FISH HABITAT ASSESSMENT IN THE OREGON DEPARTMENT OF FORESTRY LOWER NEHALEM AND NECANICUM STUDY AREA

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April, 2006

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Project Description

A collaborative project between the Oregon Department of Forestry (ODF) and the Oregon Department of Fish and Wildlife (ODFW) was initiated to synthesize aquatic habitat and fisheries information for the Lower Nehalem and Necanicum River drainages to assist in the development of operational management plans, stream habitat restoration projects, habitat conservation planning, and watershed analysis. The project summarizes the condition of stream habitat, the distribution and abundance of salmonid fishes, and the potential for restoration. The ODFW Aquatic Inventories Project has conducted stream habitat surveys as part of its basin survey project and habitat assessment project under the Oregon Plan for Salmon and Watersheds. The goal of these surveys was to document the status and trends of stream conditions in coastal drainages. These surveys in conjunction with fish distribution, fish presence, potential barriers to passage, and past restoration activities form the basis of the analyses.

The Lower Nehalem and Necanicum River project area is in northwestern Oregon (Map 1). These are separate watersheds which drain into the Pacific Ocean. The Lower Nehalem and Necanicum project area, as delineated by ODF ownership, is comprised of segments of each drainage rather than watershed boundaries. Within this, ODF ownership is located primarily in the lower portions of the Nehalem watershed and is sparse in the Necanicum watershed. The total project area is approximately 43400 hectares. There are three ODF management areas in the project area: Astoria, Tillamook and Forest Grove (Map 2). Table 1 and Map 3 display the surveyed streams in relation to the management areas and major river basins in the Lower Nehalem and Necanicum project area. Non-ODF land ownership in the watersheds include private industrial, private non-industrial, public, agricultural, urban, and rural residential (Map 4).

The Lower Nehalem basin is comprised of two level IV ecoregions as defined by Thorson et al. (2003) (Map 5): Coast Range Volcanics and Coast Range Sitka Spruce. The Salmonberry and Cook drainages are underlain by Tillamook Volcanics (Coast Range Volcanics ecoregion). The geology has a dominant influence on the basic geomorphology of streams in the study area. As a result, the Salmonberry and Cook drainages tend to be high gradient and have a highly bisected drainage network. In-channel features are dominated by larger substrate and fewer pools. The North Fork Nehalem drainage is underlain primarily by siltstones and sandstones, with a few mafic intrusions. As a result, the streams are lower gradient, have more secondary channels, and are pool rich. The differing geologies are reflected in the channel geology types as a mix of pebbles and boulders (Salmonberry and Cook), or as sand (North Fork Nehalem) (Map 6). The northwestern edge of the North Fork Nehalem drainage and Ecola Creek are underlain by Columbia River basalt. Foley Creek in the southern part of the study area reflects a combination of volcanic and sedimentary geologies.

GIS coverages – sources and scales

Three digitized maps layers were used for different features of this synthesis (Map 7). The primary layer is the 1:100,000 USGS stream layer. It is a standardized and routed coverage, and has a unique latitude and longitude field associated with each stream (Hupperts 1998). Fish distribution and aquatic habitat data are joined to the 1:100,000 coverage. The Coastal Landscape and Analysis and Modeling Study (CLAMS: http://www.fsl.orst.edu/clams/) provided a 1:24,000 coverage and a standardized 6th field Hydrologic Unit coverage. The CLAMS coverages displayed all streams at a 1:24,000 scale, and determined the valley width, mean annual flow, gradient, and channel size. The highest resolution coverage was developed for Oregon Department of Forestry (ODF) at the 1:12,000 scale. We used this layer to display a generalized (no species information) map of salmonid distribution. Because of the different development processes, the data cannot be integrated across scales, but are displayed in the same projection (Map 7).

Fish Distribution and Abundance

Coho salmon (*Oncorhynchus kisutch*), fall and early-run fall Chinook salmon (*O. tshawytscha*), chum salmon (*O. keta)*, and winter steelhead (*O. mykiss*) occur in the mainstem and tributaries of the Lower Nehalem basin (Maps 8, 9, and 10). Additionally, resident and anadromous cutthroat trout (*O. clarki clarki*) (Map 11), white sturgeon (*Acipenser transmontanus)* (Maps 8), and Pacific lamprey (*Lampetra tridentata*) are present. Chum, coho, and fall Chinook salmon, winter steelhead, cutthroat trout, and Pacific lamprey are found in the Necanicum basin. Non-salmonid native species are present in both basins; however, their distributions are not documented.

ESA Designations

Winter steelhead are listed as a species of concern under the federal Endangered Species Act in the Lower Nehalem study area (http://www.nwr.noaa.gov/ESA-Salmon-Listings/Salmon-Populations/Coho/Index.cfm). Coho salmon status was recently (January, 2006) changed from proposed federally threatened to not warranted. The State of Oregon is collaborating with NOAA Fisheries to recover coho salmon through measures in the Oregon Plan for Salmon and Watersheds. Others species are not listed at this time.

Fish Populations in the Nehalem Basin

Chum salmon spawn and rear in the low gradient, tidal portions of the basin, and into the lower reaches of the mainstem and tributaries (Map 8). Chum distribute into the North Fork Nehalem River and some of its tributaries and East Foley Creek. ODFW spawning survey data yielded peak fish counts of 406 in East Foley Creek and 20 in Coal Creek in 2004-2005, similar to counts in the 2002-2003 spawning season.

Two runs of Chinook are described for the Lower Nehalem River, an early-fall run and a fall run (Boechler and Buckman 1992) (Map 9). The early-fall run Chinook spawn primarily in October in the Lower Nehalem, specifically to the Salmonberry, mainstem Nehalem, and lower North Fork Nehalem River. The fall run Chinook salmon spawn primarily in November but sometimes into late December in the mainstem Nehalem River below Humbug Creek and in tributaries to the North Fork Nehalem and Salmonberry systems (Soapstone Creek, Cronin Creek, and Salmonberry River, for example). Peak counts of Chinook salmon throughout these reaches ranged from 10 - 44 fish per mile in 2004, according to ODFW spawning survey data. Peak counts in 2003 were similar for the same streams. Soapstone Creek consistently had the highest peak counts.

Coho salmon reside extensively throughout the mainstem and larger tributaries of the Nehalem drainage (Map 8). Coho salmon begin returning to the Lower Nehalem watershed in October and early November after spending 6 months to 1.5 years in the ocean. The peak spawning period occurs between mid-November and mid-January. Coho are distributed throughout the entire watershed except for the upper reaches of the tributaries due to barriers or high gradient. Coho prefer to spawn in the smaller tributaries and have been observed in the upper reaches of the mainstem as well. Spawning surveys have been conducted in the Nehalem basin from 1989 to 2005 by the ODFW Coastal Salmon Inventory Project. The number of coho salmon observed throughout these reaches has varied dramatically (Maps 12 and 13). Map 13 depicts the small watersheds (6^{th} field hydrologic units) in the Nehalem River basin which demonstrated higher than average abundances from 1989-2000. Highlighted HUs show the percentage of years that the average number of adult coho salmon was greater than 4 fish per mile for the 12 year period. Coho populations increased beginning in 1999 because of improved ocean conditions, beneficial changes in harvest management, and habitat improvements. Current ODFW Coastal Salmon Inventory Project peak counts ranged from a peak count of 52 coho in 2002 to 11 coho in 2004 in a tributary to Soapstone. A similar trend was noticed in North Fork Cronin Creek; seven coho was the peak count in 2002 and was 0 in 2004.

Winter steelhead reside extensively throughout the mainstem and larger tributaries of the Lower Nehalem study area (Map 10). Data are limited but accessibility to historic spawning and rearing areas is thought to be complete. Spawning surveys conducted under the ODFW Coastal Salmon Inventory Project documented abundances of adult steelhead in the mainstem and tributaries of Cook Creek and Salmonberry River. Total counts of 12 and 23 fish per mile and redd densities per mile ranging from 2.5 – 40.0 and 28 – 48.5 were counted in tributaries and mainstem Cook Creek and Salmonberry River, respectively, in 2005. In 2003, redd densities were similar to the 2005 counts in the Salmonberry watershed.

Pacific lamprey distribution has yet to be mapped, and surveys targeting Pacific lamprey are few. However, Pacific lamprey redds and adults were counted as a part of the ODFW steelhead surveys. In 2005, 2 redds per mile were counted in the mainstem and tributaries to Cook Creek and 0 – 5.6 redds per mile in Salmonberry and its tributaries. No redds were counted in the Salmonberry watershed in 2003.

Anadromous and resident cutthroat trout are not the focus of any population monitoring program; therefore, counts of adults are unknown, although they are present in most streams in the ODF study area (Map 11).

A summary of salmonid fish populations in North Coast basins, including the Nehalem watershed, was developed by Talabere and Jones (2002) to identify small watersheds (6^{th} field HUs) that supported higher than average densities of salmon during 1989 – 2000, based on ODFW Coastal Salmonid Inventory Project data (Map 13, Table 2). The maps depict the small watersheds that had above average densities for more than 50%, 75%, and 90% of the 12 years for chum, Chinook, and coho salmon. Because systematic surveys were not conducted for steelhead, Talabere and Jones (2002) relied on professional judgment and scientific reports to determine the most important watersheds for steelhead. The selection of Salmon Habitat and Diversity Watersheds was based on the combination of species abundance and distribution. Those watershed what supported a high abundance of multiple species received a higher ranking. The Oregon Department of Forestry, in consultation with ODFW, designated 4 watersheds (selected from the Salmon Habitat and Diversity Watersheds) within the Lower Nehalem as Salmon Anchor Habitats (Map 14, Table 2) to recognize the importance of the 6^{th} field watershed to salmon populations. Salmon Anchor Habitats incorporate the aforementioned abundance quartiles with habitat quality and species diversity for a more robust examination. They include Middle Salmonberry River, Upper North Fork Nehalem River, Cook Creek, and Foley Creek watersheds (Table 2).

Fish Populations in the Necanicum Basin

Fish composition in the Necanicum basin is similar to the Lower Nehalem; chum, coho, and fall Chinook salmon, winter steelhead, cutthroat trout, and lamprey are distributed throughout the basin. Chum salmon reside in the lower sections of the basin and do not enter ODF land. Coho salmon have been observed spawning throughout much of the basin and in segments of Joe Creek, Bergsvik Creek, and the Ecola River flowing through ODF lands. Fall Chinook are present in the North Fork and mainstem Ecola Rivers on ODF land. Winter steelhead are more widely distributed in the Necanicum watershed than are Chinook salmon. Steelhead distribution includes segments of Joe Creek, Bergsvik Creek, and the Ecola River flowing through ODF lands. Pacific lamprey were observed in the Necanicum basin during winter steelhead surveys. Few ODFW spawning surveys have been conducted on streams on ODF land.

Historic Fish Distribution

Lacking historic fish distribution information, we used a map of stream size and gradient developed by the Coastal Landscape Analysis and Modeling Study (CLAMS: http://www.fsl.orst.edu/clams/) to identify areas above current fish distribution that could have potentially supported salmon in the past. We assumed that fish distribution in the Nehalem and Necanicum basins would be limited by stream gradient if impediments such as physical barriers or poor habitat were not present. Comparing current maps of fish distribution with the CLAMS generated maps of gradient and Streamnet barrier database indicates that historic fish composition and distribution may be similar to present conditions (Map 15).

Salmon and Lamprey life history in coastal basins

Chinook salmon return early September to early November with peak spawning activity observed in mid November to mid December. Chinook salmon prefer to spawn in larger streams at the tail crest of pools and glides and tend to use larger substrate to build redds. As the fry emerge in early spring, some will migrate immediately to the estuary while others will remain in freshwater until early summer. After spending the summer and early fall in the estuary they will migrate to the ocean. Juvenile Chinook salmon can be found in the estuary most months of the year. Most Chinook salmon will remain in the ocean an average of 3 to 4 years. Upon return from the ocean, the adult fish often hold in the estuary until the rains increase the river water levels and then return to their native streams to repeat the cycle. Habitat requirements for adult Chinook are clean, ample gravel for spawning, cold, clean, well-oxygenated water, and deep pools for cover. Juvenile Chinook need cool, clean water, pools, and large wood debris for cover while in their freshwater environment. Estuaries and associated wetlands provide vital nursery areas for the juvenile fish prior to their departure to the ocean.

Coho salmon begin returning to their natal watershed in the fall after spending 6 months to 1.5 years in the ocean. They prefer to spawn in the smaller tributaries and have been observed in the upper reaches of the mainstem rivers as well. After hatching, fry emerge in early spring and remain in their freshwater environment for a complete year. Thus, due to this life history trait, high quality habitat conditions are necessary year-round in order to insure survival during summer and winter. Favorable attributes include off-channel habitat and beaver pond habitat to provide refuge from high velocity winter flows, large wood debris to provide cover from predators, and low levels of fine sediment in spawning gravel.

Winter steelhead return to their natal streams from November to April after spending from 1 to 3 years in the ocean. Unlike other Pacific salmonids, steelhead are iteroparous and may survive after spawning to return to the ocean and repeat the cycle. Spawning occurs in the winter and early spring, and when the fry emerge they remain close by or occasionally migrate to the upper or lower reaches of streams and rivers. Like other salmon species, juveniles and adults rely on streams, rivers, and marine habitat during their lifecycle. Juveniles usually stay in their freshwater environment for two years before migrating to the ocean in the spring. Habitat requirements include clean, ample gravel for spawning, cold, clean, well oxygenated water, deep pools and large wood debris for cover.

Coastal cutthroat trout may exhibit four main life history strategies; an anadromous form that migrates to the estuary and/or ocean before returning to freshwater to spawn, an adfluvial form that migrates from a lake to smaller tributaries to spawn, a fluvial form that migrates to small streams from other parts of the watershed to spawn, and a resident form that both resides and spawns in small streams. Both anadromous and resident cutthroat trout are found throughout the mainstem and tributaries of the Lower Nehalem and Necanicum basins but specifically resident cutthroat tend to be found in the upper headwater reaches of the tributaries.

Anadromous adults enter streams during the fall and will spawn from December through May depending on water conditions. Fry emerge from the gravel in about 2 months. The young utilize slow flowing backwater areas, low velocity pools, and side channels for rearing. Young cutthroat can spend 1 to 9 years in fresh water before they migrate to the estuaries and ocean in the spring, but most commonly it is three years from emergence. Adults usually spend less than one year in the ocean before returning to spawn. Like steelhead, sea-run cutthroat trout usually survive after spawning and will return to the ocean in late March or early April. In freshwater, adult cutthroat typically reside in large pools while the young reside in riffles.

Pacific lamprey are anadromous. Mating pairs construct a nest by digging, using rapid vibrations of their tails and by moving stones using their suction mouths. Adults die within days of spawning and the young (ammocoetes) hatch in 2-3 weeks. The juveniles swim to backwater or eddy areas of low stream velocity where sediments are soft and rich in dead plant materials. They burrow into the muddy bottom where they filter the mud and water, eating microscopic plants (mostly diatoms) and animals. The juvenile lamprey will stay burrowed in the mud for 4 to 6 years and stay in the same habitat, rarely migrating within the stream system. They metamorphose into adults averaging 4.5 inches long. Lamprey migrate to the ocean in late winter during periods of high water. After 2 to 3 years in the ocean they will return to freshwater to spawn.

Habitat Survey Approach and Methods

ODFW Aquatic habitat surveys were conducted in the Lower Nehalem and Necanicum drainages from 1992 – 2004 (Map 17; Table 1). Due to the small number of surveyed reaches on ODF land within the Necanicum basin, summaries reflect the Lower Nehalem basin unless otherwise stated.

The habitat surveys describe the channel morphology, riparian characteristics, and features and quality of instream habitat during summer flow, following methods described in Moore et al. (1999) (http://osu.orst.edu/Dept/ODFW/freshwater/inventory/publicatn.htm). Each habitat unit is an area of relatively homogeneous slope, depth, and flow pattern representing different channel forming processes. The units are classified into 22 hierarchically-organized types of pools, glides, riffles, rapids, steps, and cascades, as well as slow-water and off-channel pool habitat. Length, width, and depth were either estimated or measured for each habitat unit. In addition, water surface slope, woody debris, shade, cover, and bank stability were recorded. Substrate characteristics were visually estimated at every habitat unit. Estimates of percent silt, sand, and gravel in low gradient (1-2%) riffles were used to describe gravel quantity and quality. The surveys also provided an inventory of site-specific features including barriers to fish passage (e.g., falls or culverts), mass hillside failures, and beaver activity.

Riparian transects describe tree type and size, canopy closure, and ground cover associated with the floodplain, terraces, and hillslopes adjacent to the stream. Each transect measures 5 meters in width and extends 30 meters perpendicular to each side of the stream channel. The number and size of the trees recorded are extrapolated from these transects and summarized as the number of trees expected every 305 meters of stream length.

Descriptions of channel and valley morphology followed methods developed at Oregon State University and described in detail in Moore et al. (1999). Valley and channel morphology defined the stream configuration and level of constraint that local landforms such as hillslopes or terraces imposed upon the stream channel (Gregory et al. 1989; Moore and Gregory 1989). The channel was described as hillslope constrained, terrace constrained, or unconstrained. Channel dimensions included active (or bankfull) channel width and depth, floodprone width and height, and terrace widths and height. These descriptions of channel morphology have equivalents within the OWEB and Rosgen channel typing system (Rosgen 1994).

Two survey designs were used within the Lower Nehalem study area. Surveys conducted in 1993 – 2004 followed a basins, or census, survey design. The basins survey followed methodology proposed by Hankin (1984) and Hankin and Reeves (1988). The sampling design is based on a continuous walking survey generally from the mouth or confluence of a stream to the upper reaches. Each stream is stratified into a series of long sections called reaches and into short habitat units within each reach. A stream reach is a length of stream defined by some functional characteristic. This may be a change in valley and channel form, an entering tributary, major changes in vegetation type, or changes in land use or ownership. Within a watershed, field crews survey major streams and a selection of small tributaries. The methodology provides flexibility of scale, allowing information to be summarized at the level of microhabitat, associations of habitat, portions or reaches of streams, watersheds, and subunits within regions.

The continuous-survey approach provides field-based estimates of habitat conditions throughout a stream, describe habitat and hydrologic relationships among streams or landscape features, and permit stream-wide estimates of fish distribution and abundance.

The second survey design referred to as Oregon Plan surveys (OR Plan). This survey design was intended to provide estimates of habitat conditions across a broad geographic region. To accomplish this, we randomly selected sites each year from 1998-2005 in coastal drainages throughout western Oregon. Of the total sites surveyed to date, eight sites fell within the Lower Nehalem project. Field protocol was similar to the basins surveys except that sites were 500 meters to 1,000 meters in length and some of the sites are designated to be resurveyed on a rotational design of one, three, and nine year intervals. The randomly selected sites were combined with the basins survey reaches to describe aquatic conditions in the study area and are included in the summaries reported here.

Analysis

Habitat data were summarized at the reach (basins surveys) or site (OR Plan surveys) scale to describe channel morphology, habitat structure, sediment supply and quality, riparian forest connectivity and health, and in-stream habitat complexity. Individual attributes include:

Channel morphology	Channel dimensions
	Channel constraint features, if any
	Gradient
	Percent secondary channels
	Floodplain connectivity
Pool habitat	Percent pool
	Percent slow, backwater, and off-channel pools
	Deep Pools (>1m deep)
	Complex pools (contain > 3 pieces large wood)
Large Wood	Pieces of large wood (>0.15 diameter and >3m length)
	Volume of large wood (m^3)
	Key pieces of wood (>0.6m diameter and >12m length)
Substrate	Percent fines, gravel, cobble, boulder, bedrock
	Percent fines and gravel in low gradient riffles
Riparian	Shade
	Density of conifer trees, by size category
	Density of hardwood trees, by size category

Results are presented in tables and as frequency distribution graphs and in GIS coverages. Values were standardized as a percent or by reach length. Habitat attributes were expressed as reach or site averages or displayed at the habitat unit level. Information from a reference database was used to provide a standard point of comparison. The basins and OR Plan surveys were integrated into coverages in a Geographical Information System (Jones et al 2001). The basins surveys were routed and displayed at the channel reach and habitat unit scales, and the random surveys were displayed as points with reach summary data.

Individual stream survey reports for the Lower Nehalem and Necanicum are available from the Aquatic Inventories Project in Corvallis. Metadata for the GIS coverages is available online at http://oregonstate.edu/Dept/ODFW/freshwater/inventory/index.htm. An interpretation guide for aquatic habitat data is available online at http://oregonstate.edu/Dept/ODFW/freshwater/inventory/index.htm

Habitat quality

Individual habitat attributes portray a view of stream characteristics. They provide a point of comparison to view the relative differences between streams and reaches within a drainage network. We integrate habitat attributes in three different fashions, considering fish, landscape, or historic perspectives. The first is in comparison to a historic context, expressed in the character of streams located in minimally human disturbed areas. These sites are referred to as reference sites, and while they provide a general context and range of stream attributes they are not intended to be prescriptive in nature.

The second and third perspectives express stream quality in terms of potential carrying capacity of a reach for juvenile coho salmon (Habitat Limiting Factors Model) and potential survival of coho salmon at each life stage (HabRate). Again, each model provides a comparison of stream attributes from a salmonid biology perspective.

Reference conditions

Reference values (Table 3) were derived from streams in areas with low impact from human activities (e.g. wilderness or roadless area, late successional forest or mature forest). A total of 124 reference sites, surveyed between 1992 and 2003, were selected within the Oregon Coast Coho ESU (from Sixes River to the Necanicum, including reaches of the upper Umpqua in the Cascade ecoregion) to represent conditions within the range of coho salmon. Most of the streams surveyed by ODFW in the Lower Nehalem study area were also within the range of coho salmon. Each site was inspected using USGS 7.5 minute topographic maps for human-caused stressors such as roads, development, and forest management. A summary of reference site characteristics follows:

Attribute	Value
Number of Reaches or Sites	124
Distance Surveyed - Total (km)	161.9
Reach or Site Length (m)	
Mean (median)	1306 (971)
Range	174 - 6776
Active Channel Width (m)	
Mean (median)	9.28 (7.28)
Range	1.5 – 31.5
Gradient (%)	
Mean (median)	2.8 (2.3)
Range	0.5 – 19.2
Ownership	primarily federal
Ecoregions	Coastal 80% Cascades 20%
Geology	Sedimentary 72% Volcanic 21% Mixed 7%

While few of the sites were completely absent of human influence, we assumed that the reference sites represented a natural range of conditions. The range of data for each reference stream variable was subdivided into quartiles, 0-25%, 25-75%, and 75-100%. The value within each of the three quartiles was labeled as either low, moderate, or high. Thus, we considered that the 25th and 75th quartile breakpoints represented the values we considered low or high within a natural context. The middle 50% quartile was considered a moderate or average level. We used these values not to predict historic conditions in the Lower Nehalem project area, but to more broadly represent the potential range of historic conditions in lower gradient (<5%) fish-bearing streams in coastal Oregon, and to provide a point of comparison for the subsequent analysis.

Habitat Limiting Factors Model (HLFM)

The HLFM model estimates the potential carrying capacity of stream habitat and identifies the limiting factors for coho salmon production (Nickelson et al 1992, Nickelson 1998). We used this model to quantify critical habitat factors for juvenile coho salmon during the summer and winter and to highlight differences between reaches. The HLFM model focuses on the amount of pool habitat in a reach, particularly the beaver pool and off-channel pool habitat. Summer habitat capacity is a function of the amount of total pool habitat; winter habitat is governed by the amount of beaver and off-channel pool habitat. One advantage of HLFM is that it predicts the number of coho salmon parr that the habitat can support during a particular season (capacity), in addition to quantifying habitat quality.

Stream capacity to support juvenile coho salmon during the summer was considered high if the value exceeded 2,430 fish per kilometer and low if the value was below 1250 fish per kilometer. Similar values for capacity to support winter parr were 1950 and 1000 fish per kilometer. Habitat quality was measured as the average number of juvenile fish per square meter in a kilometer of stream. The breakpoints for low and high quality were 0.15 and 0.38 fish per m^2 in the summer, and 0.12 and 0.30 fish per m^2 in the winter (Rodgers et al., 2005).

We used data from winter surveys to estimate winter capacity for juvenile coho when available. Otherwise, summer habitat conditions were applied to a predictive model to estimate habitat capacity during the winter.

HabRate

HabRate (Burke et al. 2001) describes the quality of aquatic habitat in relation to survival of Coho salmon at a particular life stage. HabRate was based on our interpretations of the published literature. Habitat requirements for discrete early life history stages (i.e. spawning, egg survival, emergence, summer rearing, and winter rearing) were summarized and used to rate the quality of reaches as poor, fair, or good, based on attributes relating to stream substrate, habitat unit type, cover and structure (large wood, undercut banks), and gradient. Reach level summaries of stream habitat were entered into a computer spreadsheet, and interpreted by logical statements to provide a limiting factor assessment of potential egg-to-fry and fry-to-parr survival for each reach. The model is a decision making tool that is intended only to provide a qualitative assessment of the habitat potential of stream reaches within a basins context. Information not common to standard stream survey designs, such as seasonal flow or temperature extremes were excluded from this analysis. Model output ranks habitat quality from 1 to 3: poor, fair, and good.

The primary difference between the HLFM and HabRate models is that HabRate considers the influence of large wood in structuring habitat complexity, whereas HLFM model emphasizes the importance of beaver ponds and alcove habitat. Both models provide an assessment of habitat features that influence the survival of Coho salmon juveniles from parr to smolt. We include the finding from both models to describe habitat quality.

An evaluation of aquatic habitat incorporates the biological significance of stream habitat attributes and knowledge of salmonid life history. The reference benchmarks are a useful point of comparison for determining whether the value of a physical stream characteristic is high or low relative to the range of natural conditions. Fish habitat models, HLFM and HabRate, view the physical habitat from a salmon biology perspective. Values of high or low capacity reflect the importance of physical features to the productive capacity of habitat for coho salmon. Values of high or low quality describe the influence of habitat on the survival of coho salmon during a particular life stage, or from one life stage to the next.

Aquatic Habitat Conditions

Aquatic Habitat overview

The ODFW Aquatic Inventories Project has conducted aquatic habitat surveys in the Lower Nehalem since 1993. There are approximately 111 kilometers of surveyed stream habitat associated with 66 identified reaches within the ODF Lower Nehalem project area (Map 16). Table 2 lists the streams surveyed. Tables 6a and 6b provide all the stream reaches and habitat conditions for the selected attributes within the project area. Most of the streams surveyed in the project area were small to moderate sized tributaries, based on active channel width. The active channel width (bankfull width) on the surveyed streams ranged from 1.1 – 26.3m (average of 8.2m and a median of 6.2m). The gradient ranged from 0.4% to 21.1% (5.9% average and 4.2% median). Of the 111 kilometers of stream surveyed, 35km had an average gradient greater than 5 percent. Of the 35km, approximately 20km had an average gradient greater than 9 percent. The following ODF management areas compose the 111km in the Lower Nehalem project area: Tillamook 10.5km, Forest Grove 47km, and Astoria 53km (Table 4).

Thirteen core habitat attributes considered important for successful spawning, rearing, and survival throughout various fish life history stages were analyzed. These core attributes are the amount of pool habitat, quantity of deep pools per kilometer, percent of slackwater habitat, percent of secondary channel area, percent of fines and gravel substrate found in riffle units, percent bedrock substrate, large wood pieces, volume, and key pieces, shade, and large conifers in the riparian zone. The values derived from these core attributes are compared to habitat breakpoints of the reference stream reaches and conditions. Reference sites provide a general context and range of stream attributes of minimally human-influenced sites. They are intended to provide a point of comparison to view the relative differences between streams and reaches within a drainage network. Reference values are not meant to be prescriptive, that is, to indicate the value each reach of stream must attain.

Relationship of fish populations to aquatic habitat

The surveys described components and processes that contribute to the structure and productivity of a stream and fish community. The Aquatic Inventories Project selected attributes to describe important indicators of sediment supply and quality, instream habitat complexity, and riparian forest community. These variables were summarized for reaches and sites on ODF lands within the Lower Nehalem project area in Tables 6A and 6B. As mentioned earlier, we also used cumulative frequency distribution graphs to examine the survey data on ODF lands (Figures 1 through 8). The frequency distribution graphs are useful for determining medians and percentile values and for comparing the differences in distribution of values between multiple strata. These graphs also illustrate the habitat values with comparison to reference conditions. Figure 1 displays the gradient and active channel width of the reference streams against the entire Lower Nehalem project area as a whole and by each of the three management areas. The 13 habitat attributes display important habitat values comparing the reference reaches against the 3 management areas (Table 5).

The response of salmonid fishes to the character of aquatic habitat varies by life stage and time of year. Adult fish seek deep pools for holding areas while preparing to spawn and need gravel and cobble substrate that is free of fine materials to build redds and deposit eggs. Furthermore the redds require a steady flow of oxygenated water to allow the eggs and alevins to mature. Increasing amounts of fine sediments (<2mm) increases the mortality of eggs in the gravel (Everest et al. 1987). The amount of silts and fines associated with riffles is an indicator of embeddedness in spawning areas. A high percentage of fine sediment can settle (embed) in the interstitial spaces of the gravel and armor it such that it is difficult for spawning fish to dig an adequate redd (nest) and prevent oxygenated water from reaching the eggs. Fine sediment values less than 8% are desirable (Table 3). The median value among the project areas was moderate at 15% (Table 5). Fourteen reaches (25km) had low levels of fine substrate in riffle units (less than 8%) (Table 6A), and were fairly evenly distributed between the 3 management areas (Map 18, Figure 2).

After emergence in the spring, salmonid fry typically remain in freshwater for a few weeks to two years before migrating to the ocean, depending on species. Edge cover and backwater habitats are particularly important to the survival of fry in the spring, though less so as they grow and move into larger pools during the summer. The distribution of juvenile salmonids is limited primarily by the availability of pool habitat, food resources, and acceptable water quality. In the winter, coho salmon parr prefer complex pool habitat which has low velocity refugia from high winter stream flows. This habitat is often found in the form of off-channel alcoves, dam pools, and beaver ponds (Nickelson 1992). Complex off-channel habitats are also important in these large stream reaches during the winter. Large wood is an important structural component contributing to the complexity of these preferred habitats (Sedell 1984). Juvenile coho salmon extend their distribution downstream in the winter to inhabit areas previously limited by high water temperature, including tidally influenced wetlands. Juvenile steelhead and cutthroat trout are more opportunistic in regards to habitat type, residing in pools, riffles, rapids, and cascades. Additionally, pools provide resting places and over-wintering habitat for fish. Deep pools, those greater than or equal to 1 meter deep, provide temperature refugia and provide year-round cover.

The amount of available pool habitat in the Lower Nehalem project area differed depending upon the management area. Overall, the Lower Nehalem project area's median value for percent pool habitat was 27.5, which is at the moderate level (>45% pool habitat is the high breakpoint). The Tillamook management area was low (Table 5 and 6B). The project area had a median value of 1.1 for deep pools (moderate level) in relation to the habitat breakpoint derived from the reference reaches (greater than 3 pools greater than 1 meter deep per kilometer) (Table 5 and 6B, Figure 5, Map 18). Slackwater pools include backwater habitat, dammed pool, and beaver ponds. A high level is greater than 7% of total available habitat (Table 5). The Lower Nehalem project area was barely above the low breakpoint level (median 0.4). Astoria had the most reaches (9) exceeding the high breakpoint (Table 6B).

Instream wood serves many functions in a stream channel. The wood helps to scour deep pools, provide cover and nutrients, trap sediment, and provide cover from predators. Wood acts as an obstacle at higher flows, forcing the stream to cut new channels, to scour new pools, and to create undercut banks. The pools in the Lower Nehalem study area are relatively simple, with low amounts of large wood. Channel morphology and amount of secondary channel indicate relatively high connectivity to the floodplain. Secondary channels increase the potential habitat available to fishes, particularly to juveniles. Often the habitat has slower moving water than the primary channel. It provides over-wintering and summer rearing habitat for juvenile fish. A high level of secondary channels is 5.3% or more of the total channel area; sixteen reaches met or exceeded this breakpoint (25km).

Riparian vegetation is indirectly an important component of fish habitat. The riparian trees stabilize the bank, are a recruitment source of woody debris, buffer against flood impacts, and provide shade. Stabilized stream banks are more likely to develop undercut banks, which serve as important cover for fish and are less likely to contribute fine sediments. The canopy cover (shade) in all reaches rated high in relation to the reference conditions. The higher shade cover is due to a riparian composition consisting predominantly of hardwood species (red alder) 3-30 cm dbh and a narrow active channel. There were very few conifers observed in the riparian zones of any of the reaches (Tables 5, 6B, Figure 7, Map 19). This is a limiting factor for recruitment of large wood (greater than 60 cm dbh) into the channel and thus a limiting factor for increasing pool and channel complexity. Although all trees are important and contribute to the river system, conifers are particularly important as they tend to grow larger than deciduous trees; therefore, they remain in the river system longer before deteriorating and provide greater hydraulic function.

Individual attributes in the Nehalem suggest the habitat is in good condition to support salmonids. However, when more than one attribute is considered within a given reach, the results are not as positive using the HLFM and HabRate models (Figures 9 and 10, Map 27). Summer habitat capacity and quality is moderate to high in the North Fork Nehalem drainage, but only moderate in the Salmonberry drainage. Streams in the North Fork Nehalem have a greater abundance of pools. The overall capacity and quality of winter habitat is very low in both drainages. Complex pools, beaver ponds, and off channel habitats are limited in number and distribution. In contrast, the quality and availability of spawning habitat is high in the Salmonberry drainage. Because of the geology in the Salmonberry system, we would not expect to observe high numbers of beaver pools or off channel habitats, although deep pools with large wood should be more common. The map of intrinsic potential (Map 15) highlights the North Fork Nehalem drainage as one that should support an abundance of low gradient, complex pool and slow water habitat.

Basin comparison: the North Fork Nehalem River and the Salmonberry / Cook drainages

Although the Lower Nehalem drainage is presented as an entity and in management units, there are geomorphic differences between the North Fork Nehalem and the Salmonberry/Cook watersheds which is reflected in the instream habitat. First, the ecoregions and underlying geologies differ. The North Fork Nehalem drainage is underlain primarily by siltstones and sandstones (Map 5), which more readily leads to low gradient, meandering channels, pool habitat, and smaller substrate size. The map of intrinsic potential indicates an overall low gradient system (Map 15); one with high intrinsic potential for coho salmon (Map 28). Coho salmon are extensively distributed in the North Fork Nehalem tributaries. However, distribution is more limited in the Salmonberry/Cook watersheds (Map 8). This is in part due to steeper gradients and volcanic geology. There are very few areas of high intrinsic potential for coho salmon in the Salmonberry/Cook systems.

The habitat surveys are a non-random subselection of the streams in both drainages and may not necessarily reflect the overall traits of their respective basins. CDF (cumulative distribution frequency) figures (Figures 11-18) compare the two watersheds for numerous habitat attributes and helps to depict the similarities and differences between them, as well as compare them to the reference dataset. Forty-two reaches (~53 kilometers) were surveyed in the North Fork Nehalem watershed. Streams in the North Fork Nehalem had high levels of gravel and wood in the stream relative to streams in the Salmonberry. The Salmonberry/Cook watersheds exceeded both the North Fork Nehalem and reference dataset for the density of deep pools and percent bedrock substrate. The amount of secondary channel is high in the Salmonberry, but the percent of stream area in secondary channel is similar between the two drainages. However, the length of secondary channel is high in the North Fork Nehalem. Twenty-four reaches (~58 kilometers) of the Salmonberry/Cook watersheds were surveyed. Volcanic geology (Map 5) influences some of its characteristics, including the deep pools and bedrock. Although the intrinsic potential indicated a steeper gradient in this watershed than the North Fork Nehalem, the individual survey sites averaged similar gradients, 6.5% (Salmonberry/Cook) and 5.6% gradient (North Fork Nehalem). The two basins had similar levels of fines in riffle units, percent pool habitat, and riparian conifer densities. The two drainages had similarly moderate summer habitat quality and capacity levels as rated by both HabRate and HLFM. The winter habitat quality and capacity for each watershed was equally low (Figures 9 and 10).

Watershed council surveys

The Nehalem watershed council is an active organization contracting with private surveyors to conduct habitat and snorkel-count surveys. Winter habitat surveys conducted from 2002 and 2003 in the Lower Nehalem project area included some streams on ODF land using ODFW protocol (Table 7). Most surveys ranged from 500 to 2000 meters in length. The dominant landuse was second-growth timber; gradient ranged from 2.1 – 7.9. Overall, these surveys described reaches with moderate to high numbers of complex pools and deep pools/100 meters. Key pieces/100m values tended to be low to moderate in comparison to the breakpoint levels. Approximately 10 kilometers of Cook Creek was surveyed in 2003. In the sections with bedrock canyons, the number of key pieces of large wood and complex pools was low. Where the stream was able to meander and had secondary channels, the deep pools and complex pool values were moderate to high. The crews also attempted to characterize the effectiveness of habitat structures, many of which either were not interacting with the active channel or blocked access to secondary channel habitat. A program to monitor the structures would help identify and perhaps remedy situations in which the habitat structure and stream are no longer interacting.

Small streams

Coho salmon usually reside in low and moderate gradient streams, usually less than 5 % gradient. Higher gradient streams above coho salmon distribution, referred to as “small streams” in this document, are home to steelhead, cutthroat trout, sculpin, lamprey, amphibians, and other organisms. Small streams are a vital piece of the ecosystem and while they tend to function differently from larger streams, they may also be managed differently. Their importance may be overlooked due to the small channel width, lack of anadromous fish distribution, and at times, intermittent flow.

Approximately 25 percent of the streams ODFW Aquatic Inventories Project surveyed in the Lower Nehalem project area (1:100,000 scale) is above the distribution of coho salmon, referred to as small streams in this document, and is located in the upper Salmonberry and North Fork Nehalem basins (Map 29). Though represented separately in this analysis, small streams were incorporated in the larger analysis for the Lower Nehalem habitat assessment. Small streams usually have a narrower active channel and higher gradient than streams within the distribution of coho salmon (Table 8). Yet in the Lower Nehalem project area, the small streams have the same median active channel width (6.1m) and a lower median gradient (3.6 versus 4.2). The number of observed mass failures is the same (~ 1.2 failures per kilometer). The number of beaver activity sightings in smaller streams was greater than then combined reaches (Table 9). For both the small streams and all streams in the Lower Nehalem study area, the quantity of fines and gravel substrates in riffle were moderate relative to the reference conditions. The frequency of pools in small streams is moderate, as is the number of deep pools relative to the breakpoints. The median values of wood pieces (22.8 versus 24.4), volume (32.2 versus 40.5), and key pieces (0.8 versus 0.9) were similar between the small streams and the combined reaches (Figures 19-24, Table 10).

Small streams are less suitable areas for instream restoration due to the steep gradient (Table 13). Small streams are among the areas considered low priority for instream restoration by Thom and Moore, 1997. Restoration is best accomplished in a passive fashion by protecting the riparian areas. The condition of the riparian areas influences the rate and character of input of large wood debris and sediment to the system.

Flood surveys

ODFW Aquatic Inventories Project surveyed a selection of stream reaches following the large flood event that occurred during February 1996 (Jones et al. 1998). Due to the structure of the sampling, we are only able to describe conditions in the Lower Nehalem and Necanicum study area relative to the degree and extent of habitat alternation associated with the floods at specific sites. The sample size in this study area is too small generalize to the whole study area. The survey sites were randomly selected by ODFW from previously surveyed; each was one kilometer in length.

Sixty one-kilometer reaches were surveyed in the North Coast; 16 were within the Nehalem basin; 2 within the Lower Nehalem project area (Salmonberry and North Fork Salmonberry River); 9 within the Necanicum basin; 1 on ODF land in the Lower Nehalem and Necanicum project area (West Fork Ecola River) (Map 30). The data were evaluated and placed into categories according to level of flood impact. Highly impacted reaches showed evidence of debris torrents at the scale of full valley floor scour or deposition extending for more then 7 channel widths in length. Characteristics of moderately impacted reaches include various large scale channel modifications, such as channel relocation, new channel formation, deposition of new gravel bars. Reaches with low impact ranged from no perceivable impact, high water impact (clearing of litter from low terraces and floodplain), or scour and deposition patches (localized scouring or deposition).

In the three flood sites on ODF land in the Lower Nehalem and Necanicum project area, surveyors observed mass failures and moderate or high influence from the flood. The West Fork Ecola (Necanicum) and the North Fork Salmonberry (Nehalem) sites experienced low level flood impact and mass failures. However, the mainstem Salmonberry site experienced high flood effects and mass failures. In general, streams on the north coast of Oregon experienced some large scale debris torrents, channel morphology adjustments, and redistribution of habitat units, sediment, and wood. Despite the low number of surveys in this area, it appears that streams in the Necanicum and Nehalem River basins, as well as the project areas are susceptible to and showed a high to moderate level of effect in the stream channel from the 1996 flood event. These one kilometer surveys reflect a range of flood impacts. Fish use post-flood is dependent upon the extent and type of flood impact. Those with lesser impact or that are lower in the watershed may see fish use return sooner than those heavily impacted.

Flooding may alter the stream channel habitat. How floods impact fish habitat depends upon the intensity of the movements, the age and type of material on the hillsides and in the stream channel, and the channel morphology (gradient, valley width index) of the valley. Especially evident in winter storms and flood events, material from the hillsides is carried into the channel and moved downstream. Management of upslope land that is mindful of large-scale events will benefit stream processes prior to and potentially minimize downstream impact during flood events. According to Jones et al. (1998), in stream reaches in the north coast (n=60) 9% had no impact, 61% had low impact, and the remaining 30% had moderate to high impact. Of the 66 reaches (111 km) reported on in this document, 37 km (36 reaches) were surveyed after 1996.

Barriers

Barriers and potential barriers to anadromous and resident fish exist in most riverine systems due either to human-caused or natural processes. A barrier, which includes culverts, dams, velocity barriers, natural falls, lack of sufficient water flow, etc., is defined as an impediment to the movement of any fish at any life stage. The Lower Nehalem project area has 27 recorded barriers, as determined by Streamnet (Map 31 and Table 11). These barriers are located both within and outside known fish distribution. Fish distribution may extend beyond a partial barrier because the barrier may be specific to a species or life stage, or at a particular time of year.

The Streamnet barrier database incorporated the culvert inventory database; therefore, culverts in the dataset are those which do not meet acceptable fish passage criteria, not necessarily those which prevent all fish at all times. Of the 27 listed barriers, 12 are culverts. These barriers are rated as to the degree, or lack thereof, of fish passage. One is thought to have complete blockage, 3 are thought to be partially-blocking, 1 is thought to be nonblocking, and 7 have unknown passage ability. Movement may be prevented due to high velocity of water through the culvert, incorrectly sized culvert, culvert deterioration, or debris blocking the culvert. Data are not available to assess fish presence above all of the potential barriers (Table 11).

For those where anadromous fish distribution is mapped, fish use ends at or below each of the listed barriers (Map 32). The Nehalem River tributary with an impassable culvert (Record ID 1497) does not have mapped fish distribution. Most of the fish use that ends at or below a potential barrier is a natural falls. The log jam on Fall Creek may prevent Chinook passage but may not be a barrier to steelhead and cutthroat trout. Resident cutthroat trout, lamprey, and sculpin may be present above the natural and human-caused barriers.

Additionally, aquatic habitat survey crews documented many potential barriers to migratory fish. They identified culverts with corrosion and natural steps ranging from 0.25 – 10.0 meters high (Map 33). Crews labeled eight natural features as potential barriers. These are located on the following creeks: Hakura (cascade-over-bedrock, 10m high), Fall (step-over-bedrock, 2.4m high), Sweethome Tributary B (2 step-over-logs, 1.0-1.6m high, low flow barriers), Sweethome (step-over-log, 1.1m high, low flow barrier), God's Valley (step-over-beaver dam, 3.8m high), Wolf (step-over-bedrock, 4.0m high), and East Foley Creek (step-over-boulder, 8.5m high). Streamnet distribution indicates that these potential field-noted barriers do not prevent anadromous fish passage. In some cases, fish distribution stopped below, extended beyond, or was not mapped at the particular stream (usually a tributary).

The amount of aquatic habitat with restricted access or passage problems in the Lower Nehalem drainage based on Streamnet barrier data may total 45 kilometers, 40 on ODF land (Table 10). Information as to species and life stage affected is not available in the database. Conducting field surveys to improve documentation is recommended, although passage does not appear to be a major issue.

Restoration

Restoration is a technique and process used in an attempt to improve stream habitat in the short term and to achieve long-term recovery goals. The goals of restoration range from improving spawning and rearing habitat to improving natural stream processes. Treatment projects focus on improving summer and winter rearing for juvenile salmonids, improving spawning habitat, increasing channel complexity and connectivity, increasing nutrients in the stream, reducing sedimentation and bank erosion, and replanting native streamside vegetation. The quality of existing pools could be increased by recruitment of gravel, addition of wood pieces, or increased shade levels. Monitoring is a critical aspect of the restoration effort, as it is important to gauge whether the methods employed helped to achieve the desired effects. Achieving noticeable response may take several high flow events; biological response could take longer.

Since 1995, twenty instream projects funded by OWEB have been completed on ODF lands (Table 12, Map 34) in the Lower Nehalem project area. The projects on ODF lands focused on instream enhancement, road/drainage improvements, and passage issues. Three projects placed large wood in the stream, five improved the road and drainage system, and twelve improved fish passage.

In 1997, Thom and Moore identified stream reaches on ODF land in the Nehalem watershed for instream enhancement (Map 35). The majority of the selected stream segments recommended for restoration were tributaries of the North Fork Nehalem River, Cook Creek basin, Cronin Creek basin, and a few tributaries of Salmonberry Creek. Candidate streams were selected based on numerous criteria, through both in-house techniques and field verifications (Table 13). Generally, stream areas suitable for coho habitat enhancement are areas with unconstrained stream channels, <5% gradient, moderate size - channel width (4-12 meters), and either have or are adjacent to a known coho population area. Since 1997, six of the high priority sites and 24 of low to moderate priority sites (as designated by Thom and Moore 1997) on ODF land have had treatments (Map 36). In some locations, restoration projects occurred on both the mainstem and adjacent tributaries, as on the North Fork Nehalem River. Most of the projects addressed passage issues, which improved access to previously blocked (partially or completely) habitat. The balance used means to reduce erosion, improve bank stability, and to improve drainage. A limited number of projects addressed increasing channel connectivity or complexity. It is useful to note that the majority of the potential restoration reaches remain from the original list identified in 1997. The sites which have been treated to date coincide with areas of potentially high intrinsic potential, as most evident in the North Fork Nehalem. The priority (high, medium, and low) levels and locations still apply, although sites should be verified in the field. To date, most treated restoration sites have not been formally monitored. Documentation of site location and condition of past projects will help direct future restoration at these or adjacent sites. Criteria for instream restoration treatments within the Lower Nehalem River basin will require consideration of the dynamics of the large river system.

Summary of Fish Populations and Aquatic Habitat Conditions in the Oregon Department of Forestry Lower Nehalem and Necanicum Study Area

Fish distribution

What fish species are documented in the watershed?

- Chum, white sturgeon, coho salmon, fall and early-run fall Chinook salmon, winter steelhead, resident and anadromous cutthroat, and Pacific lamprey are present in the Lower Nehalem basin. Chum, coho salmon, fall Chinook salmon, winter steelhead, resident and anadromous cutthroat, and Pacific lamprey are present in the Necanicum basin. The occurrence and distribution of other native fishes is not documented.

Are any of these species currently state- or federally listed as endangered, threatened, or candidates?

- Winter steelhead are considered a species of concern in the Nehalem basin (see NOAA Fisheries web site for current status – (http://www.nwr.noaa.gov/).

Are there any fish species that historically occurred in the watershed that no longer occur there? Map potential historical fish distribution.

- No species have been extirpated from the Lower Nehalem and Necanicum study area.
- We believe current distribution is similar to historical distribution.

Which salmonid species are native to the watershed, and which have been introduced?

- All of the aforementioned salmonid species are native to the watershed. Non-native fish, including non-native salmonid stocks, may be present but have not been documented.

Are there potential interactions between native and introduced species?

- Because no introduced species have been documented, there are no known interactions between native and introduced fish.

Current habitat conditions

Show current condition of key habitat characteristics.

- Habitat surveys were conducted from 1992 – 2004. They are represented individually as well as by ODF management area (Astoria, Forest Grove, Tillamook) (Map 3).
- Habitat characteristics are listed in Tables 6A and 6B , graphed in Figures 1 through 8, and examples mapped in Maps 17 - 22.
- Small stream habitat surveys (stream sections upstream of coho distribution) are a subset of the overall Lower Nehalem project area sites. They are represented in Tables 7 and 8, Figures 10 – 16, and Map 29.

Compare to reference streams for each characteristic.

- Reference sites provide a general context and range of stream attributes of minimally human-influenced sites, and are intended to provide a point of comparison to view the relative differences between streams and reaches within a drainage network. Reference values are not meant to be prescriptive, that is, to indicate the value each reach of stream must attain.

- Key benchmarks are presented in Tables 3-5 and individual stream reaches are compared to these benchmarks in Tables 6A and 6B, Figures 1-8, and Maps 17-20.
- Within the Lower Nehalem project area, most of the median values for 13 habitat attributes are in the moderate level. Individual management areas have somewhat different values which may lend it to meeting either the high or low breakpoint.
  - Percent pools: The median value for the project area was moderate (27.5%); except for the Tillamook (17.7%), the other management area median values were moderate (23 – 28.7%); ten reaches met or exceeded the high breakpoint level.
  - Deep pools/km: The median value for the project area was moderate (1.1/km); the management areas' median value was moderate (0.7 – 2.3); sixteen reaches met or exceeded the high breakpoint level.
  - Percent slackwater pools: The median value for the project area was at the moderate (0.4%) level; management areas ranged from 0.0 – 1.2%, low to moderate; ten individual reaches met or exceeded the high breakpoint level.
  - Percent secondary channel area: The median value for the project area was moderate at 2.5%; the management area's median value ranged from 0.5 – 3.1%; sixteen reaches met or exceeded the high breakpoint level.
  - Percent fines in riffle units: The median value for the project area was moderate at 15%; management areas were at moderate levels 10.0-16.0%; fourteen reaches met or exceeded the low breakpoint level.
  - Percent gravel in riffle units: The median value for the project area was 40%; the management areas were at moderate levels of 28 – 49.0%; sixteen reaches met or exceeded the high breakpoint level.
  - Percent bedrock: The median value for the project area was 6%; bedrock was moderate to high in the three management areas (3 – 13%); thirteen reaches met or exceeded the low breakpoint level.
  - Pieces lwd/100m: The median value for the project area was high (24.4); management area median value ranged from 13.9 – 25.0 (moderate to high); 37 reaches met or exceeded the high breakpoint level.
  - Volume lwd/100m: The median value for the project area was 40.5; each management area was in the moderate level (20.6 – 52.1); 26 reaches met or exceeded the high breakpoint level.
  - Key pieces lwd/100m: The median value was 0.9; management areas median value ranged from 0.5 – 1.1 (moderate); eleven reaches met or exceeded the high breakpoint level.
  - Number of conifers >50cm dbh/305m: The median value for the project area was low at 20.0; except for the Tillamook (10.0), the management median value was moderate (24.7 – 36.2); no reaches met or exceeded the high breakpoint level.
  - Number of conifers >90cm dbh/305m: The project area and management area median value was low (0.0); no reaches met or met or exceeded the high breakpoint level.
  - Percent shade: The median value for the project area (91.5%) and management area (92.5 – 95.0) was high, except the Forest Grove management area (80.0%) which was at the moderate level; 33 reaches met or exceeded the high breakpoint level.

What stream reaches have high, moderate, and low levels of key pieces of large wood (>24-in) in the channel.

- Key pieces/100m: The median value for the project area was 0.9 which was in the low level; the management areas had low to moderate values (0.5 – 1.1); eleven reaches met or exceeded the high breakpoint level.

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What is the condition of the fish habitat in the watershed (by 5^th^ field) according to existing habitat data?

- Summer rearing habitat for juvenile coho salmon is moderate, given the high percent of pool habitat and area of low gradient (<5%) stream area in the North Fork Nehalem drainage.
- Winter capacity and quality is low in both the North Fork Nehalem and Salmonberry drainages, although streams in the North Fork Nehalem have a greater potential to support coho salmon. Off-channel habitat, slow water pools, and deep, complex pools are limited.
- The amount of spawning gravel is moderate to high in the lower Nehalem study area, although the quality of the spawning habitat is higher in the Salmonberry drainage.
- Few high quality reaches for juvenile salmonid production are present.

How many miles of fish-bearing or potentially fish-bearing streams are blocked by culverts, and where are these blockages?

- Twenty-seven potential fish barriers were identified within the Lower Nehalem project area. Two culverts are suspected to prevent fish passage (Record Id 55355 and 55356) based on fish distribution, but passage is unknown according to Streamnet; closer inspection is warranted. Four culverts are noted as impassable (completely or partially), one is noted as non-blocking, and the status of the remaining five is unknown. The other potential barriers are natural waterfalls (14); passage is unknown. A log jam is also noted to potentially prevent Chinook passage. It is possible that other barriers not noted here exist.
- The amount of aquatic habitat with restricted access in the Lower Nehalem project area based on Streamnet barrier data is approximately 45 kilometers. The amount on ODF land resulting from passage problems may total 40 kilometers. Documentation as to the species and life stage affected by each barrier is limited. Field surveys to improve documentation is recommended. As five of the seven structures potentially limiting fish distribution are natural falls, attention should be directed towards the culvert issues as well as provide adequate habitat downstream of these falls.

Are there watersheds where the current level of instream wood is a limiting factor for achieving properly functioning aquatic systems?

- Several reaches in the Lower Nehalem project area meet the lwd reference conditions for number of pieces and volume per 100m (Tables 5 and 6B and Map 19). Key pieces are found in select reaches, but the number is few. Additional large wood would increase the opportunity for complex instream habitat, creation of off-channel habitat, and sediment sorting.

- Large wood is a limiting factor in the Lower Nehalem project area for creation of high quality winter rearing habitat for salmonids.
- The Sweethome Creek watershed, and North Fork Salmonberry Tributary 1 and a reach of Soapstone each met the high breakpoint level for number of pieces, volume, and key pieces of lwd/100m.
- Watersheds limited by the level of instream wood include Sally Creek, East Fork Foley Creek, the mainstem Salmonberry River, Wolf Creek, Coal Creek, and Fall Creek. These stream systems had few to no reaches meeting the high level. Many reaches had moderate levels of wood volume or number of pieces, yet few had more than one key piece per 100m. Overall, the Astoria management area had the most reaches with high levels of pieces and volume. Key pieces rated as moderate in the management areas. The Sweethome watershed was noticeably consistent with these levels of wood.

Analyze restoration potential

Which reaches have the most potential to increase fish populations?

- Reaches with the most potential to increase fish production are those with high intrinsic potential that are within Salmon Anchor Habitat watershed or watersheds with high fish abundance. Secondarily, reaches within Salmon Anchor Habitat watersheds that have an abundance of pool habitat have the potential to respond to restoration treatments and improve fish productivity.
- A long term strategy to grow large conifer trees in the riparian area will improve conditions across the project areas and increase complexity of stream habitat for fish production as the trees naturally recruit to the channel. Although alders along the streamside serve important functions, large riparian conifers are necessary as well for their size and persistence in the system.
- Site selection will require an in-depth analysis of the unit level GIS and Oregon Plan site data coupled with field verification. Reviewing areas of high intrinsic potential (wide valley, low gradient, and low to moderate flow) (Map 15) combined with ground verification would be beneficial. Comparing areas of high intrinsic potential for coho salmon with locations that score well in the Limiting Factors and HabRate models will also help in selecting likely coho salmon restoration areas. Habitat complexity and floodplain connectivity requires the placement of large wood in selected stream segment to create complex pool and channel breaching opportunities. Taking advantage of the existing secondary channels will accelerate the process. Thom and Moore (1997) identified numerous potential reaches on ODF land for restoration, some of which have not yet been treated.
- Reduction of fine sediment in the North Fork Nehalem drainage will require additional information to determine source, transport, and storage of sediment in the basin. The data available through the stream surveys only identify areas collecting excessive amounts of fine sediment.
- Site verification prior to restoration planning is necessary because some of the surveys are 10 years old and proper implementation depends on current site-specific factors.

Which reaches have the most potential to meet or exceed benchmark levels?

- All of the reaches have the potential to meet many of the benchmark conditions over time. However, the streams in the North Fork Nehalem drainage have the greatest potential to be restored. Restoration and protection strategies can expedite the opportunity to improve aquatic habitat complexity, sediment, and riparian structure in the Lower Nehalem project area.
- Examples of areas with high intrinsic potential for coho salmon include the following:

  The upper reaches of Hakura Creek
  The upper reaches of Fall Creek
  Soapstone Creek from approximately the confluence with Jack Horner Creek and extending upstream
  The upper reaches of North Fork Nehalem River on ODF land above the confluence with Little North Fork Nehalem.
  Upper reaches of Salmonberry River

What is the magnitude of possible additional habitat with restoration of access?

- The two culverts potentially blocking upstream passage of fish should be examined. The culverts known to block passage and those with unknown passage ability should also be examined. Surveys are needed to determine the condition of the culvert, the ability of fish of many sizes and life stages and types to pass, and to document the quantity and quality of habitat for salmonid species above the culverts.

What is the relative priority of barriers for removal, replacement, or repair?

- The ODF and Streamnet barrier databases do not provide a lot of detail. Site checks are necessary to verify the nature and extent of the passage issues.

Describe the types and locations of potential enhancement projects?

- Based on the intrinsic potential information (valley width, stream gradient, active channel width, stream flow), many of the streams on ODF land are moderate to good candidates for enhancement activities. With the exception of the smallest tributaries and the headwaters areas, most streams are low gradient, in moderate to wide channels and valleys. Many streams would benefit from the addition of large woody debris, which would entrap substrate, scour deep pools, and provide cover for fish. Examples include the Sweethome Creek watershed, Coal Creek, Soapstone Creek, the Cronin watershed, and the Cook Creek basin.
- Enhancement activities can be more effective when a watershed approach is utilized. For example, rather than constructing one or two habitat structures in each of ten widely scattered locations, constructing these same structures in one watershed can enhance a longer continuous section of stream. With riparian plantings and the removal of a passage barrier, a whole stream could be improved.
- Priorities related to fish habitat are discussed above – improving habitat complexity, floodplain connectivity, scouring of pool habitat, and reduction of fine sediment, and retention of spawning gravel.
- Riparian plantings that increase the number, size, and species of conifer trees in the riparian zone would benefit floodplain connectivity and increase shade levels and long-term large wood recruitment. Riparian enhancement for larger and greater mix of conifer species will

again require site visits to identify appropriate floodplain and terrace sites within the Lower Nehalem corridor.

- The riparian surveys are a sample (not a census) of conditions along the Lower Nehalem River, and hence only indicate the need for restoration.

Describe confidence level in restoration analysis.

- The aquatic surveys, between 1992 and 2004, described the overall conditions within each reach at the time of the survey. Restoration recommendations were based on existing habitat surveys (although selected attributes of the habitat data may be out of date for this use), channel and valley configuration, and digital elevation models. Because successful restoration depends on site-specific characteristics, we recommend: 1) site visits prior to final planning, 2) analysis of habitat data (available in GIS and database) at the habitat unit scale, 3) re-examination of gradient and valley form, 4) more comprehensive road and barrier information, and 5) more detailed description of riparian conditions.

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Tables, Figures, and Maps

Table 1. ODFW habitat surveyed streams within the Lower Nehalem and Necanicum project area.

ODF management area	Basin	ODFW surveyed stream	Survey Year
ASTORIA - NECANICUM	ELK (ECOLA)	NORTH FORK ELK CREEK	1994
	NECANICUM	BERGSVIK CREEK	1992
ASTORIA - NEHALEM	FALL CREEK	HAKURA CREEK	1997
	NORTH FORK NEHALEM RIVER	FALL CREEK	1994
	NEHALEM RIVER	NEHALEM RIVER UNNAMED TRIBUTARY	2004
	NEHALEM RIVER	NORTH FORK NEHALEM RIVER	1994
	NEHALEM RIVER	NORTH FORK NEHALEM RIVER TRIB R (NC-1640)	2001
	NORTH FORK NEHALEM RIVER	SALLY CREEK	1996
	NORTH FORK NEHALEM RIVER	SOAPSTONE CREEK	1994
	SOAPSTONE CREEK	SOAPSTONE LAKE TRIB	1999
	NORTH FORK NEHALEM RIVER	SWEETHOME CREEK	2002
	SWEETHOME CREEK	SWEETHOME CREEK TRIBUTARY A	2002
	SWEETHOME CREEK	SWEETHOME CREEK TRIBUTARY B	2002
	SWEETHOME CREEK	SWEETHOME CREEK TRIBUTARY C	2002
	SWEETHOME CREEK	SWEETHOME CREEK TRIBUTARY D	2002
	SWEETHOME CREEK	SWEETHOME CREEK TRIBUTARY D1	2002
	SWEETHOME CREEK	SWEETHOME CREEK TRIBUTARY E	2004
	SWEETHOME CREEK	SWEETHOME CREEK TRIBUTARY E1	2004
	SWEETHOME CREEK	SWEETHOME CREEK TRIBUTARY F	2004
TILLAMOOK - NEHALEM	NEHALEM RIVER	ANDERSON CREEK (NC-1768)	2001
	NEHALEM RIVER	COOK CREEK (NC-1154)	2002
	FOLEY CREEK	EAST FOLEY CREEK	1994
	NEHALEM RIVER	HELLOFF CREEK (NC-1088)	2002
	NEHALEM RIVER	NORTH FORK CRONIN CREEK (NC-1098)	2000
	NEHALEM RIVER	NORTH FORK CRONIN CREEK (NC-1219)	2000
	NEHALEM RIVER	PETERSON CREEK (NC-1742)	2003
	NEHALEM RIVER	SALMONBERRY RIVER	1993
FOREST GROVE - NEHALEM	SALMONBERRY RIVER	NORTH FORK SALMONBERRY RIVER	1993
	SALMONBERRY RIVER	NORTH FORK SALMONBERRY TRIB 1	1993
	SALMONBERRY RIVER	NORTH FORK SALMONBERRY TRIB 1A	1993
	SALMONBERRY RIVER	PENNOYER CREEK (NC-1319)	2004
	SALMONBERRY RIVER	PENNOYER CREEK	1994
	SALMONBERRY RIVER	SALMONBERRY RIVER	1993
	SALMONBERRY RIVER	WOLF CREEK	1995

Table 2. Salmon Habitat and Diversity Watersheds: Species abundance within the Nehalem basin.
Coho, Fall Chinook, and Chum: based on 1989 – 2000 spawning survey data.
Steelhead: presence (X) based on professional judgment of ODFW biologists (Susac) and steelhead status review (Chilcote 1997).
Colors and percentiles on Map 13 match percentiles listed below.
Oregon Department of Forestry (ODF) Salmon Anchor Habitats (X) are indicated in the table and on Map 14..
Project Area refers to ODF Lower Nehalem Habitat Assessment project area.

Ref. #	Sub-watershed Name	Coho	Fall Chinook	Chum	Steelhead	ODF- Salmon Anchor Habitat	Within Project Area
6	Upper Nehalem River	>75				X	
7	Wolf Creek	>75				X	
8	Clear/Robinson Creek	>75					
9	Beaver/Cedar Creek						
10	Upper Rock Creek	>75			X	X	
11	Middle Rock Creek	>75			X		
12	Lower Rock Creek				X		
13	Pebble Creek						
14	East Fork Nehalem River						
15	Crooked Creek						
16	Oak Ranch Creek						
17	Ford/Lundgren Creek						
18	Deer Creek						
19	Calvin Creek						
20	Fishhawk Lake Creek	>90			X	X	
21	Northrup Creek						
22	Deep Creek						
23	Middle Nehalem River						
24	Fishhawk Creek						
25	Beneke Creek						
26	Cow/Quartz Creek		> 90				
27	Buster Creek	>75	>75			X	
28	Cronin Creek	>75	>90				X
29	Humbug Creek	>75	>90				
30	Upper Salmonberry River						X
31	Middle Salmonberry River				X	X	X
32	N. Fk. Salmonberry River						X
33	Lower Salmonberry River		>75				X
34	Upper N.Fk. Nehalem River	>90				X	X
35	Middle N.Fk. Nehalem River	>90	>90				X
36	Lower N.Fk. Nehalem River	>75		>75			X
37	Lost/Helloff Creek		>75				X
38	Cook Creek		>90		X	X	X
39	Lower Nehalem River			>75			X
40	Foley Creek	>75		>90		X	X
41	Nehalem Bay						
42	Upper Little Nestucca River						

Table 3. Habitat breakpoints based on reference streams within the distribution of coho salmon.

Parameter	Definition	Low break point	High break point
percent pools	percent primary channel area represented by pool habitat	<19%	>45%
deep pools/km	pools > 1m deep per kilometer of primary channel	=0	4
percent slackwater pools	percent primary channel area - slackwater pool habitat (beaver pond, backwater, alcoves, isolated pools).	=0%	>7%
percent seccondary channels	percent total channel area represented by secondary channels	<0.8%	>5.3%
pieces lwd/100m	# pieces of wood > 0.15m diameter X 3m length per 100 meters primary stream length	<8	>21
volume lwd/100m	volume (m3) of wood > 0.15m diameter X 3m length per 100 meters primary stream length	<17	>58
key pieces lwd/100m	# pieces of wood > 60 cm diameter X > 12 meters long per 100 meters primary stream length	<0.5	>3
percent fines in riffles	visual estimate of substrate composed of <2mm diameter particles	<8%	>22%
percent gravel in riffles	visual estimate of substrate composed of 2-64mm diameter particles	<26%	>54%
percent bedrock in stream	visual estimate of substrate composed of solid bedrock	<1%	>11%
# conifers > 50 cm dbh	number of conifer trees larger than 50 cm dbh within 30m both sides of stream per 305m of primary stream length	<22	>153
# conifers > 90 cm dbh	number of conifer trees larger than 90 cm dbh within 30m both sides of stream per 305m of primary stream length	=0	>79
percent shade	percent of 180 degree sky; includes topographic and tree shade	<76%	>91%

Table 4. Comparison of reach length, active channel width, gradient, ownership, ecoregions, and geology between reference surveys and ODF Lower Nehalem and Necanicum management areas.

		ODF management area			Lower Nehalem
Attribute	**Reference Reaches**	**Tillamook**	**Forest Grove**	**Astoria**	**study area**
Number of Reaches or Sites	124	9	15	42	66
Distance Surveyed - Total (km)	162km	10.5km	47km	53km	111km
Mean (median)	1306m (971m)	1167m (1043m)	3168m (2915m)	1260m (1039m)	1681m (1072m)
Range	174 - 6776m	457 - 2845m	487 - 6978m	241 - 4558m	241 - 6978m
Active Channel Width (meters):					
Mean (Median)	9.28m (7.28m)	9.6m (10.9m)	12.4m (10.4m)	6.4m (5.4m)	8.2m (6.2m)
Range	1.5 – 31.5m	5.7 - 13.3m	2.5 - 26.3m	1.1 - 19.5m	1.1 - 26.3m
Gradient (%):					
Mean (median)	2.8 (2.3)	7.2 (4.2)	6.0 (3.6)	5.6 (4.2)	5.9 (4.2)
Range	0.5 – 19.2	1.6 - 18.0	1.2 - 16.1	0.4 - 21.2	0.4 - 21.1
Ownership	Primarily federal	State	State	State	State
Ecoregions	Coastal 80% Cascades 20%	100% Coastal	100% Coastal	100% Coastal	100% Coastal
Geology	Sedimentary 72% Volcanic 21% Mixed 7%	Volcanic 80% Sedimentary 20%	Volcanic 100%	Volcanic 60% Sedimentary 40%	Volcanic 75% Sedimentary 25%

Table 5. Habitat survey reach values and habitat parameter breakpoints relative to reference conditions in the Lower Nehalem project area.

		ODF Lower Nehalem management areas						ODF Lower Nehalem study area	
		Tillamook		Forest Grove		Astoria			
		10.5km	n=9	47km	n=15	53km	n=42	111km	n=66
Parameter	Habitat Breakpoints	mean	median	mean	median	mean	median	mean	median
percent pools	Low <19%	18.5	17.7						
	Moderate			29.5	23.0	31.9	27.7	29.5	27.5
	High >45%								
deep pools/km	Low 0								
	Moderate	1.6	1.3		2.3	1.6	0.7	2.1	1.1
	High >3			3.6					
% slackwater pools	Low 0				0.0				
	Moderate	0.7	0.4	1.0			1.2	6.6	0.4
	High >7%					9.9			
% secondary channel area	Low <0.8%				0.5				
	Moderate	3.6	3.1	2.0		4.1	2.6	3.5	2.5
	High >5.3%								
% fines in riffles	High >22%								
	Moderate	16.3	10.0	18.9	16.0	20.1	14.5	19.3	15.0
	Low <8%								
% gravel in riffles	Low <26%								
	Moderate	45.4	40.0	28.9	28.0	47.0	49.0	42.7	40.0
	High >54%								
% bedrock	High >11%			12.4	13.0				
	Moderate	9.2	7.0			6.7	3.0	8.3	6.0
	Low <1%								
pieces LWD/100m	Low <8								
	Moderate		13.9		16.8				
	High >21	22.7		26.8		28.0	25.0	27.0	24.4
volume LWD/100m	Low <17								
	Moderate	51.2	20.6	39.5	24.3	58.0	52.1	53.0	40.5
	High >58								
key pieces/100m	Low <0.5		0.5						
	Moderate	2.3		1.3	0.5	1.8	1.1	1.8	0.9
	High >3								
# conifers >50cm dbh	Low <22		10.0						20.0
	Moderate	23.4		35.4	36.2	27.8	24.7	28.9	
	High >153								
# conifers >90cm dbh	Low 0		0.0		0.0		0.0		0.0
	Moderate	9.1		1.1		3.1		3.5	
	High >79								
% shade	Low <76%								
	Moderate			81.0	80.0	89.3		87.9	
	High >91%	92.7	95.0				92.5		91.5

Table 6A. Summary of summer habitat reaches surveyed within the Lower Nehalem project area by ODF management area.

LOWER NEHALEM PROJECT AREA
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
ASTORIA MANAGEMENT AREA														
CRONIN CR, N FK	9/5/2000	948	**8.6**	1.6	2.5	MV	CH	ST		78	4	**4**	42	96
CRONIN CR, N FK	7/31/2000	457	0.0	13.6	1	MV	CH	ST		84	12	25	40	52
FALL CREEK	7/29/1994	2689	0.3	1	4.8	CT	CA	LT		**92**	2	**5**	50	22
FALL CREEK	7/29/1994	591	**5.8**	1.5	4.7	CT	CA	LT		84	2	**7**	**62**	1
FALL CREEK	7/29/1994	1065	1.4	2.1	1.8	MV	CH	LT		84	11	13	51	10
FALL CREEK	7/26/1994	2970	2.6	2.3	2.3	MV	CH	LT		84	23	**7**	**62**	1
HAKURA CREEK	7/1/1997	674	1.9	0.4	4.9	MT	US	ST	MT	73	**0**	40	**60**	6
HAKURA CREEK	7/2/1997	516	1.4	0.7	7.8	CT	CA	MT	ST	**97**	**0**	15	**82**	0
HAKURA CREEK	6/25/1997	295	0.8	2.4	1.8	MV	CH	ST		73	6	17	**66**	65
HAKURA CREEK	7/1/1997	585	2.5	2.8	1.6	MV	CH	ST		71	15	14	**60**	12
HAKURA CREEK	6/23/1997	474	**17.2**	3	3.6	MT	US	ST		72	**1**	11	**58**	128
NEHALEM R, N FK, TRIB R	8/14/2001	499	3.7	11.5	1.2	SV	CH	MT		91	14	10	**55**	45
NORTH FORK NEHALEM RIVER	9/8/1994	3617	0.3	0.4	8.4	CT	CT	YT		62	3	45	48	7
NORTH FORK NEHALEM RIVER	9/1/1994	4558	0.7	0.9	1.8	MV	CH	ST		67	14	13	28	2148
NORTH FORK NEHALEM RIVER	9/12/1994	882	0.4	3.7	1.5	MV	CH	YT	ST	87	**0**	45	53	0
SALLY CREEK	9/4/1996	1173	2.8	5.1	3.2	MT	CA	YT	ST	90	**1**	15	42	97
SALLY CREEK	9/5/1996	487	2.4	12.2	1.7	MV	CH	MT		**100**	12	15	50	65
SOAPSTONE CREEK	6/28/1994	537	0.0	1.1	2.4	SV	CH	ST		87	15	10	10	35
SOAPSTONE CREEK	6/30/1994	1313	4.0	1.5	2.2	MV	CH	ST		90	13	19	27	22
SOAPSTONE CREEK	6/29/1994	2062	2.0	1.6	3.1	CT	CA	ST	YT	85	38	**7**	11	130
SOAPSTONE CREEK	7/7/1994	857	0.5	2.4	4.4	SV	CH	TH		62	3	48	43	0
SOAPSTONE CREEK	7/5/1994	790	8.2	4.3	4.1	CT	CA	ST		**98**	**0**	28	29	2
SOAPSTONE LAKE TRIB	7/13/1999	241	0.9	3.6	3.5	CT	CT	ST	YT	83	3	13	30	102
SOAPSTONE LAKE TRIB	7/15/1999	401	0.0	7	1	MV	CH	ST	LT	88	11	50	25	216
SWEETHOME CREEK	7/10/2002	2375	**10.3**	3.2	4.2	MT	CT	ST		**97**	16	18	36	2006
SWEETHOME CREEK	7/9/2002	1012	**8.7**	3.7	3.1	MT	CT	ST	YT	**98**	6	19	27	1452
SWEETHOME CREEK	7/11/2002	899	3.8	4.2	1.6	SV	CH	YT	MT	**98**	7	15	41	598
SWEETHOME CREEK	7/11/2002	1548	**8.8**	13.5	2.5	SV	CH	ST	MT	**100**	**0**	18	53	2096
SWEETHOME CREEK TRIBUTARY A	7/23/2002	1773	2.5	3.2	4.4	MT	CA	YT	MT	85	**0**	**5**	**60**	305
SWEETHOME CREEK TRIBUTARY A	7/22/2002	539	**15.2**	6	3.9	MT	CA	YT		**93**	3	**1**	24	647
SWEETHOME CREEK TRIBUTARY A	7/22/2002	1066	**5.3**	8.7	2.2	SV	CH	MT	ST	**93**	7	10	28	653
SWEETHOME CREEK TRIBUTARY A	7/24/2002	1259	1.6	21.1	1.4	SV	CH	MT		**100**	11	**5**	**85**	1981
SWEETHOME CREEK TRIBUTARY B	7/30/2002	966	1.8	6	1.5	SV	CH	ST		**94**	2	14	47	334
SWEETHOME CREEK TRIBUTARY B	7/30/2002	1805	2.4	10	1.5	SV	CH	ST		**100**	3	20	**59**	632
SWEETHOME CREEK TRIBUTARY C	8/1/2002	861	1.5	4.2	3.4	MT	CA	ST		**100**	**0**	13	**65**	26
SWEETHOME CREEK TRIBUTARY C	8/1/2002	1339	2.1	10.8	1.8	MV	CH	ST		**100**	3	10	**84**	74
SWEETHOME CREEK TRIBUTARY D	7/11/2002	1092	**9.2**	4.8	2.2	SV	CH	YT	MT	**98**	9	11	42	1246
SWEETHOME CREEK TRIBUTARY D	7/11/2002	1496	**9.0**	10.9	1.8	SV	CH	YT	ST	**98**	14	9	38	1627

Table 6A. Summary of summer habitat reaches surveyed within the Lower Nehalem project area by ODF management area.

LOWER NEHALEM PROJECT AREA
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
SWEETHOME CREEK TRIBUTARY D1	7/17/2002	1200	**8.4**	9.6	2.9	CT	CA	MT	ST	**96**	2	10	**80**	743
SWEETHOME CREEK TRIBUTARY E	8/10/2004	576	3.5	5.7	3.2	CT	CA	ST		**100**	**0**	45	40	0
SWEETHOME CREEK TRIBUTARY E	8/10/2004	1285	4.1	10	1.8	SV	CH	ST		91	3	65	25	47
SWEETHOME CREEK TRIBUTARY E1	8/12/2004	424	**5.7**	13.3	3.3	CT	CA	ST	LT	**99**	**0**	45	50	53
SWEETHOME CREEK TRIBUTARY F	8/12/2004	1164	4.4	8.4	2.5	MV	CH	ST		**95**	6	32	51	53
FOREST GROVE MANAGEMENT AREA														
NEHALEM RIVER UNNAMED TRIBUTARY	9/1/2004	2951	3.5	6.7	2.5	MV	CH	LT	ST	**96**	2	34	40	341
NORTH FORK SALMONBERRY RIVER	8/24/1993	1533	0.3	4.9	1	MV	CB	LT		83	23	10	27	713
NORTH FORK SALMONBERRY TRIB 1	9/13/1993	4027	0.5	11.2	1.4	SV	CH	ST		72	17	23	40	1115
NORTH FORK SALMONBERRY TRIB 1A	9/20/1993	861	0.5	16.1	1.5	SV	CH	ST		74	27	20	15	256
PENNOYER CR (NC-1319)	9/9/2004	543	3.4	4.2	1.9	MV	CH	ST		**93**	**1**	33	30	13
PENNOYER CREEK	9/19/1994	2828	0.5	3.6	2.1	SV	CH	ST		75		58	24	99
PENNOYER CREEK	9/19/1994	494	0.0	10.3	1.1	SV	CH	ST		80	14	10	15	352
PENNOYER CREEK	9/19/1994	871	0.0	14.7	1.5	SV	CH	ST		81		15	34	95
SALMONBERRY RIVER	10/18/1993	4677	2.5	2	1	SV	CH	ST		71	6	**7**	41	2025
SALMONBERRY RIVER	10/19/1993	6978	2.7	2.3	1.4	MV	CH	ST		80	5	9	38	2558
SALMONBERRY RIVER	10/20/1993	2859	1.5	3.2	1.8	MV	CH	ST		87	5	**5**	35	813
SALMONBERRY RIVER	9/2/1993	4643	**6.2**	3.2	1.6	SV	CH	LT	MT	**95**	19	33	28	1966
WOLF CREEK	8/22/1995	2971	0.5	3.5	1.3	SV	CB	ST	LT	**93**	16	**7**	23	526
WOLF CREEK	8/23/1995	5355	**6.6**	8.4	1.5	SV	CH	ST	LT	**95**	28	16	29	772
TILLAMOOK MANAGEMENT AREA														
ANDERSON CR	9/3/2001	515	2.3	18	1.6	ST	CH	ST	TH	**95**	5	**6**	24	193
COOK CREEK (NC-1154)	7/15/2002	1077	**6.1**	3	3.4	CT	CA	ST		**95**	29	**5**	17	313
EAST FOLEY CREEK	8/4/1994	2845	3.1	2.3	8.3	MT	CT	TH	ST	**93**	**0**	15	**76**	48
EAST FOLEY CREEK	8/9/1994	1049	3.8	3.5	3	CT	CA	ST	YT	**98**	3	10	**85**	86
EAST FOLEY CREEK	8/9/1994	1566	1.8	12.4	1.1	MV	CH	ST	YT	**100**	8	60	35	532
HELLOFF CREEK (NC-1088)	7/12/2002	1004	0.5	4.2	3.9	MT	CA	ST		**96**	15	**4**	50	202
PETERSON CREEK (NC-1742)	8/30/2003	1043	**6.0**	6.4	2.3	CT	CA	ST		**95**	7	18	40	1070
SALMONBERRY RIVER	10/6/1993	2915	0.1	1.2	1.1	SV	CH	YT	LT	68	13	18	26	644
SALMONBERRY RIVER	9/9/1993	5962	3.9	1.3	1.2	SV	CH	RR	LT	69	12	19	28	3119

*see methods for an explanation of abbreviations
figures in bold met or exceeded the high breakpoint for the specific attribute.

Table 6B. Summary of summer habitat reaches surveyed within the Lower Nehalem project area by ODF management area.

LOWER NEHALEM PROJECT AREA
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	WOOD DEBRIS KEY PIECES #/100m	CONIFER TREES TOTAL/1000ft	RIPARIAN CONIFERS #>50cm dbh /305m	RIPARIAN CONIFERS #>90cm dbh /305m
ASTORIA MANAGEMENT AREA													
CRONIN CR, N FK	948	13.3	2.5	36.1	2.14	1.9	0.56	**36.7**	**99.4**	**3.7**	20	20	0
CRONIN CR, N FK	457	10.7	21.3	1.7		2.2	0.95	**76.4**	**228.2**	**14.2**	325	0	0
FALL CREEK	2689	6.6	17.9	41.1	**29.7**	**4**	0.6	7.5	11.7	0.4	457	61	0
FALL CREEK	591	3.3	16.1	38.3	0.8	1.4	0.6	6.8	7.9	0.8	0	0	0
FALL CREEK	1065	6.9	13.5	44.8	**33.3**	**3.6**	0.6	15.3	15.8	0.4	183	30	0
FALL CREEK	2970	10.2	16.1	38.3	**7.9**	1.4	0.6	11	16	0.6	134	0	0
HAKURA CREEK	674	5.2	5.2	**72.8**	**31.8**	**5.7**	0.5	20.9	24.1	0.9	427	0	0
HAKURA CREEK	516	4.5	3.5	**72.2**	0.5	1.9	0.4	14.7	35.4	0.6	488	20	0
HAKURA CREEK	295	6.4	4	38.6	**14**	13	0.6	**24.8**	47.7	2	427	0	0
HAKURA CREEK	585	6.2	4.3	**46.2**	**12.8**	0	0.4	**22.8**	52.9	1.7	467	41	0
HAKURA CREEK	474	6.9	4.5	27.8	1.9	1.3	0.4	**37.7**	**68.8**	**4.4**	650	0	0
NEHALEM R, N FK, TRIB R	499	4.6	8.3	15.6		0	0.36	**33.6**	**70.5**	2.2	284	41	41
NORTH FORK NEHALEM RIVER	3617	8.7	9.7	**86.6**	**39.1**	2.5	0.5	**24.3**	25.6	0.7	488	15	0
NORTH FORK NEHALEM RIVER	4558	19.5	8.6	33.2	0.1	**4.3**	1.1	19.8	12	0.2	152	30	30
NORTH FORK NEHALEM RIVER	882	6.4	68.9	37.2		0	0.5	**31.7**	41.6	0.7		0	0
SALLY CREEK	1173	6	7.8	27.4		0	0.4	12.4	24.3	1.5	152	0	0
SALLY CREEK	487	2.5	32.5	7.3		0	0.3	**25.1**	**81.8**	**6**			
SOAPSTONE CREEK	537	15.1	4.4	**69.2**	0	**5.6**	0.8	3.9	4.6	0.2	457	122	0
SOAPSTONE CREEK	1313	5.5	8	27.5	0.35	0	0.4	16.7	32.2	1.7	102	20	0
SOAPSTONE CREEK	2062	10.2	7.4	29.9	0	**4.1**	0.6	13.2	19.3	1.1	366	15	0
SOAPSTONE CREEK	857	7.5	9.8	**88.7**	**87.6**	**3.4**	0.3	**28.7**	51.3	1.6	640	61	0
SOAPSTONE CREEK	790	5.4	6.9	27.1		1.1	0.4	**36.7**	**68.9**	**3.3**	0	0	0
SOAPSTONE LAKE TRIB	241	5.5	9	12.5	0	0	0.22	9.5	23.3	0.8	61	0	0
SOAPSTONE LAKE TRIB	401	5.3	6.9	18.8		0	0.2	**27.4**	25.4	0.2	244	0	0
SWEETHOME CREEK	2375	9.1	4.6	25.6	1.2	3	0.59	**31.9**	**72.6**	1.6	803	51	30
SWEETHOME CREEK	1012	16.9	3.8	21.3		0.9	0.57	**23**	46.9	0.7	2134	0	0
SWEETHOME CREEK	899	7.4	2.9	32.2		1	0.37	**38.9**	**58.2**	0.2	711	81	0
SWEETHOME CREEK	1548	4.1	8.9	10.8		0	0.28	**29.8**	**59.2**	1	1219	91	0
SWEETHOME CREEK TRIBUTARY A	1773	5.4	4.2	**69.3**	**50.5**	**3.1**	0.48	**26.5**	**75.2**	**5.5**	589	10	0
SWEETHOME CREEK TRIBUTARY A	539	5	4.4	35.2		0	0.39	**23.6**	46.8	0.2	1219	0	0
SWEETHOME CREEK TRIBUTARY A	1066	4.8	6.1	22.1		2.5	0.38	**87.6**	**277.4**	**10.9**	122	30	0
SWEETHOME CREEK TRIBUTARY A	1259	3.8	38.4	1.6		0	0.25	**34.8**	**107.8**	2.8	488	30	0
SWEETHOME CREEK TRIBUTARY B	966	5.1	3.5	35.5		0	0.48	**50.8**	**68.4**	0.1	472	15	0
SWEETHOME CREEK TRIBUTARY B	1805	4.2	11.3	10.8		0.5	0.42	**45.7**	**73.6**	0.5	899	46	0
SWEETHOME CREEK TRIBUTARY C	861	4.6	6	29.5		0	0.35	**24.4**	**64.3**	2.2	91	30	30
SWEETHOME CREEK TRIBUTARY C	1339	3.3	21.7	8.8		0	0.26	**52.4**	**153.2**	**5.6**	224	41	0
SWEETHOME CREEK TRIBUTARY D	1092	9.4	3.7	24.3		0	0.43	**42.8**	**91.6**	1.3	914	41	0
SWEETHOME CREEK TRIBUTARY D	1496	5.7	6.4	18.2		0.6	0.43	**51.8**	**108.6**	1.1	1250	46	0
SWEETHOME CREEK TRIBUTARY D1	1200	4.5	10.7	7.8		0	0.35	**39.3**	**83.4**	1.6	325	0	0
SWEETHOME CREEK TRIBUTARY E	576	4.4	8.5	23.7		0	0.33	20.8	**59.6**	1.4	853	0	0
SWEETHOME CREEK TRIBUTARY E	1285	2.9	47.7	32.1		0.7	0.42	17.4	**71.3**	3	813	0	0

Table 6B. Summary of summer habitat reaches surveyed within the Lower Nehalem project area by ODF management area.

LOWER NEHALEM PROJECT AREA
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	WOOD DEBRIS KEY PIECES #/100m	CONIFER TREES TOTAL/1000ft	RIPARIAN CONIFERS #>50cm dbh /305m	RIPARIAN CONIFERS #>90cm dbh /305m
SWEETHOME CREEK TRIBUTARY E1	424	1.1	0	0.0		0	0	**26.4**	39.3	0.2	1036	61	0
SWEETHOME CREEK TRIBUTARY F	1164	2.1	41	8.8		0.8	0.55	**36.6**	**82.1**	2.6	823	91	0
FOREST GROVE MANAGEMENT AREA													
NEHALEM RIVER UNNAMED TRIBUTARY	2951	4.9	17.8	19.5		0.3	0.49	**24.4**	37.5	0.9	293	49	0
NORTH FORK SALMONBERRY RIVER	1533	19.2	3.2	**48.7**		**12.3**	1.6	0.9	1.6	0	91	0	0
NORTH FORK SALMONBERRY TRIB 1	4027	10.4	9.4	15.2		2.3	0.7	**57.7**	**125.7**	**4.2**	122	0	0
NORTH FORK SALMONBERRY TRIB 1A	861	4.7	91.6	7.6		0	0.5	**88**	**121.8**	**3.5**	122	0	0
PENNOYER CR (NC-1319)	543	4.8	6.2	40.4		0	0.35	**29.1**	20	0.4	203	41	0
PENNOYER CREEK	2828	5.9	20	**80.7**		1	0.5	**33.4**	38.9	0.4	183	41	0
PENNOYER CREEK	494	5.5	15	17.4		**4.1**	0.8	**79**	**85.9**	1.6	244	0	0
PENNOYER CREEK	871	14.2	0	0.0		0	0	**38.1**	**63.9**	0.6	0	0	0
SALMONBERRY RIVER	4677	21.2	6.7	36.1	0.2	**6**	1.4	1.2	2.1	0.1	274	48.3	0
SALMONBERRY RIVER	6978	14.3	9.8	20.4	0.3	**5.3**	1.1	6.7	12.7	1.2	427	24.1	0
SALMONBERRY RIVER	2859	8.5	12.5	16.7	1.52	2.1	0.6	16.8	44.7	**3.9**	274	60.3	0
SALMONBERRY RIVER	4643	8.8	6.9	29.7	**12**	1.4	0.5	14.8	24.2	1.8	572	108.6	0
TILLAMOOK MANAGEMENT AREA													
ANDERSON CR	515	5.7	47.3	1.3		0	0.25	11.6	11.7	0	224	0	0
COOK CREEK (NC-1154)	1077	11.3	4	28.8	1.03	0.8	0.43	13.6	19.4	0.2	20	0	0
EAST FOLEY CREEK	2845	11.3	3.7	28.3	1.1	1.3	0.5	9	12.2	0.2	132	10	10
EAST FOLEY CREEK	1049	10.9	6.1	17.7	0.4	1.8	0.5	10.3	20.6	0.7	183	30	60
EAST FOLEY CREEK	1566	6.1	10.6	10.3		**6**	0.4	16.9	29.2	1.1	244	49	12
HELLOFF CREEK (NC-1088)	1004	11.6	3.2	33.4		0	0.42	13.9	18.8	0.5	41	0	0
PETERSON CREEK (NC-1742)	1043	5.7	11.1	8.7		0	0.4	15.7	21.4	0.5	305	102	0
SALMONBERRY RIVER	2915	20.8	5.4	**52.8**	0.04	**7.5**	1.1	1.5	2.4	0.2	305	36.2	18.1
SALMONBERRY RIVER	5962	26.3	5	43.4	0	**5.2**	1	2.9	3.7	0.2	219	0	0
WOLF CREEK	2971	11.9	6.7	23.0	0	**5**	0.7	6.5	12.4	0.5	869	122	0
WOLF CREEK	5355	9.7	13.6	10.4		2.2	0.7	**24.8**	32.2	0.4	1183	49	0

*see methods for an explanation of abbreviations
figures in bold met or exceeded the high breakpoint for the specific attribute.

Table 7. Streams surveyed for the Lower Nehalem Watershed Council during the 2002 and 2003 winters.

River basin	subbasin	stream name	year
Necanicum	Necanicum	Bergsvik Creek	2003
Nehalem	Nehalem	Anderson Creek	2002, 2003
		Eck Creek	2003
		Fall Creek	2002
		Helloff Creek	2003
		Lost Creek	2002
		Peterson Creek	2002
		Salmonberry River	2003
		West Fork Coal Creek	2002
	Cook	Cook Creek	2003
		Dry Creek	2003
		EF Cook Creek	2003
		Forks Creek	2003
		Hanson Creek	2003
		Harliss Creek	2002
		Hoevet Creek	2003
		McKinney Creek	2003
		SF Cook Creek	2003
		Strahm Creek	2003
	Cronin	Cronin Creek	2003
		NF Cronin Creek	2003
		MF Cronin Creek	2003
	Foley	Dry Creek	2003
	NF Nehalem	Lost Creek	2002
		Sally Creek	2002
		Soapstone Creek and tribs	2002, 2003
		Sweethome Creek and ribs	2002

Table 8. Comparison of reach length, active channel width, gradient, ownership, ecoregions, and geology between reference surveys and ODF Lower Nehalem small streams (above coho salmon distribution).

Attribute	**Reference Reaches**	**Small streams in the Lower Nehalem**
Number of Reaches or Sites	124	19
Distance Surveyed - Total (km)	162km	27km
Mean (median)	1306m (971m)	1428m (861m)
Range	174 - 6776m	295 - 5355m
Active Channel Width (meters):		
Mean (Median)	9.28m (7.28m)	7.1m (6.1m)
Range	1.5 – 31.5m	3.3 - 19.2m
Gradient (%):		
Mean (median)	2.8 (2.3)	5.8 (3.6)
Range	0.5 – 19.2	0.4 - 16.1
Ownership	Primarily federal	State
Ecoregions	Coastal 80% Cascades 20%	100% Coastal
Geology	Sedimentary 72% Volcanic 21% Mixed 7%	Sedimentary 30% Volcanic 70%

Table 9. Comparison of reach attributes between small streams (upstream of coho distribution) and the Lower Nehalem project area.

Attribute	**Small stream surveys**	**Lower Nehalem project area**
Number of Reaches or Sites	19	66
Distance Surveyed - Total (km)	27km	111km
Active Channel Width (meters):		
Mean (Median)	7.1m (6.1m)	8.2m (6.2m)
Range	3.3 - 19.2m	1.1 - 26.3m
Gradient (%):		
Mean (median)	5.8 (3.6)	5.9 (4.2)
Range	0.4 - 16.1	0.4 - 21.1
Beaver activity sightings		
Percentage of sites	32	29
Number counted	72	132
Average number / kilometer	2.6	1.2
Mass failure sightings		
Percentage of sites	30	50
Number counted	31	128
Average number / kilometer	1.2	1.2

Table 10. Habitat survey reach values and habitat parameter breakpoints relative to reference conditions in the Lower Nehalem project area.

		ODF Lower Nehalem small streams 27km n=19		ODF Lower Nehalem study area 111km n=66	
Parameter	Habitat Breakpoints	mean	median	mean	median
percent pools	Low <19%				
	Moderate	34%	38.3	29.5	27.5
	High >45%				
deep pools/km	Low 0				
	Moderate		1.4	2.1	1.1
	High >3	3.1			
% slackwater pools	Low 0				
	Moderate		0.4	6.6	0.4
	High >7%	7.3%			
% secondary channel area	Low <0.8%				
	Moderate	3	1.8	3.5	2.5
	High >5.3%				
% fines in riffles	High >22%				
	Moderate	21.3	15	19.3	15.0
	Low <8%				
% gravel in riffles	Low <26%				
	Moderate	43%	40	42.7	40.0
	High >54%				
% bedrock	High >11%				
	Moderate	9.4%	7	8.3	6.0
	Low <1%				
pieces LWD/100m	Low <8				
	Moderate				
	High >21	27.6	22.8	27.0	24.4
volume LWD/100m	Low <17				
	Moderate	40.7	32.2	53.0	40.5
	High >58				
key pieces/100m	Low <0.5				
	Moderate	1.3	0.8	1.8	0.9
	High >3				
# conifers >50cm dbh	Low <22				20.0
	Moderate	30.7	30	28.9	
	High >153				
# conifers >90cm dbh	Low 0		0		0.0
	Moderate	2.8		3.5	
	High >79				
% shade	Low <76%				
	Moderate	85%	84	87.9	
	High >91%				91.5

Table 11. Potential barriers to fish distribution and associated features (as identified by Streamnet) within the Lower Nehalem project area.

Stream LLID	Stream name	Record Id	Barrier type	*Passage	**Adult fish passage	Comments
1237791458315	Soapstone Creek Tributary	1219	Unnamed culvert	99	fish use not mapped	Straight-line chart lists as CMP. Water empties onto fill. 6" downstream there is an 18" deep pool.
1237676458566	Soapstone Creek Tributary	1220	Unnamed culvert	99	fish use not mapped	Couldn't access downstream end. Velocity of water is too high. District rank H10
1236259457976	Nehalem River	1390	Unnamed culvert	99	coho, Chinook, steelhead above	This newly installed culvert spills water 1' onto fill.
1237338458662	North Fork Nehalem Tributary	1472	Unnamed culvert	99	fish use not mapped	Culvert is too small for creek; water velocity is very high due to culvert size and slope. Another problem culvert 50' upstream.
1237258458657	North Fork Nehalem Tributary	1473	Unnamed culvert	2	fish use not mapped	High water velocity through culvert inhibits fish passage.
1236658457437	Nehalem River Tributary	1494	Unnamed culvert	99	fish use not mapped	2 culverts: East culvert falls onto fill. West culvert spills water into a 3' deep pool; the drop is 2'.
1236881457420	Nehalem River Tributary	1495	Unnamed culvert	2	fish use not mapped	Co Rd log lists a 60" culvert at 11.81 and a 36" at 11.82. Impassable at most flows due to drop and water velocity.
1236964457408	Nehalem River Tributary	1496	Unnamed culvert	2	fish use not mapped	This culvert is a barrier to fish passage at most, if not all flows.
1237140457371	Nehalem River Tributary	1497	Unnamed culvert	1	fish use not mapped	Co Rd log lists as "Big Cr". Culvert is a barrier due to slope and water velocity.
1237913456965	Nehalem River Tributary	1529	Unnamed culvert	4	fish use not mapped	
1238951456889	Nehalem River	50991	Unnamed falls	99	coho, Chinook, steelhead above	
1238777457315	North Fork Nehalem River	50995	Hamlet Falls	99	coho, Chinook, steelhead above	
1237529457011	Cook Creek	51702	Unnamed falls	99	fish use not mapped	
1237725457299	Fall Creek	51703	Unnamed log jam	99	coho, Chinook, steelhead above	Stops Chinook, may not be a barrier to Winter Steelhead and Cutthroat.
1236543457505	Salmonberry River	51706	Unnamed falls	99	ends at or below	
1236248457707	North Fork Cronin Creek	51707	Unnamed falls	99	coho, Chinook, steelhead above	
1236948458159	Fall Creek	51710	Unnamed falls	99	ends at or below	
1237634457127	Lost Creek	51714	Unnamed falls	99	ends at or below	According to the District Biologist (12/99), this waterfall is 25 feet high.
1234590457084	Wolf Creek	51718	Unnamed falls	99	ends at or below	
1234399457188	Pennoyer Creek	51719	Unnamed falls	99	ends at or below	
1236067457598	South Fork Cronin Creek	53110	Unnamed falls	99	ends at or below	
1235239457169	North Fork Salmonberry River	53114	Unnamed falls	99	ends at or below	
1237438456982	Dry Creek	55355	Unnamed culvert	99	ends at or below	
1237270456848	Harliss Creek	55356	Unnamed culvert	99	ends at or below	
1236513457482	Hatchery Creek	55357	Unnamed falls	99	ends at or below	
1238417457600	Big Rackheap Creek	55383	Unnamed falls	99	ends at or below	
1235239457169	North Fork Nehalem River	55395	Unnamed falls	99	coho, Chinook, steelhead above	

*Passage 1=complete, 2=partial, 4=non-blocking, 99=unknown
**Migratory fish passage (coho, Chinook, steelhead) as mapped by Streamnet.

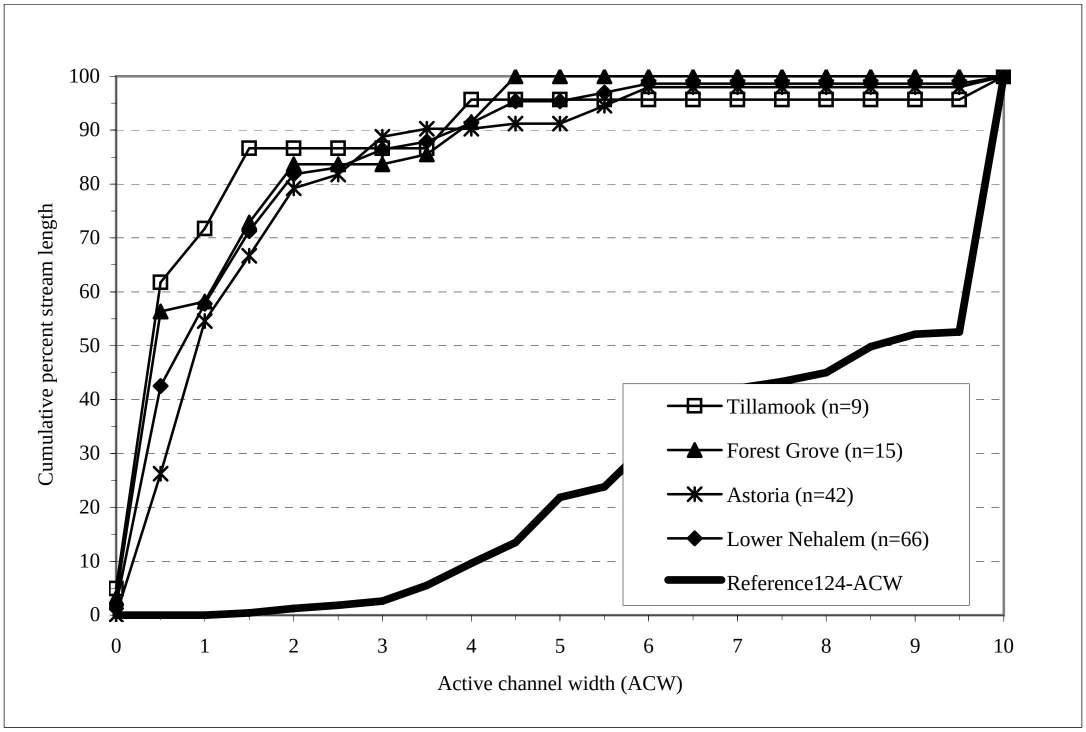
Table 12. OWEB-funded instream restoration projects on ODF land in the Lower Nehalem project area highlighting some actions, goals, and targeted species to benefit from the project.

Project Number	Stream name	Year	Project Description	Project Goal(s)	coho	steelhead	Chinook	cutthroat	all salmonids
16	Sweethome Cr	1995	instream large wood placement	Increase habitat complexity; Increase rearing and over-wintering habitat Create refuge	X				
1364	Dry Cr	1998	1 culvert replaced with bridge	Improve fish passage	X	X		X	
1666	Hatchery Cr, Anderson Cr, Tin Shack C	1997	instream habitat enhancement: weirs, deflectors, bank stabilization; peak flow passage improvements, surface drainage improvements, road closure, 1 culvert replaced	Improve fish passage; increase bank stability; Increase bank stability Decrease run-off and erosion Increase upslope stability Improve drainage	X	X	X	X	
980467	North Fork Nehalem R, trib of	1998	hardwood conversion	Increase LWD recruitment Increase shade	X	X	X	X	
980472	Sweethome Cr	1997	1 culvert replaced with bridge	Improve fish passage	X	X	X	X	
980473	Fall Cr	1997	1 culvert replaced with bridge	Improve fish passage				X	
980474	Fall Cr	1997	1 culvert replaced with bridge	Improve fish passage				X	
980475	North Fork Nehalem R, trib of	1997	1 culvert replaced	Improve fish passage				X	
980476	Hakura Cr	1997	instream large wood placement, deflectors; 1 culvert replaced, 1 culvert with weir installed below outlet riparian tree planting;	Improve fish passage; Increase bank stability; Increase pools; decrease erosion and runoff	X	X		X	
980683	Wolf Cr	1997	voluntary riparian tree retention	Increase bank stability; Decrease erosion, runoff, and temperature Increase LWD recruitment; Increase shade, nutrient					X
980685	Pennoyer Cr, trib of & Baldwin Cr	1996	voluntary riparian tree retention peak flow passage improvements, surface drainage improvements	Decrease erosion and runoff Improve drainage					X
980694	Salmonberry River	1997	voluntary riparian tree retention surface drainage improvements	Increase bank stability; Decrease erosion, runoff, and temperature; Increase LWD recruitment Increase shade and nutrients Improve drainage					X
980725	Brent Cr	1998	2 culverts replaced	Improve fish passage	X	X		X	
20000665	Headwater of N Fk Nehalem R	2000	1 culvert replaced	Improve fish passage	X			X	
20000670	Sweet Home Cr, trib of	2000	1 culvert removed and not replaced	Improve fish passage	X	X		X	
20010123	North Fork Nehalem R, trib of	2001	1 culvert replaced	Improve fish passage	X			X	
20010124	Fall Cr	2001	1 culvert replaced with bridge	Improve fish passage	X	X	X	X	
20010125	North Fork Nehalem R	2001	1 culvert replaced with bridge	Improve fish passage	X			X	
20020002	Strahm Cr	2002	instream large wood placement; 1 culvert replaced	Increase channel complexity and floodplain connectivity; Improve fish passage; Increase over-wintering habitat Increase rearing habitat	X	X		X	
20030269	North Fork Nehalem R	2003	peak flow passage improvements	Decrease erosion and runoff Improve drainage and upslope stability					

Table 13. Criteria for selecting restoration sites

Best stream reaches for restoration	Poor stream reaches for restoration	Rational	Solution
low gradient (<5%)	high gradient (>5%)	Structures placed in steep reaches will probably get washed down stream.	Although the overall gradient may be steep, it may be possible to locate flats or benches of low gradient. Instream work should be limited to such areas.
moderate channel size (<12m)	large channel size (>12m)	Structures placed in wide channels will probably get washed down stream.	Large channel restoration should use very large pieces of wood that partially extend into the channel.
moderate valley type	steep valley shape	Streams in steep valleys are constrained by the valley walls. During high flow events, there is limited over-wintering habitat potential.	Instream structures should be limited to sections of wider valley where stream energy can be dissipated.
water temperature cool enough for juvenile salmon summer survival	water too warm for juvenile salmon summer survival	Fish have water temperature tolerances.	Efforts to restore or improve streamside shading may result in water temperature suitable to salmonids.
water supply adequate to support young salmon summer survival	inadequate water supply to support young salmon summer survival	Fish need adequate water supply for survival	Although inadequate water supply during the summer, these reaches may provide over-wintering opportunities. However, if the stream is too steep, has inadequate water parameters, or not adjacent to summer rearing areas, there is little restoration potential. Restoration efforts in such streams should carefully assess winter rearing potential.
unobstructed access by juvenile and adult salmon during migration	restricted access to juvenile and adult migration	Salmon need access to the stream system	Streams blocked by culverts or other physical properties make them desirable for restoration.

Oregon Department of Forestry: Lower Nehalem Project Area



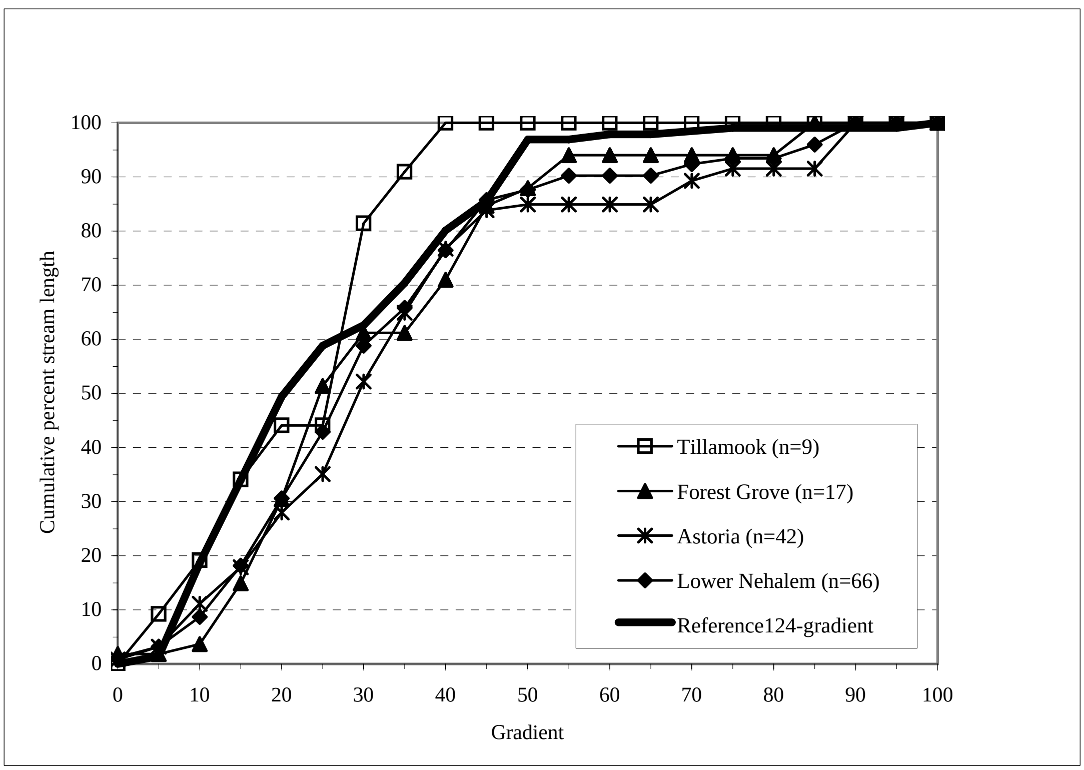
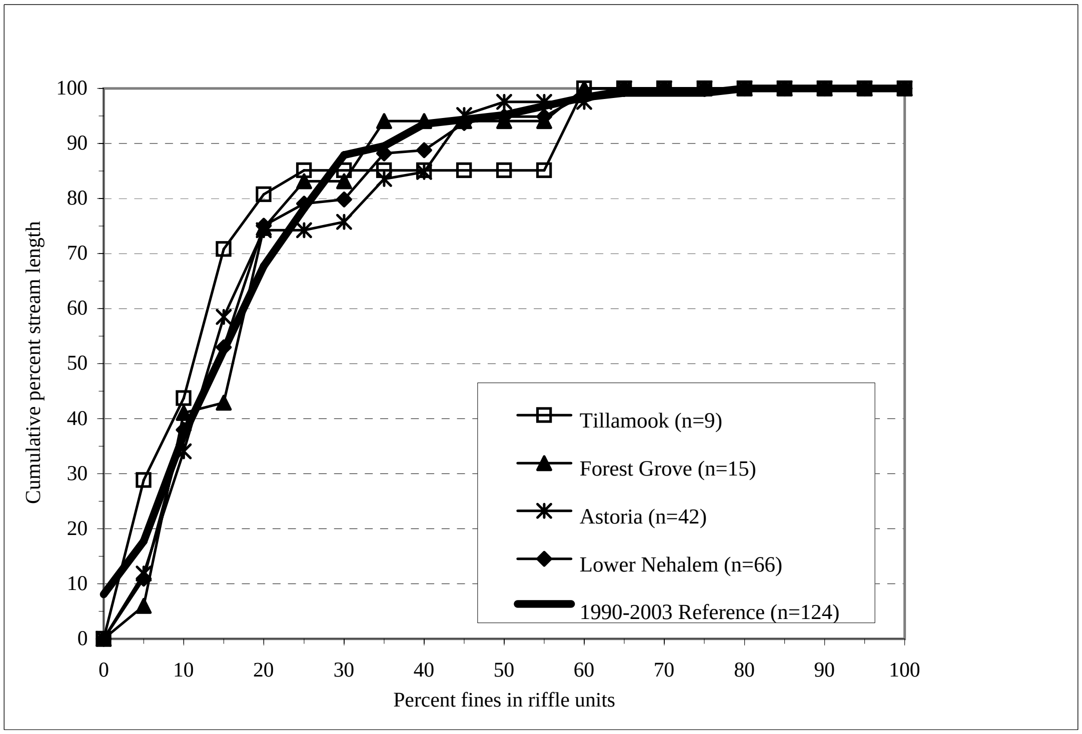


Figure 1. Cumulative frequency distribution comparing active channel width and gradient within the ODF Lower Nehalem management areas to reference conditions.

Oregon Department of Forestry: Lower Nehalem Study Area



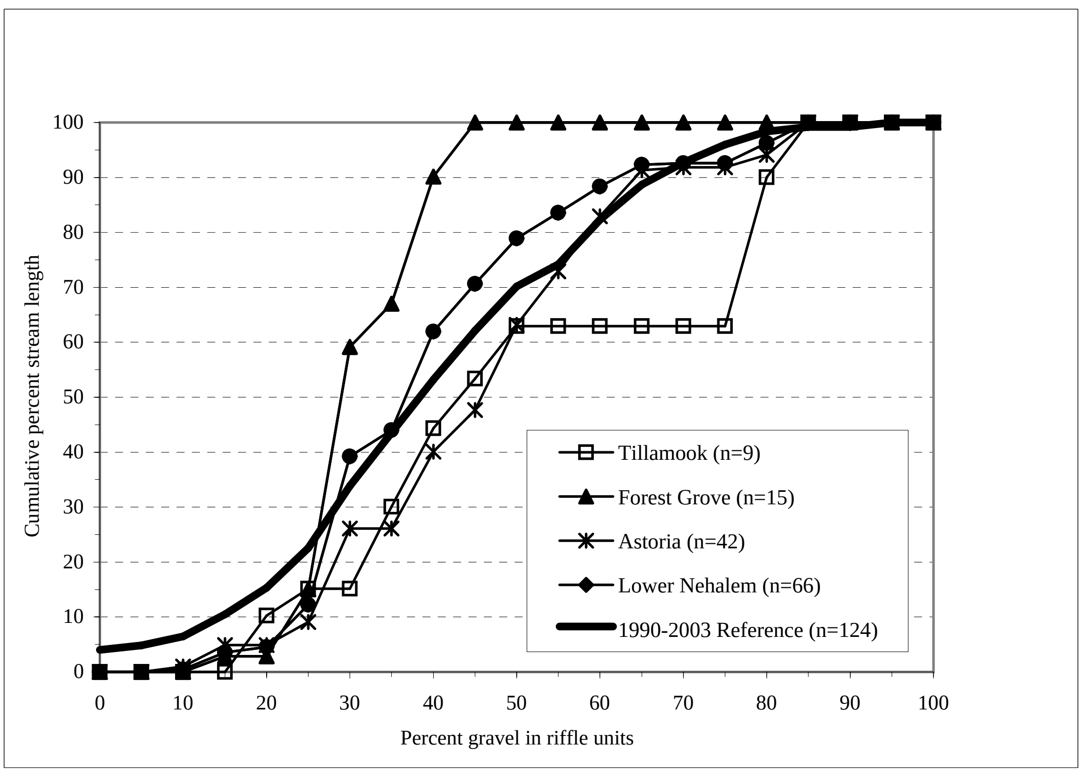
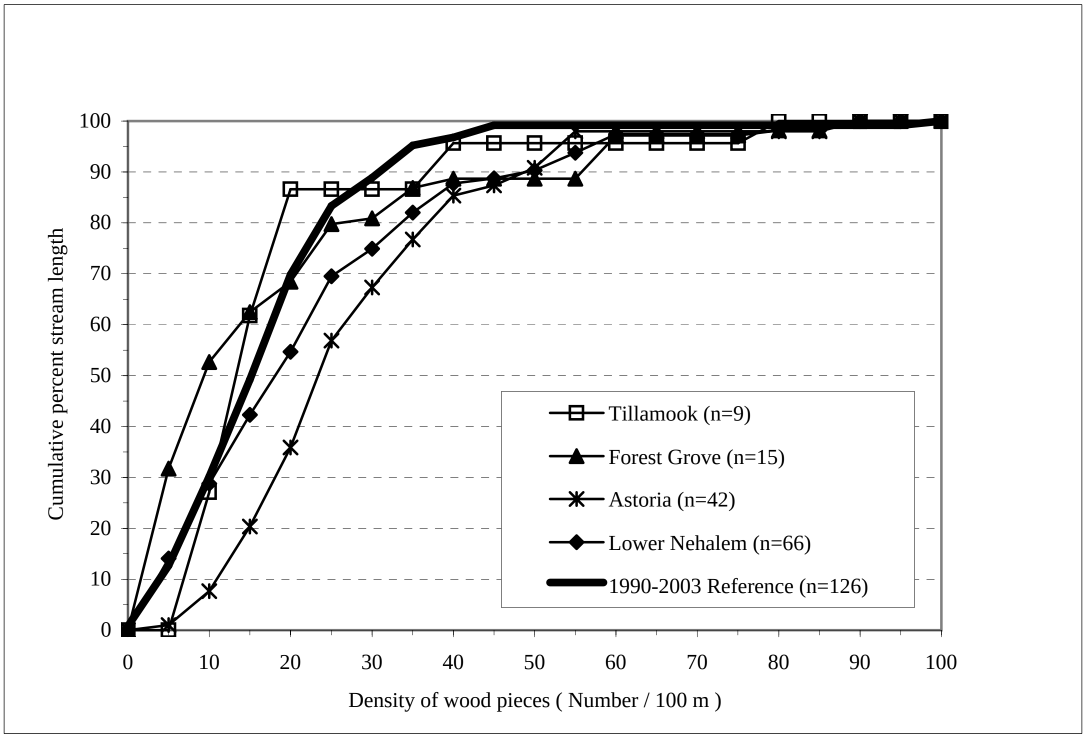


Figure 2. Cumulative frequency distribution comparing fines and gravel within the ODF Lower Nehalem management areas to reference conditions.

Oregon Department of Forestry: Lower Nehalem Study Area



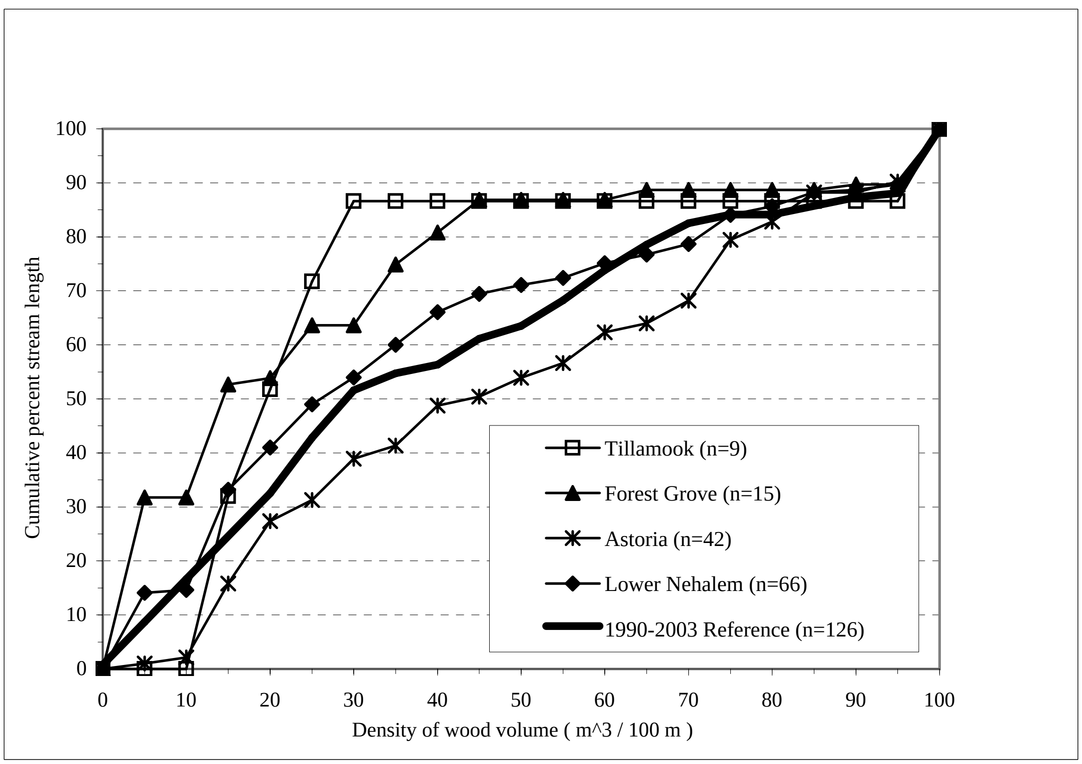
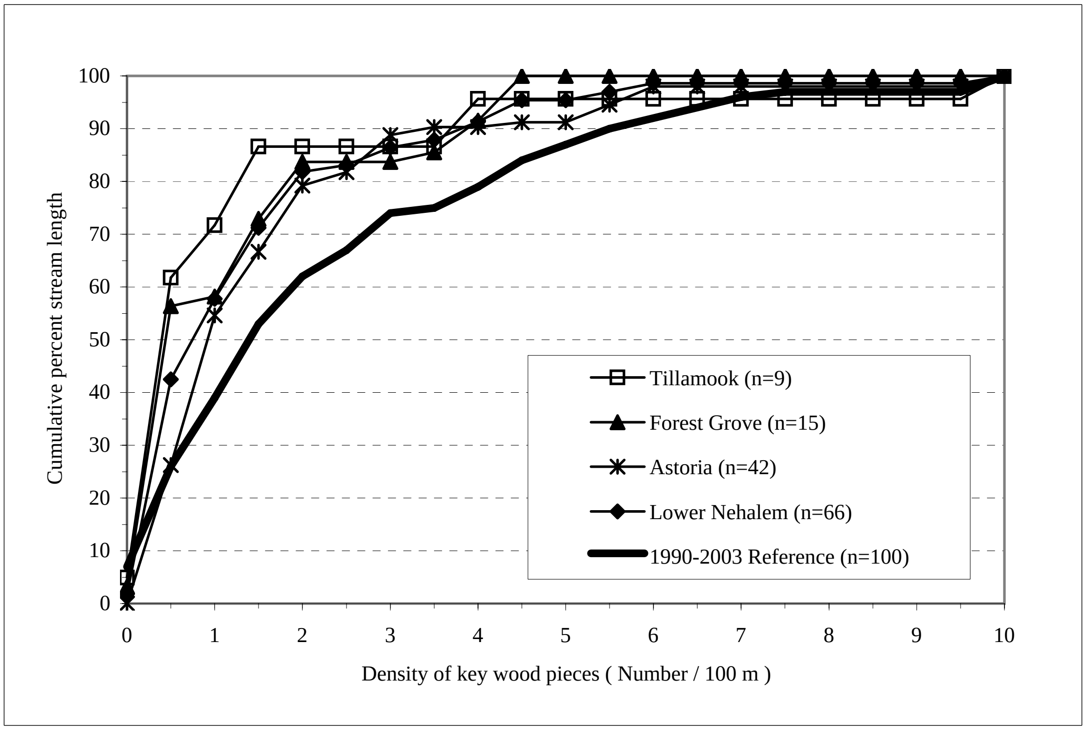


Figure 3. Cumulative frequency distribution comparing wood pieces and volume within the ODF Lower Nehalem management areas to reference conditions.

Oregon Department of Forestry: Lower Nehalem Study Area



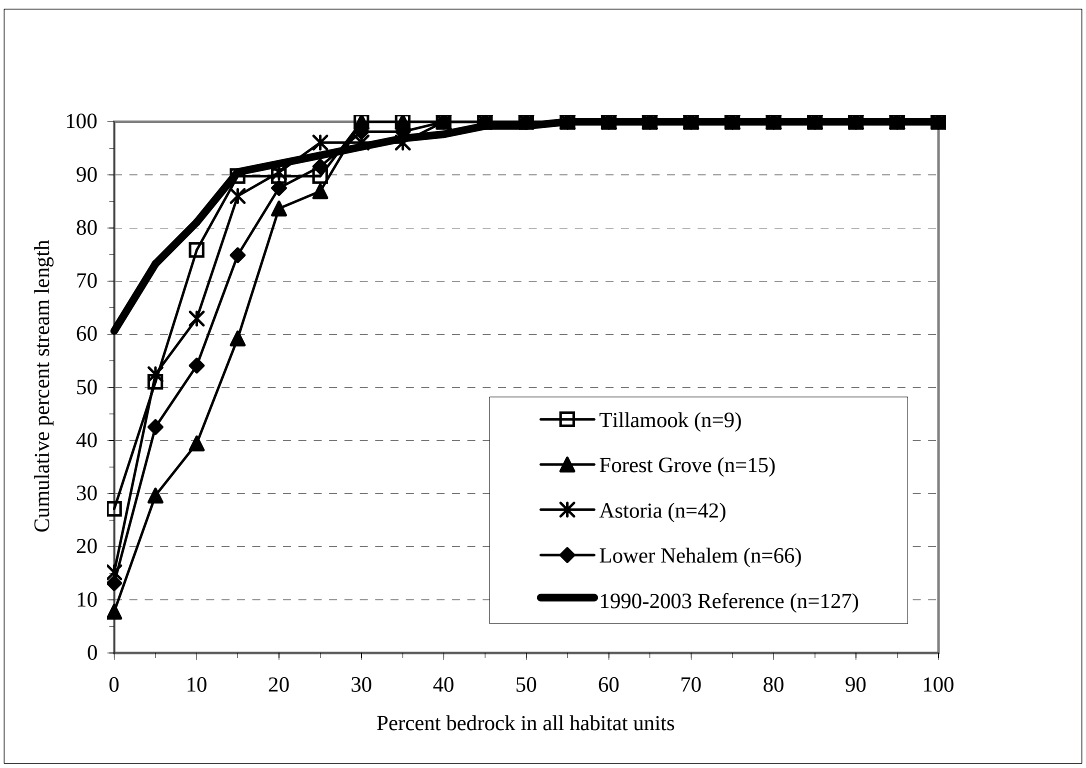
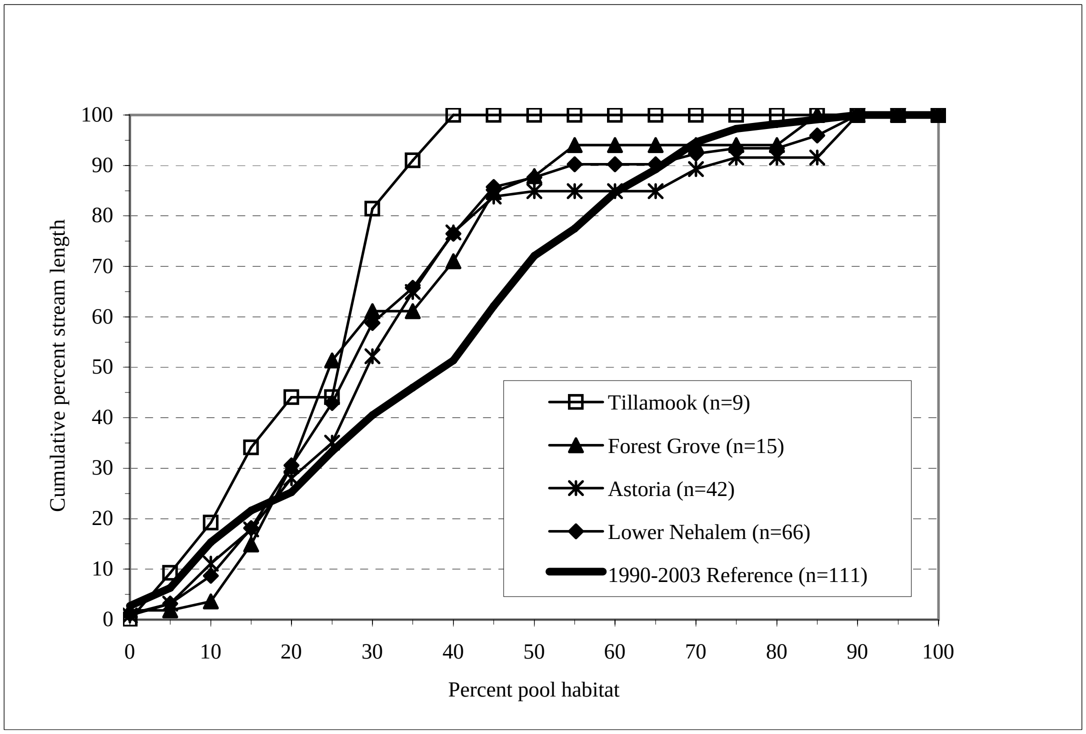


Figure 4. Cumulative frequency distribution comparing LWD keypieces and bedrock substrate within the ODF Lower Nehalem management areas to reference conditions.

Oregon Department of Forestry: Lower Nehalem Study Area



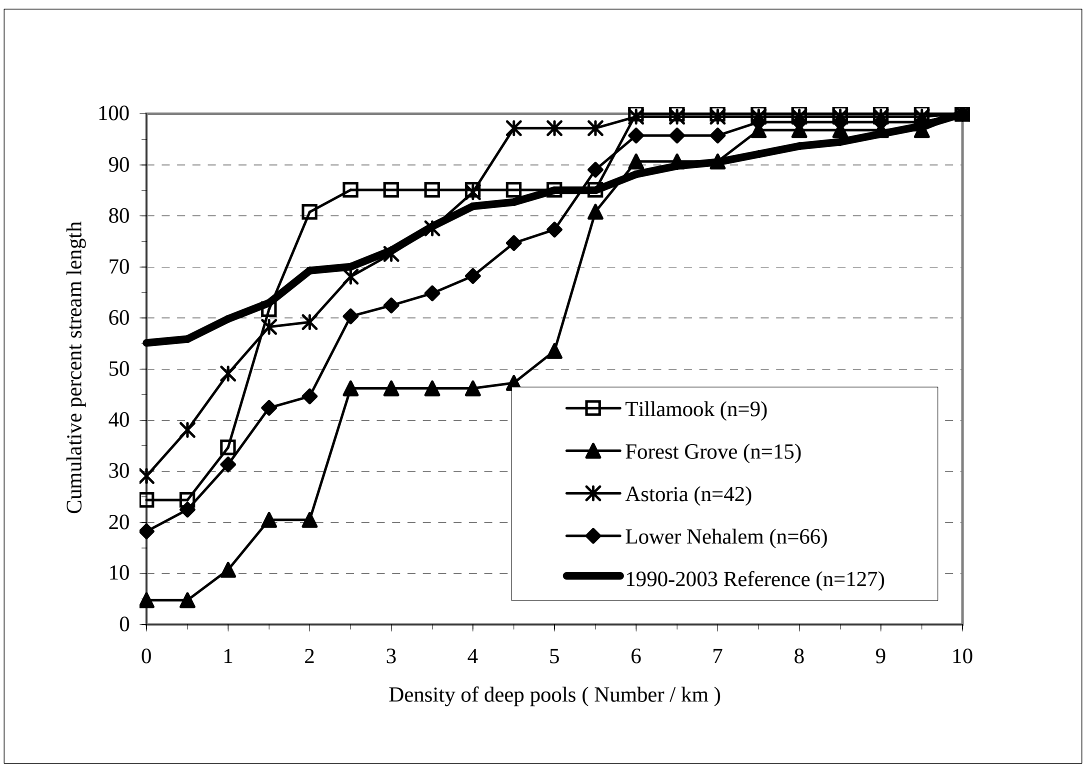
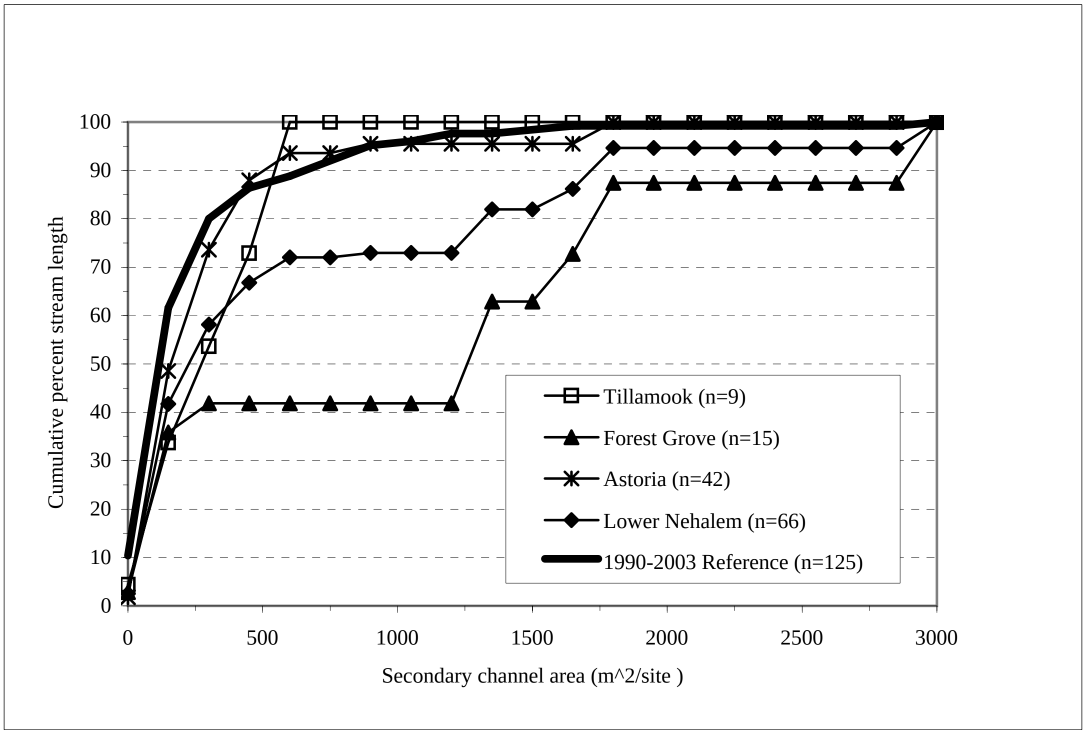


Figure 5. Cumulative frequency distribution comparing pools within the ODF Lower Nehalem management areas to reference conditions.

Oregon Department of Forestry: Lower Nehalem Study Area



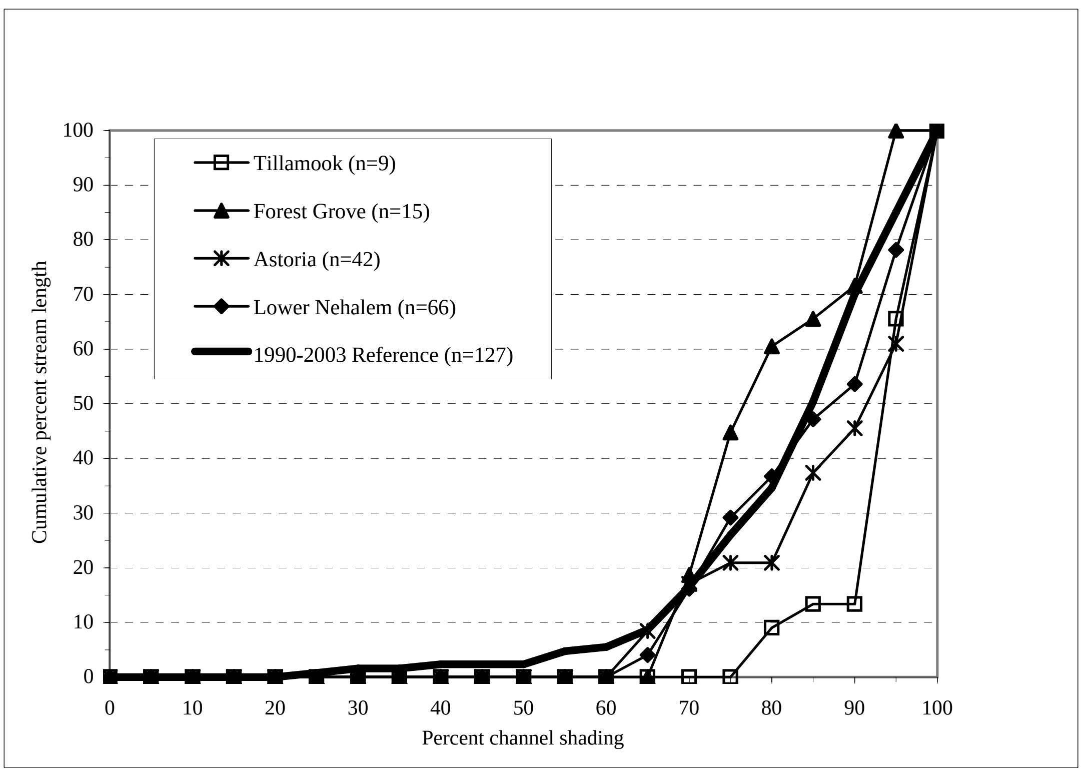
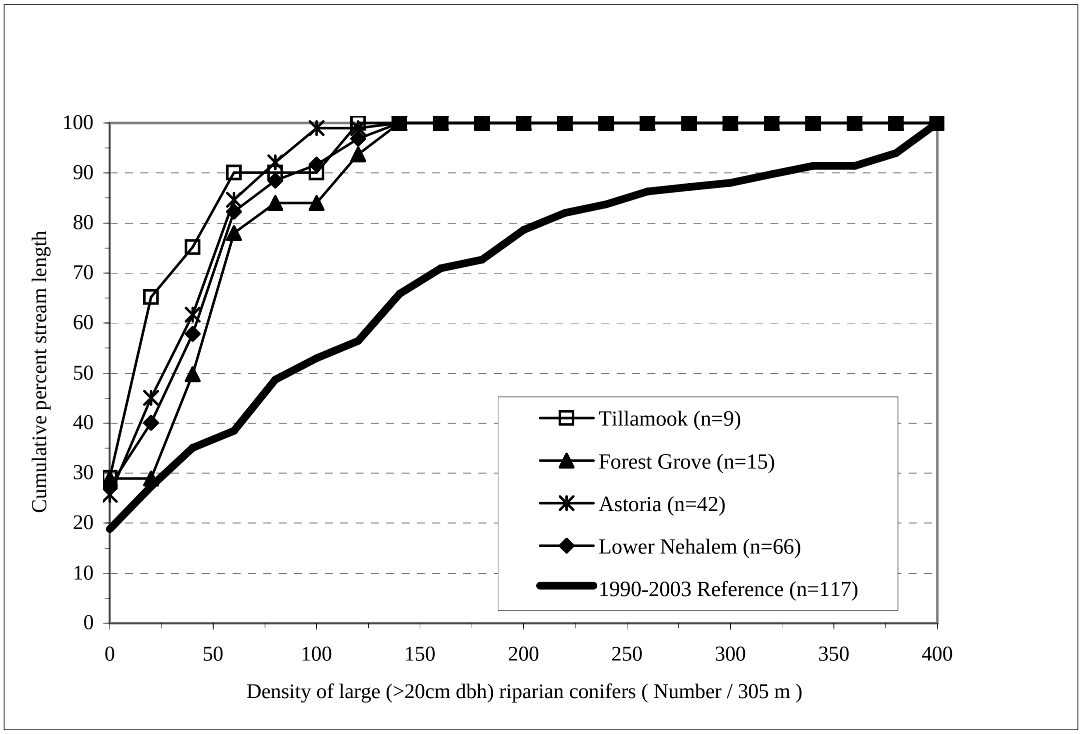


Figure 6. Cumulative frequency distribution comparing secondary channel and shade within the ODF Lower Nehalem management areas to reference conditions.

Oregon Department of Forestry: Lower Nehalem Study Area



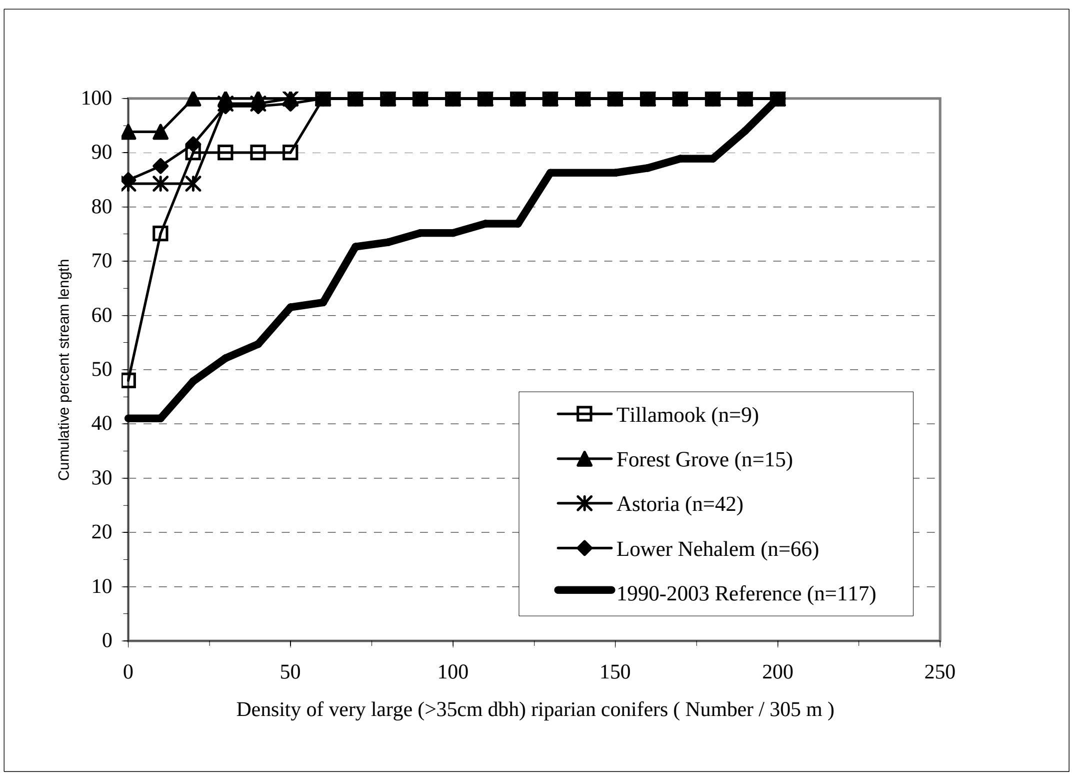


Figure 7. Cumulative frequency distribution comparing riparian conifers within the ODF Lower Nehalem management areas to reference conditions.

Oregon Department of Forestry: Lower Nehalem Study Area

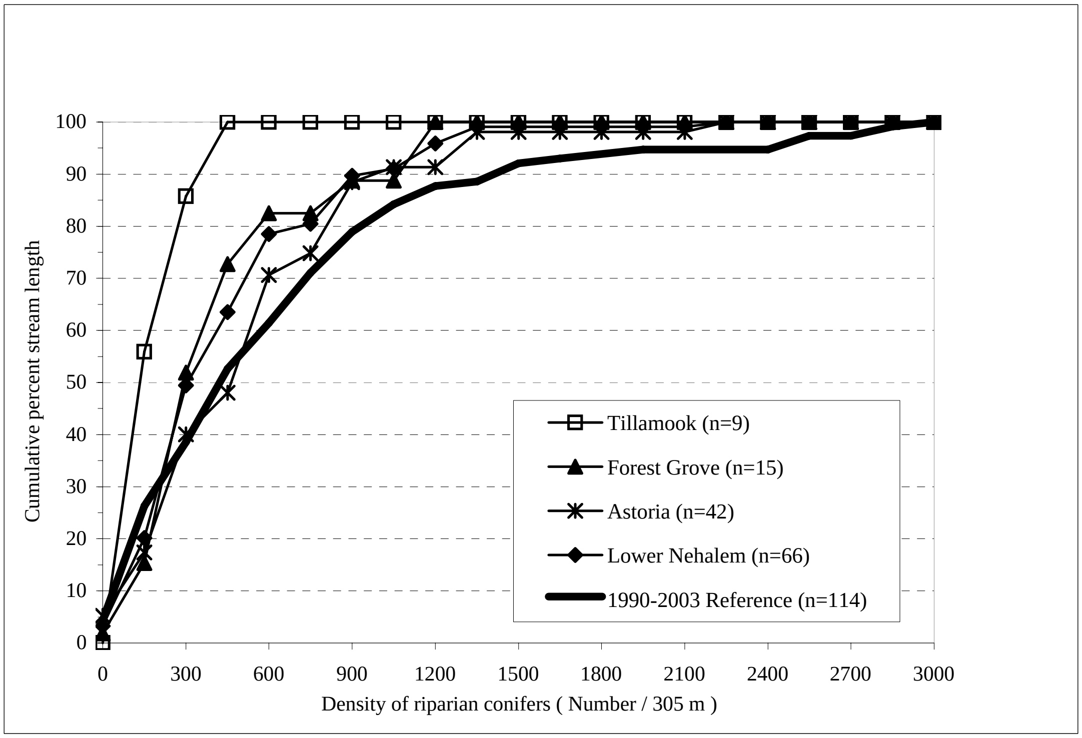


Figure 8. Cumulative frequency distribution comparing riparian conifers within the ODF Lower Nehalem management areas to reference conditions.

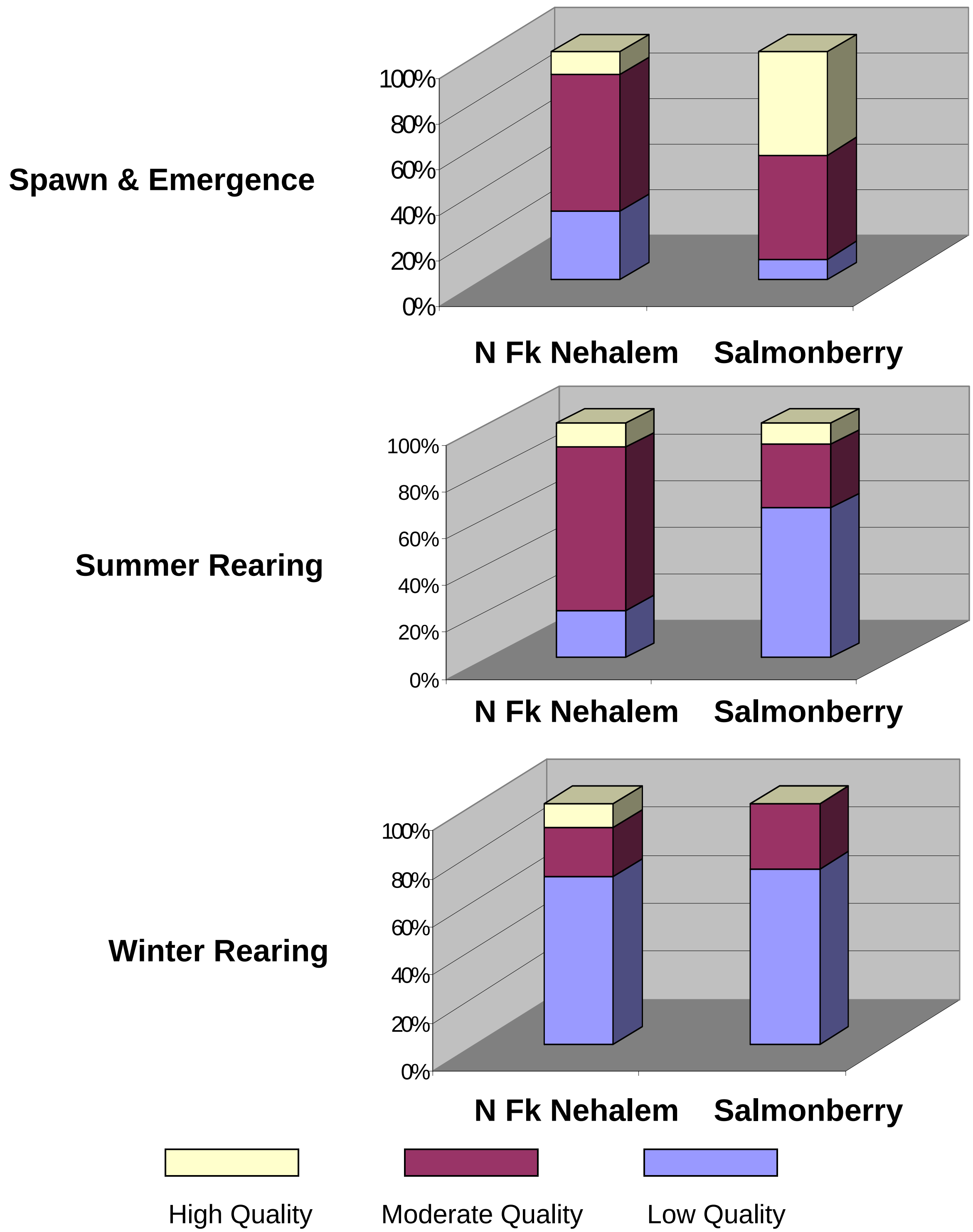


Figure 9. Fish habitat quality in the N. Fk. Nehalem and Salmonberry drainages in the Lower Nehalem study area. Ratings are based on the HabRate model, by percent of survey reaches within the distribution of coho salmon (n=21) . The crème color is high quality, burgundy is moderate quality, and blue is low quality habitat relative to each life stage of coho salmon.

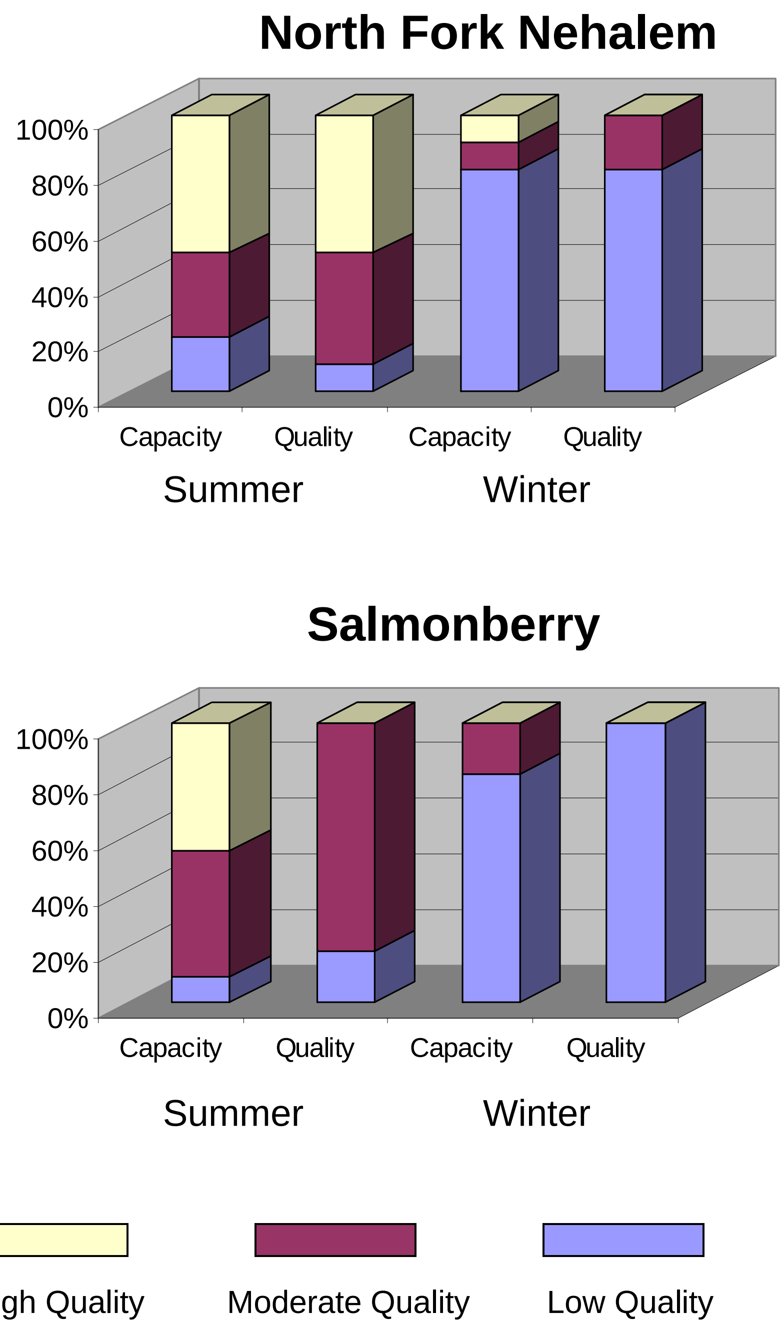
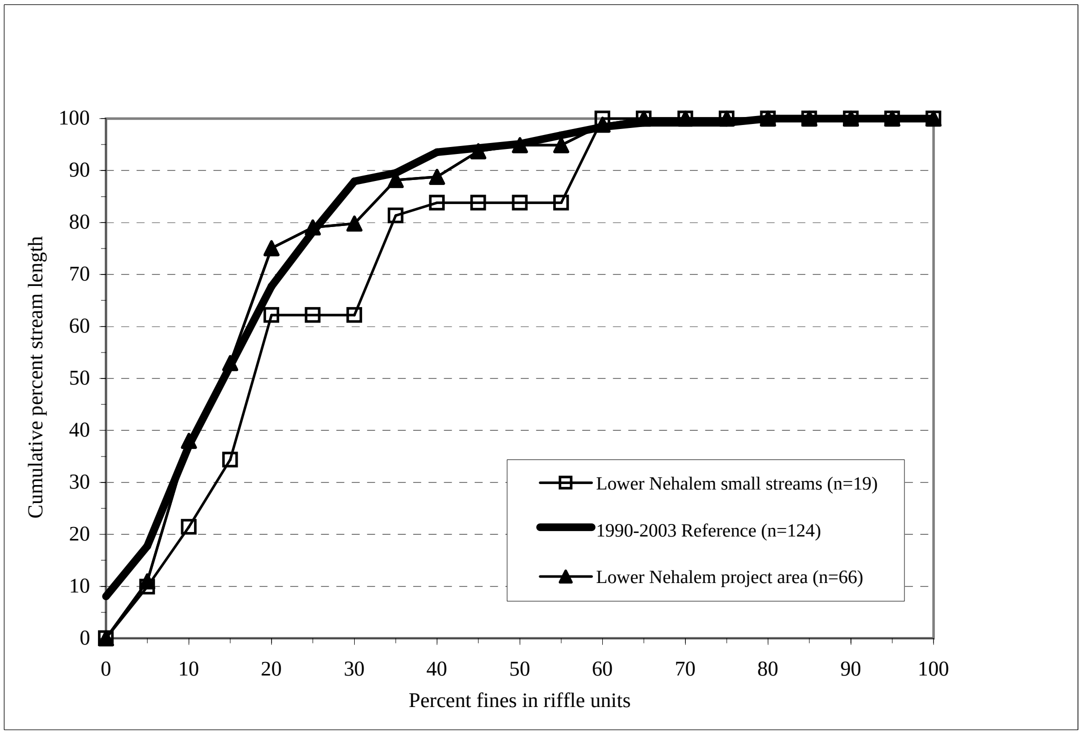


Figure 10. Fish habitat capacity and quality in the North Fork Nehalem and Salmonberry drainages in the Lower Nehalem study area. Ratings are based on the HLFM model, by percent of survey reaches within the distribution of coho salmon (n=21). The crème color is high quality, burgundy is moderate quality, and blue is low quality habitat relative to the juvenile life stage of coho salmon.

Oregon Department of Forestry: Lower Nehalem Project Area



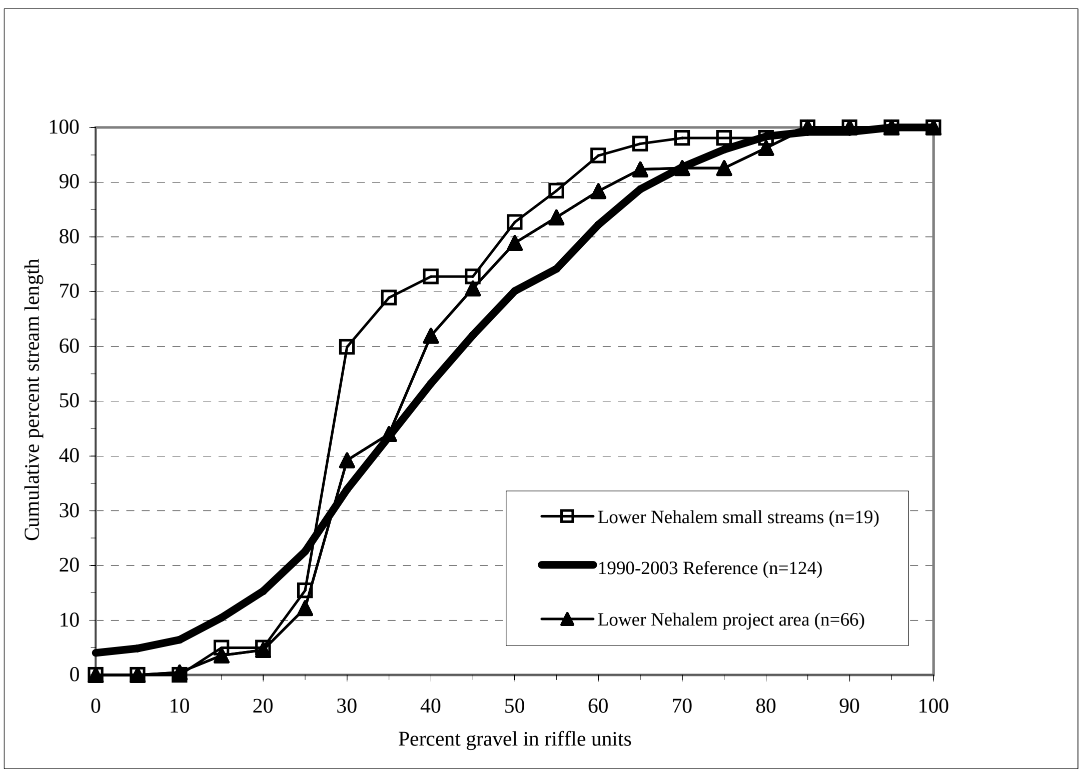
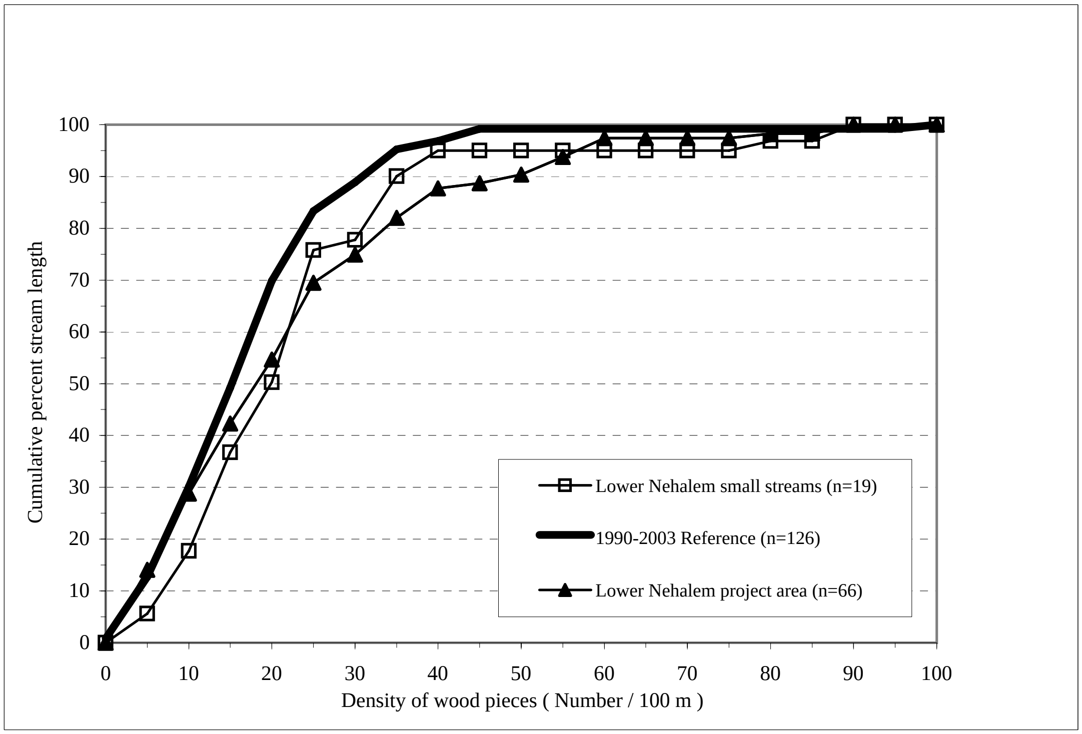


Figure 11. Cumulative frequency distribution comparing fines and gravel in small streams within the ODF Lower Nehalem study area to reference conditions and the project area.

Oregon Department of Forestry: Lower Nehalem Project Area



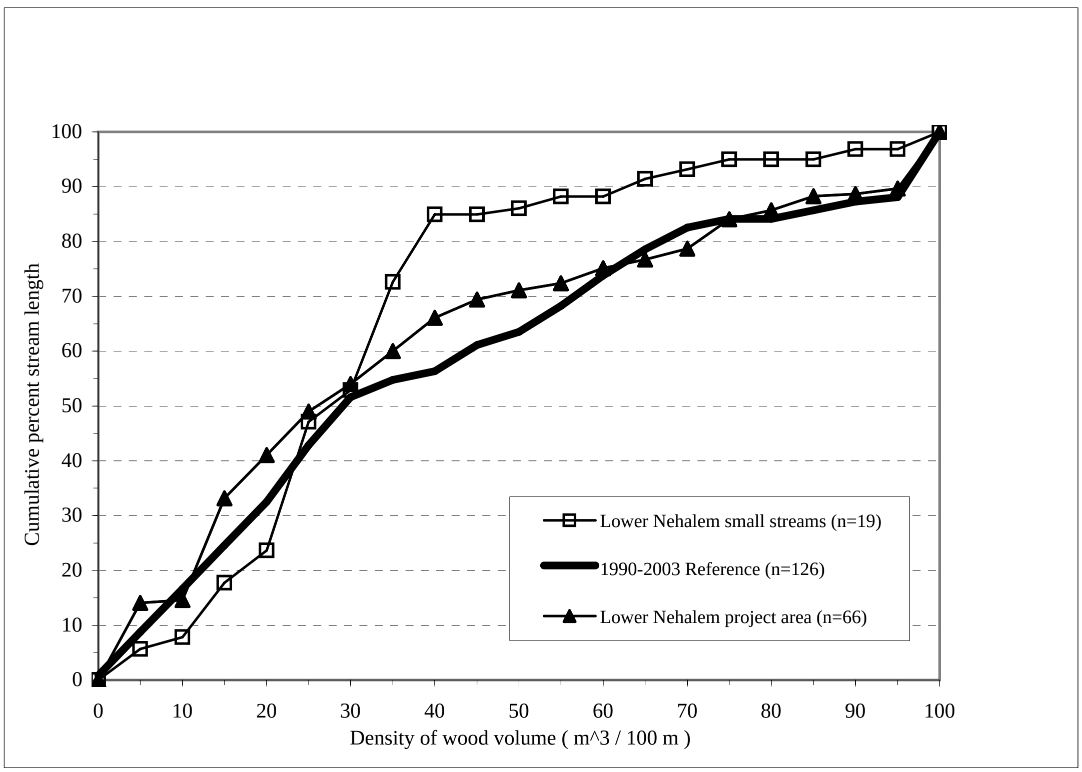
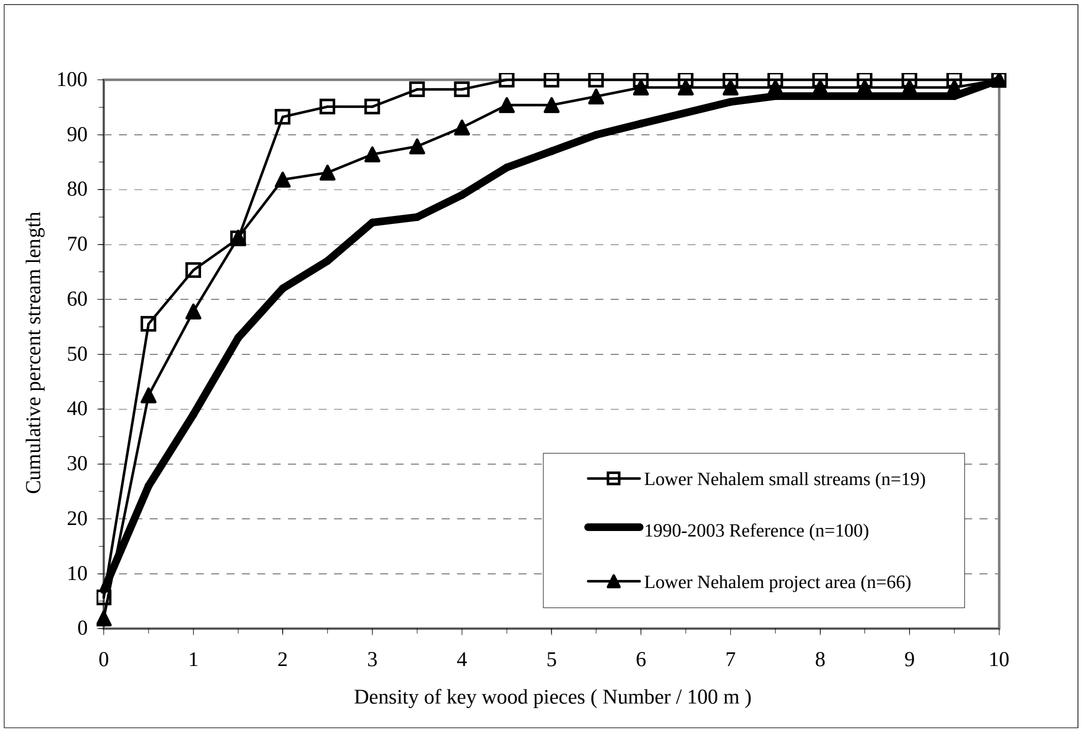


Figure 12. Cumulative frequency distribution comparing wood volume and pieces in small streams within the ODF Lower Nehalem study area to reference conditions and the project area.

Oregon Department of Forestry: Lower Nehalem Project Area



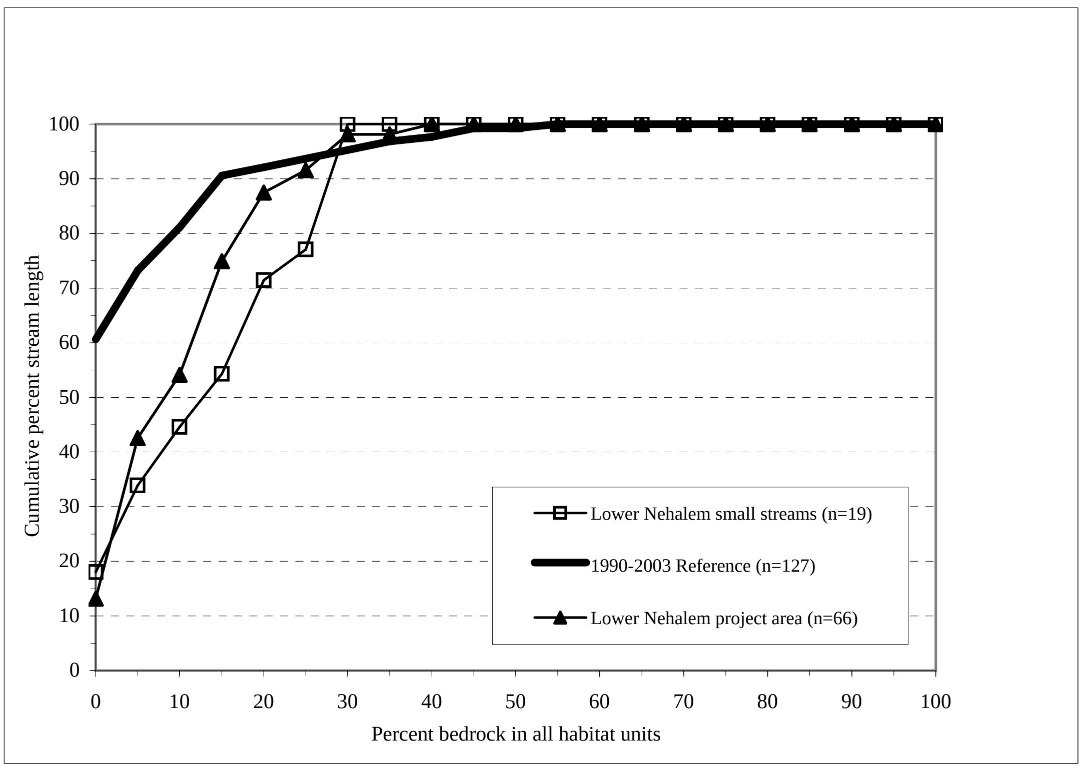
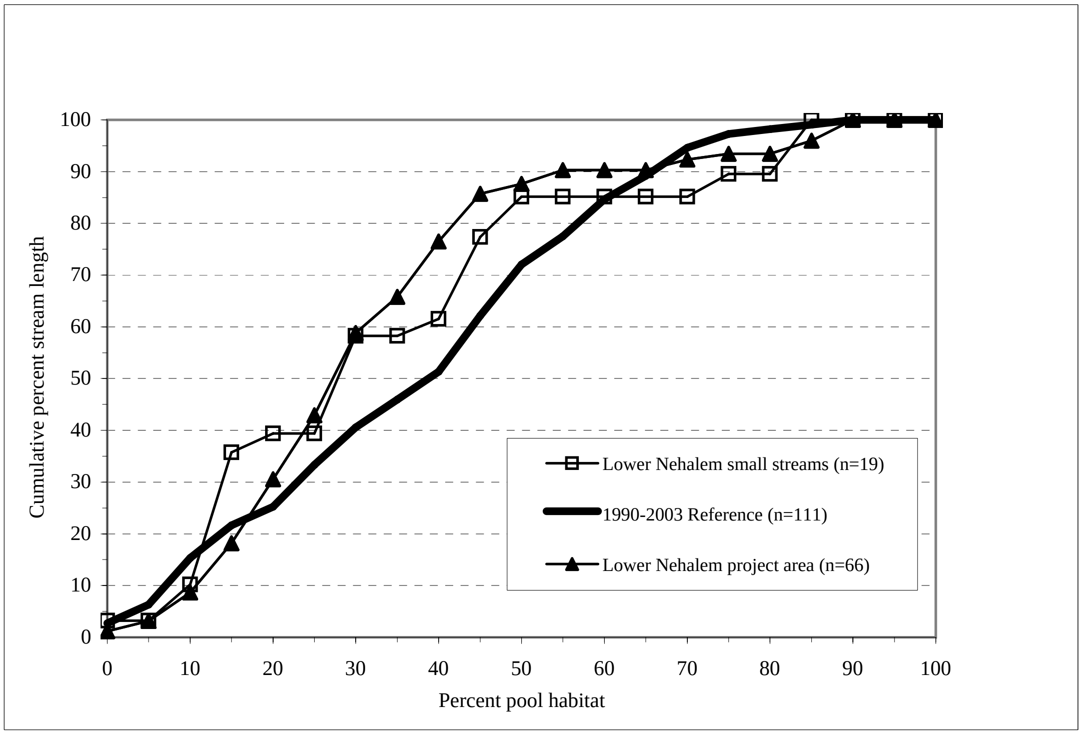


Figure 13. Cumulative frequency distribution comparing LWD keypieces and bedrock substrate in small streams within the ODF Lower Nehalem study area to reference conditions and the project area.

Oregon Department of Forestry: Lower Nehalem Project Area



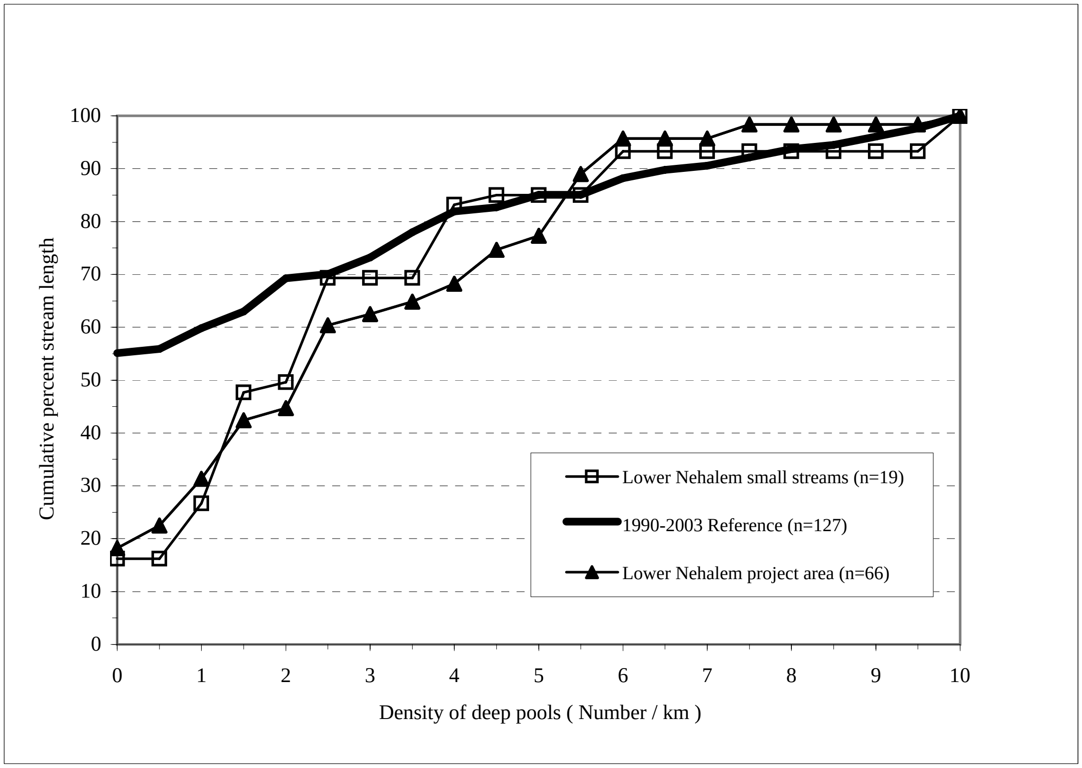
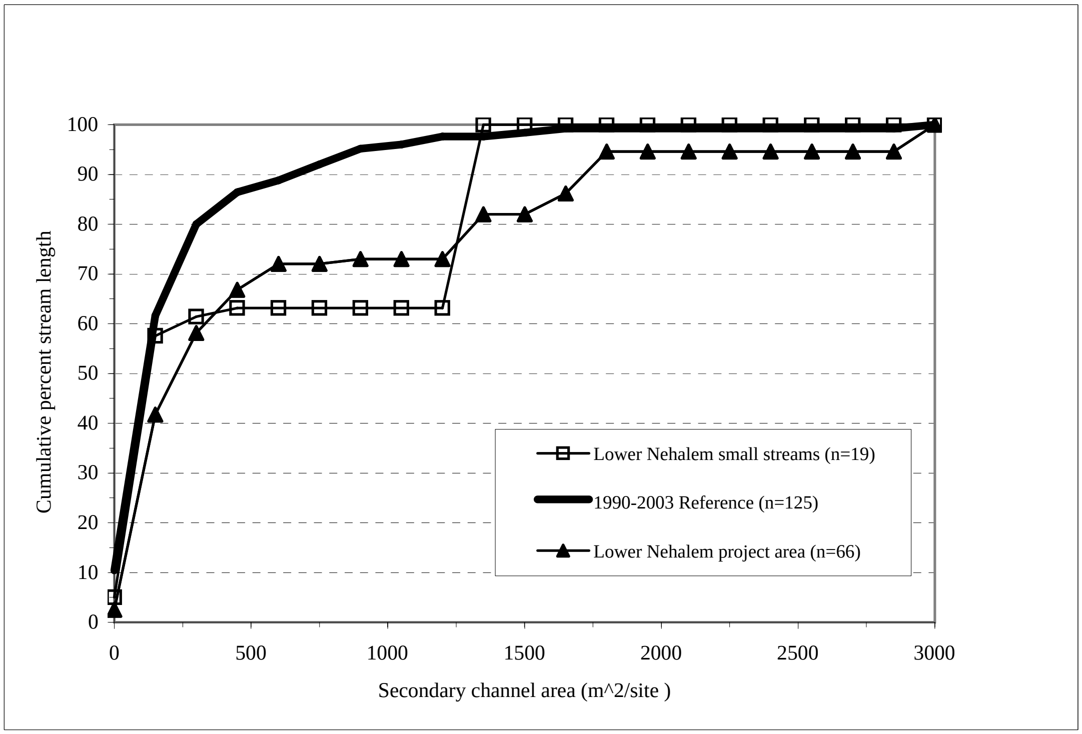


Figure 14. Cumulative frequency distribution comparing pools in small streams within the ODF Lower Nehalem study area to reference conditions and the project area.

Oregon Department of Forestry: Lower Nehalem Project Area



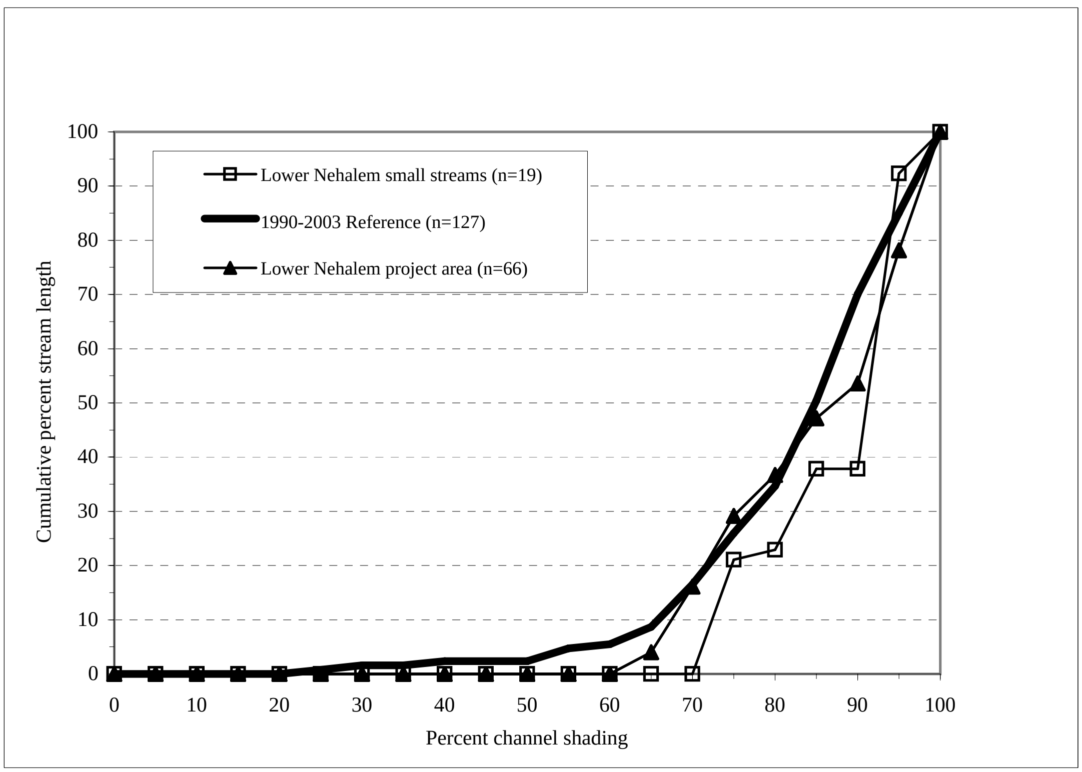
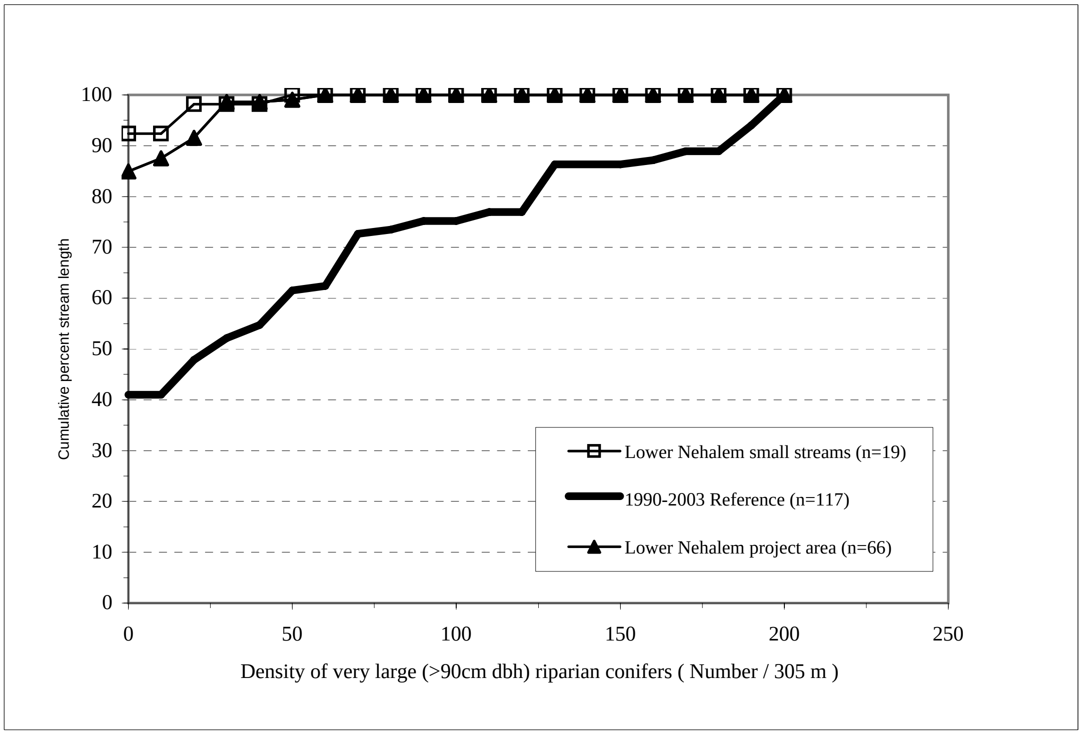


Figure 15. Cumulative frequency distribution comparing secondary channel and shade in small streams within the ODF Lower Nehalem study area to reference conditions and the project area.

Oregon Department of Forestry: Lower Nehalem Project Area



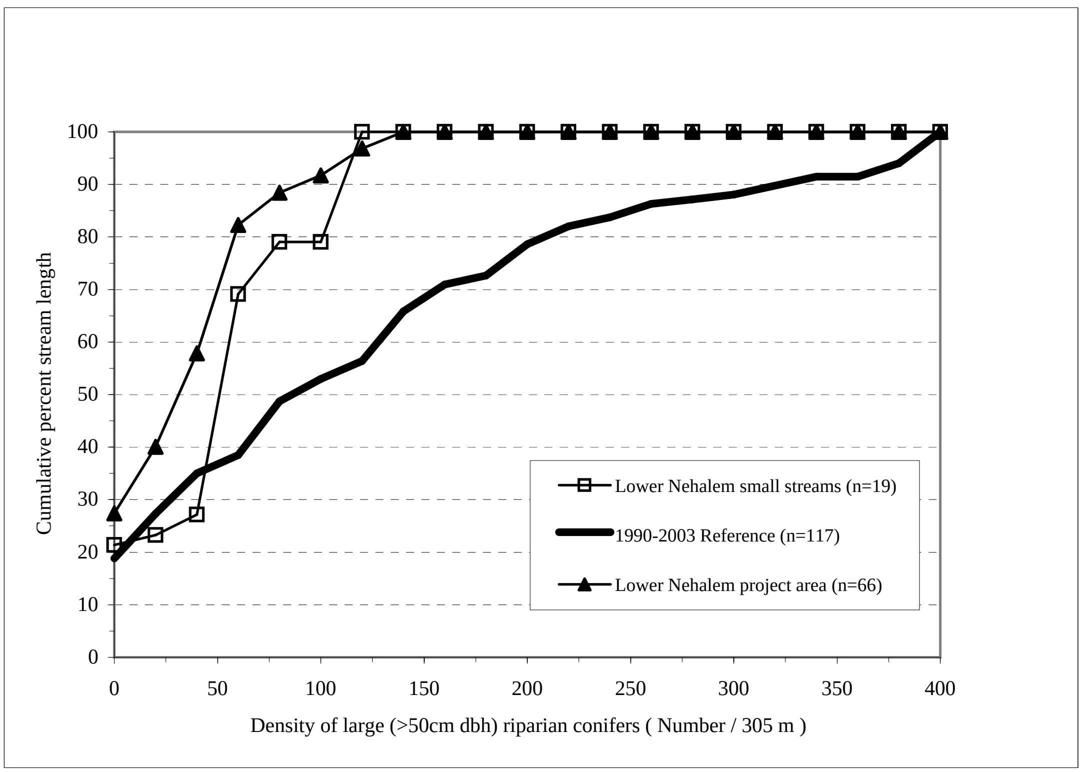


Figure 16. Cumulative frequency distribution comparing riparian conifers in small streams within the ODF Lower Nehalem study area to reference conditions and the project area.

Oregon Department of Forestry: Lower Nehalem Project Area

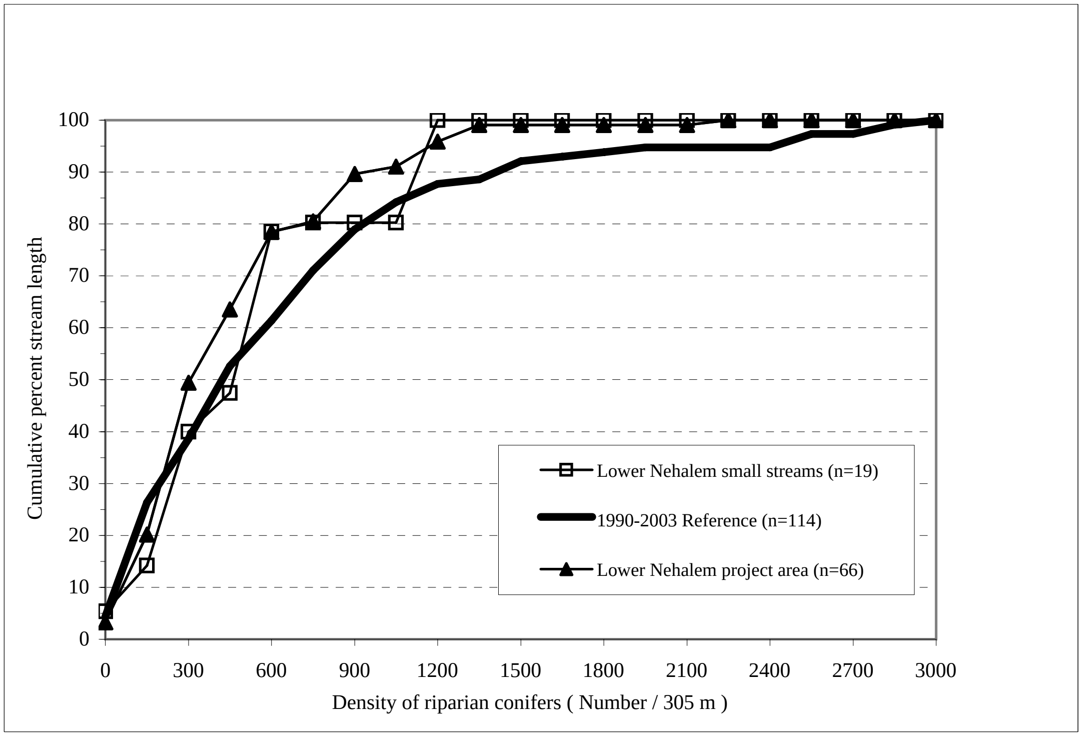
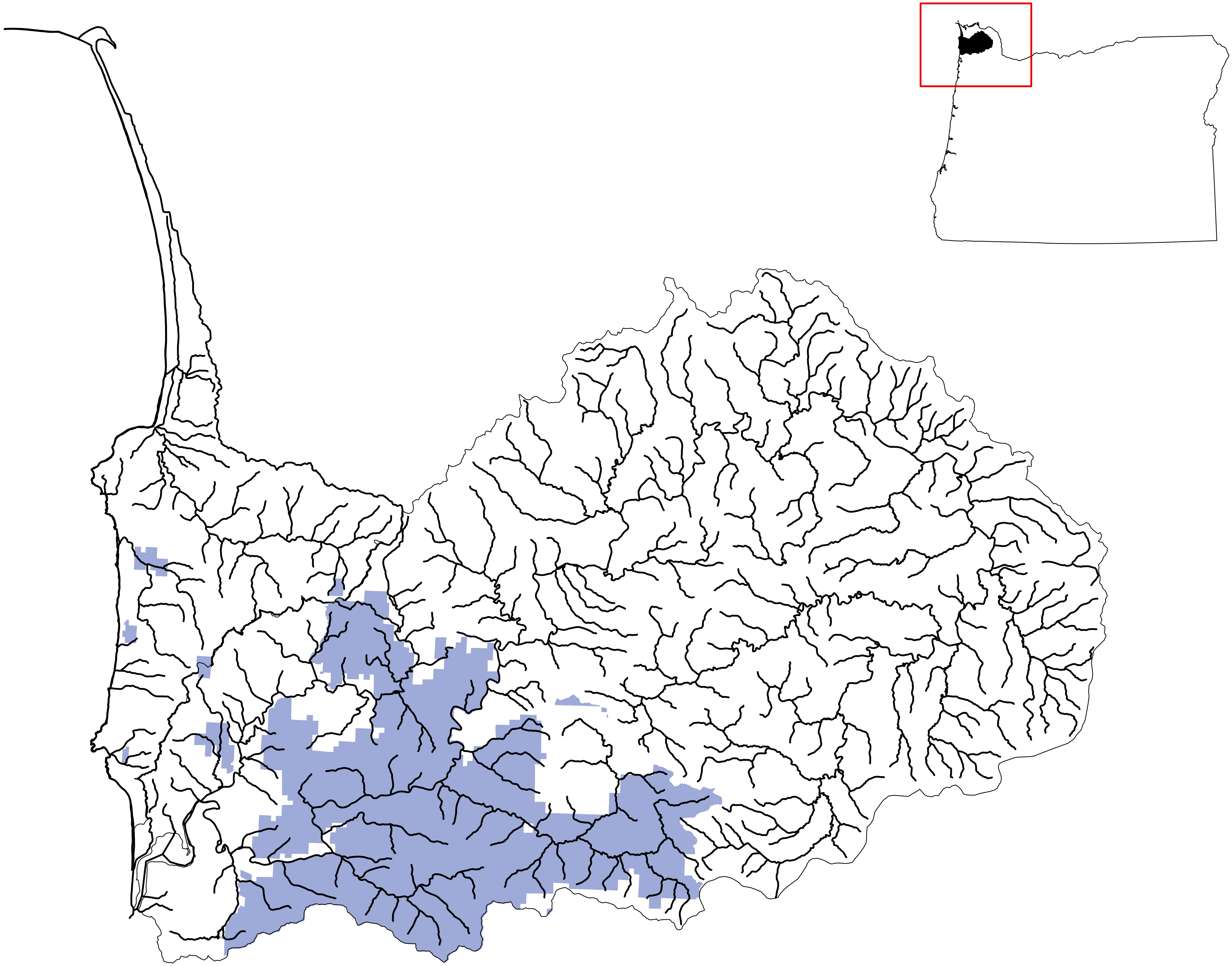
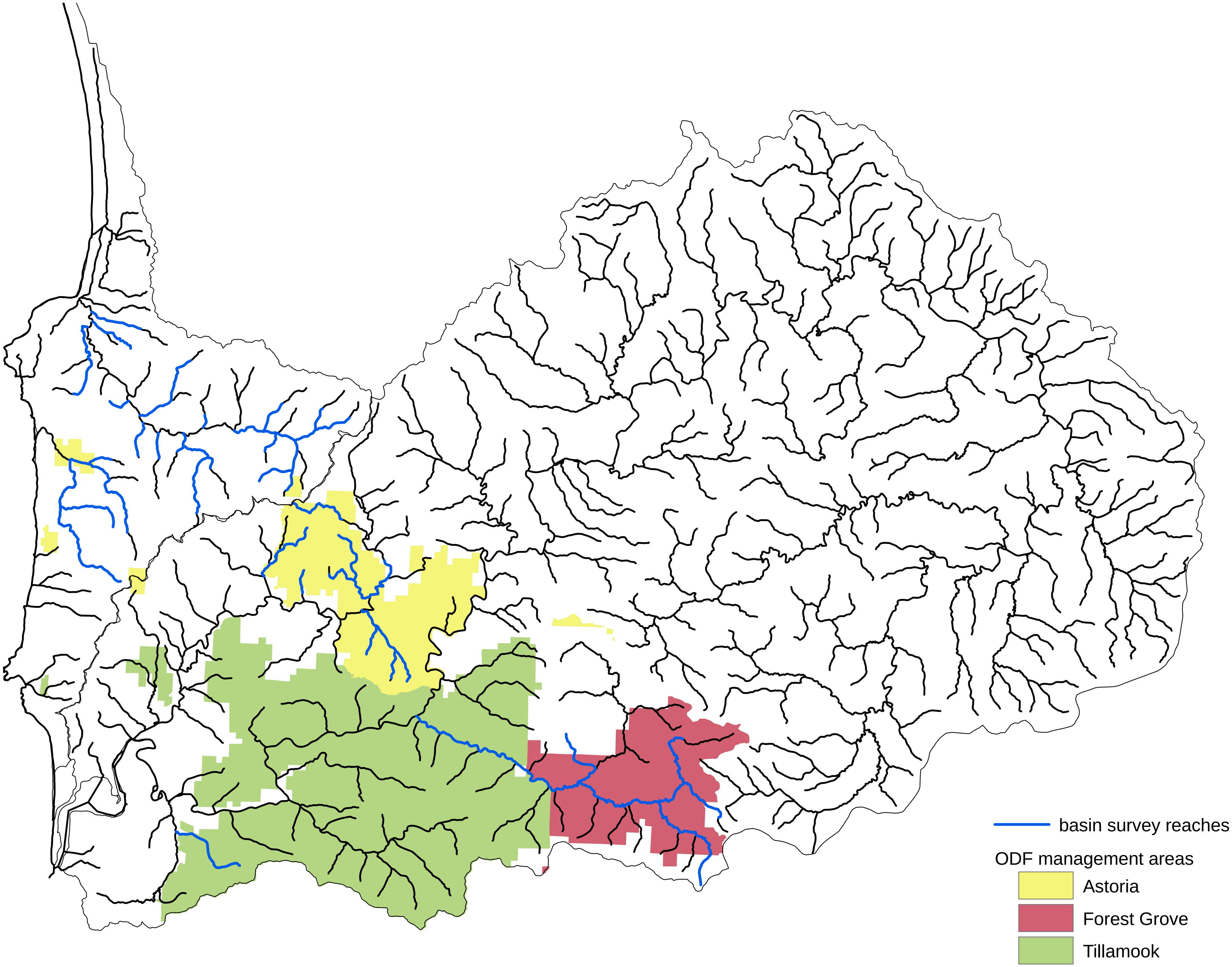


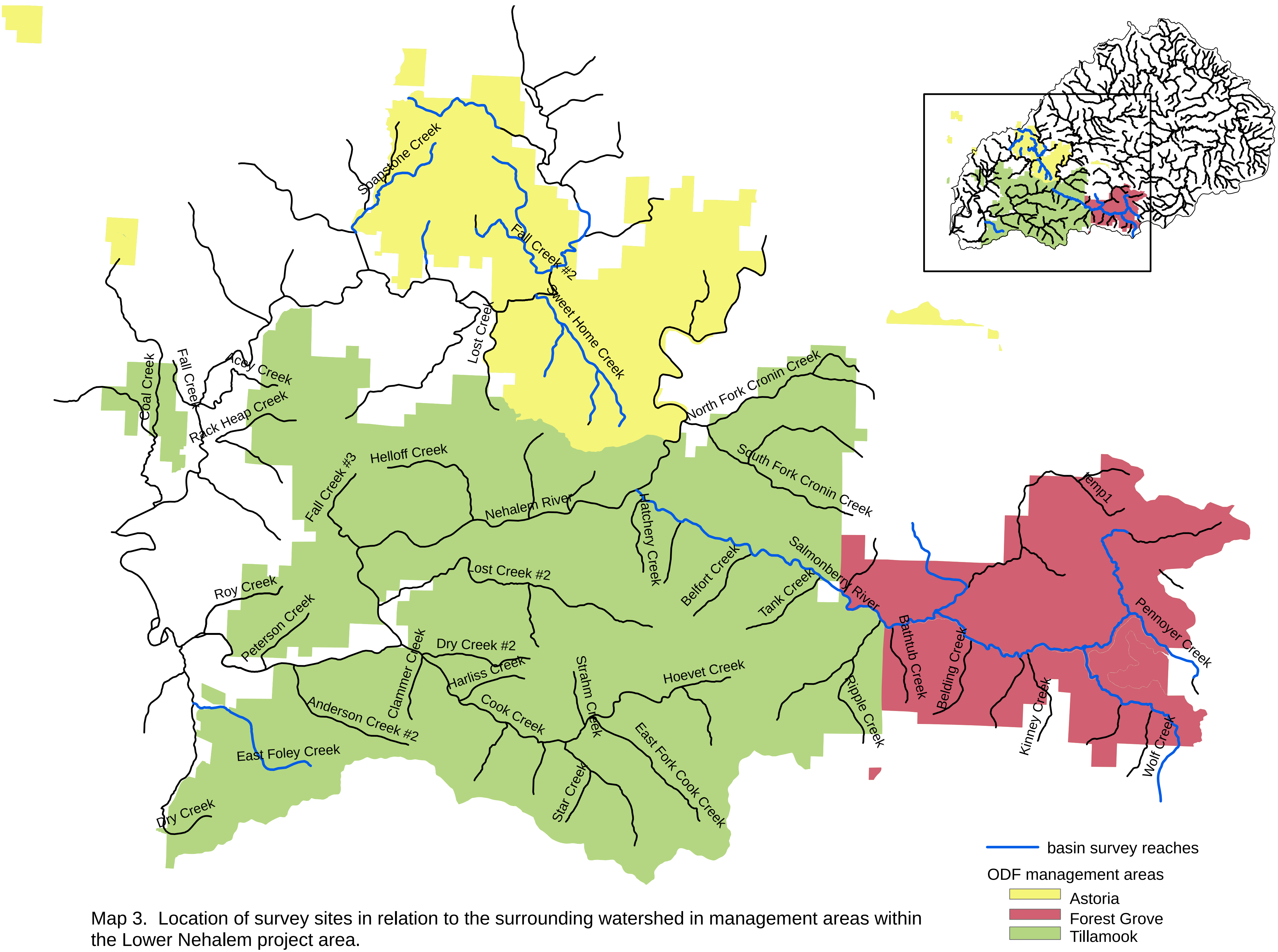
Figure 17. Cumulative frequency distribution comparing riparian conifers in small streams within the ODF Lower Nehalem study area to reference conditions and the project area.



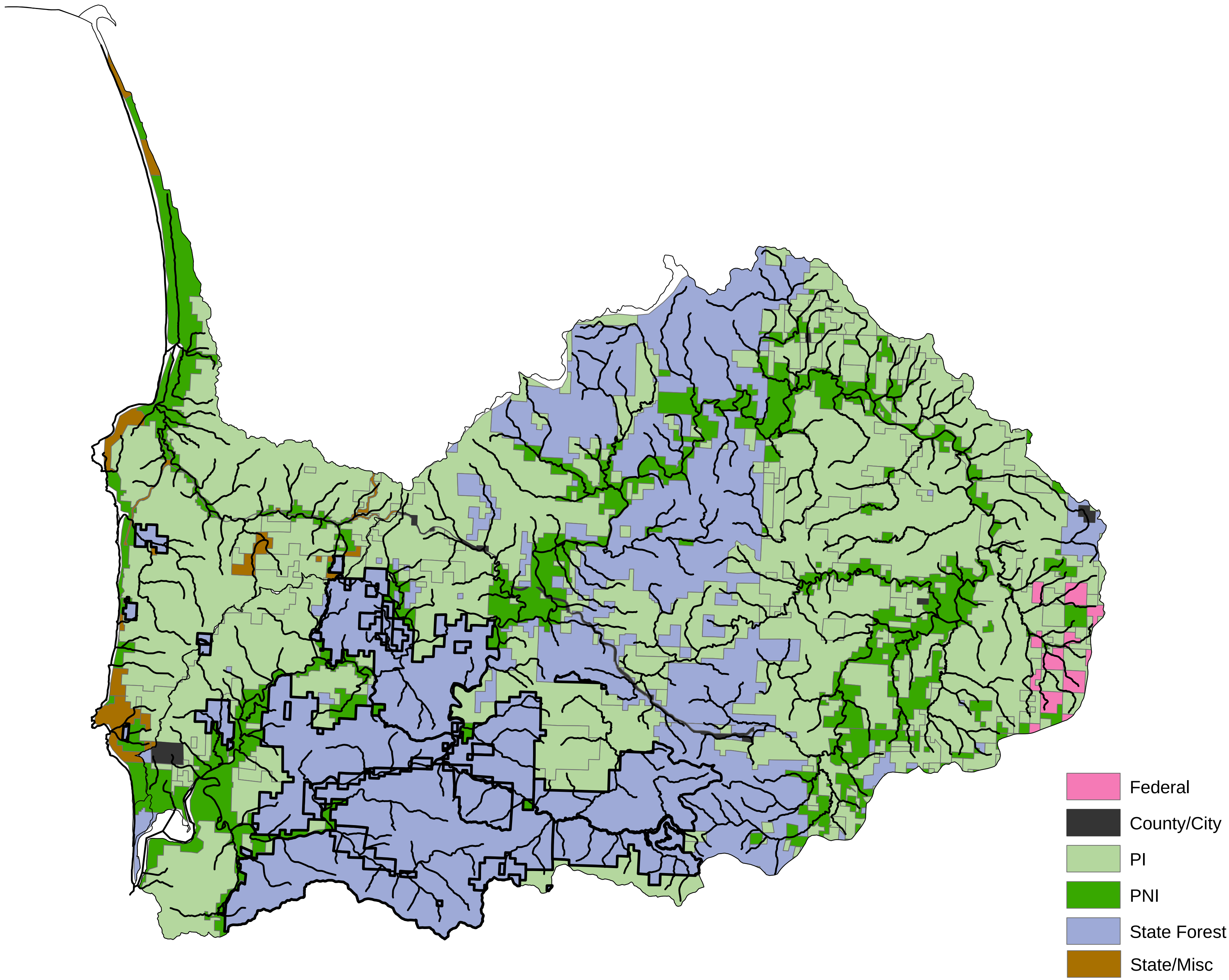
Map 1. The ODF project area (blue) within the Lower Nehalem and Necanicum study area in the state of Oregon.



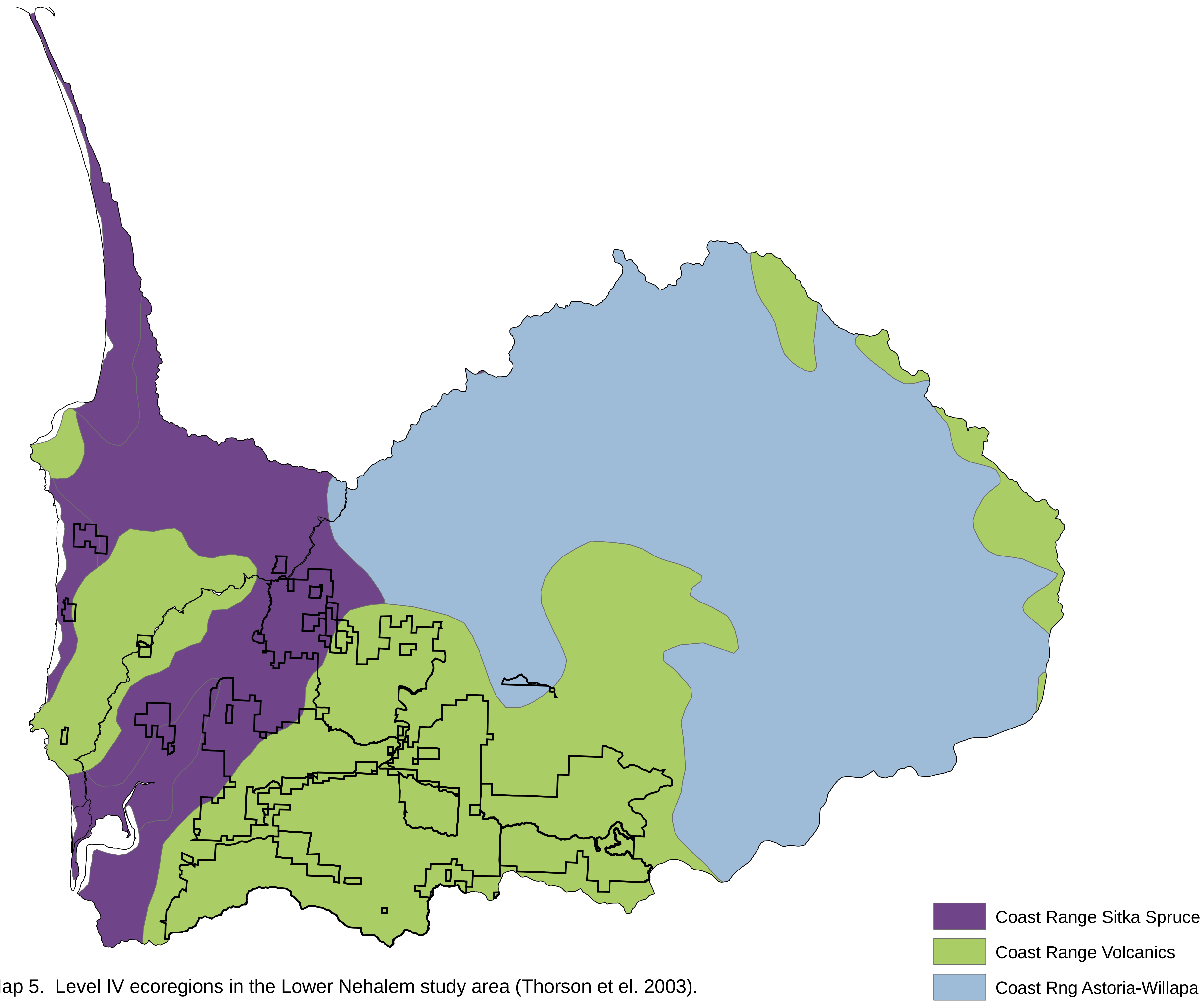
Map 2. Survey sites within management areas in the Lower Nehalem and Necanicum study area.



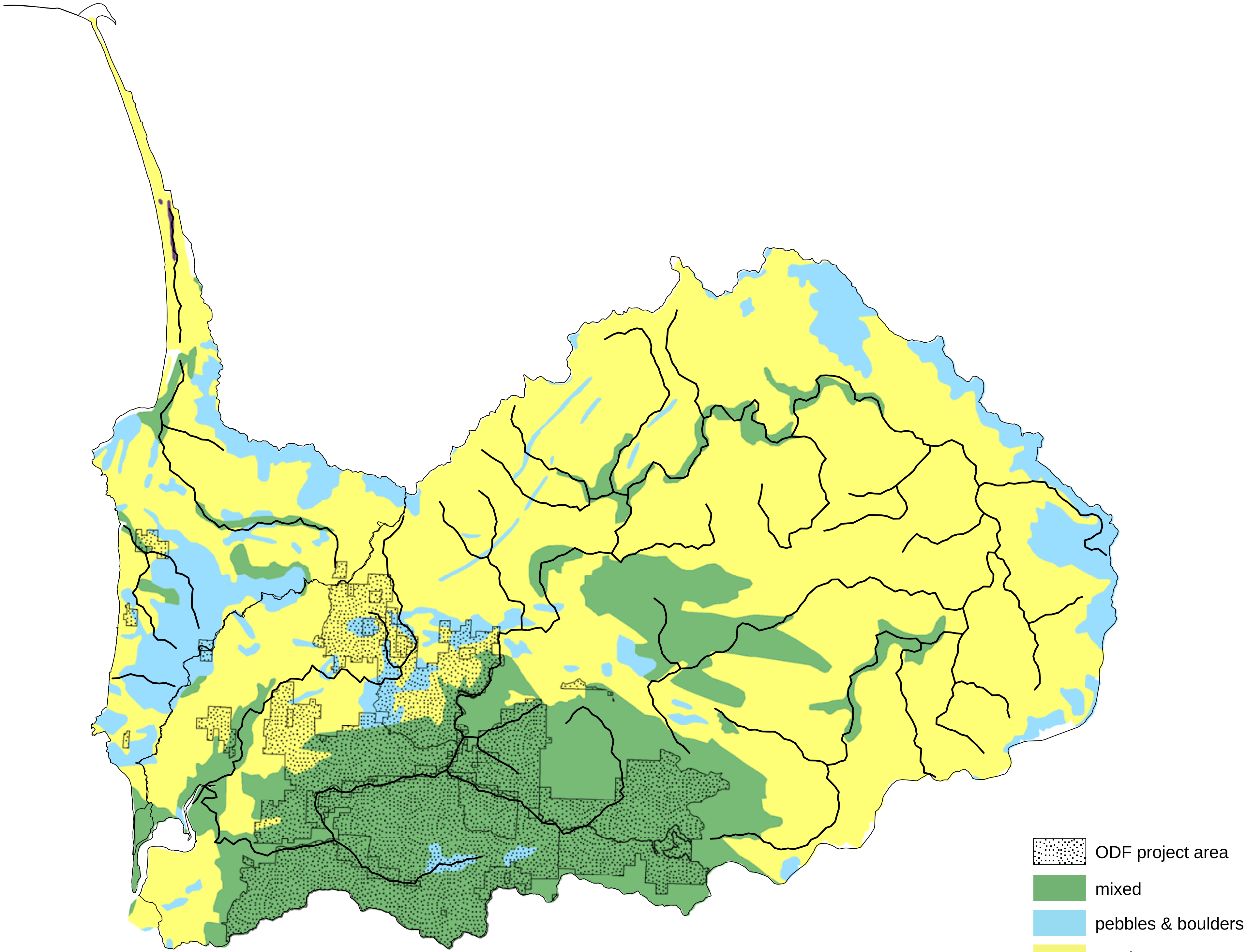
Map 3. Location of survey sites in relation to the surrounding watershed in management areas within the Lower Nehalem project area.



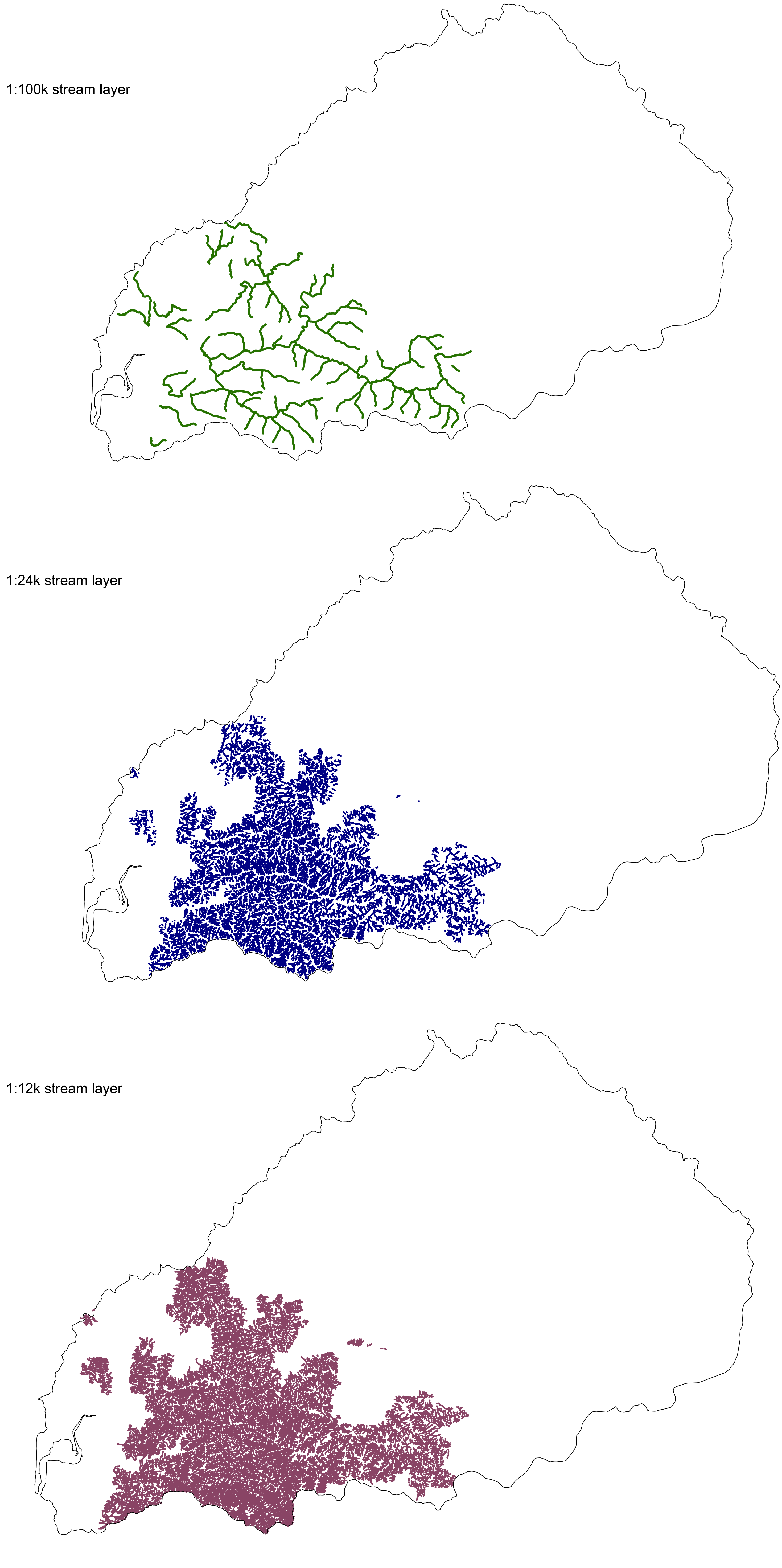
Map 4. Land ownership within the Lower Nehalem study area.



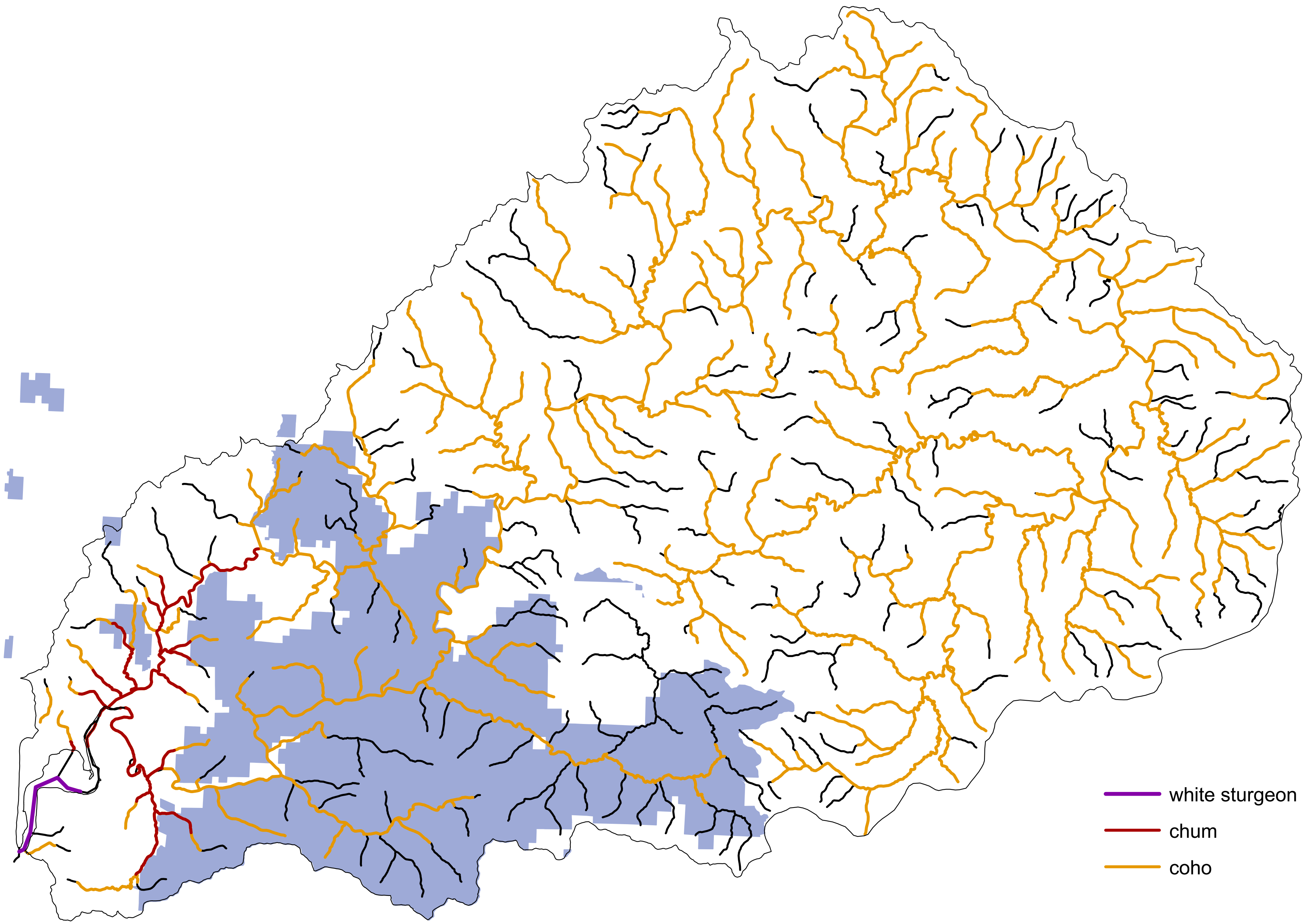
Map 5. Level IV ecoregions in the Lower Nehalem study area (Thorson et el. 2003).



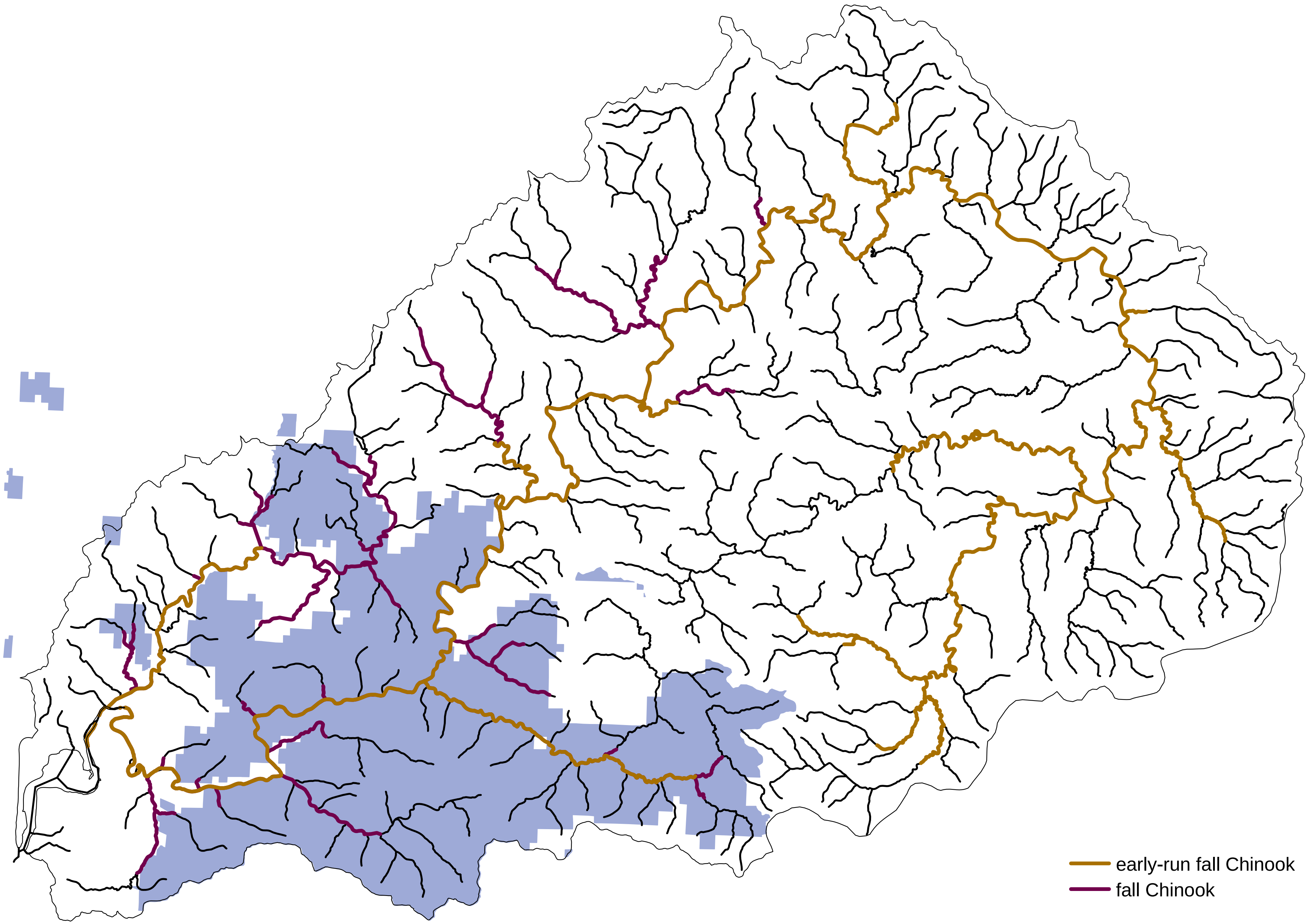
Map 6. Channel geology within the Lower Nehalem study area.



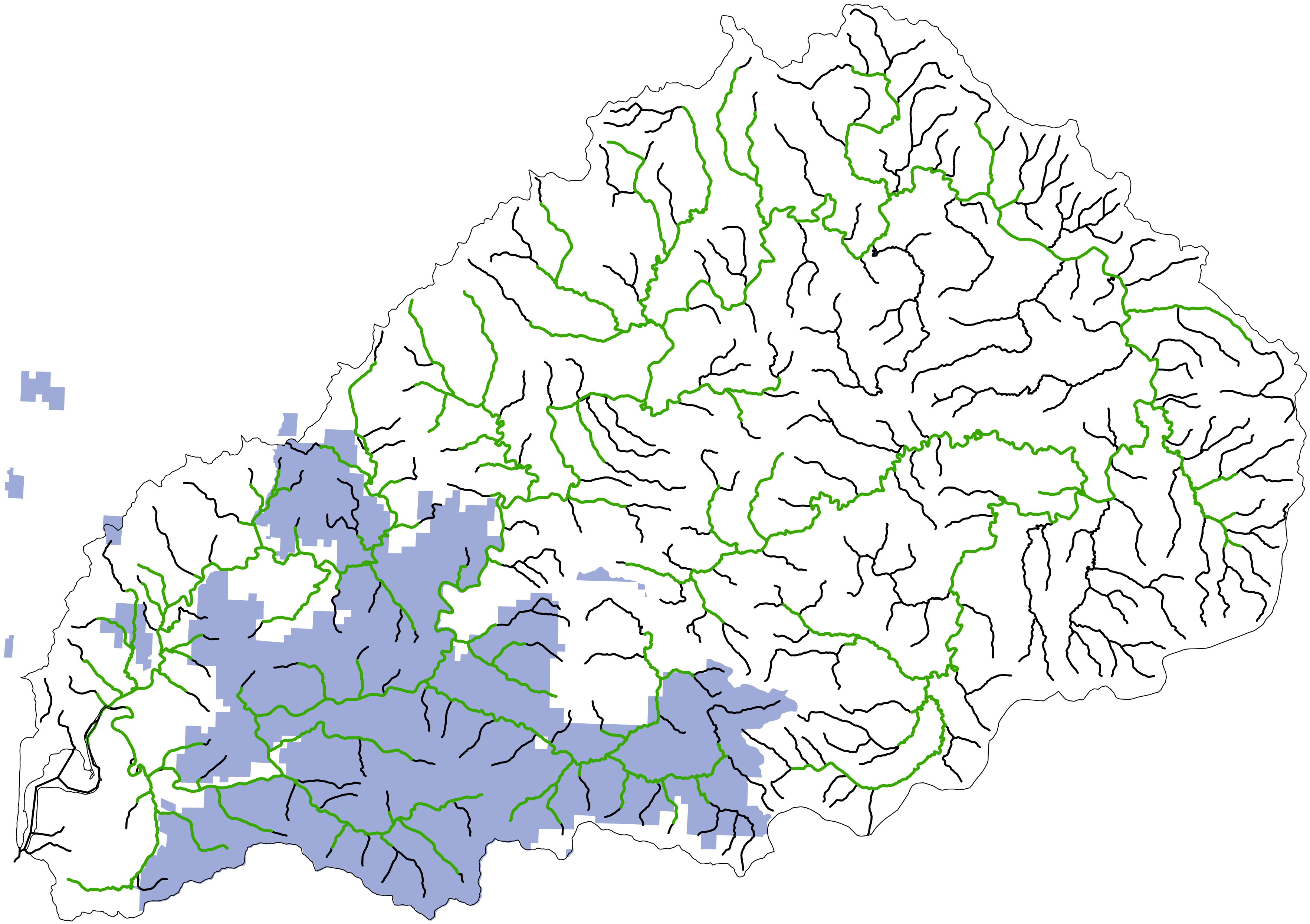
Map 7. Stream layers - 1:100k (ODFW), 1:24k (CLAMS), 1:12k (ODF) - in the Lower Nehalem project area.



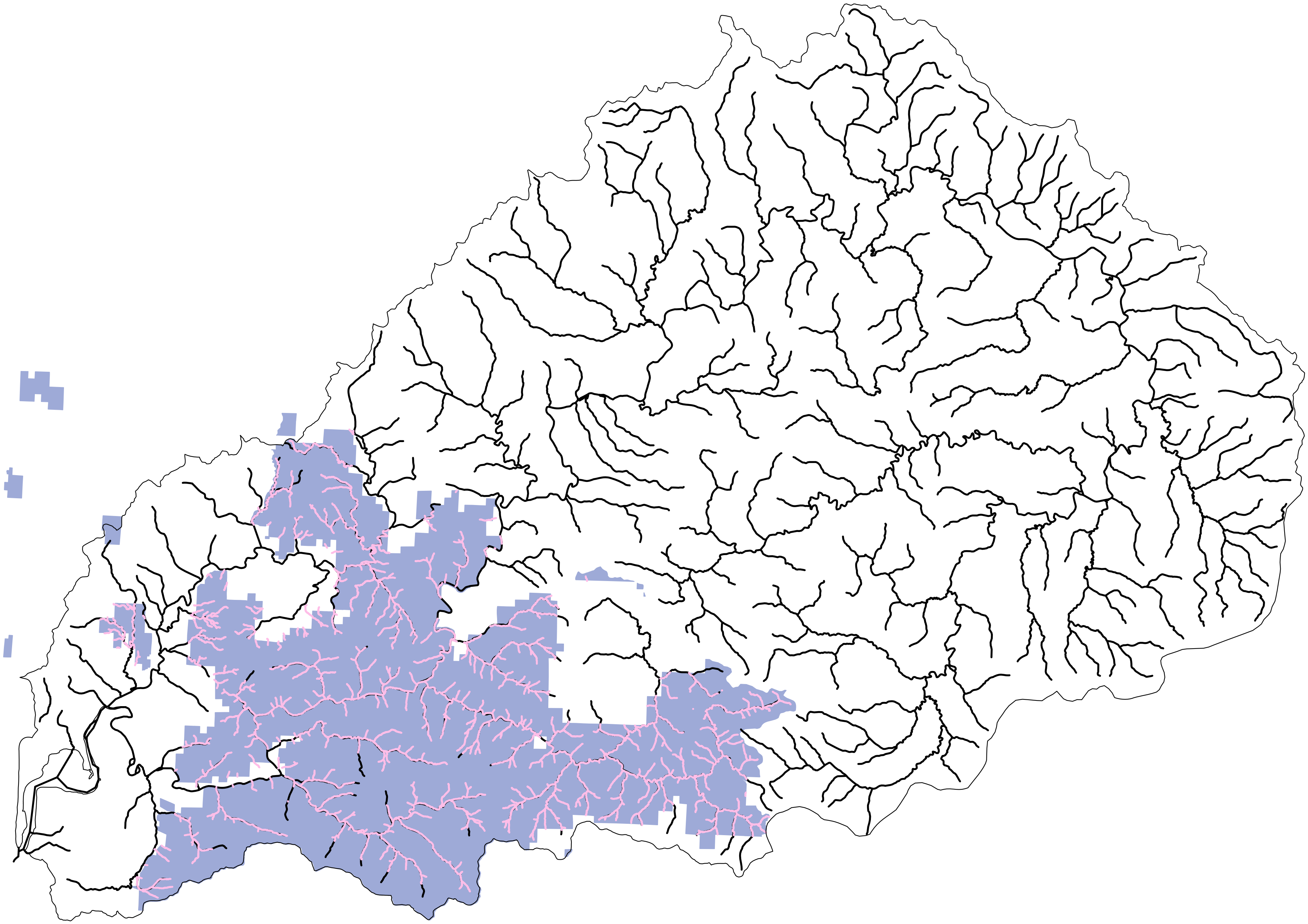
Map 8. The distribution of white sturgeon, chum salmon, and coho salmon within the Lower Nehalem study area.



Map 9. The distribution of early-run fall and fall Chinook salmon within the Lower Nehalem study area.



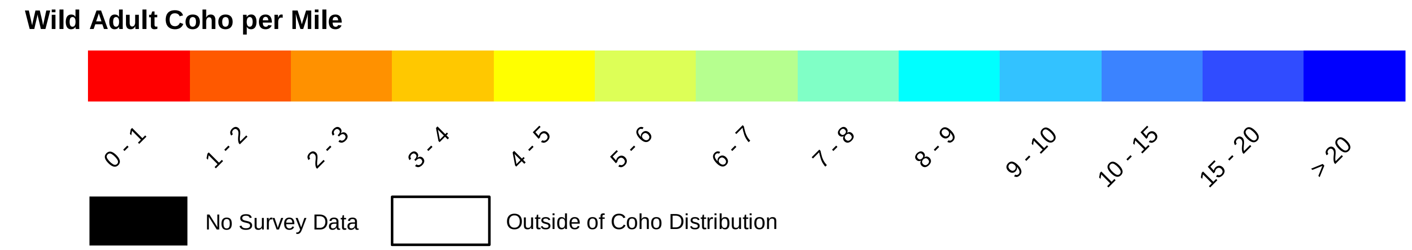
Map 10. Winter steelhead distribution within the Lower Nehalem study area.

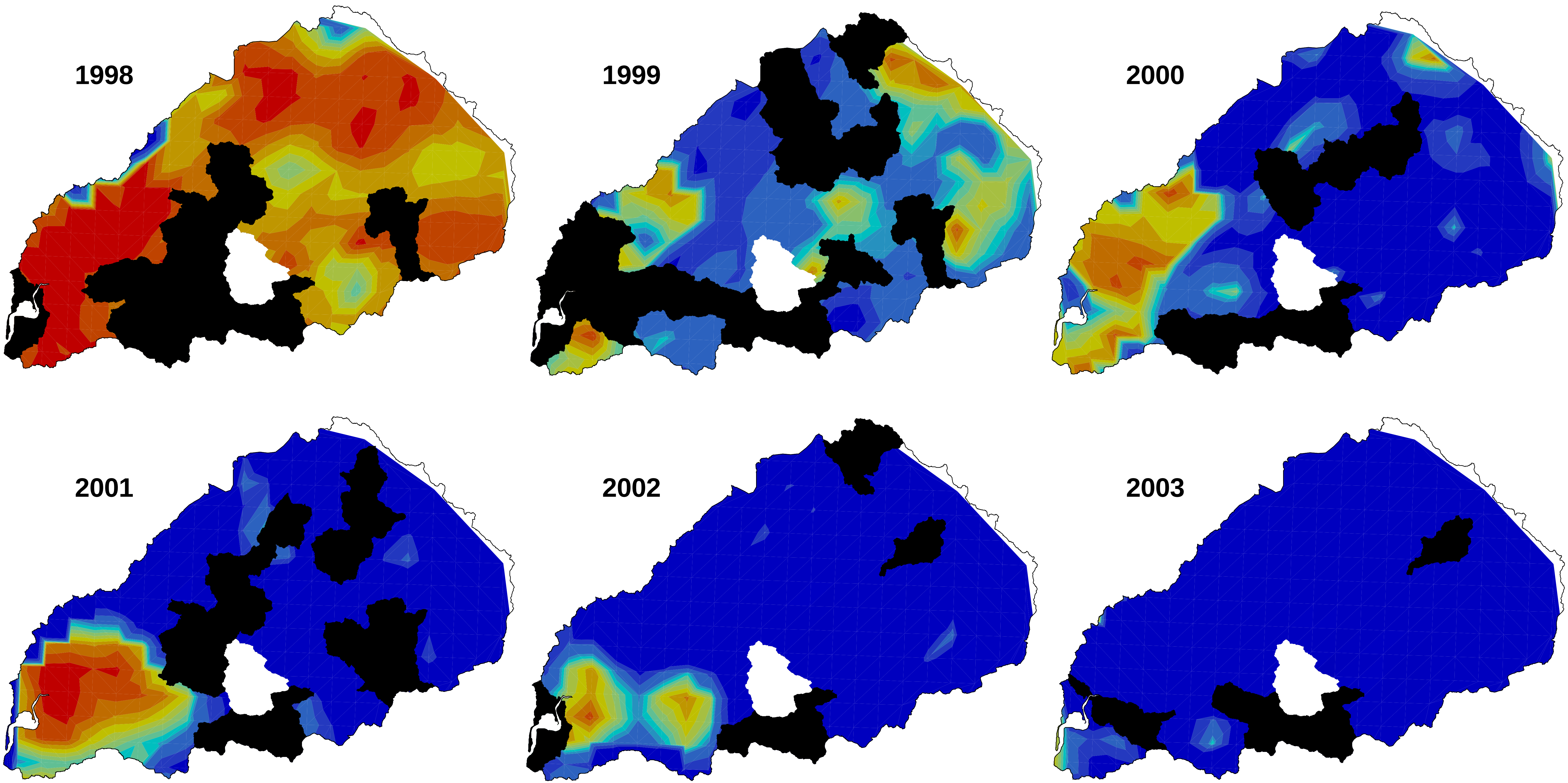


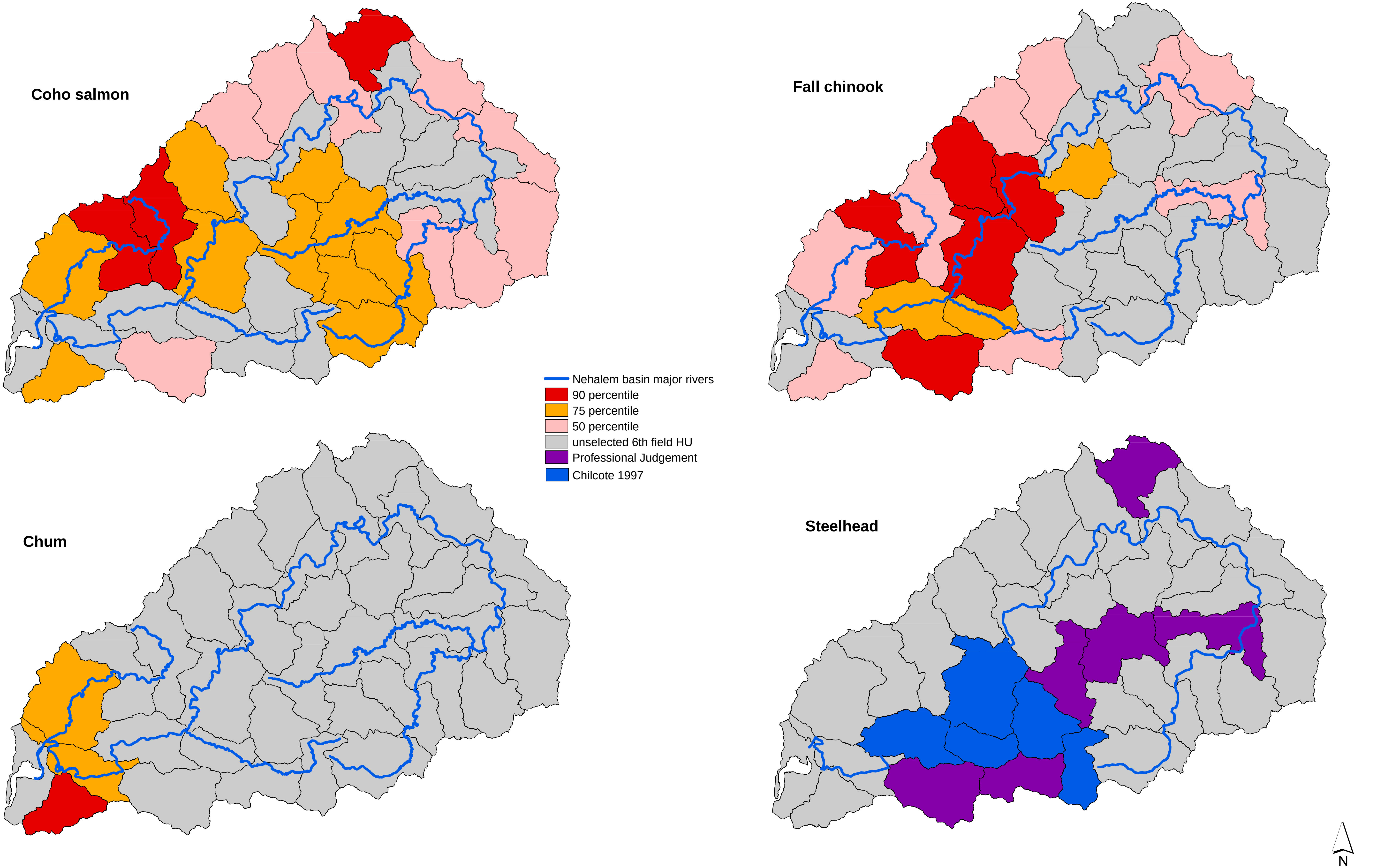
Map 11. Cutthroat trout distribution within the Lower Nehalem project area.

Map 12. Nehalem Coho Population Unit:

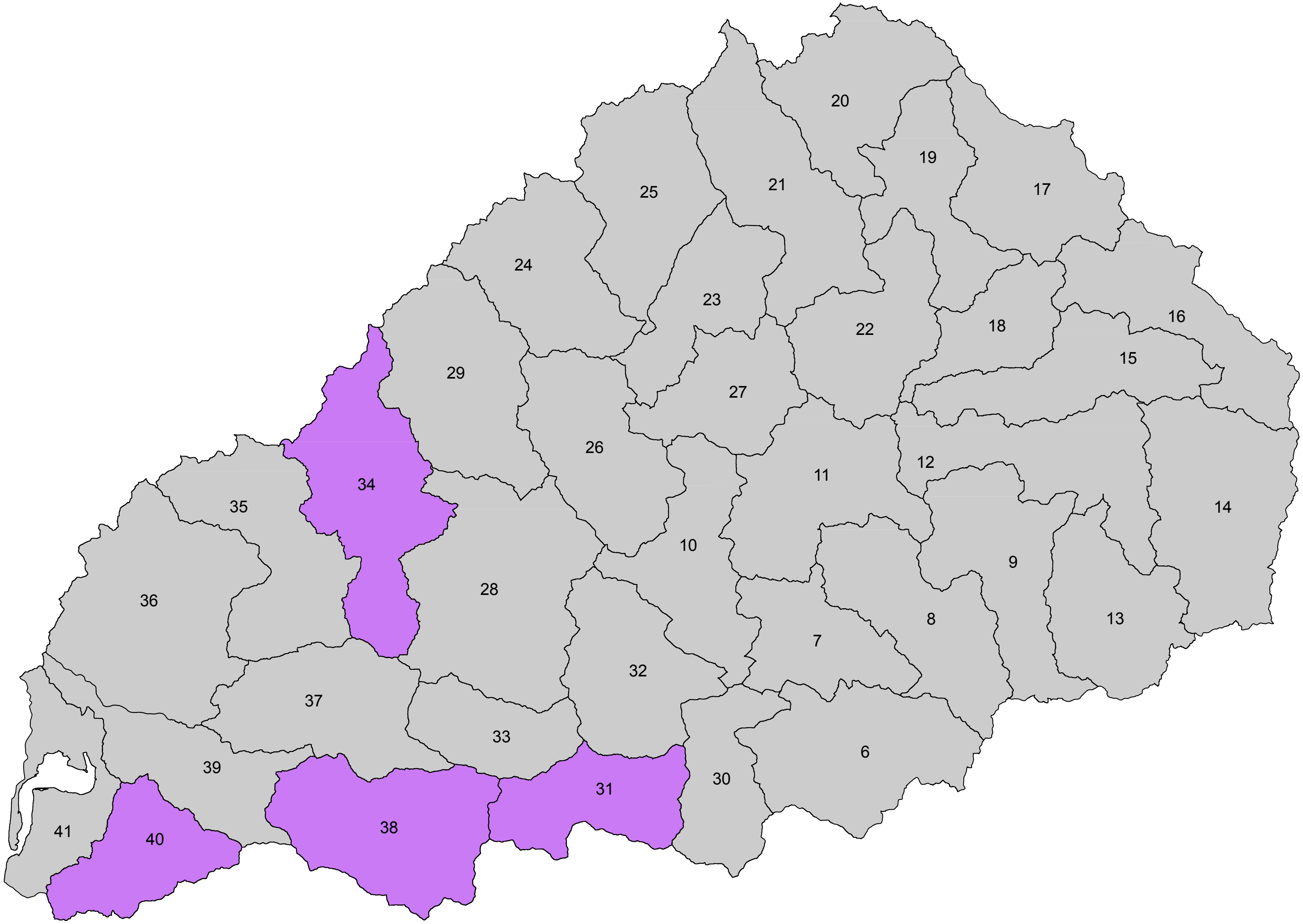
Statistical Distribution Maps of Abundance of Returning Wild Adult Coho



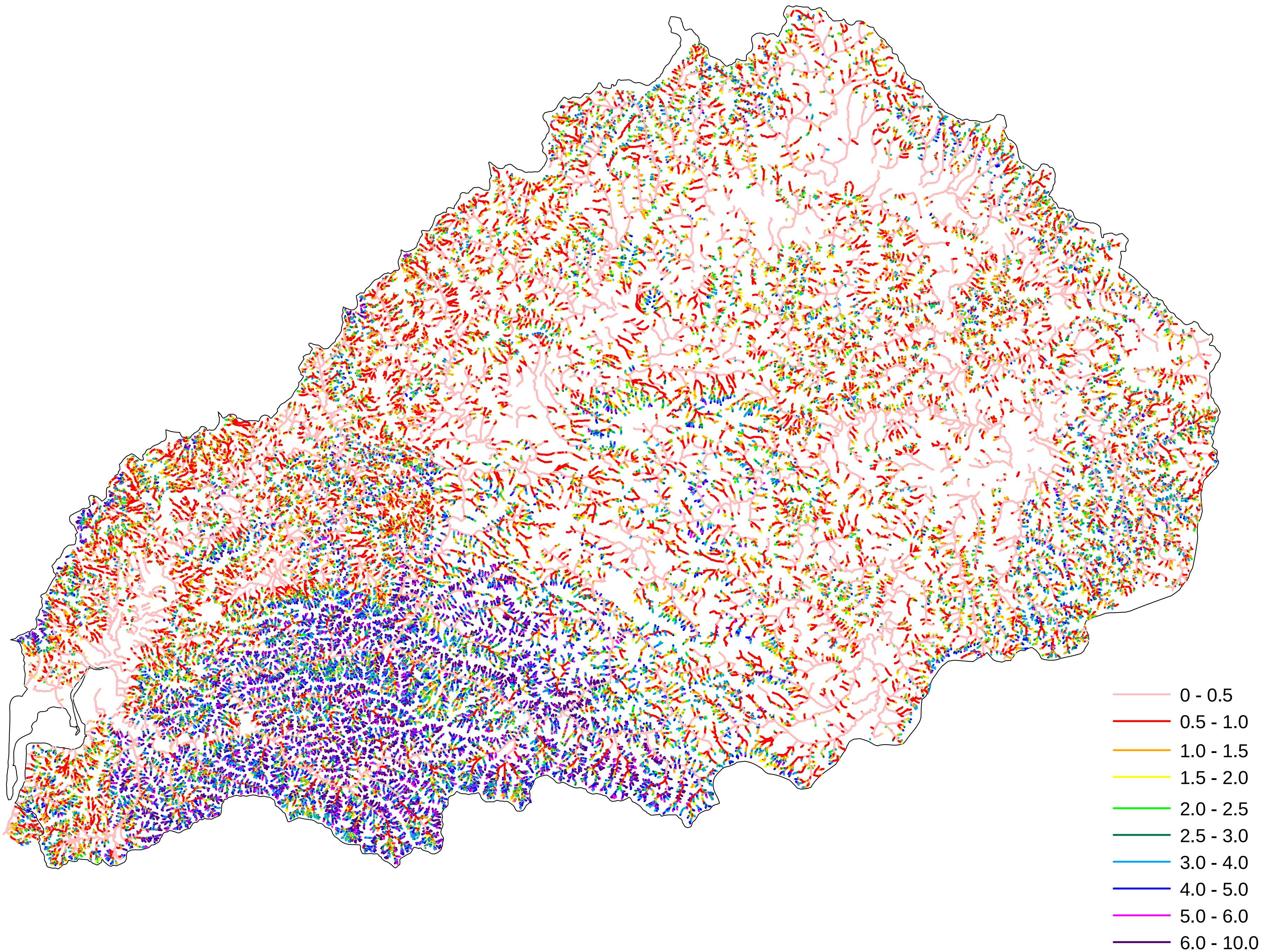




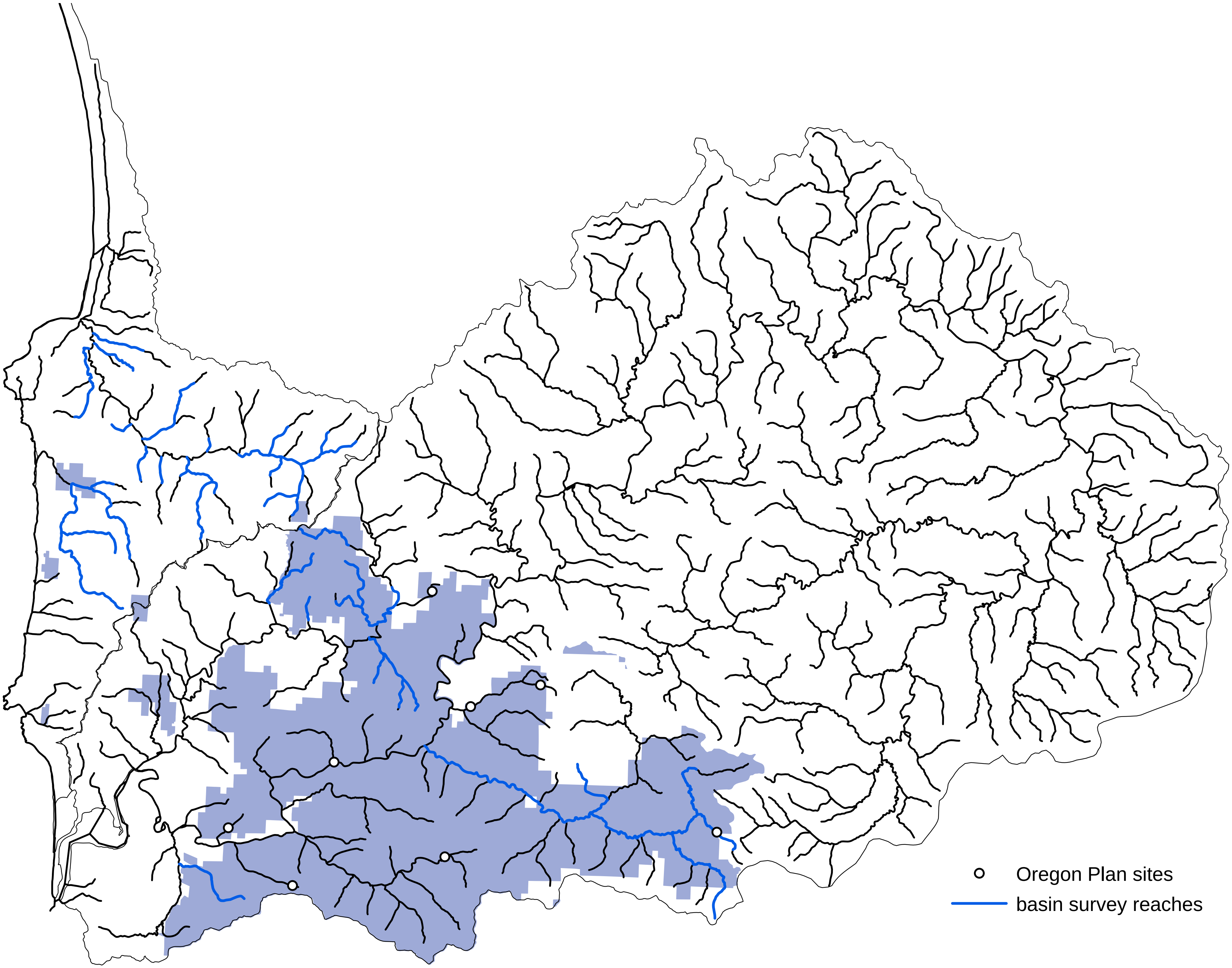
Map 13. Species abundance and diversity within the Lower Nehalem study area per ODFW Coastal Salmonid Inventory Project data 1989 - 2000. Warm-colored (red, orange, pink) 6th field HUs indicate watersheds that had above average densities for more than 50%, 75%, and 90% of the 12 years for chum, Chinook, and coho salmon (Talabere and Jones, 2002). Steelhead presence is indicated by the cool colors (purple and blue).



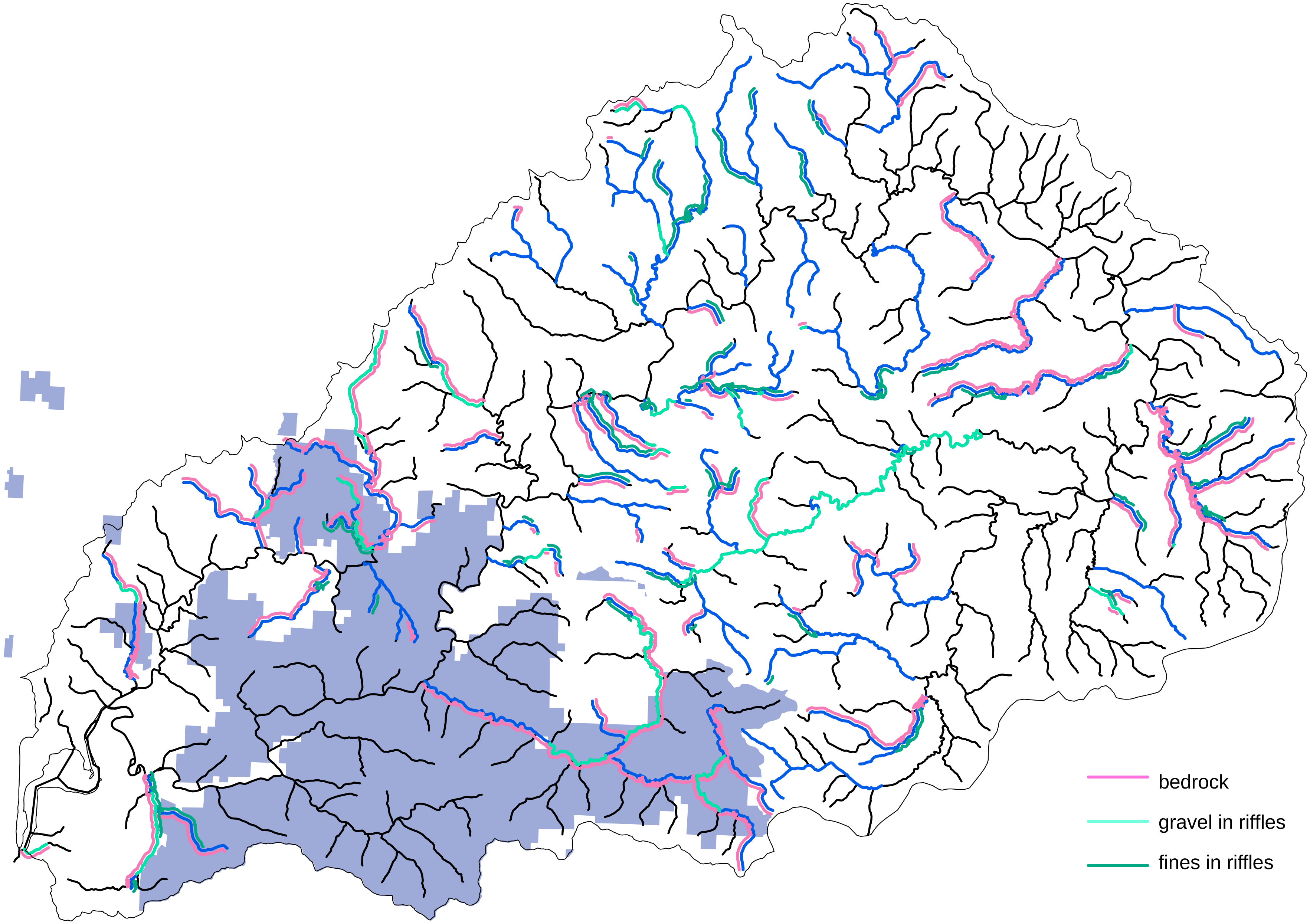
Map 14. Colored polygons indicate Salmon Anchor Habitat within the Lower Nehalem project area. Sixth field HUs identified by reference number correspond to reference numbers listed in Table 2.



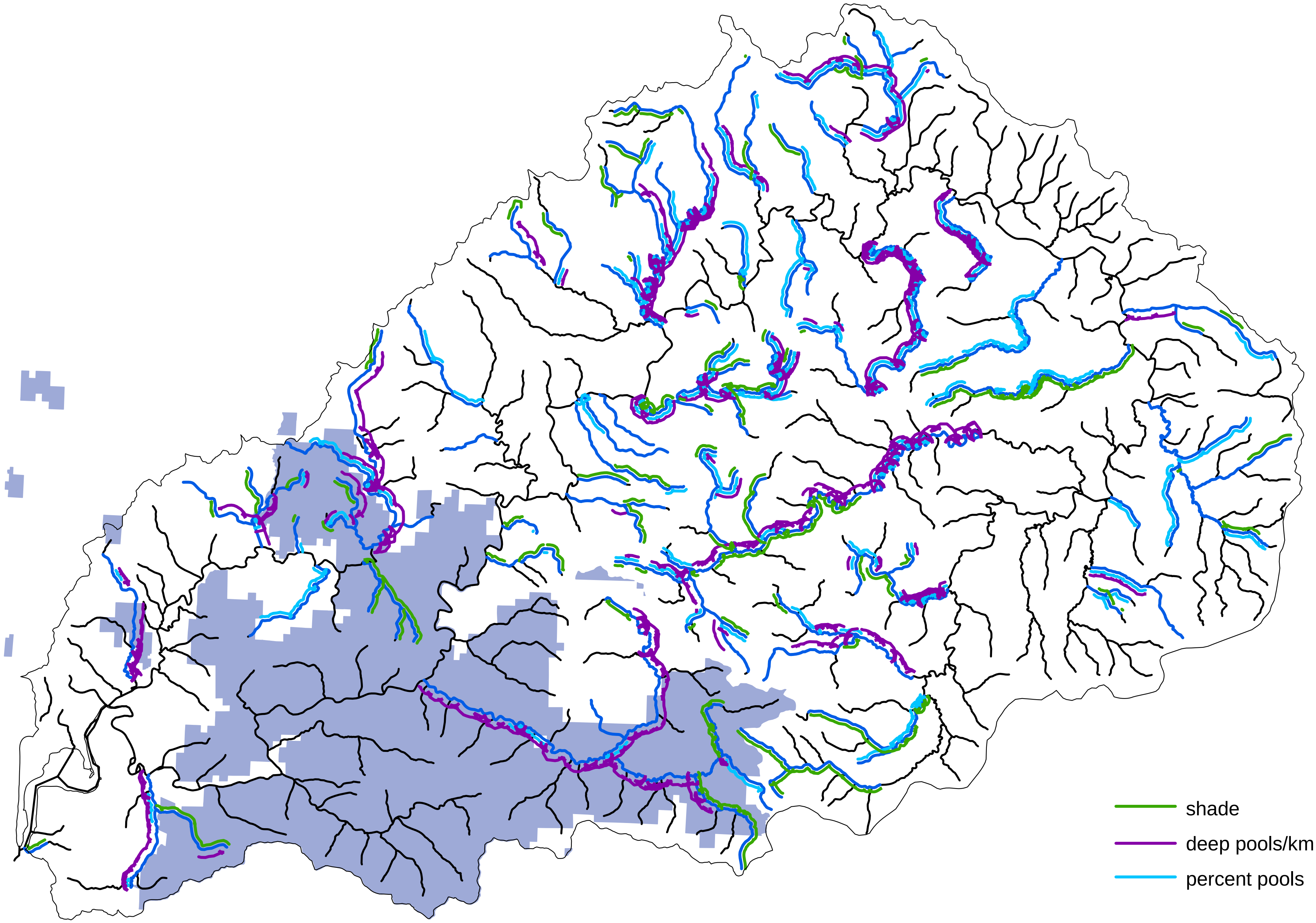
Map 15. Gradient of streams in the Lower Nehalem study area. (CLAMS).



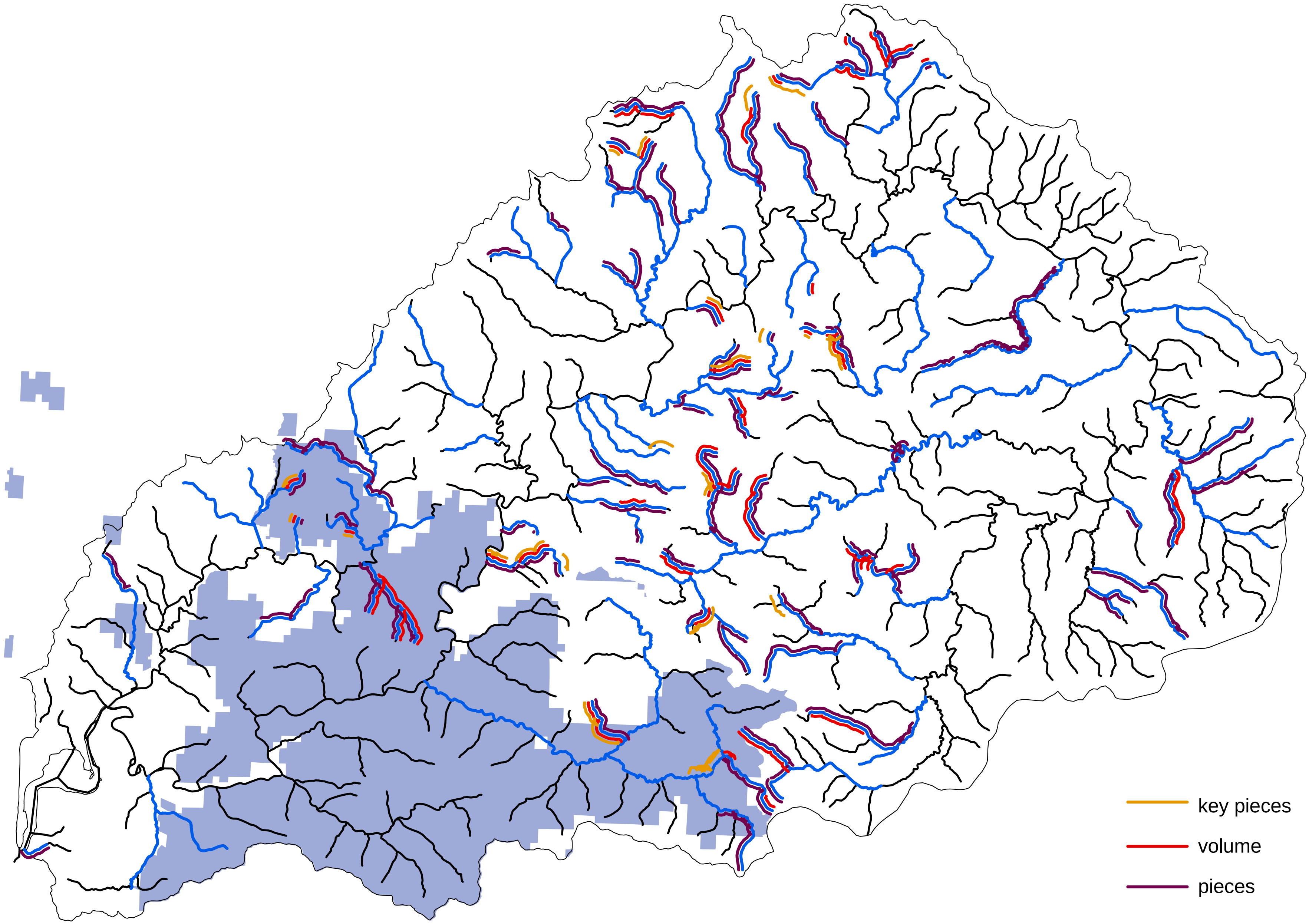
Map 16. Summer survey sites - Oregon Plan and basin - within the Lower Nehalem and Necanicum project area.



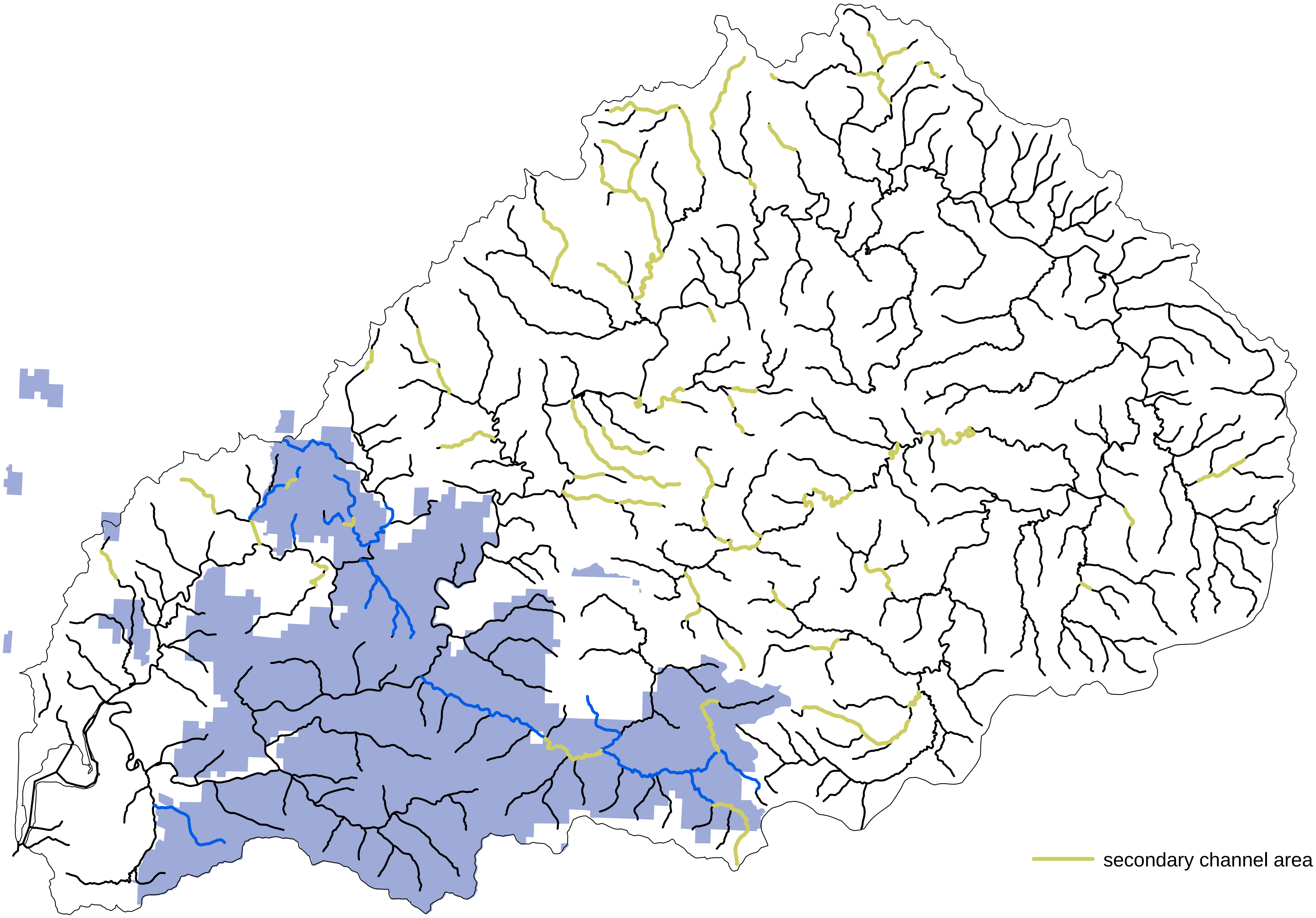
Map 17. Reaches which met or exceeded the high breakpoint for key habitat characteristics - percent bedrock and percent gravel and fine sediment in riffle units - within the Lower Nehalem study area.



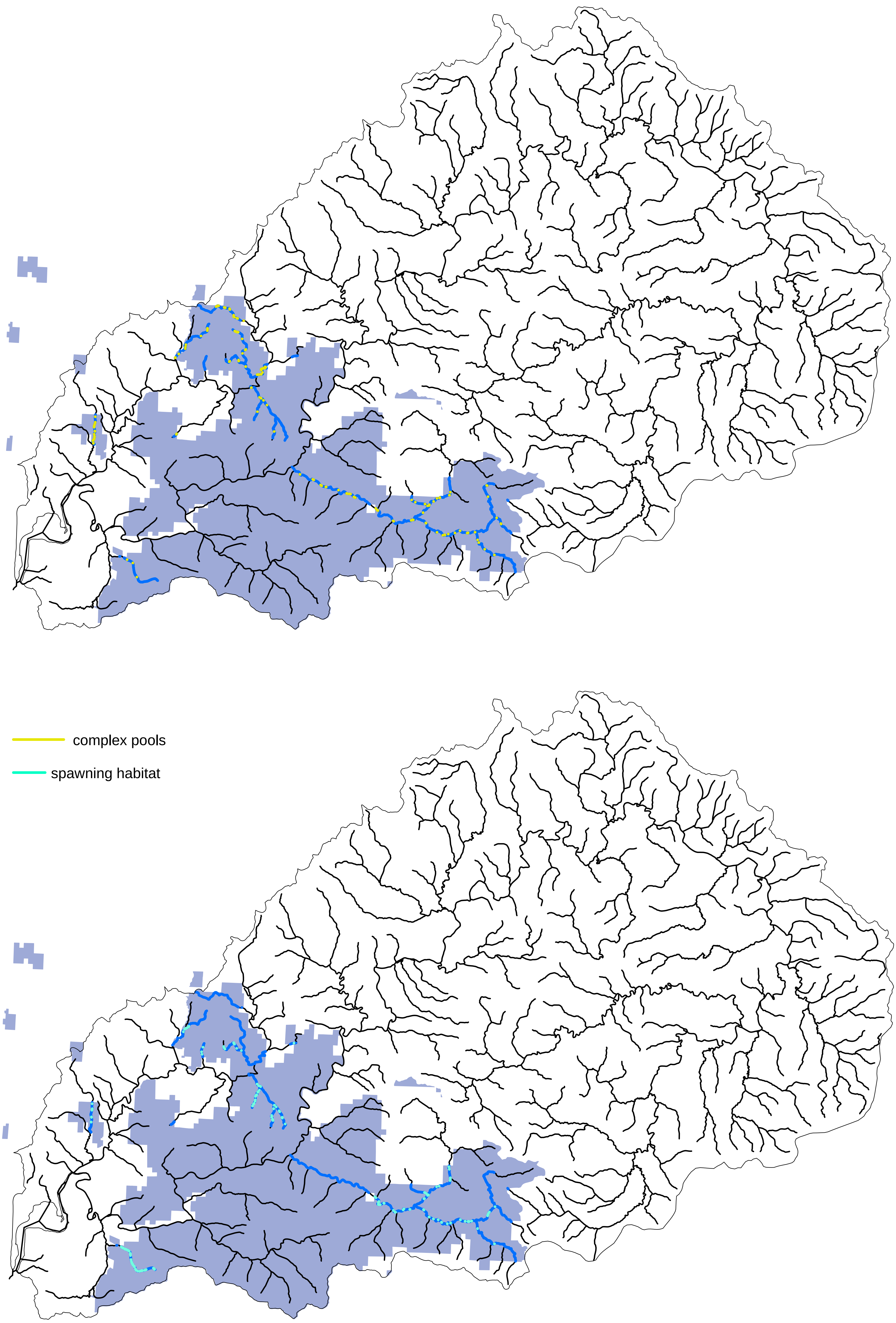
Map 18. Reaches which met or exceeded the high breakpoint for key habitat characteristics - shade, percent pools, number of deep pools (>1m deep) - within the Lower Nehalem study area.



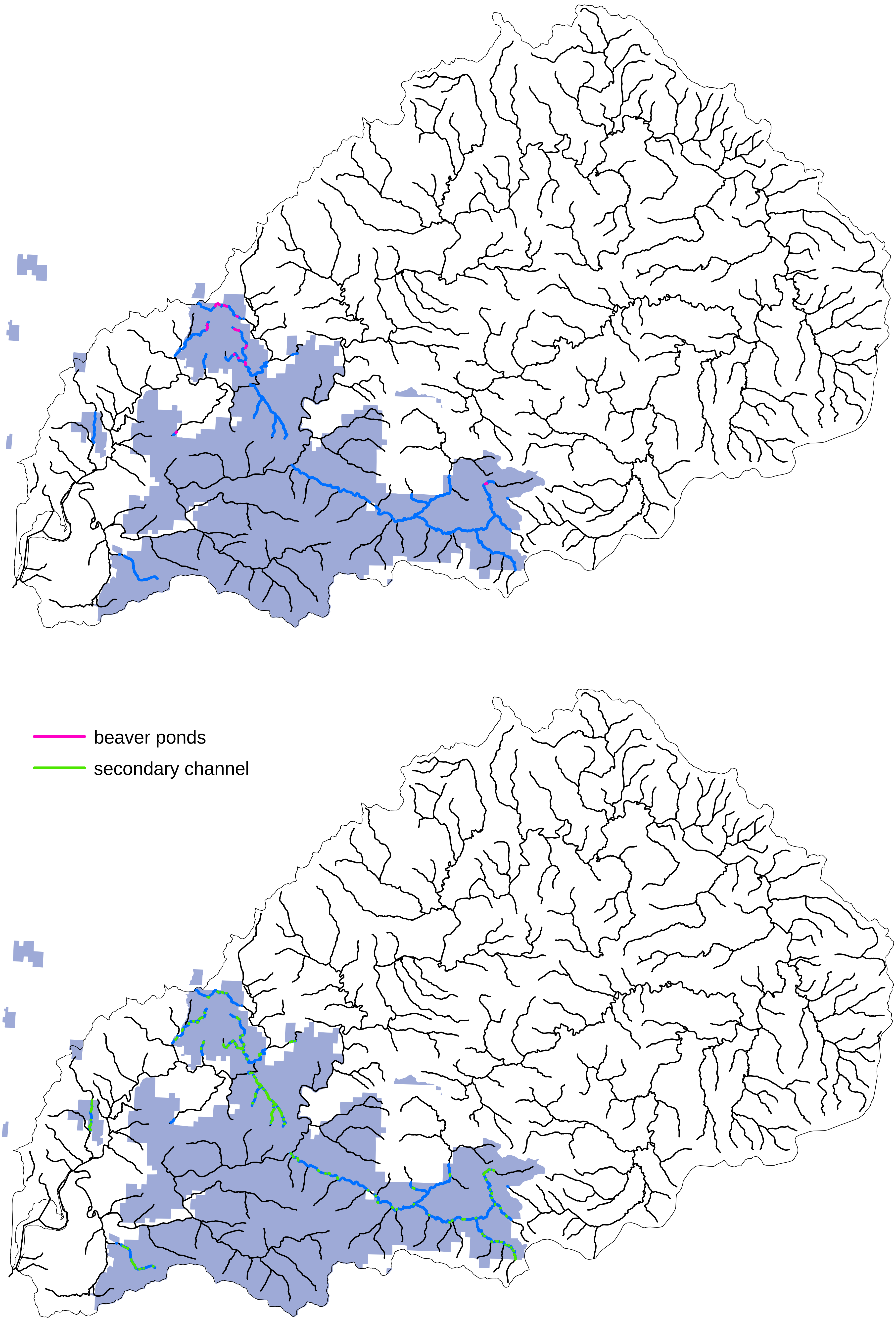
Map 19. Reaches which met or exceeded the high breakpoint for key habtiat characteristics - number of pieces, volume, and key pieces of large wood per 100m of stream length - within the Lower Nehalem study area.



Map 20. Reaches which met or exceeded the high breakpoint for a key habitat attribute - seconday channel area - within the Lower Nehalem study area.

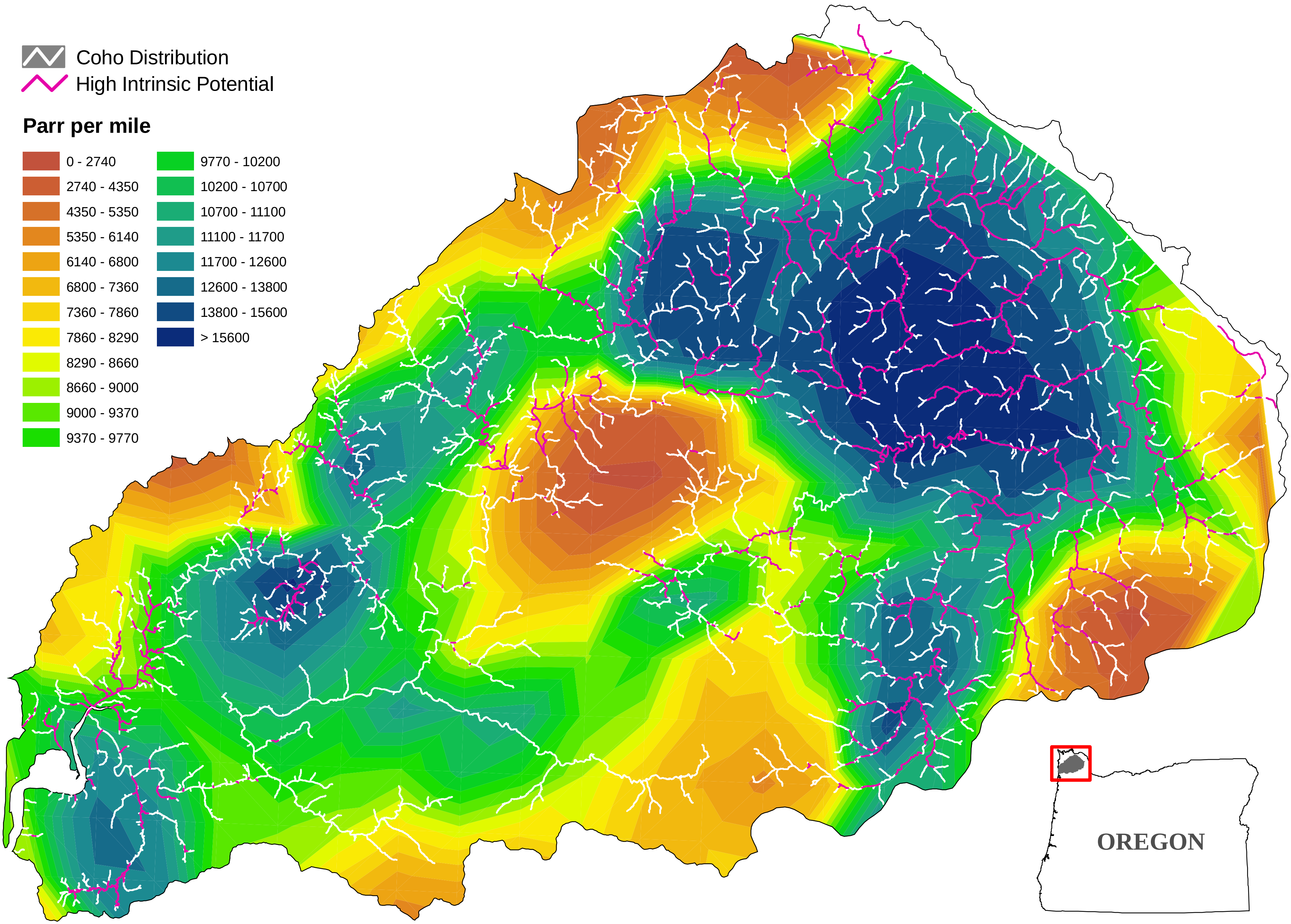


Map 21. Important habitat characteristics - complex pools (>1m deep and 3+ pieces of wood) and spawning gravel in riffle units - on the unit level scale within the Lower Nehalem project area.

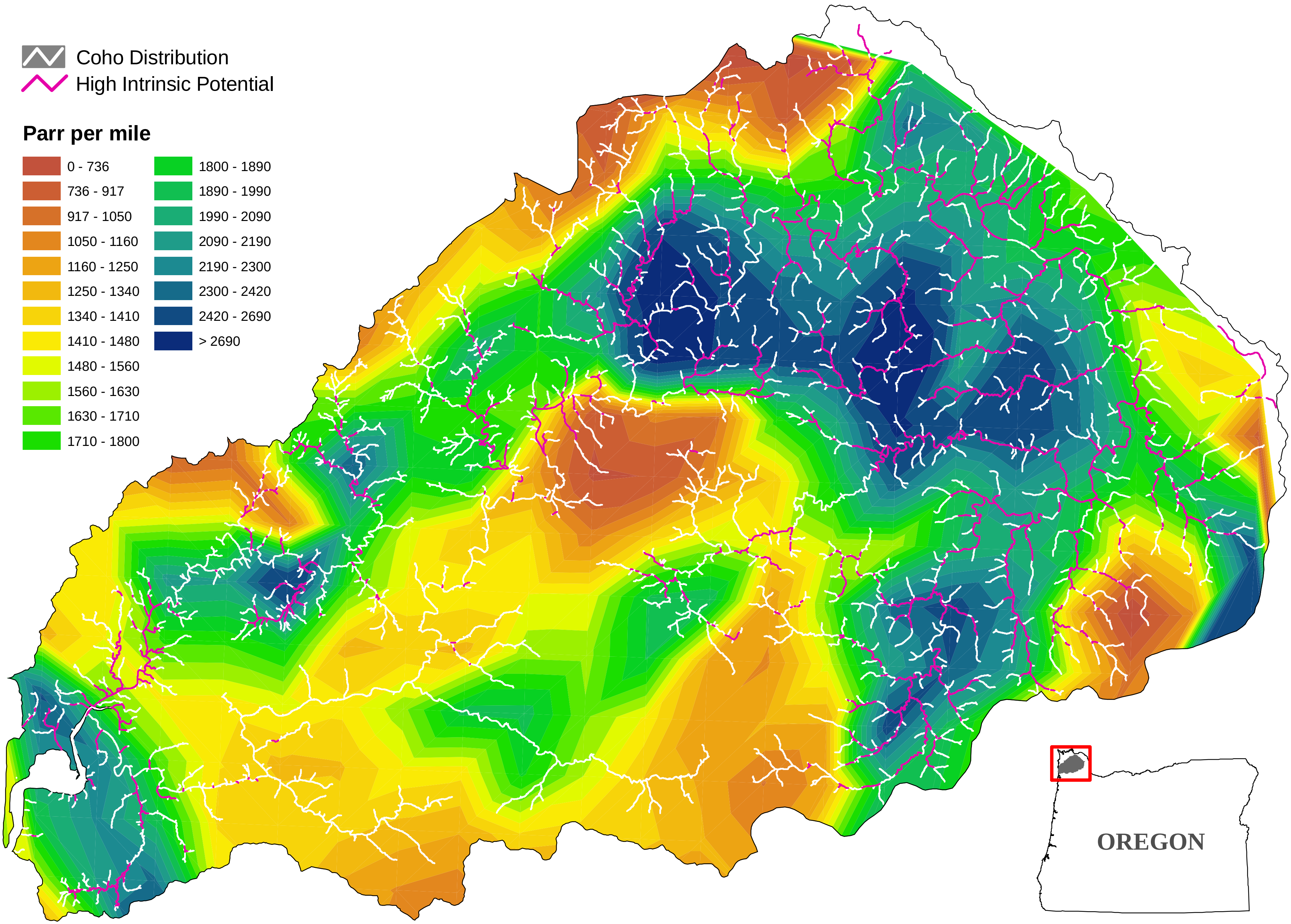


Map 22. Important habitat characteristics - beaver ponds and secondary channels - on the unit level scale within the Lower Nehalem project area.

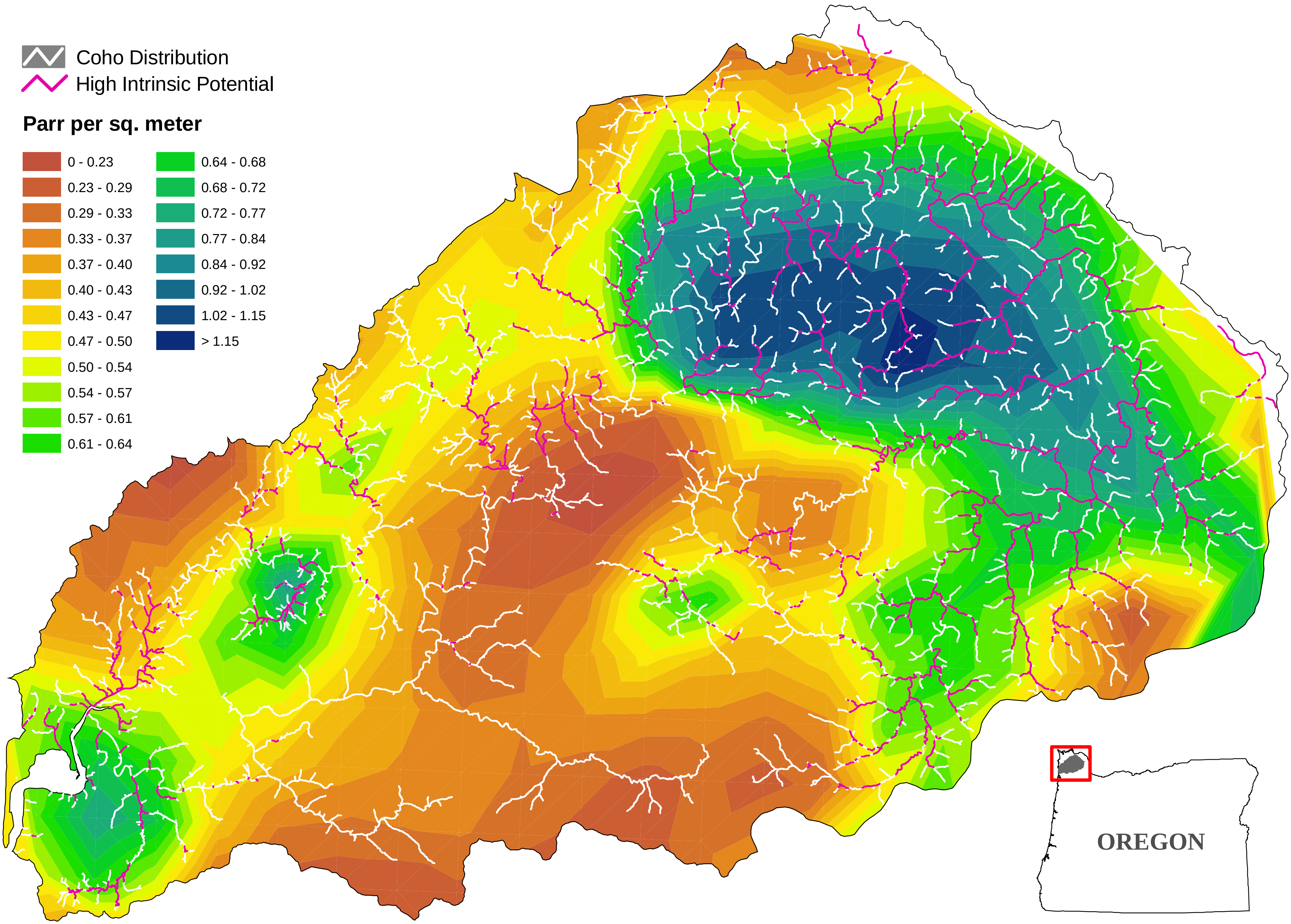
Map 23. Summer Habitat Capacity for Juvenile Coho Salmon



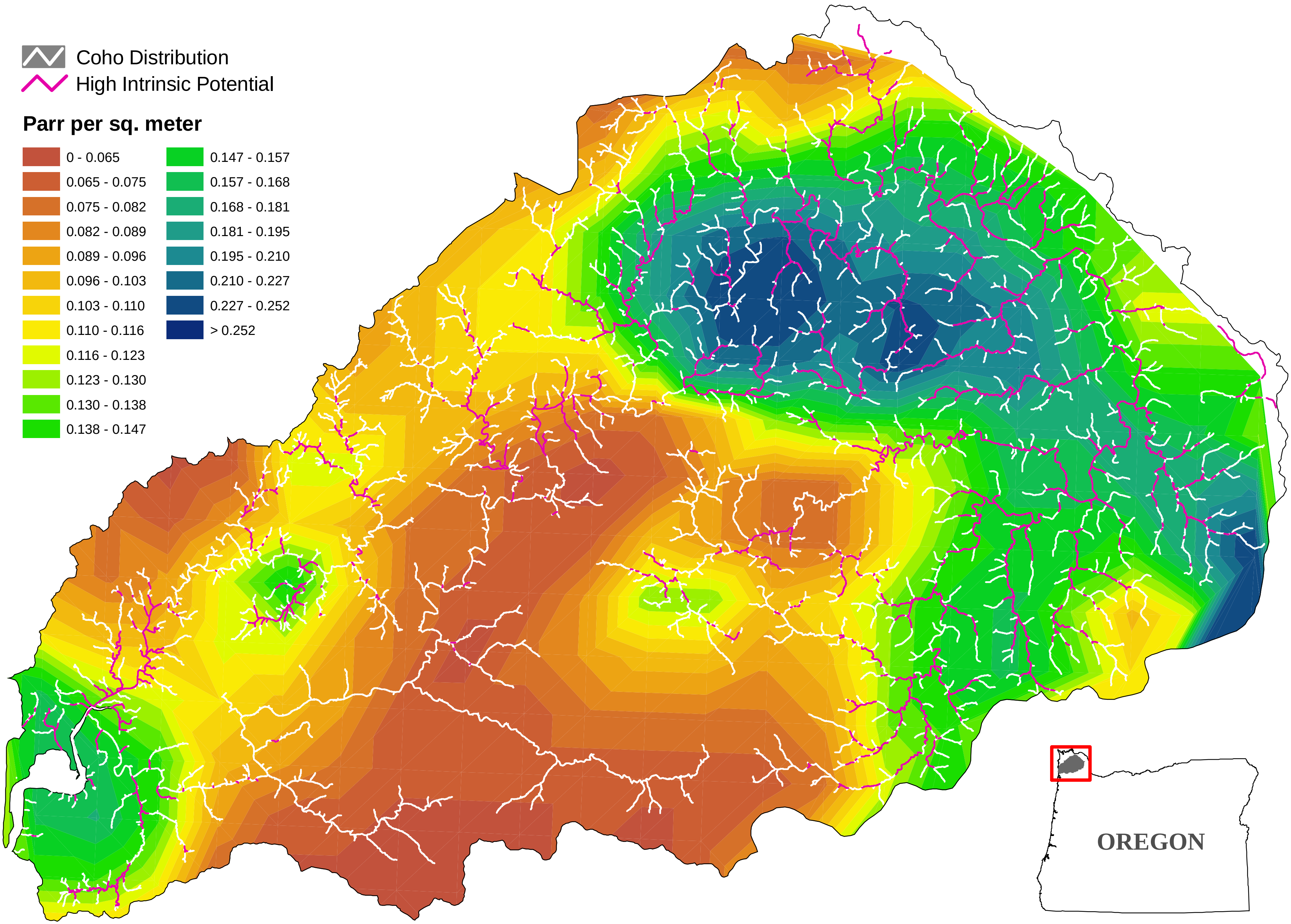
Map 24. Winter Habitat Capacity for Juvenile Coho Salmon

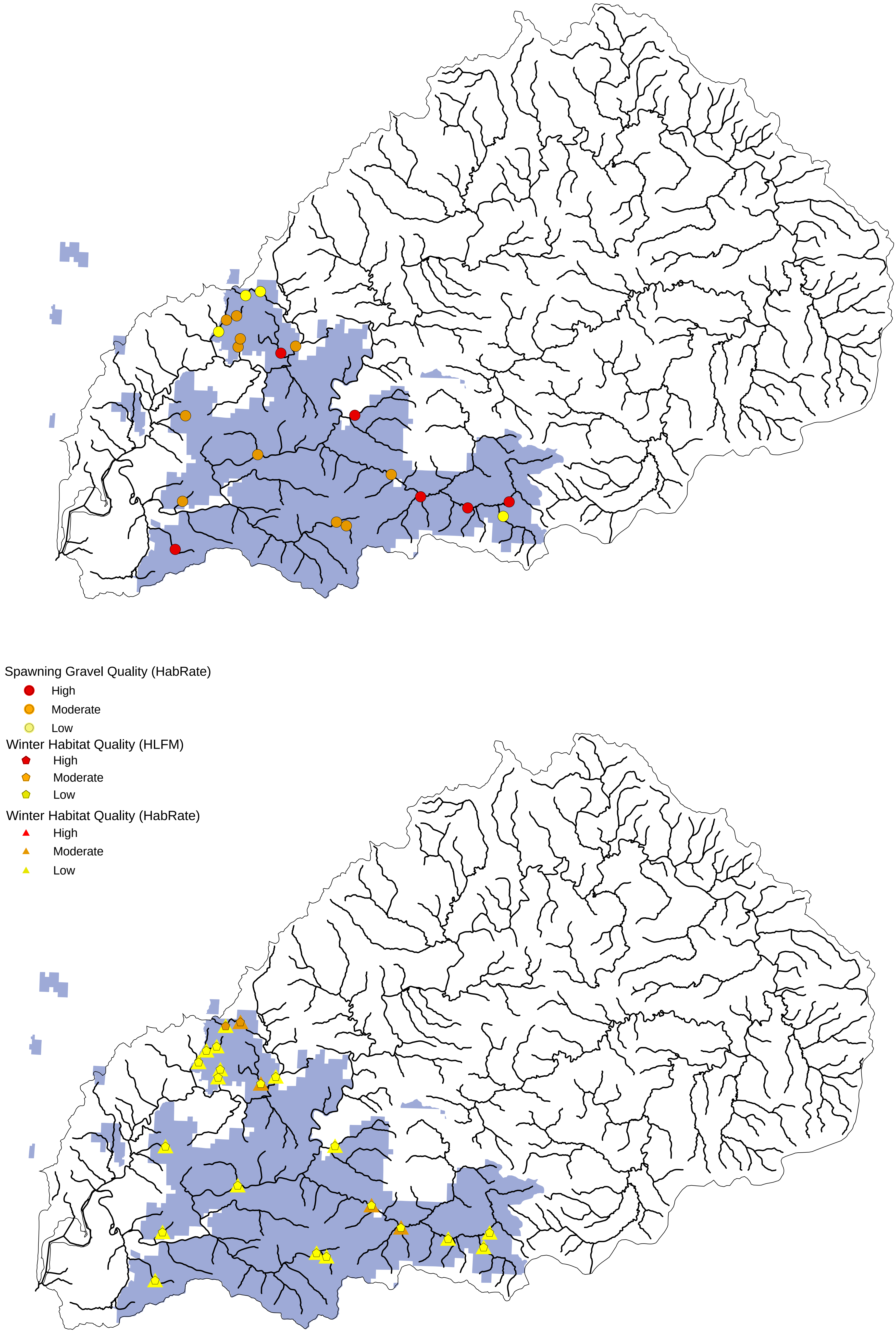


Map 25. Summer Habitat Quality for Juvenile Coho Salmon

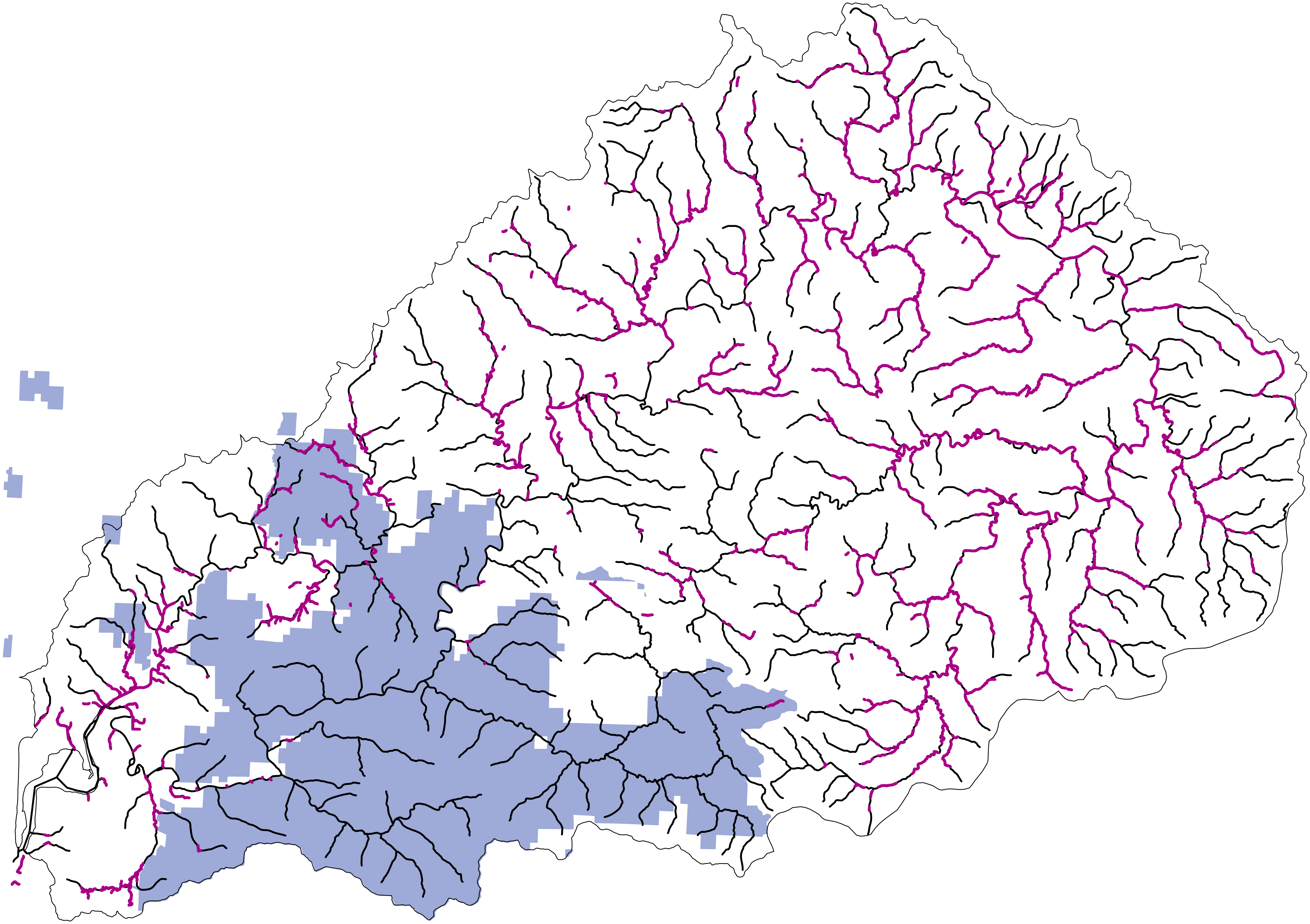


Map 26. Winter Habitat Quality for Juvenile Coho Salmon

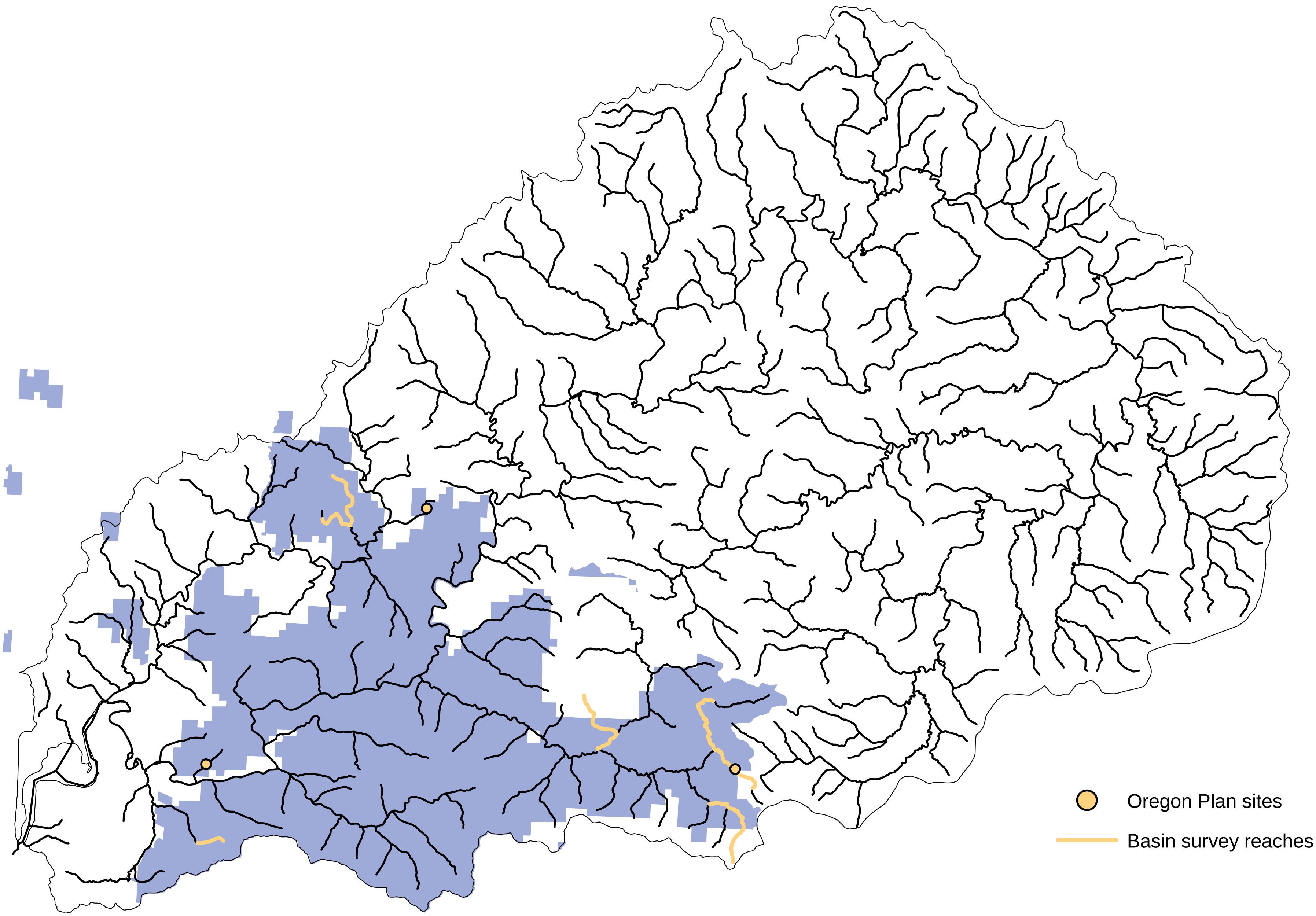




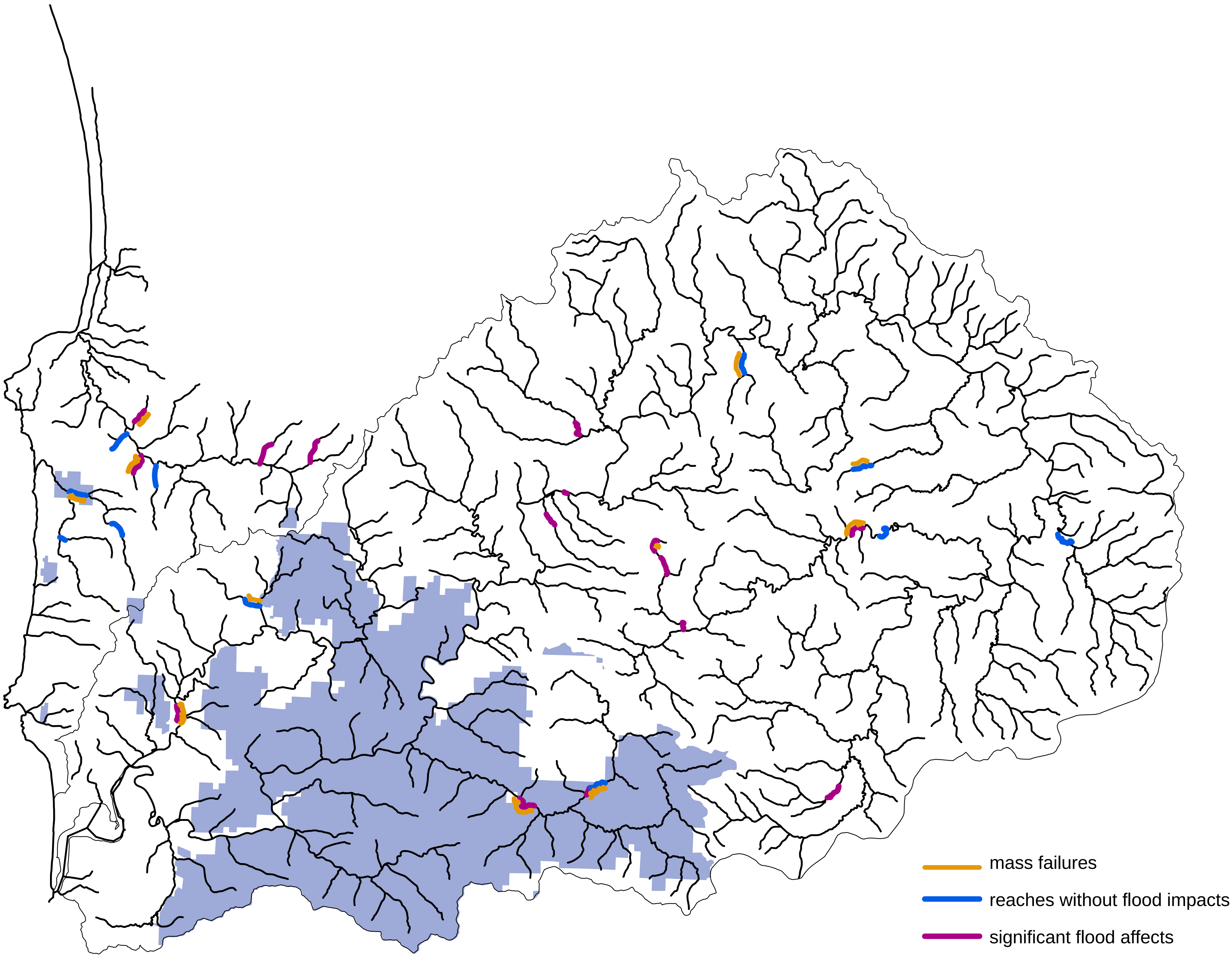
Map 27. Quality of winter habitat and spawning gravel within coho salmon distribution in the Lower Nehalem project area.



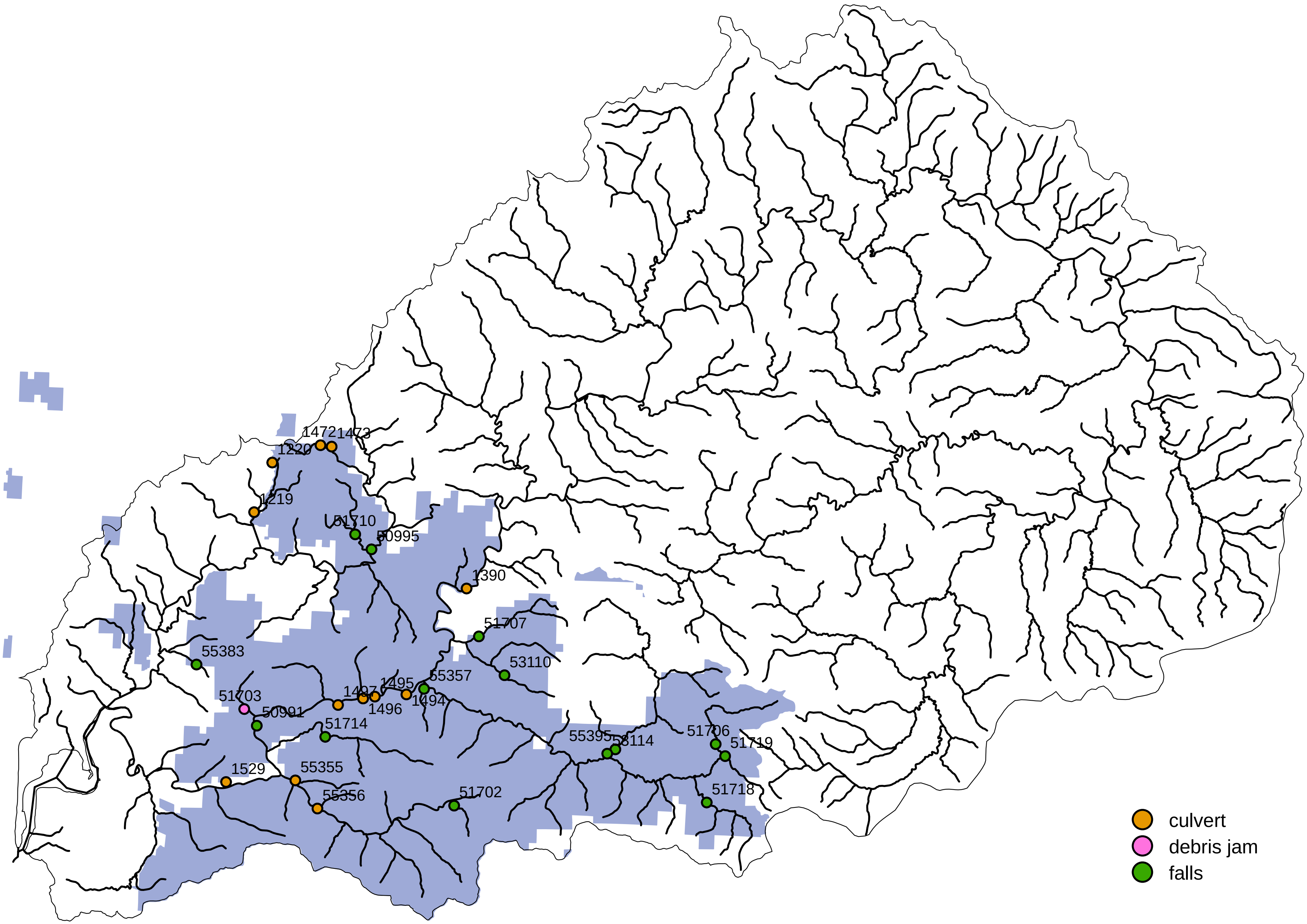
Map 28. Intrinsic potential for coho salmon (>0.8 = high) within the Lower Nehalem study area (source: CLAMS).



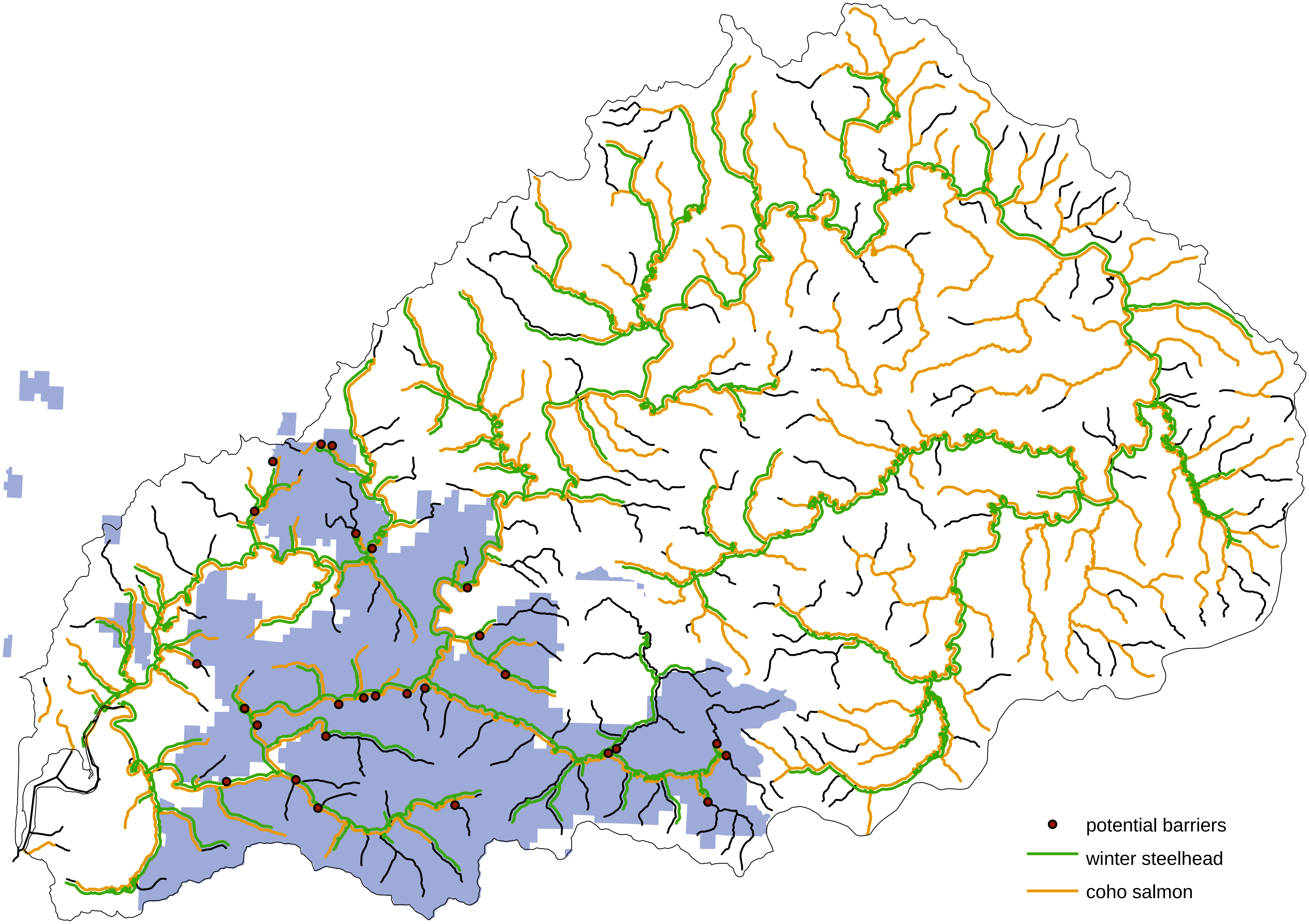
Map 29. Small stream (defined here as habitat upstream of coho distribution) survey sites, within the Lower Nehalem project area.



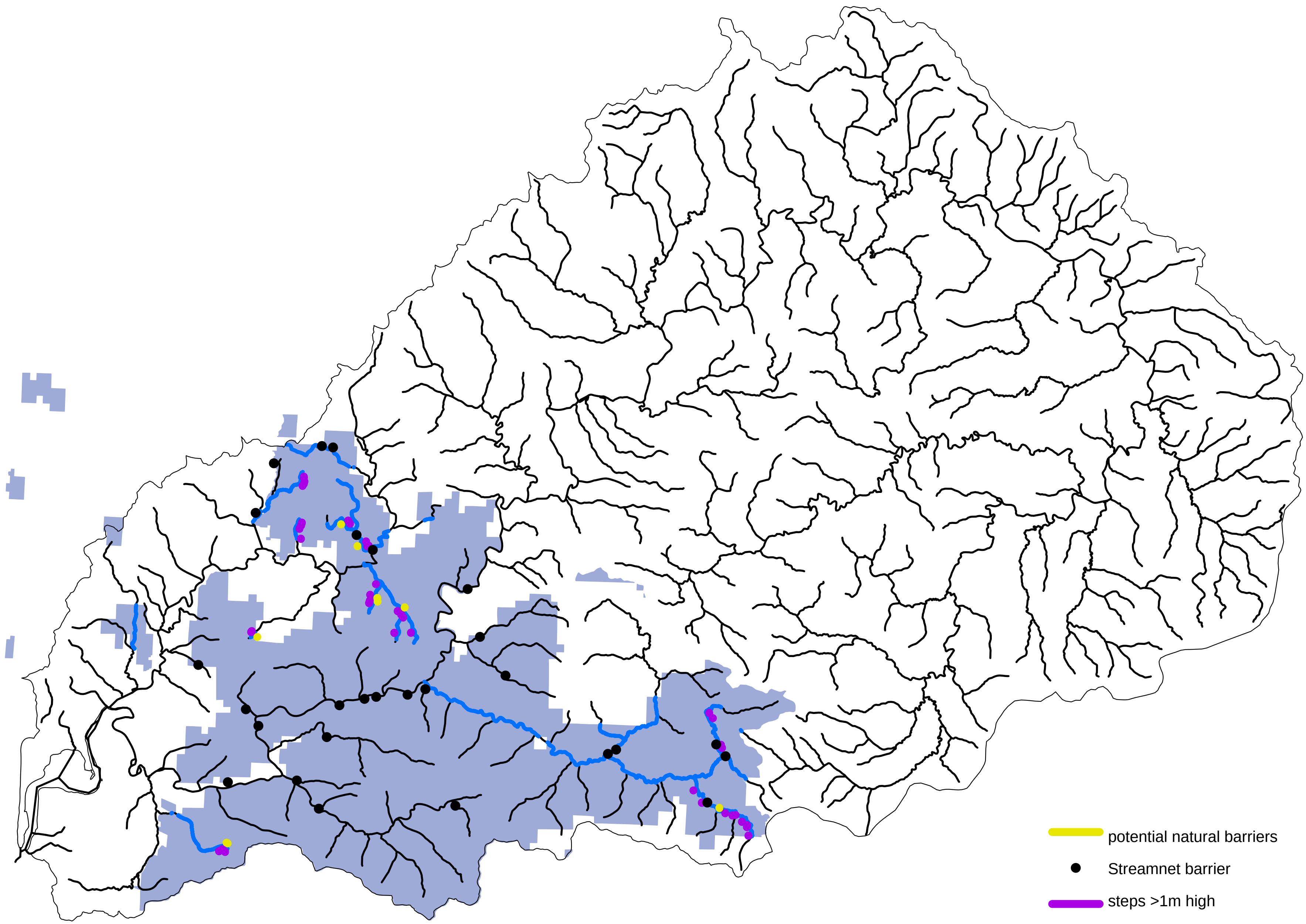
Map 30. Impacts of the 1996 flood within the Lower Nehalem and Necanicum study area, based on a random subselection of previously surveyed sites.



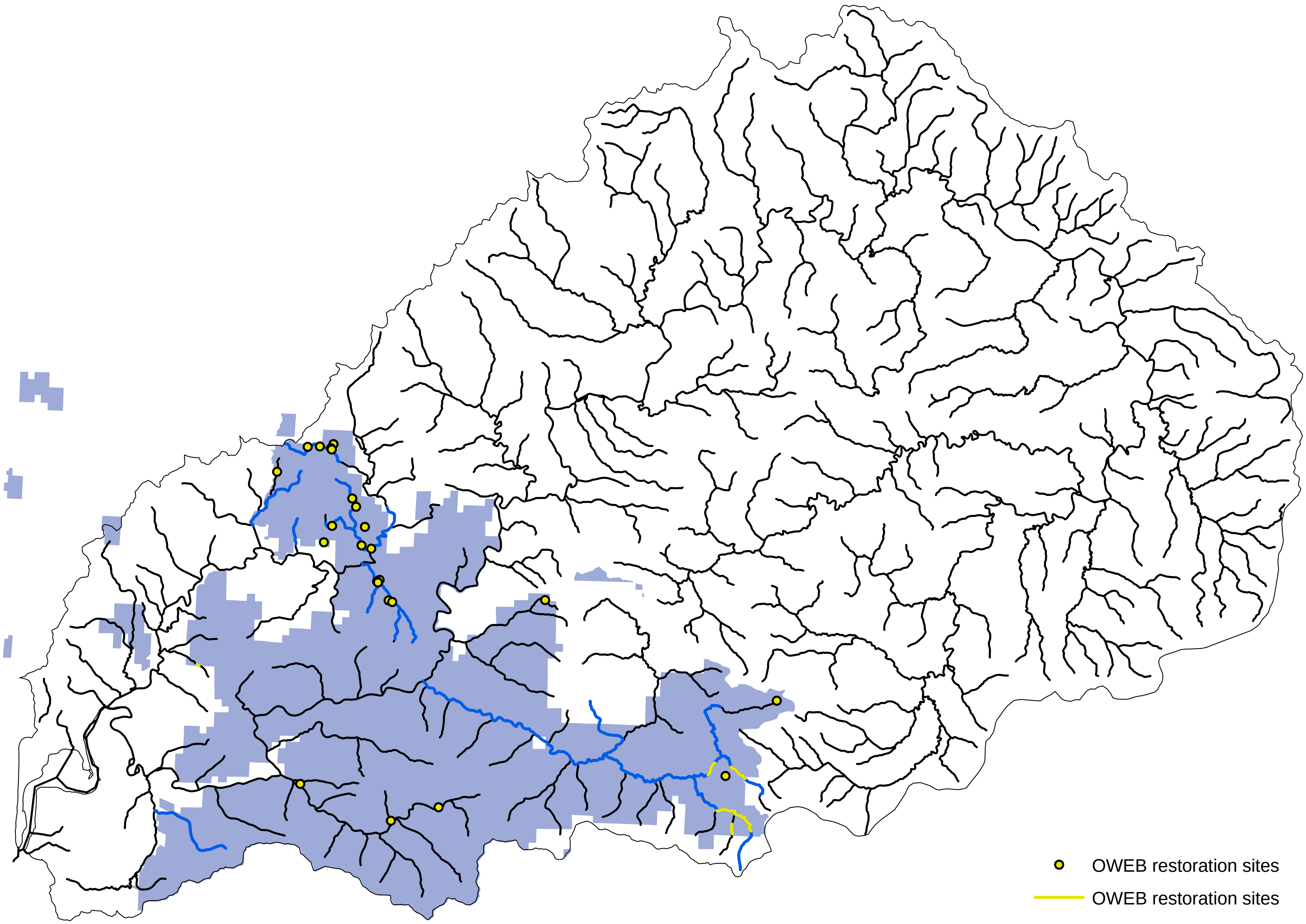
Map 31. Potential barriers to fish movement identified by Streamnet record id within the Lower Nehalem project area.



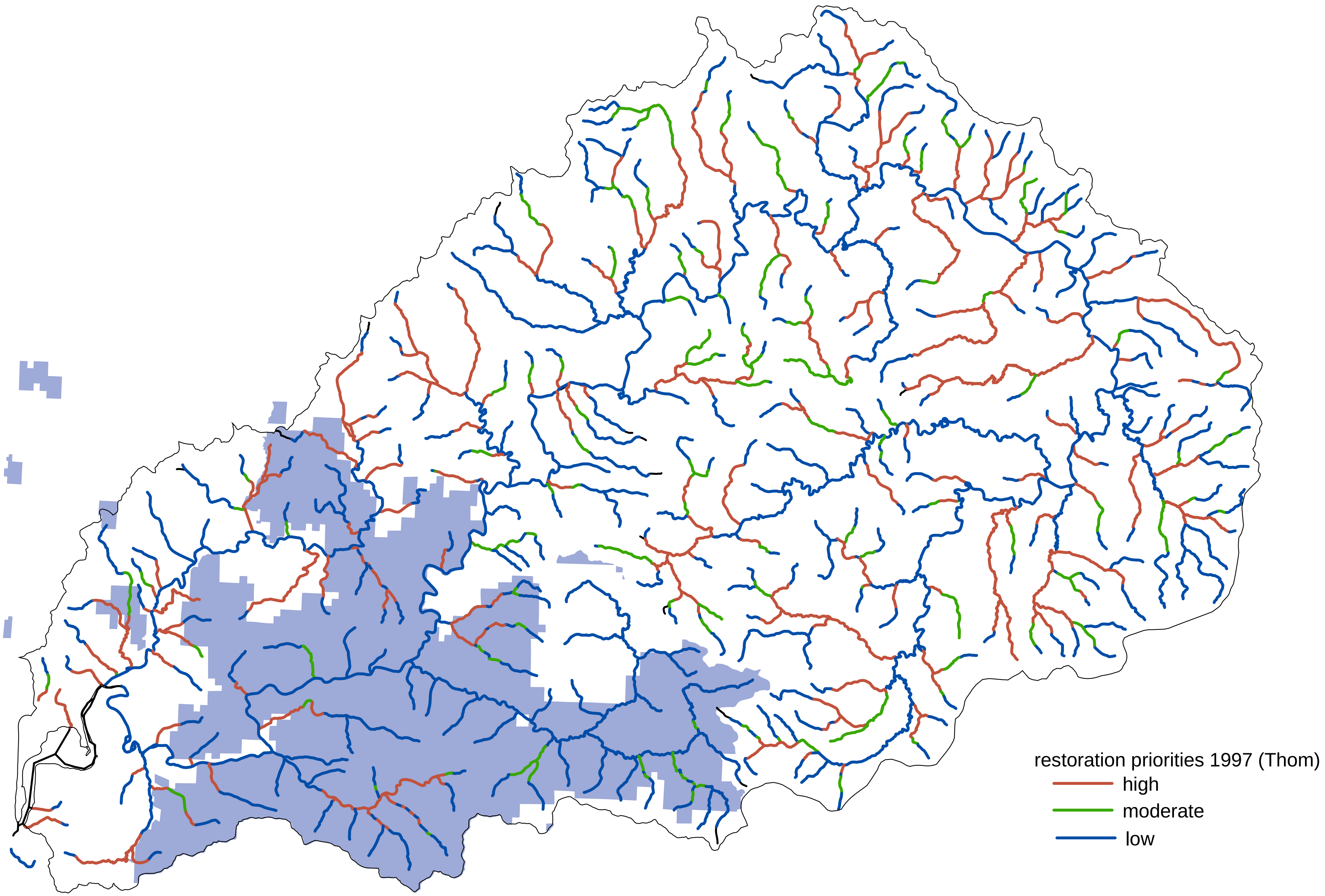
Map 32. The distribution of winter steelhead and coho salmon in relation to potential barriers (Streamnet) within the Lower Nehalem project area.



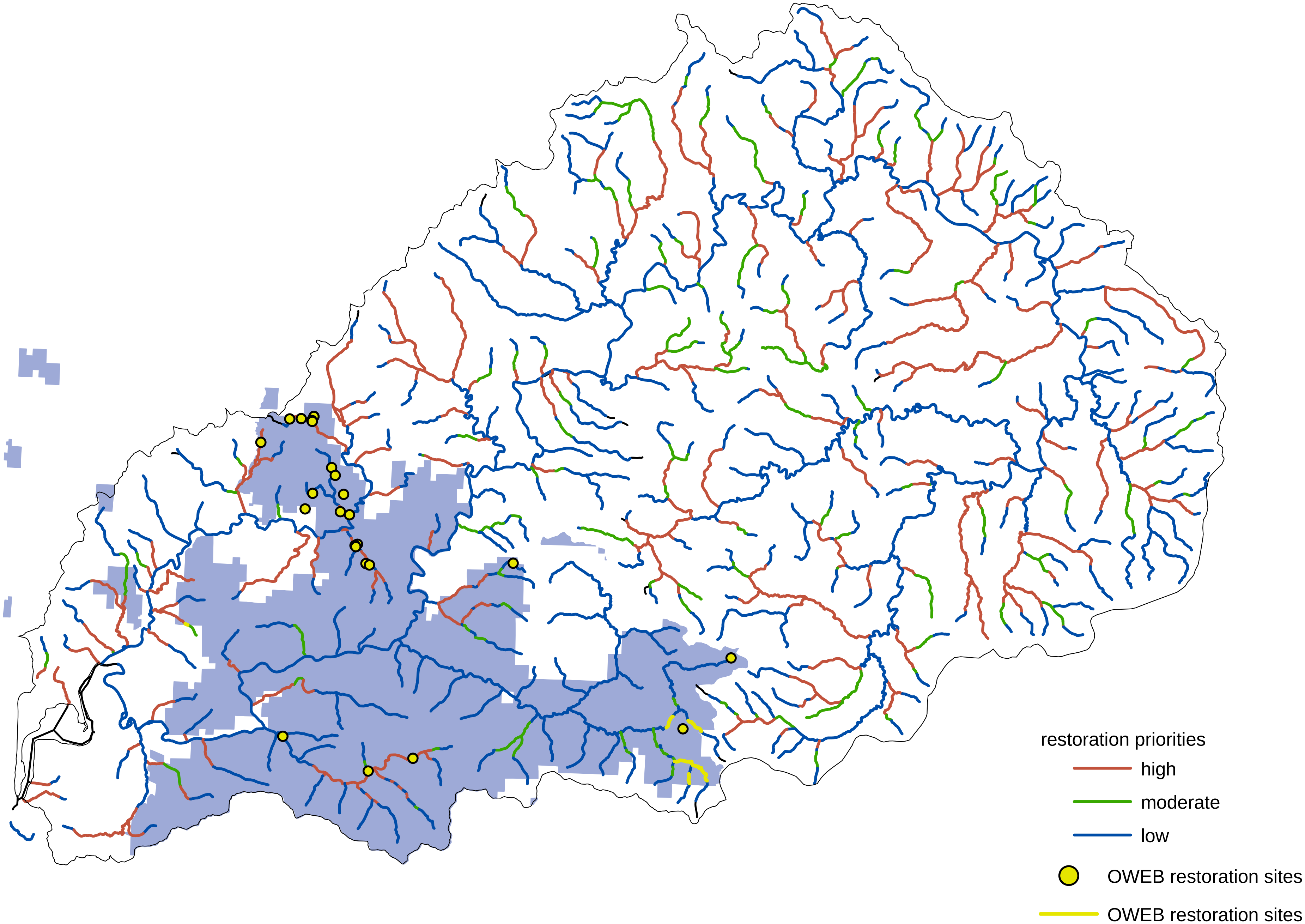
Map 33. Potential barriers to fish distribution as documented by habitat stream crews at the unit level scale and those identified by Streamnet within the Lower Nehalem project area.



Map 34. Instream restoration sites funded by OWEB within the Lower Nehalem project area.



Map 35. Potential sites for restoration based on priority level (Thom and Moore, 1997) within the Lower Nehalem project area.



Map 36. Potential sites for restoration based on priority level (Thom and Moore, 1997) paired with OWEB-funded instream restoration sites within the Lower Nehalem project area.