THE OREGON PLAN *for Salmon and Watersheds*

Status of Winter Rearing Habitat In Four Coho Population Units, 2007

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OBJECTIVES AND ACCOMPLISHMENTS FOR WINTER 2007

Objectives for conducting winter habitat surveys in 2007 were 1) complete 25 surveys approximately 1000 m in length in each of four randomly selected Oregon coastal coho salmon (*Oncorhynchus kisutch*) population units (Nehalem, Siuslaw, Coquille, South Umpqua), 2) describe the status of winter habitat surveyed in 2007 for those population units, 3) estimate the potential winter capacity for juvenile coho in streams within those population units, 4) describe the differences observed in stream habitat between winter and summer with emphasis on slow water and secondary channel habitats, 5) determine the number of survey sites necessary to represent each population unit within the desired confidence recommended in the Conservation Plan, and 6) address the general importance of continued winter survey seasons.

- Completed 87 surveys during winter 2007, and described channel morphology, physical structure of stream channel habitat, and instream wood.
- Used Habitat Limiting Factors Model 7.0 to rate quality of coho habitat in four population units.
- Employed Habitat Limiting Factors Model 7.0 to estimate potential habitat capacity for juvenile coho in four population units.
- Discussed habitat capacity estimates relative to previously estimated values.
- Compared winter to summer habitat variables at 72 sites.
- Illustrated differences between seasons regarding secondary channels, dry channels and beaver dams.
- Performed sensitivity analysis in order to determine how many sites need to be surveyed in each population area to meet goals set by Oregon Coast Coho Conservation Plan (Nicholas 2006).
- Reinforced the importance of conducting winter surveys for facilitating assessment of habitat status and determining winter rearing capacity in coastal streams.

EXECUTIVE SUMMARY

We described the status of habitat in four Oregon coastal coho salmon (*Oncorhynchus kisutch*) population units (Nehalem, Siuslaw, Coquille, South Umpqua) during winter 2007, estimated the potential winter rearing capacity of streams within those population units, and described the differences observed in stream habitat between winter and summer with emphasis on slow water and secondary channel habitats. Sample sites were randomly selected and spatially balanced within the distribution of coho salmon (juvenile and adult) in Oregon coastal watersheds south of the Columbia River. Twenty five sites were targeted within each of the four population units. Each survey was approximately 1000 m in length and adhered to protocols in Moore et al (2007). The Habitat Limiting Factors Model (HLFM) was used to estimate habitat capacity and quality for rearing juvenile coho. The HLFM predicted that the Nehalem and Siuslaw basins could support the highest density of juvenile coho, and the South Umpqua the least. Seasonal changes in habitat were similar to that reported in a previous study. Winter surveys facilitated the assessment of habitat status and estimating capacity because the surveys were conducted at the time when habitat is most limiting to survival of juvenile coho. Winter surveys were particularly valuable in capturing secondary channel and slow water habitat units such as beaver ponds and alcoves. We also performed a sensitivity analysis to determine the number of survey sites necessary to represent each population unit within the desired confidence range of 30% recommended in the Coho Conservation Plan. Twenty five target sites were not adequate to describe the winter parr capacity within a 95% confidence interval of $\pm$30% in each population unit. Confidence intervals of estimates of parr per km ranged from 34 to 60% and mean parr per m^2 ranged from 20 to 45%.

INTRODUCTION

In a recent assessment of coastal coho salmon by the Oregon Department of Fish and Wildlife (2005), the authors concluded that productivity in 21 of 21 coastal coho populations was limited primarily (13) or secondarily (8) by the complexity of stream habitat used by juvenile coho during their first winter of freshwater residence. The Oregon Coast Coho Conservation Plan (Nicholas 2006), written in response to the assessment, concluded that recovery of coho populations will depend largely on improvement of freshwater habitat. The Conservation Plan (Nicholas 2006) presents population specific goals for the amount and quality of winter habitat needed to achieve desired status of coho populations. Monitoring objectives in the Plan are 1) describe the status of freshwater habitat in each population unit with a focus on features important to overwinter survival of juvenile coho, 2) estimate carrying capacity in each population unit with ± 30% confidence, and 3) measure progress towards meeting the habitat goals of the Conservation Plan. This report describes the first two monitoring objectives for winter habitat in four population units: the Coquille, South Umpqua, Siuslaw, and Nehalem.

Winter habitat surveys are conducted to describe the freshwater habitat conditions that may limit the survival of juvenile coho during the season at which the conditions are limiting. The Habitat Limiting Factors Model (Nickelson et al. 1992a, Nickelson et al. 1992b, Nickelson 1998) estimates the capacity of streams to support juvenile salmon based on quantitative descriptions of summer and winter habitat. The model assigns value to the size, type and complexity of habitat units, giving highest value to slow water pools such as alcoves and beaver ponds, and pools with large wood. Because winter habitat limits the capacity of most coastal streams to support juvenile coho (Rodgers et al. 2005), accurate estimates of winter habitat are essential to life cycle modeling and to meet objectives of the Conservation Plan.

Rodgers et al. (2005) estimated potential carrying capacity of stream habitat within each coastal coho population unit, but statistical confidence was limited by the source and manipulation of the data. Although the data set was extensive, most of the reaches were not randomly selected, and a regression model was used to extrapolate conditions from summer to winter (Rodgers et al. 2005). Summer surveys provide applicable information, but at low flow conditions. Summer weather and stream flows are predictable and conducive to field work; study sites are more accessible, work days are longer and warmer, lower water levels enable walking in the channel more easily, and water clarity is high. However, while more difficult logistically, winter surveys provide estimates during high flow conditions thought to be most important to juvenile coho survival. The winter surveys are conducted during "base flow" when off-channel habitats and secondary channels are inundated, but not over floodplain. The winter 2007 survey sites were selected using the Generalized Random Tessellation Stratified (GRTS) sample design (Stevens 2002) from a pool of sites previously surveyed during summer. This provided an opportunity to describe status within coho population units and refine the summer to winter conversion regression model. More sites are visited during summer than winter, and the sample pool will expand if we can use summer surveys to predict winter conditions. A thorough description of seasonal habitat variation will determine the appropriateness of using summer habitat data to assess habitat conditions during the winter.

The objectives of this report are to provide the status of winter habitat surveyed in 2007 in four Oregon coastal coho salmon (*Oncorhynchus kisutch*) population units (Nehalem, Siuslaw, Coquille, South Umpqua), estimate the potential winter capacity of streams within those population units, and describe the differences observed in stream habitat between winter and summer with emphasis on slow water and secondary channel habitats. We also performed a sensitivity analysis to determine the number of survey sites necessary to represent each population unit within the desired confidence recommended in the Conservation Plan (Nicholas 2006).

METHODS

Study Area and Site Selection.

Sample sites were randomly selected and spatially balanced within the distribution of coho salmon (juvenile and adult) in Oregon coastal watersheds south of the Columbia River. Details of the survey program are described in Anlauf et al. (2007) and the GRTS sample selection in Stevens (2002). This region is stratified into four monitoring areas (MA), North Coast, Mid-Coast, Mid-South Coast, and Umpqua, which constitute the extent of the Oregon Coastal Coho Salmon Evolutionarily Significant Unit (ESU). Coho population boundaries in the Oregon Coastal Coho Salmon ESU are subdivided into independent and dependent populations based on population dynamics, genetic information, geographic distribution, species life history, and morphological traits (Lawson et al. 2004, Wainwright et al. 2006) (Figure 1). We selected one coho population at random within each of the four monitoring areas to survey for the 2007 winter survey season (January-March) (Figure 2).

Twenty five sites, and an oversample, were selected within each population. Sites selected were a subset of sites surveyed in previous summer seasons. Each survey was approximately 1000 m in length and adhered to protocols in Moore et al. (2007). Winter surveys do not include estimates of shade, percent active erosion, percent undercut, boulder counts, or riparian vegetation transects. These attributes are collected during summer surveys; our focus during winter surveys is on attributes that may differ as a result of increased flow.

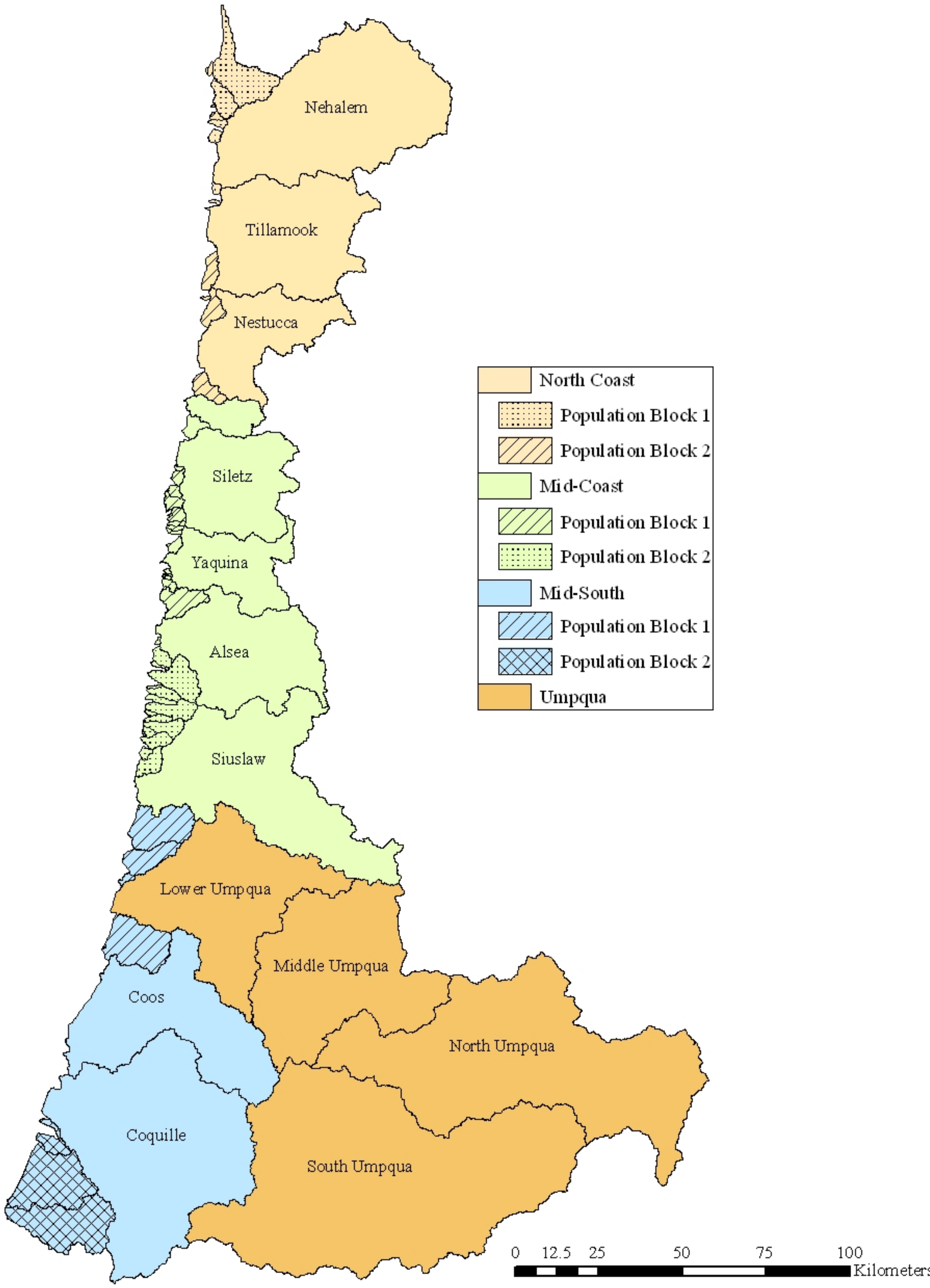

Figure 1. Coho population units and population block boundaries within the four Monitoring areas: North Coast, Mid Coast, Mid-South, and Umpqua. See Appendices 1a & 1b for lists of populations within each block.

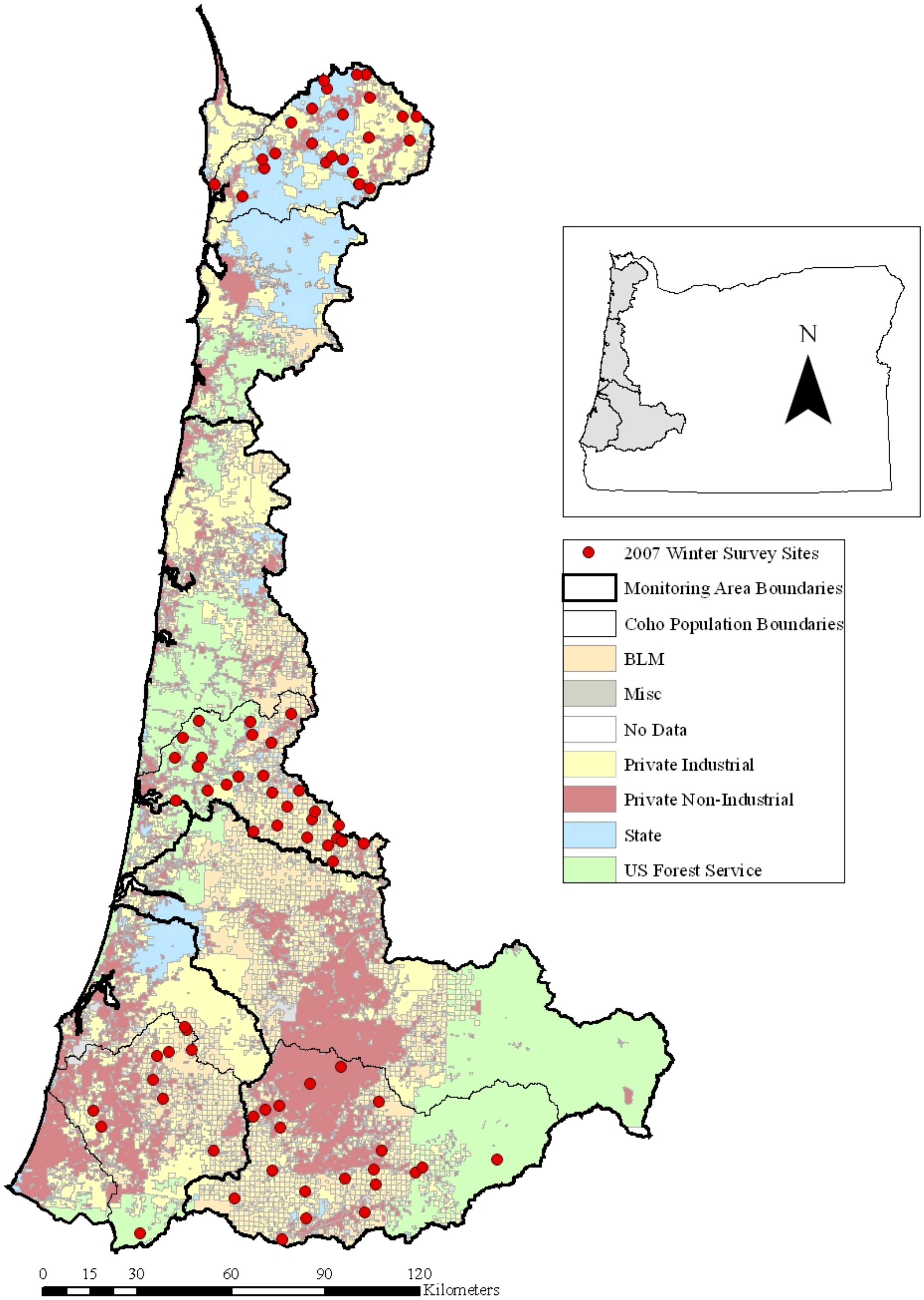

Figure 2. Location of completed 2007 winter habitat survey sites within the Nehalem, Siuslaw, Coquille, and South Umpqua coho population units.

Population Habitat Status

Surveys were summarized at the site (~1000 m reach) level to describe channel morphology, physical structure of stream channel habitat, and instream wood. Juvenile coho carrying capacity for each population was estimated using the Habitat Limiting Factors Model (HLFM version 7) (Nickelson et al. 1992a, 1992b, and Nickelson 1998), updated in 2007. This model applies a density value (per m^2) of juvenile coho to the surface area of each habitat unit. The value is based on the capacity (number of juvenile coho) that a habitat type can potentially support. The capacity is summed across all habitat units in the reach, and standardized to a kilometer reach. The standardized values are extrapolated to the kilometers of stream within coho distribution for each population unit to generate a total potential capacity. Parr per kilometer estimates of 1850 and above were considered to be high, and below 900 were considered poor. Parr per meter squared values greater than 0.3 were considered high, and values below 0.12 were considered poor. Attribute estimates and confidence intervals were estimated using S-Plus (Version 7.0, Insightful Corporation). The script employed a local-neighborhood (LNB) variance estimator (Stevens and Olsen 2003). The LNB variance estimator reduces the uncertainty (lower variance, greater precision) in the estimate by taking advantage of any spatial patterns in the distribution of a variable.

Summer/Winter Comparison

We selected only previously surveyed sites within population units. Although some of the sites had been surveyed as early as summer 1999, for the summer/winter comparison we only included surveys within the previous four years. Habitat attributes were analyzed using the S-Plus statistical package. We used Wilcoxon signed-rank tests to compare habitat variables between paired summer and winter surveys. Wilcoxon signed-rank tests were used as they are robust against non-normal distributions and the occurrence of outliers.

Secondary channel variables such as percent secondary channel area, and secondary channel length were examined and compared between seasons using Wilcoxon signed-rank tests, and illustrated with bar graphs. Bar graphs also illustrate the differences in the number of beaver pools and percent beaver pool area between seasons.

Sensitivity Analysis

A sensitivity analysis was performed to address appropriate sample sizes based on the variability in certain biological parameters. We based our sample size estimates for 2007 on previous summer sampling. The winter information will help to provide a target sample number for upcoming winter seasons by giving a statistically rigorous and representative estimate of population habitat capacity. Detailed explanation of methods found in Lichatowich and Cramer (1979). We also used the sample size estimator in S-Plus (Version 7.0 Insightful Corporation), as expressed in the equation below.

$n = (t_{\alpha} + t_{\beta})^2 2S^2/\delta^2$

Where
δ = difference between means of two normal distributions
S = Coefficient of variation
α = Probability of making a Type I error; 0.05
ß = Probability of making a Type II error; 0.2

RESULTS

Survey targets were met in three of the four populations (Table 1); we only completed 11 sites in the Coquille strata because of time constraints. We were not denied access to any sites so the surveys in the Nehalem (25), Siuslaw (28) and South Umpqua (20) represented a random, spatially balanced sample across stream sizes and land ownerships within each population unit. Three of the sites we selected in the South Umpqua were non-target, that is, they were not within coho distribution. We surveyed 11 of 25 sites in the Coquille, and even though the sites may not be randomly and spatially balanced within the population area, the streams ranged in size from 3 to 21 meters wide at bankfull stage and were distributed throughout the drainage. All 84 sites were previously surveyed during the summer, but only 72 within the past 4 years (2003-06).

Table 1. Survey sites completed in selected population areas for 2007 winter surveys.

Population Area	Surveys Completed	Non-target	Denied Access
Nehalem	25	0	0
Siuslaw	28	0	0
Coquille	11	0	0
South Umpqua	23	3	0
Total	87	3	0

Population Habitat Status

Secondary channel and off-channel habitat, beaver ponds, pools, and large wood are important habitat features for juvenile coho during the winter. The Coquille had the largest proportion of pool habitat, followed by the Nehalem and Siuslaw, and the South Umpqua (Table 2). However, the Nehalem and Siuslaw have the most beaver ponds and alcoves by percent unit area (Table 3). No beaver ponds were observed in the 20 sites in the Umpqua. Percent secondary channel area (secondary channel area as a percent of secondary plus primary channel area) ranged from 1.5% (South Umpqua) to 3 % (Nehalem), although the actual area was highest in the Nehalem and Coquille. The Siuslaw streams, on average, had the highest number of pieces, volume of wood and key pieces. The Siuslaw also had more complex pools, those with at least 3 pieces of wood, although the Nehalem and Coquille were similar on average. The South Umpqua was the lowest in all categories.

Table 2. Summary of habitat variables selected for analysis from each population area. n=number of survey sites in a population area. Refer to Moore et al (2007) for description of protocol.

Variable	Population	(n)	Mean	(SD)
Primary Channel Length (m)	Nehalem	25	1011	134
	Siuslaw	28	991	138
	Coquille	11	916	163
	South Umpqua	20	985	104
Primary Channel Area (m2)	Nehalem	25	7844	4234
	Siuslaw	28	5276	4056
	Coquille	11	7351	5694
	South Umpqua	20	4606	2654
Gradient (%)	Nehalem	25	1.96	1.22
	Siuslaw	28	2.12	1.46
	Coquille	11	3.10	3.99
	South Umpqua	20	3.4	2.7
Active Channel Width (m)	Nehalem	25	10.4	4.7
	Siuslaw	28	6.3	3.7
	Coquille	11	10.4	6.4
	South Umpqua	20	7.0	4.4
Secondary Channel Area (m2)	Nehalem	25	278	319
	Siuslaw	28	98	105
	Coquille	11	210	304
	South Umpqua	20	130	221
Number of Units/Survey (#)	Nehalem	25	47	16
	Siuslaw	28	65	27
	Coquille	11	49	18
	South Umpqua	20	37	19
Pool Habitat (%)	Nehalem	25	42.5	28.3
	Siuslaw	28	45.7	28.3
	Coquille	11	48.9	22.5
	South Umpqua	20	26.8	21.9
Wood Volume (m3/100m)	Nehalem	25	16.9	11.0
	Siuslaw	28	27.7	22.5
	Coquille	11	13.8	9.5
	South Umpqua	20	11.4	18.2
Complex pools (#/km)	Nehalem	25	6.9	3.6
	Siuslaw	28	9.4	6.1
	Coquille	11	8.2	3.8
	South Umpqua	20	2.6	2.3

The winter habitat and structural complexity metrics were used in the Habitat Limiting Factors Model to estimate habitat capacity and quality for rearing juvenile coho. Habitat capacity estimates were based on 84 winter surveys across the 4 population units. The mean density of juvenile coho predicted by the model ranged from an average of 529 coho per km or 0.09 per m^2 in the Umpqua to 2,940 per km (Nehalem) or 0.31 per m^2 in the Siuslaw (Table 3). Parr density values for individual sites are presented in Figure 3. Total parr capacity for a population area is a function of capacity at each site and expanded to all streams in the population. Approximately 30% of the surveyed length in the Nehalem, Siuslaw and Coquille population units had high habitat capacity estimates (>1850 parr/Km), while 85% of the surveyed length in the South Umpqua exhibited low (<900 parr/km) capacity potential (Figure 4). The capacity and density values, as estimated in the HLFM model, are closely tied to the amount of pool habitat, with added weight to beaver pond and alcove habitat. For example, Figure 6 shows that the Coquille had the highest amount of scour pool habitat and the Umpqua the least. The Nehalem and Siuslaw basins, on the other hand, had a moderate amount of scour pool habitat, but the highest amount of alcoves and beaver pools (Figure 7). Beaver pond and alcove habitats are relatively scarce; fewer than 25% of the sites in any population area had more than five percent (surface area) in alcove or beaver pond habitat (Figure 7). The net result is that we predicted that the Nehalem and Siuslaw could support the highest density of juvenile coho, and the Umpqua the least.

Table 3. Rearing capacity estimates projected by the Habitat Limiting Factor Model (Nickelson et al. 1992, 1998). High quality kilometers are the number of kilometers in a population unit that were estimated to support more then 1,850 parr per km. BP&ALPool is the percent of total wetted channel area in beaver pools and alcoves.

Population Unit	Variable	n	Mean	SE	95% CI (±%)	Total Kilometers Available*	High Quality (km)
Nehalem	Parr/Km	25	2,940	901	60	1297	363
Siuslaw	Parr/Km	28	1,704	323	37	1438	403
Coquille	Parr/Km	11	1,237	216	34	1088	294
S.Umpqua	Parr/Km	20	529	110	46	1948	195
Nehalem	Parr/m^2	25	0.28	0.06	42		
Siuslaw	Parr/m^2	28	0.31	0.05	28		
Coquille	Parr/m^2	11	0.19	0.04	38		
S.Umpqua	Parr/m^2	20	0.09	0.01	20		
Coquille	%BPALPool	11	0.02	0.02	153		
Nehalem	%BPALPool	25	0.11	0.04	76		
Siuslaw	%BPALPool	28	0.12	0.03	49		
S.Umpqua	%BPALPool	20	0.00	0.00	48		
Coquille	%Scour Pool	11	0.47	0.06	25		
Nehalem	%Scour Pool	25	0.32	0.03	19		
Siuslaw	%Scour Pool	28	0.34	0.03	19		
S.Umpqua	%Scour Pool	20	0.26	0.04	28		

*Total Kilometers available = number of estimated kilometers of potential rearing habitat within that population unit.

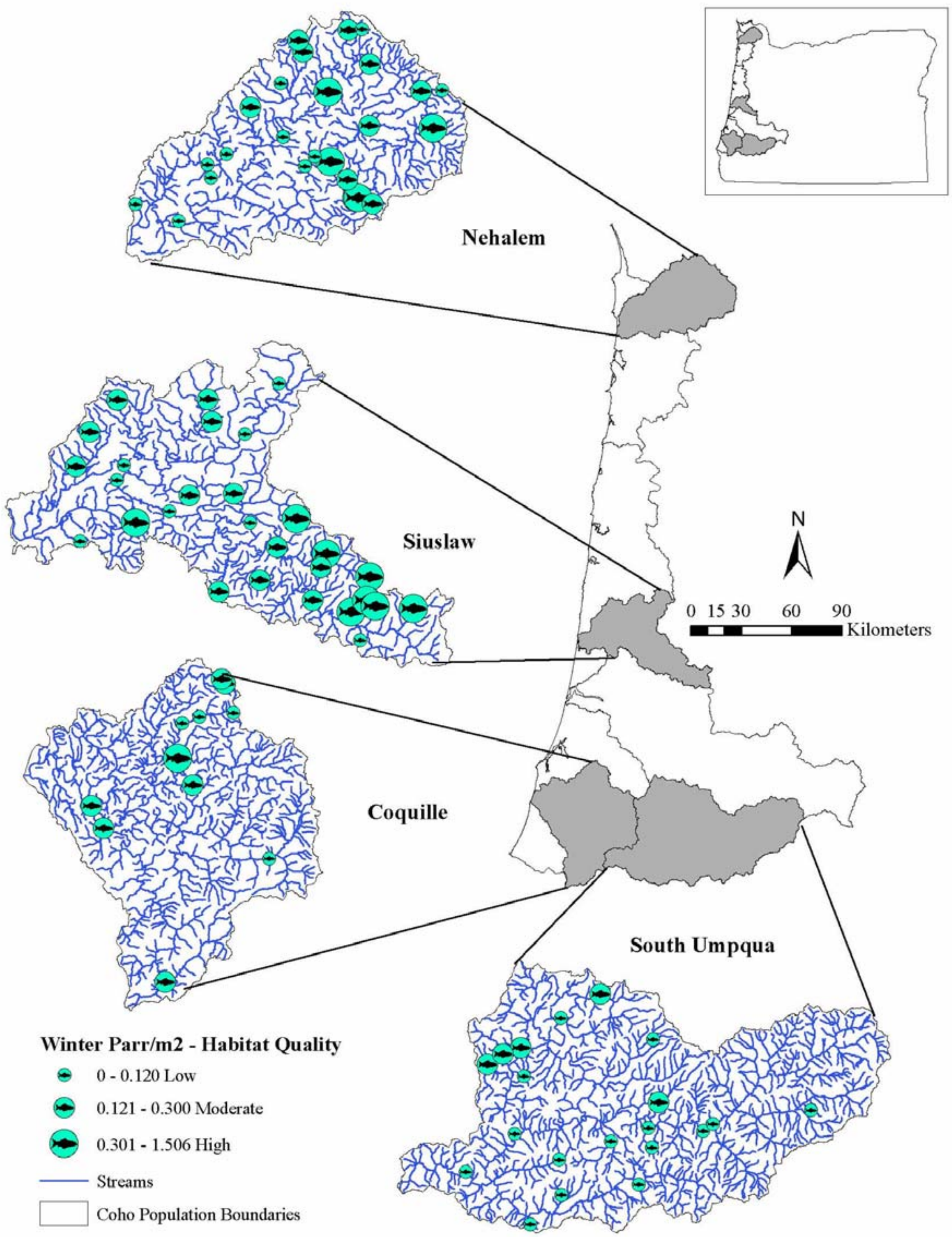

Figure 3. Parr density range (low, moderate, high) for each survey completed.

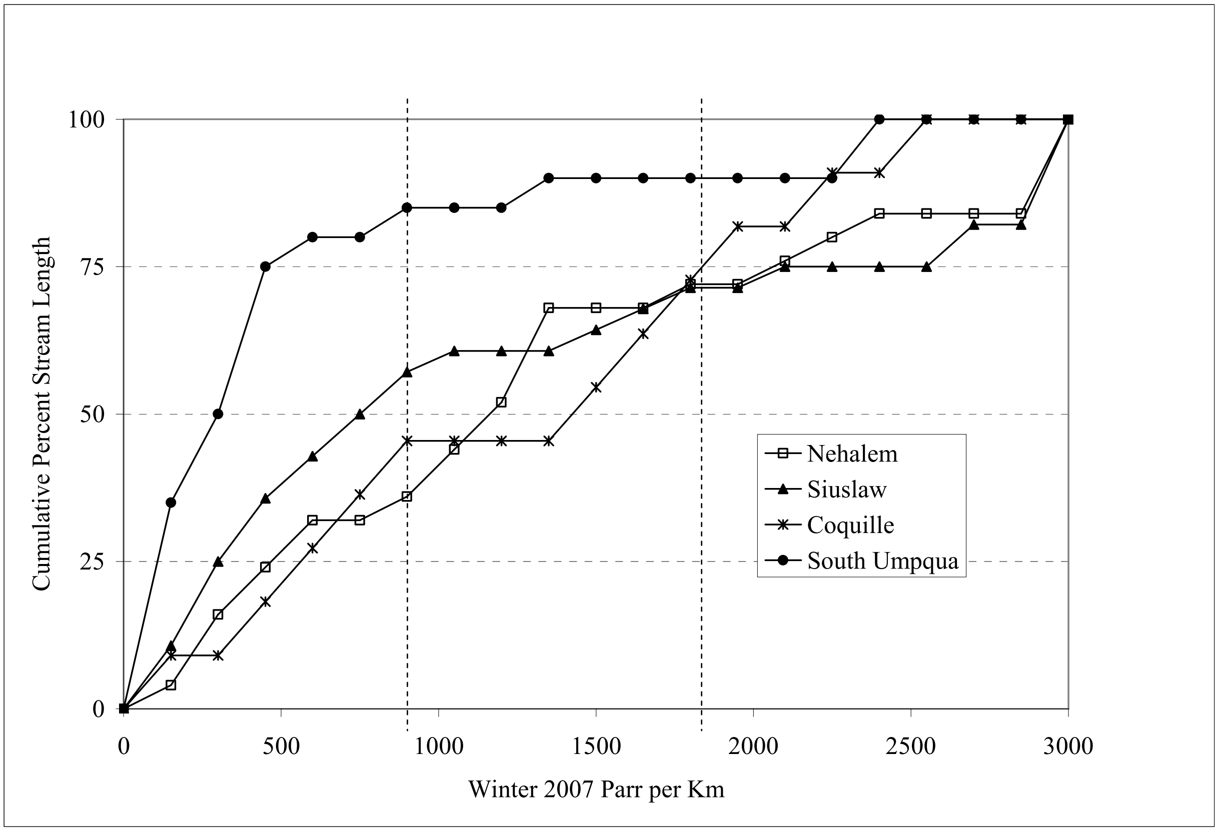

Figure 4. Cumulative frequency distribution comparing coho salmon parr per km in four population units. Vertical dashed lines represent the (<900) low value and (>1850) high value designations as presented by (Rodgers et al. 2005).

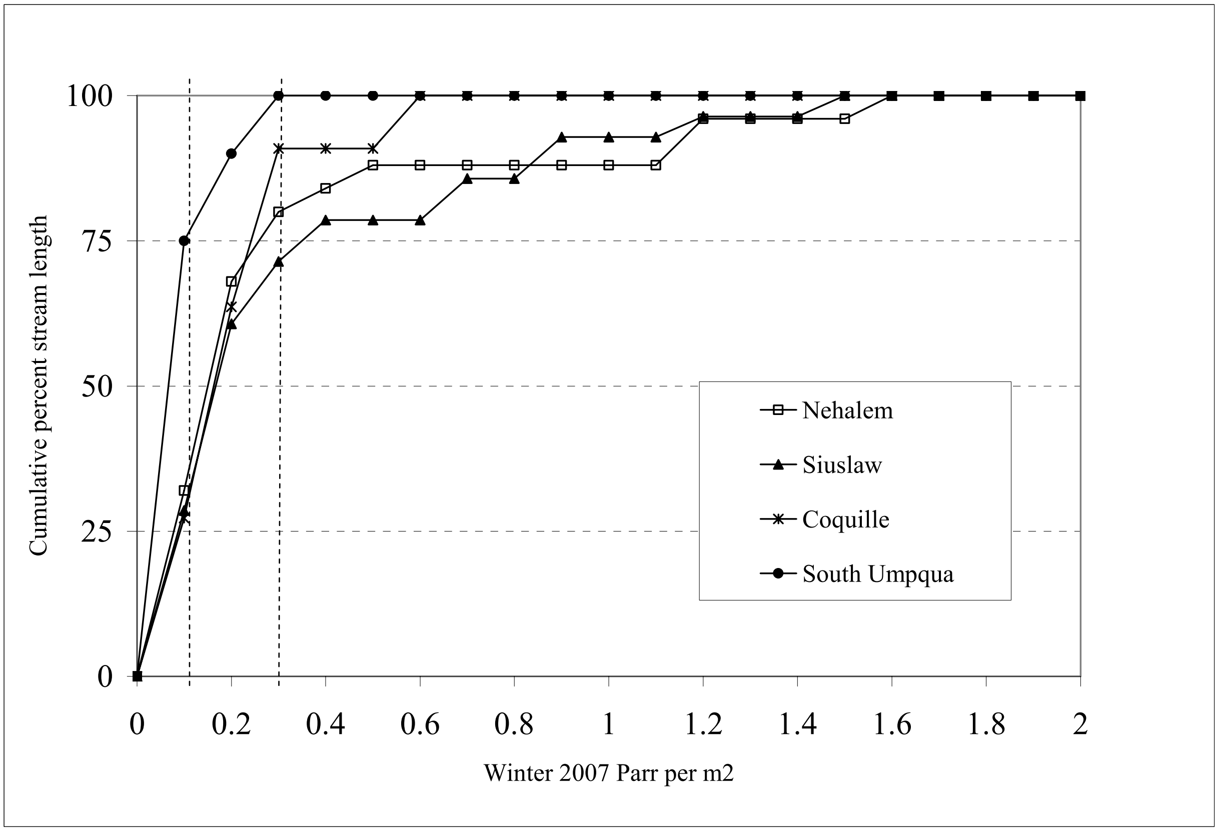

Figure 5. Cumulative frequency distribution comparing coho salmon parr per m^2 estimated from the HLFM across population units. Vertical dashed lines represent the (0.12) low value and (0.3) high value.

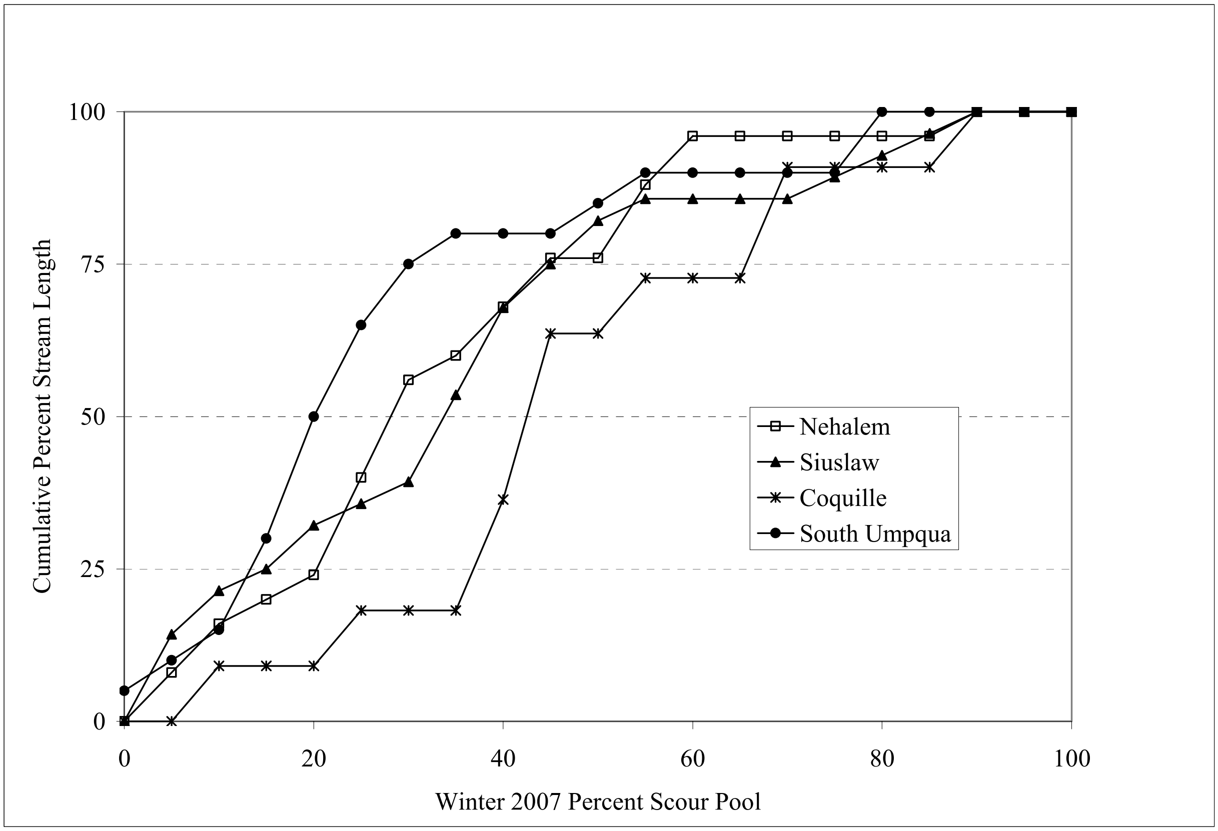

Figure 6. Cumulative frequency distribution comparing percentages of scour pools present across population units.

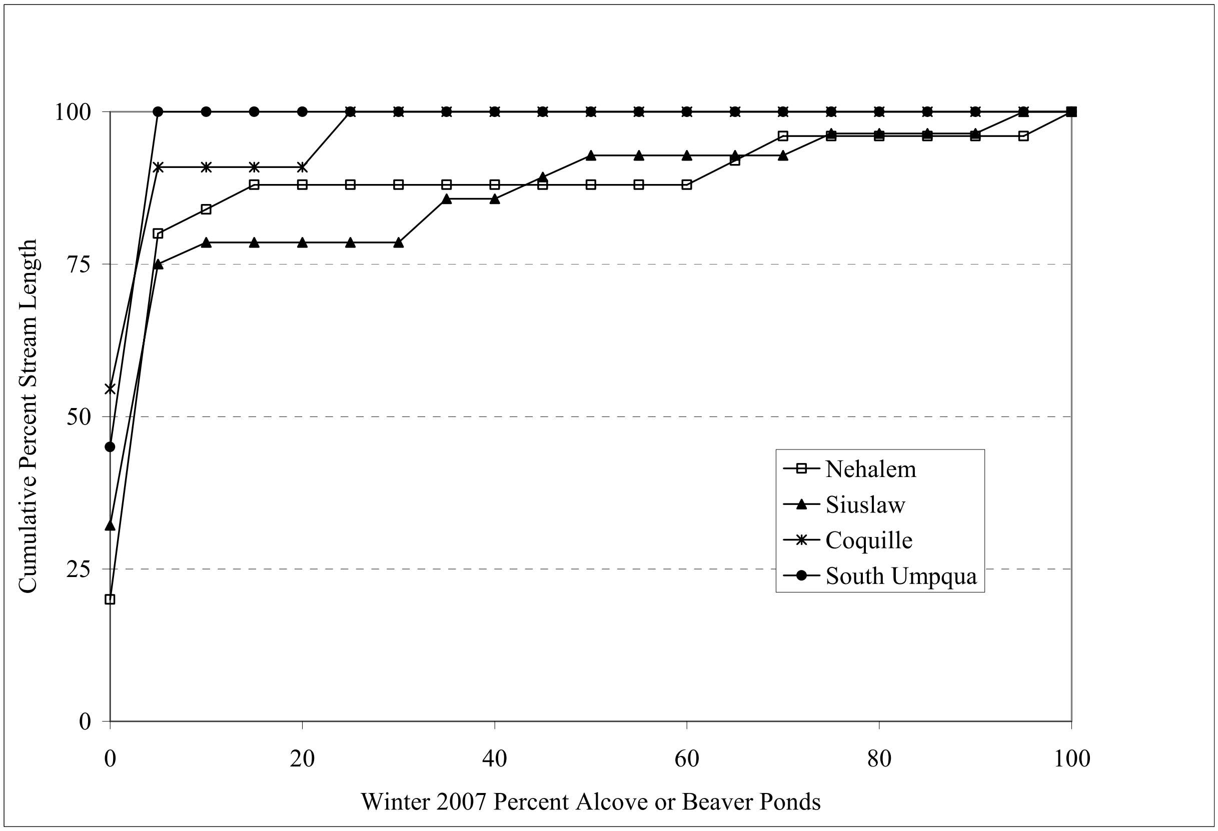

Figure 7. Cumulative frequency distribution comparing percentages of alcoves and beaver ponds present across population units.

Summer/Winter Comparison

Seventy two sites were resurveyed in the winter within four years of the summer surveys. We observed statistically significant increases in wetted width (p-value 0.03), primary channel area (p-value <0.001), scour pool depth (p-value <0.001), riffle depth (p-value <0.001), density of deep pools (p-value <0.001), and residual pool depth (p-value <0.001) during the winter survey season (Table 4). The relative amount of channel habitat in pools did not change, and although the number of pieces of wood increased slightly (p=0.03), the volume did not change.

A statistically significant difference was also found between summer and winter surveys for two channel metrics, active channel height (ACH) and flood prone height (FPH) (p-value 0.01) (Table 4). The active channel height was estimated to be on average 0.06m higher (± 0.04 95% CI) in the winter (Figure 8), but varied between population units. A few outliers are apparent which have may have skewed the means.

Table 4. Comparison of selected attributes measured in the summer and winter at 72 sites. Results from the Wilcoxon signed-rank tests. Habitat variables placed in major habitat groupings. Alpha level for p-values is 0.05.

Variable	Summer (Mean±SD)	Winter (Mean±SD)	z-value	p-value
Geomorphic				
Primary Channel Length (m)	1008.8 ± 127	993.8 ± 130	1.97	0.05
Primary Channel Area (m2)	5258.0 ± 3756	6378.7 ± 4455	-5.06	<0.001
Secondary Channel Length (m)	75.0 ± 83	70.0 ± 65	0.32	0.75
Secondary Channel Area (m2)	201.3 ± 317	172.0 ± 254	0.89	0.37
Secondary Channel Area (%)	3.7 ± 4.7	2.4 ± 2.5	2.43	0.02
Wetted Width (m)	4.82 ± 3.2	6.14 ± 4.1	-2.1	0.03
Number of Units (#)	56.4 ± 29	54.2 ± 24	0.42	0.68
Hydrologic				
Pool Area (%)	42.6 ± 26	42.5 ± 28	0.13	0.90
Scour Pool Area (%)	30.0 ± 21	31.2 ± 21	-0.10	0.92
Scour Pool Depth (m)	0.60 ± 0.2	0.85 ± 0.3	-6.93	<0.001
Riffle Depth (m)	0.10 ± 0.07	0.25 ± 0.14	-7.11	<0.001
Density of Deep Pools (#/km)	1.8 ± 2.3	4.9 ± 5.1	-6.41	<0.001
Residual Pool Depth (m)	0.49 ± 0.18	0.60 ± 0.22	-4.44	<0.001
Beaver Dams (#/km)	1.45 ± 3.0	0.63 ± 2.0	3.65	<0.001
Beaver Pool Area (%)	11.7 ± 24.8	8.6 ± 22.3	1.21	0.23
Channel Metrics				
Active Channel Height ACH (m)	0.53 ± 0.25	0.59 ±0.19	-2.60	0.01
Active Channel Width ACW (m)	8.00 ± 5.3	8.43 ± 4.9	-1.85	0.06
Flood Prone Height FPH (m)	1.10 ± 0.50	1.18 ± 0.4	-2.47	0.01
Flood Prone Width FPW (m)	12.16 ± 8.2	12.20 ± 7.1	-1.76	0.08
Physical				
Wood Density (m^3/100m)	15.7 ± 12.3	18.8 ± 17.5	-2.2	0.03
Volume Large Wood (m^3/Reach)	170.73 ± 138	188.0 ± 185	-1.00	0.32

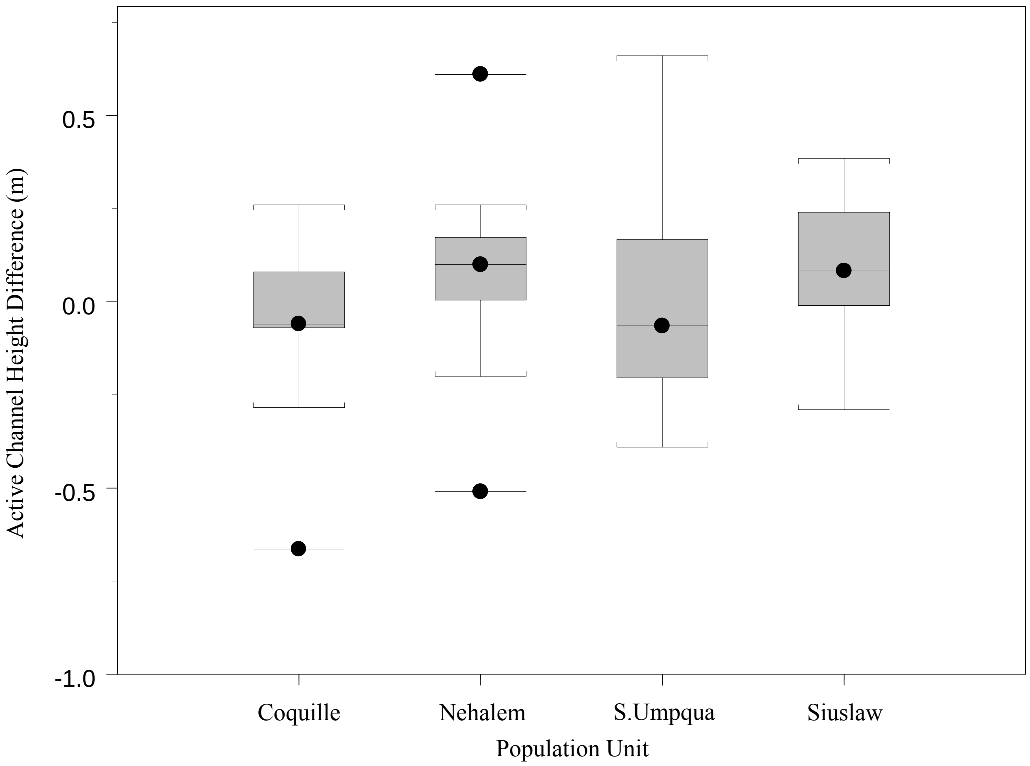

Figure 8. Box and whisker plots of differences in summer versus winter active channel height by population unit (measured in meters). n=72.

The length and area of secondary channels did not change significantly from summer to winter (Table 4). However, the relative proportion (expressed as percent) of surface area in secondary channels was higher during the summer survey season (p-value 0.02). An overall decrease in the number of beaver dams was observed in the winter compared to the summer ($p<0.001$) although the percent by area did not change significantly.

Variation in secondary channels and beaver ponds was observed between population units. Secondary channels in the South Umpqua were primarily dry during the summer whereas only 20-40% of the secondary channels in the other three population units were dry. However, the percent of secondary channel area was lower during the winter in every population area. Higher numbers and relative amounts (percent) of beaver pools were observed in the summer survey season in the Nehalem and Coquille, while the Siuslaw remained similar from summer to winter. However, in the Siuslaw some sites had beaver ponds built between the time of the summer and winter surveys. No beaver dams were observed in any of the 20 summer or winter sites in the S. Umpqua (Figures 11 and 12).

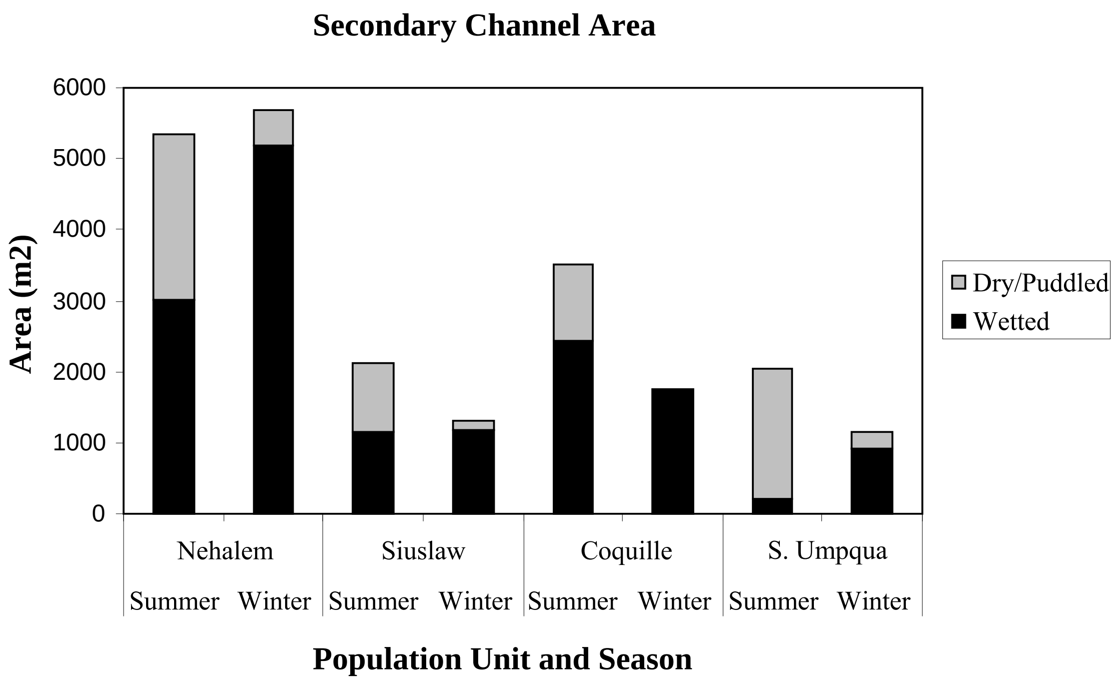

Figure 9. Seasonal comparison of secondary channel area (m2) separated into dry or puddled and wetted channel for each monitoring area.

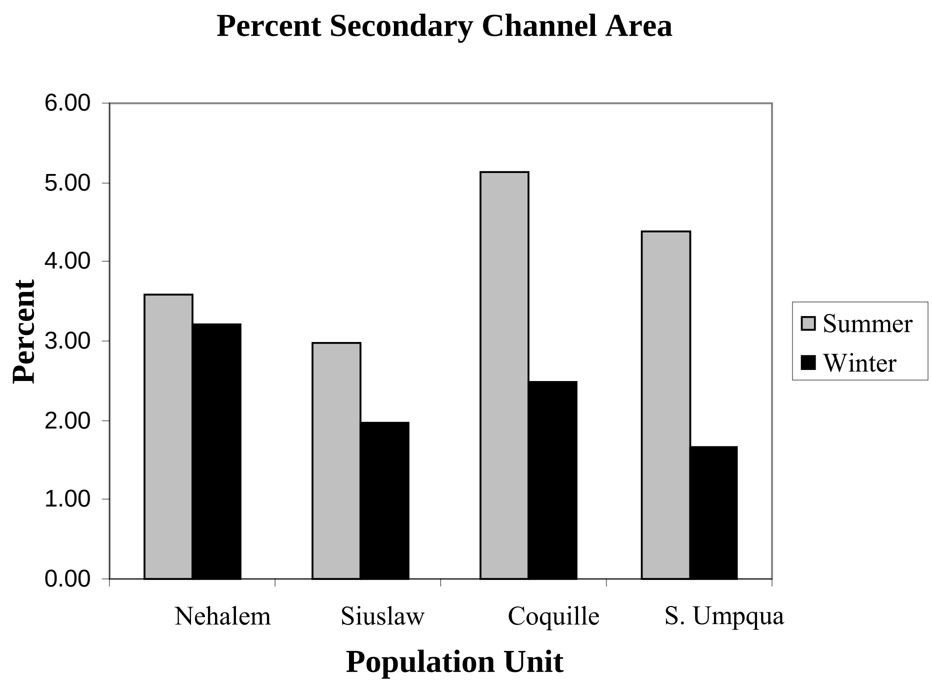

Figure 10. Percent secondary channel area for each population unit by season.

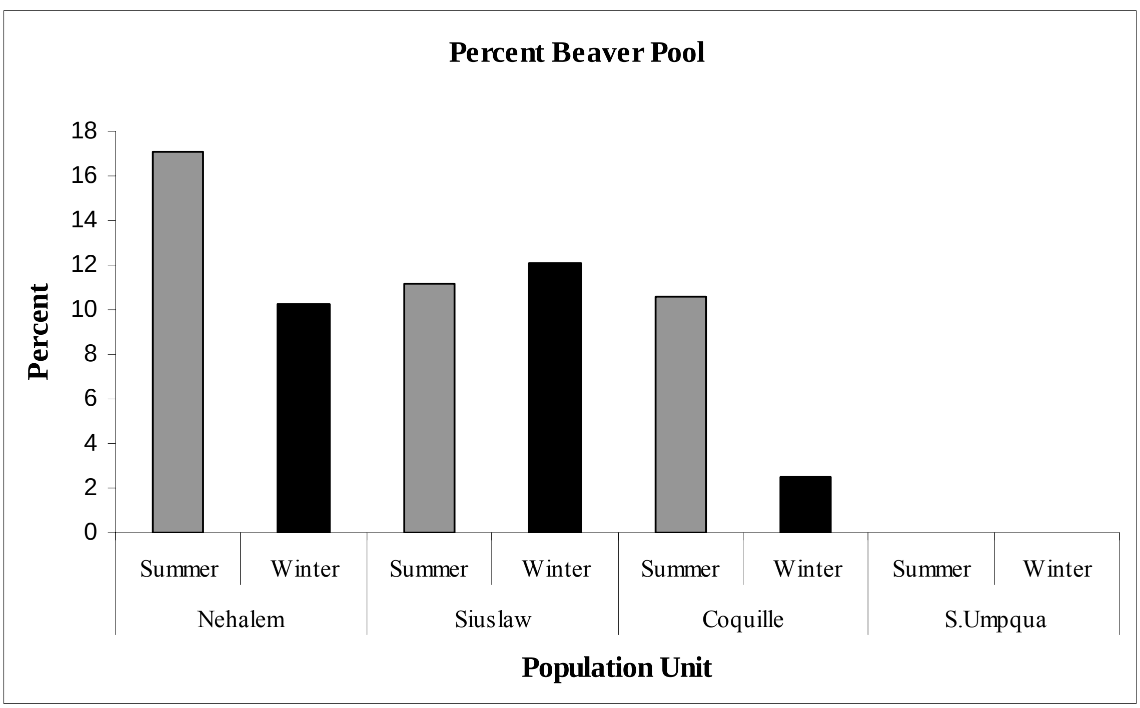

Figure 11. Average percent beaver pool during each season. No beaver dams were observed in the South Umpqua.

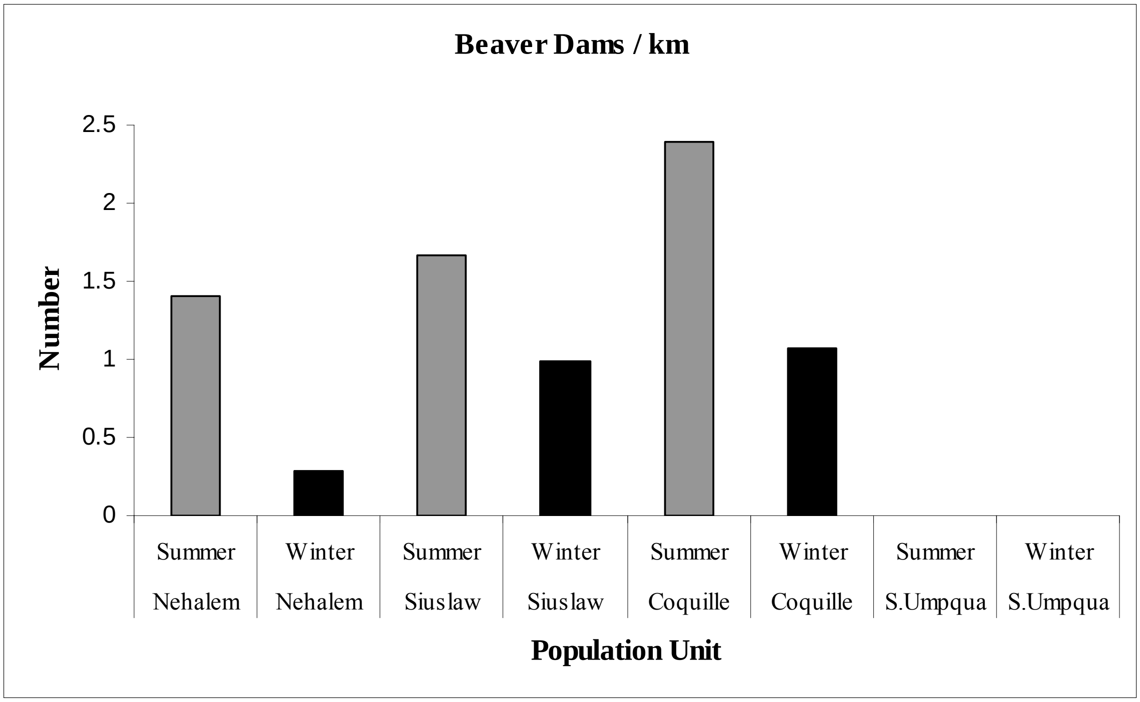

Figure 12. Average number of beaver dams per kilometer in each population unit by season.

Sensitivity Analysis

Our target sample size for winter surveys was 25 sites. The coefficient of variation (standard deviation/mean) of winter capacity (parr per km) for the four population units ranged from 62 to 186%, and confidence interval from 34 to 60%. Confidence intervals of estimates of mean parr per m^2 ranged from 20 to 45%. To achieve a precision of 30% on these two variables, we estimate that we will need to survey 30 to 150 sites per population unit assuming the variance structure remains similar to 2007.

DISCUSSION

Nickelson et al (1992) concluded that the production of coho in Oregon's coastal streams is limited by the availability of specific habitats during the winter. We know from previous surveys (Bock et al. 2004) that site-specific habitat characteristics change seasonally, and that using a regression model to predict winter carrying capacity based on summer surveys is not a perfect substitute ($r^2 \sim 80\%$) for winter surveys (Nickelson 1998, Rodgers et al 2005). Prior to the monitoring discussed in this report, we had not conducted standardized surveys during the winter at randomly selected sites at the population scale. By monitoring habitat in the winter we hope to address more directly the primary limiting factors affecting juvenile coho survival. Furthermore, because we conducted surveys at these sites during previous summers, we were able to revisit the issue of seasonal change in habitat, and evaluate the benefit in continuing winter surveys.

Summer/Winter Survey Comparison

Similar to findings in Bock et al. (2004), attributes related to depth (scour pool, riffle depths, residual pool depth, and density of deep pools) changed significantly between summer and winter survey seasons (Table 4). Of these variables, the only one not expected to change was residual pool depth, a measure thought to be insensitive to changes in water height. The residual pool depth is a measure of the difference between the maximum depth and depth at the downstream tail of the pool. This measure is generally considered flow independent because it reflects the amount of scour below a standardized water surface. However, the increase in residual pool depth (average 10 cm) may be explained by increased scour because the absolute water depth in pools increased by 25 cm while the increase in riffles was only 15 cm. We would need to monitor the cross sectional depth and thalweg profile of scour pools during winter high flows to better understand the process.

We did not see marked differences between seasons in channel and valley form or channel dimensions such as active channel and floodprone width and heights. These habitat variables should remain relatively similar regardless of when the survey is repeated because the variables are not measured relative to the wetted surface. Although we found a statistical difference in mean values of active channel height (Table 4), the increase was on average 0.06 m. The slight increase in channel height was not reflected in an increase in channel width. Outliers that were observed for active channel height (Figure 8) are likely a result of a flood prone scour that was recorded as active channel height or an underestimate during summer surveys. The floodplain surfaces are more easily observed in the winter after the vegetation has died back and high flows have swept the banks.

The amount of surface area in secondary channels is a variable used to describe complexity of channels and habitat in a stream. We describe the amount of secondary channel as either the absolute surface area (m2) or as a percent of all channel surface area. We assumed that the field crews would not observe secondary channels as effectively during summer surveys due to thick brush cover and lack of flowing water. This assumption was not consistent with results, as the surface area of secondary channel observed in the summer is similar to or slightly higher than the winter observations. Similarly, lengths of secondary channel are slightly higher in the summer. Some of the length or area attributed to secondary channel in the summer may become part of the main channel in the winter during high flow. However, because a significant portion of the secondary channels are dry in the summer (Figure 9), the crews are unable to collect detailed information. Only during winter surveys are the surveyors able to record specific unit types and depth.

Although there was not a significant difference in the surface area of secondary channels from summer to winter (Table 4), we did find that the percent of secondary channel was higher in the summer. Because the surface area and length of secondary channel was similar between summer and winter, the difference in percent channel surface area was most likely due to an increase in all channel surface area in the winter. Seasonal comparisons of the structure of habitat in secondary channel are difficult because the channels may be ephemeral or intermittent in the summer. In the Umpqua basin for example, up to 90% of the secondary channels were dry in the summer (Figure 9). The protocol used by the Aquatic Inventories Project (Moore et al. 2007) specifies that the active channel width be substituted for wetted width in a dry unit or dry channel, which will overestimate the surface area in the summer. However, the active channel width is relatively close to the wetted width in the winter. The result is that while the absolute surface area (summer and winter) are similar or slightly higher in summer, the percent of secondary channel is significantly higher in the summer. Percent secondary channel should therefore not be used to compare complexity between summer and winter data, but could be used within a season. Measuring percent secondary channel in the summer and applying it to winter habitat will also result in an overestimation.

Beaver pools have been shown to increase juvenile coho production potential by providing refuge habitat during high flow events, increasing food resources, retaining gravel, and storing water (Reeves et al. 1989, Leidholt-Bruner et al. 1992, Nickelson et al. 1992, Pollock et al. 2004). Dams built during the summer may wash out during high winter flows (Maser et al. 1981, Leidholt-Bruner 1992), and even though they are often rebuilt the following summer as flows recede they have not provided refuge for overwintering fish. Beaver pools that do survive the force of the high flows provide important slack-water refuge for overwintering fish but need to be recorded during the winter season for accurate habitat capacity estimates. We found the percentage of pool habitat provided by beaver dams to be highly variable between monitoring areas, and between seasons. Overall, our data shows a significant reduction from summer to winter in the number of beaver dams (Figure 12), and except in the Siuslaw where some dams were built between the time of summer and winter surveys, a reduction in the percent of beaver pools (Figure 11). Seasonal changes in the periodicity and distribution of beaver activity makes it difficult to assess the status of winter habitat provided by beaver except with winter surveys.

Benefit of seasonal surveys

Winter surveys may be able to capture and describe freshwater habitat variables at the flows most crucial to the survival of over wintering juvenile salmonids. In addition, winter surveys might enable better detection of secondary channels and tributaries, produce better estimates of the amount of slack water refuge available to juvenile fish during high flows, and provide more accurate measurements of channel metrics. Winter surveys also increase the likelihood of encountering redds or adults in tributaries, which helps in identifying areas of suitable spawning habitat. On the other hand, winter surveys are more difficult logistically because of access and environmental conditions.

Findings presented in this report suggest data collected in the summer is applicable to winter conditions although variables associated with water depth, beaver ponds, and secondary channels show significant differences between seasons. Changes in depth are predictable and follow the pattern observed by Bock et al. (2004). The amount and distribution of beaver pools is less predictable and the relative importance of beaver pools to juvenile coho during the winter stresses the importance of conducting winter surveys. The seasonal change in habitat unit composition of secondary channels is also difficult to assess during the summer. A cautionary note is highlighted by a study in the Umpqua basin. Ebersole (2006) observed that streams important for spawning and winter rearing habitat for coho in West Fork Smith River were dry during the summer. Adult and juvenile coho entered the stream from the mainstem immediately after the first fall rains. Spawner density was high as was juvenile coho growth and overwinter survival. It is clear that the ephemeral nature of side channels, and also some streams, requires that we survey during winter to assess winter habitat conditions.

Status of Habitat in Coho Population Units

Winter 2007 surveys were viewed as a "pilot" study in order to pinpoint logistical challenges of population focused winter sampling, assess sensitivity relative to key variables, and assess winter rearing habitat in four coho population units. We propose to conduct yearly winter surveys with a targeted sample size of at least 25 sites within randomly chosen population units spread across the four monitoring areas. The number of populations surveyed annually will vary upon the availability of funding to ensure the completion of at least 25 sites within selected populations. Our goal, however, is to survey four population units or blocks each year to complete all units (Appendices 1a and 1b), and repeat the cycle every five years. Survey sites chosen beyond 2007 will be pulled from an updated 1:24k hydrography layer, and the sites will overlap with coho spawning survey sites.

Potential juvenile coho capacity and the number of kilometers of high quality habitat in each of the selected populations were estimated using HLFM 7.0. Capacity estimates in parr/km were considered high at values greater than 1850 and low if they were less than 900. Parr/m^2 values were considered high if they were greater than 0.3 and low if they were less than 0.12. These high/low distinctions were based on survival curves presented in the Oregon Coast Coho Habitat Assessment 1998-2003 (Rodgers et al. 2005) and refined in the Conservation Plan (Nicholas 2006). The HLFM model places emphasis on beaver pools and alcove habitats. These features are abundant in the Siuslaw and rare in the Umpqua, helping to explain why the Siuslaw had the highest parr/m^2 value with nearly 25% of the surveyed length above 0.30 parr/m2 and the South Umpqua had a very low mean parr/m^2 of 0.08 with 0% of the surveyed length greater than 0.3 (Figure 5).

The amount of high quality habitat estimated with the 2007 winter surveys is not directly comparable to the values published in Rodgers et al (2005). The values presented in Rodgers et al (2005) were lower than the estimates presented here because 1) fewer stream kilometers are represented on a 1:100,000 scale than on a 1:24,000 scale stream coverage, 2) the regression model used to convert the summer data to winter values underestimated the number of higher capacity sites, and, 3) the method used to determine the number of high quality miles generated a lower estimate. However if we look at percentages rather than absolute values, which eliminates the stream coverage scale issue (1:100K vs 1:24K), the percent of stream miles that were above the benchmark of 0.30 winter parr per m^2 were similar for the South Umpqua (0-3%) and Coquille (9-13%), and increased slightly in the Siuslaw (22-28%) and Nehalem (14-20%) when comparing estimates from Rodgers et al (2005) and values from winter surveys in 2007, respectively. The relative increases in parr density shown above may be in part explained by an increase in percent of beaver pond area from 6.5 to12% in the Siuslaw and 8 to 11% in the Nehalem population area. The ability to precisely determine carrying capacity and the kilometers of high quality habitat to measure progress toward goals in the Conservation Plan may hinge on conducting winter surveys rather than use summer data to extrapolate winter values.

We were not able to achieve **c**onfidence intervals (CI) within 30% on parr per km and parr per m^2 in all population units as recommended in the Conservation Plan. Based on 25 sites per population unit, a more achievable goal is CI within 45%. The higher values of parr per km had higher coefficients of variation (CV) because a few sites had very high values. In the Nehalem population, the mean value was considerably higher than the median value. Standardizing the values (log) lowers the CV of the parr per km, and confidence interval. Given limited resources, sampling additional sites within a population unit to lower the confidence interval needs to be weighed against reducing the number of population units that could be surveyed. We will reassess the sensitivity of the winter surveys following the 2008 season. Despite the logistical difficulties of conducting surveys during the winter, the information provides an accurate and useful assessment of winter rearing potential.

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Appendix 1a. Coho population units categorized within monitoring areas. Population type designation and total coho kilometers (based on a 1:24k coverage) within each population unit also indicated. See Appendix 2b for the full list of population units within blocks.

Sampling Block	Population Unit	Population Type	Coho 1:24k Kilometers
North Coast	Necanicum + (Block 1)	Independent & Dependent	169
	Nehalem	Independent	1253
	Tillamook	Independent	721
	Nestucca	Independent	419
	Neskowin + (Block 2)	Independent & Dependent	74
Mid-Coast	Salmon River, Devils Lake	Independent & Dependent	122
	Siletz	Independent	536
	Yaquina	Independent	394
	Beaver Creek + (Block 1)	Independent & Dependent	158
	Alsea	Independent	686
	Yachats + (Block 2)	Independent & Dependent	258
	Siuslaw	Independent	1389
Mid-South Coast	Lakes Basins (Block 1)	Independent	304
	Coos	Independent	737
	Coquille	Independent	1051
	Sixes, Floras (Block 2)	Independent & Dependent	287
Umpqua	Lower Umpqua	Independent	1235
	Middle Umpqua	Independent	1320
	North Umpqua	Independent	631
	South Umpqua	Independent	1882

Appendix 1b. Coho population units categorized as dependent within population blocks based on coho kilometers and size. * Population units are small, though considered independent.

Sampling Block	Population Block	Population Unit
North Coast	Block 1	Necanicum *
		Ecola Creek
		Arch Cape Creek
		Short Sand
		Spring Creek
		Watseco Creek
	Block 2	Netarts Bay
		Sand Creek
		Rover Creek
		Neskowin Creek
Mid Coast	Block 1	Schoolhouse Creek
		Fogarty Creek
		Depoe Bay Creek
		Rocky Creek
		Johnson Creek (Siletz)
		Spencer Creek
		Wade Creek
		Coal Creek
		Moolack Creek
		Big Creek (Yaquina)
		Thiel Creek
		Beaver Creek*
	Block 2	Little Creek
		Big Creek (Alsea)
		Yachats River
		Vingie Creek
		Gwynn Creek
		Cummins Creek
		Bob Creek
		Tenmile Creek
		Squaw Creek
		Rock Creek
		Big Creek (Siuslaw)
		China Creek
		Blowout Creek
		Cape Creek
		Sutton Creek (Mercer Lake)
		Berry Creek
Mid-South Coast	Block 1	Siltcoos River (Lake) *
		Tahkenitch Lake *
		Threemile Creek
		Tenmile Creek *
	Block 2	Johnson Creek (Coquille)
		Twomile Creek
		Floras Creek *
		Sixes Creek *.