat indicators were within the natural range of variation of wood levels in unmanaged forest streams and other reference values. Thus at a sub-watershed level, Nehalem River aquatic habitat was assessed as currently occurring within PFC. However, there are specific reaches with low levels of wood when compared to reference values (Figure 11-1). Aquatic habitat in these stream reaches could benefit by habitat enhancements that lead to increased levels of wood loading.

2. Are there sub-watersheds were stream sediment deposition (associated with hillslopes and/or erosion) is a limiting factor for achieving properly function aquatic systems?
The available data on the upper Nehalem River substrate habitat indicators are within the natural range of variation of unmanaged forest streams and other reference values. Thus at a sub-watershed level, Nehalem River aquatic habitat was assessed as currently occurring within PFC. However, specific reaches exist with high levels of fines when compared to reference values (Figure 11-2). Aquatic habitats in these stream reaches could benefit by habitat enhancements that lead to reductions in fine sediment and decreased inputs of fines in the future.

3. Given the stream temperatures that are reasonably achievable, what is the likelihood (rate as high, moderate, low, or unknown) that stream temperatures and/or shade conditions are a limiting factor for achieving properly functioning aquatic systems?
Likelihood that stream temperatures currently limit the achievement of PFC for surface water thermal regimes is low as shown in Figures 11-4 and 11-5 and summarized in Tables 11-x; and 12-4.

4. Are there any other conditions limiting the achievement of PFCs?
No other conditions we identified as limiting the achievement of PFC in aquatic habitats surveyed.

Alternative Vegetative Management

ODF Questions

1. *Given current management strategies, which sub-watersheds have aquatic and riparian conditions that have already achieved the PFC?*

Many of the 6th field HUCs and Management Basins are currently predicted to offer riparian conditions characteristic of PFC for large wood recruitment and shade/surface water temperatures (Table 6-2; 9-x; Appendix 9-2; Table 11-10, Table 12-2). Details are summarized in Sections 11.3, 12.1 and 12.2.

Large Wood Recruitment Potential

A discussion of sub-watersheds with a potential to achieved PFC for large wood is provided in Section 12.1.1.1. None of the sub-watersheds currently support riparian conditions consistent with OWEB reference stand conditions PFC for large wood (> 24in. diameter). Based on the estimated natural historic distribution of stand characteristics supporting high, moderate and low recruitment potential of large wood, the Fishhawk Management Basin is currently consistent with PFC and the Buster and Wilark Management Basins are approaching PFC (Table 6-2).

Water Temperature

Currently, all management basins are consistent with PFC for water temperature, as estimated from predicted historic forest-age distributions of young and mature stands, with the exceptions of Lousignot and Crawford Management Basins in the Astoria Forest District.

2. *Which sub-watersheds have aquatic and riparian conditions suitable for the development of the PFC in a 50-yr timeframe? In 100-yr timeframe? Longer than a 100-year timeframe?*

Many of the riparian zones adjacent to fish-bearing waters in the project area are on a trajectory to PFC and should achieve such conditions within a 50-year time frame under proposed management strategies.

Large Wood Recruitment Potential

All of the Management Basins are predicted to exceed conditions consistent with PFC, for large wood recruitment within 50 years with the exception of the Quartz, Sager and Northrup Management Basins in the Astoria Forest District. Discussion of the anticipated distribution of riparian stand conditions in comparison to historic PFC for the 50-, 100- and greater than 100 year time frames is included in Section 12.1.2.

Water Temperature

Discussion of the anticipated distribution of riparian stand conditions in comparison to historic PFC for the 50-, 100- and greater than 100 year time frames is included in Section 12.2.2. Nearly 98 and 97 percent of the fish-bearing stream miles on ODF lands in the upper Nehalem watershed are anticipated to develop sufficient riparian stand characteristics to generate PFC for shade and water temperature in the next 50 and 100 years, respectively. All of the Management Basins are predicted to be consistent with PFC in 50 years with the exception of the Quartz Management Basin.

3. For those sub-watersheds where it will take longer than 100 years to develop the PFC, prioritize by stream reach (and map) for alternative vegetation management to achieve the PFC. Specific stream reaches that are anticipated to exceed PFC distributions of surface water temperatures after 100 years are mapped in Figure 12-3.

Slope Stability

ODF Questions

1. Are there landslide-prone hillslopes that pose a high risk of downstream sediment or scour impacts? If so, identify the specific hillslopes and stream reaches, describe why they pose a high risk to streams, and describe how management will affect possible stream sediment or scour impacts?

Landslide-prone hillslopes that pose a high risk of downstream sediment or scour impacts can be identified based on the slope gradient, landslide density, and debris flow probability maps provided in this section for each of ODF's management areas (see Table 13-1 and Appendix D, Figures D-9 to D-59). The specific stream reaches likely to be impacted can also be identified using the debris flow probability maps (both scour along the predicted paths and deposition at the downstream end of the predicted path). Information was not available to evaluate how forest management will affect debris flow risk and ultimately the ecological condition of channels.

2. *Which of the mechanisms (shallow landslides, deep-seated landslides, and soil creep) provide a substantial source of sediment to streams?*

In certain portions of the study area, such as along the western margin, shallow landslides and debris flows likely dominate the supply of sediment to large fish-bearing streams and rivers. Inner gorge slides are also likely important in certain areas. Soil creep is probably minimal. In other, less highly dissected and lower gradient portions of the Nehalem Project Area (northern and eastern portions), the role of shallow slides and debris flows is probably diminished (< 50%) with soil creep becoming more important. Over the entire area, post fire erosion is probably significant and may dominate the erosion regime in the form of landslides, debris flows, inner gorge failures, surface erosion, and gullying over the long term (i.e., centuries).

3. Which steep slopes will likely provide future in-stream key pieces of large wood to debris flow prone channels?
In general, most of the Nehalem watershed has a limited ability to deliver wood to fish-bearing channels by debris flow because of the overall low potential for shallow failures and debris flows. The highest potential for wood delivery from debris flows exists in the southwest corner of the study area. Results of the debris flow model are presented in Appendix D, Figures D-8 to D–59 for each of the 13 management basins, organized by HUC6th-field watersheds.

Road Management

ODF Questions

1. Which roads need review by ODF for repair and why? What are the specific locations of the road issues?
A total of 85 road segments in the project area were identified and prioritized for repair (Table 14-1).

2. What road segments should be considered by ODF for vacation or relocation and why?
No road segments within the project area were identified in need of vacation or relocation.

3. Which stream crossings identified in the assessment phase, including fish passage barriers and crossings in poor condition, should be considered for replacement?
A total of five stream crossings were identified for consideration of replacement within the project area (Table 14-2).

15.3 DATA GAPS

The following critical data gaps were identified during the upper Nehalem River Watershed Analysis.

1. Riparian Conditions along stream channels within Clatskanie River contiguous parcels.
2. Field surveys are needed to detect deep seated landslides.
3. Detailed site-specific field surveys of steep slopes would be required to determine basin potential and sediment delivery potential of particular areas.
4. More detailed information is needed to assess the effects of nitrate-nitrogen levels in Quartz Creek.

5. Hydrology data gaps identified include forest-specific streamflow data including low flows in managed and non-managed streams.
6. Additional field information is needed to assess wetlands and in the Project Area.
7. Additional field information is needed to assess exotic/invasive plants.
8. Additional site-specific information is required to evaluate the risk posed by debris flows to fish-bearing channels.
9. To evaluate how forest management will affect debris flow risk and ultimately the ecological condition of channels requires additional information on rates and spatial patterns of timber harvest.
10. To estimate how mass wasting would alter channel and valley floor morphology detailed field surveys in landslide and debris flow deposition zones are needed.
11. To obtain a more quantitative and accurate estimate of the various rates of erosion in the Nehalem watershed would require additional aerial photograph interpretation and field surveys.
12. To verify the need for culvert replacements at five road crossings further field assessment of these crossings are needed.

15.4 CONFIDENCE EVALUATION

Multiple sources of evidence were brought forward from each of the modules, leading to the conclusions stated herein. We attempted to use the weight of available evidence in making conclusions when certainty was unclear. The resource analysts have a moderately high level of confidence the location of resource impacts and probable causes were accurately represented via this synthesis section.

The analyst team wishes to re-emphasize that the map products provided herein are a simplified representation of landscape conditions. They should not replace field level determinations of sensitive areas based on the descriptions of landforms and site conditions described in each module.

REFERENCES

Beechie, T. J. and T. H. Sibley. 1997. Relationships between channel characteristics, woody debris, and fish habitat in northwestern Washington streams. Transactions of the American Fisheries Society 126: 217-229.

Beechie, T.J. 1998. Rates and Pathways of Recovery for Sediment Supply and Woody Debris Recruitment in Northwestern Washington Streams and Implications for Salmonid Habitat Restoration. PhD Dissertation. University of Washington. Seattle, Washington.

Benda, L., and T. Dunne. 1997a. Stochastic forcing of sediment supply to channel networks from landsliding and debris flow. Water Resources Research 33:2849-2863.

Benda, L. and T. Dunne. 1997b. Stochastic forcing of sediment routing and storage in channel networks, Water Resources Research, Vol. 33, No. 12 2865-2880.

Bilby, R. E. and J. W. Ward. 1989. Changes in characteristics and function of large woody debris with increasing size of streams in western Washington. Transactions of the American Fishery Society. 118: 368-378.

Dietrich, W.E. and T. Dunne. 1978. Sediment budget for a small catchment in mountainous terrain. Zietshrift für Geomorphologie Suppl. Bd. 29:191-206.

Fox, M.J. 2001. A new look at the quantities and volumes of instream wood in forested basins within Washington State. MS Thesis. College of Forest Resources, University of Washington, Seattle, Washington. 116 p. + app.

Grette, G. B., and E. O. Salo. 1986. The status of anadromous fishes of the Green/Duwamish river system. Prepared for the U.S. Army Corps of Engineers.

Kavanagh, P., K. Jones, C. Stein, and P. Jacobsen. 2005. Fish habitat assessment in the Oregon Department of Forestry mid-Nehalem and Clatskanie study area. Report prepared by the Oregon Department of Fish and Wildlife, Aquatic Inventories Project, Corvallis, Oregon. April 3, 2005. 22 p. + Tables, Figures and Maps.

Kennard P., G.R. Pess, T.J. Beechie, B. Bilby, and D. Berg. 1999. Riparian-in-a-box: A manager's tool to predict the impacts of riparian management on fish habitat. *In* Proceedings of the Forest-Fish Conference: Land Management Practices Affecting Aquatic Ecosystems Calgary, AB May 1-4, 1996, Eds. M.K. Brewin and D.M.A. Monita, Information Report NOR-X-356 Canadian Forest Service-Northern Forestry Centre Alberta, pp. 483-490.

McArdle, R. E., W. H. Meyer, and D. Bruce. 1949. The yield of Douglas-fir in the Pacific Northwest. United States Department of Agriculture Technical Bulletin No. 201. Washington, DC. 74 p.

National Marine Fisheries Service (NMFS). 1999. A guide to biological assessments. Prepared by the National Marine Fisheries Service Washington Habitat Conservation Branch, March 23, 1999. Lacey, Washington. 19 p.

Nickelson, T., J.D. Rodgers, S.L. Johnson, and M. Solazzi. 1992. Seasonal changes in habitat use by juvenile coho salmon (*Oncorhynchus kisutch*) in Oregon coastal streams. Canadian Journal of Fisheries and Aquatic Sciences 49: 783-789

ODF. 2001. Northwest Oregon State Forests Management Plan. Appendix J: Management Standards for Aquatic and Riparian Areas. Oregon Board of Forestry and the Oregon Department of Forestry, Salem, OR.

ODF. 2003. Northwest Oregon State Forests Management Plan. Appendix J: Salmon Anchor Habitat Strategies. Oregon Board of Forestry and the Oregon Department of Forestry, Salem, OR.

OWEB Manual. 1999. (See: Watershed Professionals Network 1999).

Reid, L.M., and T. Dunne. 1996. Rapid Construction of Sediment Budgets for Drainage Basins. Catena-Verlag, Cremlingen, Germany.

Reneau, D. K., and W. E. Dietrich. 1991. Erosion Rates in the Southern Oregon Coast Range: Evidence for an Equilibrium Between Hillslope and Sediment Yield. Earth Surface Processes and Landforms 16:307-322.

Robison, G. E., K. A. Mills, J. Paul, L. Dent, and A. Skaugset. 1999. Storm Impacts and Landslides of 1996: Final Report. Forest Practices Technical Report 4, Oregon Department of Forestry

Roering, J.J., and M. Gerber. 2005. Fire and the evolution of steep, soil-mantled hillslopes. Geology 33:349-352.

Spence, B. C., G. A. Lomnicky, R. M. Hughes, and R. P. Novitzki. 1996. An ecosystem approach to salmonid conservation. TR-4501-96-6057. ManTech Environmental Research Services Corp., Corvallis, Oregon.

U.S. Fish and Wildlife Service (USFWS). 1998. A framework to assist in making Endangered Species Act determinations of effect for individual or grouped actions at the bull trout subpopulation watershed scale. Prepared by the U.S. Fish and Wildlife Service, February 1998, 47 p.

U.S. Forest Service (USFS). 1996. Upper Sandy Watershed Analysis- Mt. Hood National Forest.

Washington Forest Practices Board (WFPB). 1997. Standard methodology for conducting watershed analysis, Version 4.0. Washington Forest Practices Board Manual, prepared by the Washington Department of Natural Resources. Olympia, Washington. November 1997

Watershed Professionals Network. 1999. Oregon Watershed Assessment Manual. Developed for the Governor's Watershed Enhancement Board. Salem, Oregon.