THE OREGON PLAN *for Salmon and Watersheds*

Stream Habitat Conditions in Western Oregon
2006-2010 Monitoring Report

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SUMMARY

Monitoring programs implemented under the Oregon Plan for Salmon and Watersheds (OPSW) in 1998 were designed to assess the status and trends in fish populations and aquatic habitat in Oregon's coastal basins. We assessed habitat conditions from 2006 through 2010, summarizing instream habitat data surveyed across the four monitoring strata (North Coast, Mid-Coast, Mid-South Coast, and Umpqua) in the Oregon Coast Coho Salmon (Coastal) Evolutionary Significant Unit (ESU) and one monitoring stratum (South Coast) in the Southern Oregon/Northern California Coast (SONCC) Evolutionary Significant Unit (ESU). Across the five years approximately 207 sites were surveyed each year. Coho salmon (*Oncorhynchus kitsutch*) were detected outside their known distribution at 29 sites in the Coastal ESU and three sites in the SONCC ESU. We estimated stream habitat in the field in the years 2006-2010 with adequate precision; active channel width, primary channel length, gradient, pool habitat, and percent gravel were approximated with the best precision. Differences in instream condition did not vary across the five years in the Coastal ESU, but channel shade increased and slack water pools decreased in the SONCC ESU. Within the Coastal ESU, all the pool metrics, gradient, active channel width, and percent bedrock varied across the distribution of coho salmon. Values for winter rearing capacity for coho salmon (estimated as parr/km) ranged from 1733 parr/km in the North Coast to 1122 parr/km in the Umpqua. The Mid-Coast had the most sites with high quality habitat (52 sites) but the Mid-South had the highest percentage of high quality habitats (21% ±6.67%). In contrast, the Umpqua had the fewest sites with high quality habitat (15 sites) and the lowest percentage of high quality habitats (12.29% ±5.05%). Overwintering habitat for coho salmon continues to be limiting with low pool complexity and structure. The median values for most of the habitat attributes evaluated were within the range of the upper and lower breakpoints designated by reference conditions. Amounts of gravel relative to fine substrate resulted in high quality spawning and summer rearing habitats for coho salmon.

INTRODUCTION

Monitoring programs under the Oregon Plan for Salmon and Watersheds were designed to assess the status and trend in fish populations and aquatic habitat in Oregon's coastal basins. Although the Oregon Plan for Salmon and Watersheds was initiated in response to the petition to list Oregon Coastal coho salmon (*Oncorhynchus kisutch*) as threatened under the Endangered Species Act (ESA), monitoring was subsequently expanded to include other salmonids. Through coordinated surveys we are able to evaluate freshwater habitat, fish distribution, and abundance of juvenile and adult coho salmon and steelhead trout. The habitat survey project provides the broadest geographic scope of inference and ties to other program components as well – basin or census surveys, surveys at habitat restoration sites, adult and juvenile coho salmon surveys, and life cycle watersheds (Flitcroft et al. 2002). The current sampling region lies within the Oregon Coastal Coho Salmon Evolutionary Significant Unit (ESU) or the Coastal ESU and the Southern Oregon/Northern California Coast Evolutionary Significant Unit (ESU) or the SONCC ESU.

In 2007, the Oregon Department of Fish and Wildlife (ODFW) re-evaluated the current coastal sampling frame for monitoring coho salmon and their habitat in the four monitoring strata in the Coastal ESU (Firman and Jacobs 2001; Stevens 2002). The original sampling frame was based on all first through third order (i.e. wadeable) streams on a 1:100,000 scale digitized stream network. After ten years of monitoring, an evaluation of survey data collected to date, and the creation of a 1:24,000 scale digitized stream network, the sampling frame was revised. While retaining annual, three-year, and nine-year legacy sites from the 1998 rotating panel design, a new Generalized Random Tessellation Stratification (GRTS) based sample was created on a 1:24,000 scale digitized stream network, revising the coho salmon spawning and rearing distribution. This increased our sampling precision and efficiency. Migration to a new sampling frame with greater resolution enabled the program to refine the distribution of coho salmon and steelhead with expectations to increase the precision upon which annual estimates of adults and juveniles are based, and increase the breadth of instream habitat evaluation across the Coastal ESU. The sampling frame in the SONCC ESU remains based on the 1:100,000 stream network as of 2010.

The desired status of stream habitat conditions for both independent and dependent coho salmon populations was established in the Conservation Plan for the Coastal ESU. In the plan, measurable criteria were established and evaluation thresholds were set for the amount of high quality habitat available across all freshwater life stages. The thresholds identified habitat that is capable of producing ≥ 2800 smolts/mile (1850 parr/km). This represents the number needed for adult spawners to replace themselves during extended periods of low marine survival (Oregon Department of Fish and Wildlife 2007). We used the Habitat Limiting Factors Model (HLFM) to calculate the amount of high quality habitat available based on stream conditions across the Coastal ESU. Because winter rearing habitat has been identified as limiting (Chilcote et al, 2005), we calculated the capacity of the habitat to rear juvenile coho salmon and used that value in our evaluation of high quality habitat.

This report discusses the findings from aquatic habitat surveys conducted between June and September in the five year period from 2006 - 2010, in drainages within both the Coastal and

SONCC ESUs. Our objectives are to (1) describe and evaluate channel morphology, instream habitat and complexity, and riparian conditions in the ESUs, (2) quantify and summarize the habitat capacity for juvenile coho salmon in all wadeable streams in the four monitoring strata comprising the Coastal ESU, and (3) compare stream conditions and habitat capacities to benchmark values and empirical juvenile coho salmon densities, respectively.

For this report, we summarize the five-year findings for the Coastal and SONCC ESUs:

1. Signal-to-noise (*S:N*) ratio test utilizing resurveys to determine precision and accuracy of individual attribute estimation.
2. Status of the channel morphology, substrate composition, instream wood, and riparian structure in all wadeable streams in coastal drainages.
3. Sites surveyed outside the range of coho salmon where coho salmon were observed.
4. Presence of beaver, mass failures, habitat structures, and debris jams.
5. Sampling design to extrapolated to all streams within the sample frame and post-stratification of sites into additional frames (coho distribution, geology, land use).
6. Habitat Limiting Factors Model (HLFM) version 7.0 (Version 5.0 in Nickelson 1992), used to describe the summer and winter capacity of the habitat for coho salmon.
7. HabRate model (Burke et al. 2010) used to describe habitat quality for coho salmon.
8. Empirical juvenile density estimates compared with summer parr capacities estimated from the HLFM

METHODS

Study Area and Site Selection. Oregon Plan habitat survey sites were selected within coastal watersheds (those draining into the Pacific Ocean south of the Columbia River, west of the Cascade Range). The region is divided into five monitoring strata (North Coast, Mid-Coast, Mid-South Coast, Umpqua, and South Coast) which constitute the extent of the Coastal ESU and the Oregon portion of the SONCC ESU (Figure 1). Each stratum is composed of coho salmon population areas designated as independent or dependent (very small coastal basins generally dependent on the periodic influx of adult fish from adjacent, larger basins). These population areas typically reflect watershed boundaries and are based on population dynamics, genetic information, geographic distribution, species life history, and morphological traits (Wainwright et al. 2006).

In 2006, sites were selected on streams within coastal monitoring strata derived from a 1:100,000 scale hydrography layer developed by the United States Geologic Survey (USGS). Potential sample sites were chosen within each monitoring strata based on a generalized random tessellation stratified (GRTS) design (Stevens 2002). In 2007, the GRTS design was applied to a 1:24,000 scale hydrography layer for all coastal basins. Samples were selected randomly within a monitoring stratum and were spatially balanced across the landscape. Sampling intervals were based on a rotating panel design consisting of four temporal strata; annual, three year, nine year, and once only (Stevens and Olsen 2004). Using this design we were able to balance our ability to describe conditions within and across each geographic area, while acknowledging spatial variability and reducing potential site selection bias. Habitat surveys were distributed in coastal basins across all streams with a basin size larger than 0.6 km^2 irrespective of fish use. The panel structure also assigned selected sites, within the rearing and spawning distribution of coho salmon, to spatially co-occur with adult spawning and juvenile rearing surveys.

Stream Habitat Surveys

Aquatic habitat surveys were conducted in the field from mid-June through late September. Survey reaches were either 500 m or 1000 m in length depending on whether they were outside or within the current coho salmon distribution, respectively. Surveys were summarized at the reach level to describe channel morphology and the physical structure of stream channel habitat, substrate compositions, instream wood, and the adjacent riparian vegetation. At sites upstream of the known distribution of coho salmon, fish were sampled using a backpack electrofisher. At least three pools and three fast water units totaling up to 60 m were electrofished to determine fish species composition. During each field season, 10% of the total number of survey sites in each monitoring strata were re-surveyed. Detailed survey methods can be found in Moore et al. (2007).

Site Statistics

Habitat attributes (Table 1) were chosen from field metrics to describe the status of instream and riparian conditions and quality within the ESUs, monitoring strata, and coho salmon populations from 2006–2010 (Figure 1). The total numbers of target sites pulled, surveyed, and not surveyed were summarized by year and geographic region. The re-survey data were used to determine the variance between and within habitat surveys, indicated by the signal to noise ratio (*S:N*). We characterized *S:N* as high (>6.5), moderate (2.5–6.5), and low (<2.5) (Roper et al. 2010). Attributes with high (>6.5) values were considered to be precise, repeatable for analytical purposes, and have the ability to discern differences among streams. These values were considered when selecting habitat attributes for further analysis.

We quantified the total number of observed occurrence of habitat structures, beaver dams, debris jams, and mass failures (i.e. landslides) and the number of sites at which coho salmon were observed outside their known distribution. The distribution of sites across land uses and geologies were also evaluated and compared to the proportion of particular land uses and geologies characterized across an ESU. Land use categories as identified by a USGS land cover layer in a Geographic Information System (GIS) (1992) included: agriculture, federal forest, other, private industrial forest, private non-industrial forest, private forest (private land-holdings were already combined in the SONCC ESU), state forest, and urban. Geology categories as identified by a USGS geology layer (Walker et al. 2003) included: intrusive, metamorphic, mixed (specifically, a mélange or varied Jurassic geology), sedimentary, and volcanic.

Habitat Condition

Analysis of variance (ANOVA) tests were conducted on a selection of habitat attributes (Table 1) to determine whether there were differences in habitat conditions across years. In the Coastal ESU, where no difference across years was detected, a *t*-test was conducted to determine whether there were differences in stream habitat conditions across the hydrography (within or outside the range of coho salmon salmon). Habitat values were averaged across years where multiple years of data were available at a site. All analyses were performed using R software (R Development Core Team 2006). For a more extensive trend analyses with these data please see Anlauf et al. (2011).

We used benchmark values to provide context for evaluating the condition of the habitat, within the range of coho salmon, over the last five years (Appendix C). These values were created from reference sites selected using the process outlined in Thom et al. (2001) and refined by Rodgers et al. (2005). These values generally represent sites in watersheds with low human impact, late successional or mature forests, and a low density of roads. The 25th and 75th quartiles of these sites represent the lower and upper breakpoints.

Habitat Capacity and Quality

To evaluate habitat capacity (estimated as parr/km) with respect to production potential of juvenile coho salmon, we used the HLFM methodology as described by Nickelson et al. (1992) and Nickelson (1998), and updated in 2007 (Anlauf et al. 2009). The model was used to estimate summer and winter habitat capacities (parr/km) at each site for coho salmon by applying a density of juvenile coho salmon to each habitat unit and multiplying by the surface area of the habitat unit. The capacities are therefore an integrated variable that emphasizes particular stream habitat features. Summer habitat capacity is a function of the amount of total pool habitat, while winter habitat capacity is dependent on the amount of beaver-influenced and off-channel pool habitats, and complex scour pools. Stream capacity to support juvenile coho salmon during the winter was considered high if the value exceeded 1,850 parr/kilometer and low if the value was below 900 parr/kilometer. The same methods that were used to assess habitat condition were employed to determine whether there was a difference in winter parr capacity across years. In general, when winter data were not available, we used a modeled relationship in order to obtain winter parr estimates from summer habitat data (Anlauf et al. 2009). Only sites within the range of coho salmon were evaluated. Summer and winter habitat capacities (parr/km) were not calculated for the SONCC ESU as there were too few sites within the distribution of coho salmon.

The average winter parr capacity (winter parr/km) and the lower and upper 95% confidence intervals (CI) were calculated at the stratum and population scales. The total kilometers of high quality habitat was estimated for each population in the Coast ESU. To calculate this value, the total number of sites that exceeded the high capacity value (1850 parr/km) was multiplied by the site weight. The site weight is the total number of kilometers of coho salmon spawning and rearing habitat in a stratum or population divided by the total number of sites surveyed in that stratum or population. An error estimate of the kilometers of high quality habitat in each stratum or population was calculated based on the 95% CI of the cumulative distribution function (CDF) for winter parr, at a value of 1850 winter parr/km on the CDF.

To evaluate habitat quality with respect to production potential of juvenile coho salmon, we used the HabRate model developed by Burke et al. 2001, and updated the model with criteria for coho salmon (Burke et al. 2010). HabRate is designed to evaluate juvenile coho salmon habitat quality based on critical habitat values defined in the literature (see Anlauf and Jones 2007 for summary). Habitat ratings of high, medium, and low are created for each habitat variable and for each stream rearing life stage for coho salmon. The model output ranks habitat quality from 1 to 3: poor, fair, and good, respectively. Results of the model were evaluated and displayed spatially at the ESU scale. 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 (i.e. large wood, undercut banks), and gradient. A Kruskal-Wallis one-way analysis of variance was conducted on the maximum HabRate rating across years, to determine if there was statistically significant difference in HabRate values across monitoring strata. The Krustal-Wallis test is a non-parametric method analogous to the one-way ANOVA. A comparison of maximum and median HabRate values across monitoring strata was also conducted.

Empirical Juvenile Estimates and Capacity

To evaluate habitat capacity relative to juvenile coho salmon rearing in the summer, we compared the summer habitat capacity estimates (summer parr/km) over the last five years with empirical juvenile coho salmon estimates (juvenile coho/km) based on snorkel counts from the Western Oregon Rearing Project (WORP) (Constable et al. 2012). For that comparison, we used summer parr/km estimated from the HLFM using pool exclusive habitat data and juvenile coho salmon/km data from the same sites in the same strata collected annually in the months of August and September, from 2006-2010. Juvenile coho salmon are identified and enumerated in pools equivalent or exceeding ≥ 20 cm in maximum depth (Constable et al. 2011).

RESULTS AND DISCUSSION

Site Statistics

From 2006–2010, a total of 751 unique sites spanning approximately 590 km were surveyed across the two coho salmon ESUs, while for all years, 1035 sites encompassing 817 km were surveyed (Figure 1; Table 2). Over the five year period, between 69% (Mid-South) and 82% (North Coast) of the target sites in the original pull were surveyed. Dropped sites constituted 25% of the pull, with 6% of these sites designated as non-target and 19% designated as target. Non-target sites are generally those sites that are within the geographic sampling frame but are in locations that were identified initially as being difficult to sample with wadeable habitat methodology due to watershed area size (too small), stream/river size, or tidal influence. Target sites are typically dropped due to landowner denial, difficult site access or lack of time. Landowner denials made up the majority of all dropped target sites, with 39% and 18% of the total number of un-surveyed sites in the Coast and SONCC ESUs, respectively (Table 2). Across all years, the Mid-South Coast monitoring stratum in the Coastal ESU typically had the lowest survey response. In general, the number of sites surveyed averaged between 41 and 43 sites across years with exception of the Mid-South at an average of 37 sites across years. Note, the differences in the number of sites pulled each year was a function of the scale of the hydrography (1:100k in the SONCC ESU versus 1:24k in the Coastal ESU) from which the GRTS sample was created (Table 2).

Outside the currently known distribution of coho salmon salmon, 202 sites (unique across years) were surveyed in the Coastal ESU and 122 sites in the SONCC ESU. Across the 5 year period, juvenile coho salmon were observed at 29 of the 202 sites in the Coast ESU and at 3 of the 122 sites in the SONCC ESU (Table 3). The North Coast had the highest number of these sites from 2006–2010 and the majority of those (10 out of 13) were in the Nehalem population area (Table 3). These data were used to expand the sampling frame from which ODFW draws sites. In the future, these areas will be incorporated into the sampling frame, thus allowing for potential juvenile rearing and/or adult spawning surveys to be conducted.

To determine the precision of our habitat estimates, we followed Roper et al. (2010) characterization of high (>6.5), moderate (2.5–6.5), and low (<2.5) *S:N* ratios. Those attributes categorized as high are considered to be measured or estimated consistently and repeatable across crews. Active channel width, gradient, primary channel length, percent gravel, percent bedrock, percent pools, and residual pool depth were measured with the highest precision across years, with each having *S:N* ratios greater than 6.5 (Table 4). Of those attributes, four were measured with the highest precision each year (Figure 2). A range of metrics were considered moderately precise with *S:N* ratios between 3.16 and 3.90, including the wood metrics, percent secondary channel area, and percent fine sediments. These results appear consistent with metrics collected by other habitat programs (Roper et al. 2010). Those attributes that were least precise and most variable included the riparian metrics (conifers at 50 cm diameter at breast height (DBH) and conifers at 90 cm DBH), active channel height, and riffle depth, each with *S:N* ratios less than 2.5. In these cases, there was a considerable amount of noise not attributed to the condition at the site but to other error such as crew variability or imprecision of the collection method (Table 4). There were slight inconsistencies among habitat metrics by the way in which conditions were summarized. Crews appeared to identify the same number of pieces of wood in a stream (*S:N* = 6.06), but they did not measuring each piece consistently (wood volume *S:N* = 3.90). These data can be used to help inform on training improvements or allow the project to rethink the value of a particular metric given its precision.

Over the five year period, approximately 444 beaver dams were noted in the Coastal ESU (Table 5). The majority of those beaver dams were located in the North Coast and Mid-Coast monitoring strata. Approximately 26% of the sites surveyed in the North Coast over the 5 year period had at least 1 beaver dam. Approximately seven (or 3% of the total number of sites surveyed) beaver dams were identified in the SONCC ESU (Table 5). The majority of the beaver dams were found on private lands, specifically private industrial lands in the Coastal ESU. The Mid-South stratum in the Coastal ESU had the highest proportion of debris jams noted at 67% of the total number of sites surveyed. The South Coast has the highest proportion of landslides (mass failures) noted at 43%. Across all the monitoring strata in both ESUs, the frequency of sites with at least one landslide was equivalent or equal to 25%. The number of sites with habitat restoration structures (habitat logs) ranged from 9 to 15% in the Coastal ESU to just 1% in the SONCC ESU (Table 5). The Mid-South had the highest proportion of habitat structures at 15% of the total number of sites surveyed.

The majority of the surveyed sites across the five year period were on federal forest and private industrial lands. In general, the land use proportions represented by sites surveyed in a population are a reflection of the overall land use proportions in a population (Figure 3). This information is useful as we strive to survey an adequate proportion of sites across all land uses and ownerships. There is some variation among the proportion of land use in a population across and within monitoring strata. The majority of the site access denials in the monitoring strata in the Coastal ESU were associated with private non-industrial lands whereas in the SONCC ESU, denials were associated both with private agricultural land ownership and private ownership adjacent to federal forest lands. Similar results were found when assessing the distribution of sites across particular geologies. The geology proportions represented by the sites surveyed in each ESU reflect the overall geologic template in the ESU.

Habitat Condition

Overall, habitat attributes did not vary across years, therefore data were averaged for sites surveyed in multiple years and then averaged at the monitoring stratum scale (Table 6; Figure 4). One exception was noted in the SONCC ESU, for percent channel shade and slack water pools, which did vary significantly across years. Channel shade values in the SONCC increased steadily each year, from 67.5% in 2006 to 81.3% in 2010, while those in the Coastal ESU remained fairly static on average, from 79.8% in 2006 to 83.6% in 2010. In contrast, slack water pools (which are categorized as dammed pools, beaver pools, alcoves, backwaters, or isolated pools) have decreased across the years in the SONCC, from 3.6% in 2007 to less than 1% in 2010. This habitat attribute is consistently lower in the SONCC relative to the Coastal ESU (range from 6.5%-8.2%). Several explanations could account for these differences. On average, the gradient of the surveys conducted in the SONCC tend to be higher (range 5.4%–8.8%) than those conducted in the Coastal ESU (range 3.3%–4.1%) therefore fewer slack water pools are likely to exist in those surveys. Additionally, the characterization of geology is distinctly different in the SONCC ESU relative to the Coastal ESU (Figure 6). The Coastal ESU is dominated by sedimentary geologies. In the SONCC ESU, while sedimentary and volcanic geologies do constitute the majority of the geography, there is significantly more intrusive and metamorphic rock types prevalent (Figure 6). Stream underlain with these geologies typically are dominated by riffle habitat types (Hicks et al. 1991). For more information on trend analyses in these data at smaller spatial scales, please see Anlauf et al. (2011).

There were differences between instream habitat condition designated as within the distribution of coho salmon and outside the distribution (Table 7). Fine sediment, gravel, channel shade, residual pool depths, and wood pieces/100 m did not differ across the two distributions (Table 8). Morphological stream structure did vary with lower stream gradients, wider channel widths, and more overall and complex pool habitats within the distribution of coho salmon. The percentage of bedrock was higher in streams within the distribution of coho salmon (Table 7; Table 8). In the Coastal ESU, locations with the highest percentages of bedrock often coincided with historic splash damming and log drives (Figure 8).

As evident from the ANOVA analysis and boxplots in Figure 4, overall habitat condition across the Coastal ESU has not changed over the five year period. The median values of the majority of the habitat attributes evaluated were within the range of the upper and lower breakpoints designated by reference conditions. One notable exception includes fine sediment which fell outside the range of reference condition. The median of gravel aligned with the lower breakpoint for reference conditions, indicating that in most years, more gravel in these systems would be needed to more closely resemble unaffected conditions. Bedrock was nearly completely within the range of reference, as were shade, secondary channel area and wood pieces/100m. In most years the median for percent pools and slack water pools was within the range of reference.

Depending on coastal monitoring strata or region, differences emerge for a select number of habitat metrics (Figure 5). The Umpqua, typically, provides lower shade values, fewer wood pieces, and fewer pools and complexity relative to the other monitoring strata and reference conditions. The Mid-Coast falls outside the breakpoints with exceedingly high fine sediments, low gravel percentages, and higher pool percentages. However, wood pieces appear contained within the range of reference with the median nearly matching the upper breakpoint. Active channel widths and gradients tend to be similar across the Coastal ESU.

Habitat Capacity and Quality

Winter parr estimates did not vary across years, therefore the data were averaged for sites surveyed in multiple years, and then averaged either at the monitoring stratum or population scale for the Coastal ESU (Table 6; Figure 7). A total of 647 unique sites were used to estimate habitat capacity for the Coastal ESU; only sites within the range of coho salmon were used, and where winter data were available, they were included. At the stratum scale, there was little variation between winter parr capacity per kilometer; however, at population scales there was substantial variation (Table 9). In many populations, we simply do not have adequate sample sizes to precisely estimate the parr capacity or the percent of the habitat that is high quality

(Table 10). Across monitoring strata at a site, mean values of winter parr capacity ranged from 1123 parr/km in the Umpqua to 1733 parr/km in the North Coast, where the Mid-Coast and Mid-South Coast averaged approximately the same winter parr/km at a site (Table 9). Across populations, the values range from 464 parr/km in the South Umpqua to 2940 parr/km in the Nehalem (note that only populations where the sample size was greater than 10 sites are included; Table 9).

The percent of the habitat considered high quality ranged from 12.29% (±5.05%) in the Umpqua to 21.05% (±6.67%) in the Mid-South (Table 10; Figure 6). This is notable, as the Mid-South had the greatest number of habitat structures observed during habitat surveys across the last five years, indicating a great deal of restoration work that occurred during that time. At the population level, the percent of high quality habitat in the Coastal ESU ranged from 8.70% (± 10.17%) in the South Umpqua to 28.57% (± 11.81%) in the Siletz (note only populations where the sample size was greater than 10 sites are included; Table 10). When the data are categorized by strata (e.g. monitoring strata, year, geology, or land use), overall, habitat capacity rarely meets or exceeds high quality (Figure 8).

While the HLFM estimates the capacity of the habitat for winter parr (age 0+) based on the presence of key habitat types (e.g. beaver ponds, alcoves), the HabRate model provides a categorical assessment of habitats, assigning a rating based on critical values identified in the literature. Similar to ANOVA results on habitat capacity, results of the Kruskal-Wallis test indicate that there are significant differences in habitat quality based on HabRate values across monitoring strata (Kruskal-Wallis chi-squared = 7.741, df = 3, P-value = 0.051). For coho salmon across the Coastal ESU, habitat quality was fair for spawning and emergence, and summer rearing life stages but was considered poor for winter rearing. A spatial representation of both the HLFM and HabRate ratings for the winter rearing life stage, along with a graph of the rating proportional to the total site count across the Coastal ESU can be seen in Figure 7. While both models generally characterize the habitat for winter parr as poor, HabRate tends to consider more of the overall habitat condition at this life stage to be deficient.

Empirical Juvenile Estimates and Capacity

In general, juvenile abundance estimated from the summer snorkel counts did not exceed the summer habitat capacity. Exceptions were seen for 2006 estimates in the North Coast and 2009 estimates in the Mid-South. Juvenile coho salmon estimates and capacities were consistently low in the Umpqua, with the lowest estimate in 2007. These estimates are likely driven by the South Umpqua population area which is one of only two populations in the ESU that is interior of the coast range. The South Umpqua had the lowest habitat capacities along the coast when averaged across all years. Overall, summer parr capacities were highest in the Mid-Coast across all years, with the exception of 2008 where the North Coast had the highest estimated capacity (Figure 8). In addition to stream temperatures, stream sizes in many of the coastal drainages are quite small limiting the abundance of juveniles. For more information on the juvenile abundance estimates see Constable et al. (2012).

FUTURE ANALYSIS

As restoration in coastal streams continues and expands, the signal of those instream improvements may become detectable at larger spatial scales. We will continue to assess whether changes in stream habitat or coho salmon rearing capacity result from restoration project implementation.

Habitat attributes may vary at scales not assessed in this annual report. Land cover, land use and ownership, and other key landscape features influence the condition of instream habitat and the magnitude by which habitats can improve or change. We will continue to evaluate these relationships to determine whether stream protection strategies are effective and further inform restoration efforts that aid in more effective treatments at broader scales.

The relationship among habitat and coho salmon is complex and varies at multiple scales. We plan to assess the correlations between instream habitats and the occupancy and abundance of spawning salmon in an effort to refine our monitoring strategies. The comparisons between estimates of habitat capacity for juvenile coho salmon and empirical values obtained from field surveys also suggest variations in the relationships between habitat and rearing fish. We will continue to explore methods to quantify those relationships and evaluate whether additional biological and environmental information (e.g. macroinvertebrate composition and abundance, temperature) will be significant covariates.

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Table 1. Habitat attributes used in report analyses, categorized by general stream template grouping.

Habitat Category	Habitat Attribute
Channel and valley form	Valley width index
	Active channel height (m)
	Active channel width (m)*
	Channel gradient (%)*
	Width : Depth Ratio
Stream morphology	Primary channel length (m)
	Secondary channel length (m)
	Secondary channel area (%)*
	Pool habitat (%)*
	Slack water pools (%)*
	Complex Pools / km*
	Number of pools
	Residual pool depth (m)*
	Riffle depth (m)
	Units per 100 m
Substrate composition	Sand and organics (%) (weighted by habitat unit area)*
	Gravel (%) (weighted by habitat unit area)*
	Sand and organics in riffle habitat units (%)
	Gravel in riffle habitat units (%)
	Bedrock (%) (weighted by habitat unit area)*
Instream wood	Number of wood pieces / 100 m*
	Wood volume (m^3) / 100 m
Riparian structure	Channel shading (%)*
	Density of 50 cm DBH riparian conifers
	Density of 90 cm DBH riparian conifers

* Habitat attributes with ANOVA results.

Table 2. Site statistics for Oregon plan habitat survey sites. The total number of target sites pulled from the GRTS sampling design (including target and non-target sites whether completed or not), from 2006-2010. Non-target sites included those that fell outside the geographic scope of inference such as tidal and non-wadeable sites, or sites with inaccuracies in point location (i.e. no stream). Note: The annual 2006 site pull was based on the 1:100,000 sampling frame. Site pulls from 2007-2010 were based on the 1:24,000 sampling frame. SONCC = Southern Oregon/Northern California Coho salmon ESU.

					Year			
ESU	Strata	Status	2006	2007	2008	2009	2010	Total
Coastal	North Coast	Target pulled	42	47	56	54	55	254
		Target response	41	42	35	48	50	216
		Target non-response	1	5	21	6	5	38
		Non-target	5	5	0	0	1	11
Coastal	Mid-Coast	Target pulled	48	49	54	51	52	254
		Target response	43	41	38	44	46	212
		Target non-response	5	8	16	7	6	42
		Non-target	2	3	2	1	4	12
Coastal	Mid-South	Target pulled	45	49	55	49	51	249
		Target response	36	34	39	36	41	186
		Target non-response	9	15	16	13	10	63
		Non-target	7	3	1	3	5	19
Coastal	Umpqua	Target pulled	56	56	55	52	54	273
		Target response	39	39	45	43	46	212
		Target non-response	7	7	10	9	8	41
		Non-target	5	6	1	0	2	14
SONCC	South Coast	Target pulled	53	56	50	51	51	261
		Target response	42	48	42	39	38	209
		Target non-response	11	8	8	12	13	52
		Non-target	5	2	4	3	5	19

Table 3. Oregon plan habitat survey sites where coho salmon (*Oncorhynchus kitsutch*) were observed outside of their current, known distribution. Results based on electrofishing surveys.

ESU	Monitoring stratum	Population area	Year	Surveyed	Site count length (m)
Coastal	North Coast	Nehalem	2006	1529.0	3
Coastal	North Coast	Nehalem	2007	1019.2	2
Coastal	North Coast	Nehalem	2008	1003.2	2
Coastal	North Coast	Nehalem	2009	1074.3	2
Coastal	North Coast	Nehalem	2010	1611.2	2
Coastal	North Coast	Tillamook	2006	1059.5	1
Coastal	North Coast	Tillamook	2009	499.4	1
Coastal	North Coast	Necanicum	2010	1005.7	1
Coastal	Mid-Coast	Alsea	2006	949.3	1
Coastal	Mid-Coast	Alsea	2010	505.3	1
Coastal	Mid-Coast	Siletz	2006	484.2	1
Coastal	Mid-Coast	Siuslaw	2006	954.0	1
Coastal	Mid-Coast	Siuslaw	2009	1011.1	2
Coastal	Mid-Coast	Siuslaw	2010	518.1	1
Coastal	Mid-Coast	Yaquina	2010	486.9	1
Coastal	Mid-South	Coos Bay	2006	497.2	1
Coastal	Mid-South	Coos Bay	2010	500.0	1
Coastal	Mid-South	Coquille	2006	493.5	1
Coastal	Mid-South	Coquille	2009	975.5	1
Coastal	Mid-South	Floras	2006	690.2	1
Coastal	Umpqua	Lower Umpqua	2008	561.5	1
Coastal	Umpqua	Lower Umpqua	2009	351.6	1
SONCC	South Coast	Middle Rogue	2008	944.5	1
SONCC	South Coast	Pistol River	2008	1003.4	1
SONCC	South Coast	Euchre Creek	2009	564.9	1

Table 4. Signal to noise (*S:N*) by attribute within Oregon plan habitat survey sites, from 2006-2010 (where N=108 across years, ESUs, and monitoring strata). SD = Standard deviation, CV = Coefficient of variation.

Habitat Attribute	Survey Mean	Survey (SD)	Re-survey Mean	Re-survey (SD)	Mean (diff.) SD	CV	*S:N*	% Noise	% Signal
% Bedrock	10.34	(24.26)	9.95	(24.02)	77.61	750.72	7.59	13.18%	86.82%
% Fine sediments	29.10	(11.75)	30.91	(10.99)	49.40	169.77	2.79	35.80%	64.20%
% Gravel	26.21	(14.55)	25.40	(13.71)	19.49	74.36	10.87	9.20%	90.80%
% Pool habitat	32.80	(26.16)	35.72	(26.75)	71.52	218.05	9.57	10.45%	89.55%
% Secondary channel area	5.43	(6.23)	4.64	(6.49)	9.80	180.49	3.96	25.26%	74.74%
% Shade	82.48	(13.86)	80.85	(13.64)	56.68	68.72	3.39	29.51%	70.49%
Active channel height	0.44	(0.18)	0.39	(0.12)	0.02	3.60	2.10	47.71%	52.29%
Active channel width	6.65	(5.03)	6.46	(4.57)	1.28	19.30	19.72	5.07%	94.93%
Density of conifer 50 cm	43.44	(79.86)	52.26	(76.41)	3333.64	7674.77	1.91	52.27%	47.73%
Density of conifer 90 cm	12.49	(54.95)	14.00	(29.25)	1444.18	11562.45	2.09	47.83%	52.17%
Gradient	5.44	(5.69)	5.25	(5.01)	1.83	33.57	17.75	5.63%	94.37%
Number of pools	17.53	(12.04)	18.61	(10.81)	33.41	190.58	4.34	23.05%	76.95%
Primary channel length	754.68	(265.89)	757.10	(270.85)	1490.00	197.43	47.45	2.11%	97.89%
Residual Pool Depth	0.48	(0.18)	0.48	(0.18)	0.00	0.74	9.14	10.94%	89.06%
Riffle Depth	0.11	(0.08)	0.10	(0.07)	0.00	2.64	2.24	44.71%	55.29%
Secondary channel length	90.06	(140.53)	80.58	(132.12)	4904.99	5446.63	4.03	24.84%	75.16%
Units/100 m	6.28	(2.34)	6.64	(2.54)	1.69	26.96	3.25	30.81%	69.19%
Valley width index	6.38	(9.85)	5.58	(5.82)	25.91	406.23	3.75	26.69%	73.31%
Wood pieces	126.94	(98.67)	122.49	(87.11)	1605.50	1264.81	6.06	16.49%	83.51%
Wood volume	159.04	(149.44)	128.68	(111.66)	5725.75	3600.15	3.90	25.64%	74.36%

Table 5. Summary of comment codes within Oregon plan habitat survey sites for beaver dams, beaver activity, restoration habitat structures, wood debris jams, and mass failures (i.e., landslide activities). Data depict total number of sites, sum of occurrence across sites, and proportion of total number of sites exhibiting at least one occurrence. Values based on the max number of occurrences recorded at each site from 2006–2010.

ESU	Monitoring Stratum	Total # Sites	Beaver dams		Habitat structures		Debris jams		Mass failures	
			Sum	%	Sum	%	Sum	%	Sum	%
Coastal	North Coast	154	161	26	68	11	189	41	122	36
Coastal	Mid-Coast	160	144	23	196	12	324	60	97	27
Coastal	Mid-South	143	67	10	133	15	514	67	120	36
Coastal	Umpqua	158	72	16	79	9	323	51	151	25
SONCC	South Coast	136	7	3	11	1	363	54	276	43

Table 6. Results of ANOVA testing whether differences appeared among instream habitat attributes across years. The Dependent variable = Habitat attribute, the Independent variable = Year, and Alpha = 0.05. DF = Degrees of freedom, MSE = Mean Square Error. Winter parr/km was not calculated for the South Coast monitoring stratum (SONCC).

ESU	Habitat attribute	Residual DF	DF	MSE	*F* value	*P*-value
Coastal	% Fine sediments	824	1	203.00	0.29	0.587
	% Gravel	824	1	132.00	0.66	0.414
	% Bedrock*	824	1	1.03	0.34	0.554
	% Channel shade	824	1	212.00	1.10	0.294
	% Pool habitat	824	1	527.00	0.67	0.412
	% Slack water pool*	824	1	0.19	0.08	0.773
	Active channel width*	824	1	0.18	0.49	0.482
	Gradient*	824	1	0.21	0.41	0.521
	Residual pool depth*	824	1	0.01	0.25	0.611
	Complex pools/km	824	1	0.93	0.03	0.856
	Wood pieces/100m*	824	1	0.37	0.64	0.420
	Winter parr/km*	756	1	0.14	0.09	0.757
SONCC	% Fine sediments	207	1	246.00	0.48	0.488
	% Gravel	207	1	13.80	0.09	0.758
	% Bedrock*	207	1	0.24	0.09	0.760
	% Channel shade	207	1	4153.00	10.48	0.001
	% Pool habitat*	207	1	562.00	1.44	0.230
	% Slack water pools*	207	1	11.21	12.42	0.000
	Active channel width*	207	1	0.01	0.03	0.856
	Gradient*	207	1	0.63	0.90	0.342
	Residual pool depth*	207	1	0.00	0.00	0.933
	Complex pools/km	207	1	0.60	1.14	0.285
	Wood pieces/100 m*	207	1	0.89	1.17	0.280

* Habitat attributes were transformed.

Table 7. Results of a t-test evaluating whether differences appeared among instream habitat both inside and outside the range of coho salmon. Data from sites solely within the Coastal ESU evaluated. Data were averaged across years when data spanning multiple years identified. The Dependent variable = Habitat attribute, and Alpha=0.05.

Habitat attribute	DF	*t*-value	*P*-value	Lower 95 % CI	Upper 95 % CI
% Fine sediments	727.48	0.85	0.392	0.000	5.388
% Gravel	738.46	1.13	0.256	0.000	3.137
% Bedrock*	741.61	2.67	0.007	0.089	0.584
% Channel shade	696.08	0.20	0.836	0.000	2.501
% Pool habitat	747.20	7.94	0.000	11.750	19.458
% Slack water pools*	738.99	2.91	0.003	0.101	0.517
Active channel width*	653.38	5.60	0.000	0.201	0.418
Gradient*	690.76	-8.66	0.000	-0.856	-0.539
Complex pools*	735.15	7.45	0.000	0.378	0.649
Residual pool depth*	643.30	0.51	0.608	0.000	0.082
Wood pieces/100 m*	640.69	1.57	0.115	0.000	0.251

* Habitat attributes were transformed.

Table 8. Tabular summary of habitat conditions summarized by habitat attribute. Distribution indicates within the range of coho (Coho) or outside the range (Habitat). The data for the SONCC is summarized across the entire hydrography. SE = Standard Error; Coastal N = 202, SONCC N = 136.

ESU	Habitat attribute	Distribution	Mean	SE	Lower 95 % CI	Upper 95 % CI
Coastal	% Fine sediments	Habitat	32.84	1.52	29.86	35.83
		Coho	31.62	0.869	29.91	33.32
	% Gravel	Habitat	25.23	0.846	23.58	26.89
		Coho	27.49	0.568	26.38	28.61
	% Bedrock[1]	Habitat	7.66	0.696	6.30	9.03
		Coho	11.02	0.625	9.79	12.24
	% Channel shade	Habitat	84.18	0.768	82.67	85.69
		Coho	80.23	0.578	79.10	81.36
	% Pool habitat[1]	Habitat	26.52	1.39	23.79	29.25
		Coho	41.99	1.09	39.84	44.14
	% Slack water pool[1]	Habitat	6.41	1.08	4.29	8.53
		Coho	7.90	0.740	6.45	9.35
	Active channel width[1]	Habitat	5.34	0.270	4.81	5.87
		Coho	8.28	0.282	7.73	8.84
	Gradient[1]	Habitat	6.63	0.31	6.01	7.25
		Coho	2.96	0.127	2.71	3.21
	Residual pool depth	Habitat	0.437	0.012	0.412	0.462
		Coho	0.544	0.009	0.525	0.563
	Complex pools/km[1]	Habitat	4.98	0.322	4.35	5.61
		Coho	6.16	0.208	5.75	6.57
	Wood pieces/100m	Habitat	18.44	0.740	16.99	19.89
		Coho	13.86	0.353	13.17	14.55
SONCC	% Fine sediments		25.31	1.26	22.83	27.79
	% Gravel		28.13	0.840	26.49	29.78
	% Bedrock		6.46	0.677	5.14	7.79
	% Channel shade		75.55	1.23	73.13	77.97
	% Pool habitat		17.00	1.31	14.42	19.58
	% Slack water pools		1.63	0.584	0.486	2.77
	Active channel width		6.10	0.391	5.33	6.87
	Gradient		7.96	0.550	6.88	9.04
	Residual pool depth		0.454	0.022	4.40	2.22
	Complex pools/km		1.81	0.208	1.40	2.22
	Wood pieces/100 m		9.56	0.499	8.58	10.54

[1] Significant t-test (Table 7)

Table 9. Summary statistics for winter parr/km in the Coastal ESU. Only estimates within the distribution of coho salmon evaluated. Winter survey data from 2007-2011 used where available.

Coastal ESU	*N*	Mean	Winter parr/km 95% Lower CI	95% Upper CI
Monitoring Stratum				
North Coast	178	1733.48	1270.01	2196.94
Mid-Coast	258	1375.12	1039.49	1710.75
Mid-South	95	1356.04	1122.79	1589.28
Umpqua	122	1122.89	652.71	1593.06
Population				
Alsea	28	798.65	561.87	1035.43
Beaver*	5	3107.49	0.00	7143.06
Coos	21	816.31	623.36	1009.27
Coquille	11	1237.31	815.42	1649.19
Floras*	3	3362.42	289.01	6435.84
Lower Umpqua	24	1150.05	841.18	1458.91
Middle Umpqua*	22	1512.26	615.12	2409.40
Necanicum	7	1127.69	647.38	1607.99
Nehalem	25	2939.95	1174.27	4705.63
Nestucca	23	2034.45	862.59	3206.31
North Umpqua*	12	1364.95	642.14	2087.76
Salmon	22	838.06	234.08	1436.05
Siletz	23	1009.94	745.61	1274.27
Siuslaw	28	1703.20	1067.48	2338.92
Sixes*	3	993.49	0.00	2129.28
South Umpqua	23	464.48	256.88	672.08
Tahkenitch*	3	1314.08	1008.39	1619.77
Tenmile*	8	983.56	486.81	1480.31
Tillamook	23	2129.67	19.61	4239.72
Yaquina	23	1897.91	612.42	3183.39
MC Dependent*	17	906.27	513.85	1298.69
NC Dependent*	7	500.40	199.51	801.29

*Summer survey data used to calculate winter capacity.

Table 10. Kilometers of high quality (HQ >1850 winter parr/km) coho salmon habitat by population within the Coastal ESU. Winter surveys from 2007-2011 evaluated where available. Only estimates within the distribution of coho salmon were calculated. Error refers to standard error estimates.

Coast ESU	Total # Sites	Surveyed length (km)	Coho salmon (km)	# Sites w/ HQ habitat	HQ habitat (km)	Error (km)	% HQ	% Error
Monitoring Stratum								
North Coast	178	308.56	2263.57	30	381.50	103.84	16.85	4.59
Mid-Coast	252	346.53	3021.08	52	608.90	118.92	20.15	3.94
Mid-South	95	128.82	2131.57	20	448.75	142.22	21.05	6.67
Umpqua	122	136.99	4014.34	15	493.57	202.56	12.29	5.05
Population								
Alsea	28	25.28	568.82	4	81.26	61.60	14.29	10.83
Beaver*	6	5.51	64.91	2	21.64	27.12	33.33	41.79
Coos	21	20.72	645.82	3	92.26	64.97	14.29	10.06
Coquille	11	10.08	877.22	3	239.24	223.65	27.27	25.50
Floras*	3	2.66	156.04	2	104.03	52.01	66.67	33.33
Lower Umpqua	24	24.26	858.48	3	107.31	102.84	12.50	11.98
Middle Umpqua*	22	21.26	1022.21	4	185.86	150.34	18.18	14.71
Necanicum*	7	6.86	121.26	2	34.65	38.92	28.57	32.09
Nehalem	25	25.28	1074.74	7	300.93	140.55	28.00	13.08
Nestucca	23	24.24	362.55	6	94.58	54.52	26.09	15.04
North Umpqua*	12	11.71	524.96	3	131.24	117.60	25.00	22.40
Salmon	24	24.91	107.55	3	13.44	11.72	12.50	10.89
Siletz	26	25.01	441.24	4	67.88	50.61	15.38	11.47
Siuslaw	28	27.75	1211.46	8	346.13	143.07	28.57	11.81
Sixes*	3	2.15	82.64	1	27.55	53.99	33.33	65.33
South Umpqua	23	21.74	1608.46	2	139.89	163.54	8.70	10.17
Tahkenitch*	3	3.01	50.92	0	0.00	0.00	0.00	0.00
Tenmile*	8	7.50	120.04	1	15.01	26.05	12.50	21.70
Tillamook Bay	23	23.48	599.81	3	78.24	63.29	13.04	10.55
Yaquina	23	23.22	323.97	5	70.43	43.15	21.74	13.32
NC Dependent*	7	6.97	105.21	0	0.00	0.00	0.00	0.00
MC Dependent*	17	16.87	303.13	2	35.66	37.18	11.76	12.27

*Summer survey data used to calculate winter capacity

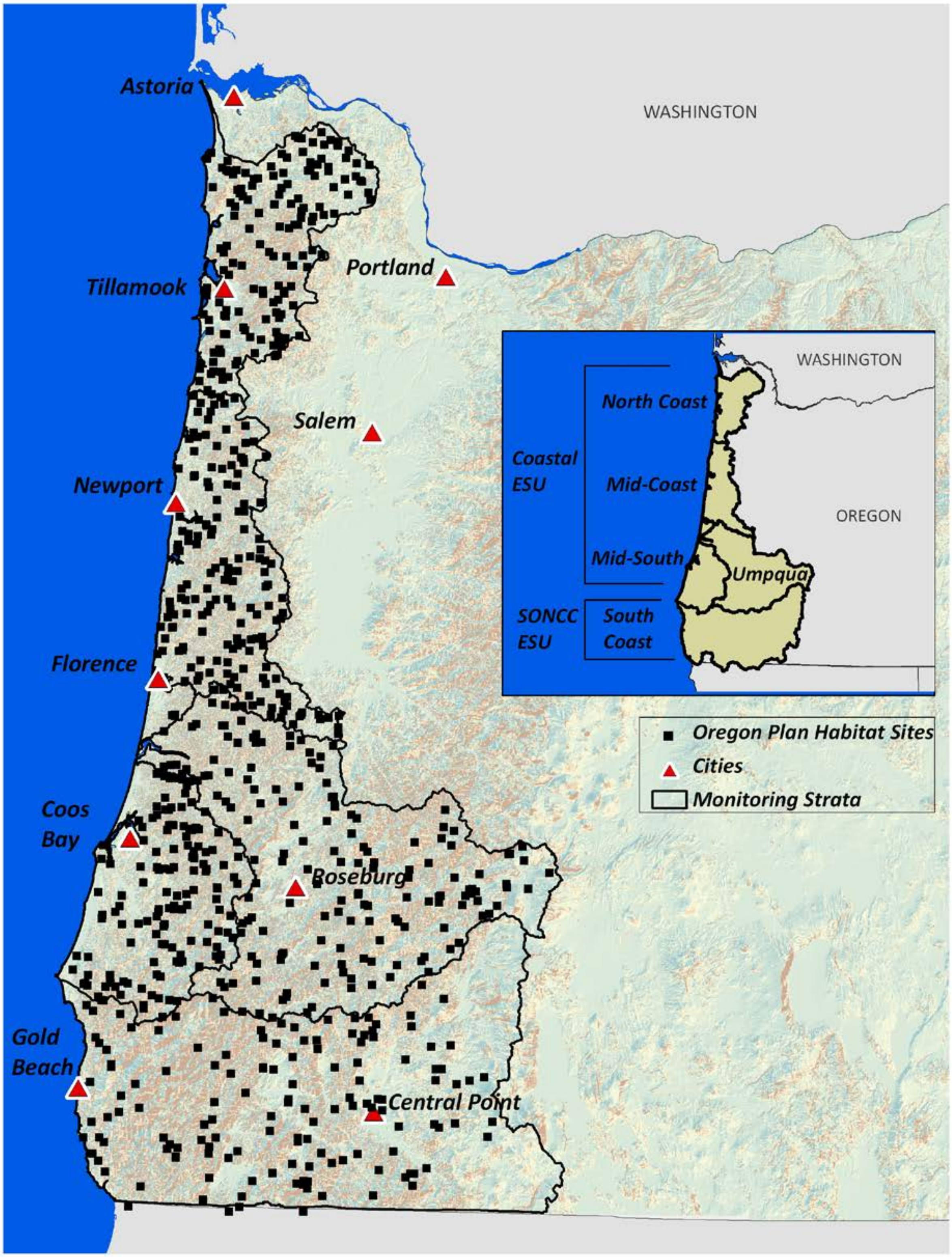


Figure 1. Oregon plan habitat survey sites in Coastal and SONCC ESUs from 2006-2010.

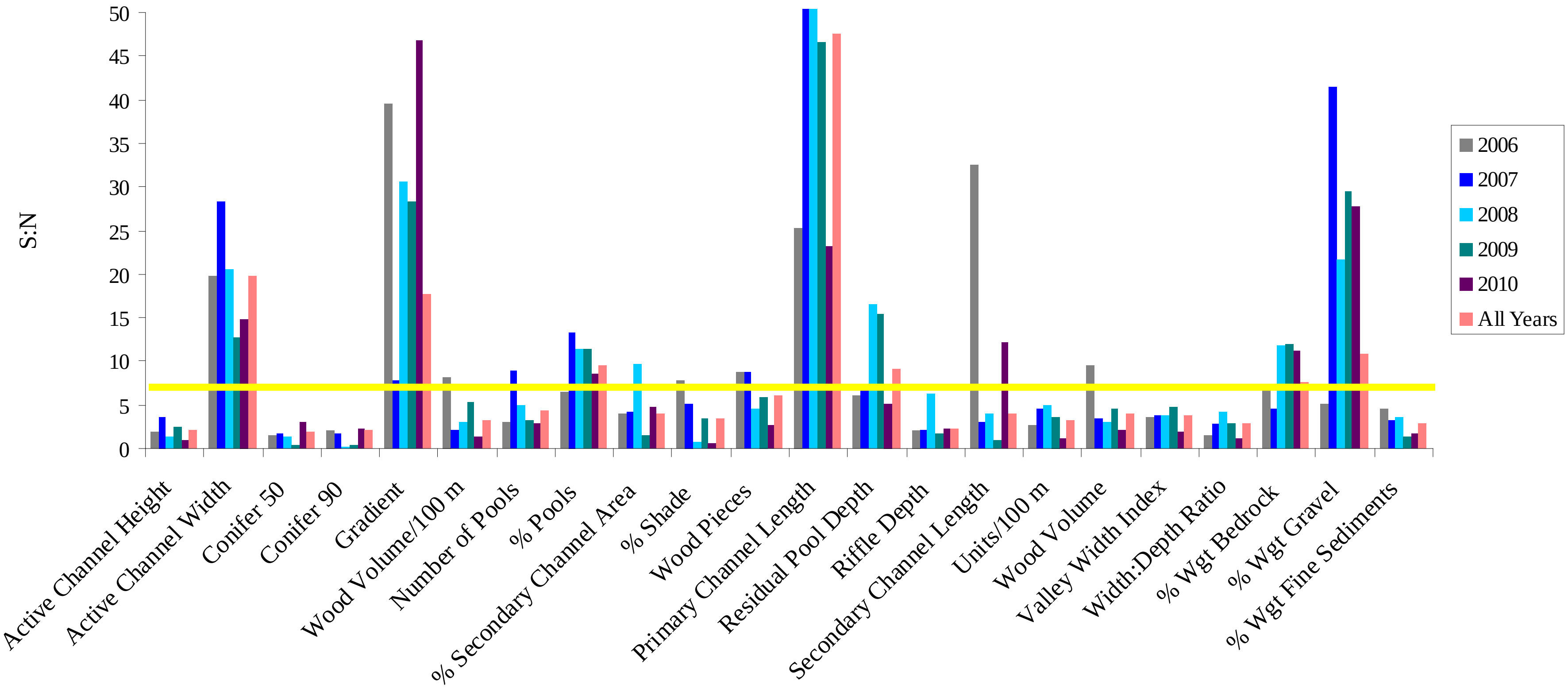


Figure 2. Signal to Noise (*S:N*) ratios for 20 habitat attributes. The horizontal yellow line signifies high (i.e., precise) *S:N* ratios at y=6.5. [Noise in Gradient data in 2007 was due to a habitat unit type discrepancy in one unit at one site (i.e., a st step over bedrock versus a cascade over bedrock), which altered the way gradient data were collected.]

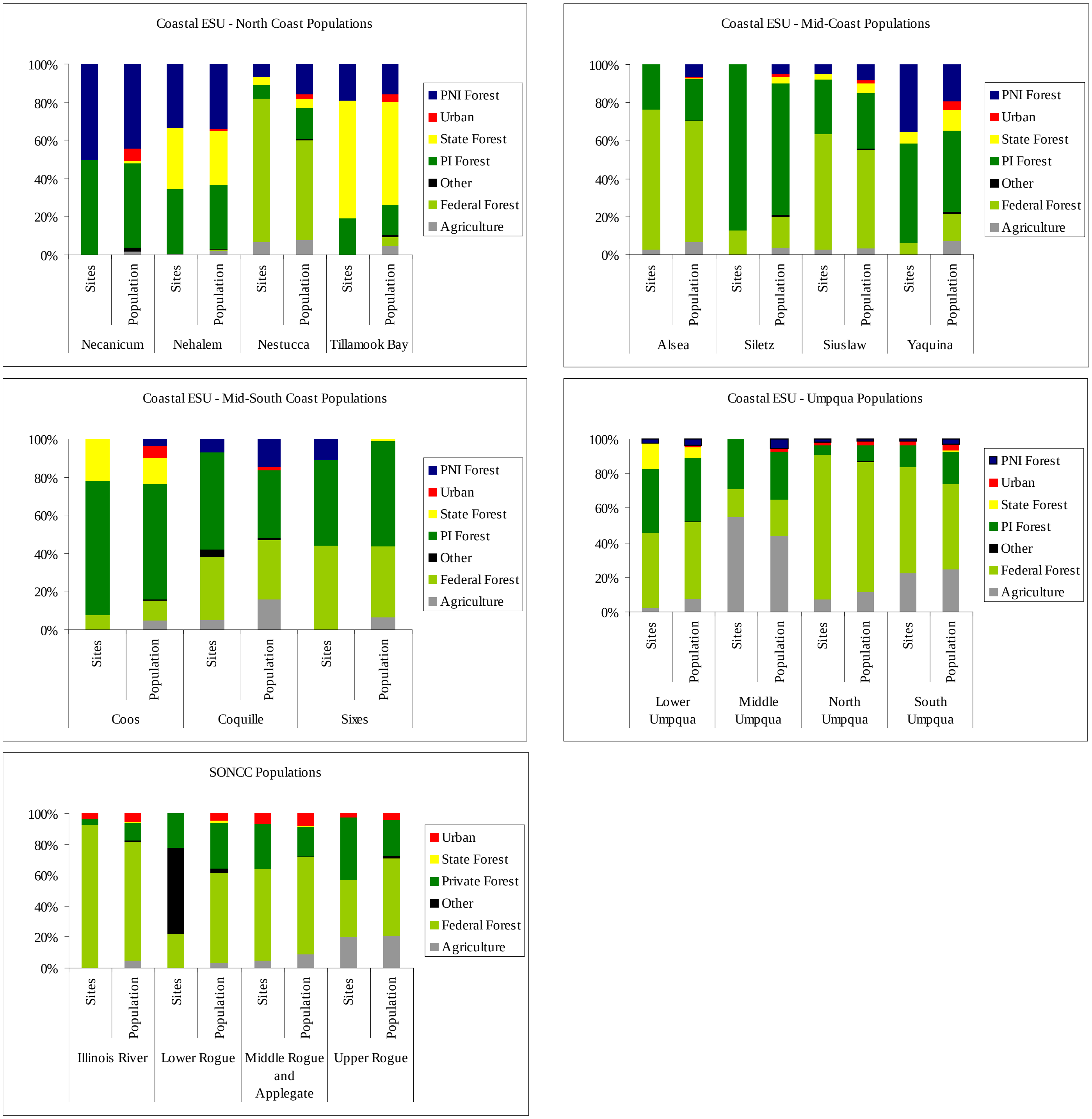


Figure 3. Oregon plan habitat survey sites by monitoring strata, depicting land use proportions by (1) sites (area based on 500 m buffer around survey point) and (2) populations of independent coho salmon (area based on percent total land base in population area). Note: PNI and PI Forest is combined in the SONCC ESU.

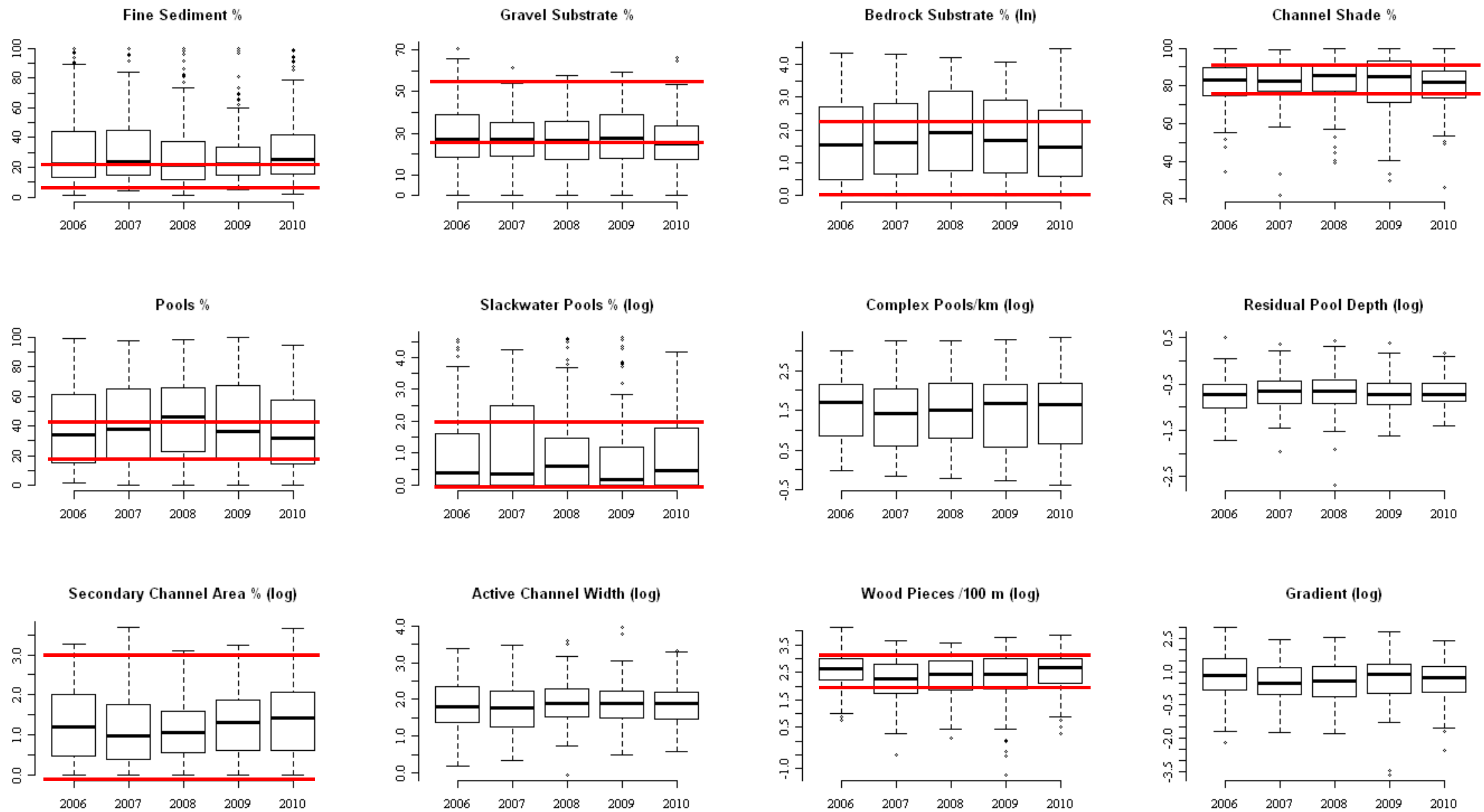


Figure 4. Boxplots of each habitat attribute in the Coastal ESU by year. Only data within the range of coho salmon included. Plots depict minimum values, lower quartile bounds, medians, upper quartile bounds, and maximum values. Years and corresponding sample sizes: 2006=159; 2007=156; 2008=157; 2009=171; 2010=183. Horizontal red lines indicate upper and lower breakpoints for the respective habitat attributes (see Appendix C).

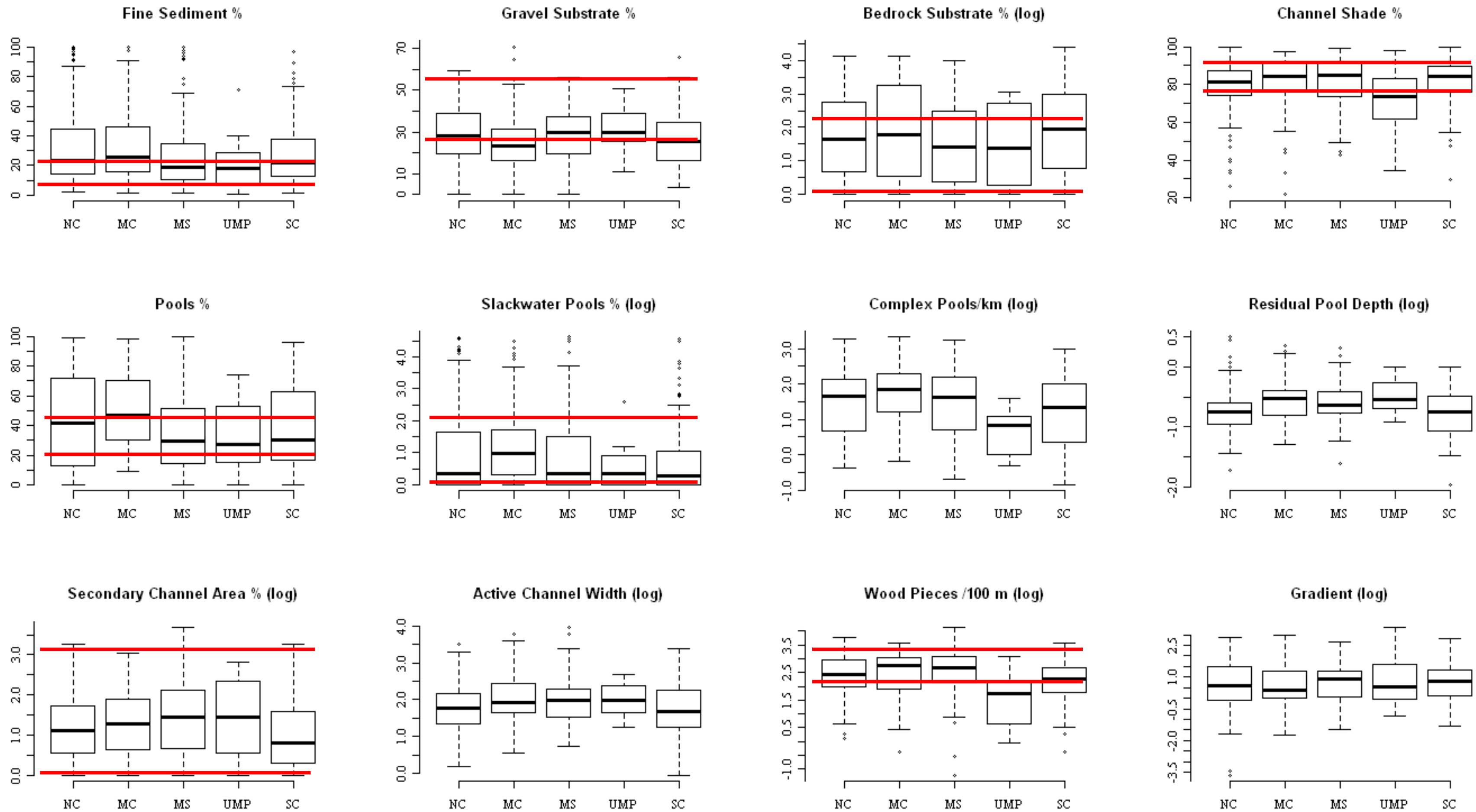


Figure 5. Boxplots of each habitat attribute in Coastal and SONCC ESUs by monitoring strata. Only data within the range of coho salmon included. Plots depict minimum values, lower quartile bounds, medians, upper quartile bounds, and maximum values. Monitoring strata and corresponding sample sizes: North Coast=154; Mid-Coast=160; Mid-South=143; Umpqua=158; South Coast=136. Horizontal red lines indicate upper and lower breakpoints for the respective habitat attributes (see Appendix C).

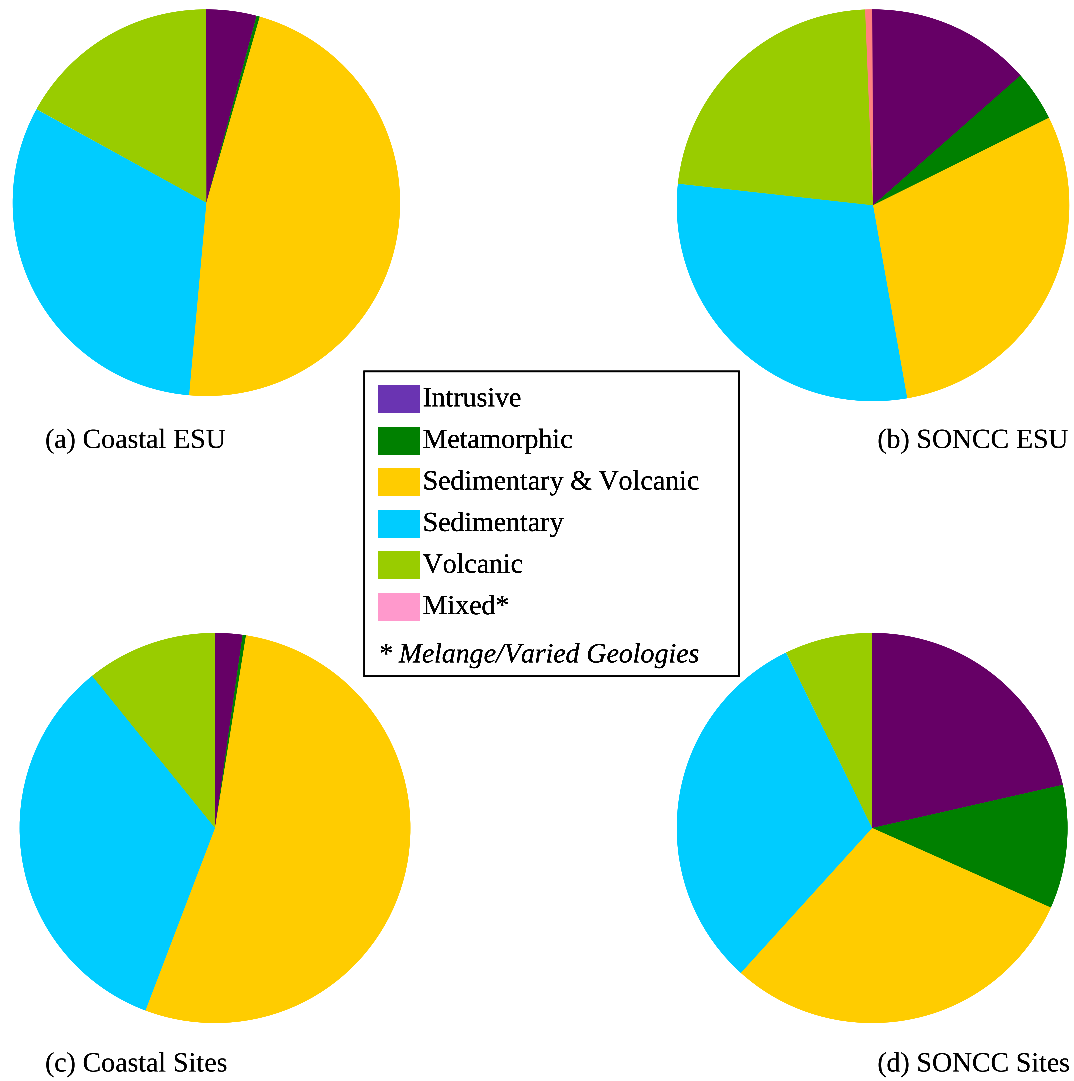


Figure 6. Representation of geology within Oregon plan habitat survey sites, depicting (a) proportion of geology by area for Coastal ESU, (b) proportion of geology by area for SONCC ESU, (c) proportion of geology by site total for Coastal ESU, and (d) proportion of geology by site total for SONCC ESU.

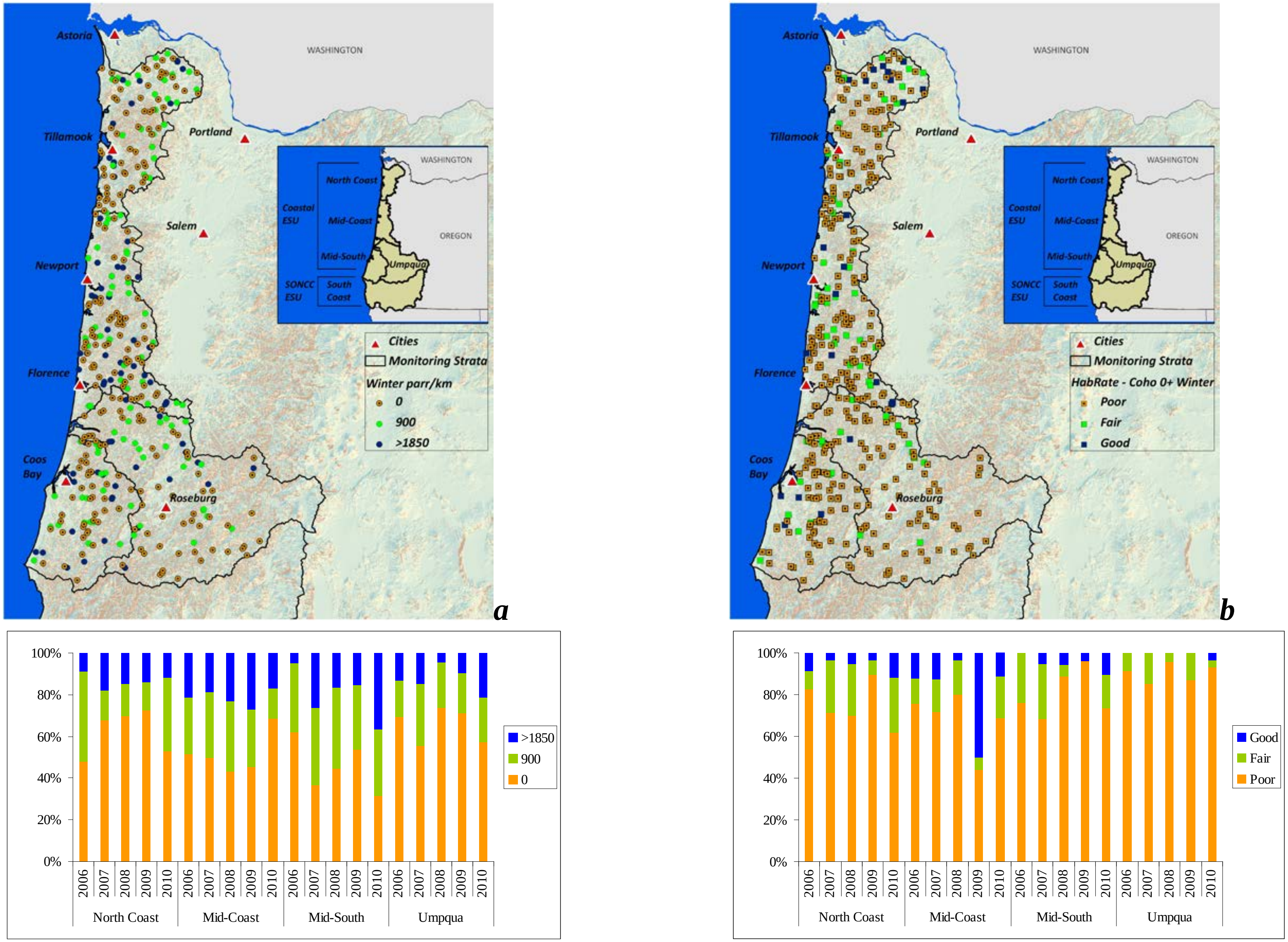


Figure 7. Spatial distribution and rating proportion within Oregon plan habitat survey sites by (a) winter parr/km estimates, and (b) HabRate values for coho salmon 0+ winter. Spatial data were averaged across years where multiple years of data identified (HLFM estimates); otherwise the max rating across years provided for sites (HabRate values). Only estimates within the distribution of coho salmon in the Coastal ESU provided.

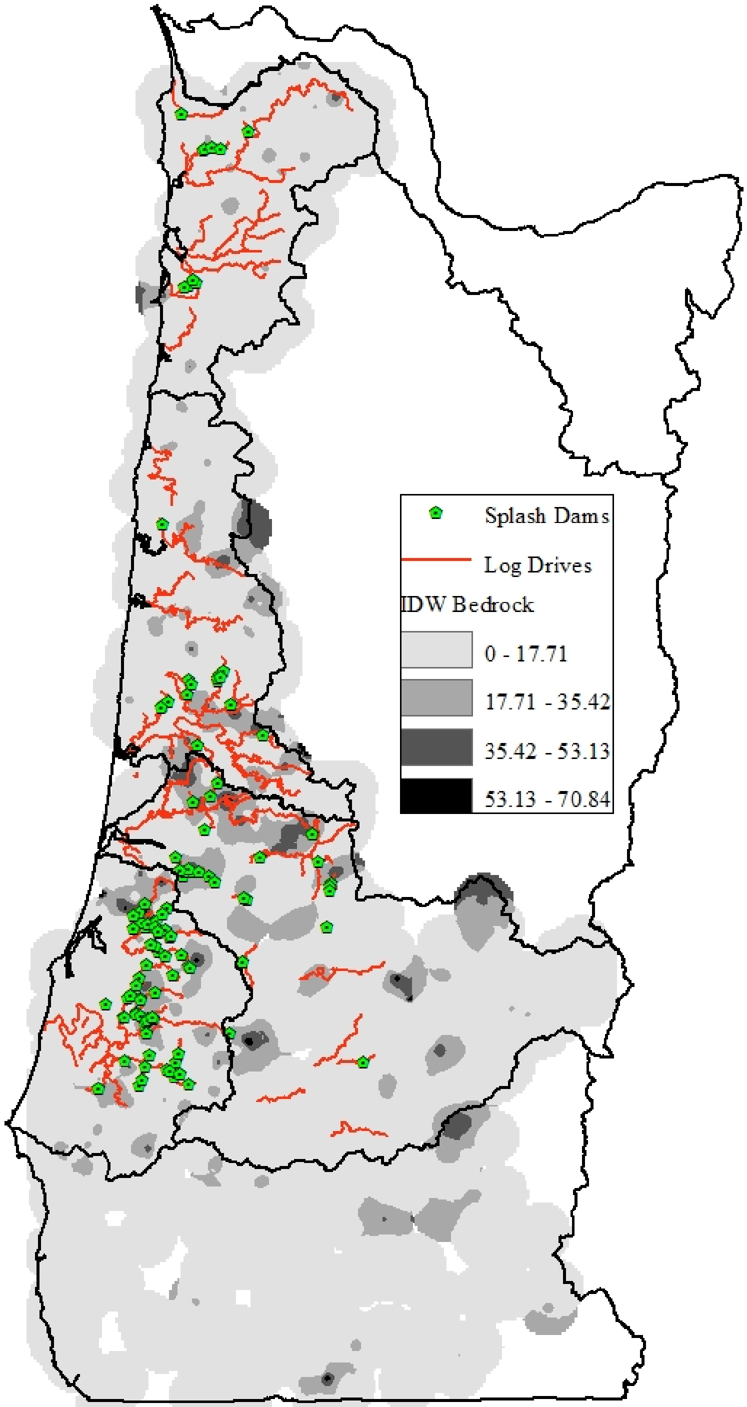


Figure 8. Interpolation of bedrock substrate from survey sites using an inverse distance weighted (IDW) technique and location of historic splash dam and log drive sites (Miller 2010). The IDW interpolation uses a linearly weighted combination of points to determine the cell values. The result is a surface indicating where higher percentages of bedrock are likely to occur given the value of neighboring sites.

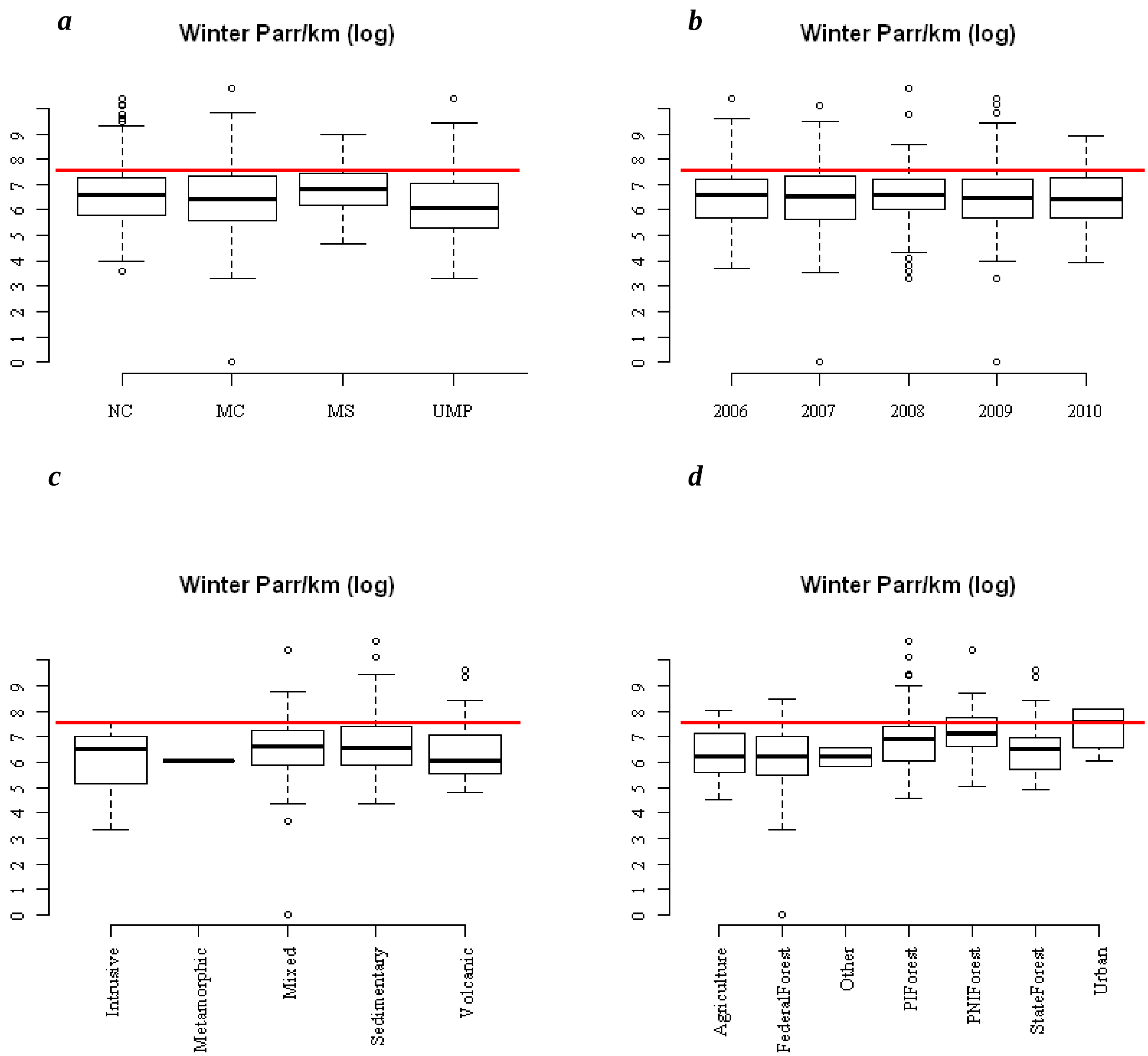


Figure 9. Boxplots of winter parr/km (loge) throughout the Coastal ESU depicting (a) average across years, (b) years, (c) average across years by geology type, and (d) average across years by each land use. Only data within the distribution of coho displayed. Horizontal red lines indicate high quality values (>1850 winter parr/km corresponding to y=7.52 on log scale).

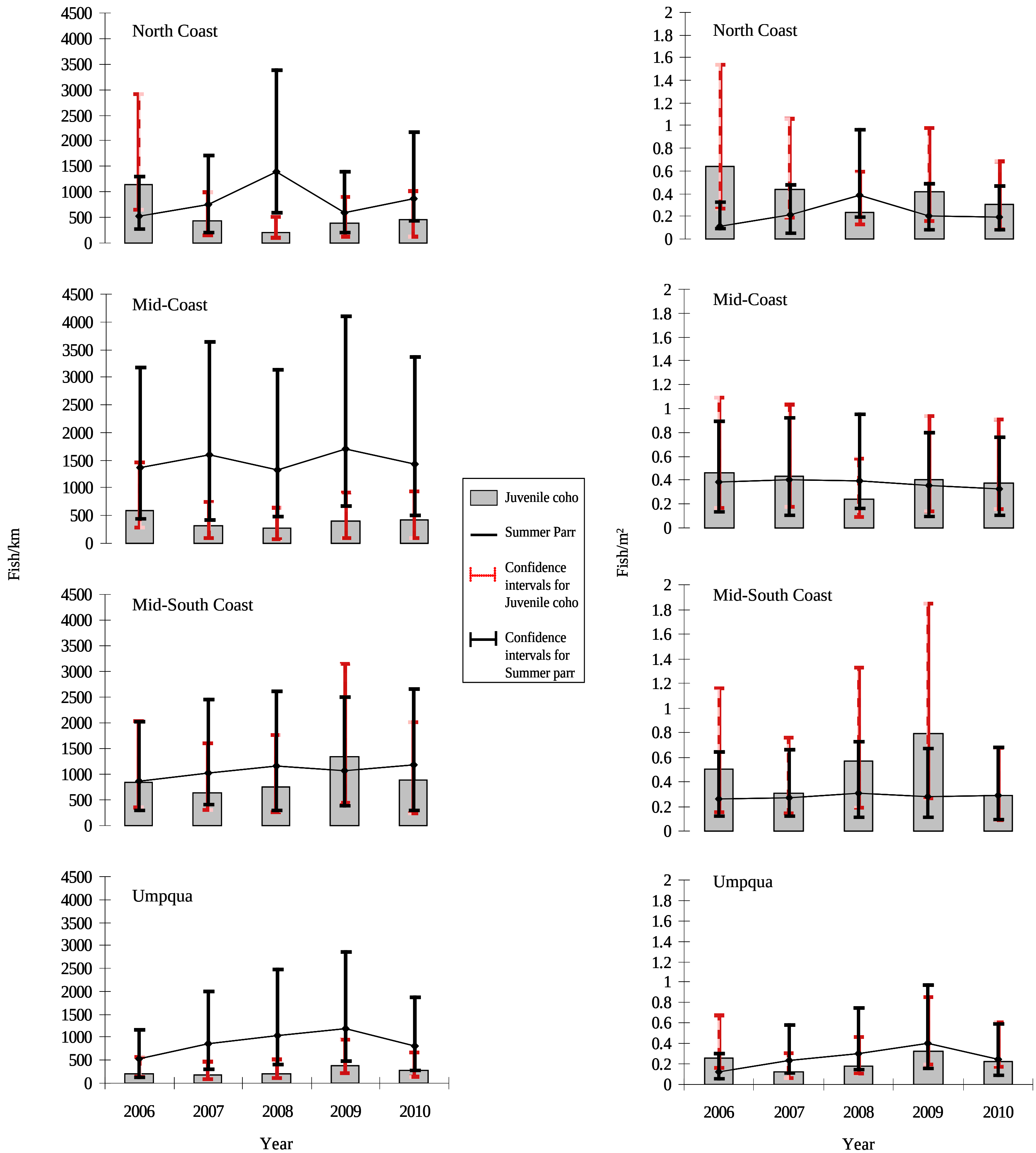
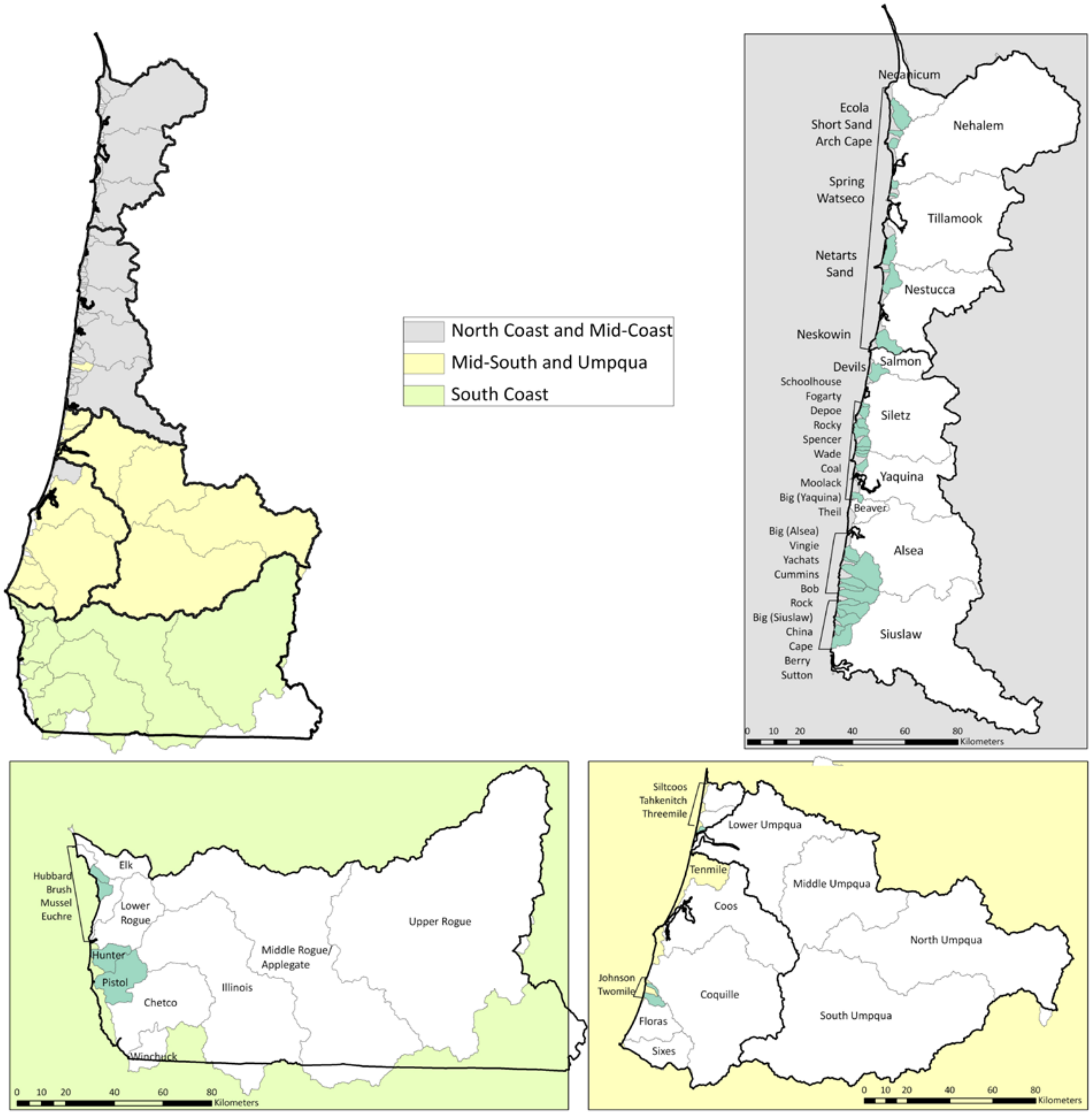


Figure 10. Comparison by year of empirical estimates within Oregon plan habitat survey sites for (a) juvenile coho salmon/km and summer parr/km (estimated from HLFM) and (b) juvenile coho salmon/m2 and summer parr/m2.

Appendix A. Count of Oregon plan habitat survey sites within coho salmon populations studied from 2006-2010. Data based on unique sites across years.

ESU	Monitoring Area	Coho Population	Total Sites	Coho Sites
Coastal	North Coast	Necanicum	9	9
		Nehalem	67	41
		Nestucca	31	17
		Tillamook Bay	37	22
		Dependents	10	7
	Mid-Coast	Alsea	31	21
		Beaver	6	5
		Salmon	7	6
		Siletz	26	11
		Siuslaw	59	48
		Yaquina	13	8
		Dependents	18	16
	Mid-South Coast	Coos Bay	48	30
		Coquille	67	29
		Floras	3	2
		Sixes	14	3
		Tahkenitch	3	3
		Tenmile	6	5
		Dependents	2	0
	Umpqua	Lower Umpqua	32	20
		Middle Umpqua	25	20
		North Umpqua	44	11
		South Umpqua	57	27
SONCC	South Coast	Chetco River	6	0
		Elk River	3	0
		Illinois River	22	4
		Middle Rogue	42	6
		Upper Rogue	44	3
		Winchuck River	2	0
		Dependents	8	0



Appendix B. Coho salmon (*Oncorhynchus kisutch*) population distribution along Oregon coast. Coastal ESU comprises (a) North Coast, (b) Mid-Coast, (c) Mid-South, and (d) Umpqua monitoring strata. Southern Oregon and Northern California (SONCC) ESU includes South Coast monitoring stratum.

Appendix C. Habitat breakpoints for Oregon Coast basins based on reference streams within the distribution of coho salmon (*Oncorhynchus kisutch*). Reference values derived from streams in areas with low impact from human stressors. Stream sites surveyed from 1992-2003 (Thom et al. 2001; Rodgers et al. 2005).

Habitat Attribute	Definition	Low Break Point	(log)	High Break Point	(log)
% Bedrock	Estimate of substrate composed of solid bedrock	<1%	(0.00)	>11%	(2.40)
% Fine Sediments	Estimate of substrate composed of <2 mm diameter particles (weighted by habitat unit area)	<8%		>22%	
% Gravel	Estimate of substrate composed of 2-64 mm diameter particles (weighted by habitat unit area)	<26%		>54%	
% Pool habitat	Percent primary channel area represented by pool habitat	<19%		>45%	
% Shade	Percent of the 180 degree sky; includes topographic and tree shade	<76%		>91%	
% Secondary channel area	Percent total channel area represented by secondary channels (weighted by habitat unit area)	<0.8%	(0.00)	>5.3%	(1.67)
% Slackwater pool	Percent primary channel area represented by slackwater pool habitat (beaver pond, backwater, alcoves, isolated pools)	0%	(0.00)	>7%	(1.95)
Wood pieces/100 m	Number of pieces of wood >0.15 m diameter X 3 m length per 100 m primary stream length	<8	(2.08)	>21	(3.04)