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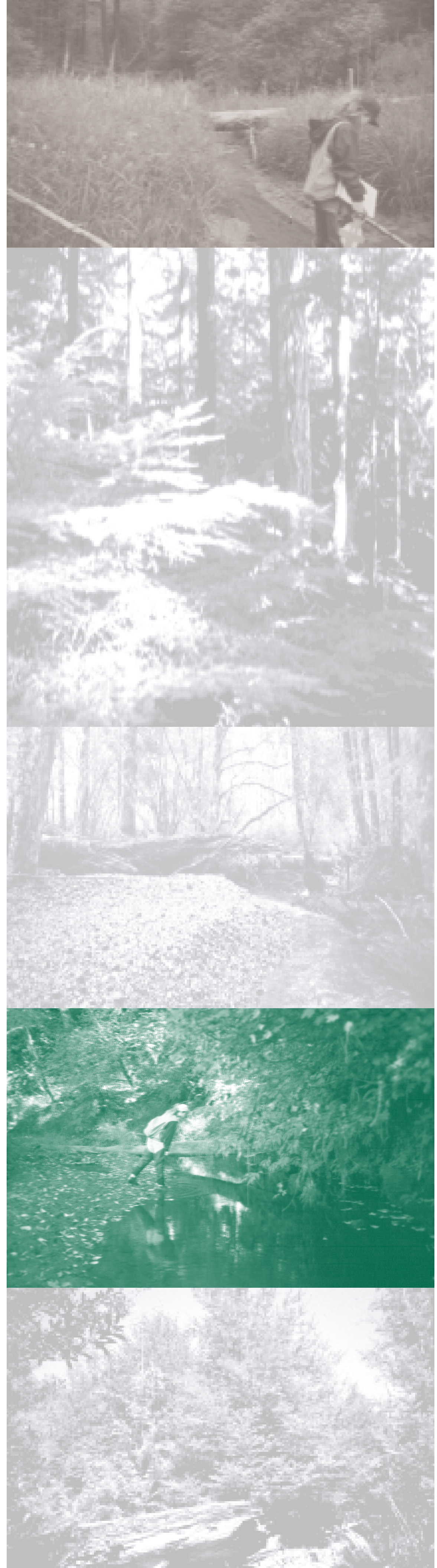

Stream Habitat Conditions in Western Oregon

1999

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Western Oregon, 1998

Oregon Plan for Salmon and Watersheds

Monitoring Program Report No. 1999-1

November 1, 1999

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Citation: Thom, B. A., K. K. Jones, and R. L. Flitcroft. 1999. Stream Habitat Conditions in Western Oregon, 1998. Monitoring Program Report 1999-1 to the Oregon Plan for Salmon and Watersheds, Governor's Natural Resources Office, Salem, Oregon.

Abstract

In the summer of 1998, watersheds in western Oregon were sampled for stream habitat. Sites were selected using a random tessellation stratified design. Oregon Department of Fish and Wildlife Aquatic Inventories methods were used to quantify indicators of sediment supply and quality, riparian forest connectivity and health, habitat structure, in-stream complexity, and presence of salmonid species. Two hundred and seventy seven sites were surveyed for habitat with a 10% repeat survey effort. One hundred and fifty seven sites were sampled for salmonid presence/absence. Approximately 49% of the sites sampled for habitat were within the range of anadromous salmonids.

Upstream catchment area and gradient were the two major factors driving the overall patterns of habitat variables. Secondarily, land ownership and geology were other factors correlated with the habitat variables analyzed. The private non-industrial land oownership type was characterized by slightly higher fine sediment levels, lower wood volumes and number of key wood pieces, lower densities of deep pools, and lower levels of stream shading. State and industrial forest lands show similar patterns to federal lands in wood levels in the stream channel, although they show lower levels of conifers in riparian zones. The sedimentary geologic type was characterized by higher levels of fine sediments in riffle units. Only six high quality, unconstrained stream reaches occurred in the 1998 habitat sample.

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INTRODUCTION

Current and historic aquatic habitat conditions in western Oregon were summarized in the 1998 annual monitoring report of the Oregon Plan for Salmon and Watersheds (Thom et al. 1998). The report summarized data from basin level stream surveys conducted in eight geographic areas from 1990-1997 (Figure 1). The objectives of the basin surveys were to describe important stream and watershed components and processes at different spatial scales, develop habitat protection and restoration strategies, and estimate salmonid survival and production based on habitat characteristics. Stream selection was based on status of fish population(s), proposed management activities within the basin, or priority for restoration. These surveys were biased in the areas that surveys took place, and therefore potential differences in geographic areas may have been possible.

In the summer of 1998, through a cooperative project with EPA Region 6, the ODFW undertook a new monitoring method using randomly selected points across the landscape from which to make unbiased determinations of habitat quality (Firman and Jacobs 1999). This data report presents results of this new monitoring method. In this report, habitat conditions in western Oregon streams will be summarized. Potential reasons for differences between areas will be explored and future analysis questions will be developed. The 1998 monitoring surveys will be compared to previous basin level surveys as well as to a group of reference stream conditions in order to provide a context from which to compare changes in habitat over time.

This report on aquatic habitat conditions in western Oregon encompasses the sampling period of June-October 1998. The purpose of this report is to:

1) Describe the baseline habitat conditions in western Oregon streams during the summer of 1998 for year 1 of the monitoring program.

2) Explore potential reasons for differences in habitat features because of stream type, geology, and land management.

3) Compare the 1998 monitoring surveys against previously collected basin level stream surveys.

METHODS

STUDY AREA

The target populations were watersheds west of the Cascade Crest that contained historic populations of wild coho salmon (*Oncorhynchus kisutch*), chinook salmon (*O. tshawytscha*), cutthroat trout (*O. clarki*) or steelhead trout (*O. mykiss*) (Figure 1). The target populations of streams for the study were based upon a hydrography data layer developed by the USGS at the 1:100,000 scale. Streams upstream of large dams that blocked anadromous fish passage were removed from the selection frame. In the Willamette basin, only those streams in the Eastern Willamette valley that occurred within the Willamette Valley Foothills, and Western Cascades ecoregions (Clarke et al. 1991) were selected. The selection frame for this area was narrowed due to limited funding for surveys in this area and the desire to focus on streams containing winter run steelhead or spring run chinook salmon.

SITE SELECTION PROTOCOL

A random tessellation stratified (RTS) design (Stevens 1997) was used to select potential sample site locations. Stevens and Olsen (1999) describe the RTS survey design as applied to streams. The advantage of the RTS selection protocol was the selection of sites spread randomly across the landscape. In all areas surveyed, samples were weighted to provide an equal number of sample sites in each area (50), with the exception of the Southwest Washington area that only had 35 sample sites. In the Willamette, Lower Columbia, and Southwest Washington areas, site selection was weighted by stream order (Strahler). An equal number of sample sites were apportioned to first, second, and third order streams as shown on the 1:100, 000 scale hydrography layer.

We attempted to sample every site. However, some site were either not surveyed, or were later dropped from the analysis. The two main reasons for not surveying a site were denial of access from landowners and lack of time. Additional sites were discarded from analysis as non-target sites because they were either: too small (<0.6 km^2 catchment area), located in tidally influenced areas, or a result of errors in the selection coverage (Table 1).

SURVEY METHODS

HABITAT

Channel habitat and riparian surveys were conducted as described by Jones and Moore (1999) with some modifications. Modifications to the survey methods included: Surveying stream lengths of only 500-1000 m and measurement of all habitat unit lengths and widths (as opposed to estimation). A site length of 500-1000 m allowed data to be collected at more than 20 habitat units at each site which was sufficient to characterize stream features and attributes that tended to be patchy in nature. In most cases the number of units surveyed at each site allowed for a a stable mean to be developed for each of the habitat attributes (Figure 2, Figure 3).

HABITAT RESURVEY

A repeat survey was conducted at 10 % of the sites sampled in order to compile a database on within year variation in the habitat surveys. Repeat surveys were a randomly selected subsample from each geographic area. The repeat surveys were intended to measure within season habitat variation and differences in estimates between survey crews. Variation in survey location was assumed minimal because survey starting and ending points were marked in the field.

FISH

Fish presence/absence surveys were conducted in all of the study areas. In the five coastal areas, fish presence/absence surveys were conducted in areas outside of historic coho salmon distribution using either electrofishing or snorkeling methods. A separate project within ODFW conducted coho salmon summer density estimates and results from that effort will be reported separately. In the Willamette, southwest Washington and lower Columbia areas fish presence/ absence surveys were conducted at all sites. A complete description of the methods used is contained in ODFW (1998).

ANALYSIS

DATABASE MANAGEMENT

All data were entered into DbaseIV and summarized using a report form. The data were linked to geographic point coverage of the sites for GIS analysis.

COMPILATION

Summarized data were entered in a database in MSAccess97. Habitat conditions were described using a series of cumulative distributions of frequency (CDF). The variables described were indicators of sediment supply and quality, riparian forest connectivity and health, habitat structure, and in-stream habitat complexity. The specific attributes were:

Percent of substrate area with fine sediments (<2 mm) in riffle units
Percent of substrate area with gravel (2-64 mm) in riffle units
Density of riparian conifers (>50cm DBH) within 30 m of the stream channel.
Percent of channel shading (Percent of 180 degrees)
Density of woody debris pieces (> 3 m length, >0.15 m diameter).
Density of key woody debris pieces (>10 m length, ≥60 cm diameter).
Density of wood jams (groupings of more than 4 wood pieces)
Density of deep pools (pools >1 m in depth).

While these attributes do not describe all of the conditions necessary for high quality salmonid habitat, they do describe important attributes of habitat structure within and adjacent to the stream channel. Water quality and quantity as well as food production are not addressed in the discussion of physical habitat, while they are important to ecological integrity. The median and first and third quartiles were used to describe the range and central tendencies of the frequency distributions of the key habitat attributes used in the analysis of current habitat conditions (Zar 1984).

A set of reference conditions are also presented from which to gauge differences between the areas analyzed. A complete description of the reference database is included in the 1998 report of historic habitat conditions (Thom et al. 1998).

Exploratory analysis was conducted using GIS and cumulative distributions of frequency. Sites were post stratified to look at differences resulting from land ownership, channel gradient, and catchment area. Small sample sizes hindered the analysis that could be conducted using the first year sampling data. The design of the sample selection and the number of sites allowed for post-stratification (Cochran, 1977), given a minimum of 20 sites were included in each new strata and the weights of the sample were known. The purpose of the exploratory analysis was to describe some patterns that might be emerging in habitat attributes across the landscape, and to develop hypothesis that can be tested in future years of sampling.

HABITAT RESURVEY

The precision of an individual metric was calculated using the mean variance of the resurveyed streams "Noise" and the overall variance encountered in the habitat surveys "Signal". Three measures of precision were calculated, the standard deviation of the repeat surveys SD_{rep}, the coefficient of variation of the repeat surveys (CV_{rep}), and the signal to noise ratio (S:N). The precision measures are reported in Table 14.

S:N ratios of < 2 can lead to distorted estimates of distributions and limit regression and correlation analysis. S:N ratios > 10 have insignificant error caused by field measurements and short term habitat fluctuations (Kauffman et al. 1999).

OVERALL HABITAT QUALITY MEASURES

The interactions between habitat metrics were examined through a series of data queries relating to habitat quality. Potential anadromous salmonid reaches less than 5% in stream gradient were examined for habitat quality. The number of sites that had high quality habitat, or the potential for high quality stream habitat were summarized by channel type. The major channel type divisions were the wide valley width types of: unconstrained reaches, potentially unconstrained reaches (terrace height less than 25% greater than flood prone height), and deeply incised reaches (terrace height more than 25% greater than flood prone height); and the narrow valley width type of hillslope constrained reaches.

The criteria used to define high quality in-channel habitat were: pool area > 30% of channel area, the presence of slackwater pools or secondary channels, wood volumes greater than 10 m^3 per 100 m of stream channel and the presence of key pieces of woody debris.

RESULTS AND DISCUSSION

PROBLEMS ENCOUNTERED

The overall rate of access denial was relatively low (10%), but did encompass a large percentage of the sites on private lands. The assumption that the sites not surveyed due to access denial were a random sample of all sites may have been erroneous given the lower quality habitat that was observed on private non-industrial lands. Due to this fact, the findings of the 1999 surveys may paint a better picture than reality.

The change to a random site selection protocol did come with costs. Any previously gathered information would be difficult to compare to the more robust sample. In the future, a GIS could be used to select habitat unit level data from previous basin surveys. Basin survey data could also be used as "found" data to provide a larger sample for trend detection (Overton et al. 1993).

CURRENT HABITAT CONDITIONS

Mean channel gradients, mean active channel widths, and mean catchment area of stream segments surveyed in each geographic area are listed in Table 2. The South Coast and Willamette areas had the highest mean channel gradients at 8.5 and 8.6 % respectively. The stream segments surveyed in the Mid-South Coast area had a low mean gradient (3.5%), a high mean active channel width (8.4 m), and a large mean catchment area (22.5 km^2) (Table 2).

The following descriptions of habitat variables are intended to highlight selected features of the aquatic habitat in western Oregon. Figures 3-12 and Tables 3-12 provide an exhaustive summary.

FINE SEDIMENTS

The areal extent of silt and sand on the surface of low gradient (0.5-2.0%) riffles was selected to typify potential accumulation of fine sediments in a stream. All of the areas had higher fine sediment levels than the reference reaches (Figure 4). The Mid-Coast, Lower Columbia, and Willamette fine sediment values were slightly higher than the reference values both in range and median value (Table 3). The North Coast and Southwest Washington areas were the most different from other areas, and the reference database, with a shift towards higher fine sediment levels (Figure 4). Over 70% of the sites surveyed in the North Coast and Southwest Washington areas had over 20% fine sediments in low gradient riffle units.

GRAVEL SUBSTRATE

Gravel substrate did not differ greatly between areas, or the reference reaches, in either range or distribution. The amount of gravel in riffle units is normally distributed, with the reference reaches approaching a median frequency distribution. The low variability between areas, and between sites within areas, does not allow for small differences between areas to be discernable. The Southwest Washington area did however show very low gravel values, while the Willamette area showed higher gravel values than the other areas sampled. Based on the observed frequency distributions, gravel quantity does not appear to be limited for spawning salmon at the scale of the large geographic areas used in this analysis. (Figure 5,Table 4).

RIPARIAN HEALTH

Channel shading appears to mimic the distribution of shading observed in the reference reaches. The 1st quartile falls around 70% shading for most of the basins studied and the 3rd quartile falls slightly above the 90% shading observed in the reference reaches (Table 5). The Mid-South Coast area appeared to have higher shading than the reference database, and the Southwest Washington area fell below the reference conditions in all quartiles (Figure 6,Table 5). The Lower Columbia area had more stream length with less than 70% average channel shading than any other area sampled.

The number of riparian conifers observed differs markedly from the reference reaches. All of the areas show low conifer numbers with over 30% of the stream lengths surveyed having no large conifers in the riparian zone (Figure 7). The 75th percentile occurs at less than 120 conifers per 305 m of stream length for all of the areas, while the reference reaches had a 75th quartile of 240 conifers (Table 6).

WOODY DEBRIS

The reference values observed for the distribution of the number of pieces of wood in the stream channel falls within the range observed in the streams used for current conditions analysis (Figure 8).

The North Coast and Willamette areas had a slightly higher proportion of stream length with higher numbers of wood pieces.

The number of key pieces of wood differs more markedly than the number of wood pieces. These large pieces were low in all of the areas with 50% of the stream length surveyed in each basin having less than 1.0 key piece per 100 m of stream channel (Table 8). The median value for the reference reaches is 1.8 key pieces per 100 m of stream channel (Table 8). Again, the North Coast and Willamette areas had higher levels of key pieces of woody debris than any other area (Figure 9). The Mid-Coast, South Coast, and Lower Columbia areas had the lowest number of key wood pieces with over 75% of the stream length in those areas having less than 1.0 key piece per 100 m of stream channel.

POOL QUALITY

An overall difference in the distribution of deep pool numbers was readily apparent between the reference reaches and the western Oregon basins that were analyzed (Figure 10). Much of this difference is likely due to differences in mean channel sizes between the reference reaches and the random survey sites (Table 2). All of the coastal basins had a higher proportion of streams without any deep pools as compared to the reference reaches (Figure 10). Over 40% of the sites in each area did not have any pools deeper than one meter. The Lower Columbia area had the lowest density of deep pools with over 75% of the stream length in the area having no deep pools.

NEW VARIABLES

For the 1998 surveys, new variables were explored to better describe habitat conditions. The new variables were percent area of bedrock, wood volume density, and density of wood jams.

BEDROCK

The distributions of percent bedrock area are similar between the areas sampled, with the exception of the Umpqua Basin. The Umpqua basin had a slightly higher length of stream with a high amount of bedrock substrate (Figure 11). Less than 25% bedrock substrate occurred in more than 75% of the sites (Table 10). Sites occurred within the Umpqua and Mid South Coast areas that had more than

50% bedrock substrate. The distribution of bedrock in streams appears very patchy and highly variable between the areas surveyed.

WOOD VOLUME

Wood volume density showed a wide range of distributions between the different areas surveyed. The general pattern was similar to the density of wood pieces, but the distributions had a much wider range (Figure 12). This wide range of distributions may increase the ability to detect change in wood levels and be of use in future analysis.

WOOD JAMS

The number of debris jams was analyzed to measure clumping of woody debris in the stream channel. 1998 was the first year that the number of jams has been documented in the reach level database, therefore a baseline for comparison does not currently exist. The distribution of jams does appear to be widely distributed from 0 to 25 jams per km (Figure 13). The North Coast and Willamette areas had the highest number of stream miles with a higher number of jams. These two areas were also areas with the highest levels of wood pieces and volumes.

BASIN SURVEY COMPARISON

A descriptive comparison was conducted between the observed patterns in the monitoring surveys and those observed in the previous basin surveys. Much of the difference between the two types of surveys appears to be a result of a shift towards smaller, steeper channels in the monitoring surveys. These smaller channels had fewer deep pools, more woody debris, and higher levels of fine sediments and are likely source areas for the downstream segments. A matrix of habitat variables and geographic areas is presented in Table 13 to highlight the differences between the random monitoring surveys and the previous basin surveys.

FINE SEDIMENTS

The levels of fine sediments in riffle units observed in the random monitoring sites appears to be higher than those levels observed in the basin surveys, with the exception of the South Coast area. In the North Coast area the 75th percentile increased to 46% in the random monitoring surveys. The reference database has a 75th percentile of 22% fine sediments.

GRAVEL SUBSTRATE

Gravel substrate in riffle units appears to occur at lower levels in the random surveys than the basin surveys, with the exception of the Willamette area which has higher gravel levels than observed in the basin surveys (Table 13). The decrease in gravel quantity may be due to a shift towards smaller, high gradient streams and larger low gradient streams that are dominated by bedrock, or cobble and boulder substrates.

RIPARIAN

Differences were observed between the basin surveys and random surveys for both stream shade and riparian conifers. All basins appeared to have adequate channel shading. The Willamette, Lower Columbia, Mid Coast and Mid-South Coast areas had higher stream shading than the basin surveys, while the North Coast and Southwest Washington areas had decreased channel shading (Table 13).

Large riparian conifers were rare and patchy in their distribution. The 75th percentile of the frequency distributions for riparian conifers were higher in the North Coast, Mid-Coast, South Coast, and Lower Columbia area than the basin surveys (Table 13). The Mid-South Coast, and Umpqua basin appeared to have lower riparian conifer levels than the basin surveys.

WOOD

In all areas, wood piece density was higher than those levels observed in the basin surveys. The density of key wood pieces did not show the same pattern. In the Willamette, North Coast and Umpqua areas the number of key pieces was higher in the random surveys, while in the Mid-Coast and Southwest Washington areas the number of key pieces was lower than the basin surveys (Table 13).

POOLS

The distribution of density of pools more than 1 m in depth were very different than the previous basin surveys. Much of this difference is due to the decrease in average channel size in the random surveys

(Table 2). In the Mid-South Coast, South Coast and North Coast areas the 75th percentile was higher than those observed in the reference reach database (Table 13).

RESURVEY ANALYSIS

The signal to noise ratio of many of the indicators used in the analysis of current conditions fall within the range of 3- 10, with the exception of wood pieces and volume (Table 14). Other indicators that had higher signal to noise ratios, and which also may be useful indicators of aquatic habitat health are entrenchment ratio and the percent area of slow water pool habitat. Channel gradient, bankfull channel width and terrace width had signal to noise ratios greater than 10 which makes them useful independent variables in comparisons of stream channels. Another interesting note is that percent pool habitat has been stated in many surveys to be imprecise and useless in many comparisons (Kauffman et al. 1999). Pool area was not used in this analysis because of this fact. After conducting the resurveys in 1998, we achieved a signal to noise ratio of 6.7. A S:N ratio of 6.7 suggests a level of precision useful for analysis in the future.

The reasons for the moderate and low S:N ratios for many of the attributes were due to many factors. Low variance between streams occurs in the estimates of substrate area. The standard deviation of riffle gravel for the repeat surveys is +/- 9%, while the overall standard deviation for all surveys is only 18%.

FISH SURVEYS

Seventy-seven sites were sampled in the five coastal areas for fish presence/absence. Juvenile coho salmon were present at six of these sites. Three sites were located outside of the known range of coho salmon, for a total of 1.5 km of previously undocumented distribution. One site was located above a hatchery (Fall Creek, Alsea River) that is not sampled for adult spawners, two sites resulted from errors in the site selection coverage. Cutthroat trout were documented at 43 sites, and steelhead/rainbow trout were documented at 16 sites. One site in the South-Coast area had exotic species present (sunfish, *Lepomis sp*.).

Seventy-five fish presence/absence surveys were conducted in the three Columbia tributary study areas. Cutthroat trout were the most ubiquitous species, with presence documented at 40 sites. Steelhead/resident rainbow trout were documented at 35 sites. Coho salmon were documented in 8 sites within the Lower Columbia and Southwest Washington areas, and chinook salmon were found at only one site.

The use of the salmonid presence/absence surveys was valuable in two ways. The first is that the surveys helped to better define the range of coho salmon in the affected watersheds. Secondly, the distribution helped to classify sites based on fish use of the surveyed reaches.

LANDSCAPE PATTERNS OF HABITAT

Upstream catchment area and gradient were the two major factors driving the overall patterns of frequency distributions of habitat variables. Upstream catchment area and gradient show a high degree of intercorrelation. In order to account for catchment area and gradient, random samples from all areas were stratified into three major groupings for the comparison of frequency distributions. The groupings were catchment areas of < 4 km^2, 4-20 km^2 and > 20 km^2. Only one group, those streams between 4 and 20 km^2 in catchment area, had an adequate sample size (n = 81) to allow post-stratification based on land ownership, geology, and valley type. We explored regionwide trends in habitat as well as spatial trends across the landscape. Maps of site charactersitics were visually analyzed to look for spatial pattern and patchiness. Other attributes of the site database were also plotted to explore if any patterns may exist with these variables. The other variables that were plotted included landslide frequency and fire history.

Land ownership appears to affect both the level and distribution of habitat variables across the landscape. Land ownership was stratified into three major groupings: Private non-industrial lands, Industrial and State owned forest lands, and Federal lands. The private non-industrial lands were characterized by slightly higher fine sediment levels, lower wood volumes and number of key wood pieces (Figure 15), lower densities of deep pools (Figure 16), and lower levels of stream shading. State and industrial forest lands show similar patterns to federal lands in wood levels in the stream channel, although they show lower levels of conifers in the riparian zones. This may pose a potential concern for future woody debris recruitment on state and industrial forestlands.

The degraded habitat conditions on private non-industrial lands may pose an even greater problem for protecting and restoring coho salmon populations. Federal lands which are the most protected of all of the land ownership types have the lowest percent of sites within the range of coho salmon, while the private non-industrial lands have the highest (Figure 14).

The distribution of the densities of pools shows state and industrial forest land with higher densities of deep pools than federal or private non-industrial (Figure 16). For streams of 4-20 km^2 catchment area, over 40% of sites on private non-industrial forestlands did not have any deep pools over 1 m in depth.

The parent geologic type of the sites shows a high correlation to the distribution of fine sediment levels across the landscape, with higher fine sediment levels observed in the sedimentary geologic types (

Figure 17). This pattern is also apparent spatially across the landscape (Figure 18). The distribution of landslides along the sites surveyed appears to be inversely correlated with high sediment levels in the North Coast area (Figure 19). The patterns of fine sediment levels and landslide frequency do not appear to hold true in the more southern areas surveyed. Landslide frequency may be more closely correlated with topographic relief and will need to be explored in future analysis.

OVERALL HABITAT QUALITY IN WESTERN OREGON

While individual habitat attributes are important, it is the interaction between individual metrics that creates and maintains habitat. Of the 302 reaches surveyed and analyzed, 137 reaches were less than 5% in stream gradient. Nineteen reaches were unconstrained, 36 were potentially unconstrained, 29 were terrace constrained, and 53 were hillslope constrained (Table 15). Unconstrained reaches usually retain the highest quality habitat in the form of complex pools, adequate spawning gravel and high woody debris levels. Heavily incised (terrace constrained) channels are usually the lowest quality habitat with less complexity, woody debris, and spawning substrate.

Six of the 19 unconstrained reaches had high habitat quality (Table 15). Overall the reaches that were unconstrained had higher habitat quality than the other channel types. Only 2 of the 19 unconstrained reaches listed some form of agriculture or grazing as a land use. The potentially unconstrained reaches included seven high quality reaches out of 36. All seven reaches were located in forested land uses. The deeply incised channel type did not include any high quality reaches. None of the deeply incised reaches had a pool area greater than 12% in the deeply incised channel type. Hillslope-constrained reaches contained seven high quality sites out of the 53 surveyed. These hillslope-constrained reaches are source areas to the lower gradient wide-valley floor segments for woody debris and sediment. In many cases these reaches are fulfilling that function with high wood levels and high gravel quantities. The number of wood jams was also different between the different channel and valley types. Hillslope constrained reaches had the highest densities of wood jams, followed by the unconstrained reaches, the potentially unconstrained reaches, and the deeply incised reaches.

In western Oregon, very few stream reaches had high quality habitat. A majority of streams consisted of moderate quality habitat. These moderate quality areas may, and do, support salmonids. Without high quality refuge habitat, moderate quality areas cannot support a large abundance of salmonids through periods of frequent disturbance. Due to sample size limitations, the lack of high quality habitat also limits what conclusions may be drawn between land management interactions and habitat.

CONCLUSIONS

The overall program of randomly selecting sites across the landscape that was initiated in 1998 was very successful. The sampling program proved to be very efficient both financially and in field effort expended. The new sampling program allowed a somewhat unbiased sample of both fish habitat and salmonid presence/absence in many reaches of stream in western Oregon. The problems encountered in the initial year of sampling were minor in nature and were corrected for the second year of the sampling program.

Overall western Oregon streams were typified by high fines in riffle units, moderate gravel quantities, low woody debris levels, a low frequency of deep pools, low densities of large riparian conifers, and high amounts of stream shading.

In the analysis of 1998 monitoring data, several areas of potential concern in habitat quality arose. The greatest area of potential concern was in the quantity of fine sediments in the stream reaches surveyed. All areas surveyed had fine sediment levels higher than the reference surveys. The presence of excessive fine sediment levels was even a concern in 15 of the 20 reaches denoted as high quality habitat.

A note of caution is in order regarding all of the analysis presented in this report. Any of the observed results must be weighed in the context of channel size, gradient, valley and channel from, geology and land use history. As an example the depth of pools > 1 m in depth appear different than in previous basin surveys. These differences are likely due to differences in the size of the channels surveyed as opposed to actual differences across the landscape.

The analysis of the resurveyed streams was very useful in determining which variables are the most precise for use in future analysis. In the future, the precision of habitat metrics can be weighed against their usefulness in describing natural conditions in order to more accurately reflect conditions on the landscape. The resurvey analysis also allows the Aquatic Inventories Project to better focus training and field supervision to increase precision. The resurvey of 10% of the surveyed streams will continue in order to build a larger data set of within season variability in the surveys

FUTURE RESEARCH QUESTIONS

- Can an improved method for integration of habitat metrics be developed to better assess habitat quality on a reach scale?
- Do the presence of wood jams lead to improved winter habitat condition in streams?
- What are the effects of land management activities on wood levels, fine sediments, bank erosion, and channel stability?
- Can the current habitat monitoring program be linked with the monitoring of in-stream restoration sites to answer questions regarding restoration effectiveness?
- How does the presence of beaver activity affect reach type, wood levels, fine sediments, etc.?
- What is the relationship between the density of juvenile coho salmon and habitat quality?
- Can an improved set of reference conditions be developed that more closely represent the target population of streams (size and gradient)?
- Can the randomly selected stream reaches be discussed in context with their location in the watershed in order to describe some of the more process driven factors affecting habitat?

MODIFICATIONS TO 1999 SAMPLING

- All sites with catchment areas less than 0.6 km^2 and all tidally influenced sites were dropped from the target frame and will not be sampled in future years.
- The Southwest Washington, Lower Columbia, and Willamette areas were not surveyed in 1999 due to cuts in funding.
- Trend detection techniques will be developed to establish an analysis format for the future.

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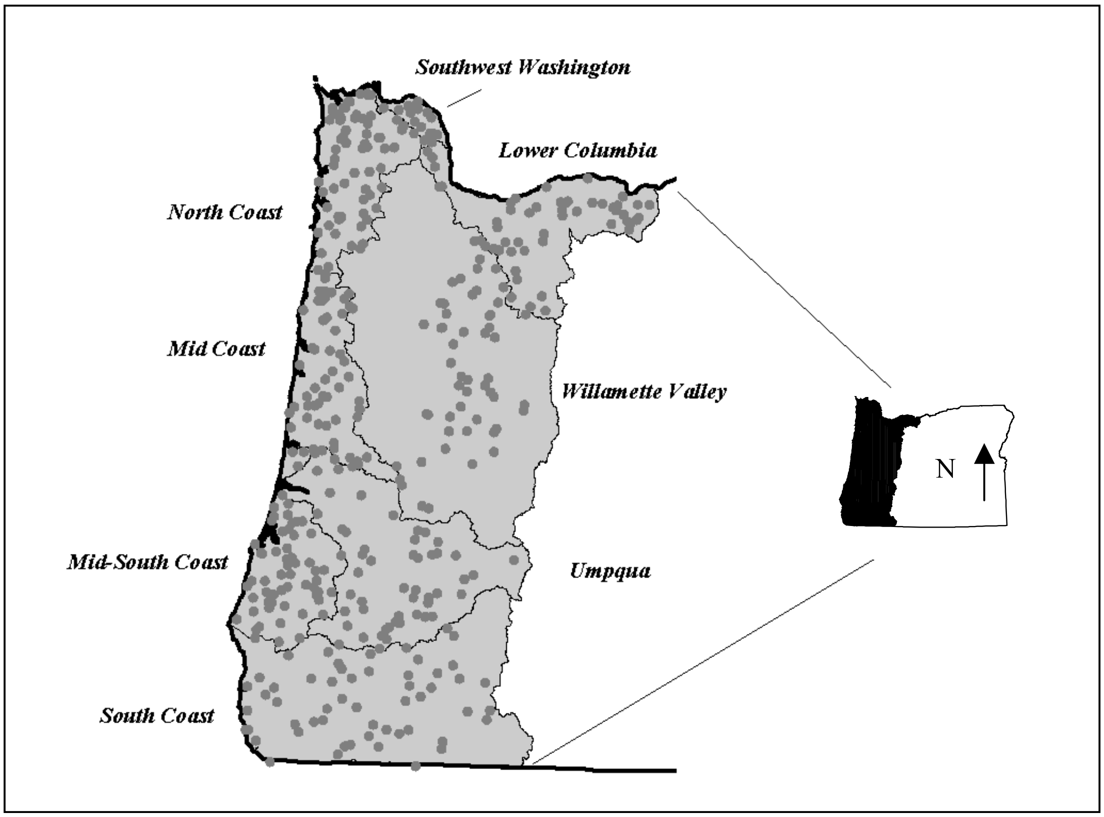

Figure 1: Randomly selected sample site locations in Western Oregon

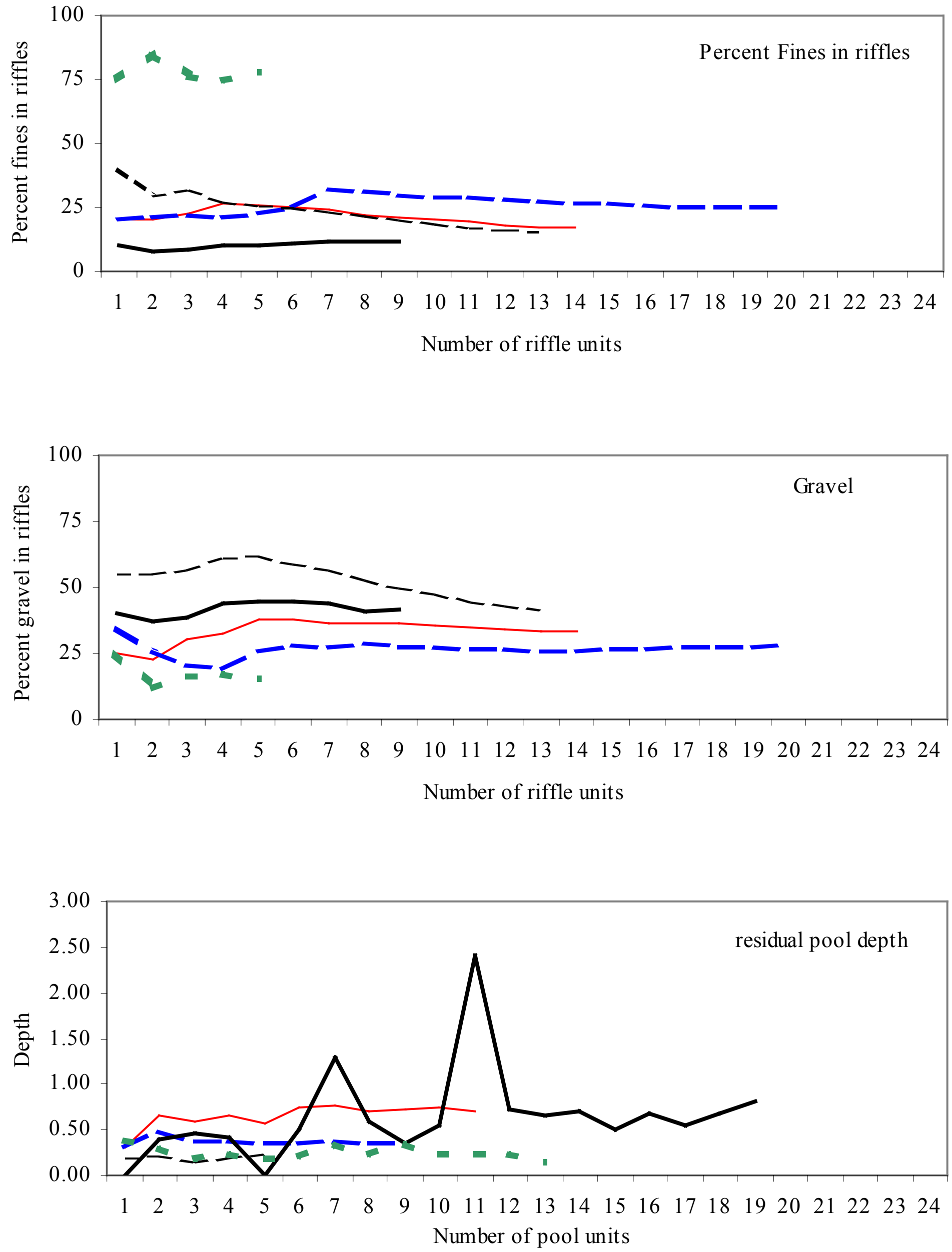

Figure 2: Number of channel habitat units surveyed vs. running average of percent fines in riffles, percent gravel in riffles and residual pool depth. In all cases, the number of units surveyed at each site was sufficient to stabilize the mean value observed.

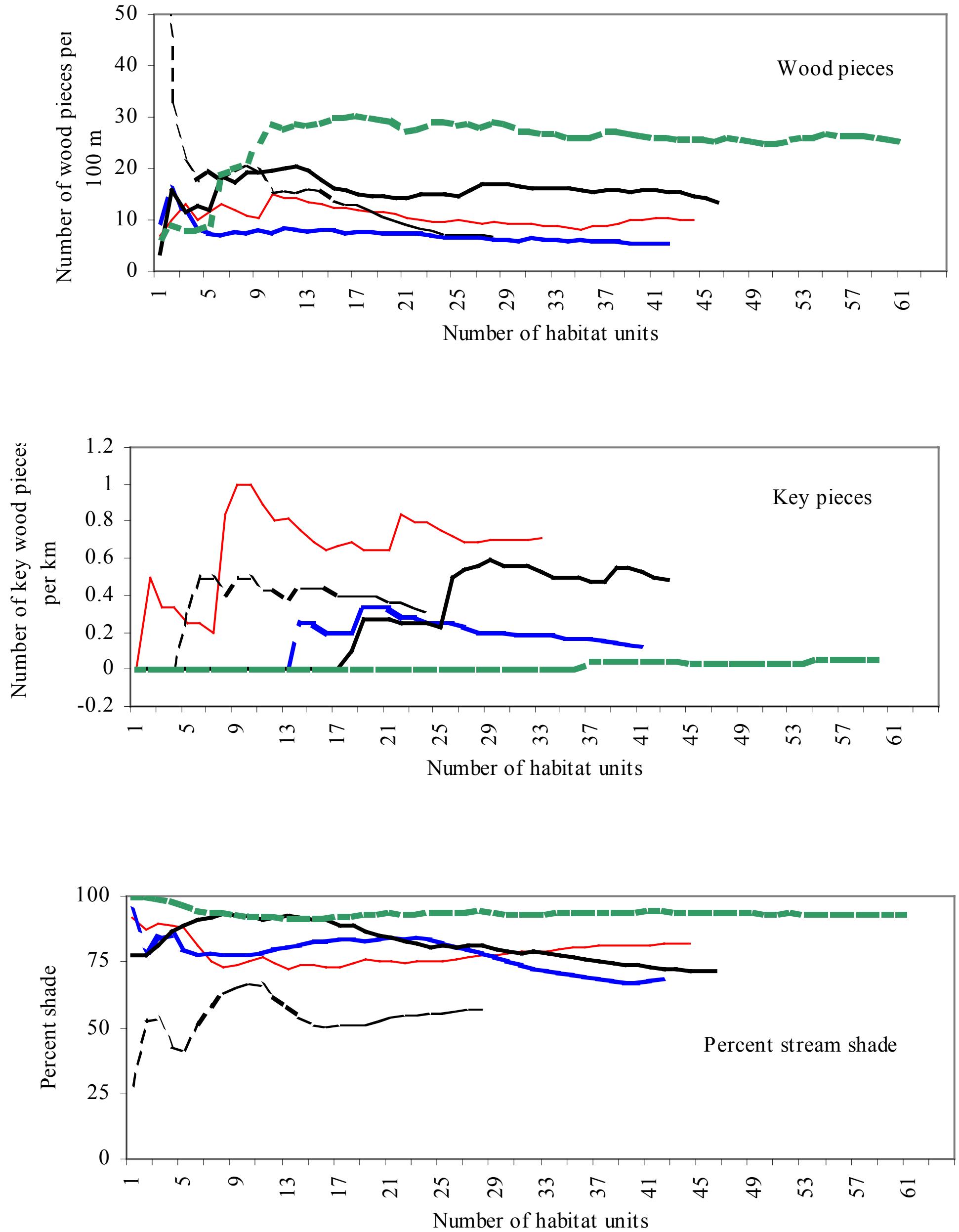

Figure 3: Number of channel habitat units surveyed vs. running average of wood pieces, key wood pieces and stream shade. In all cases, the number of units surveyed at each site was sufficient to stabilize the mean value observed

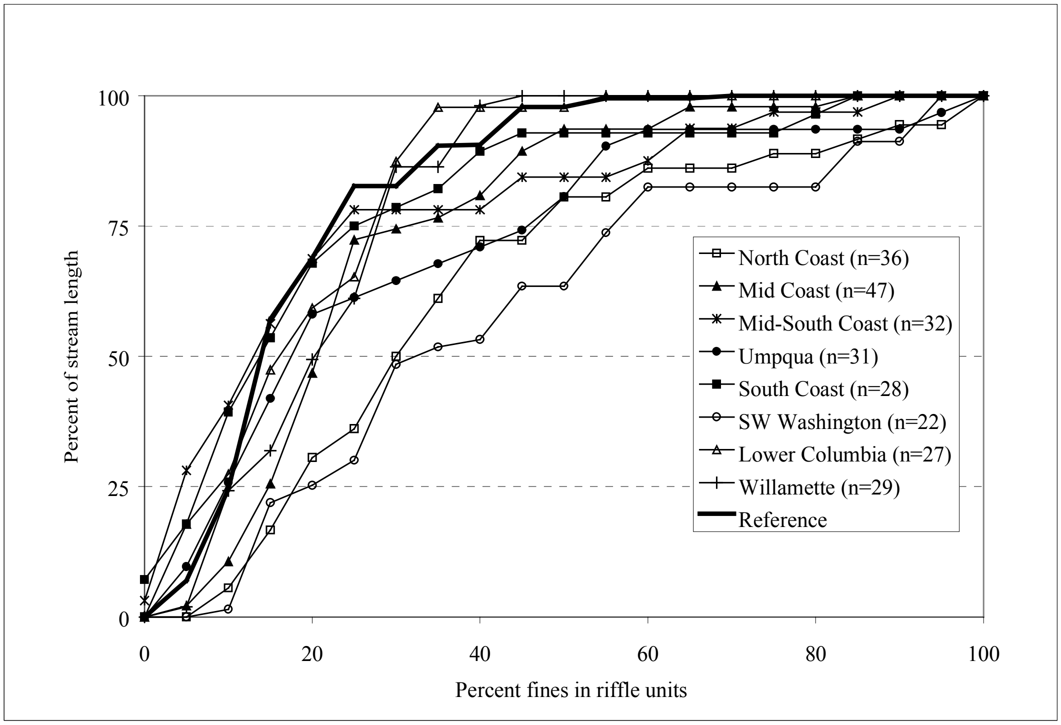

Figure 4: Cumulative distribution of frequency for the percent fine sediments in riffle units for eight geographic areas in western Oregon.

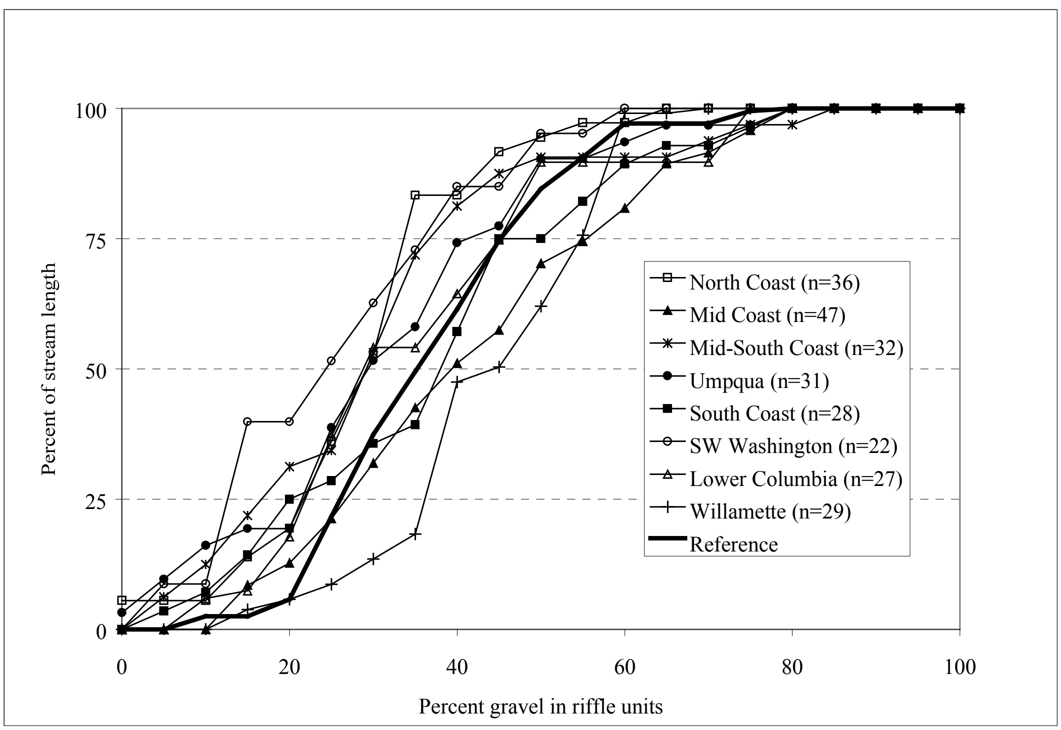

Figure 5: Cumulative distribution of frequency for the percent gravel in riffle units for eight geographic areas in western Oregon.

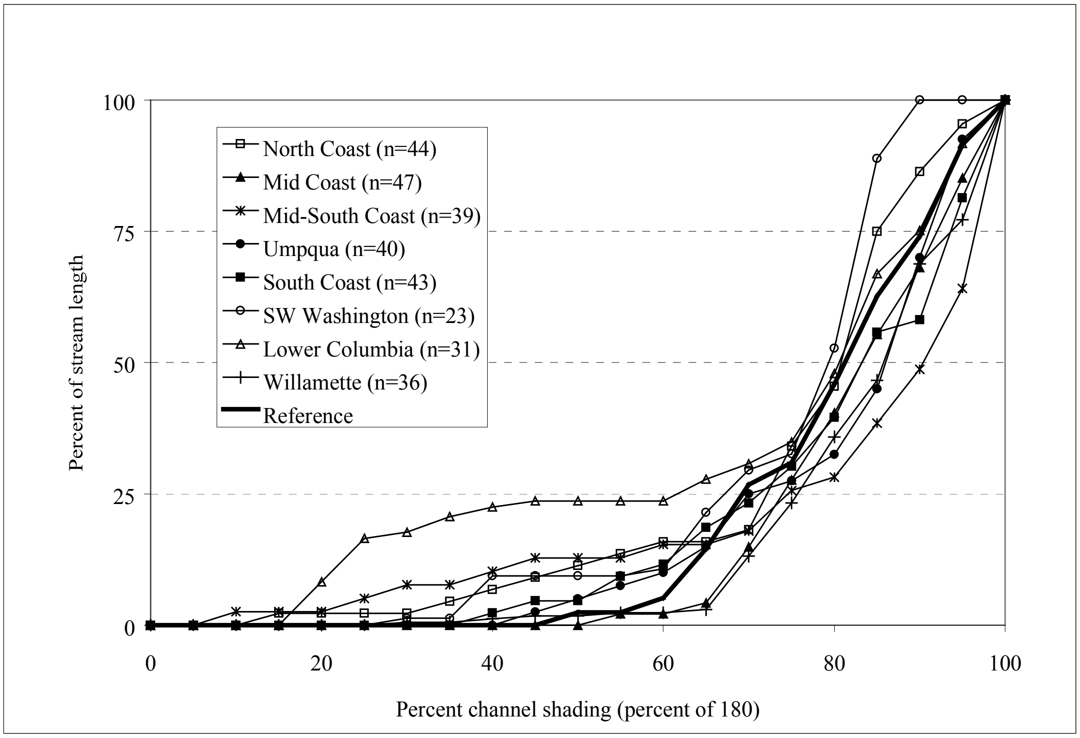

Figure 6: Cumulative distribution of frequency for the percent channel shading for eight geographic areas in western Oregon.

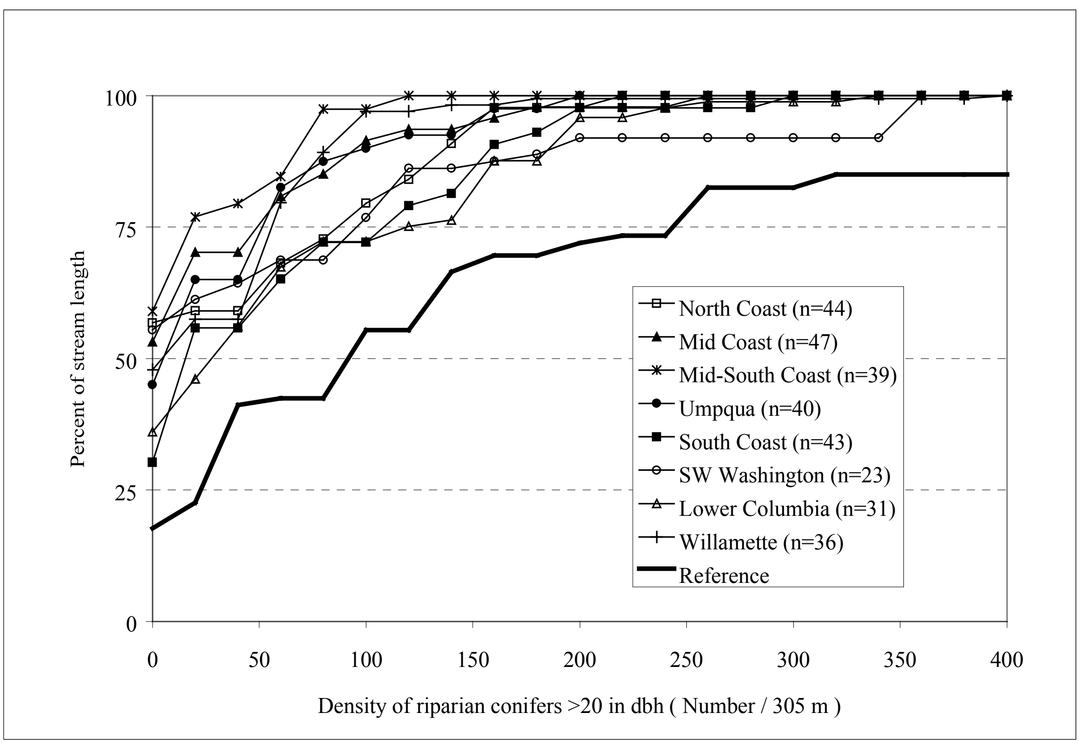

Figure 7: Cumulative distribution of frequency for the density of large riparian conifers for eight geographic areas in western Oregon.

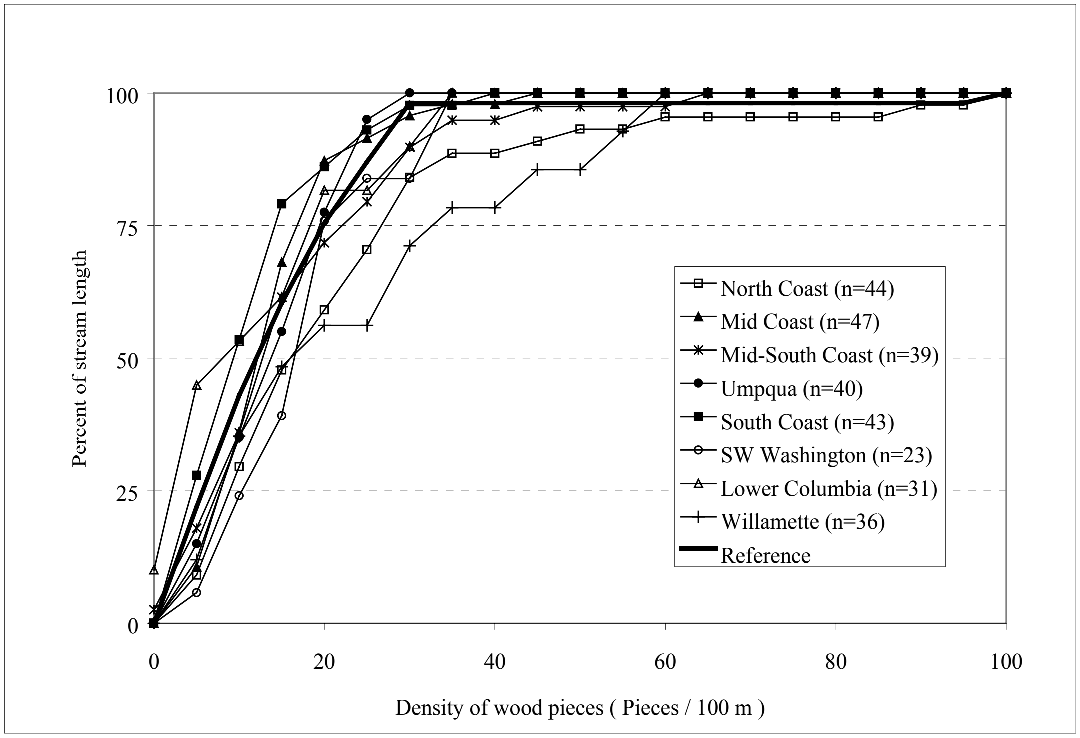

Figure 8: Cumulative distribution of frequency for the density of wood pieces for eight geographic areas in western Oregon.

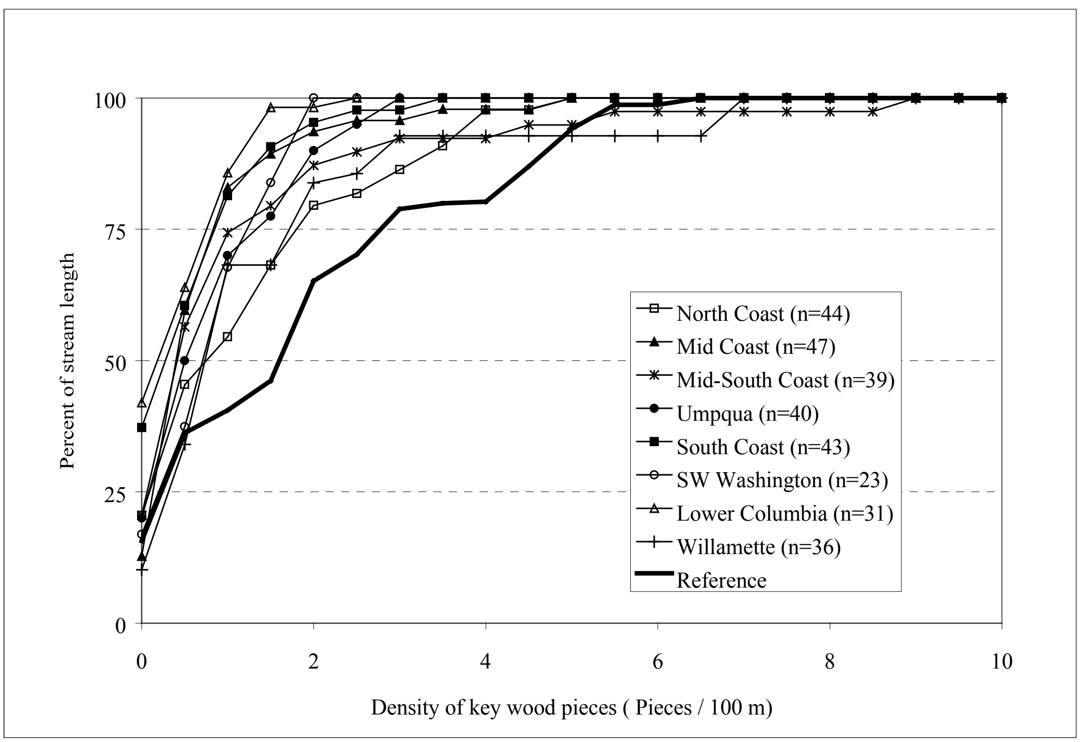

Figure 9: Cumulative distribution of frequency for the density of key wood pieces for eight geographic areas in western Oregon.

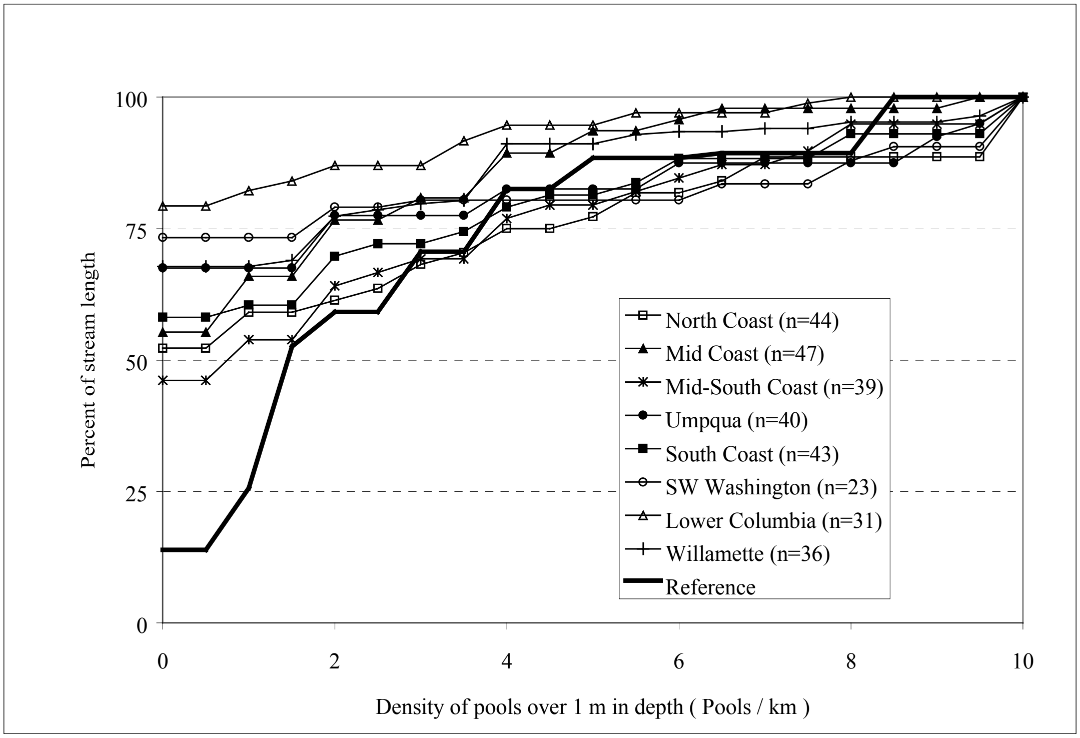

Figure 10: Cumulative distribution of frequency for the density of deep pools for eight geographic areas in western Oregon.

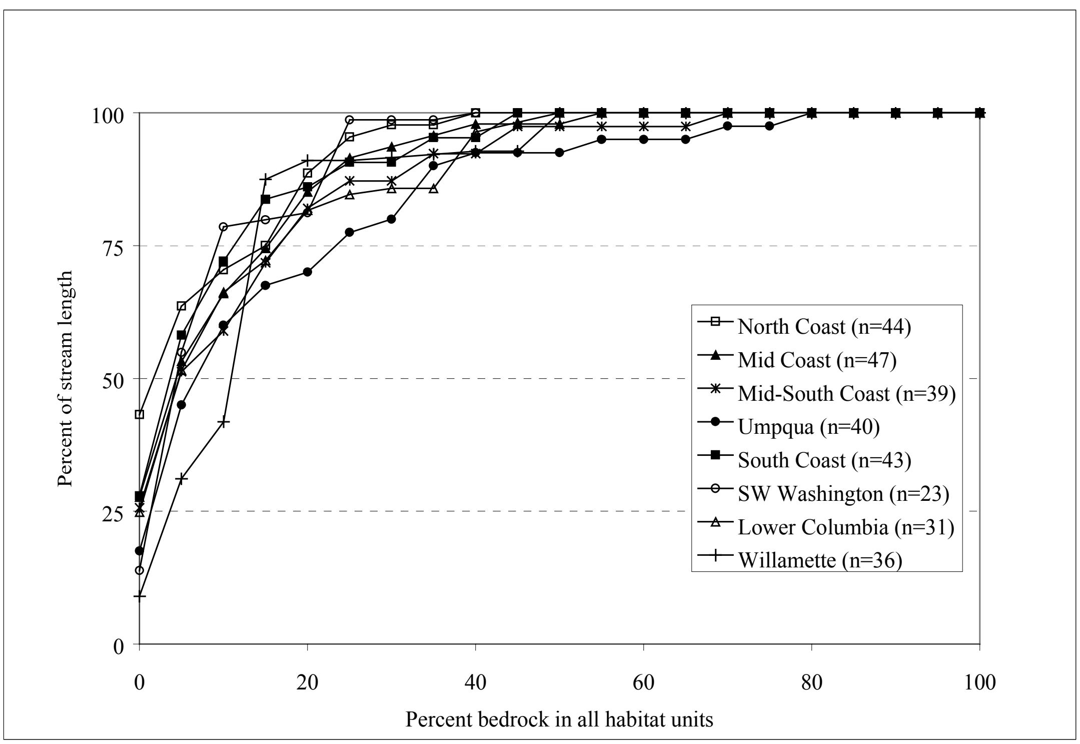

Figure 11: Cumulative distribution of frequency for the percent bedrock as substrate for eight geographic areas in western Oregon.

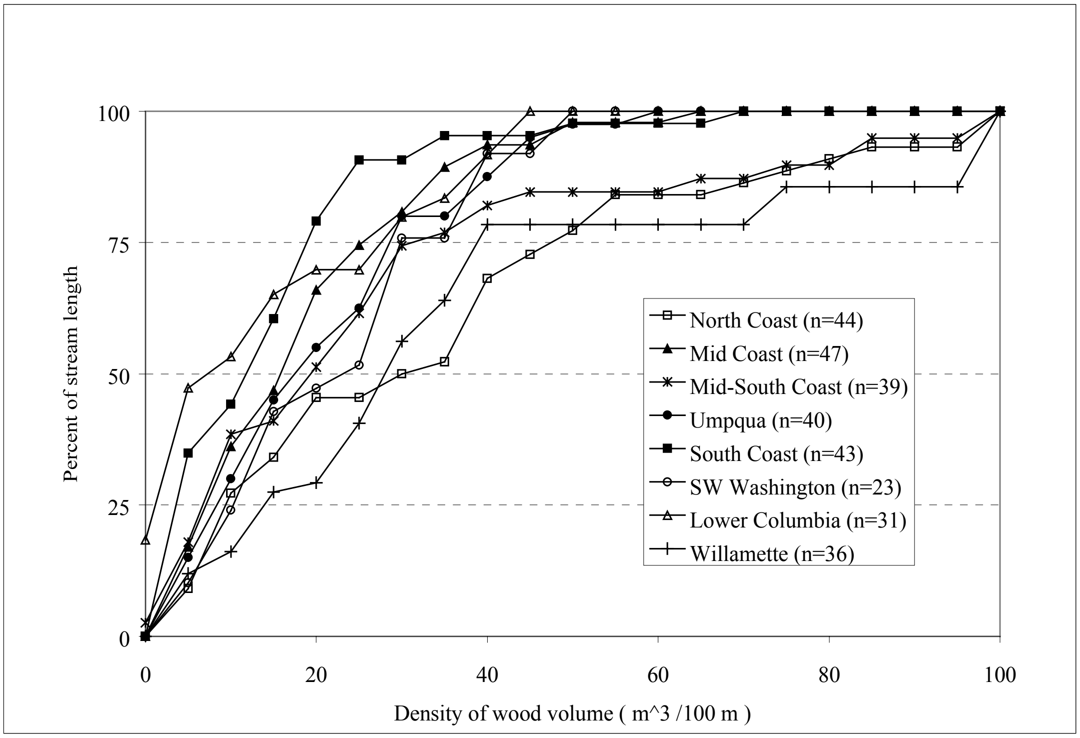

Figure 12: Cumulative distribution of frequency for wood volume density for eight geographic areas in western Oregon.

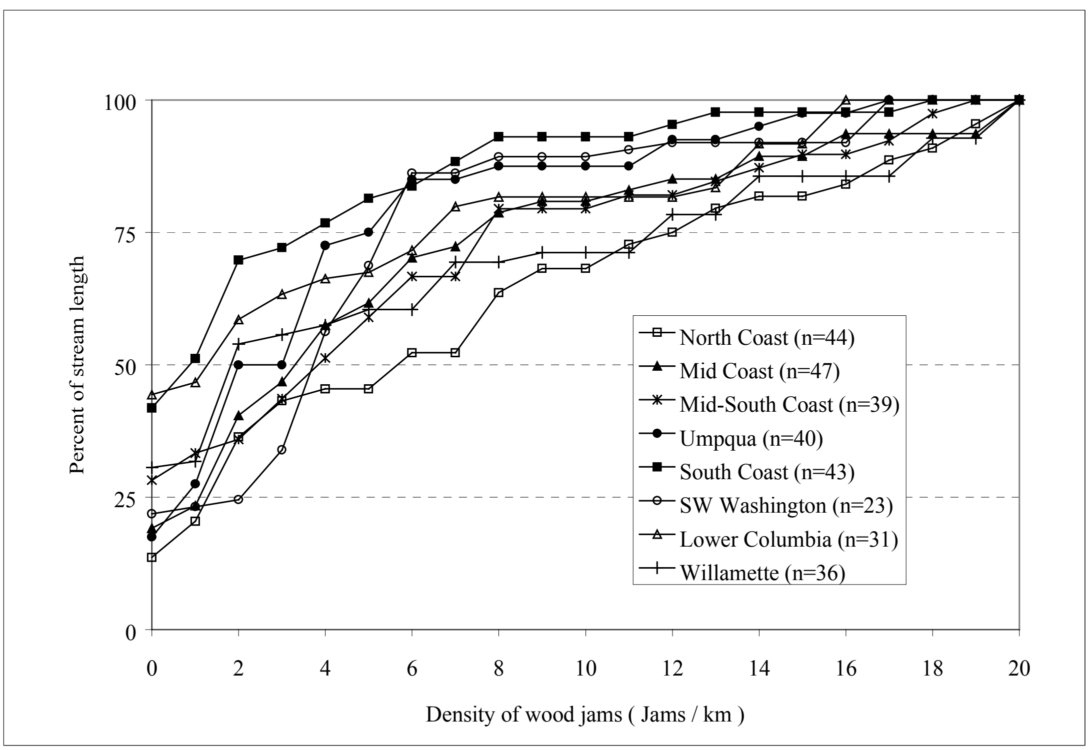

Figure 13: Cumulative distribution of frequency for the density of wood jams for eight geographic areas in western Oregon.

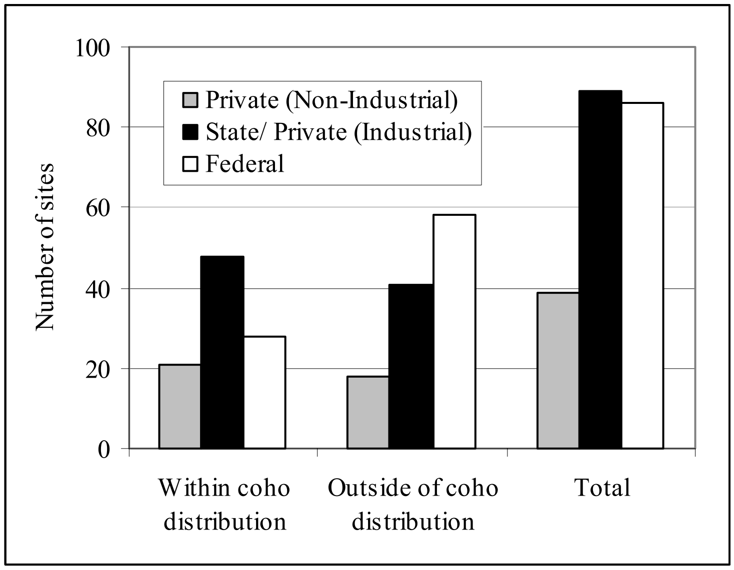

Figure 14: Distribution of randomly selected habitat survey sites within and outside of coho salmon distribution between three land management types in coastal Oregon.

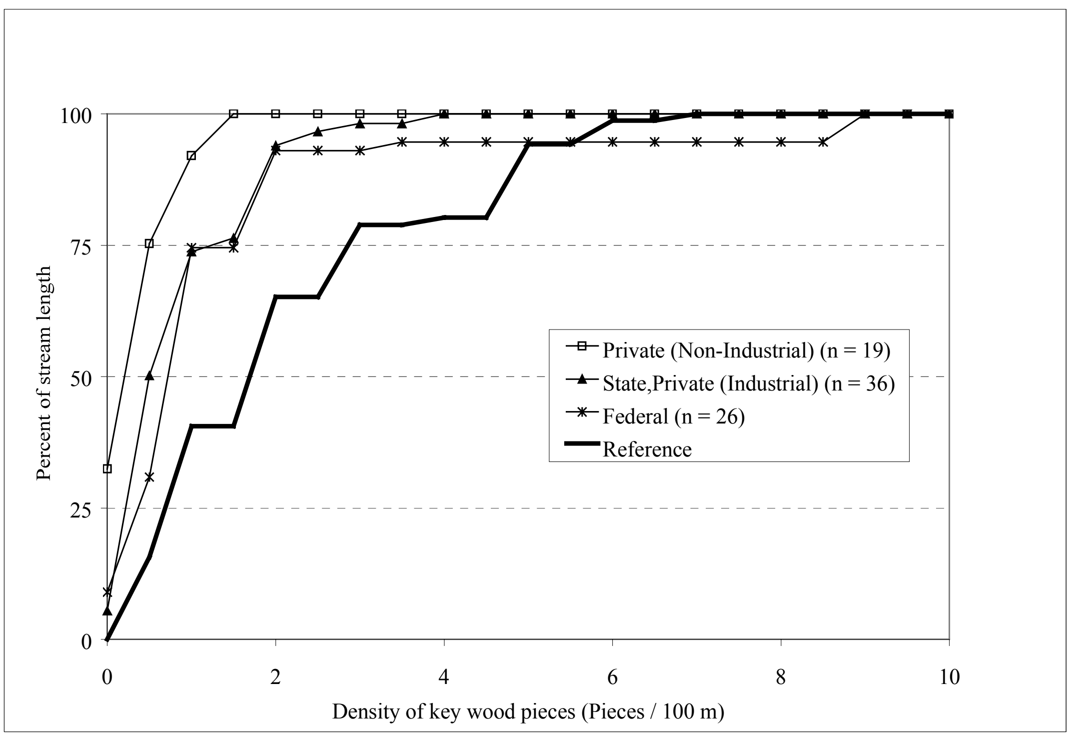

Figure 15: Cumulative distribution of frequency for the density of key wood pieces for three land management types in western Oregon for streams between 4 and 20 km^2 catchment area. Reference sites are not 4-20 km^2 in catchment area.

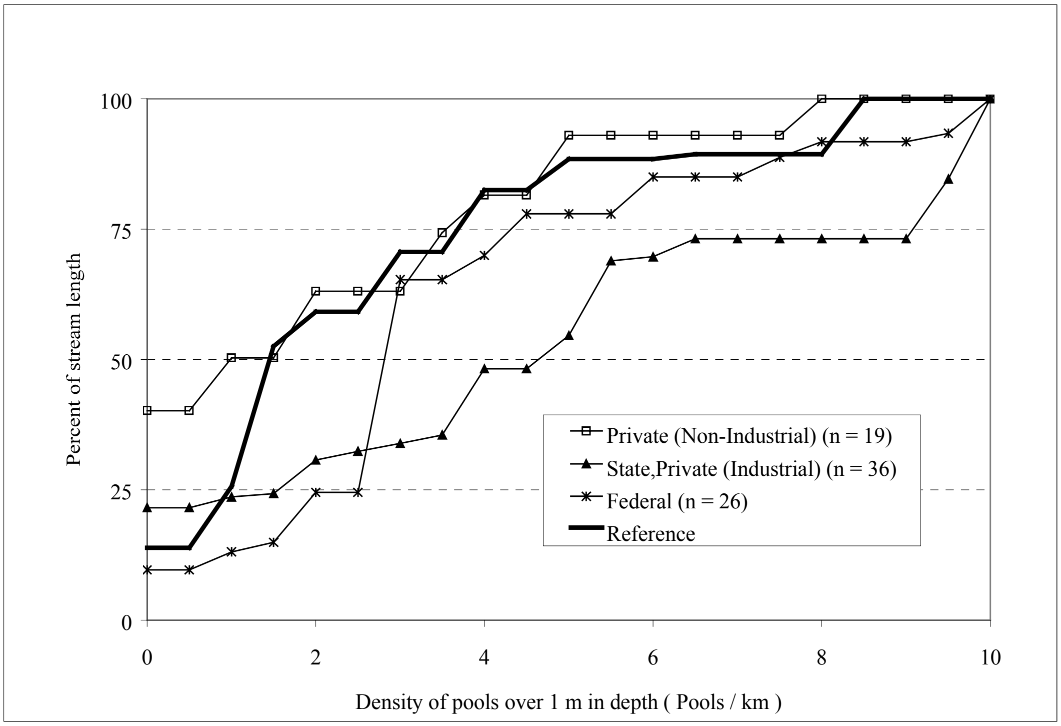

Figure 16: Cumulative distribution of frequency for the density of deep pools for three land management types in western Oregon for streams between 4 and 20 km^2 catchment area. Reference sites are not 4-20 km^2 in catchment area.

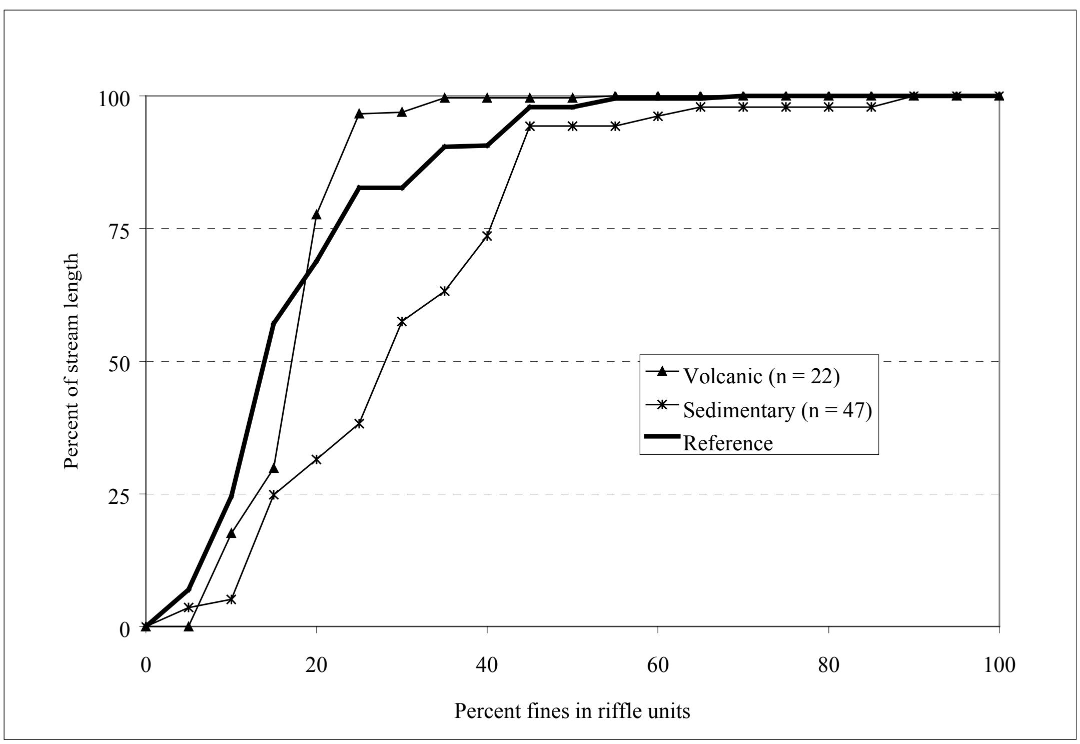

Figure 17: Cumulative distribution of frequency for the percent fine sediments in riffle units for volcanic and sedimentary geologic types in western Oregon.

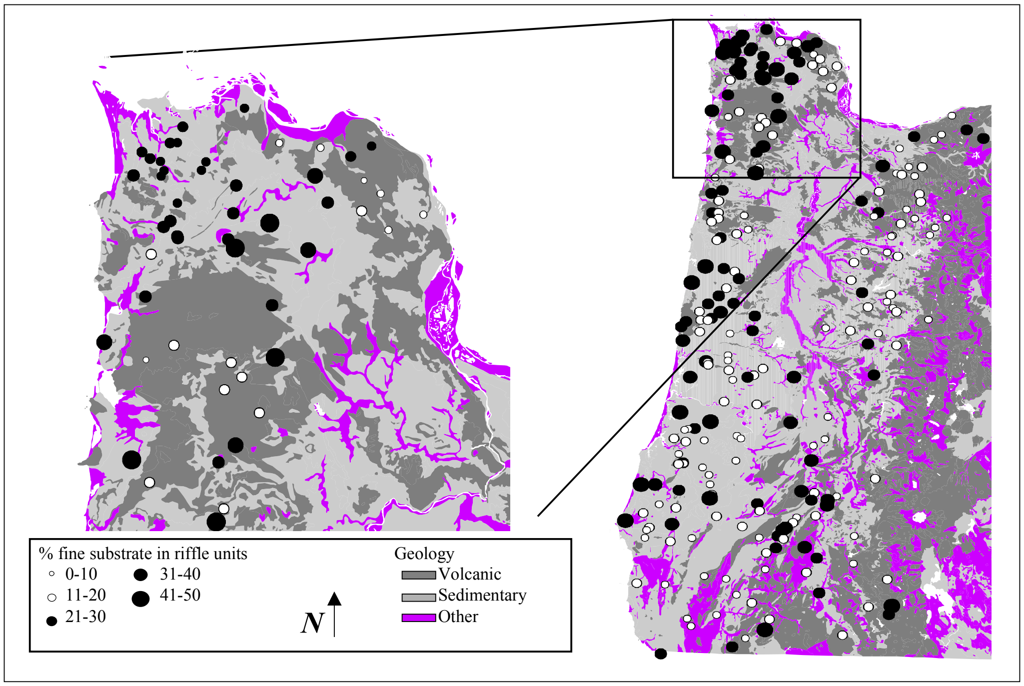

Figure 18: The spatial relationship between percent fine sediments in riffle units and geologic types in western Oregon.

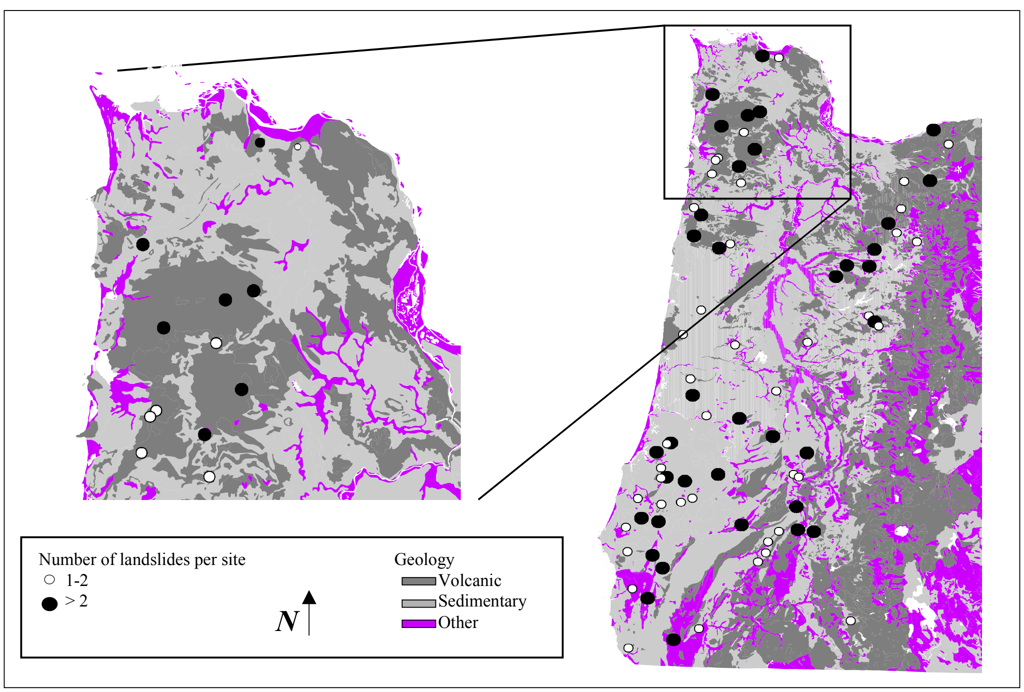

Figure 19: The spatial relationship between landslide frequency and geologic types in western Oregon.

Table 1. Summary table of completed and not completed sites

Analysis Area	Target					Non-Target	Total selected
	Completed		Not Completed		Total		
	Habitat	Salmonid Presence/ Absence	Denied Access	Lack of Time			
North Coast	41	14	1	2	44	5	49
Mid-Coast	41	20	3	3	47	10	57
Mid-South Coast	34	9	10	4	48	13	61
Umpqua	38	5	1	4	43	7	50
South Coast	40	34	6	1	47	8	55
Southwest Washington	21	18	0	7	28	8	36
Lower Columbia	30	29	1	12	43	9	52
Willamette	32	28	9	1	42	10	52
Total	277	157	31	34	342	70	412

Table 2. Mean gradient, mean active channel width, and mean catchment area for sites surveyed in western Oregon.

Analysis Area	Mean gradient (%)	Mean active channel width (m)	Mean catchment area (km^2)
North Coast	4.3	7.1	9.7
Mid-Coast	4.3	6.8	6.8
Mid-South Coast	3.5	8.4	22.5
Umpqua	6.0	5.7	18.2
South Coast	8.5	6.9	13.6
Southwest Washington	4.5	7.5	13.7
Lower Columbia	5.2	7.5	16.3
Willamette	8.6	6.7	15.1

Table 3. Cumulative frequency distribution quartiles for the percent areal extent of fine sediments in riffle units. Habitat quality decreases with increased fine sediment levels.

Analysis Area	Quartile		
	25th	50th	75th
North Coast	17	30	46
Mid-Coast	15	20	32
Mid-South Coast	4	14	24
Umpqua	10	16	44
South Coast	6	13	25
Southwest Wash.	20	29	55
Lower Col.	10	16	28
Willamette	10	20	28
Reference	10	14	22

Table 4. Cumulative frequency distribution quartiles for the percent areal extent of gravel sediments in riffle units. Habitat quality decreases with increased and decreased gravel quantity.

Analysis Area	Quartile		
	25th	50th	75th
North Coast	21	28	34
Mid-Coast	27	40	56
Mid-South Coast	17	29	37
Umpqua	22	29	40
South Coast	20	38	45
Southwest Wash.	14	26	37
Lower Col.	22	29	42
Willamette	36	45	55
Reference	26	35	45

Table 5. Cumulative frequency distribution quartiles for stream shade.

Analysis Area	Quartile		
	25th	50th	75th
North Coast	74	81	86
Mid-Coast	74	82	93
Mid-South Coast	82	92	97
Umpqua	70	86	92
South Coast	70	84	94
Southwest Wash.	65	77	82
Lower Col.	42	79	91
Willamette	76	85	89
Reference	70	81	90

Table 6. Cumulative frequency distribution quartiles for the number of riparian conifers > 50 cm.

Analysis Area	Quartile		
	25th	50th	75th
North Coast	0	0	85
Mid-Coast	0	0	50
Mid-South Coast	0	0	<20
Umpqua	0	<20	50
South Coast	0	<20	105
Southwest Wash.	0	0	95
Lower Col.	0	25	120
Willamette	0	<20	60
Reference	25	90	240

Table 7. Cumulative frequency distribution quartiles for the number of pieces of wood. Habitat quality increases with increased number of wood pieces.

Analysis Area	Quartile		
	25th	50th	75th
North Coast	10	16	26
Mid-Coast	7	12	16
Mid-South Coast	7	13	22
Umpqua	7	13	19
South Coast	4	9	14
Southwest Wash.	9	17	22
Lower Col.	2	8	19
Willamette	7	16	32
Reference	6	12	20

Table 8. Cumulative frequency distribution quartiles for the number of key pieces of wood. Habitat quality increases with increased number of key wood pieces.

Analysis Area	Quartile		
	25th	50th	75th
North Coast	<0.5	<0.5	1.8
Mid-Coast	<0.5	<0.5	<1.0
Mid-South Coast	<0.5	<0.5	1.1
Umpqua	<0.5	0.6	1.4
South Coast	0.0	<0.5	<1.0
Southwest Wash.	<0.5	0.6	1.2
Lower Col.	0.0	<0.5	<1.0
Willamette	<0.5	0.6	1.7
Reference	0.5	1.8	2.7

Table 9. Cumulative frequency distribution quartiles for the number of deep pools. Habitat quality increases with increased number of deep pools.

Analysis Area	Quartile		
	25th	50th	75th
North Coast	0.0	0.0	4.5
Mid-Coast	0.0	0.0	2.0
Mid-South Coast	0.0	0.8	3.9
Umpqua	0.0	0.0	1.7
South Coast	0.0	0.0	3.5
Southwest Wash.	0.0	0.0	1.5
Lower Col.	0.0	0.0	0.0
Willamette	0.0	0.0	1.5
Reference	1.0	1.8	3.8

Table 10. Cumulative frequency distribution quartiles for the percent areal extent of bedrock. Habitat quality decreases with increased amounts of bedrock.

Analysis Area	Quartile		
	25th	50th	75th
North Coast	0	2	15
Mid-Coast	0	4	15
Mid-South Coast	2	7	17
Umpqua	2	7	24
South Coast	0	4	10
Southwest Wash.	2	6	17
Lower Col.	0	4	17
Willamette	3	11	17
Reference	---	---	---

Table 11. Cumulative frequency distribution quartiles for the volume of wood. Habitat quality increases with increased wood volume.

Analysis Area	Quartile		
	25th	50th	75th
North Coast	8	30	46
Mid-Coast	7	15	22
Mid-South Coast	8	21	32
Umpqua	8	16	27
South Coast	4	12	18
Southwest Wash.	9	26	36
Lower Col.	2	7	20
Willamette	12	25	32
Reference	14	33	46

Table 12. Cumulative frequency distribution quartiles for the number of wood jams. Habitat quality increases with increased number of wood jams.

Analysis Area	Quartile		
	25th	50th	75th
North Coast	1.2	5.7	12
Mid-Coast	1.0	3.2	7.5
Mid-South Coast	0.0	4.0	7.5
Umpqua	<1.0	3.0	5.0
South Coast	0.0	1.0	3.8
Southwest Wash.	2.0	3.8	5.2
Lower Col.	0.0	1.2	6.5
Willamette	0.0	2.0	11.3
Reference	---	---	---

Table 13. Comparison of frequency distribution quartiles between 1998 random surveys and 1990-1997 basin surveys.
+ (random surveys higher),=(both surveys equal), -(random surveys lower).

Geographic area	North Coast			Mid-coast			Mid-South Coast			Umpqua			South Coast			Southwest Washington			Lower Columbia			Willamette		
Quartile	25	50	75	25	50	75	25	50	75	25	50	75	25	50	75	25	50	75	25	50	75	25	50	75
Fines	+	+	+	+	+	+	-	+	+	+	+	+	=	-	=	+	+	+	+	+	+	+	+	+
Gravel	-	-	-	+	=	+	-	-	-	-	-	-	-	+	+	-	-	-	+	+	+	+	+-	+
Shade	-	-	-	+	+	+	+	+	+	-	+	=	-	-	=	-	-	-	-	+	+	+	+	+
Con_20	=	-	+	=	=	+	=	-	-	=	=	-	=	-	+	=	-	+	=	+	+	=	=	+
Wood Pieces	+	+	+	-	-	-	+	+	+	+	+	+	+	+	+	+	-	-	-	+	+	+	+	+
Key wood pieces	=	-	+	=	-	-	+	=	+	+	+	+	=	=	-	=	-	-	-	=	=	=	+	+
Pools > 1 m	=	-	+	-	-	-	-	-	=	=	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 14. Precision of habitat metrics for streams in western Oregon.

Variable	SD_{rep}	CV	S:N
%Riffle Fines	7.6	29.9	8.2
%Riffle Gravel	9.5	28.2	3.5
Riparian conifers >50 cm (#/305 m)	20.0	58.7	6.9
%Channel Shading	5.2	6.4	7.4
Wood Pieces (#/100 m)	3.6	24.4	15.2
Key Wood Pieces (#/km)	0.6	68.5	4.1
Deep Pools (#/km)	2.0	76.0	4.9
%Bedrock	2.9	26.5	25.4
Wood volume (m^3/100 m)	7.4	33.6	11.3
Wood Jams (#/km)	2.6	49.8	4.9
% Pools	8.1	26.3	6.7
%Slow water Pools	0.9	15.9	259.6
Bank Full Width (m)	1.3	18.1	13.7
Bank Full Height (m)	0.1	22.8	3.4
Gradient (%)	0.5	10.9	76.9
Terrace Width (m)	2.7	23.5	11.5
Entrenchment ratio	0.4	19.7	41.7

Sd_{rep} –Standard Deviation of the repeat surveys, CV-coefficient of variation of the repeated surveys, S:N - ratio of variance among all streams to variance of repeat visits.

Table 15. Number of reaches with high quality habitat based on channel type and instream habitat. All reaches < 5% gradient.

	Wide Valley Floor			Narrow Valley
	Unconstrained	Potentially Unconstrained[a]	Deeply Incised[b]	Constrained by hillslopes
High Quality	6	7	0	7
Moderate-Low quality	13	29	29	46
Total number	19	36	29	53

a Terrace height < 1.25*Floodprone height, b Terrace height > 1.25* Floodprone height