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Stream Habitat Conditions in Western Oregon
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Stream Habitat Conditions in Western Oregon, 2005

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Objectives and Accomplishments in 2005

We selected sample sites using the Environment Monitoring Assessment Program (EMAP) protocol to obtain a random, spatially balanced set of aquatic habitat sites. The habitat sample frame for western Oregon included all 1st through 3rd order (wadeable) streams on a 1:100,000 scale digitized stream network. Our target was to monitor 40 sites (500m to 1000m in length) in the four monitoring areas within the Oregon coastal coho Evolutionary Significant Unit (ESU) and 40 sites within the South Coast (included in the Southern Oregon Northern California Coho ESU). All habitat surveys were conducted between June and September 2005 (see methods for details). Within each monitoring area, 11% of the sites were resurveyed to assess quality assurance. The following analyses were completed:

- Performed quality assurance to ensure data were accurate and complete.
- Summarized data by monitoring area at the reach scale for each individual survey.
- Performed signal-to-noise ratio test utilizing resurveys to determine precision and accuracy of individual attribute estimation.
- Described status of the channel morphology, substrate compositions, instream wood, and riparian structure in all wadeable streams in coastal drainages and selectively in coho and steelhead streams.
- Compared attribute values at sites surveyed within the current range of coho salmon and outside their range.
- Utilized the sampling design to extrapolate to all streams within the sample frame and post-stratify sites into additional frames (coho distribution and high intrinsic potential streams).
- Used the Habitat Limiting Factors Model (HLFM) version 7.0 (Version 5.0 in Nickelson 1992) and Habrate Model version 2.0 (Burke et al. 2001, criteria for coho salmon in this report) to describe the quality of habitat for coho and steelhead.
- Determined if there were differences in habitat conditions among monitoring areas for specific habitat attributes.

Executive 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. Habitat conditions in 2005 were summarized based on 209 habitat surveys across five monitoring areas along the Oregon coast. Overall, streams were found to have high amounts of pool habitat but low complexity and structure. Low amounts of instream wood, particularly in pool habitats, contributed to low habitat quality ratings across the coastal coho ESU. Amounts of gravel relative to fine substrate resulted in high quality spawning habitats although the percentage of fine sediments in all monitoring areas was higher than reference conditions. Coho salmon were found in a select number of streams outside their current distribution. When comparing habitat conditions within and outside the range of coho salmon, we found that higher percentages of pool habitat and gravel substrates were observed at sites within the range of coho in most monitoring areas. We estimated stream habitat in the field in 2005 with adequate precision; channel width and length, gradient, and pool habitat were approximated with the best precision. There were no significant differences between monitoring areas in terms of deep pools, gravel substrate percentages, wood volume, or active channel width. However, the South Coast and the Umpqua differed from all other regions in terms of instream wood pieces and riparian structure respectively.

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 has the broadest geographic scope of inference and ties to other program components as well – basin surveys, surveys at habitat restoration sites, adult and juvenile coho surveys, and life cycle watersheds (Flitcroft et al. 2002).

The Oregon Plan facilitated cooperation and partnerships to study the contemporary life history dynamics of coho salmon in the Oregon coastal ESU (Evolutionary Significant Unit). A viability and status assessment of Oregon coastal Coho (Chilcote 2005) and the Conservation Plan for the Oregon Coast Coho Evolutionary Significant Unit (Nicholas 2006) evaluated the relationship of aquatic habitat to the productivity of coho salmon populations and recommended actions to promote recovery. The habitat portion of the viability assessment was based on a review of aquatic and riparian habitat collected by the Aquatic Inventories Project (ODFW) from 1990 to 2004 (Rodgers et al. 2005). The authors of the habitat assessment (Rodgers et al 2005) and viability assessment (Chilcote 2005) concluded that coho productivity in 22 coastal coho populations was limited by the complexity of stream habitat used by juvenile coho during their first winter of freshwater residence.

The term "stream complexity" integrates geomorphic and structural characteristics of streams and associated aquatic habitat. Complex geomorphic features may be observed in low gradient streams flowing through wide valley floors with multiple channels and off-channel habitats. Structural complexity refers to the size and configuration of pools, large wood pieces and jams, substrate, and undercut banks. The combination of geomorphic and structural features provides cover and refugia during high winter flows for juvenile coho. Stream reaches that can or have the potential to create these conditions are commonly located in lower reaches of moderate size streams in areas with wide valley floors and are considered to contain high quality habitat for juvenile coho. Burnett et al. (2007) developed spatial models to estimate high-quality habitat rearing potential, termed intrinsic potential, in coastal streams. A stream's intrinsic potential was modeled using valley width, gradient, and stream flow. Historically, streams identified as having high intrinsic potential may have been the most productive for juvenile coho salmon; restoration of these reaches may be the key to recovery of coho salmon. The viability assessment and Coho Plan recommend that we monitor the trends in total amount and spatial distribution of these habitats in coastal drainages.

This report discusses the findings from aquatic habitat surveys conducted in summer 2005 in coastal drainages. Our objectives are to describe and compare channel morphology, instream habitat and complexity, and riparian conditions in all wadeable streams in five monitoring areas. The sample design permitted us to post stratify the sample sites into three additional frames: sites within coho and steelhead distribution, sites outside coho distribution, and sites within high intrinsic potential for coho. We also used two habitat models to integrate habitat attributes to describe the habitat quality and capacity for different life stages of juvenile coho and steelhead.

Methods

Study Area and Site Selection. Oregon Plan habitat survey sites were selected within watersheds draining into the Pacific Ocean south of the Columbia River. This region is stratified into five monitoring areas (MA) (North Coast, Mid-Coast, Mid-South Coast, Umpqua, and South Coast) which constitute the extent of the Oregon Coastal Coho Salmon Evolutionarily Significant Unit (ESU) and the Oregon portion of the Southern Oregon Northern California Coho ESU (Figure 1).

Samples sites were selected on streams within each MA derived from a 1:100,000 scale hydrography layer developed by the USGS. Potential sample sites were chosen within each monitoring area using a generalized random tessellation stratified (GRTS) design (Stevens 2002). Samples were selected randomly within a monitoring area and were spatially balanced across the landscape. Sampling intervals were based on a rotating panel design consisting of four temporal strata; annual, 3 year, 9 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 that have a basin size larger than 0.6 km^2 irrespective of fish use. The panel structure also assigned selected sites to spatially co-occur with adult spawning and juvenile rearing surveys for those sites within the rearing and spawning distribution of coho salmon.

Stream Habitat Surveys. Aquatic habitat surveys (500 m or 1000 m reach lengths) were conducted in the field from mid-June through late September. A total of 209 unique sites were sampled, of which 25 sites were resurveyed. 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 with electrofishing gear to assess species composition and distribution. Detailed survey methods can be found in Moore et al. (2007).

Analysis. Habitat attributes were chosen to describe instream and riparian conditions and quality within and across all monitoring areas in 2005 (Figure 1; Table 1). The resurveys were used to determine the variance between and within habitat surveys, indicated by a signal to noise ratio. Those variables with a high signal to noise ratio (S:N) were considered to be precise and repeatable for analytical purposes.

We selected stream size (active channel width), gradient, and the amount of secondary channels to describe channel morphology. Channel morphology in turn influences the formation of geomorphic channel units and the deposition and transport of sediment and wood. The percent of secondary channel area indicates floodplain connectivity and potential for complex habitat. Key characteristics of pool channel units include the amount of pool habitat (percent of pool habitat present) and the number of deep (>1 m) pools. We used the percentages of gravel and fine sediments to describe substrate composition and potential embeddedness within a stream reach. We described the percent of fines (organics, silt, sand) and gravel averaged throughout the survey reach and in the low gradient (1-2%) riffles. Not all sites had low gradient riffles; the values of riffle fines and gravels at these sites were null. We evaluated the function of large wood as the number of pieces, the volume, and number of key pieces (>0.6m diameter and >12m length). Riparian vegetation was characterized by the number of conifer and hardwood trees, number of large conifers, bank stability, and shade.

To describe the condition and status of habitat during the 2005 survey season we examined boxplots to evaluate the distribution of the habitat values. Boxplots display means, standard errors, medians, and the 25th and 75th quartiles for individual attributes by monitoring area. Data were displayed spatially and cumulative distribution frequency (CDF) curves were examined for each monitoring area and compared to a reference condition dataset. Cumulative distribution frequency (CDF) curves enabled us to evaluate the value of a habitat metric relative to the cumulative stream length surveyed. Values at the 25th (25% of the surveyed stream length), 50th (50% of the surveyed stream length or the mean), and 75th (75% of the surveyed stream length) percentiles were highlighted to measure how well each metric performed relative to a reference condition dataset. This enabled a common point of comparison. We additionally compare attributes measured within and outside the current distribution of coho salmon. Habitat conditions were also evaluated within streams described as having high (>0.75) intrinsic potential for coho salmon based on stream flow, valley constraint, and channel gradient (Burnett et al. 2007).

An analysis of variance (ANOVA) using SAS statistical software was performed on each habitat attribute to determine if there was a difference in habitat metric mean values between the five monitoring areas. Least square (LS) means were used due to the unbalanced nature of the data. *P*-values were obtained for the differences in LS mean values between monitoring areas and a multiple comparisons test was performed to see which of the monitoring areas differed for a given habitat attribute. An adjustment due to the unbalanced data was made to the multiple comparison tests using the Tukey-Kramer method (Kramer 1956).

The reference dataset consists of random survey sites (Oregon Plan), census survey reaches (Basin surveys), and restoration sites surveyed from 1990-2003. These sites typically have had a low impact from human activities. Reference sites were selected from all habitat surveys conducted by ODFW in the Coastal Coho ESU using a process outlined in Thom et al. (2001) and Rodgers et al. (2005). A total of 124 coastal reference reaches were selected based on gradient, land use, and riparian criteria. Criteria for each of these parameters were less than 5% average reach gradient; dominant land uses identified as old growth, mature timber, no use, or designated wilderness; and riparian areas with 50-90cm dbh conifer tree stands (Table 2a, 2b). We further screened candidate reference sites by eliminating reaches in watersheds with streamside roads.

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. HabRate is designed to evaluate juvenile coho habitat quality based on critical habitat values defined in the literature (Table 3). The model is a qualitative decision making tool that inputs reach level summaries of stream habitat and provides a limiting factor assessment at each life stage. Habitat ratings of high, medium, and low are created for each habitat variable and for each stream rearing life stage. The model output ranks habitat quality from 1 to 3: poor, fair, and good, respectively. Variable scores are combined to provide a rating for each life stage. Results of the model were evaluated and displayed at the monitoring area 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 (large wood, undercut banks), and gradient. We further examined attributes that contribute to the spawning, summer rearing, and winter rearing habitat quantity ratings.

Summer habitat capacities (parr/km) were estimated using the Habitat Limiting Factors Model (HFLM) as described by Nickelson et al. (1992) and Nickelson (1998), and updated in 2007. The model uses habitat attributes of specific value to juvenile coho salmon, applying a density of juvenile coho salmon to each habitat unit and multiplying by the surface area of the habitat unit. The model draws on channel morphology diversity with respect to the amount of different habitat unit types. Summer habitat capacity is a function of the amount of total pool habitat; winter habitat values the amount of beaver-influenced and off-channel pool habitat. 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.

Results

Site Selection Statistics. A total of 209 reaches were surveyed in 2005 across all monitoring areas (Figure 1a), representing 78% of the original site selection (265). Dropped sites constituted 21% of the pull with 9% of these sites designated as non-target and 12% of these sites designated as target. Non-target sites are sites identified in the original pull that were recognized as sites with a GIS coverage error, small watershed area, or in a tidal area. Target sites are sites identified in the original pull and dropped due to landowner denial, or other access or time issues (Table 4). The majority of the denials to surveying were on private non-industrial lands in all monitoring areas. In the North Coast, the majority of the reaches were surveyed on state lands while in the Mid-Coast and Mid-South Coast reaches were concentrated on private industrial forest lands. In the Umpqua and the South Coast, the majority of the reaches were surveyed on US Forest Service lands (Figure 1b). A total of 96 surveys were conducted within the range of coho salmon and 113 surveys conducted outside their current range (Figure 2a, b). Juvenile coho salmon were observed at thirteen sites outside of the known distribution of coho (Table 5; Figure 2a, b). The Mid-Coast had the highest number of these sites in 2005.

Signal-to-Noise Ratio. A high signal to noise ratio (>95% signal) indicates the variable was measured with a high level of precision. Channel length, active channel width, and gradient were examples of variables with high ratios (Table 6; Figure 3). Wetted width and percent of pool habitat also had low residual variation (5% Noise). The attributes that performed poorly were gravel and fine substrates quantified in riffle habitats and residual pool depth. The residual variation exceeded the site variation indicating a considerable amount of noise not attributed to site conditions but to other error such as crew variability or imprecision of the collection method.

Descriptive Statistics and Spatial Patterns. All habitat variables were summarized by reach and evaluated by monitoring area. We used cumulative distribution frequency graphs to compare current conditions with reference conditions. Tables 2a and 2b describes the reference condition benchmarks and values for Oregon coastal basins based on the reference streams. Boxplots displaying the median, 25th and 75th quartiles, standard error, and outliers associated with each attribute are plotted in Appendix 2 - 6b. Reach results were also mapped to examine spatial relationships. Habitat variables are summarized and reported within four broad categories; stream morphology, substrate composition, instream wood, and riparian structure.

Stream Morphology. Three attributes were examined to describe stream morphology: secondary channel area (%), pool habitat (%), and deep pools (pools >1 m/km). Overall, monitoring areas had lower values than in reference reaches for secondary channel area (Figure 4a, b). At the 50th percentile, pool habitat and the quantity of deep pools in the Mid-Coast exceeded reference conditions (45% pool habitat and 0.5 deep pools/km respectively). At the 75th percentile, both the Mid-Coast and Mid-South coast exceeded the reference dataset for percentage of pool habitat (70% and 60% respectively). The South coast had the lowest pool habitat percentages (25%) while the Umpqua had the lowest quantity of deep pools (1.5 deep pools/km) (Figure 6a, b; Figure 7a, b).

Substrate Composition. Four attributes were examined describing substrate composition within a reach; total fine sediments (%), fine sediments within riffle habitats (%), total gravel substrates (%), and gravel within riffle habitats (%). Overall, all monitoring areas had higher amounts of total fine sediments and riffle fine sediments in comparison with reference conditions (Figure 9a, b; Figure 11a, b). At the 75th percentile, total fine sediment and fine sediment in riffle habitat percentages ranged from 25% (North Coast) to 50 % (Mid-South) and 15 % (North Coast) to 50 % (Mid-South) respectively. The Mid-South consistently had the highest percentages of fine sediment both within the reach and within riffle habitats.

Most of the monitoring areas performed at or just above reference conditions with reference to total gravel substrates and gravel in riffle habitats. At the 75th percentile, total gravel substrates and riffle gravel percentages ranged from 30% (Umpqua) to 45% (Mid-Coast) and 40% (Umpqua) to 60% (North Coast) respectively (Figure 8a, b; Figure 10a, b). The South Coast had the lowest amounts of gravel across the sites and within riffles.

Instream Wood. Two attributes were examined describing instream wood; the density of wood pieces (wood pieces/ 100m) and the wood volume (m^3/ 100m) in a reach. Most of the monitoring areas performed equal to or lower than reference conditions with regards to the density of wood pieces. All monitoring areas were within 5 pieces/ 100m of the reference conditions (20 pieces/ 100m) at the 75th percentile with the exception of the South Coast which performed the lowest with 10 pieces/ 100m (Figure 12a, b).

The entire coastal coho ESU rated low for wood volume within a reach when compared to reference conditions. At the 75th percentile, reference conditions had wood density values of 60 m^3/ 100m while the Umpqua had 30 m^3/ 100m of wood (Figure 13a, b). Wood volume in 2005 ranged from 0 to 116 m^3/100m across the entire ESU while reference conditions ranged from 1.1 to 300 m^3/100m.

Riparian Structure. Three attributes were examined describing riparian structure; total channel shade (%), the density of large riparian conifers (20 cm DBH or greater/ 305 m), and the density of very large riparian conifers (36 cm DBH or greater/ 305 m). Reference conditions exceeded most of the monitoring areas with regards to percent channel shade, however all regions were within 10% of the reference condition (90% shade) values at the 75th percentile. The North Coast performed lowest with approximately 80% channel shade at the 75th percentile (Figure 14a, b).

Reference conditions exceeded most monitoring area values with regards to the density of large (20 cm DBH or greater) riparian conifers with the exception of the Umpqua basin. At the 75th percentile, the Umpqua had a density of 180 large conifers/ 305 m while reference conditions had a density of 200 large conifers/ 305 m. This monitoring area nearly matched the reference condition values for the entire cumulative percent of the stream length surveyed (Figure 15a, b).

The entire coastal coho ESU had very few large (36 cm DBH or greater) riparian conifers when compared to reference conditions. Riparian conifers greater than 36 cm DBH in 2005 ranged from 0 to 142 conifers/305m across the entire ESU while reference conditions ranged from 0 to 302 conifers/305m.

Comparison of metrics within and outside coho range. Higher percentages of pool habitat and gravel substrates were observed in most monitoring areas at sites within the range of coho (Table 5). The percent of fine sediments in reaches varied within and outside the range of coho across all monitoring areas. The density of large wood and channel shade both had higher average values at sites outside the range of coho which tend to be geographically positioned higher within a drainage. There was moderate site to site variability around each of the mean values for all habitat attributes (Table 7).

Habitat Quality. We summarized habitat quality using the HabRate model at three different life stages for coho salmon (spawning, incubation, emergence (egg-to-fry); summer 0+ rearing; winter 0+ rearing) and four different life stages for steelhead (spawning, incubation, emergence (egg-to-fry); summer 0+ rearing; winter 0+ rearing; summer 1+ rearing; winter 1+ rearing) (see Table 3 for coho salmon criteria; Burke et al. (2001) for steelhead criteria and model assumptions). Habitat quality was further classified in coho salmon bearing streams where the intrinsic potential was > 0.75 in the North coast, Mid-Coast, Mid-South, and Umpqua (Burnett et al. 2006).

HabRate. Spawning/Emergence Habitat – Coho salmon and steelhead
Within the range of coho salmon, the North Coast and Umpqua had the highest percentage of high quality spawning/emergence habitats with over 50% of the stream length surveyed in those monitoring areas receiving a good habitat rating (Figure 16a; 19, upper). These same patterns were also evident within coho bearing streams with high intrinsic potential (Figure 19, lower). We assessed substrate composition and habitat morphology, two composite attributes that contribute to the overall habitat rating for the spawning/emergence life stage. For both attributes, the majority of the stream length surveyed in the North Coast, Mid-Coast, and the Umpqua monitoring areas had good habitat ratings assigned (Figure 20, upper left). In the Mid-South and South coast monitoring areas, nearly 70% of the spawning/emergence habitats rated as poor quality (Figure 19, upper; Figure 20, upper left). Substrate compositions in the majority of the surveyed habitat in the Mid-South coast rated poorly in accordance with the coho criteria (Figure 19, upper; Table 3) and contributed to the overall poor rating for the life stage.

The same patterns among the composite attributes appear within coho bearing streams with high intrinsic potential (Figure 21, upper left), with the Umpqua monitoring area having the greatest percentage of high quality habitat ratings for both substrate composition and channel morphology, although the ratings are based on only two sites.

Within the distribution of steelhead, the South Coast and the Umpqua monitoring areas had the greatest percentage of surveyed stream that received a good habitat rating. The Mid-South coast had greater than 70% of the surveyed length rating poorly (Figure 22).

HabRate. Summer Rearing Habitat – Coho salmon and steelhead

Within the range of coho salmon, over 70% of the surveyed streams in most monitoring areas received fair or poor habitat ratings. The majority of the stream habitat in the South coast received a fair habitat rating with no high quality habitat identified (Figure 16b; Figure 19, upper). The South coast had the lowest designated coho mileage and therefore the fewest number of sites within coho distribution. In coho bearing streams with high intrinsic potential, approximately 10% of the surveyed habitat in the Mid-Coast and 35% of the surveyed habitat in the Umpqua received good habitat ratings (Figure 19, lower). The North coast and Mid-Coast received a poor habitat quality rating for over 60% of the surveyed length. When examining habitat ratings for percent of pool habitat and pool complexity, two composite attributes that contribute to the overall rating for the summer 0+ life stage for coho, less than 30% of the stream lengths surveyed in the Mid-Coast, Mid-South, and South coast monitoring areas received good habitat quality ratings for percent of pools (Figure 20, upper right). The majority of the surveyed habitat across the coast received fair ratings with reference to pool complexity relative to summer 0+ rearing habitats, with exception to the North coast monitoring area which had over 50% of the surveyed habitat receiving good ratings for this attribute (Figure 20, upper right).

Similar patterns emerge among the composite attributes within coho bearing streams with high intrinsic potential (Figure 21, upper right). The percent of pool habitat within surveyed streams rated poorly for the North coast, Mid-Coast, and Mid-South. Pool complexity received fair habitat quality ratings across the monitoring areas (Figure 21, upper right).

Within the distribution of steelhead, the Umpqua and South Coast monitoring areas had more than 50% of surveyed stream habitat receiving good habitat ratings for the summer 0+ rearing life stage. The Mid-South coast rated fair for summer 0+ rearing habitats with more than 70% of the surveyed habitat receiving a fair habitat rating (Figure 22). Overall, the majority of the stream lengths surveyed in each monitoring areas received fair habitat quality ratings for the summer 1+ rearing life stage. The average depth of riffle habitats is the additional habitat attribute that distinguishes the 0+ summer rearing and 1+ summer rearing life stages due to steelhead 1+ fry beginning to exploit deeper riffle habitats at this stage.

HabRate. Winter Rearing Habitat – Coho salmon and steelhead

Within the range of coho salmon, less than 0 to 15% of surveyed stream habitat received good habitat ratings in all monitoring areas. The majority of the surveyed habitat in the Umpqua and South coast had fair habitat quality for coho salmon, while the North coast, Mid-Coast, and Mid-South received poor quality ratings for nearly 50% of the surveyed length (Figure16c; Figure 19, upper). In coho bearing streams with high intrinsic potential, all surveyed habitat in the North coast received a fair habitat rating (Figure 19, lower). Overwintering habitat within high intrinsic potential in the Umpqua monitoring area rated well, although only two sites fell within the mapped distribution of high intrinsic potential (Figure 16c; Figure 19, upper). Three composite attributes were assessed within this life stage; pool habitat, pool complexity, and sheltered pools. Sheltered pools include beaver or dammed pools, special case habitats such as backwaters and alcoves, and pools in secondary channels, while pool habitat is a composite metric among pool percentage, complexity, and sheltered pools. The majority of the surveyed habitat across all monitoring areas for each attribute received a fair habitat quality rating. The North coast and Mid-Coast had the greatest percentage of good quality pool habitat (Figure 20, lower). Pool complexities were variable across the coast with the North Coast having the greatest complexity among pools and the Mid-South having the poorest within the surveyed habitat (Figure 20, lower). Relatively high percentages of the surveyed habitat in the Mid-Coast, Mid-South, and Umpqua monitoring areas received good quality ratings for sheltered pools (Figure 20, lower).

Among the composite attributes within coho bearing streams with high intrinsic potential, pool habitat in all monitoring areas had relatively equivalent percentages of good quality habitat when compared to all surveyed habitat within coho distribution (Figure 21, lower). Pool complexity patterns in high intrinsic potential streams were similar to all reaches within the distribution of coho. The Mid-South remained limiting in pool complexity with less than 20% of good quality habitat assigned. The percent of the habitat surveyed with good quality sheltered pools also showed a similar pattern to all surveyed streams with the exception of the Umpqua. There was no good quality habitat identified in this monitoring area for sheltered pools; the majority of the habitat was of poor quality (Figure 21, lower).

Within the distribution of steelhead, the Umpqua and South Coast monitoring areas had more than 50% of surveyed stream habitat receiving a good habitat rating for overwintering at both the 0+ and 1+ life stages. The majority of the surveyed stream lengths in the northern monitoring areas had fair habitat for both overwintering life stages with the range of habitat receiving good HabRate ratings between 25 – 55% (Figure 22).

Habitat Capacity. Habitat capacity was estimated using HLFM 7.0. Based on 2005 stream surveys, the majority of the stream habitat for coho salmon summer parr had high estimated capacities at an average of 2,500-3,500 parr per kilometer in the North coast, Mid-Coast, Mid-South, and Umpqua, and fair at 1,700 parr per kilometer in the South coast.

Differences between monitoring areas. Results of the analysis of variance are displayed in Table 8. There was no mean difference between monitoring areas for deep pools, gravel substrate percentages, wood volume, or active channel width. The South Coast had wood density values that were different from all monitoring areas. The Umpqua differed from all monitoring areas with regards to large riparian conifers (20 cm DBH or greater) (Table 8).

Discussion

The majority of the habitat attributes collected by the field surveyors have signal to noise ratios higher than 4. This indicates that the field protocol and implementation by field crews provides sufficient precision and repeatability to describe the differences between sites despite some residual variation. Fines and gravel in riffle units are difficult to estimate because of protocol precision and lack of riffles within some sites which reduces the number of observations, potentially decreasing the accuracy of the test. However, most of the attributes can be measured or estimated with sufficient precision for comparisons between sites and over time.

Instream and riparian habitat was relatively similar between monitoring areas, but varied from reference conditions. We observed less large wood and more fine sediment in the streams, and fewer conifers in the riparian zone. The reference sites used in this report represent less disturbed stream reaches within the range of coho salmon (Rodgers et al. 2005). The difference in values between 2005 habitat conditions and reference conditions could be attributed to the fact that the majority of the reference surveys are located in streams where land management impacts are reduced.

The values of instream wood densities in the North Coast, Mid-Coast, Mid-South, and Umpqua monitoring areas on average ranged from 14 – 16 pieces/100m. The South Coast had an average value nearly half that range at 8 pieces/100m. These LWD values may indicate why stream structure in the South Coast was less complex when compared to the other monitoring areas. Low instream wood would reduce the stream’s ability to retain gravel substrates and create pool habitats. These habitat attributes were also lower in comparison to the other monitoring areas and reference conditions.

Riparian condition metrics in the Umpqua basin were more than double the values in the other monitoring areas. The average density of riparian conifers greater than 20 cm DBH in the Umpqua was considerable higher compared to the other monitoring areas. Land ownership of surveyed reaches within the Umpqua MA is dominated by the U.S. Forest Service and U.S. Bureau of Land Management, accounting for nearly 60% of the total area compared to 12% in the NC, 36% in the MC, and 25% in the MS. The difference may be that the public lands are not actively managed for timber within 30 m of the stream.

Channel morphology, instream habitat, and riparian characteristics varied with location in the drainage network. We post-stratified the sites by location within high intrinsic potential, coho, steelhead, and non-anadromous stream reaches. Some stream characteristics varied as expected with respect to location within the basin; channel size decreased and gradient increased higher in the drainage, and attributes such as pool depth and percent decreased accordingly. However, structural components (large wood) and stream complexity (secondary channels, off channel habitats) were low in streams within the distribution of coho salmon (lower in the drainage), and particularly in reaches considered to have high intrinsic potential. The low instream complexity in lower gradient streams has implications for salmon productivity where as a result, there is a high priority for restoration.

We used the HabRate model as a way to integrate multiple habitat attributes to describe the potential quality of habitat for different life stages of coho salmon. Good spawning habitat was abundant throughout the majority of the coastal basins, but the quality in some streams was limited by high proportions of fines in the substrate. Summer rearing habitat within the range of coho in all monitoring areas in 2005 was rich in pool habitat but lacked the complexity and structure necessary to be designated as high quality habitat for coho salmon. However, the capacity of the summer habitat was high as rated by HLFM, potentially supporting 2400-3500 parr per kilometer. Many sites had greater than 60% pool habitat, which lowers the quality of the reach for summer rearing. The amount of high quality winter rearing habitat was also limited along the coast. The most heavily rated factors in the winter rearing score was a combination of amount of pool habitat, complexity of pools, and amount of sheltered pools. The amount of pool habitat was usually high, but the quality was limited by either lack of wood complexity or amount of off channel and slow water pool habitat.

Within the range of coho, similar patterns were found when comparing surveyed habitats of high intrinsic potential (IP) with habitats outside of high IP. In general, there were no overall differences between habitats surveyed with high IP versus those that were considered of lower potential based on the model, although sample size was small in streams with high IP. Some differences did emerge when we examined the individual habitat attributes that contribute to overall habitat quality. In the Mid-South MA, the quality of substrate compositions in spawning and emergence habitats was lower in high IP streams. In the Umpqua MA, sheltered pools in winter were of lower quality within high IP streams.

Important habitat features such as secondary channels, off channels, and beaver pools are uncommon in coastal streams relative to other instream characteristics such as scour pools or low gradient riffles. These habitats increase survival and thus carrying capacity of juvenile salmonids by providing off channel refugia during high flow events. While slow water pool habitat types (beaver ponds, dam pools, alcoves, and backwaters), other pool habitats, and large wood debris have a major influence on the survival of juvenile coho salmon during the critical over-winter period, the configuration of these attributes in relation to one another provides complexity to the habitat (Nickelson 1992). The areas that rated lower in the summer because pools dominated the reach may be some of the better winter rearing habitats when temperatures cool and flows increase. Pool rich reaches are commonly located in lower gradient streams that have higher intrinsic potential. Although salmon have differing requirements when seeking summer versus winter habitats, instream habitat feature diversity and the complexity of those features, are required to attain conditions necessary to achieve the desired population status. These findings highlight the importance of the location of spawning, summer rearing, winter rearing, and high IP habitats along the stream network in a basin.

The finding of low instream complexity displayed across surveyed sites in 2005 is not an unexpected outcome. A recent summary of aquatic habitat conditions within the range of coho salmon has also shown instream complexity to be a limiting feature (Rodgers et al. 2005). In general, due to low instream complexity as a result of decreased floodplain connectivity, the distribution of higher quality habitats has decreased and potentially less capacity for the habitat to support fish. The habitat sites selected and analyzed in this report are based on summer surveys and reflect high summer habitat capacities. Winter habitat capacity (estimated with HLFM), which was not calculated, may be more likely to reflect the limiting instream complexity inherent in the data. The Coho Conservation Plan (Nicholas 2006) recommends restoration and protection of coho habitats by identifying the primary limiting factors for coho and developing management strategies to address them. This summary of 2005 habitat conditions reinforces the value and continued need for restoration monitoring, and reflects the importance of the projects being implemented. Restoration has effectively improved complexity, increasing pool habitats at individual sites which will enhance over-wintering habitat for coho salmon (Jacobsen and Jones 2007). However, restoration efforts alone will not alleviate habitat quality issues. Although long term restoration monitoring is occurring, rethinking how lands are managed specifically within riparian zones will be needed in order to create stream systems capable of sustainable and productive salmon populations. Continuing efforts to improve instream structure and complexity will increase the amount of high quality habitat and translate into higher abundances of fish.

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Table 1. Four major stream habitat template categories and the habitat attributes chosen to represent each category.

Habitat Category	Habitat Attribute
Stream Morphology	Channel Gradient (%)
	Percent secondary channel area
Pool Habitat	Percent pool habitat
	Density of deep pools (>1 m)
Substrate Composition	Percent sand and organics (fines)
	Percent gravel
	Percent fines in riffle habitat types
	Percent gravel in riffle habitat types
Instream Wood	Density of wood pieces
	Wood volume
Riparian Structure	Density of large (>50cm dbh) riparian conifers
	Density of very large (>90cm dbh) riparian conifers
	Percent channel shading

Table 2a. Description of coastal reference sites in streams with low impact from human activities. A total of 124 sites, surveyed between 1992 and 2003, were selected within the Oregon Coastal Coho ESU and the South Coast in the Southern Oregon Northern California ESU to represent conditions within the range of coho salmon.

Habitat 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 Lands
Ecoregion		
	Coastal	80%
	Cascades	20%
Geology		
	Sedimentary	72%
	Volcanic	21%
	Mixed	7%

Table 2b. Habitat breakpoints for the Oregon coastal basins based on reference streams within the distribution of coho salmon.

Parameter	Definition	Low Break Pt	High Break Pt
Percent Pools	Percent primary channel area represented by pool habitat	<19%	>45%
Deep Pool/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 Secondary Channels	Percent total channel area represented by secondary channels	<0.8%	>5.3%
Pieces LWD/100m	No. pieces of wood > 0.15m diameter X 3m length per 100 meters primary stream length	<8	>21
Volume of LWD/100m	Volume (m3) of wood > 0.15m diameter X 3m length per 100 meters primary stream length	<17	>58
Percent Fines in Riffles	Visual estimate of substrate composed of <2mm diameter particles	<0.5	>3
Percent Gravel in Riffles	Visual estimate of substrate composed of 2-64mm diameter particles	<8%	>22%
Percent Bedrock in Stream	Visual estimate of substrate composed of solid bedrock	>1%	>11%
No. Conifers >50 cm dbh	No. of conifer trees larger than 50 cm dbh within 30m both sides of stream per 305m of primary stream length	<22	>153
No. Conifers >90 cm dbh	No. 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 3. The coho salmon habitat criteria on which the HabRate model (Burke et al. 2001) rates habitat quality as good, fair or poor.

	Good	Fair	Poor
Spawning, egg survival, emergence			
Fines (%)	≤ 10	10 to ≤ 30	> 30
Gravel (%)	≥ 30	≥ 15 to 30	< 15
Cobble (%)	≥ 10 to ≤ 40	40 to ≤ 60	> 10 and > 60
Residual Pool Depth (m)	≥ 0.2		< 0.2
Gradient (%)	≤ 6		> 6
Pool Area (% pools)	≥ 40 to ≤ 60	≥ 20 to < 40	< 20 and > 60
Summer Rearing 0+			
Fines (%)	≤ 10	10 to 30	> 30
Gravel (%)	≥ 15	≥ 5 to 15	< 5
Cobble and boulder (%)	≥ 15	≥ 8 to 15	< 8
Pool Area (% pools)	≥ 40 to ≤ 60	≥ 20 to 40	< 20 and > 60
Pool complexity	3	2	1
Additional Cover			
% undercut	≥ 15	≥ 10 to 15	< 10
LWD / 100m	≥ 20	≥ 10 to 20	< 10
Boulders / 100m	≥ 20	≥ 5 to 20	< 5
Gradient (%)	≤ 5		> 5

Table 3. Continued.

	Good	**Fair**	**Poor**
Overwintering 0+			
Fines (%)	≤ 10	10 to ≤ 30	> 30
Cobble and boulder (%)	≥ 25	≥ 10 to 25	< 10
Pool Area (% pools)	≥ 40 to ≤ 80	≥ 20 to 40	< 20 and > 80
Pool complexity	3	2	1
Additional Cover			
% undercut	≥ 20	≥ 10 to 20	< 10
LWD / 100m	≥ 20	≥ 10 to 20	< 10
Boulders / 100m	≥ 20	≥ 5 to 20	< 5
Sheltered Pools	≥ 15	5 to < 10	< 5
Gradient	≤ 5		> 5
Pool Complexity (summer and winter)			
Average Reach Attributes			
Depth (min. at summer flow)			
≤ 10m wetted width	> 0.5	≥ 1	> 0.5
> 10m wetted width	> 0.9	≤ 1 to ≥ 1	> 0.5
LWD			
Keypieces of LWD / 100m	≥ 2	≥ 1 to 2	
Pieces of LWD / 100m	≥ 20	> 7	≤ 7

Table 4. Total number of sites pulled in the annual draw and the total number of sites completed and not completed in 2005 by monitoring area. Non-target sites are sites not surveyed due to GIS cover error, tidal areas, or small watershed area (upstream catchment must be <0.6 km^2). Target sites not surveyed due to landowner denial, lack of time, or dangerous conditions.

Monitoring Area	Total Sites Pulled		Surveyed	Not-surveyed
North Coast	52			
		Target	38	8
		Non-target	0	6
Mid-Coast	53			
		Target	47	2
		Non-target	0	4
Mid-South	55			
		Target	42	5
		Non-target	0	8
Umpqua	49			
		Target	36	5
		Non-target	0	8
South Coast	56			
		Target	44	10
		Non-target	0	2
Grand Total	265		207	58

Table 5. Habitat metric summary at survey sites where coho salmon were found in 2005 outside of their current distribution.

Monitoring Area	Watershed Area (km)	Secondary Channel Area (%)	Gradient	Active Channel Width	Channel Shade (%)	Pool Habitat (%)	Pools >1m Depth	Riffle Fines (%)	Riffle Gravel (%)	Wood Pieces /100m	Wood Volume /100m	Conifers (>50cm dbh)	Conifers (>90cm dbh)
North Coast	10.3	3.7	3.1	6.4	83.3	18.4	1.2	0.0	0.0	10.7	9.2	41	0
North Coast	4.2	2.0	3.3	6.7	85.4	12.4	0.0	0.0	0.0	8.7	4.6	0	0
Mid-Coast	1.6	17.2	5.9	5.7	93.5	5.2	0.0	18.1	72.7	34.1	39.4	224	0
Mid-Coast	1.0	2.3	7.4	3.9	85.2	0.4	0.0	11.3	53.8	15.7	22.9	81	0
Mid-Coast	0.9	0.0	2.1	2.3	94.2	28.4	0.0	43.4	38.8	12.1	7.2	81	41
Mid-South	7.3	14.0	5.5	6.0	94.5	26.3	0.0	18.6	25.7	13.9	10.5	41	0
Mid-South	2.6	3.0	8.0	3.4	86.1	10.1	0.0	35.0	60.0	26.1	41.8	61	41
Mid-South	6.9	7.7	2.7	7.7	98.1	35.0	3.3	10.8	44.7	10.3	6.6	0	0
Mid-South	2.8	3.2	0.4	4.3	82.1	80.6	1.3	69.4	26.9	14.4	7.3	20	20
Mid-South	1.8	1.8	2.4	2.0	91.5	16.9	0.0	21.7	72.4	10.8	5.9	0	0
Umpqua	8.5	0.0	1.8	6.5	89.0	46.7	3.8	9.2	35.4	10.9	10.2	284	142
Umpqua	2.2	2.6	2.4	4.9	86.1	35.0	0.0	23.6	43.1	35.0	75.2	224	20
South Coast	4.8	0.0	3.7	6.7	93.0	34.0	3.9	5.0	55.0	5.7	13.4	81	61

Table 6. Signal to noise ratio for all monitoring areas in 2005. A total of 209 surveys were completed with 25 (11%) resurveys across all monitoring areas.

Attribute	Standard Deviation (rep)	CV	S:N	Standard Deviation (Total)	Variance (Total)	Mean (Total)	Mean Variance (rep)	Site	Residual
Channel Length	44.35	5.79	34.71	261.30	68276.88	765.83	1966.83	97%	3%
Active Channel Width	1.03	15.46	34.02	6.03	36.34	6.69	1.07	97%	3%
Gradient	1.34	24.44	23.74	6.51	42.37	5.47	1.78	96%	4%
Wetted Width	0.65	18.09	20.59	2.96	8.76	3.61	0.43	95%	5%
Pool Habitat (%)	6.02	19.04	20.43	27.20	739.97	31.61	36.22	95%	5%
Wood Volume	4.58	27.88	16.04	18.34	336.44	16.43	20.98	94%	6%
Floodprone Width	2.50	24.74	13.53	9.18	84.33	10.09	6.23	93%	7%
Slackwater Pools (%)	5.59	77.80	12.43	19.72	388.92	7.19	31.29	92%	8%
Wood Volume(log)	0.14	13.30	11.30	0.46	0.21	1.03	0.02	91%	9%
Fine Sediments (%)	7.51	24.69	10.79	24.68	609.09	30.43	56.44	91%	9%
Key LWD Pieces	0.35	60.91	7.06	0.93	0.86	0.57	0.12	86%	14%
Channel Shade (%)	6.92	8.96	6.57	17.75	314.98	77.26	47.96	85%	15%
Density of Wood Pieces	4.49	32.93	5.88	10.89	118.60	13.64	20.18	83%	17%
Density of Wood Pieces(log)	0.16	15.03	5.20	0.36	0.13	1.04	0.02	81%	19%
Secondary Channel Length	58.74	89.24	5.12	132.95	17675.90	65.82	3450.01	80%	20%
Pools >1m Deep	1.27	83.18	3.48	2.36	5.58	1.52	1.60	71%	29%
Gravel Substrates (%)	8.36	28.13	3.17	14.87	221.22	29.70	69.84	68%	32%
Secondary Channel Area (%)	3.98	102.44	2.69	6.52	42.48	3.88	15.81	63%	37%
Active Channel Height	0.17	35.96	2.53	0.27	0.07	0.46	0.03	60%	40%
Floodprone Height	0.33	35.96	2.53	0.53	0.28	0.93	0.11	60%	40%
Fines in Riffles	18.36	63.15	1.78	24.50	600.36	29.08	337.24	44%	56%
Residual Pool Depth	0.24	46.07	1.52	0.29	0.08	0.51	0.06	34%	66%
Gravel in Riffles	17.12	41.86	1.22	18.92	357.91	40.90	293.10	18%	82%

Table 7. Comparison of average values by monitoring area (MA) for select habitat attributes in 2005. Means and standard deviations for all data, within the range of coho, and outside the range of coho (habitat only sites) are displayed.

		Coho Range		Outside Coho Range	
Habitat Attribute	MA	n	Mean (SD)	n	Mean (SD)
Pool habitat (%)	North Coast	23	32.08(22.38)	15	19.27(26.89)
	Mid-Coast	30	52.93(27.46)	17	31.61(30.32)
	Mid-South	19	54.25(30.83)	23	26.59(19.22)
	Umpqua	15	43.31(25.28)	21	15.73(16.56)
	South Coast	9	25.26(9.94)	37	16.30(19.06)
	All MA	*96*	*44.10(27.25)*	*113*	*20.99(22.28)*
Fine Sediments (%)	North Coast	23	24.50(26.46)	15	22.91(23.58)
	Mid-Coast	30	35.89(27.13)	17	37.19(28.51)
	Mid-South	19	46.57(26.60)	23	32.87(23.94)
	Umpqua	15	21.96(10.78)	21	26.54(25.03)
	South Coast	9	15.76(7.25)	37	29.01(19.95)
	All MA	*96*	*31.21(25.99)*	*113*	*29.76(23.60)*
Gravel Substrates (%)	North Coast	23	34.14(17.53)	15	31.49(14.92)
	Mid-Coast	30	31.46(17.46)	17	30.57(16.64)
	Mid-South	19	26.35(17.26)	23	29.67(13.23)
	Umpqua	15	32.30(15.33)	21	31.75(14.68)
	South Coast	9	29.15(7.62)	37	24.04(9.66)
	All MA	*96*	*31.00(16.36)*	*113*	*28.59(13.45)*
Density of wood pieces	North Coast	23	12.30(7.69)	15	22.38(13.85)
	Mid-Coast	30	13.50(9.40)	17	19.56(14.71)
	Mid-South	19	8.79(6.2)	23	18.91(13.27)
	Umpqua	15	8.64(8.02)	21	18.49(9.26)
	South Coast	9	8.73(7.75)	37	7.61(6.93)
	All MA	*96*	*11.07(8.20)*	*113*	*15.69(12.40)*
Channel Shading (%)	North Coast	23	67.46(17.56)	15	71.69(17.58)
	Mid-Coast	30	77.18(15.04)	17	78.33(14.04)
	Mid-South	19	70.55(24.34)	23	87.51(13.00)
	Umpqua	15	77.68(16.12)	21	87.97(5.76)
	South Coast	9	70.47(26.57)	37	77.60(17.77)
	All MA	*96*	*72.99(19.20)*	*113*	*80.87(15.59)*

Table 7 continued. Comparison of average values by monitoring area (MA) for select habitat attributes in 2005. Means and standard deviations for all data, within the range of coho, and outside the range of coho (habitat only sites) are displayed.

		Coho Range		Outside Coho Range	
Habitat Attribute	MA	n	Mean (SD)	n	Mean (SD)
ACW (m)	North Coast	23	5.69 (3.30)	15	9.14 (6.41)
	Mid-Coast	30	5.75 (6.77)	17	6.98 (4.49)
	Mid-South	19	4.60 (3.15)	23	9.92 (8.52)
	Umpqua	15	3.48 (2.17)	21	8.72 (7.25)
	South Coast	9	5.07 (6.32)	37	12.00 (5.91)
	All MA	*96*	*4.87 (4.92)*	*113*	*8.83 (6.52)*

Table 8. Results of the analysis of variance (ANOVA) comparing differences in individual habitat metric mean values among monitoring areas. Least square means used. Independent variable in all analyses was the monitoring area.

Dependent Variable	MS Error	F-Value/Pr > F	LS Means Differences
Pool Habitat (%)	5251.92	8.06/<0.0001	MC different from NC, UMP, SC; SC different from MC, MS
Deep Pools (>1 m/100m)	1.79	0.32/0.8655	No difference
Gravel Substrates (%)	454.65	2.10/0.0823	No difference
Fine Sediments (%)	2092.03	3.61/0.0073	MS different from NC
Wood Pieces (no./100m)	513.77	4.62/0.0014	SC different from all monitoring areas
Wood Volume (m3/100m)	389.97	1.16/0.3284	No difference
Channel Shade (%)	1083.80	3.61/0.0072	NC different from MC, UMP
Conifers >20 cm DBH	44897.46	9.75/<0.0001	UMP different from all monitoring areas
Conifers >36 cm DBH	1981.99	3.78/0.0055	UMP different from NC, MC
Active Channel Width (m)	22.92	0.63/0.6443	No difference

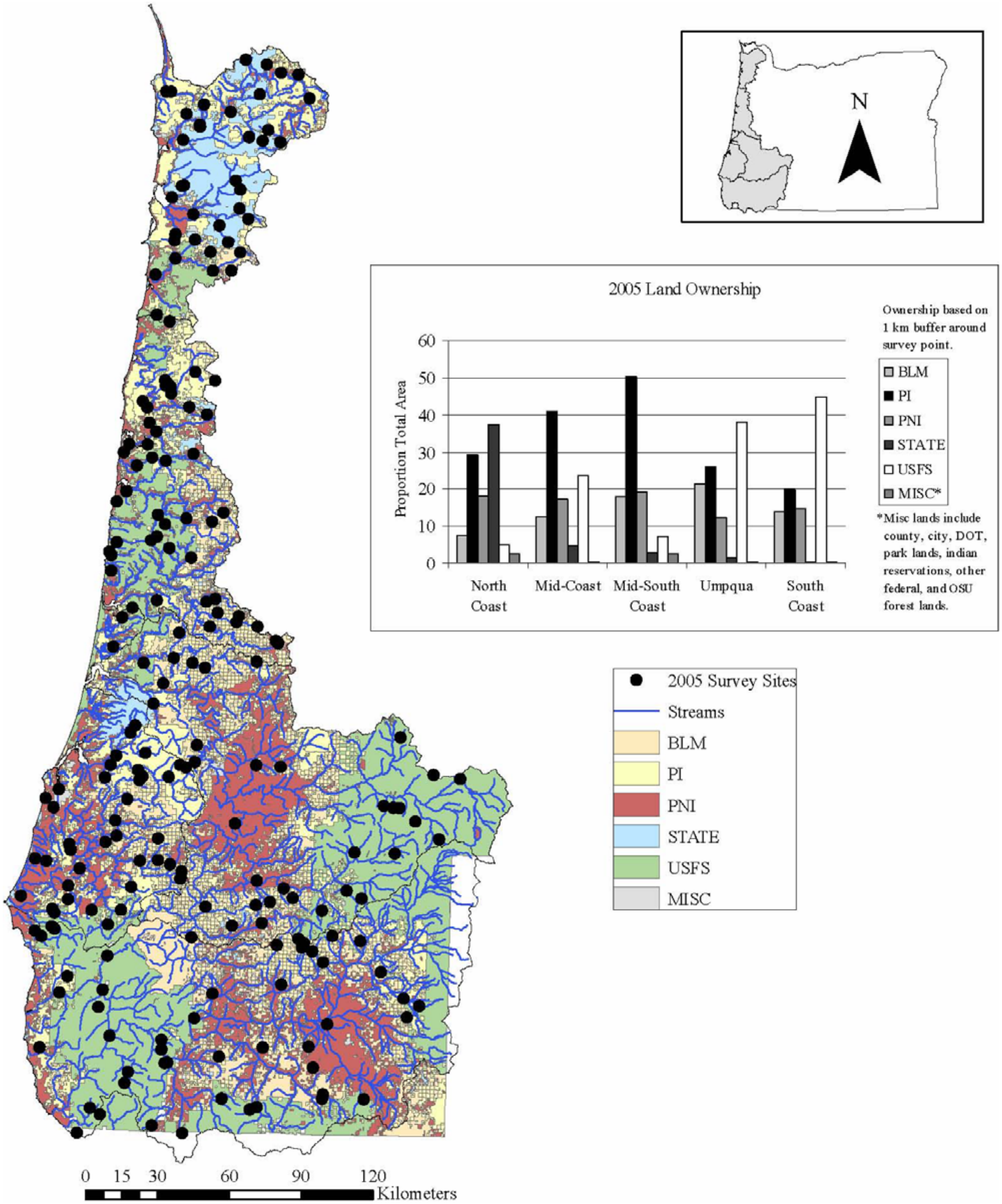


Figure 1. 2005 Oregon plan habitat survey sites. Spatial land ownership and monitoring area boundaries (a) and the proportion of the total area associated with each land owner (b). BLM=Bureau of Land Management, PI=Private Industrial, PNI=Private Non-Industrial, STATE=State, USFS=U.S. Forest Service, MISC=Miscellaneous ownership

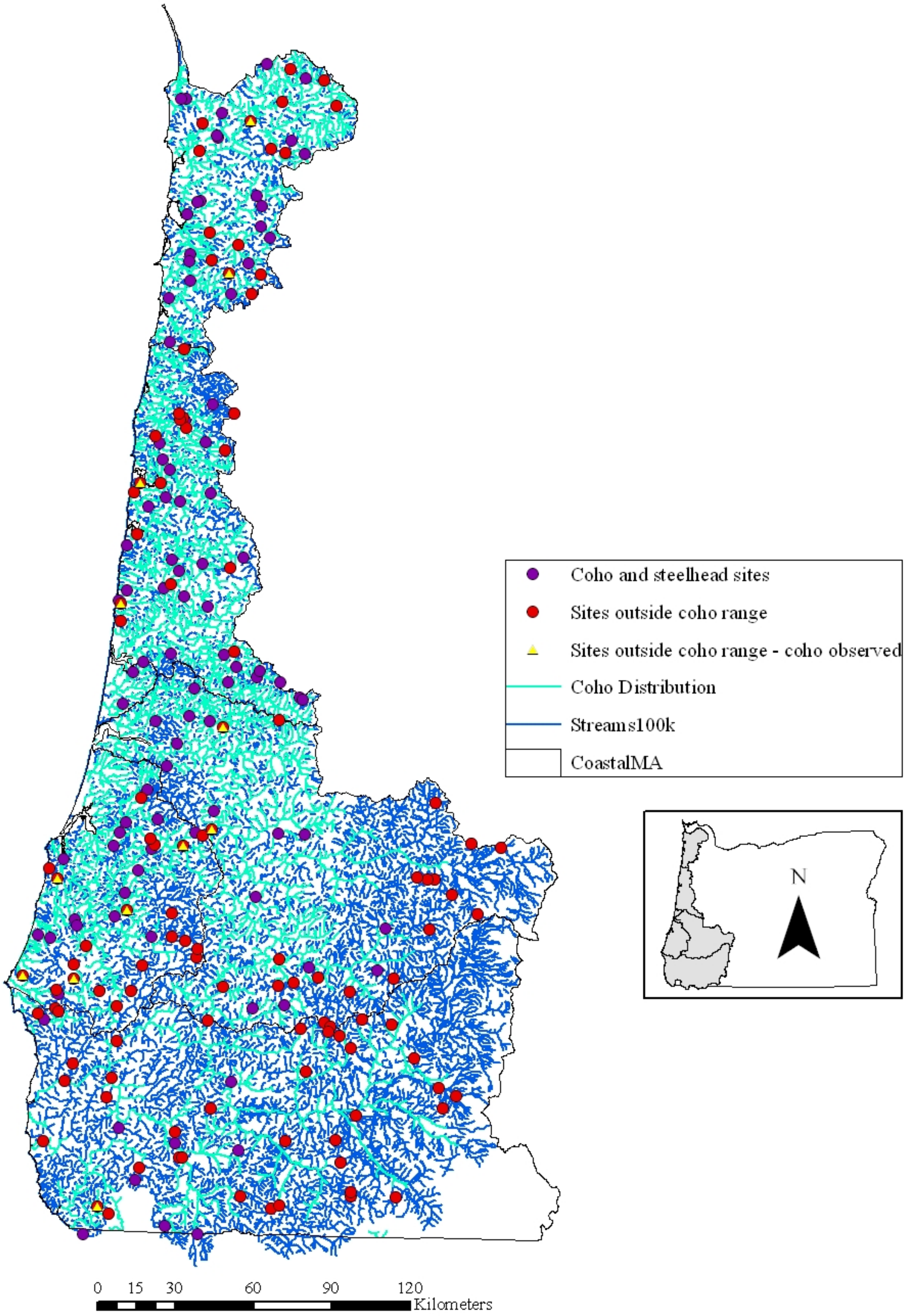


Figure 2. 2005 Oregon plan habitat survey sites within the range of coho salmon and steelhead, outside the range of coho salmon, and sites outside the range of coho where coho were observed.

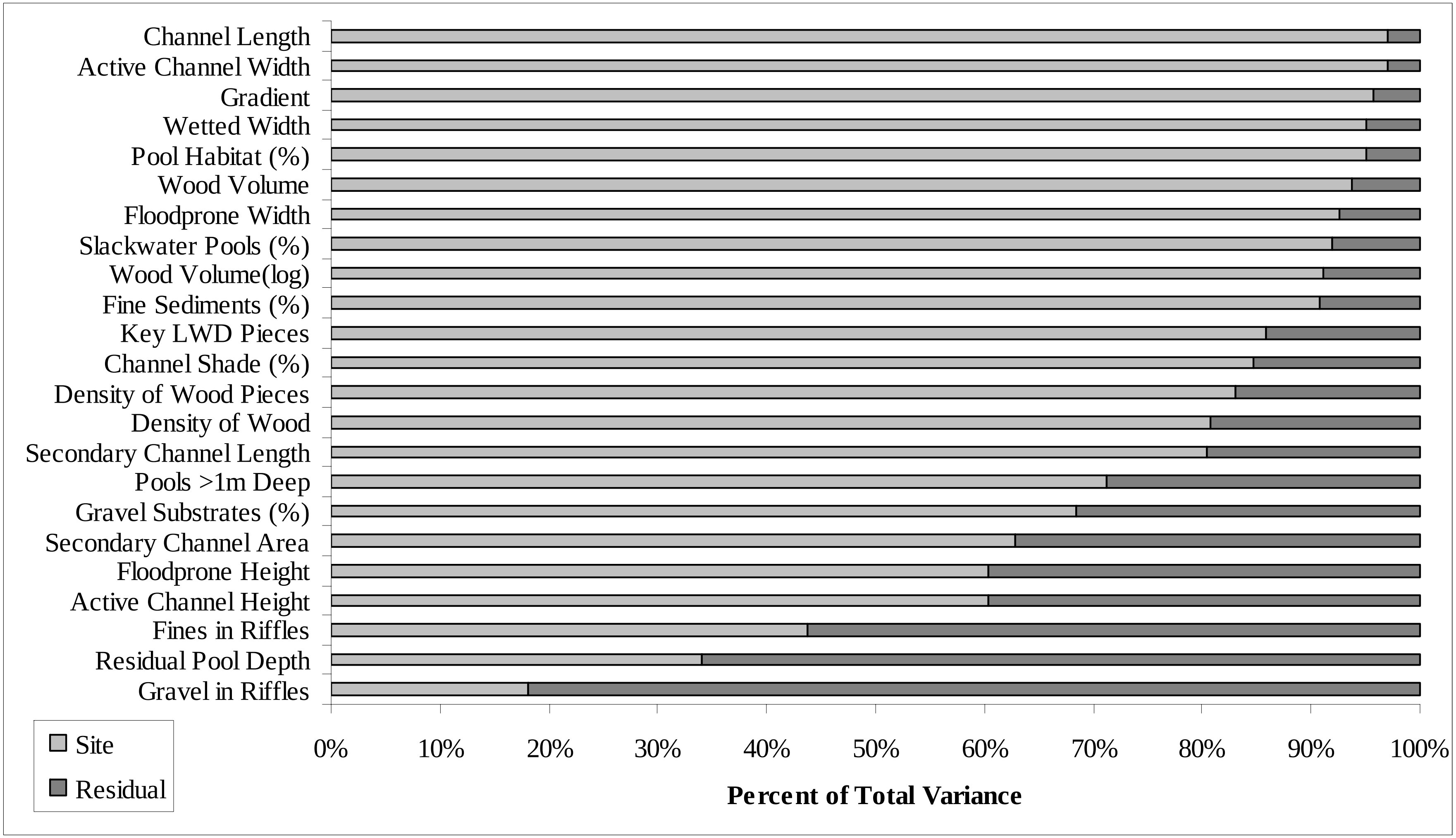
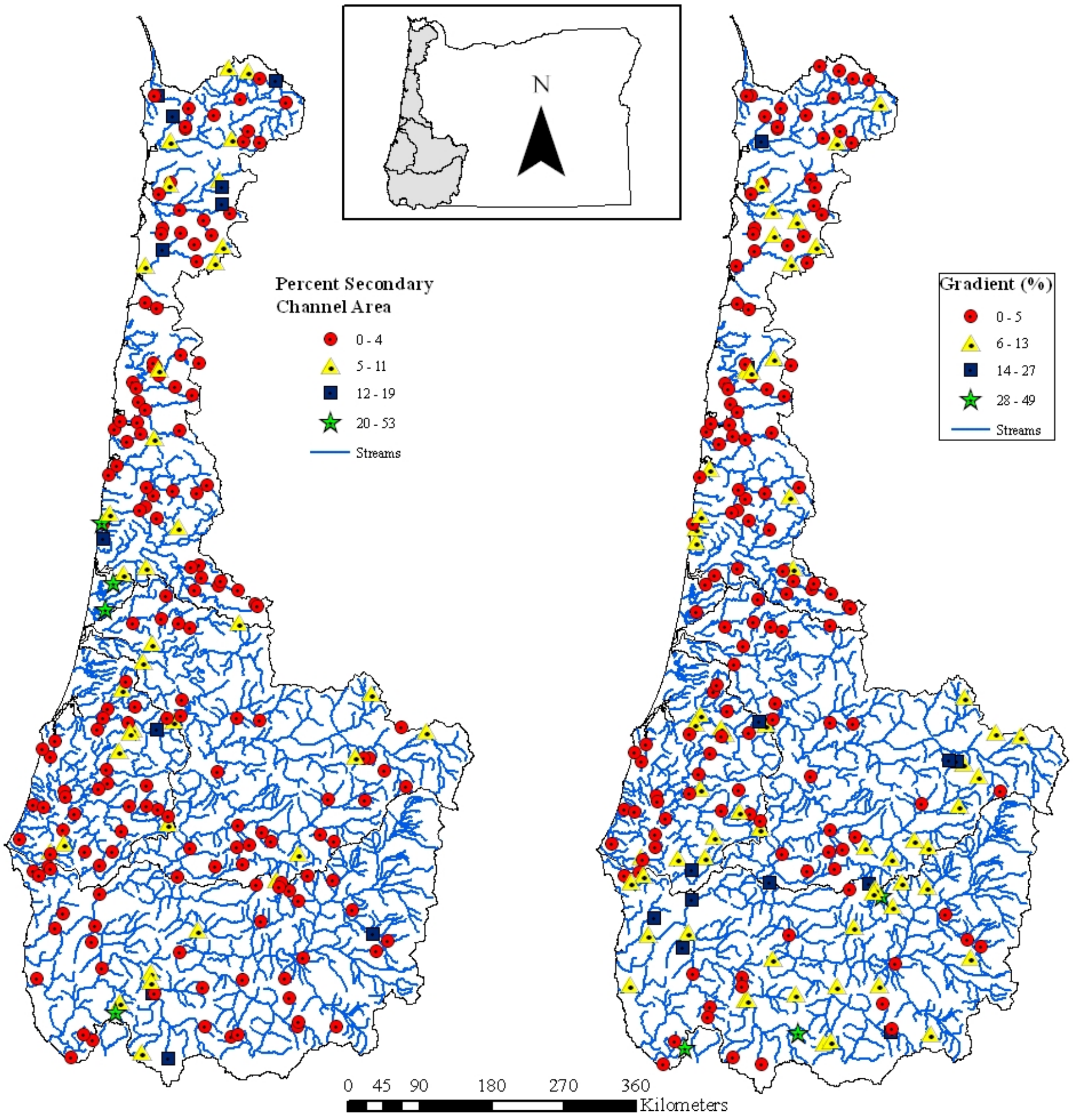


Figure 3. Signal (site variation) to noise (residual variation) ratio for all monitoring areas in 2005. A total of 209 surveys were completed with 25 (11%) resurveys across all monitoring areas.



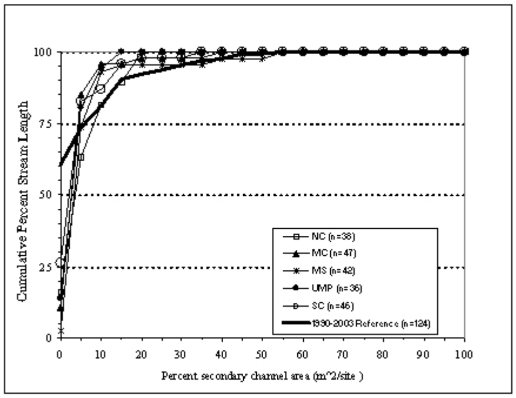


Figure 4. Spatial distribution of secondary channel area (%) (a) and cumulative distribution frequency comparing secondary channel area to reference conditions (b).

Figure 5. Spatial distribution of channel gradient.

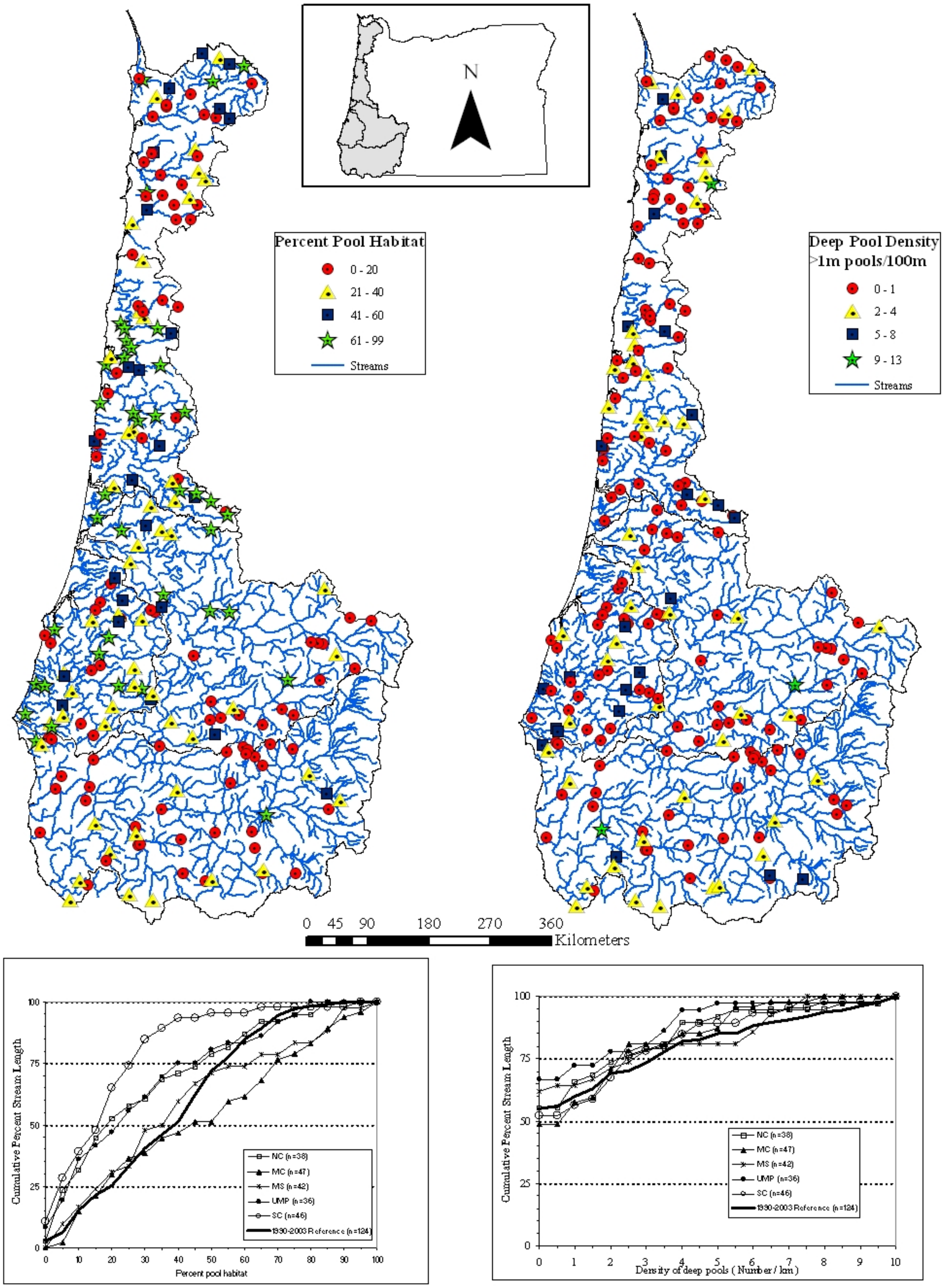
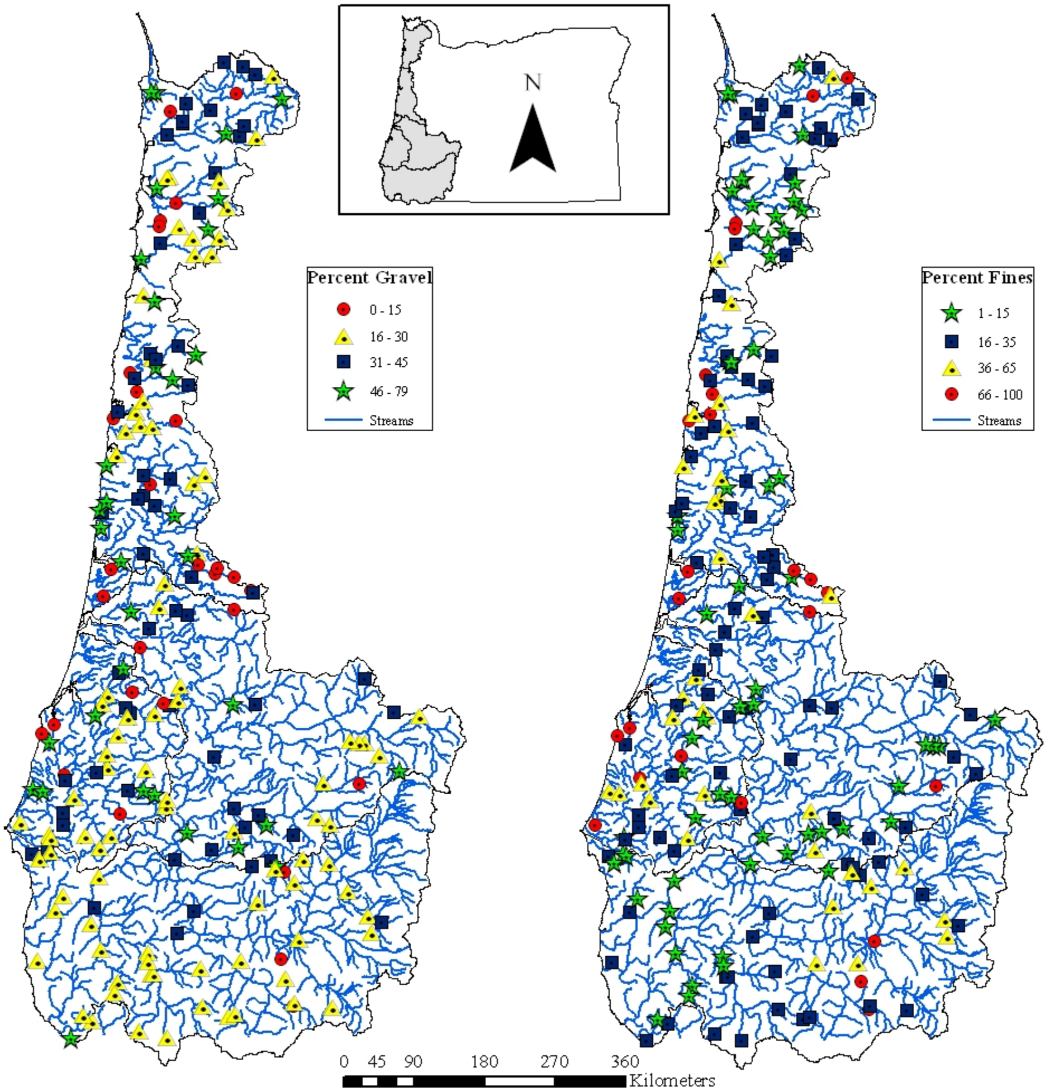
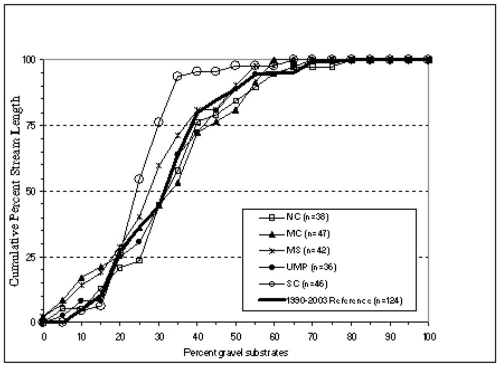


Figure 6. Spatial distribution of pool habitat (%) (a) and the cumulative distribution frequency comparing pool habitat to reference conditions (b).

Figure 7. Spatial distribution of deep pool density (a) and the cumulative distribution frequency comparing deep pool density to reference conditions (b).





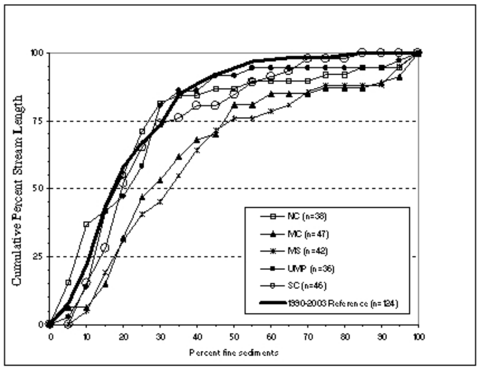


Figure 8. Spatial distribution of gravel substrates (%) (a) and the cumulative distribution frequency comparing gravel substrates to reference conditions (b).

Figure 9. Spatial distribution of fine sediments (%) (a) and the cumulative distribution frequency comparing fine sediments to reference conditions (b).

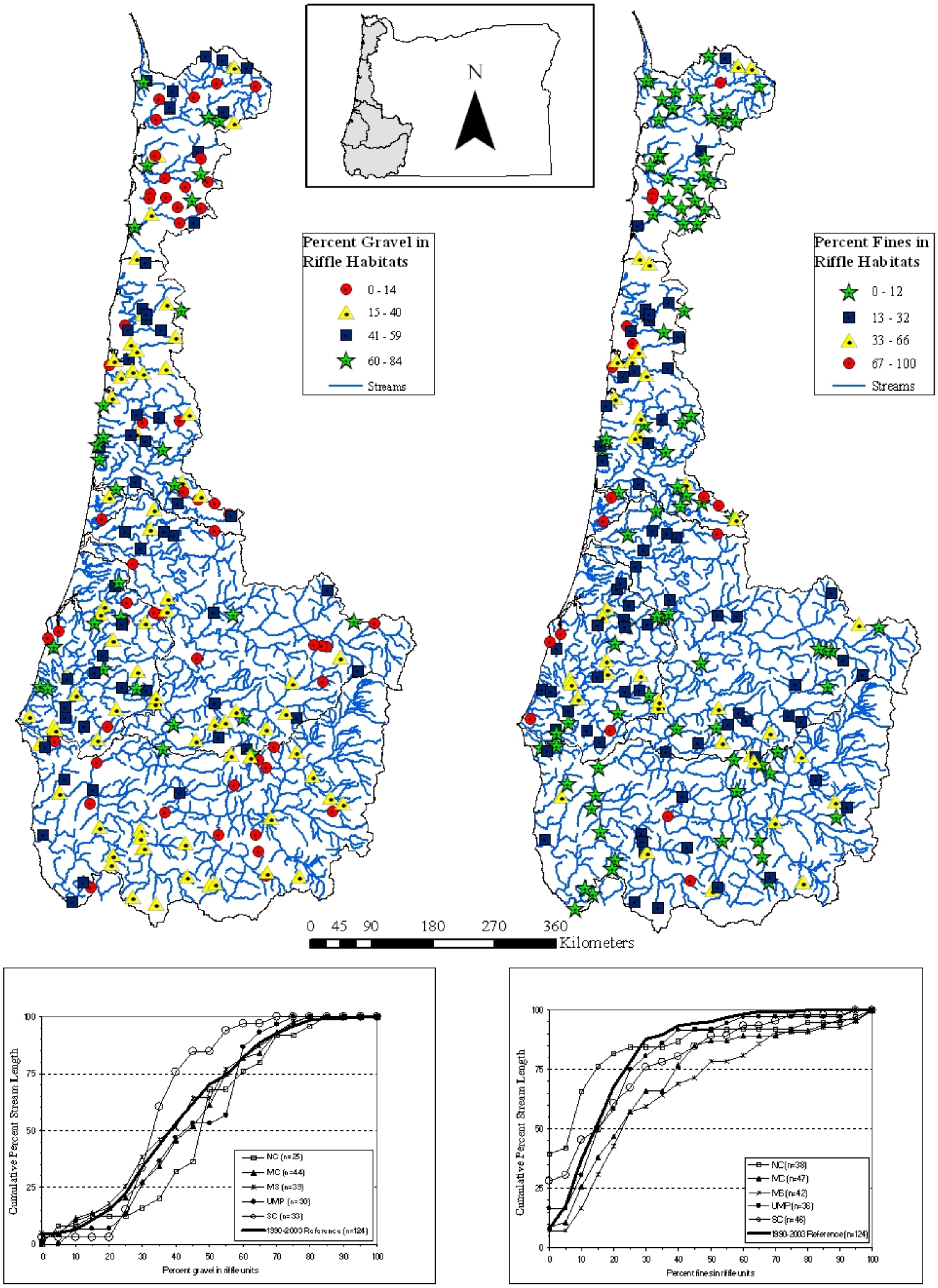
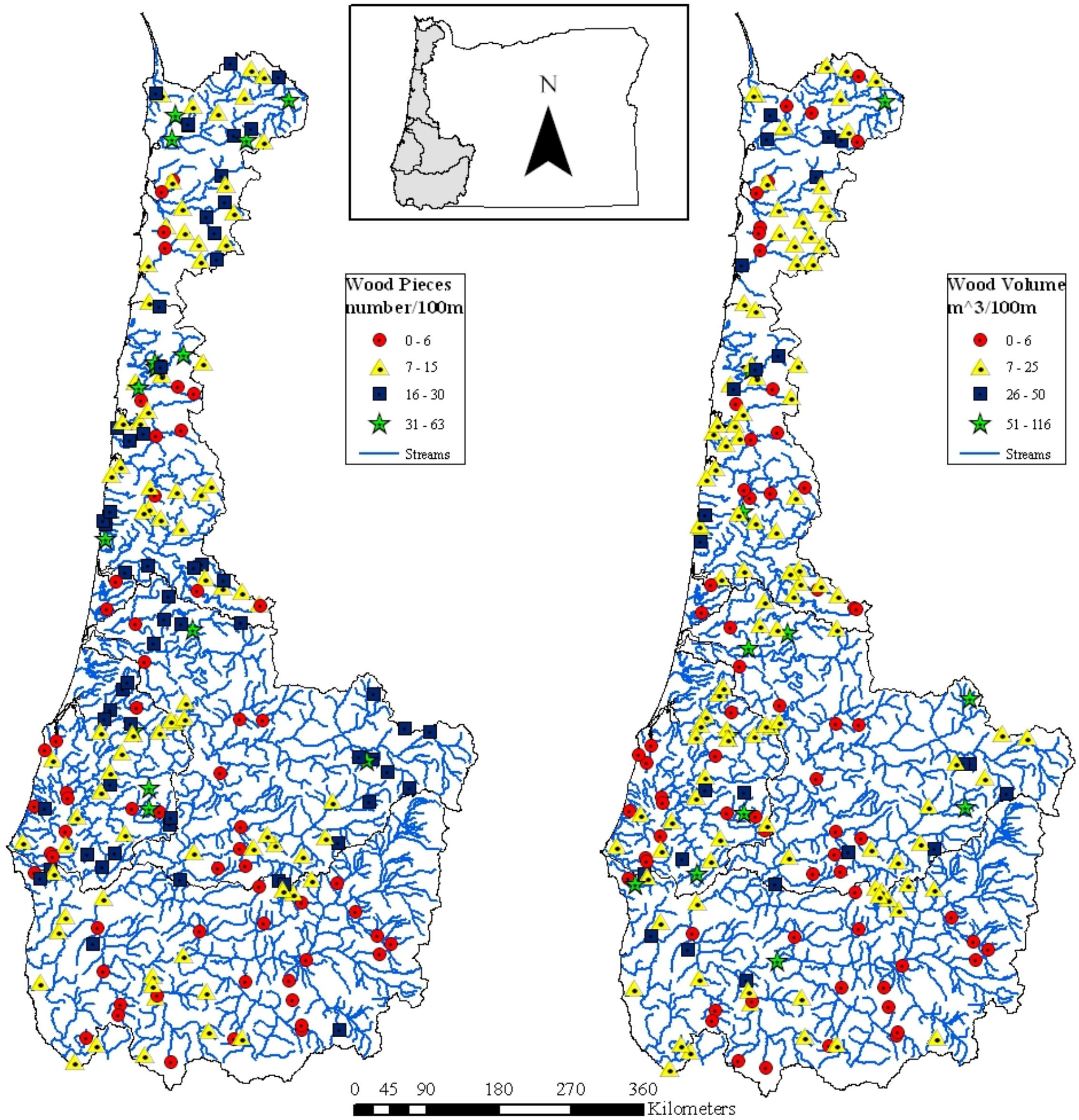
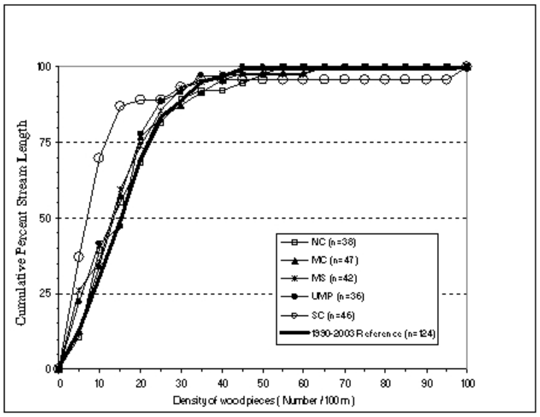


Figure 10. Spatial distribution of gravel substrates (%) in riffle habitats (a) and the cumulative distribution frequency comparing gravel substrates in riffle habitats to reference conditions (b).

Figure 11. Spatial distribution of fine sediments (%) in riffle habitats (a) and the cumulative distribution frequency comparing fine sediments in riffle habitat to reference conditions (b).





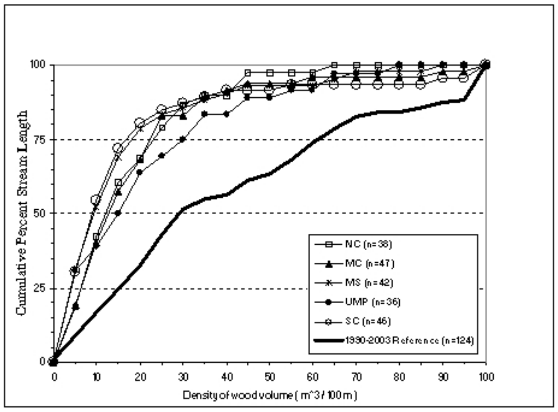
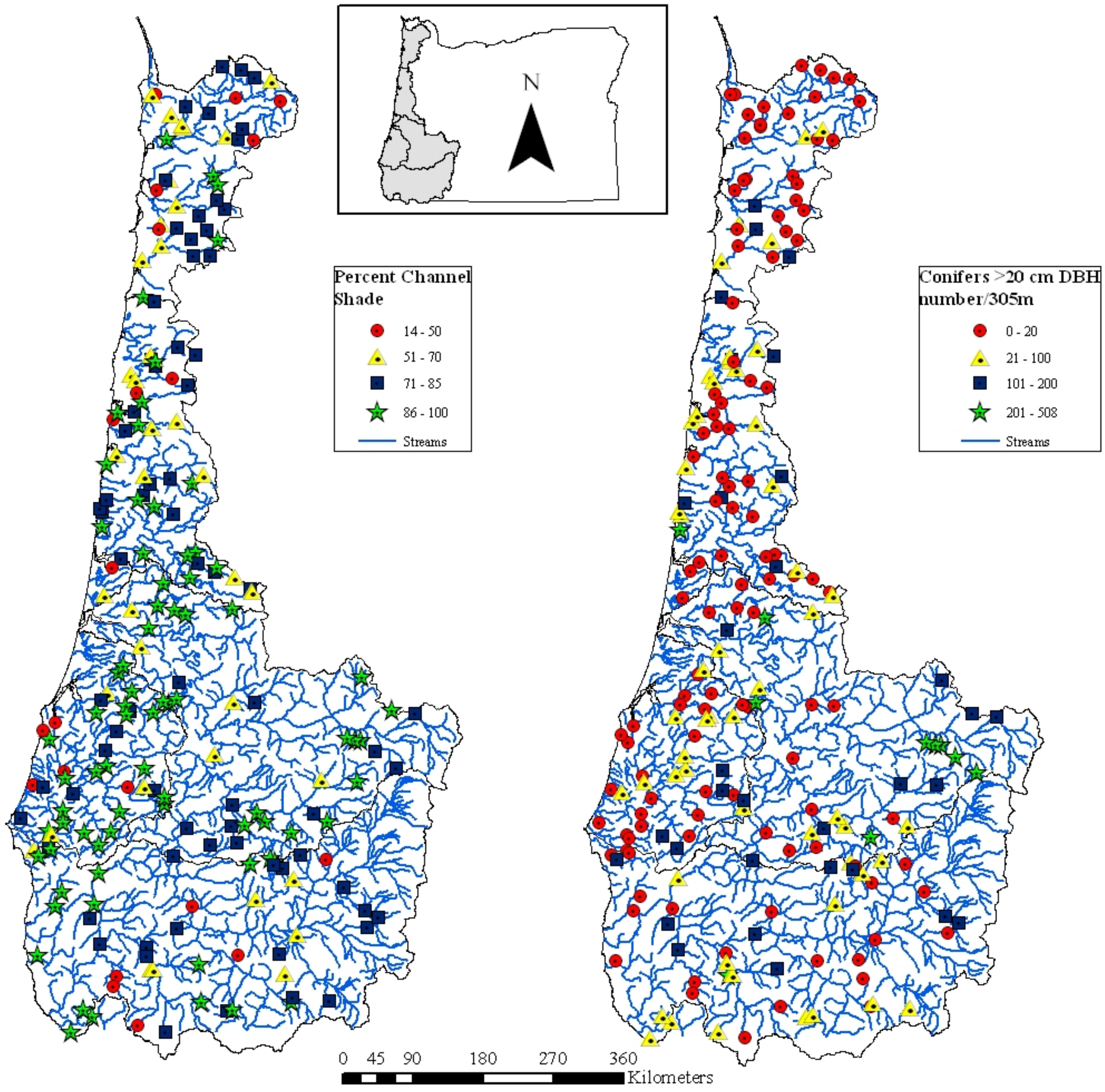
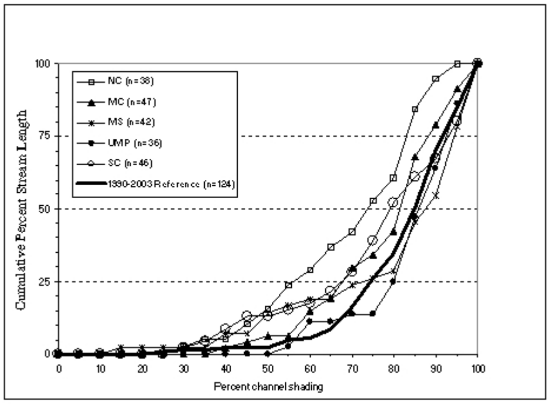


Figure 12. Spatial distribution of wood piece density (a) and the cumulative distribution frequency of wood piece density compared to reference conditions (b).

Figure 13. Spatial distribution of wood volume (a) and the cumulative distribution frequency of wood volume density compared to reference conditions (b).





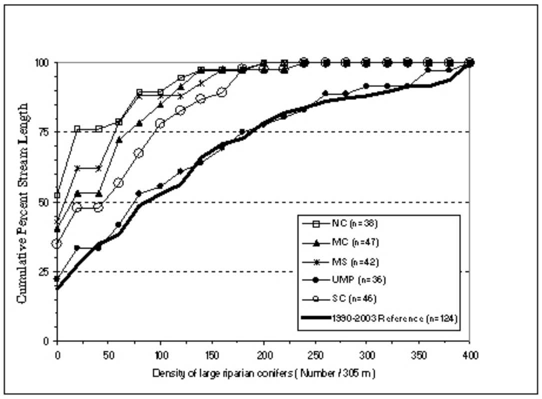


Figure 14. Spatial distribution of channel shading (%) (a) and the cumulative distribution frequency of channel shade compared to reference conditions (b).

Figure 15. Spatial distribution of large riparian conifer density (a) and the cumulative distribution frequency comparing large riparian conifer density to reference conditions (b).

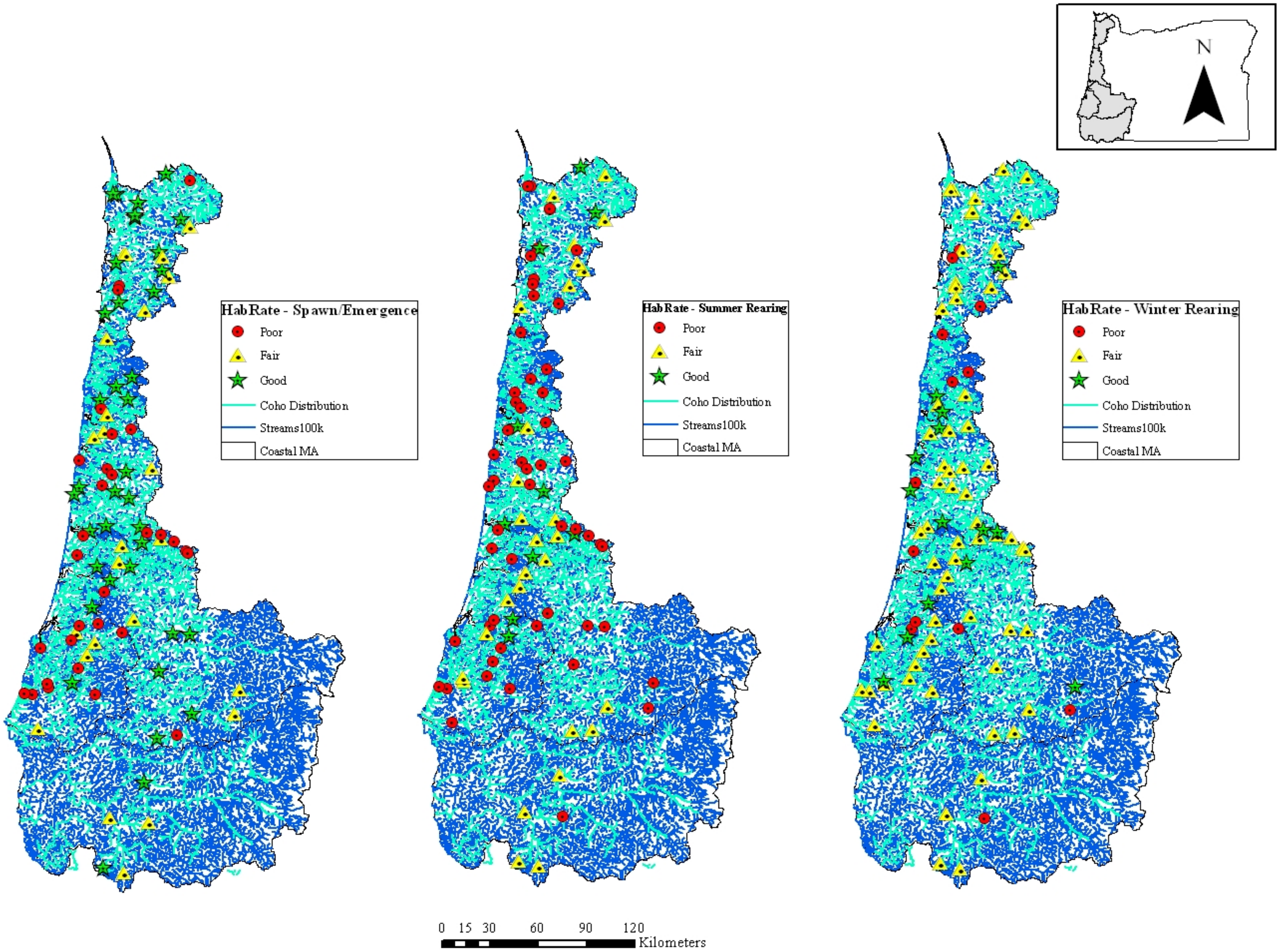


Figure 16. Spatial distribution of good, fair, or poor habitat quality ratings assigned by the HabRate model (Burke et al. 2001) across all monitoring areas within the distribution of coho salmon for (a) spawning and emergence habitat, (b) summer habitat for 0+ coho salmon, and (c) winter habitat for 0+ coho salmon.

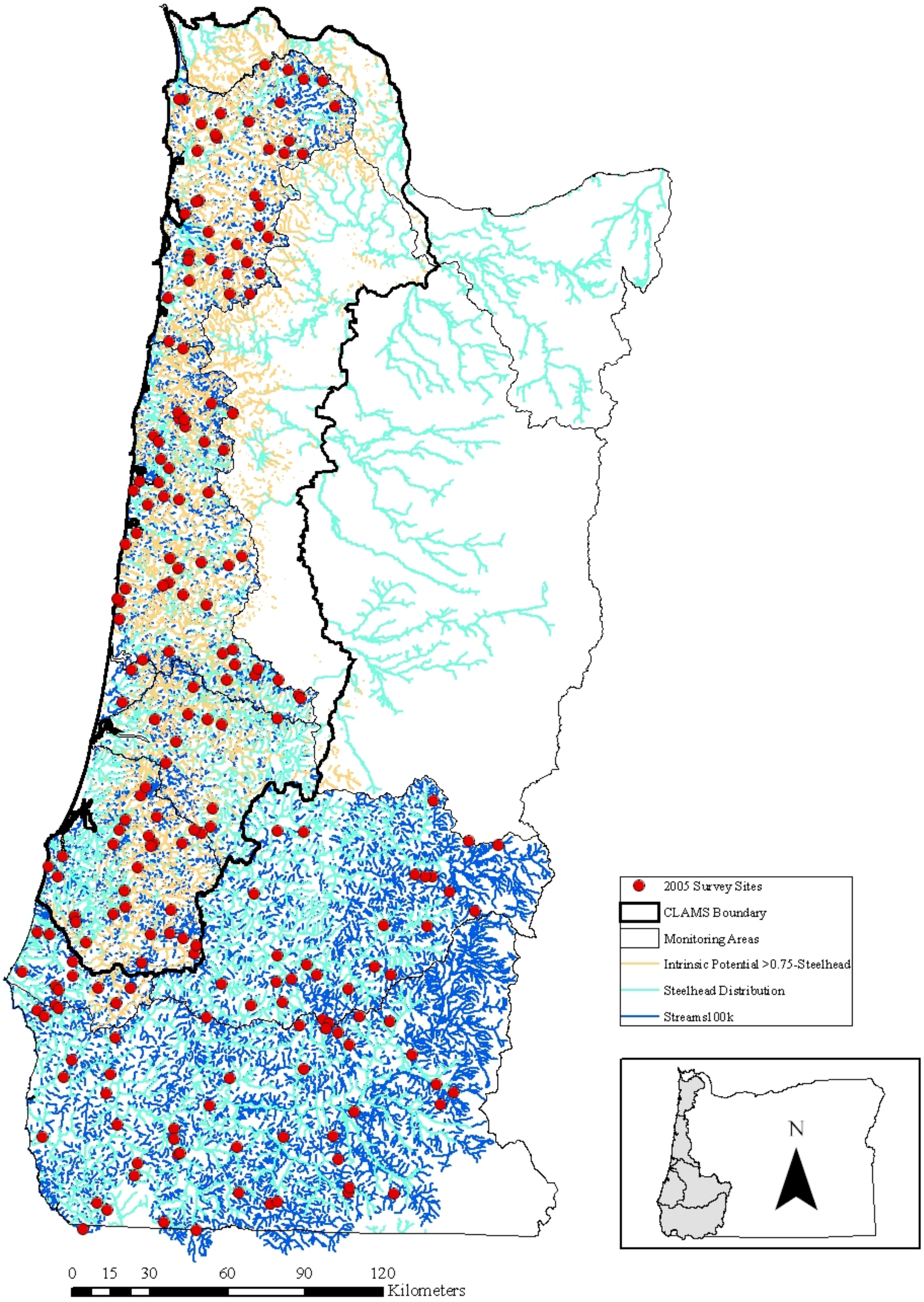


Figure 17. Spatial distribution of 2005 Oregon plan habitat survey sites relative to steelhead (summer and winter) distribution and high intrinsic potential (Burnett et al 2006) for steelhead within the CLAMS boundary.

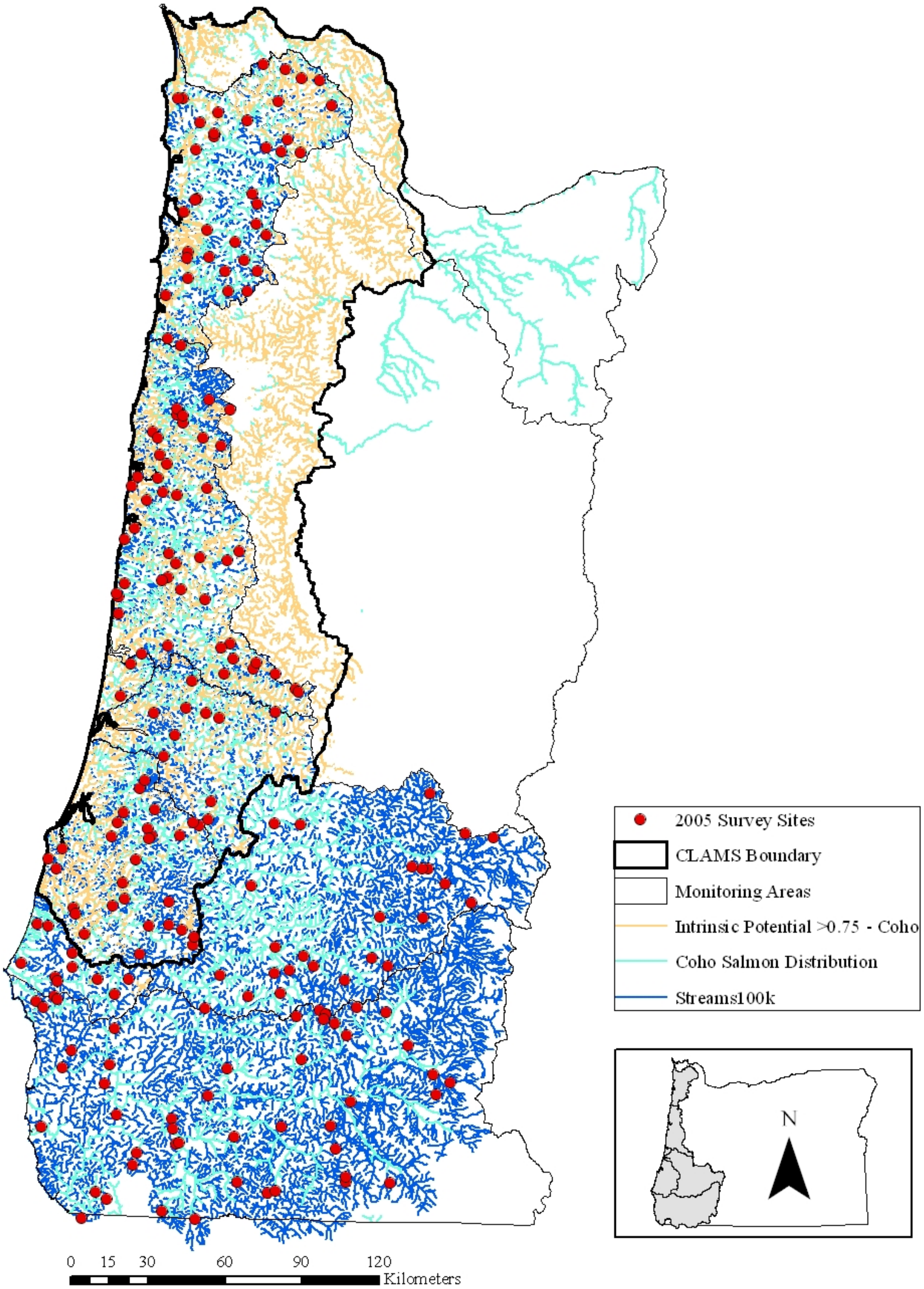


Figure 18. Spatial distribution of 2005 Oregon plan habitat survey sites relative to coho salmon distribution and high intrinsic potential (Burnett et al. 2006) for coho within the CLAMS boundary.

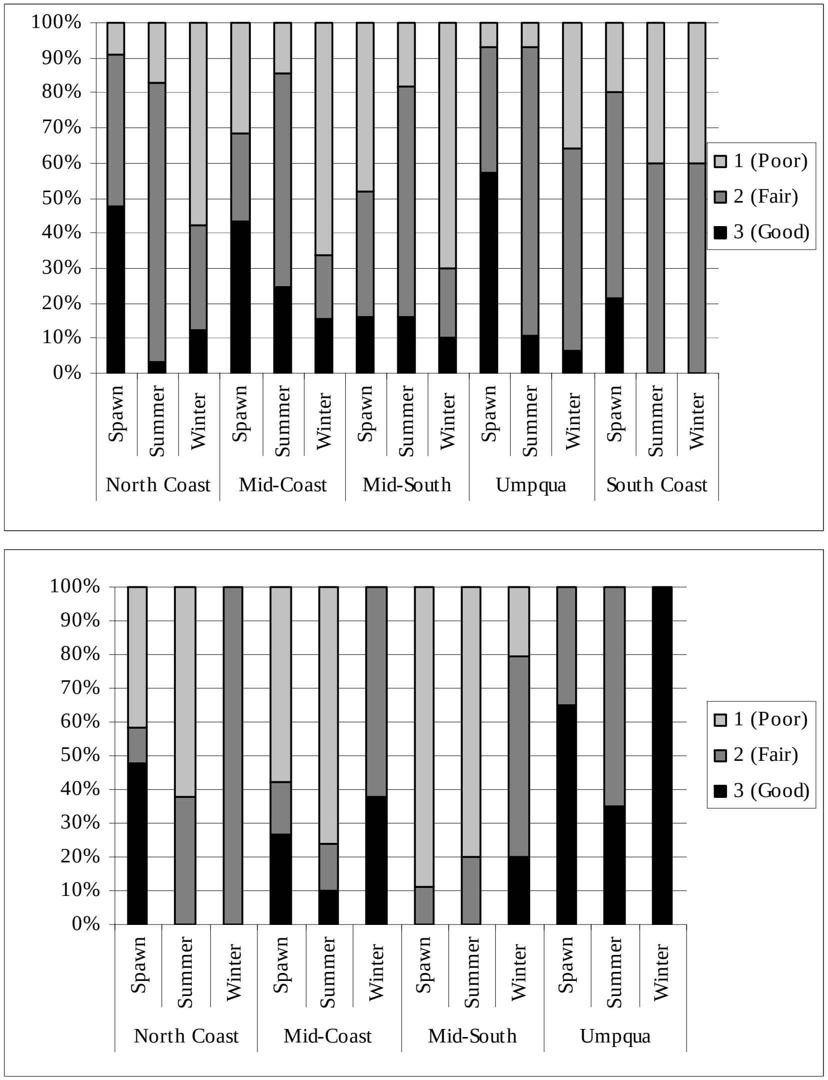


Figure 19. The overall quality of stream habitat by monitoring area and life stage of coho salmon as assessed by the HabRate model (Burke et al. 2001): (upper) within the distribution of coho salmon (n=92) and (lower) within the distribution of coho salmon designated with high intrinsic potential (>0.75) (Burnett et al. 2006) (n=37).

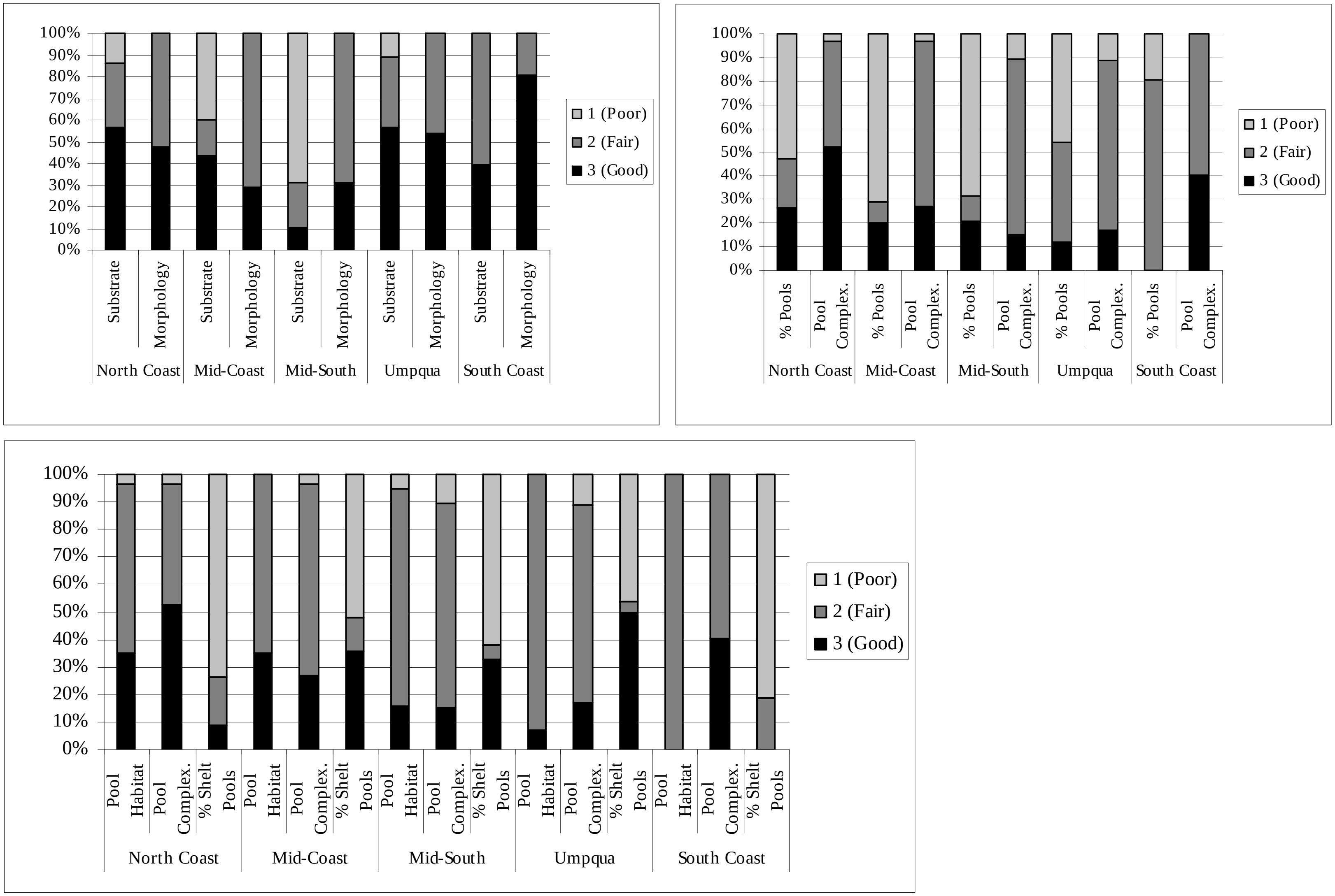


Figure 20. The quality of stream habitat within the distribution of coho salmon, as assessed by the HabRate model (Burke et al. 2001). Habitat ratings for specific attributes associated with the spawning/emergence (upper left), summer 0+ (upper right), and winter 0+ (lower) life stages are presented.

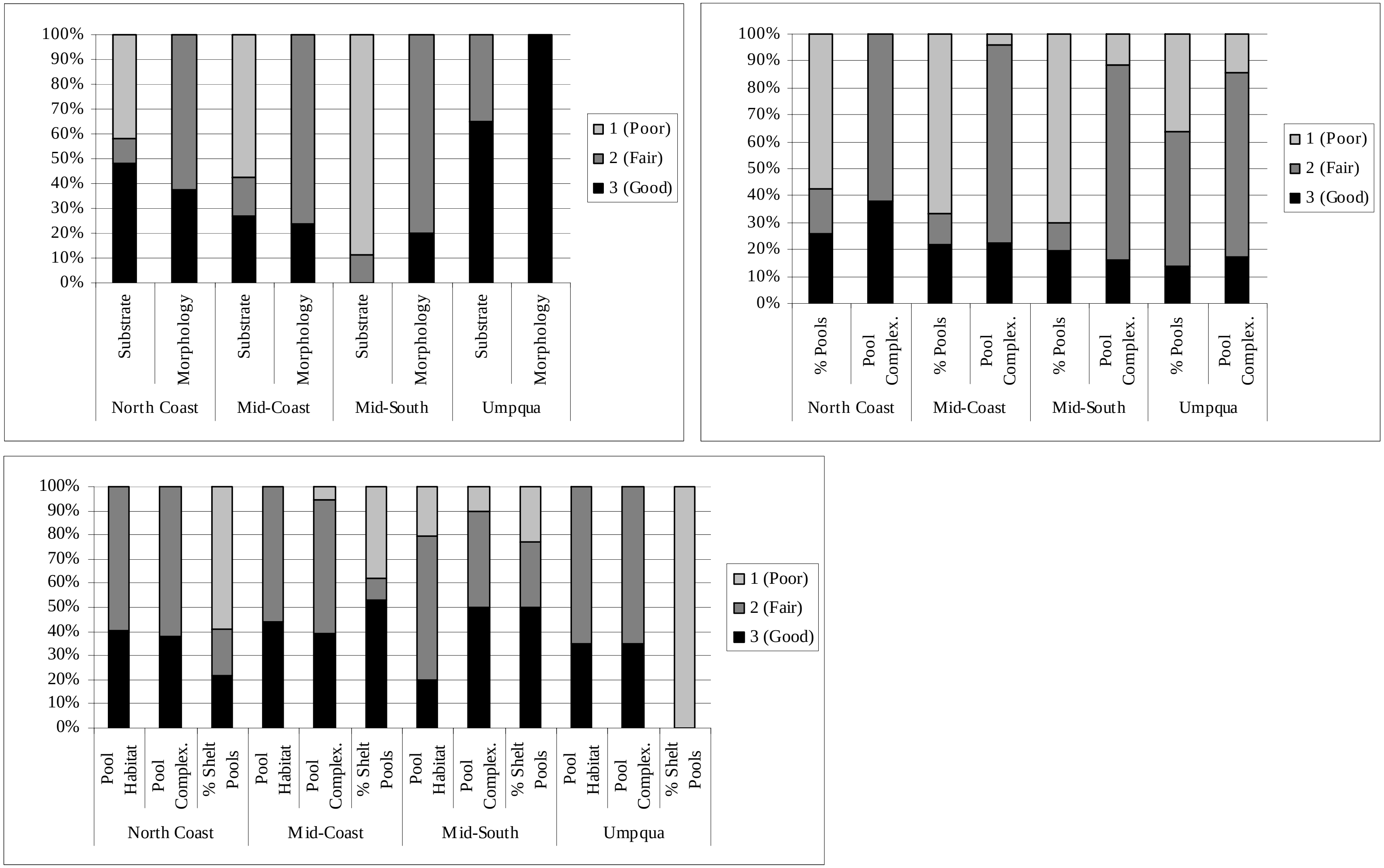


Figure 21. The quality of stream habitat within stream reaches designated as having high intrinsic potential for coho salmon (>0.75) (Burnett et al. 2006) (n=37) as assessed by the HabRate model (Burke et al. 2001). Habitat ratings for specific attributes associated with the spawning/emergence (upper left), summer 0+ (upper right), and winter 0+ (lower) life stages are presented.

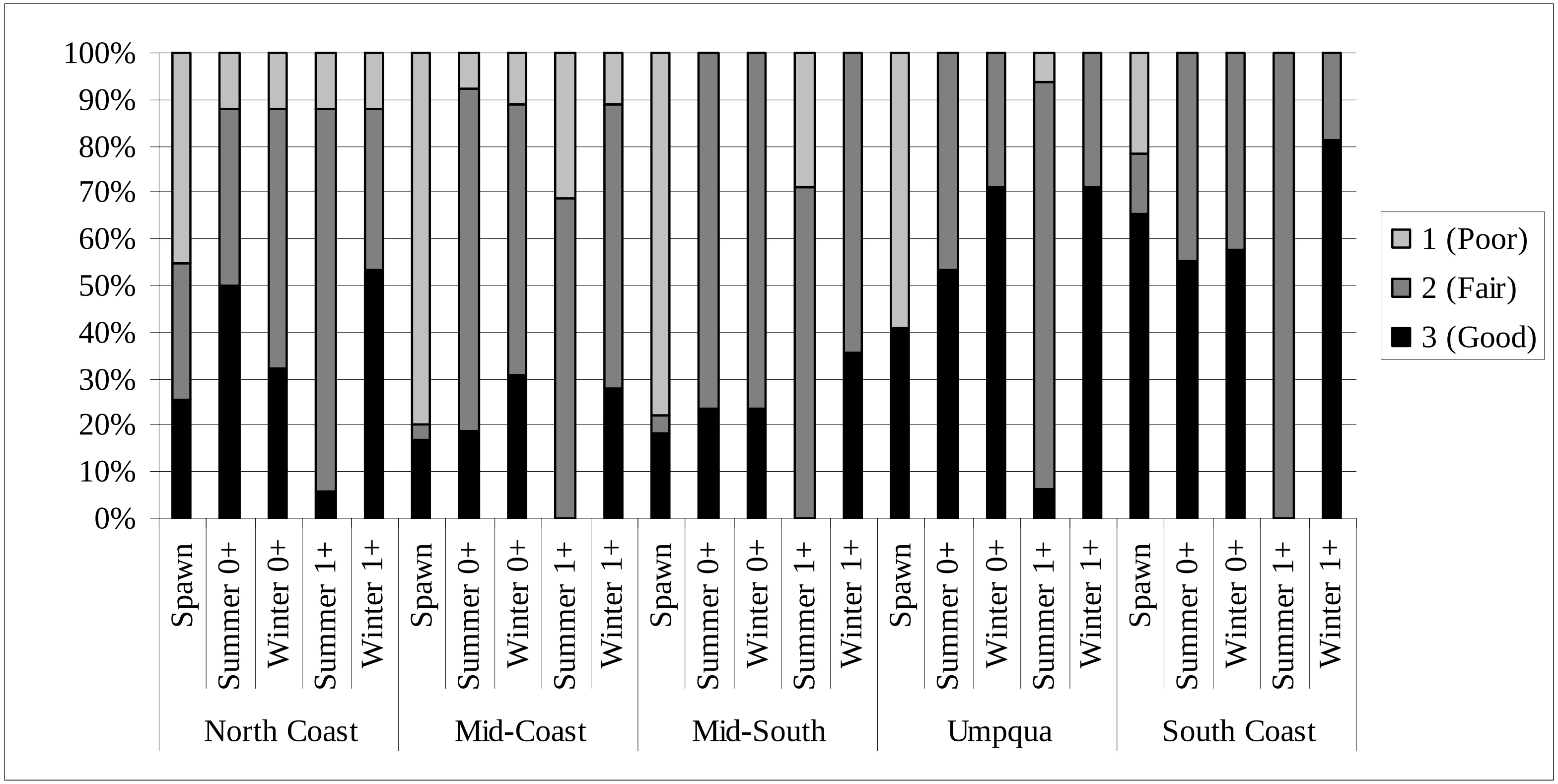


Figure 22. The quality of stream habitat within the distribution of steelhead (n=102) by monitoring area for each life stage of steelhead as assessed by the HabRate model (Burke et al. 2001).

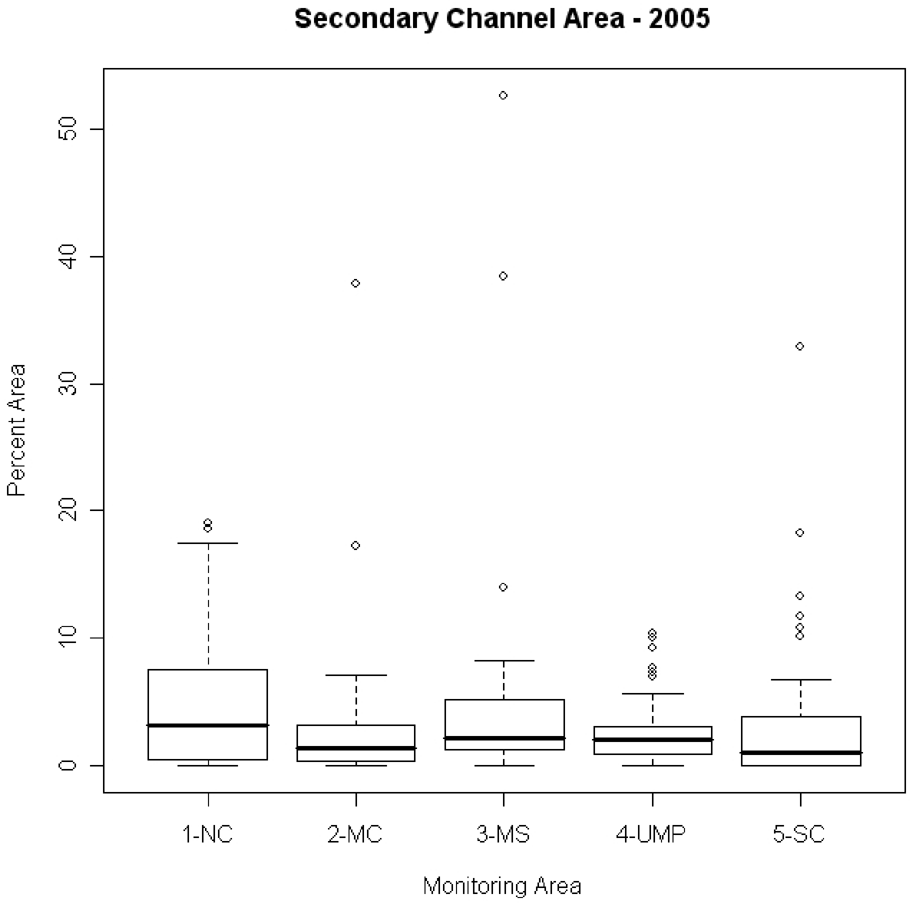
Appendix 1. Summary statistics by monitoring area (MA) for habitat attributes in 2005.

Category	Habitat Attribute	MA	n	Median	Mean	SD	Variance
Stream Morphology	Pool habitat (%)	North Coast	38	17.97	27.02	24.73	611.74
		Mid-Coast	47	44.68	45.22	30.04	902.62
		Mid-South	42	34.50	39.10	28.45	809.90
		Umpqua	36	21.93	27.23	24.54	602.62
		South Coast	46	16.29	18.05	17.92	321.19
	Density of deep pools	North Coast	38	0.0	1.55	2.71	7.37
		Mid-Coast	47	0.86	1.54	2.08	4.36
		Mid-South	42	0.0	1.61	2.53	6.42
		Umpqua	36	0.0	1.13	2.13	4.53
		South Coast	46	0.0	1.68	2.39	5.71
	Second. chann. area (%)	North Coast	38	3.10	5.07	5.70	32.53
		Mid-Coast	47	1.34	3.03	5.95	35.50
		Mid-South	42	2.10	5.08	9.72	94.50
		Umpqua	36	1.97	2.81	2.95	8.76
		South Coast	46	1.01	3.48	6.00	36.03
Substrate Composition	Fine sediment (%) (all units)	North Coast	38	18.46	23.87	25.05	627.71
		Mid-Coast	47	27.49	36.36	27.34	747.56
		Mid-South	42	33.12	39.07	27.20	739.99
		Umpqua	36	21.42	24.63	20.24	409.88
		South Coast	46	19.88	26.42	18.87	356.09
	Gravel substrates (%) (all units)	North Coast	38	31.04	33.09	16.39	268.88
		Mid-Coast	47	34.80	31.44	16.99	288.89
		Mid-South	42	27.29	28.17	15.08	227.70
		Umpqua	36	32.49	31.98	14.74	217.36
		South Coast	46	23.98	25.04	9.44	89.18
	Fines in Riffles (%)	North Coast	38	6.09	14.83	25.23	636.87
		Mid-Coast	47	20.41	28.27	25.69	660.09
		Mid-South	42	21.81	32.96	27.34	747.76
		Umpqua	36	15.71	20.20	18.42	339.58
		South Coast	46	13.90	21.04	22.87	523.08

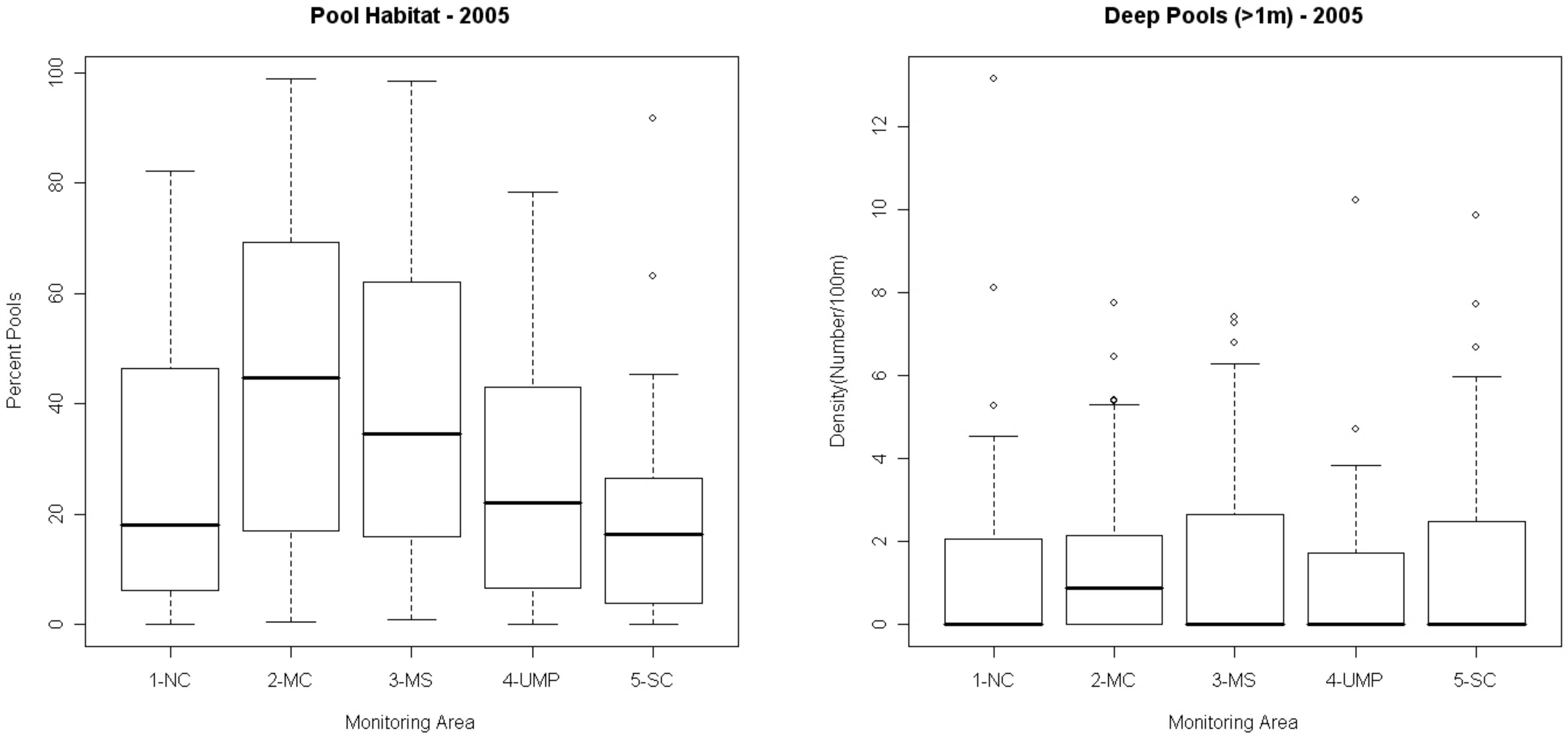
Appendix 1. Continued.

Category	Habitat Attribute	MA	n	Median	Mean	SD	Variance
Substrate Composition	Gravel in Riffles (%)	North Coast	38	36.10	30.41	27.83	774.62
		Mid-Coast	47	40.41	38.99	22.24	494.68
		Mid-South	42	33.96	36.20	22.59	510.64
		Umpqua	36	35.544	36.33	23.07	532.42
		South Coast	46	30.00	25.56	19.19	368.51
Instream Wood	Density of wood pieces (#/100m stream length)	North Coast	38	13.30	16.28	11.52	132.84
		Mid-Coast	47	12.11	15.69	11.82	139.80
		Mid-South	42	12.64	14.33	11.72	137.53
		Umpqua	36	15.77	14.39	9.95	99.14
		South Coast	46	6.23	7.83	7.03	49.43
	Wood volume (cu m/100m stream length)	North Coast	38	12.16	16.26	13.74	189.03
		Mid-Coast	47	12.23	18.80	21.54	464.07
		Mid-South	42	8.53	15.60	19.26	370.98
		Umpqua	36	15.26	19.88	19.81	392.74
		South Coast	46	8.55	12.16	15.72	247.12
Riparian Structure	Density conifers (>50cm)	North Coast	38	0	25.94	42.50	1806.32
		Mid-Coast	47	20	38.78	47.91	2295.51
		Mid-South	42	20	33.38	45.96	2113.07
		Umpqua	36	61	112.33	122.32	14962.45
		South Coast	46	41	53.47	58.91	3470.43
	Density conifers (>90cm)	North Coast	38	0	3.42	18.05	325.81
		Mid-Coast	47	0	6.46	14.59	212.99
		Mid-South	42	0	11.16	21.26	452.04
		Umpqua	36	0	22.55	37.56	1410.93
		South Coast	46	0	11.02	19.51	380.86
	Channel shading (%)	North Coast	38	72.34	69.13	17.45	304.74
		Mid-Coast	47	80.91	77.60	14.67	215.30
		Mid-South	42	87.26	79.84	20.58	423.94
		Umpqua	36	86.55	83.69	12.22	149.46
		South Coast	46	78.90	76.20	19.65	386.40

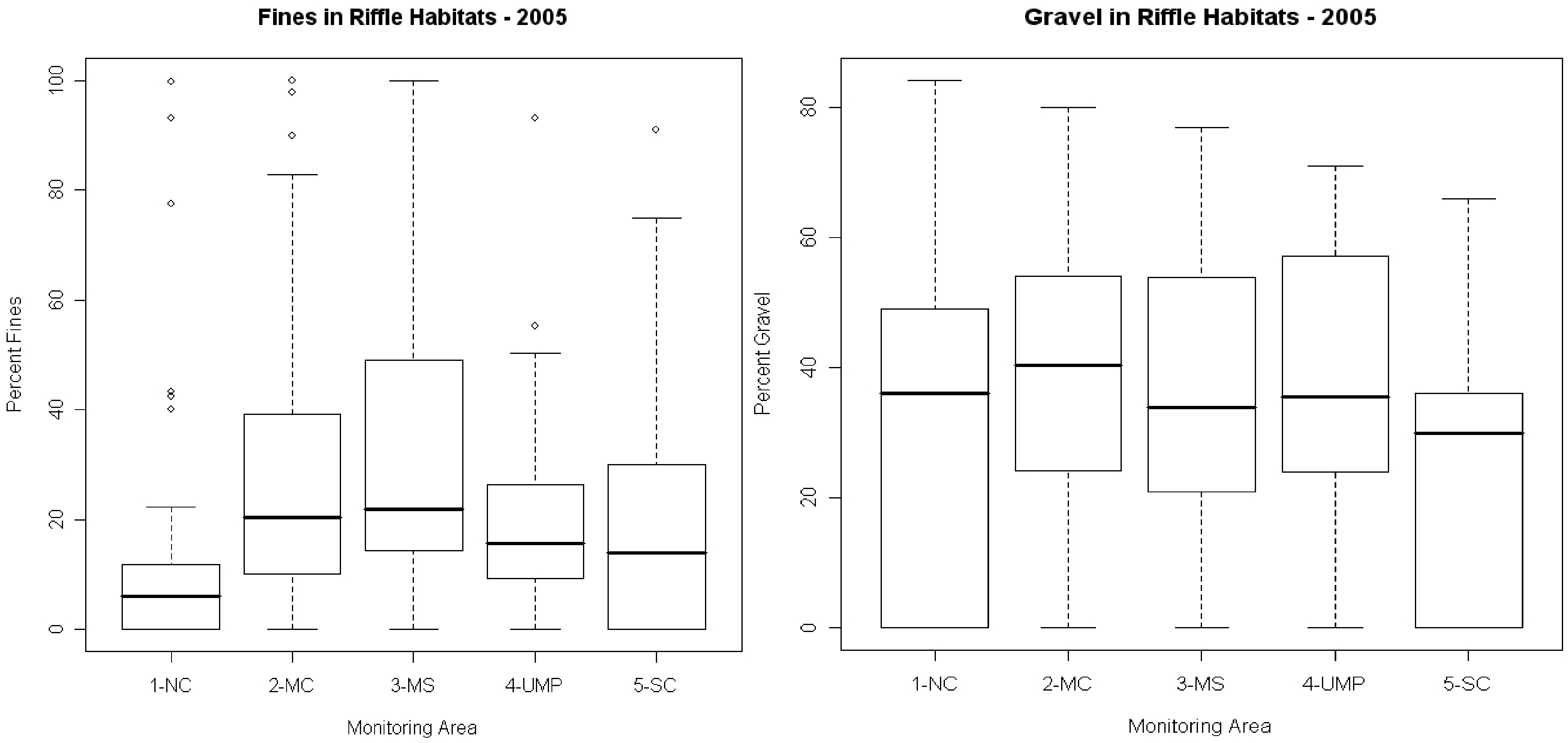
Appendix 2. Boxplot for percent secondary channel area. The median value, upper (75th) and lower (25th) quartiles, standard error, and outliers are represented.



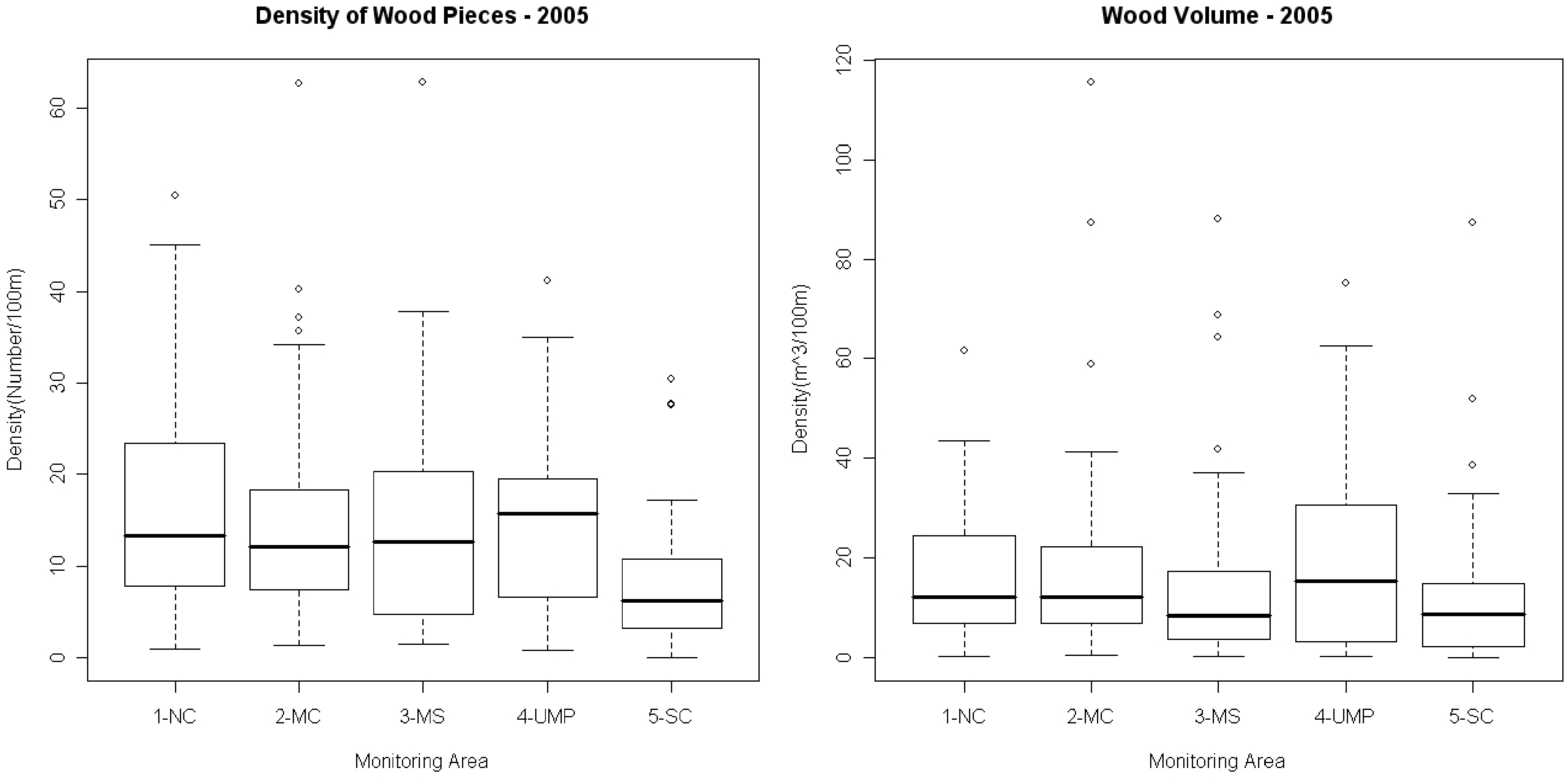
Appendix 3. Boxplot for percent pool habitat (a) and density of deep pool (b). The median value, upper (75th) and lower (25th) quartiles, standard error, and outliers are represented.



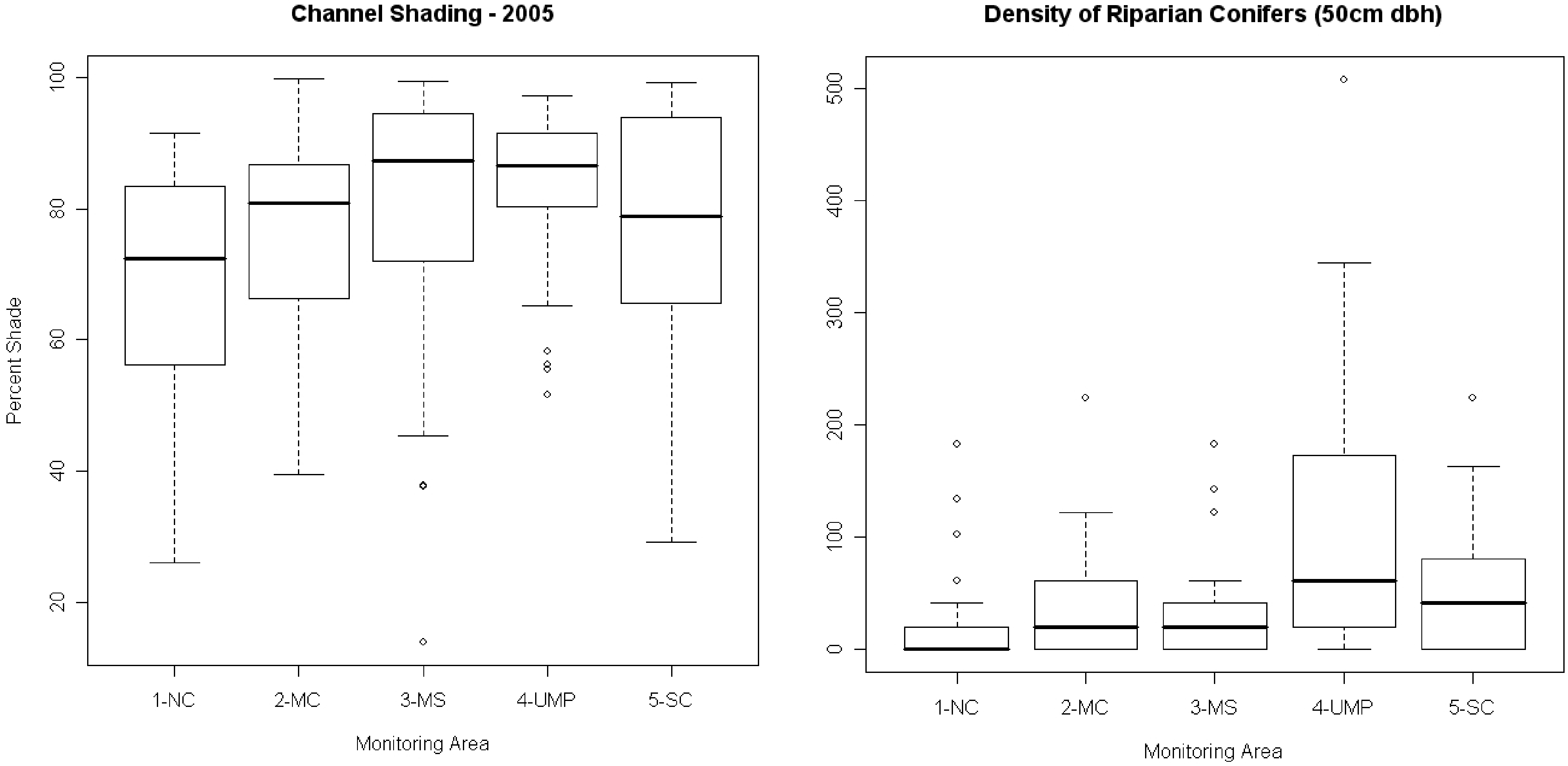
Appendix 4. Boxplot for fine sediments in riffle habitats (a) and gravel substrates in riffle habitats (b). The median value, upper (75th) and lower (25th) quartiles, standard error, and outliers are represented



Appendix 5. Boxplot for density of wood pieces (a) and wood volume (b). The median value, upper (75th) and lower (25th) quartiles, standard error, and outliers are represented.



Appendix 6. Boxplot for percent channel shading (a) and density of >50 cm DBH riparian conifers (b). The median value, upper (75th) and lower (25th) quartiles, standard error, and outliers are represented.


Channel Shading - 2005

Density of Riparian Conifers (50cm dbh)