Pacific Salmon Conservation: Designating Salmon Habitat and Diversity Watersheds
A Process to Set Priorities for Watershed Protection and Restoration

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Introduction

In 1892 Livingston Stone proposed protecting entire watersheds as salmon refuges to safe-guard against declining numbers of returning fish (Stone 1892). Requests for protection of rivers and entire watersheds were made to the American Fisheries Society as early as 1911 following recognition of the decline in native fishes in the eastern United States (Lichatowich 1999). Serious consideration was repeatedly given in 1928, 1938, and 1959 to establishing sanctuaries in some of Oregon's largest river basins, including the Umpqua, McKenzie, Deschutes, Rogue, and Snake to prevent the decline of salmon and steelhead (Lichatowich 1999). While none of these proposals was implemented, the necessity to protect and restore populations of salmon and steelhead, and the link between health of fish populations and quality of aquatic habitat has been recognized since the late 1800s.

Reserve networks have been designed for terrestrial mammals (i.e. Greater Yellowstone Ecosystem; Noss and Cooperrider 1994) and birds (i.e. Pacific Northwest Forest Plan; FEMAT 1993), and for freshwater (Moyle and Yoshiyama 1994; Aquatic Diversity Areas in Oregon; Li et al. 1995) and marine systems (reviewed by Murray et al. 1999). Management of the reserves follows two basic strategies – minimize human impacts within a specific area (i.e. national park or wilderness area) and/or manage use within large geographic areas of diverse landscape and ownership. The biological basis for the design of a reserve system varies with the conservation issue, but one or more of three basic approaches have been employed. The primary approach is based on identifying and protecting a spatial array of high quality habitats to provide an appropriate level of protection (Roni et al. 2001). The second approach calls for protecting key processes that maintain metapopulations (Reiman and Dunham 2000) rather than a spatially explicit reserve system based on a limited definition of quality habitat. Others have recommended a reserve system based on current distribution and abundance of salmonids (Ecotrust et al. 2000), and Frissell et al. (2000) combined information on distribution and abundance of salmonids with an overlay of high quality watersheds to identify a sequence of refuges. However, no single approach to designating habitats to protect a species may suffice to recover a species. The application of principals of metapopulation theory, life history diversity, and habitat relationships to a species or community of species that live in a diverse and dynamic landscape can be a daunting task, given the uncertainties of our knowledge (Rieman and Dunham 2000). We may be able to address some uncertainties and develop a richer more effective conservation strategy by integrating metapopulation theory and landscape ecology (Wiens 1997). We are attempting to apply these principles to the recovery of Pacific salmon in Oregon's coastal watersheds and if successful, expand that application to other regions.

We propose a habitat based conservation strategy, which has as its core the protection of watersheds to maintain or restore high quality habitat and hydrologic function (Reeves et. al. 1995). Protected areas must have significant habitat connectivity to maintain the necessary sequence of habitats in primary, secondary, and off-channel areas to meet life history needs of each species that utilizes the watershed, from headwater drainages to lower river and estuary. Estuaries may be particularly important as juvenile salmon make a physiologic adjustment to a saline environment while experiencing substantial changes in habitat and food resources. Where necessary, appropriate habitat restoration must occur to compensate for lost connectivity, habitat, and hydrologic function.

High quality habitats can be defined as reaches, streams, or watersheds where processes function to create and maintain critical habitats important to salmonids over long periods of time (e.g., 50+yr). Functioning watersheds act as refugia, providing spawning or rearing habitats and serving as important migratory corridors for salmonids through the inherent fluctuations in natural disturbances (Schlosser and Angermeier 1995). Watershed processes that form critical habitats include of riparian community succession, sediment and nutrient flow, habitat connectivity, large wood recruitment to the stream channel, annual hydrologic cycles, and natural disturbance regimes (Swanston 1991). These processes operate at different spatial and temporal scales depending on climate, underlying geology, and natural or anthropogenic disturbances, creating a unique mosaic of aquatic habitats in each watershed along the coast. The scales at which these processes operate range from local (1-10 km^2) to regional, influencing reaches within streams and entire river basins. Static measurements of aquatic characteristics that reflect these processes include channel morphology, substrate composition, riparian composition, and distribution of deep pools, off channel habitats, and large wood (Beechie and Bolton 1999). However, we know the processes shaping aquatic systems are dynamic and static measurements do not reveal the shifting mosaic of habitat patches that may influence distribution of salmonids.

Metapopulation theory focuses on identifying centers of fish population abundance and trying to understand population dynamics. The persistence of population centers in an array of habitat patches can be described by a balance of overall rates of birth and immigration against rates of death and emigration. The balance of extinction and recolonization can be controlled by the quality of habitat within patches (Harrison and Taylor 1996), the connectivity among patches (Taylor et. al. 1993), and the size of the patches (Hanski and Gilpin 1996). Metapopulation theory predicts a positive abundance-distribution relation, such that a species composed of many population centers will have a distribution that will wax and wane with overall abundance. In times of low overall abundance, population centers will shrink to core areas or patches, with local extinctions occurring in outlying patches, or sub-optimal habitats. In times of high abundance, core areas can act as sources for recolonization. The quality and connectivity of habitats are closely linked to formative features of stream systems that are controlled by dynamic landscape processes. Core areas will vary spatially in response to changes in relative quality of habitat patches across the landscape.

Reiman and Dunham (2001) recommend an approach based on protecting the processes that influence metapopulation dynamics. The maintenance of processes such as dispersal and colonization becomes critical if populations are to exploit the spatial diversity and quality of suitable habitat. In effect, Reiman and Dunham (2001) suggest that creating a reserve system is less useful than protecting important processes across the landscape, given the uncertainties of metapopulation structure for salmonid species. Such a strategy may be inherently more satisfying, but very difficult to quantify and implement. However, any conservation strategy that considers the implications of life history diversity, habitat complexity, patch size, and the mosaic of habitats between patches will have a higher probability of being successful.

Landscape ecology focuses on environmental heterogeneity and attempts to describe the structure, function, and interactions of ecosystems in a spatially explicit manner (Forman and Godron 1986, Wiens et. al. 1993, Pojar et. al. 1994). Environmental heterogeneity is described by variance in quality in both space and time of habitat elements making up the landscape mosaic. The structure, function, and interactions of ecosystems are dependent on and influenced by the boundaries of habitat patches, the spatial context of the patch within the surrounding landscape mosaic, and the connectivity among elements of the landscape mosaic (Wiens 1996).

Recent efforts at identifying areas critical to salmon conservation in Oregon have ranged from individual stream reaches to medium sized river basins. In 1993, the Forest Ecosystem Management Assessment Team (FEMAT 1993) report revised and expanded the Key Watersheds identified by Johnson et al. (1991). Key Watersheds directly contribute to the conservation of habitat for at-risk salmonids (Tier 1) or are sources of high water quality (Tier 2). Restriction of Key Watershed designations to federal land eliminated much of the range of Pacific salmonids from consideration. In 1994, Oregon Department of Fish and Wildlife biologists identified source and recovery areas for salmon across the state. Source areas were considered streams or stream reaches where wild salmonids were relatively more abundant than in other parts of the river basin. These areas served as a source of individuals to repopulate adjacent recovery areas. The source/recovery strategy applied a simple metapopulation model at the scale of stream reaches for Oregon coastal stocks of coho. The Oregon Chapter of the American Fisheries Society identified Aquatic Diversity Areas (Li et al. 1995). Aquatic diversity areas are composed of small to medium sized basin reserves selected based on a classification system that emphasized habitat, fish species endemism, and evolutionary significance of a population to the species or stock. The aquatic diversity area strategy applied metapopulation theory at regional level of species distribution.

Perhaps the most comprehensive effort to date came in 1995. A group of experts in the physical and biological sciences gathered to develop a system for prioritizing watersheds and restoration activities under the leadership of then Oregon State Senate President Bill Bradbury (Bradbury 1995). A procedure was developed to identify the best watersheds for protection and restoration. The Bradbury Process, as the strategy has become known, aligns a ranking system of biological resources, risk factors, and protection / restoration potential with Key Watersheds, ODFW source areas, and ADAs to rank watersheds. The integrated approach was the first widely distributed attempt to identify watersheds through a systematic process applicable across a broad geographic area. Using a less integrative but more data rich approach, the Oregon Department of Fish and Wildlife expanded on the source area concept and developed core areas as part of The Oregon Plan (OCSRI 1997). Core areas were stream reaches or segments identified for each species based on spawning survey data. Where necessary, 'professional judgment' was used to delineate reaches. The core area concept represented ODFW's best effort at identifying reaches of stream critical to the conservation of salmonids. Additionally, the Oregon Plan, Steelhead Supplement identified priority areas for steelhead (OPSS 1997). The areas identified were the best steelhead producing watersheds and basins based on professional judgment. Ecotrust et al. (2000) identified potential watershed reserves (Salmon Anchor Habitats) for coastal basins in northwest Oregon following a survey of juvenile salmonids in 1999-2000.

Most recently, Kruger (2001) identified streamflow restoration priorities for recovery of anadromous salmonids in Oregon's coastal basins. Priorities were based on individual rankings of several biological and physical factors, water use patterns and restoration optimism. Biological and physical factors included the number of native anadromous species, presence of a designated "Core Area", fish related ecological benefits, other types of ecological benefits, physical habitat condition, the extent of human influence, water quality, current status or proposed as sensitive, threatened, or endangered, presence of instream flow protection (Instream Water Rights), and natural low flow problems.

Changes in the landscape of western Oregon since the mid-1850s have long-term implications for the resiliency of salmon populations and necessitate a more comprehensive approach to the recovery of salmon. The diversity of salmon life histories coupled with historic landscape conditions and processes allowed salmon populations to remain abundant across the landscape and over time. Emulation of historical conditions and processes will be important in the long-term recovery of these populations (Reeves et. al. 1996). Surveys in 15 streams in coast range drainages of the Columbia River (Oregon and Washington) have shown dramatic changes in the structure of the instream habitat (McIntosh 2000). The change in regional patterns of aquatic habitat over time is indicative of the relationship between landscape features, channel forming processes, and instream and riparian habitat characteristics. Recovery of salmon populations will depend on protection of salmon richness and abundance, and the recognition of the relationship of salmon population structure to landscape processes.

Current Strategy to Identify Salmon Anchor Habitats

The goal of this strategy is to identify watersheds that are important for the short-term conservation of local salmon populations, and for the long-term persistence of the salmon metapopulations in coastal drainages of Oregon. Factors important to meeting this goal are 1) determine the appropriate scale at which to summarize data and select watersheds, 2) identify population centers or cores for each species, 3) identify biological factors that may influence metapopulation dynamics, 4) identify high quality aquatic habitat and landscape features that may influence local populations and the maintenance of interconnected populations, and 5) identify centers of salmonid biodiversity. The network of watersheds identified through this process is intended to serve as a dynamic template for the protection of salmon habitat and diversity.

The minimum scale for our analysis is a subwatershed as defined by Rickenbach (2000), in accordance with US Geological Survey standards (Seaber et. al. 1987). The subwatershed unit was chosen for our analysis because it had a standardized and available map base for the coastal basins of Oregon, was biologically meaningful for salmonid populations, had sufficient data available to allow for summarization of biological parameters and physical features, and is of a size that can be effectively managed for landscape processes. The criterion of small manageable watersheds precludes selecting large blocks of land as some earlier plans have done.

Subwatersheds are designated as sixth field hydrologic units and are nested within successively larger drainages comprising a hierarchy of watersheds up to the regional scale (e.g. Pacific Northwest). Sixth field hydrologic units are defined as true (a complete watershed with one outlet), composite (comprised of multiple catchments), and frontal (comprised of several streams that flow directly into the ocean) (Rickenbach 2000). Sixth field hydrologic units for the Oregon Coast average 6119 hectares (15119 acres), range from 3723 – 9769 hectares (9200 – 24139 acres), and contain an average of 46.4km of stream (range 9.9 – 104.9km) at the 1:100000-scale map base. This size of watershed was considered the minimum necessary to support a local self-sustaining (viable) population of coho salmon given moderate to high quality aquatic habitat (Nickelson 2001). The abundance, distribution, and frequency of occurrence define the strength of each population. Population centers are identified as subwatersheds containing consistently high abundances of adult salmon that are distributed within and across basins. (Move to Methods?) A spatial array of watersheds containing the consistently highest abundance of each species are the most important to protect in the short-term as they form local population cores.

The spatial structure of, life history strategies, and movement between local populations defines the dynamics and connectivity within a metapopulation. The diversity of life history strategies within a population determines spawning time, growth, habitat use, and migration timing. Dispersal rate and direction vary among species and populations, and affect the rates of local population expansion, recolonization of vacant habitat, and gene flow. For example, local populations residing in a subwatershed in close proximity to a large estuary may have different life history characteristics than local populations in headwater drainages. In addition, an influx of hatchery fish may overwhelm a local population, infusing genetic material from a non-local stock, and reducing the fitness of the local population (Waples 1999, Lynch and O'Hely 2001, Schroeder et al. 2001). We will use data on spatial structure of core populations, life history diversity, and incidence of adult hatchery fish to indicate some of the key biological processes affecting potential metapopulation structure and dynamics. These data will help us identify the contemporary centers of abundance, and postulate how local populations currently and historically interacted across the landscape.

Habitat quality and landscape features influence the distribution of core populations and the connectivity of population elements. Knowing the relationship of quality aquatic habitat to population centers will help describe what refugia are available to the core populations and how the quality of habitat may influence recolonization of vacated habitat. .

Finally, centers of salmonid biodiversity influence population dynamics will be identified from overlapping population centers for each species. Overlapping provide the most efficient return on management resources.

The short-term strategy is based on fish populations, whereas the long-term strategy will incorporate subwatersheds of high quality habitat where physical processes are coupled with life history adaptations and population dynamics. The overall approach will transition from protection of population centers and high quality habitats to connectivity of habitats and populations, accomplished at the watershed scale, regardless of jurisdiction.

Site Description

All of Tillamook State Forest and most of Clatsop State Forest is within the North Coast Management Area (MA; formerly Gene Conservation Area (GCA)) for coho, as designated by the ODFW and the National Marine Fisheries Service. Drainages in the Clatsop State Forest that flow into the lower Columbia River will be treated separately in a conservation strategy for the lower Columbia River ESU and its associated fish species.

All Salmon Anchor Habitats designated in this document are located in watersheds comprised of greater than 20% ownership by Oregon Department of Forestry (ODF). Additional watersheds containing ODF land may be included in a future document identifying watersheds as part of an overall conservation strategy for the North Coast MA, which will encompass federal, state, and private lands.

Methods

The data that supported our selections were derived from existing adult spawning survey and stream habitat survey datasets managed by the Oregon Department of Fish and Wildlife (ODFW), and summarized within each subwatershed in the coastal basins.

Annual surveys to enumerate the number of adult coho, chinook, and chum salmon in coastal basins have been conducted by the Coastal Salmonid Inventories Project, ODFW (Jacobs et al. 2000). No systematic surveys have been conducted for steelhead or cutthroat. Three different survey types (standard, random, supplemental) have been conducted (Jacobs et al. 2000). All survey types censused the number of each species of adult salmon within a reach of stream, averaging 1.6 km in length. *Standard* survey reaches have been surveyed consistently over a long period of time, and were used to index spawning abundance over time. These areas were selected as early as 1948 based on varied criteria including ease of access and assurance of finding some level of spawning. *Random* surveys, conducted for the past 12 years, are used to provide unbiased estimates of spawning adult abundance with a focus on coho salmon. These survey reaches are selected randomly from the estimated available spawning habitat within geographic strata of coastal stream basins. *Supplemental* surveys are typically selected to fill specific information needs and may vary from year to year.

The stream habitat data is collected and managed by the Aquatic Inventories Project, ODFW. The project has been actively acquiring stream habitat inventory information for the purpose of habitat assessment since 1990. This information is collected primarily during the summer months by stream survey crews using methods described in Moore et al. (1997). The survey designs followed that of a basin, or census, survey, or were conducted at selected representative sites (Jones et al. 2001). The field data focused on channel and valley morphology (stream and reach data), riparian characteristics and condition (reach data), and instream habitat (habitat unit data). Approximately 8,000 km *(double-check with Becky)* of stream have been inventoried in coastal drainages and are available as GIS coverages based on 1:100k stream hydrography. The smallest scale of measure was channel habitat units, such as pools, riffles, glides, and off-channel backwaters and alcoves, measured on the scale of meters. Habitat characteristics collected at each habitat unit included depth, gradient, substrate size, boulders, large wood, bank erosion, and shade. Habitat units were recorded for primary and secondary channels within reaches. Reaches were up to 10 km in length, and were composed of a group of continuous habitat units that were analyzed together due to similar geomorphology, hydrology, land use, or riparian characteristics. Information on type, size, and character of riparian vegetation within 30 m of the channel was collected every 1/2 to 1 km along the stream. Aquatic surveys were also conducted at 660 randomly selected sites in coastal basins during 1998-2000. Each site was 0.5 - 1.0 km in length and the data gathered within the short reach was identical to that collected during the basin surveys.

Spawning Survey Data Analysis

The abundance and frequency of occurrence of adult salmon within a 6th field HU was used as the primary basis for selecting salmon anchor habitats. Only spawning data collected since the *random* surveys began in 1989 was considered for this first analysis. The *random* surveys provide a more accurate assessment of spawner numbers and distribution (Beidler and Nickelson 1984; Ganio et al. 1986; Firman and Jacobs 2001). For all analyses we used the peak count of adult salmon within each survey reach for that year. The only consistent measure at all sites across years was the peak count, the highest number of fish observed at a site during the spawning period. Were we to restrict the analysis to those sites and years for which an estimate of the total number of salmon were present at a site during the 3-month spawning period, the number of data points would be too few for an effective analysis.

For each species - coho, fall chinook, and chum salmon - we determined the number of stream reaches surveyed each year within a geographic region, and developed frequency histograms of peak counts. A threshold value was determined based on quartile values of peak counts for each species. We then calculated the number of reaches, by year, within each subwatershed with a peak count greater than the 75th percentile, which provided a frequency of occurrence above the threshold value for each species at sites within a subwatershed. The subwatersheds selected as Salmon Anchor Habitats had a frequency of occurrence (number of surveys) greater than 50% for the threshold value for years surveyed from 1989 to 2000. For example, the threshold value for coho salmon in the Northern Oregon coastal drainages was a peak count of four adult spawners per mile. We selected subwatersheds with more than four adult coho salmon in at least 50% of the spawning surveys during the past 12 years. .

Additional input on subwatersheds was solicited from the ODFW field biologists. Our primary objective in soliciting information from field biologists was to identify areas not accurately depicted by or outside the scope of the spawning survey data. These included 1) subwatesheds that had very few surveys for chum, chinook, or coho salmon, 2) subwatersheds important for steelhead, a species for which we have limited quantitative spawning data, 3) areas outside the spawning survey area, such as the Lower Columbia, and, 4) areas heavily influenced by hatchery production or other local factors such as barriers.

Habitat Survey Data Analysis

Sixth code hydrologic units with high quality aquatic habitat were also selected as Salmon Anchor Habitats. Stream survey data collected from 1990-2000 during basin surveys and at randomly selected sites was used to describe habitat conditions in 6th code hydrologic units. We selected measures of percent pool area, residual pool depth, and wood volume as criteria for instream habitat quality. Value ranges for high, medium, and low quality habitat (Table X) were determined for each of three stream sizes (active channel width <4m, 4 – 15m, >15m). The active channel width (ACW) gives a rough approximation of stream power, which has a strong influence on pool size and frequency and on wood retention and distribution. A habitat quality code of high (H), medium (M), or low (L) was applied only to 6th code hydrologic units where we had habitat surveys for greater than 20% of the total stream length. Total stream length in each 6th code catchment was determined from the US Geological Survey (USGS) 1:100000 scale (100K) stream cover. We selected subwatersheds where greater than 40% of the surveyed stream length met the high habitat quality criteria. Additional information that resulted from the habitat analysis but not used in the selection process, was a rating of restoration potential based on the area of pools and wood volume within a 6th code hydrologic units.

Final Selection Process

Additional input from ODF district foresters and ODFW district biologists refined the set of SAH subwatersheds. In several instances two adjacent subwatersheds were of equal "value" and we allowed selection of one of those subwatersheds with input from local agency staff. Judgment was influenced by which subwatershed also had high wildlife value (e.g. spotted owl habitat) or was already identified for other management activities.

Results

Oregon Department of Forestry owns land in sixty-nine 6th code hydrologic units within the study area. Thirty-two of these sub-watersheds had greater than 20% ODF ownership. From this set, a total of twenty-four subwatersheds were selected as Salmon Anchor Habitats. Abundance of spawning adult salmon was the primary factor in selecting eleven of the watersheds, habitat quality was the primary factor for three of the watersheds, and local knowledge (professional judgment) was the primary factor in one of the watersheds (Table 1).

The three species of salmon (chum, chinook, and coho) considered in our quantitative analysis have differing habitat requirements and co-occur only in some subwatersheds. Of the fifteen watersheds selected, three have one species (coho salmon), seven have two species (coho and chinook salmon) and five have three species (coho, chinook, and chum salmon) (ODFW 2001) (Figure XX- *map*). Additionally, steelhead (ODFW 2001) and coastal cutthroat trout are considered present in all watersheds.

Peak counts of spawning adult salmon varied by species, subwatershed and year (Figures 1 and 2). Of the three species, chum had the highest average peak count (22.3, range 0 – 963); fall chinook averaged 18.2 (range 0 – 363) and coho averaged 8.1 (range 0 – 1097) (Figure 1).

We selected Salmon Anchor Habitats with median peak counts greater than 4 fish. Some of the watersheds were selected based on more than one species of fish, or contained high densities of coho, chinook, and chum salmon (Table 1, Figure 1). Sixth field Hus with high proportions of hatchery spawners were removed from consideration (e.g. South Fork Trask River and Middle North Fork Nehalem River). In addition, subwatersheds such as the upper Tillamook River and Lower Kilchis River in the Tillamook Bay basin, and Bear Creek in the Nestucca basin had less than 20% ODF ownership.

Selected subwatersheds were concentrated in the Nehalem and Tillamook Bay basins because of the predominance of ODF ownership. With these basins, 8 Salmon Anchor Habitats were selected in the Nehalem basin and 6 in the Tillamook Bay basin. Within the Nehalem basin, 3 subwatersheds were selected in the upper Nehalem, 1 in the mid-Nehalem, 1 in the North Fork Nehalem, 1 in the Salmonberry, and 2 in the lower Nehalem. Within the Tillamook Bay basin, 1 was selected in the Kilchis River, 3 in the Wilson River, and 2 in Trask River watersheds.

Mainstem rivers provide critical habitat within each major basin. Sections of the rivers provide important spawning habitat for fall chinook, spring chinook, summer chinook (Nehalem), and chum salmon. The rivers provide important rearing areas for juvenile salmon, cutthroat, and steelhead; and are migration corridors for downstream migration of juvenile fish, and upstream migration of adult fish. The maintenance of high quality habitat within the rivers also maintains the connectivity between Salmon Anchor Habitats.

Discussion

This conservation strategy identifies subwatersheds that support core populations of salmonids on Oregon Department of Forestry lands in the Lower Columbia River, Necanicum, Nehalem, Tillamook Bay, and Nestucca basins. Oregon Department of Forestry manages large blocks of the landscape within portions of these drainages. Subwatersheds contain the minimum kilometers of stream to sustain local populations of coho salmon, chum, and chinook salmon (Nickleson and Lawson 1998). While this strategy identifies only subwatersheds, or combinations of subwatersheds on ODF managed land, the conservation of salmonids within these watersheds will integrate with a broader scale conservation strategy for the Northern Oregon Coastal ESU. In particular, additional subwatersheds with partial ODF ownership in the Nestucca River and Ecola Creek basins will be selected. The strategy for the North Coast MA will identity critical habitat areas within mainstem rivers for adult spawning and juvenile rearing. The strategy will also identify migratory corridors, tidal freshwater habitat, and estuarine habitats that are critical to the persistence and recovery of salmonid metapopulations, because few of these habitats are contained within ODF ownership.

Despite these limitations, the Salmon Anchor Habitats identified on ODF land are sufficient to maintain the local populations of salmon and steelhead, given continued recovery of the freshwater habitat. Nickelson and Lawson (1998) modeled the viability (population viability model - PVA) of coho salmon within the Tillamook Bay basin and found that the coho salmon population within the basin has a significant probability for extinction under many model scenarios because of an overall poor freshwater habitat quality within the basin. Important habitat parameters were the amount, type, and quality of pool habitat. The ability of coho salmon populations to maintain a core population within the moderate and good quality habitats, and to recolonize and maintain populations in the poor quality reaches will become critical for the long-term persistence of the metapopulation. Furthermore, the results of the PVA model suggested that if freshwater habitat were to improve incrementally, but at the landscape scale, significant increases in long-term population abundance could occur in basins with poor habitat and small populations.

An important feature of this proposed conservation strategy is the emphasis on protecting and improving habitat at the landscape scale while protecting the core populations within the Salmon Anchor Habitats. While coho salmon may be more specific in their freshwater habitat requirements, the need to have high quality habitat within the Salmon Anchor Habitats for other salmonid species, and in adjacent and downstream habitats remains constant for all salmonid species. The overall strategy is to expand the core populations into the adjacent drainages, maintaining the resiliency of the core and satellite population as a functioning metapopulation.

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Table 1. List of Salmon Anchor Habitats with reason (spawning, habitat, or professional judgement) for selection and species with consistently high numbers of spawning adults present.

Watershed	Spawning	Habitat	Professional Judgement	Species*
Nehalem River				
Foley Creek	**X**			**Chum**
Cook Creek			**X**	**StW, ChF**
S.Fk. Salmonberry R.	**X**			**StW,**
Upper N. Fk. Nehalem R.	**X**	**X**	**X**	**Co, ChF**
Buster Creek		**X**		
Fishhawk Lake Creek	**X**	**X**		**Co**
Lousignont Creek	**X**			**Co**
Wolf Creek	**X**			**Co**
Upper Rock Creek		**X**		**Co**
Kilchis River				
Middle Kilchis R.	**X**			**Chum, ChF**
Wilson River				
Little N. Fk. Wilson R.	**X**	**X**		**Chum, ChF**
Cedar/ Ben Smith Creek	**X**			**ChF, Co**
Devils Lk. Fk. Wilson R.	**X**	**X**		**Co**
Trask River				
E. Fk. S. Fk. Trask R.		**X**	**X**	**Co**
Elkhorn Creek	**X**		**X**	**ChF, Co**

Salmon Anchor Habitat Areas