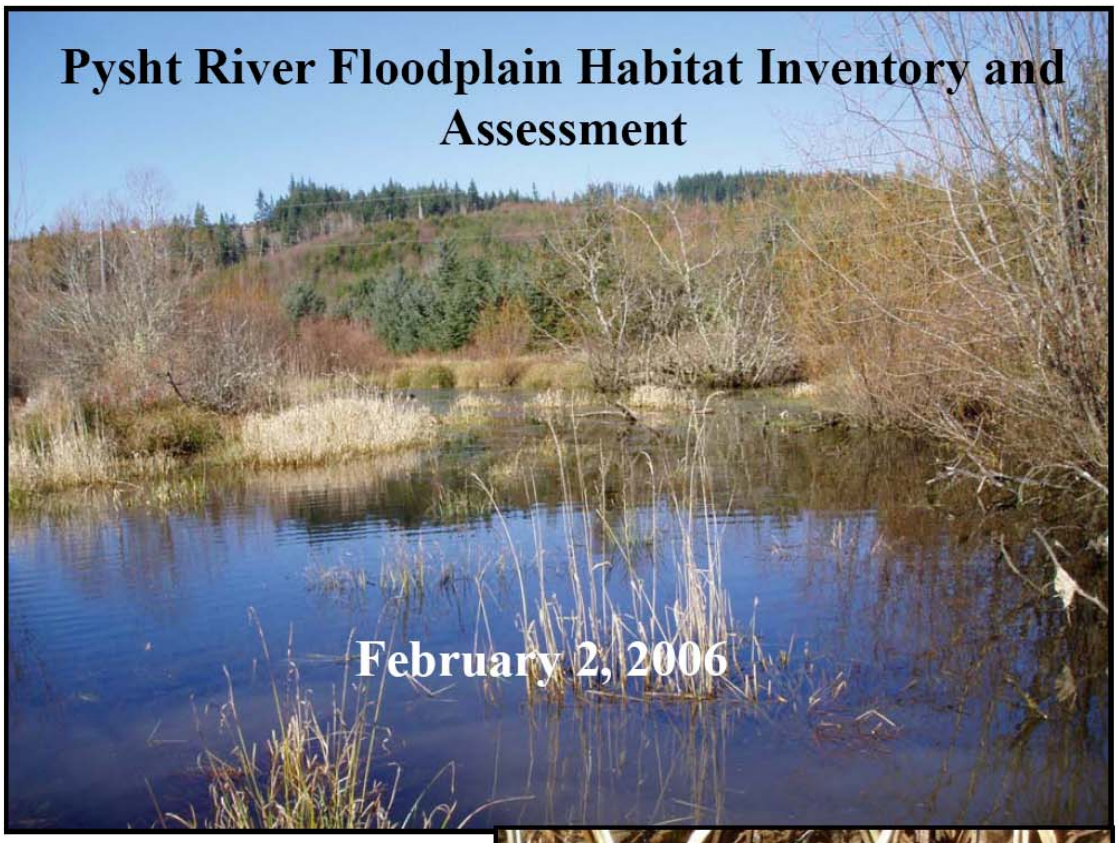
Pysht River Floodplain Habitat Inventory and Assessment



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LIST OF ACRONYMS/ABBREVIATIONS USED

BFD	Bankfull Depth
BFW	Bankfull Width
BY	Brood Year
CMZ	Channel Migration Zone
CW	Channel Width
DBH	Diameter at Breast Height
DNR	Washington State Department of Natural Resources
GIS	Geographic Information System
GLO	Government Land Office
GPS	Global Positioning System
LBT	Left Bank Tributary
LFA	Limiting Factors Analysis
LiDAR	Light Detection and Ranging
LWD	Large Woody Debris
M&R	Merrill and Ring
MSH	Maximum Sustainable Harvest
NMFS	National Marine Fisheries Service
PSC	Pacific Salmon Commission
RBT	Right Bank Tributary
RK	River Kilometer
RM	River Mile
RMAP	Road Maintenance and Abandonment Plan
RY	Return Year
SASSI	Salmon and Steelhead Stock Inventory
SaSI	Salmonid Stock Inventory
SSHIAP	Salmon Steelhead Habitat Inventory and Assessment Project
TAG	Technical Advisory Group
TFW	Timber, Fish, and Wildlife
USGS	United States Geological Survey
USFWS	United States Fish and Wildlife Service
WAU	Watershed Administrative Unit
WDF	Washington State Department of Fish
WDFW	Washington State Department of Fish and Wildlife
WFPB	Washington State Forest Practice Board
WRIA	Water Resource Inventory Area

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We would like to thank the following: Washington State Department of Transportation for Pysht River watershed LiDAR data, Herrera consulting for providing the geo-rectified 2003 WDOT color aerial photography, Merrill and Ring (especially Joe Murray) for access to their lands, access to the 1951 black and white aerial photography, and providing insight into the preliminary developments of the Pysht Tree Farm. Don Hamerquist and Janeen Porter provided access to their land and the photo used in Figure 34, as well as participated in numerous conversations regarding the locations of off-channel habitats on the Pysht River floodplain. We would like to thank June and Bob Bowlby, and John and Karolyn Burdick for unlimited access and cooperation. Tim Rymer and Chris Byrnes of WDFW provided insight into the location and utilization off-channel habitats in the lower river. Steve Todd (Point No Point Treaty Council) for provided GIS data from the historic GLO surveys of the lower Pysht River. Larry Burtness for provided copies of the Harry Hall transcript. Technical reviews of the draft manuscript were made by Ted Labbe and Jeff Shellberg.

EXECUTIVE SUMMARY

We assessed floodplain habitats (including off-channel and estuary) of the Pysht River between river mile 0 and 11.5 to evaluate impacts to salmon habitat productivity within the basin. This assessment was developed to guide restoration efforts on the Pysht floodplain through the development of a prioritized restoration list. Road and railroad grade construction, road maintenance and protection (e.g. rip-rap), channelization, channel relocation, logging, in channel wood removal, dredging, homesteading, agricultural development, wetland filling, and rural development have all contributed to floodplain habitat alterations in the Pysht Watershed. A total of 130 floodplain tributary habitat segments were identified in 29 tributary subbasins. Of these, 128 (98.5%) were identified as providing habitat for anadromous fish or having the potential to provide habitat.

Nearly 62% of the habitat segments inventoried were classified as off-channel/over-wintering habitats. Habitat types were unevenly distributed both longitudinally and horizontally along the river valley. Higher gradient habitats were almost entirely identified in the upper watershed and along the margins of the floodplain. Nearly 80% (calculated by length and wetland area) of all low gradient, off-channel habitat entered the mainstem Pysht River below river mile 5. A total of 29 of the 37 (78%) culverts were classified as partial or complete fish barriers. Only 9 (24%) of the culverts were classified as 100% passable and of these, only four were considered properly functioning. In all, 34 out of 37 (92%) of the culverts inventoried were either partial or complete fish barriers and/or not properly functioning (undersized, blocking tidal exchange, or preventing natural sediment and LWD transport).

Culverts were estimated to represent barriers (partial or total) to nearly 53% of the total length of floodplain habitat. Fish-bearing (or potential fish bearing) wetland areas upstream of culvert blockages were also examined by acreage. A total of 74.9 acres of fish bearing wetlands were identified along the Pysht River floodplain. Only 29% of these habitats were classified as 100% accessible to fish. Other habitat alterations were identified as a result of poorly designed and placed culverts. Several culverts that were undersized and improperly placed acted to alter sediment and LWD transport, disconnect the tidal prism of the lower river from floodplain tributaries, cause downstream erosion through accelerated velocities and outfall drops, and cause backwater flooding and habitat disconnection.

Encroachment of roads was determined to be the greatest floodplain impact because roads prevent lateral migration of the river and reduce riparian influence (LWD recruitment, shade). Within the first 30 m of the Pysht River's banks, roads represented 78% of the total length of floodplain encroachment. SR 112 contained the greatest length of stream parallel road network and contained more stream parallel length than all roads combined in all four encroachment zones evaluated. Road construction and protection, channelization, and wood-removal have affected the river's ability to migrate across the valley, hence decreasing the river's ability to form off-channel habitats now and into the

future. While rates of channel migration are not available for the Pysht River a review of the 1951 aerial photos indicates that the channel has not undergone drastic lateral migration. A series of historic impacts were identified in the lower river and estuary. These were associated with historic water based log transport and include dredging, wetland filling and disconnection (associated with the deposition of dredge spoils), channelization, and road construction. Restoration projects were identified in all subbasins and include correction of barriers, road relocation, riparian replanting, and LWD additions. A prioritized list of projects was developed based upon the amount of habitat improved, cost and feasibility.

1 INTRODUCTION

1.1 BACKGROUND

The Pysht River is a 30,000 acre (12,100 ha) watershed that drains primarily industrial forest lands on the North Olympic Peninsula (Figure 1). The Pysht River historically supported robust runs of chinook, coho, and chum salmon, as well as steelhead and cutthroat trout. These runs, particularly mainstem dependent chum and chinook populations, have declined as a result of the cumulative effects of over-exploitation, and reduced marine and freshwater survival. Tributary dependent populations, particularly coho have increased recently, most likely in response to increases in total marine survival. The primary causes of habitat degradation and reduced freshwater salmonid survival in the Pysht Watershed are thought to have resulted from historic logging, as well as impacts associated with highway construction, railroad grade construction, log transport and channelization (Smith 1999).

Previous studies in the Pysht Watershed have focused mainly on mainstem habitat conditions (McHenry et al. 1994; McHenry and Murray 1996;). No comprehensive assessments of the Pysht River floodplain or its extensive estuary have been conducted to date. Floodplain habitats likely supported extensive spawning and rearing habitats essential for several salmonid species. Over-wintering juvenile coho are noted for their preference and utilization of off-channel floodplain habitats which can include: beaver ponds, swamps, forested wetlands, wall-based channels, and low energy tributaries (Peterson and Reid 1984; Brown and Hartman 1988; Nickelson et al. 1992).

This study was funded by the Pacific Salmon Commission (PSC) in order to identify floodplain habitats of the Pysht River and human caused impacts that may be limiting salmon production within the basin. This assessment was developed to guide restoration efforts on the Pysht through the development of a prioritized restoration list. We inventoried all potential floodplain habitats (including mainstem and estuary) in the Pysht River between river mile (RM) 0 and 11.5 (RK 18.5) to achieve these goals. Over the short term we identified a number of projects that can be immediately implemented by groups interested in conducting restoration in the Pysht River. This information may also be used to guide restoration efforts through the Washington State Salmon Recovery Funding Board (SRFB) and other local, state, or federal funding sources of restoration. Over the long-term we also initiated the long process of disconnecting human infrastructure from the floodplain of the Pysht River. While this will not occur quickly or cheaply, planning must be initiated in order to have any hope of restoring natural processes in the Pysht River watershed.

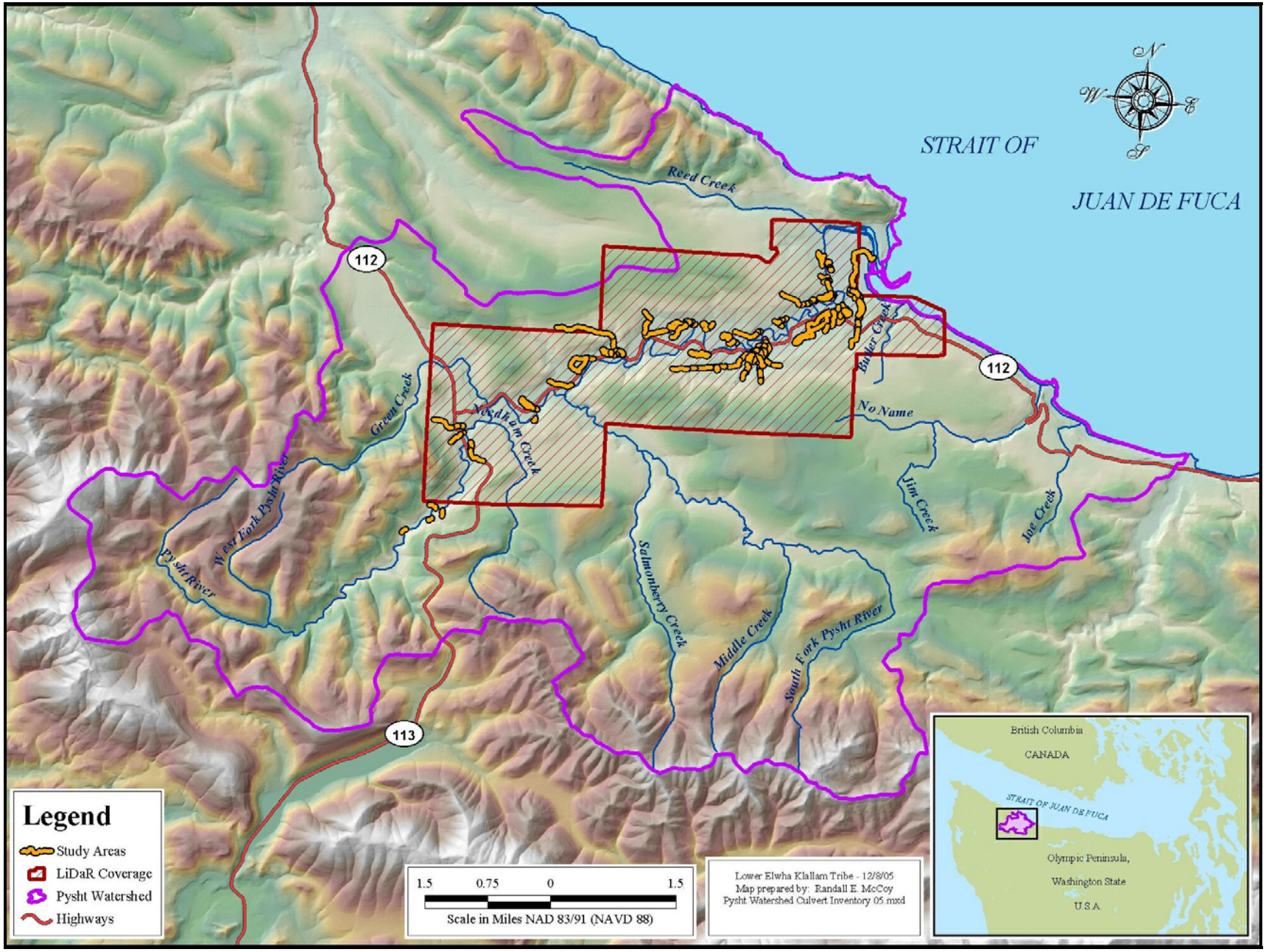

Figure 1. Pysht River Watershed location and floodplain habitat study areas.

1.2 PHYSICAL SETTING

The Pysht River watershed is located on the northwest Olympic Peninsula, Clallam County, Washington (Figure 1). The Pysht River watershed drains approximately 30,000 acres (46.9 sq mi or 121.4 sq km) and is approximately 17 miles (27.4 km) long. The upper watershed drains a series of steep, low elevation mountains that parallel the Strait of Juan de Fuca (maximum elevation 2,655 ft [810 m]). In the upper watershed the river is confined in a narrow valley bound by steep hills and low mountains. The lower river meanders through a low gradient unconstrained valley bound by low, gently sloping hills. Valley width is approximately 1,950, 2,100, 1,620, 620, and 325 feet at RM 2, 4, 6, 9, and 11, respectively. Watershed bedrock geology is primarily composed of marine sedimentary rock types, including silt-, mud-, and sand-stone (Tabor and Cady 1978). Mean annual precipitation averaged by precipitation zone across the watershed is estimated to be 80 inches (203.2 cm) per year (Jones and Stokes Associates 1991). Most of the precipitation in the watershed falls as rain, between October and March (Figure 2). Pysht River stream flow characteristics are similar to those of other nearby rain dominated watersheds where maximum stream flows occur during fall and winter months and low flows occur during the summer months (Figure 3).

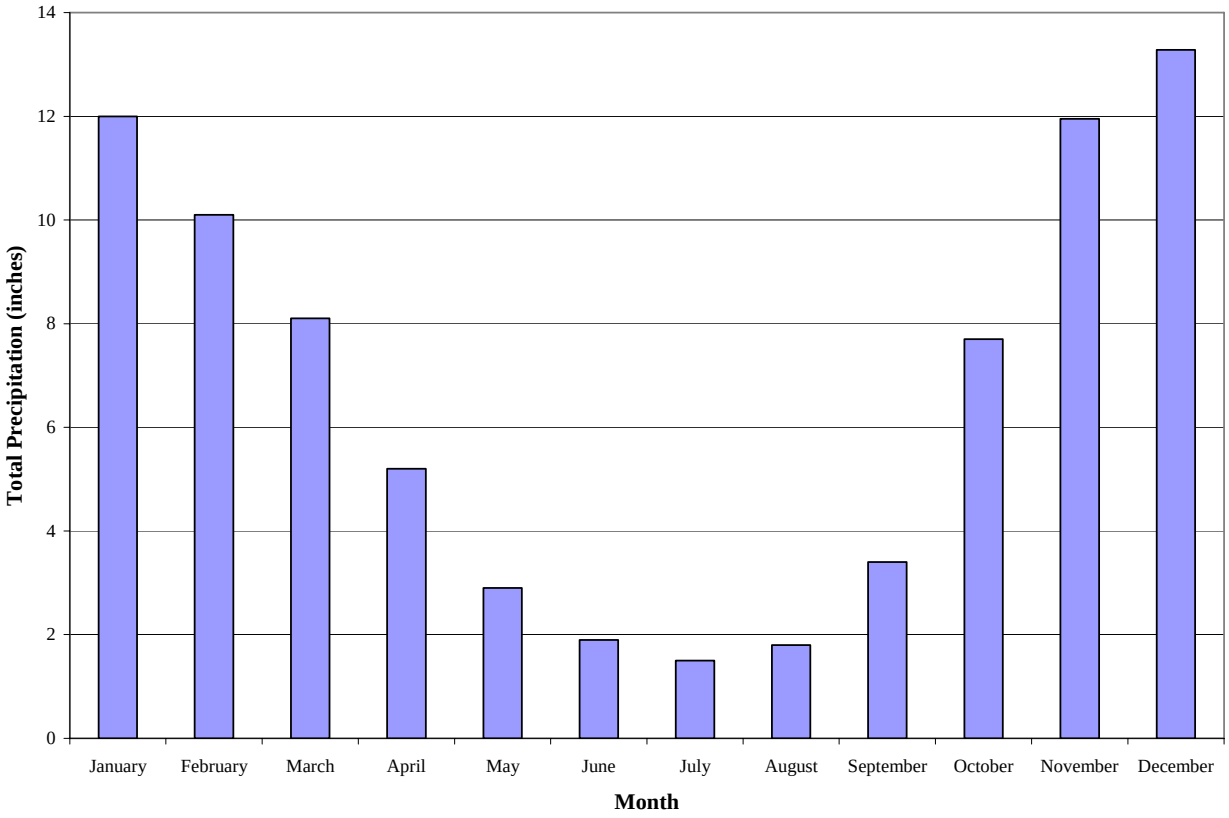

Figure 2. Estimated mean monthly precipitation for Pysht River watershed (modified from Jones and Stokes Associates 1991).

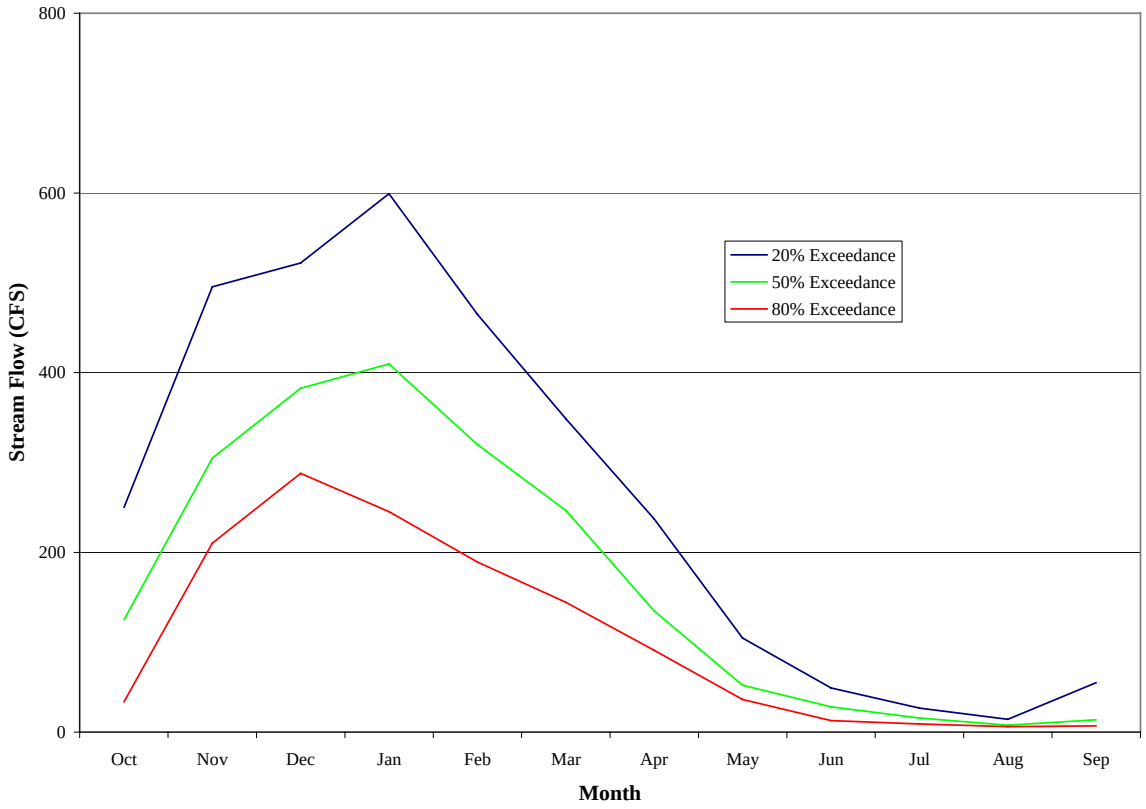

Figure 3. Estimated mean monthly streamflow exceedence curves for Pysht River for the period from 1961 to 1999 (source: Draft WRIA 19 Watershed Plan 2005).

1.3 ECOLOGICAL SETTING

Historically, the lower elevation forests of the Pysht River watershed were composed of large-diameter stands of Sitka spruce (*Picea sitchensis*), Douglas fir (*Psuedotsuga menziesii*), western hemlock (*Tsuga heterphylla*), and western red cedar (*Thuja picata*). Minor components of red alder (*Alnus rubra*) and big-leaf maple (*Acer macrophyllum*) were also present historically (GLO 1877). This study focused primarily in floodplain areas less than 40 m (131 ft) in elevation where forests are currently composed primarily young stands of deciduous species, particularly red alder. Vegetation age and size varies dependent upon timber harvest history. Most riparian areas, with the exception of some areas which were harvested with riparian buffers, are composed of young forests less than 30 years old.

The Pysht River system supports nine species of freshwater fish: five species of salmonids and four species of non-salmonids (WDFW 2002; Mongillio & Hallock 1997). Non-salmonid species known to be present in the Pysht River include: coastrange sculpin (*Cottus aleuticus*), prickly sculpin (*Cottus asper*), Pacific lamprey (*Lampetra tridentata*), and three-spine stickleback (*Gasterosteus aculeatus*). Salmonids present include:

chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*Oncorhynchus kisutch*), chum salmon (*Oncorhynchus keta*), coastal cutthroat trout (*Oncorhynchus clarki clarki*), and steelhead/rainbow trout (*Oncorhynchus mykiss*). Several other species are likely present in the estuary (starry flounder, surf perches, smelt) however these habitats have not been formally sampled to date. Salmonid population size, status, and trends vary by species, but in general run-sizes have decreased from their historic sizes. Table 1 depicts the status of salmonid populations in the Pysht River. Chinook escapements of several hundred fish were observed into the 1950s, but the run rapidly collapsed in the 1960s and 1970s (McHenry et al. 1996). A few chinook salmon are observed annually during chum and coho spawning ground surveys, however it is unclear whether these few fish represent a remnant population or strays from adjacent populations such as the Hoko River. Coho salmon population estimates for the Pysht River are available from 1998 to present, and total escapement has ranged from 1,700-6,100 adults. WDFW coho redd counts from index reaches on Green Creek and the South Fork illustrates an increasing trend in abundance (Figure 4). Between 1985 and 1994 coho redd counts averaged approximately 95, from 1995 to 2004 counts averaged approximately 206, an increase of more than 100%.

Pysht River chum salmon are a species of concern, representing a historically large population. During the period from 1986 to 1994 Pysht River chum salmon escapements averaged 2,146 (median 1,896), from 1995 to 2003 escapement averaged 1,039 (median 800), a decrease of more than 50%. Annual Pysht River estimated chum salmon spawning escapements are depicted in Figure 5. Wild winter steelhead has been surveyed annually by WDFW since 1984. The population is considered healthy by WDFW, as it is currently meeting its established escapement goal of 200 fish for all years since surveys were initiated. It should be noted however, that the escapement methodology (Gibbons et al. 1985) has never been agreed to by Washington Treaty Tribes. Population trends of Pysht River steelhead show no significant increase in abundance over time (Figure 6). No population data exists for cutthroat trout, though there is anecdotal information that the population has declined significantly since the 1950's (Personal Communication, Dick Goin, Olympic Sportsman's Association).

Table 1. Salmonid stock status information for Pysht River watershed.

Stock/Species	1992 Status (SASSI)[1]	2000/2002 Status (SaSI)[2,3]	2003 Status NOPLE[4]	Trend (NOPLE)	Current Range of Run-Size[1,2,3,4,5]
Chinook	NA	NA	Critical	Stable	<100
Coho	Depressed	Healthy	Depressed	Increasing	1,433-6,995
Chum	Healthy	Healthy	Depressed	Declining	123-2,685
Steelhead	Healthy	Healthy	Healthy	Stable	200-450
Cutthroat	NA	Unknown	Unknown	Unknown	Unknown

Sources: [1]WDF et al. 1994, [2]WDFW 2000, [3]WDFW 2002, [4]NOPLE 2003, [5]Haggerty 2005

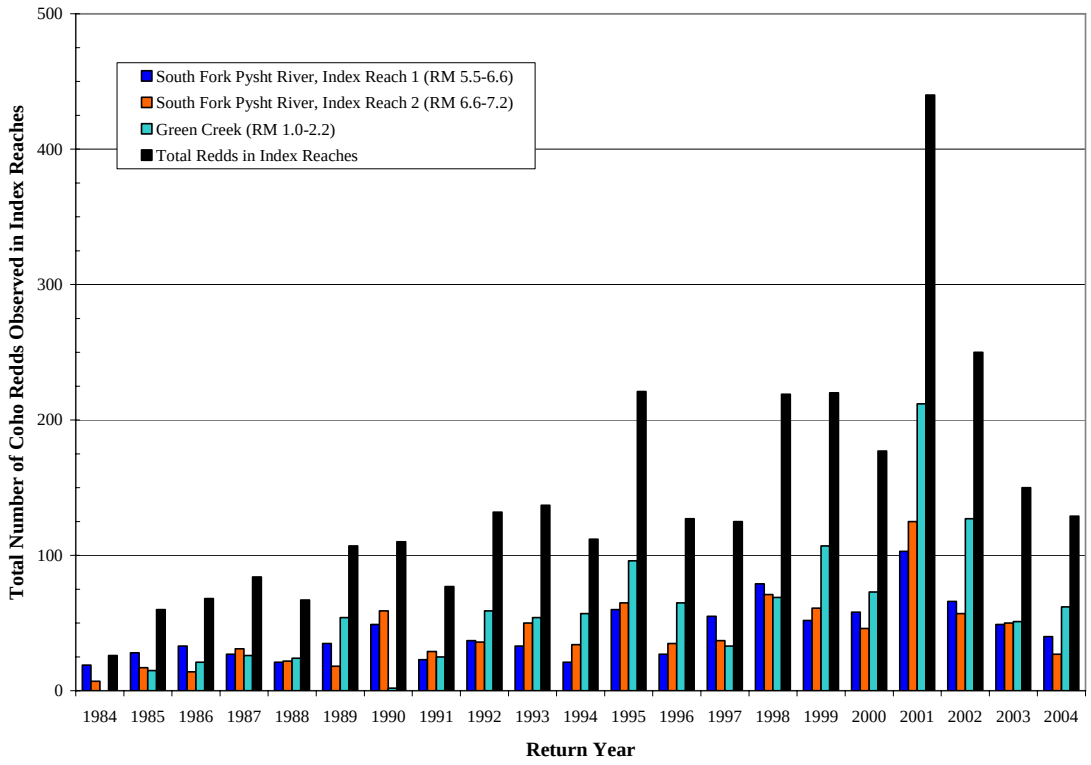

Figure 4. Pysht River system coho redd counts from WDFW coho spawning ground index reaches (source: WDFW spawning ground database).

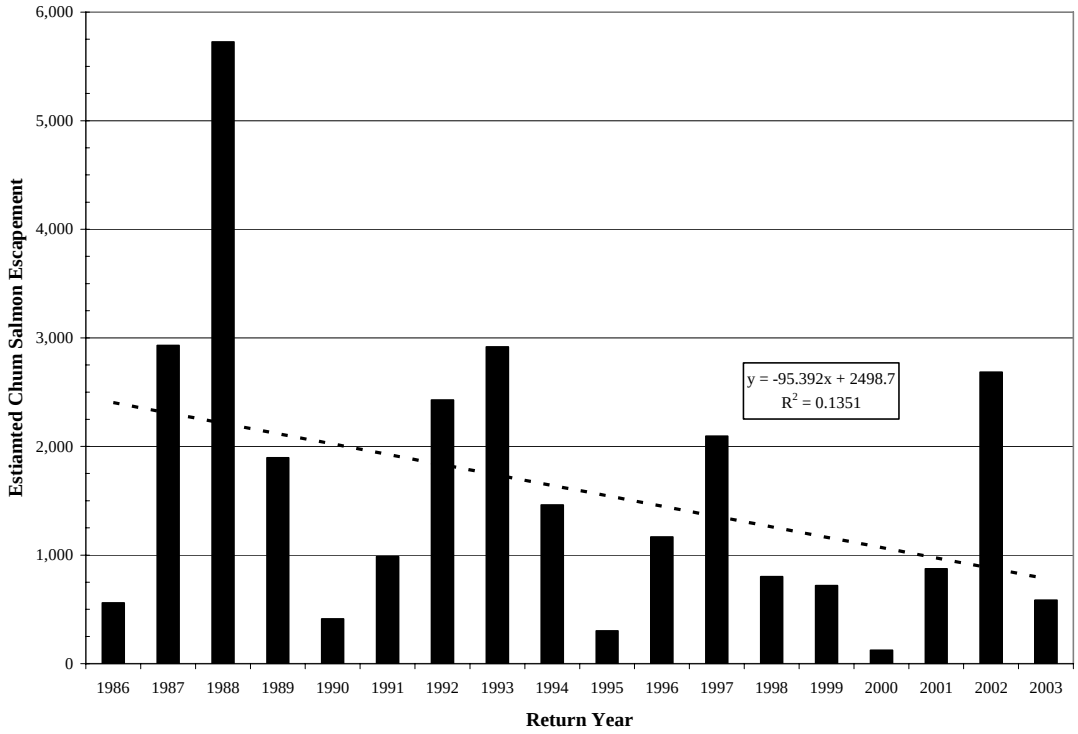

Figure 5. Estimated Pysht River chum salmon escapement (modified from SaSI 2002).

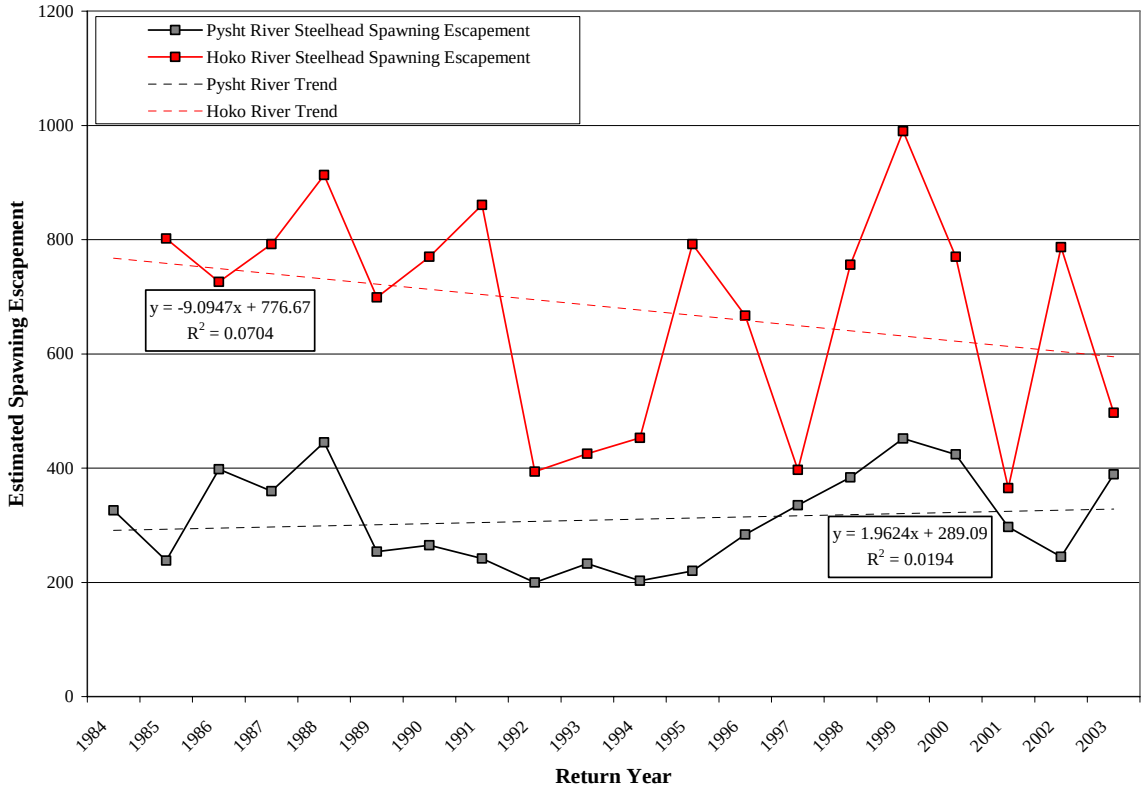

Figure 6. Estimated wild steelhead spawning escapement to the Pysht and Hoko River, 1984 through 2003 (source: WDFW unpublished escapement data).

1.4 WATERSHED DISTURBANCE HISTORY

The floodplain of the Pysht River was historically very dynamic, with the river flowing 11 miles through an unconstrained valley surrounded by old-growth conifer forests. Logging beginning in the early 20th century eliminated these old-growth forests, and the Pysht was channelized to facilitate log transport in the lower river and estuary. The lower river habitats were routinely dredged using a combination of suction and bucket dredges. Dredge spoils were reportedly discharged into tidally flooded marshes to facilitate agricultural development (Hall undated). A system of railroad grades was constructed adjacent to the Pysht River, and its largest tributary (South Fork Pysht River) to deliver logs to the lower river. A wagon road that paralleled the Pysht River was converted to a paved state highway (SR 112) in the 1940s. None of these actions were conducted with consideration for fish habitat or fish passage. These actions not only restricted channel migration processes, but also isolated tributary habitats, associated wetlands, and off-channel areas critical to fish. These problems have been exacerbated by channel incision of 1-2 m in the lower mainstem. Channel incision is thought to be a direct result of historic imbalances in sediment supply, channelization, and loss of channel roughness through LWD depletion.

1.5 A REVIEW OF THE PYSHT RIVER LIMITING FACTORS ANALYSIS

In 1998, the Washington State legislature passed several bills focused on salmon and salmon habitat recovery. The Salmon Recovery Planning Act (HB 2496; now RCW 78.55) directed the Washington State Conservation Commission to convene technical advisory groups (TAGs) in each WRIA of the state to identify habitat limiting factors affecting populations of salmonids statewide. The WRIA 19 TAG results are described in detail in, "Salmon and Steelhead Limiting Factors in the Western Strait of Juan de Fuca" (Smith 1999). This limiting factors report relied heavily on expert opinion and contains little quantitative data concerning habitat impacts within the Pysht River watershed. Limiting factors were categorized as major and minor limiting factors included:

- Floodplain impacts
- Sedimentation from roads and mass wasting
- Increased peak flows
- Loss/lack of LWD
- Loss of conifer riparian areas and LWD recruitment

Minor limiting factors included:

- Channelization
- Estuarine sediment impacts
- Nearshore habitat degradation
- Fish passage barriers

Interestingly, the Pysht River floodplain was considered to have the most significantly impacted floodplain habitat in WRIA 19 (Smith 1999). State route 112 and the M&R 2100 Road are described as the primary sources of impacts to the Pysht River floodplain (Smith 1999). Floodplain road densities were estimated to be 3.6 mi/mi^2 (Smith 1999).

2 METHODS

2.1 FLOODPLAIN HABITAT INVENTORY AND ASSESSMENT

We assessed only mainstem Pysht River floodplain habitats (RM 0–11.5) and the major tributaries (Reed Creek, S.F. Pysht River, Green Creek, and Needham Creek) were not included in the survey. We defined Pysht River floodplain tributary habitats as habitats that are located on the Pysht River valley bottom. These habitats include not only the "floodplain" proper; they may also be located on terraces, alluvial fans, or other low gradient landforms adjacent to the Pysht River valley. Initially, floodplain tributary habitats were identified and cataloged for field surveys using a combination of aerial photographs, the Washington State Department of Natural Resources (DNR) GIS

hydrography layer, the WRIA 19 Salmon Steelhead Habitat Inventory and Assessment (SSHIAP) GIS stream channel segment layer, and information provided by local fish biologist, foresters, and landowners.

Floodplain habitats were surveyed from their confluence with the mainstem Pysht, upstream to the end of the floodplain habitat or potential habitat (in the cases where barrier culverts were present). In cases where floodplain habitats were spring-fed, the end of survey coincided with the upper extent of the channel or wetland. Where floodplain habitats were part of larger tributary habitats they were surveyed upstream until the stream gradient exceeded 8% or geologic controls, such as waterfalls, cascades, or chutes prevented upstream fish migration. Almost the entire valley bottom of the Pysht River is privately owned; therefore complete surveys of all habitats were not possible since a few landowners would not permit surveys on their property. In total, five streams were only partially surveyed due to access limitations.

Floodplain habitats were surveyed using a handheld GPS, digital camera, string box, clinometer, stadia rod, and tape measure. Physical channel attributes were measured at intervals (measurement stations) of approximately 5-20 m dependent upon the degree of habitat and channel variation. Channel measurements were taken at representative stream cross-sections and included the following attributes: stream gradient, channel confinement, bankfull width (BFW), wetted width (WW), bankfull depth (BFD), and average depth. Additional data were recorded at each measurement station and included the following: channel type, substrate composition, right bank (RB) and left bank (LB) riparian conditions, floodplain presence and connectivity, and fish presence and species. Channel confinement was defined as the ratio of valley or floodplain width to channel width and recorded as either confined (C- less than 2 BFW's between valley walls), moderately confined (M- 2-4 BFW's between confining valley walls) or unconfined (U- greater than 4 BFW's between confining valley walls). Additionally, where channel segments were determined to be highly incised and function as if they were confined, channel confinement was recorded as functionally confined (FC).

Bankfull width and depth measurements were measured to the nearest 0.1 and 0.01 m respectively. Measurement methods used the guidelines established in Plues & Schuett-Hames (1998b). Wetted width and average depth were measured to the nearest 0.1 and 0.01 m respectively. However, the lack of well defined channels including significant areas of associated and forested wetland types made it impossible to measure BFW and BFD in many cases. Wetted width and depth measurements were also difficult to measure in situations with undefined banks and limited or no flow; in these cases the width and depth were often recorded as undefined.

The channel type between each measurement station was classified as one of the following: estuarine (E), estuarine wetland (EW), open water wetland (OWW), forested wetland (FW), wall-based (WB), regime (R), pool-riffle (PR), alluvial fan (AF), forced pool-riffle (FPR), plane-bed (PB), step-pool (SP), forced step-pool (FSP), or cascade (C). Substrate type was recorded in one of the following categories: fines (F; <0.16 mm), sand (S; 2-0.16 mm), gravel (G; 2-64 mm), cobble (C; 64-256 mm), boulder (B; >256 mm), or

bedrock (R). The substrate composition field was used to distinguish between areas with high quality, glacially derived gravels versus gravels primarily derived from the mechanically weak native sedimentary rock types. Riparian conditions were classified using the methods outlined in WFPB (1997). Notes regarding the presence, absence, size, and connectivity of the floodplain were recorded at each measurement station. Additional notes were recorded at each measurement station and included topics such as: aquatic vegetation, fish presence or absence, aggradation, incision, and the presence of road crossings. Each stream system surveyed was divided into discrete channel/habitat segments using the methods outlined in Pleus and Schuett-Hames (1998a). GPS points were collected at the upper and lower boundary of each segment. For the majority of stream segments surveyed GPS points were also collected at significant channel features, such as tributary junctions, road crossings, and major changes in stream course.

2.1.1 HABITAT CLASSIFICATION

In order to quantify the amount and type of different floodplain habitats we developed a habitat classification system based upon eight primary habitat types found on and adjacent to the Pysht River valley. We classified each channel segment as one of the 13 channel types found during the floodplain tributary surveys (see Section 2.1). Habitat units have the potential to contain from one to six different channel types. Table 2, depicts the different channels types that may be contained within each of the different habitat types.

Table 2. Pysht River floodplain habitat types and channel types that have the potential to occur within each habitat type.

	Low Energy, Over-Wintering Channels	**Off-Channel Wetland Habitat**	**Ponds**	**Off-Channel Wetland Habitat with Ponds**	**Low Gradient Spawning and Rearing Habitat**	**Moderate Gradient Spawning and Rearing Habitat**	**Mod.- to High Gradient Habitat**	**Ditches**
Channel Types	E FW WB R PR AF	FW OWW EW AF	OWW EW	OWW EW	WB PR FPR PB AF	FPR PB SP FSP AF	SP FSP C	D
Channel Type Codes: estuarine (E), estuarine wetland (EW), open water wetland (OWW), forested wetland (FW), wall-based (WB), regime (R), pool-riffle (PR), alluvial fan (AF), forced pool-riffle (FPR), plane-bed (PB), step-pool (SP), forced step-pool (FSP), cascade (C), or ditch (D)								

Habitat types were defined as follows:

Low Energy, Over-Wintering Channels: These are low gradient (<5%), low energy habitats that consist of stream or wetland channels with definable banks, although banks

are often low and adjacent wetland habitats. The majority of these stream systems do not contain high gradient tributaries: most are fed by springs and/or wetlands. Substrate is composed of fine sediment and is typically high in organic debris.

Off-Channel Wetland Habitat: This is a low gradient, very low energy habitat that consists of shallow open water wetlands (average depth < 1m), forested wetlands, and/or seasonally flooded areas. Banks and channels are typically non-definable throughout these habitat units, although some habitat units contain multiple, poorly defined channels rather than broad expansive flooded areas. These habitats are composed mainly of very fine sediment, organic debris, and are often highly vegetated. Coarser sediment may be present in areas adjacent to or overlapping with alluvial fans.

Ponds: This habitat unit can either be natural or man-made; a significant portion of the habitat units contain open water > 1m depth. Some small pond like features were not separated from habitat units classified as off-channel wetland habitat because they were small and not necessarily different enough from the adjacent habitat to discreetly separate. Where this occurs the habitat units were classified as off-channel wetland habitat with ponds.

Off –Channel Wetland Habitat with Ponds: see wetland and ponds description.

Low Gradient Spawning and Rearing Habitat: This habitat unit was made up of mostly gravel bedded stream channels from 1 to 3% gradient. Habitats are almost exclusively unconfined and often associated with alluvial fans along the floodplain of the Pysht. Stream segments within this habitat unit are both perennial and seasonal and therefore not all habitat units provide summer rearing habitat for juvenile salmonids. Some habitat segments contained high value over-wintering habitat but were distinguished from the low energy, over-wintering channels based upon the presence of spawning habitat and other potential differences in the type of over-wintering habitat provided.

Moderate Gradient Spawning and Rearing Habitat: This habitat unit was made up of moderate energy, gravel and cobble bedded stream channels ranging in gradient from 3-8%. These habitat units were typically associated with the largest floodplain tributaries that contained complex drainage networks or with stream systems draining steeper topography adjacent to the floodplain.

Moderate to High Gradient Spawning and Rearing Habitat: This habitat unit was made up of moderate energy, gravel and cobble bedded stream channels ranging in gradient from 5-12%. The vast majority of these channel segments were not contained within the study area, but where they occurred as tributaries to habitats surveyed they were noted. Two of these habitat segments were surveyed in the upper-Pysht (Boulder and Bridge Creeks).

Ditches: This habitat unit was made up of fish bearing ditches that occurred adjacent to logging roads and the highway. These habitats were typically low energy environments with fines, sand, or small gravel substrate.

2.2 STREAM CROSSING INVENTORY AND ASSESSMENT

Partial surveys of stream crossings in the Pysht watershed are included in road maintenance and abandonment plans (RMAPs), and in the WDFW culvert inventory database. In order to develop an inventory of all road related fish blockages we conducted a comprehensive assessment of floodplain tributary road crossings within the study area. During the floodplain habitat inventory and assessment all stream crossing inventoried were included into a single stream crossing dataset. Stream crossings were defined by type: bridge, culvert, or open channel. During the floodplain habitat inventory all non-culvert stream crossings were evaluated for fish passage and functionality. GPS data were collected at all stream crossings inventoried and a list of culvert only stream crossings was developed.

At each of the culverts identified, fish passage was assessed using the methods outlined in WDFW (2000). Culvert and channel attribute data were collected at each culvert and included the following: stream name, road name, GPS location, fish use, survey date, culvert type, culvert shape, culvert width and height, culvert length, bed material, outfall drop, culvert slope, channel width, water velocity, apron presence, fill depth, outlet pool depth, width, and length, and culvert notes. These culvert attributes were the basis for determining fish passage through the culverts. Each culvert was categorized by the degree of passability in four categories: 100%, 67%, 33%, and 0% (WDFW 2000). All culvert field data were assembled into a single GIS database. There are several culverts which include data from multiple inventories (WDFW and RMAPs). The primary culvert data analysis presented in this report comes directly from the inventory work we conducted unless noted otherwise.

2.3 FLOODPLAIN ENCROACHMENT ASSESSMENT

Infrastructure and non-forest land use encroachment along the Pysht River floodplain was assessed using high resolution digital aerial photographs from the estuary, upstream to the confluence with Green Creek (RM 9.0; RK 14.5). Upstream of Green Creek, the banks of the river are far less distinguishable on the aerial photos and therefore this area was not included in the assessment. The first step used in assessing floodplain encroachment was to delineate the bankfull edge of the Pysht River from rectified 2003 WADOT aerial photographs using ArcMap. Once the bankfull edge of the channel was delineated, zones of 10, 20, 30, and 60 meters (33, 66, 98, and 197 ft) were generated parallel to the river's bankfull edge. Encroachment of roads, railroad grades, parking facilities, residences, and pastures were identified within each of the four zones adjacent to the river.

Infrastructure and land use within these zones was categorized into three broad encroachment types: roads, residential development, and agricultural. Roads were classified according to their type, use, and position relative to the river. Road types consisted of the following categories: highway, mainline, secondary, abandoned, railroad grade, and parking area. Road length and stream crossing width were used to define the percent length of riparian floodplain encroachment. Areas of residential and agricultural development within zones of influence were also delineated and classified. Driveways, gardens, parking areas, houses, barns and adjacent non-forested areas were all defined as residential land use. The length of land used for non-forest, agricultural purposes (fields and pastures) parallel to the river was also delineated and measured. Several of these segments were verified in the field and additional information and data were collected at several of these sites, such as the presence of rip-rap. All measurements of infrastructure encroachment along the floodplain were measured using tools in ArcMap.

Additional observations of floodplain encroachment on tributary floodplain habitats were assessed during the floodplain habitat field surveys, results are included in Section 3.2.2.2.

2.4 DEVELOPMENT OF PRIORITIZED RESTORATION PROJECT LIST

We developed a list of habitat, channel, and fish passage issues for each of the stream systems evaluated in the inventory. This list along with data from each of the potential projects was developed into a Powerpoint presentation and presented to the restoration project committee. The committee was composed of technical staff from Merrill and Ring, Lower Elwha Klallam and Makah Tribes. Projects were ranked in importance based upon the amount of and quality of habitat improved. We developed a weighted matrix that included the area of spawning and rearing habitat accessed/improved for each project along with an estimate of cost. Because of difficulty assigning numerical values between projects, we chose to assign relative qualitative values of high (5), medium (3), and low (1). The total score was summed for each parameter and ranked by value. The project list was reviewed by biologists from the WDFW, along with citizens from WRIA 19 watershed committee. Based upon this input a final prioritized list of projects was developed for the Pysht River floodplain. The projects were grouped into tiers that reflect highest through lowest priorities for the watershed.

3 RESULTS

3.1 FLOODPLAIN HABITAT INVENTORY

A total of 130 floodplain tributary habitat segments were identified in 29 tributary subbasins. The distribution of habitat types inventoried along the Pysht River floodplain is depicted in Figure 7. It was estimated that at least 80% of the total floodplain habitat length was field verified and surveyed. The remaining unsurveyed areas were either inaccessible because of access or determined to be "unsurveyable" due to impenetrable brush and/or blowdown. Of the 130 habitat segments, 128 (98.5%) were identified as providing habitat for anadromous fish or having the potential to provide habitat. Two segments were classified as having undefined potential use. One segment was upstream of a steep channel segment and had a potential barrier caused by rip-rap associated with SR 113 (Bowlby Creek segment 3). The other stream segment was part of an alluvial fan and the channel had been rerouted in such a way that access to the stream segment was not possible under the current channel alignment. Nearly 62% of the segments inventoried were classified as off-channel/over-wintering habitats. Low energy, over-wintering channels were the most frequent habitats, followed by off-channel wetland habitats, and low gradient spawning and rearing habitat (Table 3; see APPENDIX A).

Table 3. Summary of habitat types by number of habitats, length, and wetland area.

	Low Energy, Over-Wintering Channels	Off-Channel Wetland Habitat	Ponds	Off-Channel Wetland Habitat with Ponds	Low Gradient Spawning and Rearing Habitat	Moderate Gradient Spawning and Rearing Habitat	Mod.- to High Gradient Habitat	Ditches
Number of Habitat Units	38	30	7	4	25	13	6	5
Habitat Length (Miles)	3.29	3.19	0.51	0.92	3.95	2.24	0.77	0.29
Habitat Area (acres)	na	59.57	3.79	11.51	na	na	na	na

It is important to note that there were several wetland areas that appear to have been historically connected to the estuary. These areas were identified during a field visits but were not included in the main habitat inventory. Information on these habitats is included in Section 3.2.3. Just over 53% of the total floodplain tributary habitat (by length) was classified as functioning as off-channel habitat. Some low gradient spawning and rearing habitat was observed to contain high juvenile fish use during winter, essentially functioning as over-wintering habitat. Figure 8, depicts the percentage of habitat (by length) that each floodplain habitat type represents for the entire Pysht River floodplain.

Habitat Key

>Low Energy, Over-Wintering Channels: These are low gradient (<5%), low energy habitats that consist of stream or wetland channels with definable banks, although banks are often low and adjacent wetland habitats. The majority of these stream systems didn't contain high gradient tributaries: most were fed by springs and/or wetlands. Substrate is composed of fine sediment and typically high in organic debris.
>Off-Channel Wetland Habitat: This is a low gradient, very low energy habitat that consists of shallow open water wetlands (average depth < 1m), forested wetlands, and/or seasonally flooded areas. Banks and channels are typically non-definable throughout these habitat units, although some habitat units contain multiple, poorly defined channels rather than broad expansive flooded areas. The bottoms are composed mainly of very fine sediment, organic debris, and are often highly vegetated. Coarser sediment may be present in areas adjacent to or overlapping with alluvial fans.
>Ponds: This habitat unit can either be natural or man-made; a significant portion of the habitat units contain open water > 1m depth. Some small pond like features were not separated from habitat units classified as off-channel wetland habitat because they were small and not necessarily different enough from the adjacent habitat to discreetly separate. Where this occurs the habitat units were classified as off-channel wetland habitat with ponds.
>Off-Channel Wetland Habitat with Ponds: see wetland and ponds description.
>Low Gradient Spawning and Rearing Habitat: This habitat unit was made up of mostly gravel bedded stream channels from 1 to 3% gradient. Habitats are almost exclusively unconfined and often associated with alluvial fans along the floodplain of the Pysht. Stream segments within this habitat unit are both perennial and seasonal and therefore not all habitat units provide summer rearing habitat for juvenile salmonids. Some habitat segments contained high value over-wintering habitat but were distinguished from the low energy, over-wintering channels based upon the presence of spawning habitat and other potential differences in the type of over-wintering habitat provided.
>Moderate Gradient Spawning and Rearing Habitat: This habitat unit was made up of moderate energy, gravel and cobble bedded stream channels ranging in gradient from 3-8%. These habitat units were typically associated with the largest floodplain tributaries that contained complex drainage networks or with stream systems draining steeper topography adjacent to the floodplain.
>Moderate to High Gradient Spawning and Rearing Habitat: This habitat unit was made up of moderate energy, gravel and cobble bedded stream channels ranging in gradient from 5-12%. The vast majority of these channel segments were not contained within the study area of this project but where they occurred as tributaries to channels surveyed there were noted. Two habitat segments were surveyed in the upper-Pysht.
>Ditches: This habitat unit was made up of fish bearing ditches that occurred adjacent to logging roads and the highway. These habitats were typically low energy environments with fines, sand, or small gravel substrate.

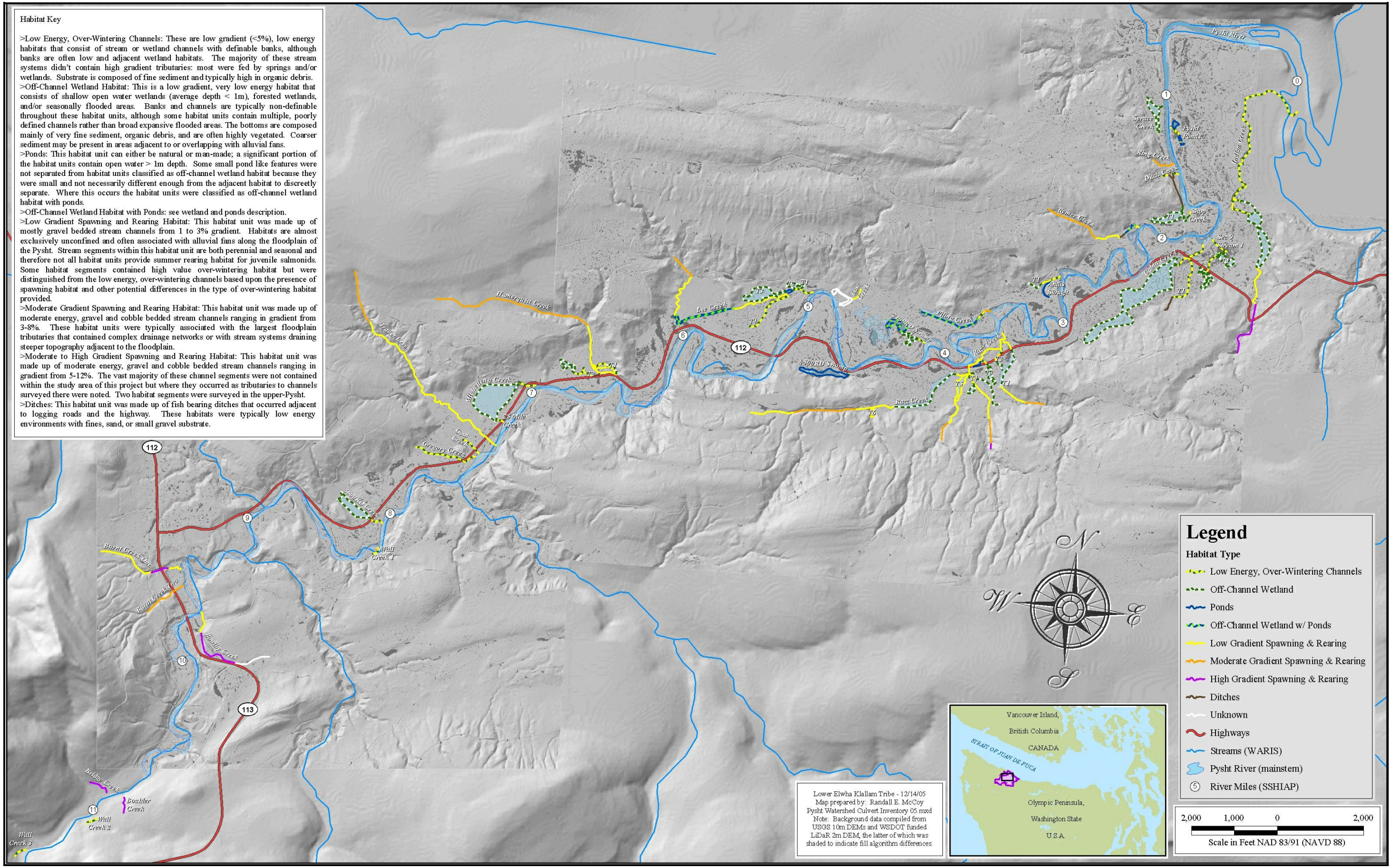

Figure 7. Map depicting the distribution of different Pysht River floodplain tributary habitat units.

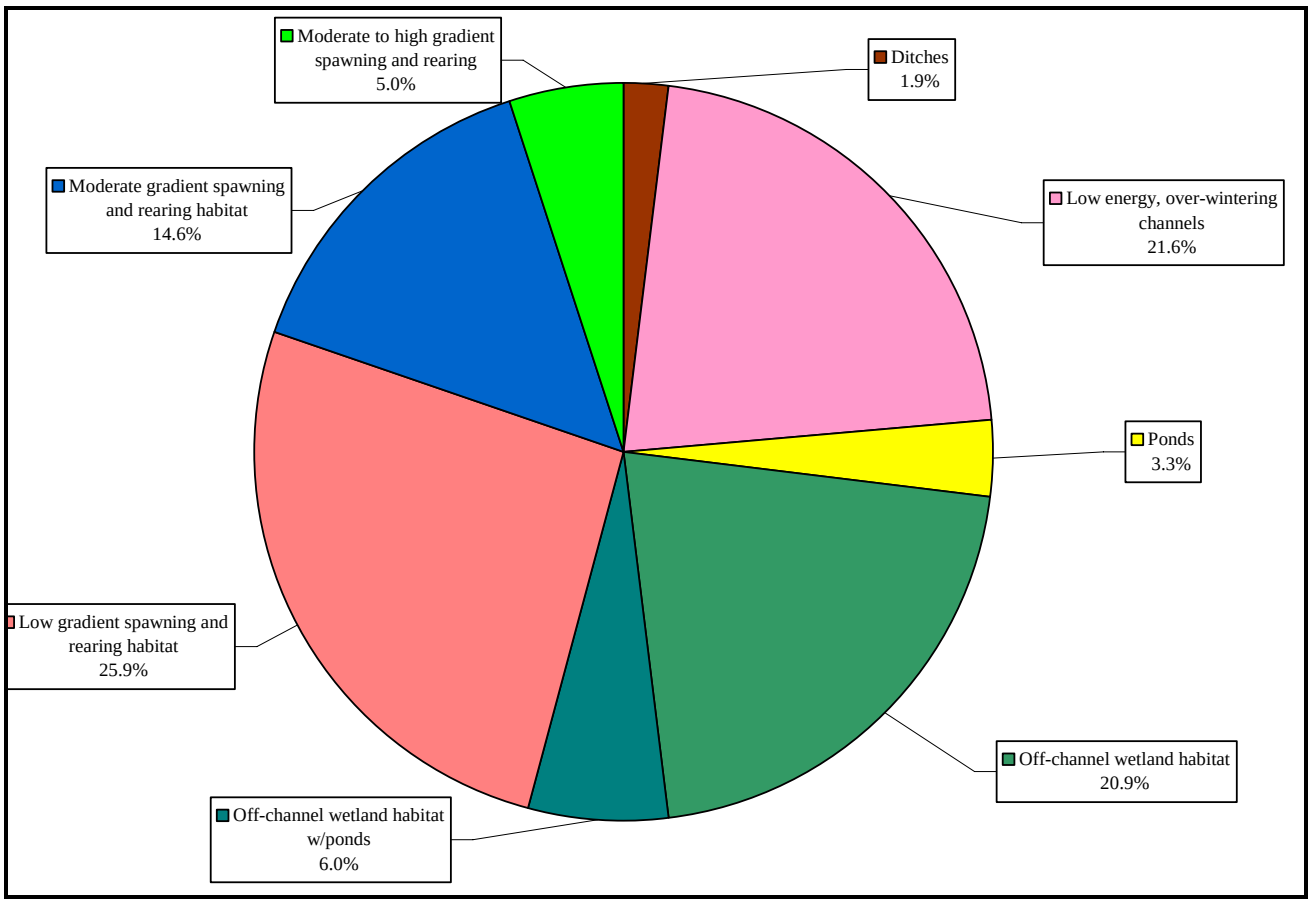

Figure 8. Habitat types as a percent of the total floodplain habitat available in the Pysht River floodplain (by length).

Habitat types were unevenly distributed both longitudinally and horizontally along the river valley. Higher gradient habitats were almost entirely identified in the upper watershed and along the margins of the floodplain. Nearly 80% (calculated by length and wetland area) of all low gradient, off-channel habitat entered the mainstem Pysht River below river mile[1] (RM) 5 (Figure 9). Valley width decreases in the upstream direction which provides less opportunity and area for low gradient habitats to develop.

Channel segment attributes varied widely between and among habitat types. Channel segments ranged from 5 to 1,340 m (15 to 4,400 ft) in length, averaging 192 m (630 ft). The shortest channel segments typically occurred where short channel reaches connected off-channel habitats to tributary streams or the mainstem. In habitats with defined channels BFW ranged from 0.3 to 13.4 m (1 to 44 ft), averaging 2.7 m (9 ft). Wetted widths during the month of February ranged from 0.18 to 4.9 m (0.6 to16 ft; excluding portions of dry channel where wetted width was 0). Detailed descriptions of each floodplain habitat are included in APPENDIX B.

[1] Note: all direct references to river miles in this report come from GIS stream lengths in the SSHIAP database.

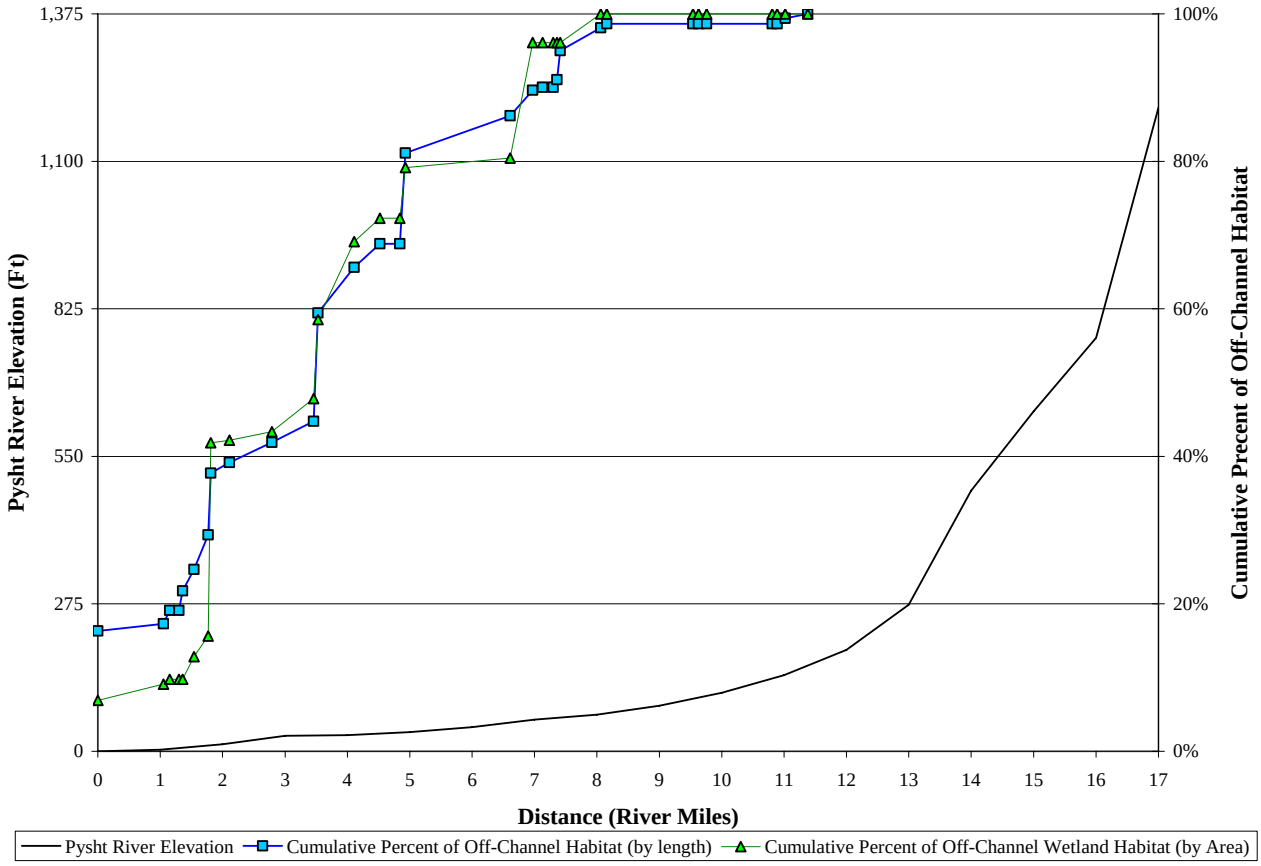

Figure 9. Plot of Pysht River elevation versus distance contrasted with the cumulative percent of off-channel habitat (by length and wetland area) entering the mainstem by distance from mouth to headwaters.

3.2 FLOODPLAIN HABITAT ALTERATIONS

The primary objective of this study was to identify impaired floodplain tributary habitats in order to improve degraded habitats through restoration. We focused our efforts less on identifying physical habitat alterations to the mainstem, and more so to alterations of off-channel habitats adjacent to the mainstem. Road and railroad grade construction, road maintenance and protection (e.g. rip-rap), channelization, channel relocation, logging, in channel wood removal, dredging, homesteading, agricultural development, wetland filling, and rural development have all contributed to floodplain habitat alterations in the Pysht Watershed. The main impacts of road construction on floodplain tributary habitats are loss of access through stream crossings. However, other alterations such as wetland filling have also limited access to habitat, as well as reduced the quantity of habitat available for fish use. Channelization and channel relocation have also affected floodplain tributary habitats in several locations. Channel incision, potentially associated with LWD removal and removal of riparian forests has disconnected some floodplain

habitats (through loss of access and loss of water connectivity in side channels). In some locations where significant (> 1 m) channel incision has occurred, a lowering of the water table may have also occurred, limiting the use and viability of some floodplain habitats, as well as stranding rearing juvenile salmonids.

3.2.1 HABITAT ALTERATIONS FROM STREAM CROSSINGS

The most significant impact to habitat from stream crossings comes from the loss of access by fish. Improperly designed stream crossings may result in other habitat alterations including: loss of tidal influence and estuarine habitat, channel scour from undersized pipes, sediment deposition and channel dewatering from poorly placed culverts. Most stream crossing problems identified were caused by culverts versus other crossing types. A total of 45 stream crossings were inventoried during the floodplain tributary surveys (Figure 10).

Stream crossings were divided into three categories: bridges, hardened/removed stream crossings, and culverts. A total of 37 (82%) of the stream crossings were culverts. Five (11%) stream crossings consisted of either previously removed fill with a natural streambed or a hardened crossing where a portion of the fill was removed but the channel flowed across part of the old road prism or rocks placed across the crossing. The remaining three stream crossings were all bridges. With the exception of one stream crossing, all of the bridges and hardened crossings were properly functioning and 100% passable for both adult and juvenile salmonids. Of the 37 culverts, 35 were included in the comprehensive culvert inventory and two culverts were only surveyed as part of the floodplain habitat inventory. Both of these culverts were complete barriers to juvenile and adult salmonids.

A total of 29 of the 37 (78%) culverts were classified as partial or complete barriers. Only 9 (24%) of the culverts were classified as 100% passable and of these, only four were considered properly functioning. In all 34 out of 37 (92%) of the culverts were either partial or complete fish barriers and/or not properly functioning (undersized, blocking tidal exchange, or preventing natural sediment and LWD transport). Culverts were estimated to represent barriers (partial or total) to almost 53% (8.1 mi; 12.9 km) of the total length of floodplain habitat (Figure 11).

Habitat types classified as spawning and rearing habitat were affected to a greater extent by loss of access due to culverts than off-channel habitat. Almost 45% of the floodplain habitat length classified as off-channel habitat had partial or complete barriers to juvenile salmon, while 63% of the spawning and rearing habitat had downstream barriers. Approximately 66% of the floodplain tributary habitat length is upstream of culverts but over 76% of the spawning and rearing habitat length is upstream of culverts. Only 21% of the floodplain habitat length upstream of culverts was categorized as 100% accessible.

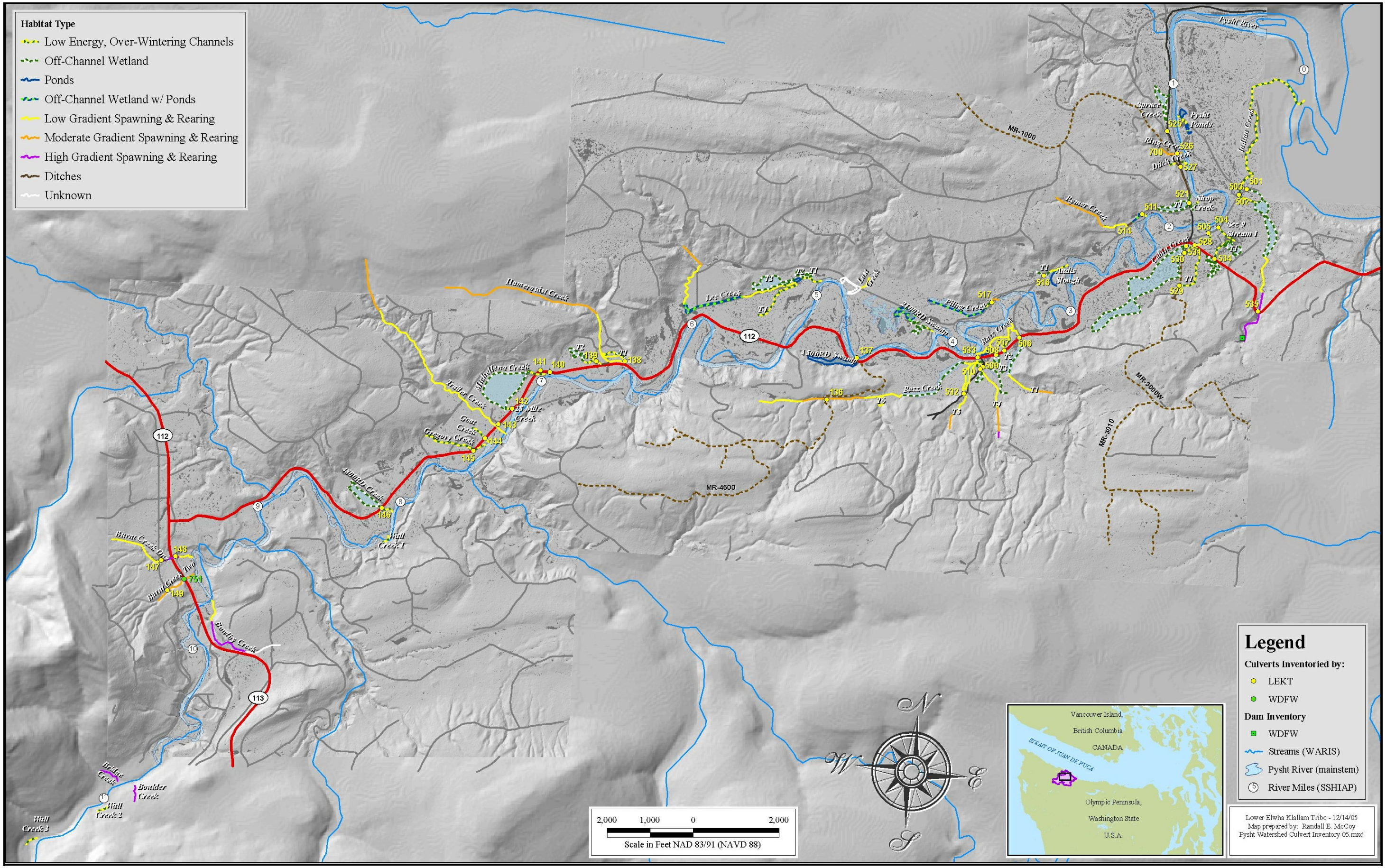

Figure 10. Pysht River floodplain culvert inventory sites.

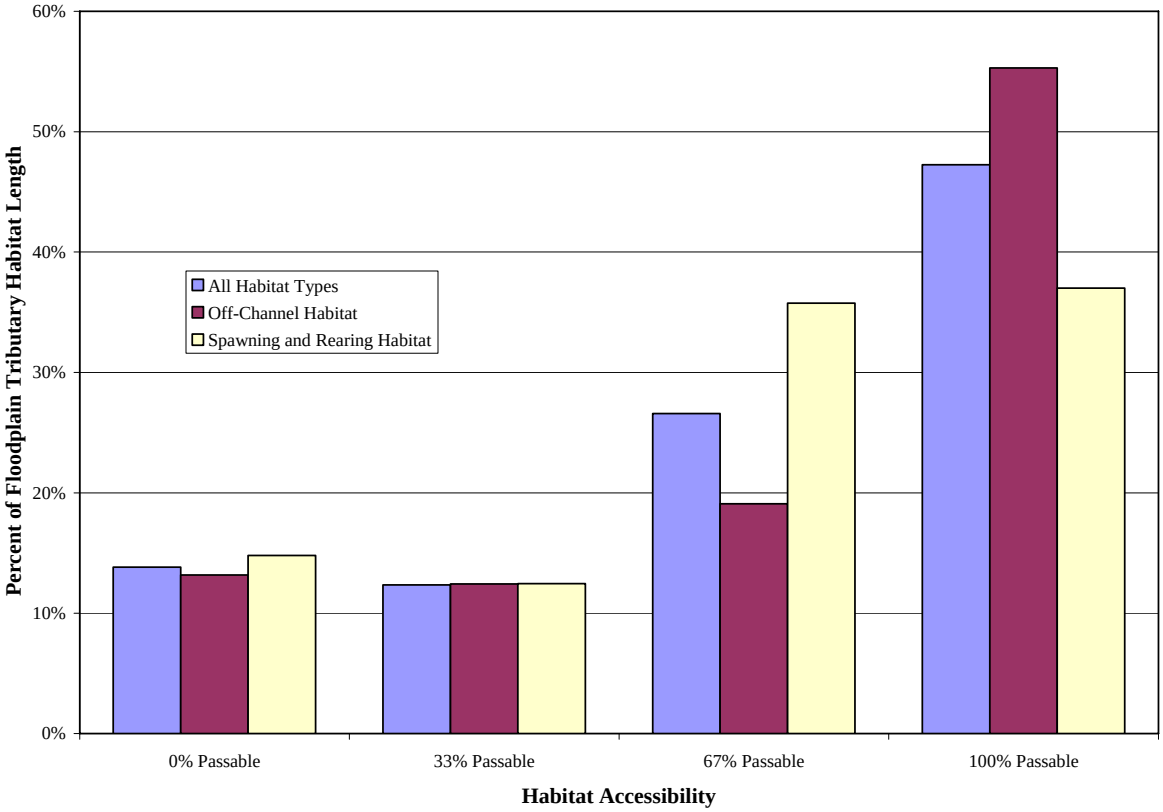

Figure 11. Comparison between all habitat types, off-channel habitat, and spawning and rearing habitat accessibility resulting from culverts (note not all streams have culverts streams without culverts were categorized as 100% passable throughout their anadromous fish-use range).

It is important to consider that the length of the habitat blocked by culverts is only one metric for describing the quantity of habitat blocked. Fish-bearing (or potential fish bearing) wetland areas upstream of culvert blockages were also examined by acreage. A total of 74.9 acres of fish bearing wetlands were identified along the Pysht River floodplain. Only 29% of this habitat was classified as 100% accessible to fish, just over 27% is above culverts classified as 0% passable (Figure 12). Over 21% of the wetland area is downstream of culverts or in systems without culverts; therefore only 8% of the off-channel wetland habitat area upstream of culverts was classified as 100% accessible. All culverts included in the analysis are depicted in Table 4. As described in Section 2.2 additional data were collected at each culvert and included the following: GPS location, fish use, survey date, culvert shape, culvert width and height, culvert length, bed material, outfall drop, culvert slope, channel width, water velocity, apron presence, fill depth, outlet pool depth, width, and length, and culvert notes. These data were entered into a database and included in determining the fish passability through each culvert but are not presented in this report. Detailed information on each culvert barrier is included in Section 4.2 and APPENDIX B.

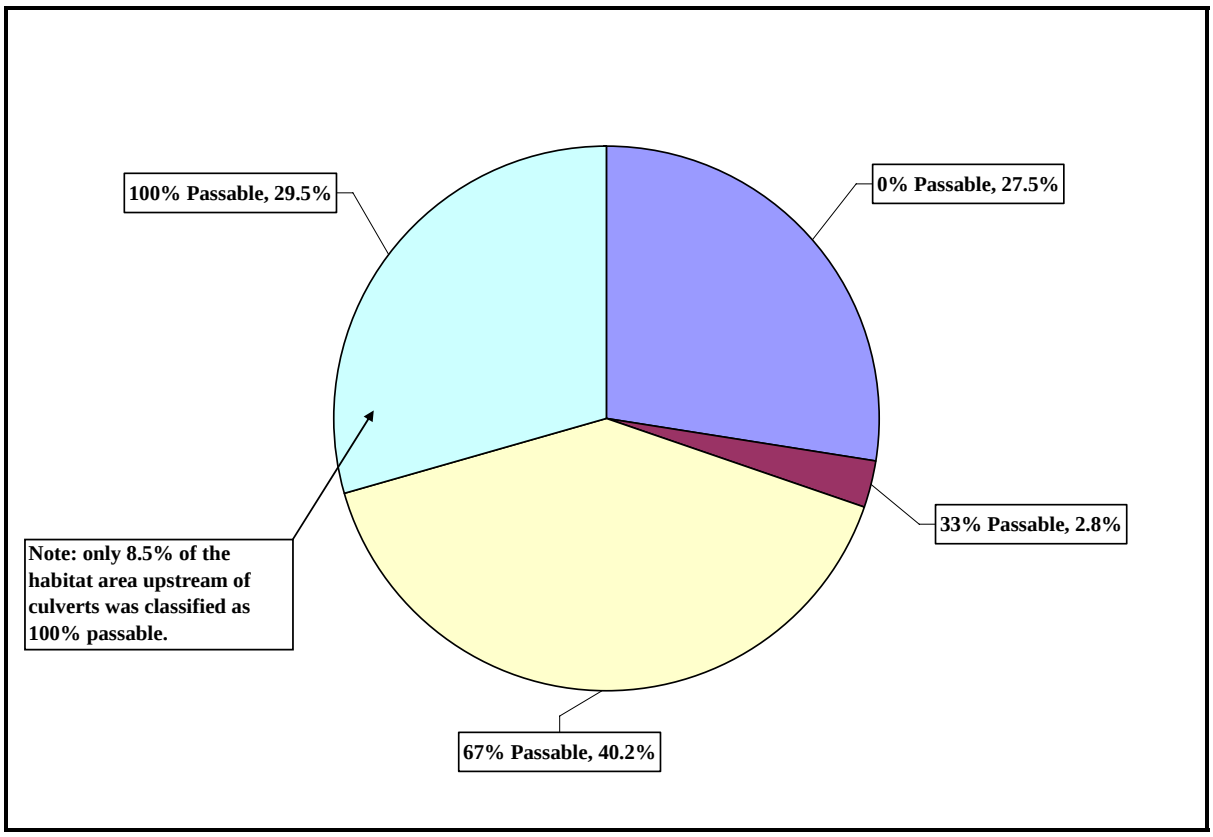

Figure 12. Comparison of the percent of total off-channel wetland habitat area accessible by culvert percent passability rating (note: area of only wetland habitats which were wide enough to delineate and calculate acreage, calculations do not include narrow <30 ft wide wetland habitats).

As described above, several different types of habitat alterations were identified as a result of poorly designed and placed culverts. Several culverts that were undersized and improperly placed acted to alter sediment and LWD transport, disconnect the tidal prism of the lower river from floodplain tributaries, cause downstream erosion through accelerated velocities and outfall drops, and cause backwater flooding and habitat disconnection. Where altered sediment and LWD transport were identified due to culverts, there was also a measurable loss of habitat. At one site (Culvert ID FS2; Ring Creek) a large sediment wedge developed upstream of the culvert which was placed several feet above the natural streambed elevation. This resulted in the stream traveling subsurface through the sediment deposit for approximately 30 m (98 ft). Disconnection of the tidal prism as a result of culvert elevations was observed at two sites (Culvert ID 504 and 505). In another case (Culvert ID 502 and 503; Indian Creek) undersized culverts caused the roadway to be overtopped by the stream, causing significant downstream erosion which resulted in the downstream sediment deposition which in turn altered the tidal stage influence upon upstream habitat, resulting in a net loss of estuarine habitat. Detailed information on habitat alterations caused by non-properly functioning culverts is included in Section 4.2 and APPENDIX B.

Table 4. Detailed culvert inventory data for Pysht River floodplain tributaries.

Culvert ID	Road Name	Stream Name	Culvert Type	Barrier	Percent Passability	Culvert Problem
142	HW112	25 Mile Creek	Concrete	Yes	0%	Outfall
137	HW112	4500 Road Swamp	CMP	Yes	0%	Outfall
146	HW112	4800 RD Creek	Concrete	Yes	0%	Slope; Velocity; Outfall
516	2100RD	Andis Slough_T1	CMP	No	100%	Depth
140	HW112	Burdick Springs	CMP	Yes	0%	
147	801 RD	Burnt Creek One	CMP	Yes	0%	Slope; Velocity; Outfall
148	HW113	Burnt Creek One	Concrete	Yes	0%	Slope; Velocity; Outfall
FS1	HW 113	Burnt Creek Two	CMP	Yes	0%	Slope; Velocity; Outfall
149	HW113	Burnt Creek Two	Concrete	Yes	0%	Slope; Velocity; Outfall
530	3000W RD	Cabin Creek	CMP	Yes	67%	Perched
505	ESTUARY RD	Cabin Creek	CMP	Yes	33%	Outfall Drop
528	HW112	Cabin Creek	Concrete	No	100%	Slope
531	3000W RD	Cabin Creek_T2	CMP	Yes	67%	Depth
527	2000 RD	Ditch Creek	CMP	Yes	67%	Slope
144	HW112	Goat Creek	Concrete	Yes	67%	Velocity
145	HW112	Gregory Creek	Concrete	No	100%	Velocity
138	HW112	Hamerquist Creek (Bradley Creek)	Concrete	Yes	67%	Slope
139	Spur road	Hamerquist Creek _T2	CMP	No	100%	None
535	HW112	Indian Ck	CMP	Yes	0%	Slope; Velocity; Outfall
502	ESTUARY RD	Indian Creek	CMP	No	100%	Velocity, undersized
503	ESTUARY RD	Indian Creek	Concrete	No	100%	Velocity undersized
501	ESTUARY RD	Indian Slough	CMP	Yes	67%	Velocity
141	HW112	Michelena Creek	Concrete	Yes	0%	Outfall; Slope
517	2100RD	Piling	CMP	Yes	0%	Slope
533	HW112	Razz Creek	CMP	Yes	67%	Velocity

Culvert ID	Road Name	Stream Name	Culvert Type	Barrier	Percent Passability	Culvert Problem
136	4500RD	Razz Creek	CMP	Yes	0%	Outfall; Slope
506	HW112	Razz T-1	Concrete	Yes	67%	Velocity
507	HW112	Razz T-2	Concrete	Yes	0%	Slope
508	HW112	Razz T-3	Concrete	No	100%	Velocity
509	Unnamed	Razz T-4_T3	CMP	Yes	67%	Slope
532	Unnamed	Razz T-5	CMP	Yes	0%	Outfall; US end plugged
526	2000 RD	Ring Creek	CMP	Yes	0%	Outfall Drop
FS2	Spruce Road	Ring Creek	CMP	Yes	0%	Slope; Velocity; Outfall
511	2100RD	Rymer Creek	CMP	No	100%	None
534	HW112	Section 9 Stream 1	Concrete	No	100%	None
504	ESTUARY RD	Section 9 Stream 1	Concrete	Yes	33%	Outfall Drop
521	2000 RD	Shop Creek	CMP	Yes	67%	Velocity
143	HW112	Trailer Creek (Mossy Rock)	Concrete	Yes	33%	Outfall; Slope

3.2.2 FLOODPLAIN ENCROACHMENT

3.2.2.1 MAINSTEM FLOODPLAIN ENCROACHMENT

Roads and other infrastructure and non-forest land use (agricultural or residential land use) existing along the Pysht River floodplain were inventoried from RM 0 to RM 9.0. Within this reach the river valley is approximately 5.6 miles long (sinuosity 1.6) and ranges from approximately 0.2 (near Green Creek) to 0.8 miles (near the mouth) in width. Encroachment was measured in four distinct zones adjacent to the river's bankfull edge: 10, 20, 30, and 60 m (corresponding to zone 1, zone 2, zone 3 and zone 4 respectively). Encroachment types were classified into three broad categories: roads, residential, and agricultural (see Section 2.3). The length of riparian encroachment increased from zone 1 to zone 4. Approximately 15% of the length of zone 1 contained roads or non-forest land use, 25% of zone 2, 32% of zone 3, and 45% of zone 4 (Table 5).

Table 5. Summary of the percent of riparian area length with stream parallel roads and non-forest land use in each of the four encroachment zones.

Zone	Length of Riparian area (Miles)	Percent of Riparian Area Length with Stream Parallel Roads	Percent of Riparian Area Length with Non-Forest Land Use	Percent of Riparian Area Length with Stream Parallel Roads and/or Non-Forest Land Use
Zone 1	18	12.5%	2.1%	14.8%
Zone 2	18	18.5%	6.2%	24.8%
Zone 3	18	23.7%	7.7%	31.5%
Zone 4	18	37.0%	7.7%	44.9%

Roads were by far the most significant floodplain encroachment type in all four zones. Within the first 30m of the river's banks roads represented 85%, 74%, and 75% of the length of encroachment. Roads were considered the most impacting land use in the riparian area because they prevent lateral migration of the river and reduce riparian influence (LWD recruitment, shade). In contrast, features such as pastures only reduce riparian influence. SR 112 contained the greatest length of stream parallel road network and contained more stream parallel length than all roads combined in all four encroachment zones. SR 112 is consistently closer to the river than other roads built on the floodplain. In fact, 68% of the road length in zone 1 is SR 112. The percentage of stream parallel road length within the four zones represented by SR 112 decreases as the distance away from the river's edge increases, but remains >50% of the entire stream parallel road network (Figure 13).

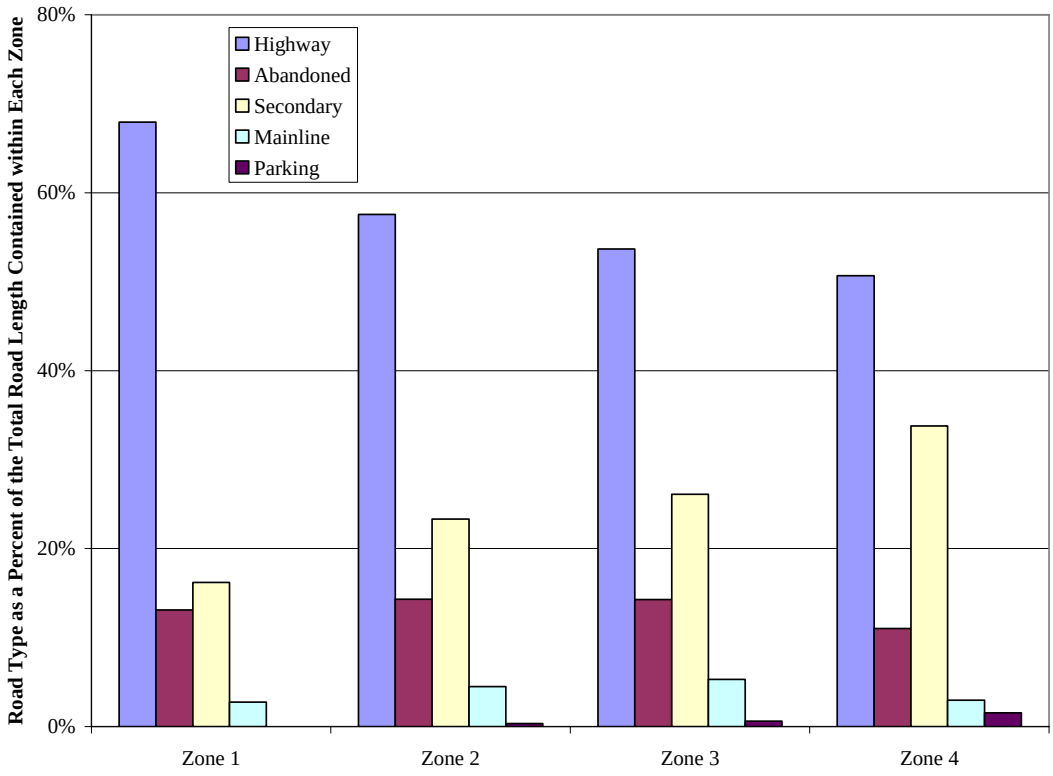

Figure 13. Road type as a percentage of the total road length contained within the four encroachment zones.

We did not attempt to quantify habitat impacts to mainstem river habitat or water quality as a result of floodplain encroachment. Most habitat impacts seem obvious, for example large sections of stream parallel road exist without any riparian forest, and without riparian forests there is no LWD recruitment or shade provided to the river. Over time old LWD either rots away or is mobilized downstream resulting in LWD reductions from historic levels. Loss of LWD likely contributes to decreased habitat complexity and channel incision which further degrades freshwater habitat productivity. Other floodplain habitat impacts have also resulted from the installation of pilings and rip-rap along the banks of the river. This was typically done to protect the road network from erosion but in some cases may have been done to facilitate the transport and storage of logs. Bank armoring and protection decreases or eliminates bank erosion and lateral channel migration. Bank erosion can be the main mechanism of LWD recruitment and therefore where riparian forests exist landward of bank armoring LWD recruitment rates are diminished. Decreased lateral channel migration also limits or prevents the development of off-channel habitat.

3.2.2.2 TRIBUTARY FLOODPLAIN ENCROACHMENT

Road and infrastructure encroachment on tributary floodplain habitats was observed along several different streams during field surveys. However, no attempt to quantify

these impacts at a watershed scale was made. Stream systems with observed road and infrastructure encroachment affecting the quality and quantity of habitat provided include: Lee Creek, Lee Creek_T4, Hamerquist Creek, Rymer Creek, Ditch Creek, Shop Creek, and Piling Creek. Direct fish mortalities as a result of floodplain encroachment were observed in Hamerquist, Andis Slough, and Shop Creeks. Details of floodplain encroachment on each of these habitats are included in Section 4.2 and APPENDIX B.

3.2.3 ESTUARY HABITAT ALTERATIONS

It was not possible to quantify the full extent of estuarine habitat alterations in the Pysht River estuary. Aerial photos only extend back to 1951 for this area, so pre-development conditions in the estuary are relatively unknown. A hand drawn map from 1877 (GLO 1877), shows little change in the general channel pattern in the estuary, however the map lacks sufficient detail to assess changes. The lack of aerial photos prior to alterations of the estuary makes it difficult to understand the quantity of habitat alteration that has occurred. The primary impacts to this area resulted from historic water based log transport. The most significant impacts were associated with dredging and channelization of the estuary and lower Pysht (below RM 1.5). Beginning in the mid 1910's suction dredges were used to deepen the channel to stage logs for marine transport by rafts. Dredge deposits were apparently discharged into tidally flooded marsh lands which were ultimately converted to agricultural lands (Hall undated). Clam shell dredging also was conducted in the vicinity of RM 0.5, and a large spoils pile was deposited along the south bend of the first large river meander. This deposit is approximately 600 m in length, 60 m in maximum width, and up to 13 m high, and has disconnected a portion of the estuary from the lower river (Figure 14). In addition there are also more dredge spoils located downstream and upstream of those described above. These spoil piles are more discontinuous and characterized by a much smaller volume and footprint. However, these deposits also disconnect what appear to be historically connected estuarine channels and wetlands. They are located along the right bank from RM 1.75 (southwest corner of Figure 14 to the northeast corner) downstream to RM 0.

The lower river has also been channelized by driven log piling. Most log piles are located along the left bank of the river from RM 0 to RM 1.0. There are also piling located mid-channel in the lower 0.5 miles of the river. Log pilings placed in several locations in the estuary have resulted in decreased channel migration and bank erosion which in turn has decreased LWD recruitment and perpetuated simplification of habitat in the estuarine portion of the lower Pysht River. Additional habitat alterations include road construction which has filled and disconnected wetlands habitats. Road construction through wetlands was not conducted with consideration for fish passage to the mainstem or between fragmented wetland habitats. As described above no comprehensive inventory of these habitats was conducted but Figure 14 illustrates several examples of fragmented wetland habitats.

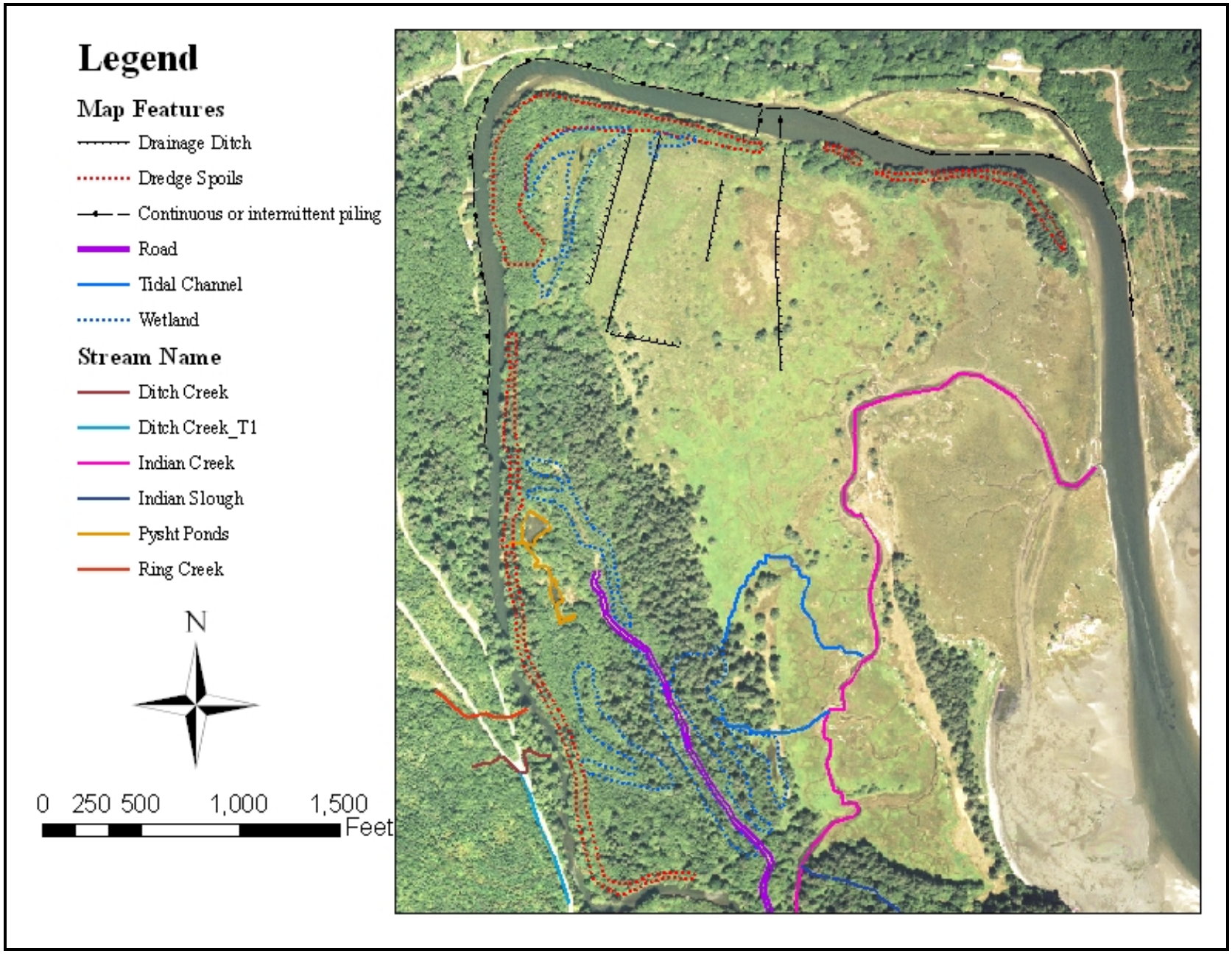

Figure 14. Map depicting streams and development features in the lower Pysht River and estuary.

3.2.4 OTHER HABITAT ALTERATIONS

During field surveys several additional habitat alterations were observed that affect the quantity and quality of both floodplain and mainstem river habitats. Timber harvest within several of the different over-wintering habitat types appears to have resulted in increased growth of aquatic vegetation which appears to be choking channels and potentially decreasing their productivity as over-wintering habitat. Fish use in forested wetlands was often observed in areas where fallen trees had left deep depressions where the tree roots had previously been established, creating high use micro-habitats. The importance of these habitats over other forested wetland habitats utilized was not measured, but windfall of mature trees in forested wetlands appears to be an important habitat forming process that increased habitat quality and complexity. Down trees also provided cover for juvenile salmonids in many habitats inventoried. Additional land use activities and habitat manipulations have also altered the quality of some floodplain habitats. These activities have included channel re-routing/channelization, riparian forest removal (from timber harvest, agricultural and residential development), LWD removal, wetland filling, and sediment inputs from multiple different activities.

LWD removal in some floodplain tributaries (e.g. Hamerquist Creek segment 2) appears to have resulted in channel incision, and downstream sediment aggradation, as well as simplified channel habitat. Channelization appears to have occurred in some channel segments resulting in habitat fragmentation (e.g. Razz Creek Tributary 1 Segment 1). Channel re-routing appears to have resulted in decreased habitat quality and/or hydrologic connectivity (e.g. Razz Creek, 2100 Road Swamp, Lost Creek). Wetland filling in some floodplain tributary systems has resulted in decreased habitat quality, quantity, and/or connectivity (e.g. Shop Creek). Riparian forest removal was observed in most floodplain habitats. All wetland habitats have been logged at least once and many have been logged twice (Figure 15). No consideration for fish or fish habitat appears to have been taken during any of the operations that removed riparian forests. It is likely that most of the small stream and wetland habitats harvested since the implementation of forest practice regulations prohibiting these activities were done under the assumption that these habitats were non fish-bearing. Sediment aggradation on the lower portions of alluvial fans fragmented habitat in some systems (e.g. Indian Creek, Razz Creek Tributary 4, 5, and 6, Hamerquist Creek). It was not possible to determine whether this aggradation was a natural condition or whether upstream land management activities had increased sediment inputs resulting in these degraded habitat conditions.

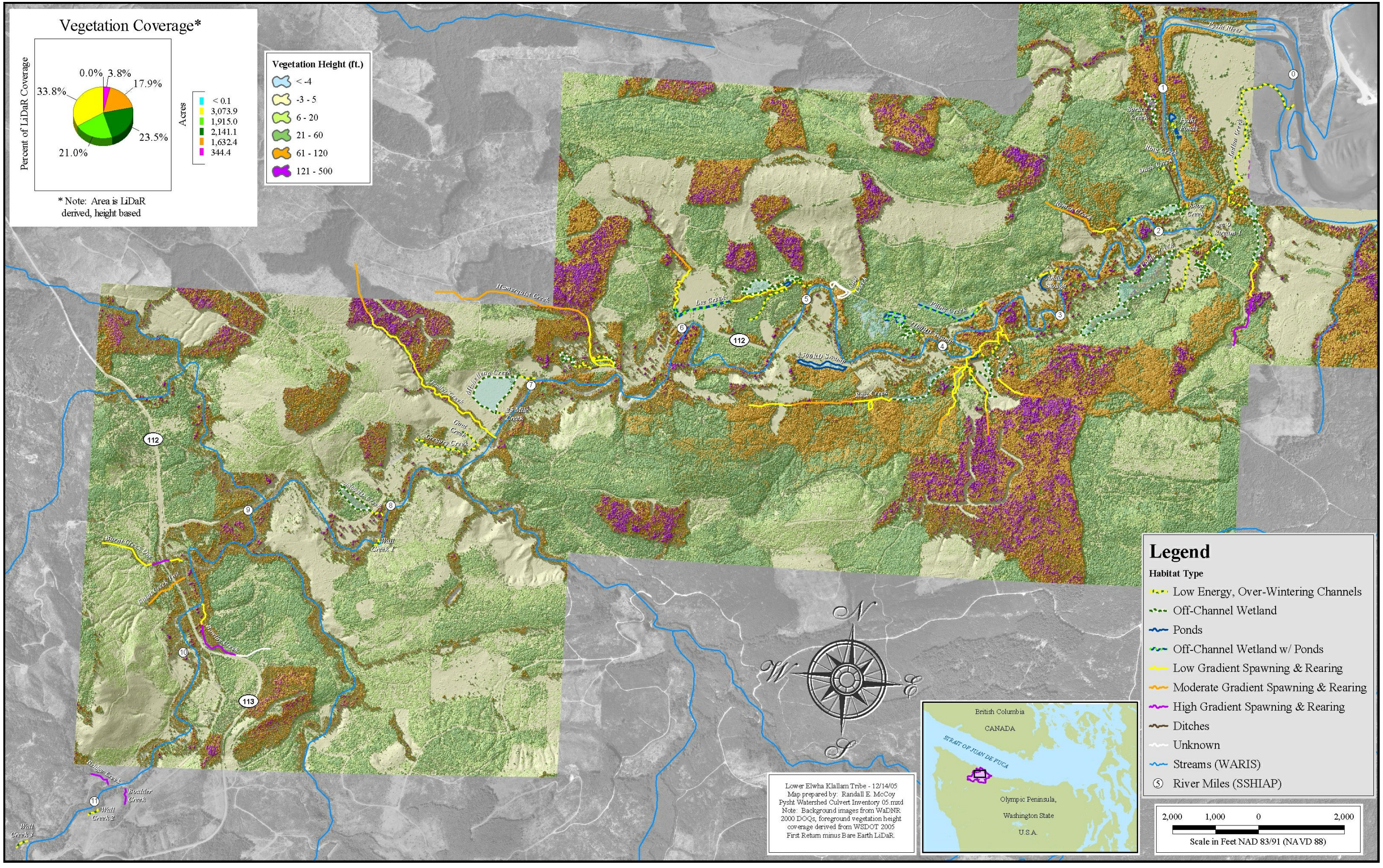

Figure 15. Vegetation height and percentages of LiDAR data coverage area within specified tree height categories.

4 DISCUSSION

4.1 HABITAT FORMING PROCESSES

Identification of floodplain habitat forming processes was beyond the scope of this project. But field surveys and a review of aerial photographs revealed that several of the floodplain habitats formed as a result of channel migration, examples include: Wall Creek 1, Wall Creek 2, Wall Creek 3, Andis Slough (segment 2), and Rymer Creek (segment 2). At least a few of these habitats have formed during the last 50 years. For example Wall Creek 1 was the mainstem of the Pysht River in 1951 and now is a wall based off-channel habitat. Other habitats such as Wall Creek 3 are currently in the process of development. Road construction and protection, channelization, and wood-removal have affected the river's ability to migrate across the valley, hence decreasing the river's ability to form these habitats now and into the future. While rates of channel migration are not available for the Pysht River a review of the 1951 aerial photos indicates that the channel has not undergone drastic lateral migration. The greatest amount of lateral migration observed from aerial photos between 1951 and 2003, was approximately 180 feet (near RM 2.3). Constructed ponds, channels, and roadside ditches also make up a portion of the floodplain tributary habitats in the Pysht, some examples include: Pysht Ponds (segments 1-4), Cabin Creek (segment 2), Ditch Creek (segment 2), and Lee Creek (segment 2).

4.2 IMPAIRED HABITATS

4.2.1 PYSHT RIVER FLOODPLAIN ENCROACHMENT

As described in Section 3.2.2.1 a significant portion of the Pysht River floodplain contains infrastructure that has altered the natural river-riparian-floodplain processes. We believe the most critical processes altered by floodplain encroachment are reduced lateral migration and riparian function (shade and LWD recruitment). Historically, large conifer trees growing adjacent to the banks of the Pysht River provided sufficient shade to moderate stream temperatures. Currently, large stretches of river contain only small riparian zones or none at all along the south side of the stream (from RM 5 to 2.5; See Figure 15). Stream reaches with reduced shade levels are a source increased solar radiation, which has likely increased stream temperatures above their pre-disturbance levels. Daily maximum stream temperature data collected in 1997 (Figure 17) and 2005 (Figure 18) shows increasing stream temperature between the SR 112 Bridge and Piling Creek (this stream reach corresponds to the longest and most significant floodplain encroachment zone along the Pysht River).

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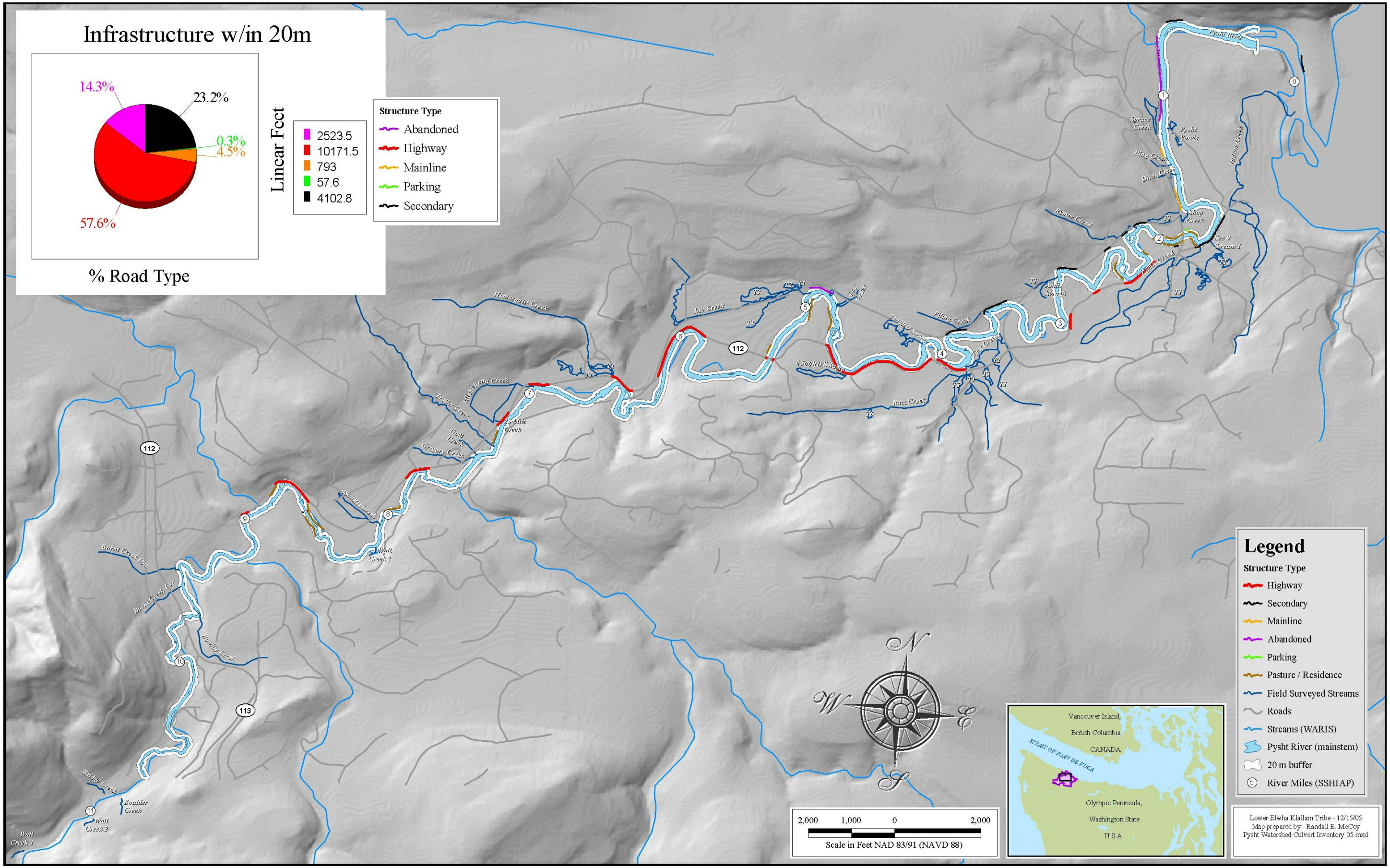

Figure 16. Infrastructure within 20 meters of the bankfull edge of the Pysht River and SSHIAP river miles.

Cumulative floodplain encroachment impacts have resulted in the loss of LWD, decreased LWD recruitment potential, loss of floodplain area, floodplain disconnection, and channel incision. While it may not be likely to remedy all of the floodplain problems we examined all floodplain infrastructure in an attempt to define the largest scale features that have a potential to be removed and floodplain processes restored. The state highway has the biggest overall impact on the floodplain of the Pysht and floodplain processes in general. In most cases it appears to be one of the more simple features to relocate. Other features, such as pastures could also easily be converted or partially converted to floodplain forests. Included below is a description of sites along the river that were considered to impact floodplain processes. Areas are described by their river mile location (based on SSHIAP lengths). All areas described below have infrastructure within 20 m of the bankfull edge of the Pysht River. Figure 16 illustrates all areas identified with floodplain infrastructure within 20 m of the bankfull edge of the Pysht, as well as the SSHIAP river miles

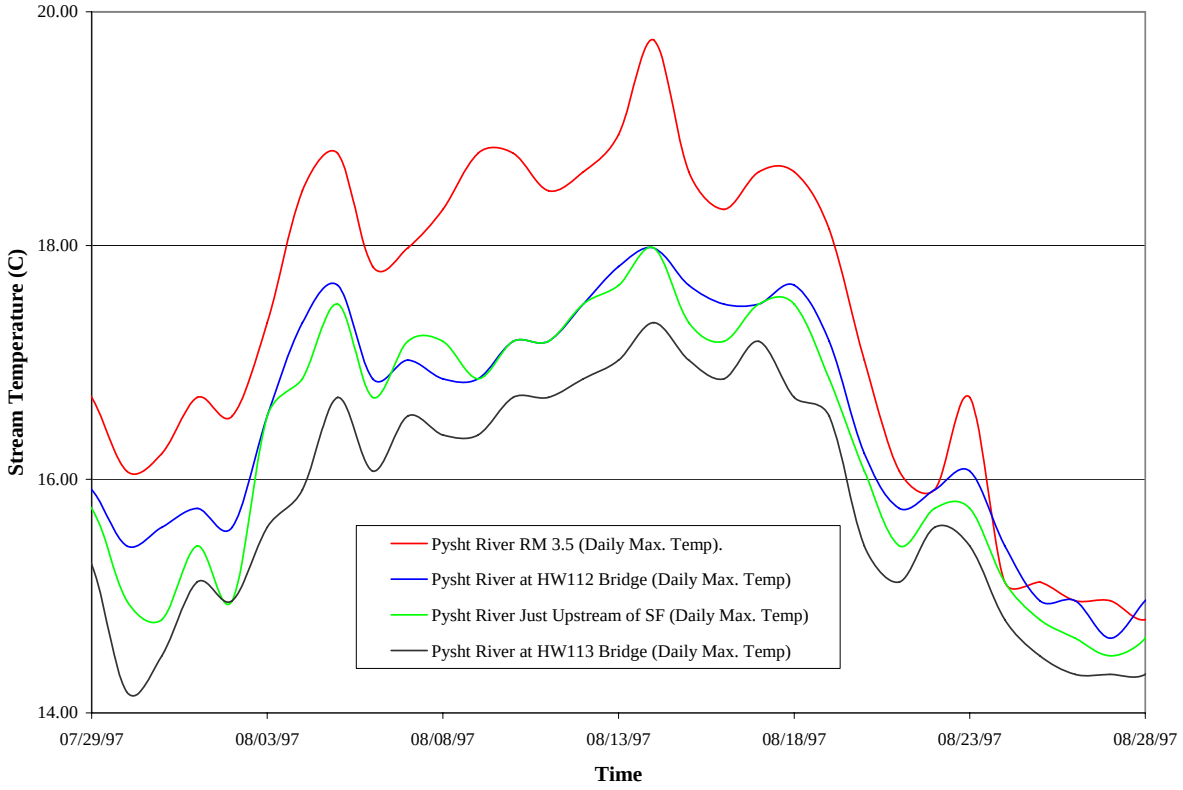

Figure 17. 1997 Pysht River stream temperature data for four mainstem sites (source: Elwha Fisheries data).

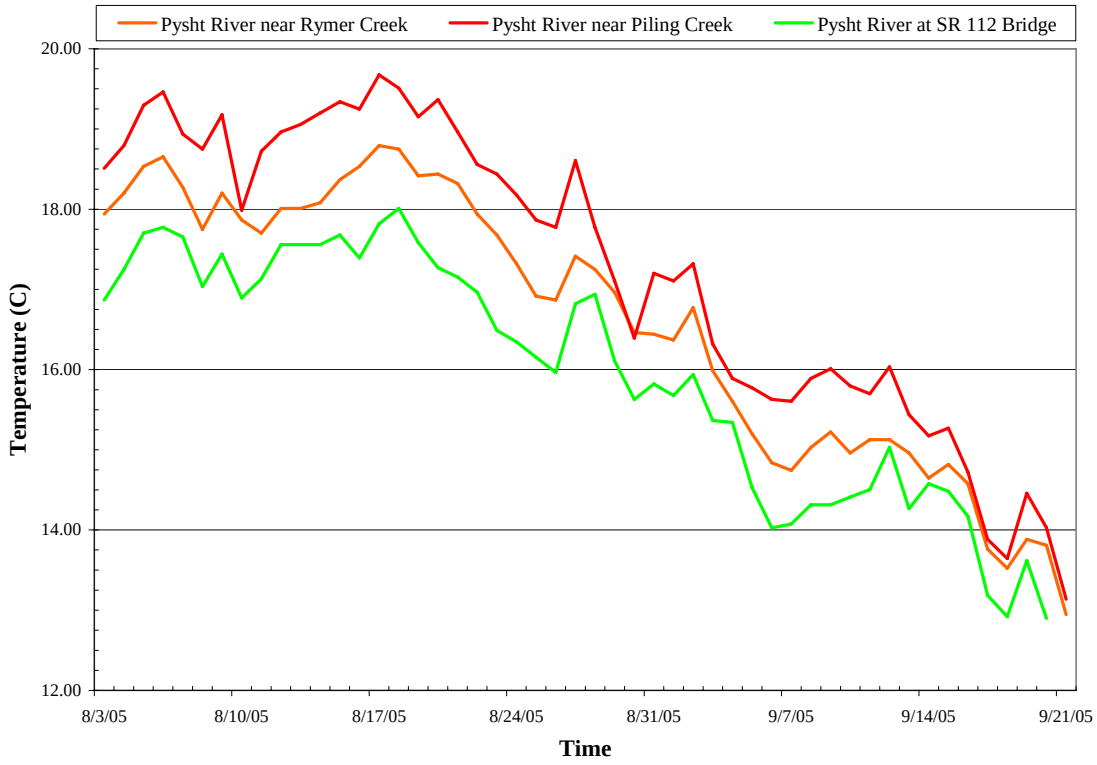

Figure 18. 2005 Pysht River stream temperature data for three mainstem sites (source: Elwha Fisheries data).

4.2.1.1 RM 0.62 to 1.11

There are two segments within this section of river that contain logging roads within 20 meters of the Pysht River. The downstream segment is short, 113 meters and is part of the active road system. It is unlikely that this portion of road can be relocated due to topography. The upstream segment is 601 meters in length and has been abandoned; it is assumed that this stretch of road will naturally recover into floodplain forest. There are sections of driven pile adjacent to the road prism in this area. These could potentially be removed to promote connectivity of the adjacent floodplain

4.2.1.2 RM 1.11 to 3.0

There are 17 segments within this section of river that contain infrastructure within 20 meters of the Pysht River. The 2000 Road has two segments with a total length of 229 meters of floodplain road; it is unlikely this road can be relocated due to topography. The Pysht Tree Farm headquarters contains 7 floodplain segments with infrastructure (mostly pasture, lawn, and parking areas) within 20 meters. Most of the floodplain encroachment associated with the Pysht Tree Farm headquarters could be addressed by planting trees in the pastures adjacent to the river. The total length of these segments is 720 meters. Farm

Road contains one floodplain segment and has a length of 316 meters. This road segment could be abandoned and but a sewer line runs adjacent to the road and relocating this line could prove difficult. SR 112 contains three road segments totaling 409 meters. This section of road could be relocated in association with upstream road relocation efforts. The 2100 Road contains 4 floodplain segments (320 m total length) within 20 meters of the Pysht. It is unlikely that these road segments can be relocated without totally abandoning the 2100 Road system. Wetlands and topography limit the possible road relocation alternatives.

4.2.1.3 RM 3.0 to 3.9

There are 2 floodplain segments within this section of river that contain infrastructure within 20 meters of the Pysht River. The 2100 Road has two segments (351 m total length) within 20 meters of the Pysht. It is unlikely that these road segments can be relocated without totally abandoning the 2100 Road system due to wetlands and topography.

4.2.1.4 RM 3.9 to 4.65

This section of river contains the most heavily impacted floodplain habitat. Most of this length of river contains riprap and very little riparian forest. SR 112 is the only floodplain infrastructure along this stream reach. There is a total length of 1,132 meters of state highway within 20 meters of the river. There are several possible locations to reroute the highway around this area and away from the river.

4.2.1.5 RM 4.65 to 5.29

The majority of floodplain impacts in this stream reach are associated with pastures. There is a total length of 385 meters of pasture within 20 meters of the bankfull edge of the Pysht in this reach. All pastures contain a minimum 10 meter riparian buffer in this reach. Expansion of the riparian buffer could easily provide long-term benefits to the floodplain and river. A portion of the abandoned railroad grade is also present within this reach. The grade is elevated above the floodplain and mostly vegetated with alder.

4.2.1.6 RM 5.29 to 5.87

This is the only stream reach free of floodplain infrastructure.

4.2.1.7 RM 5.87 to 6.23

This entire stream reach is impacted by the close proximity of SR 112. Very little riparian forest is present in this stream reach and a large portion of this reach contains rip-rap. Road relocation to the west is a possible solution to some of the problems associated with SR 112 in this stream reach.

4.2.1.8 RM 6.23 to 8.0

This reach contains six floodplain segments with infrastructure within 20 meters of the Pysht River. Four segments (total length 620 m) are associated with the highway. Three of these segments are located at large river bends where topography and residences limit road location possibilities. One segment is adjacent to a straight reach of river and road relocation may be an option at this location. The remaining two segments in this reach are associated with residences and comprise a total floodplain length of 227 meters.

4.2.1.9 RM 8.0 to 9.0

This reach contains five floodplain segments with infrastructure within 20 meters of the Pysht River. Two segments are associated with SR 112 and comprise 320 meters of floodplain length. The most downstream segment is adjacent to a topographic feature which limits the potential of road relocation and is a natural feature limiting river migration and the development of floodplain habitat. The upstream segment is elevated above the floodplain and at the base of the hillslope bounding the Pysht River valley. The remaining three floodplain segments contain residences, fields, and lawns. They comprise a total floodplain length of 482 meters, of which 342 meters contains riparian buffers at least 10 meters wide. These areas could easily be enhanced by establishing riparian buffers and planting trees.

4.2.2 FLOODPLAIN TRIBUTARY HABITATS

4.2.2.1 INDIAN CREEK

This right bank tributary drains from a forested catchment, crosses Highway 112 and flows through low gradient forested habitat eventually emerging on saltmarsh habitat in the estuary. The lower portions of the system are mostly mud bottomed and very low gradient. The primary impacts to Indian Creek include road crossings at RM 0.84 and 1.57 (Figure 19). The lower road crossing (Figure 20) is extremely undersized, limits tidal exchange and is a significant source of localized erosion. The upstream culvert at RM 1.57 (SR 112 crossing) is impassible (Figure 21). However, stream gradient steepens dramatically above the culvert and only 280 m of 5-12% habitat is found above this blockage and the M&R reservoir.

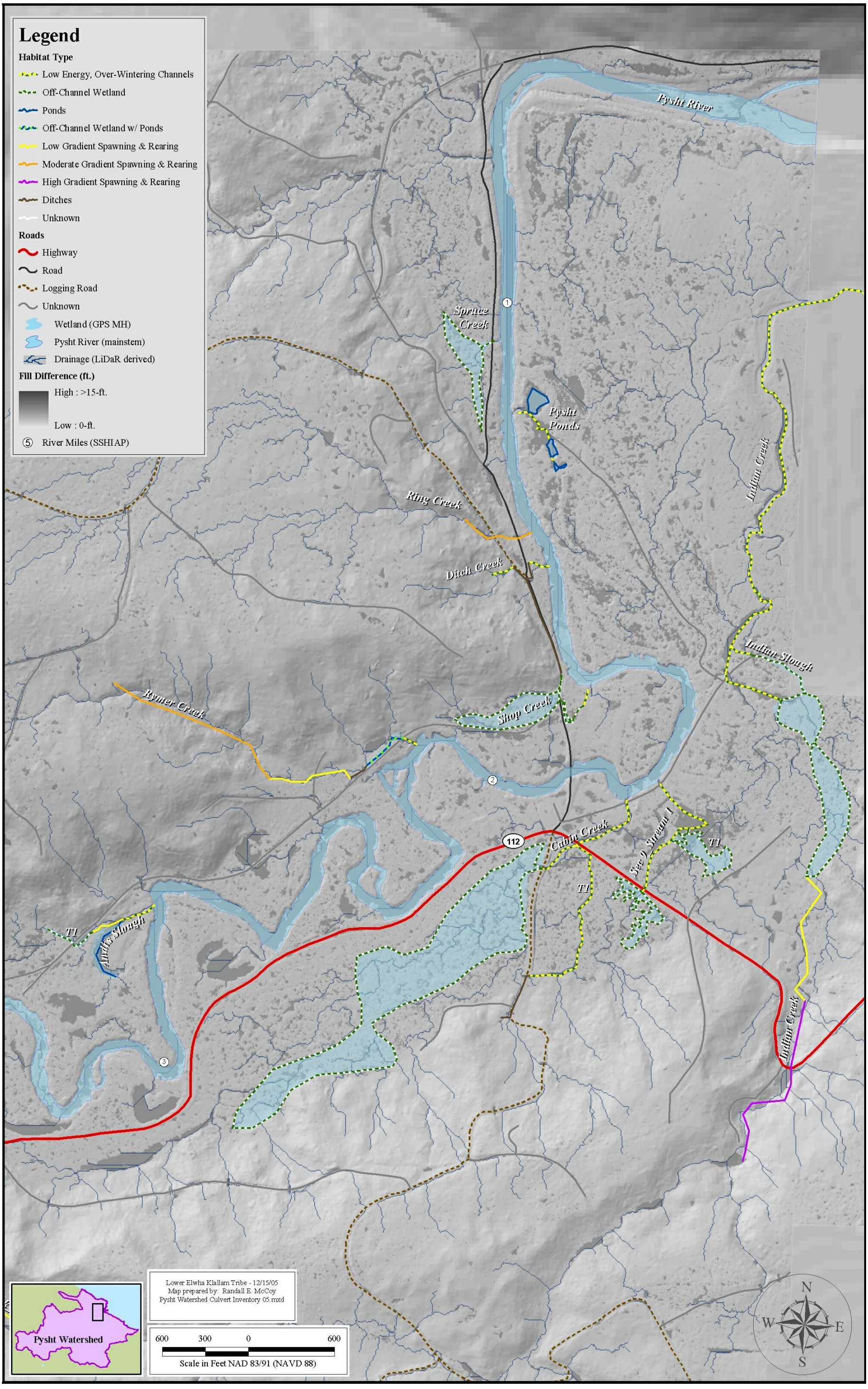

Figure 19. Pysht River floodplain habitats from Indian Creek to Andis Slough.

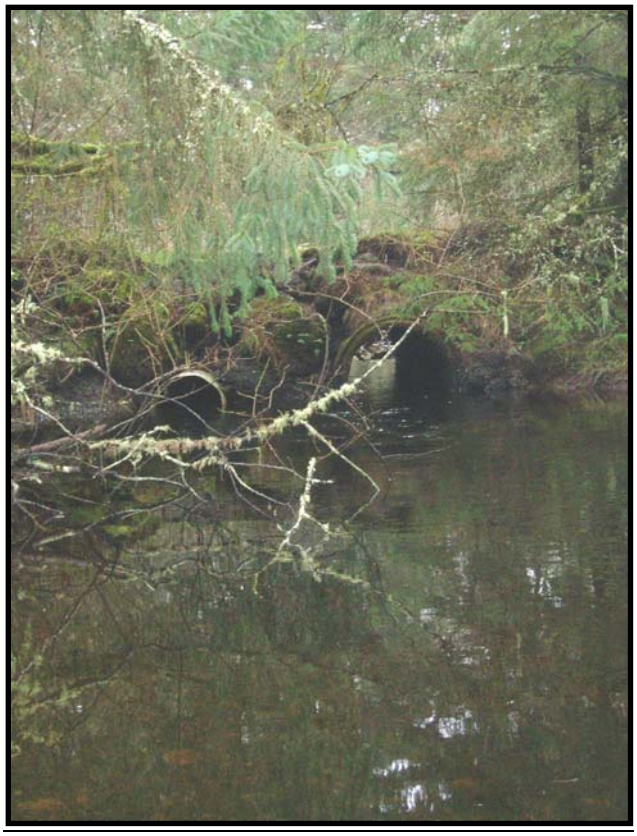

Figure 20. Lower Indian Creek double culverts (Farm Road), looking upstream.

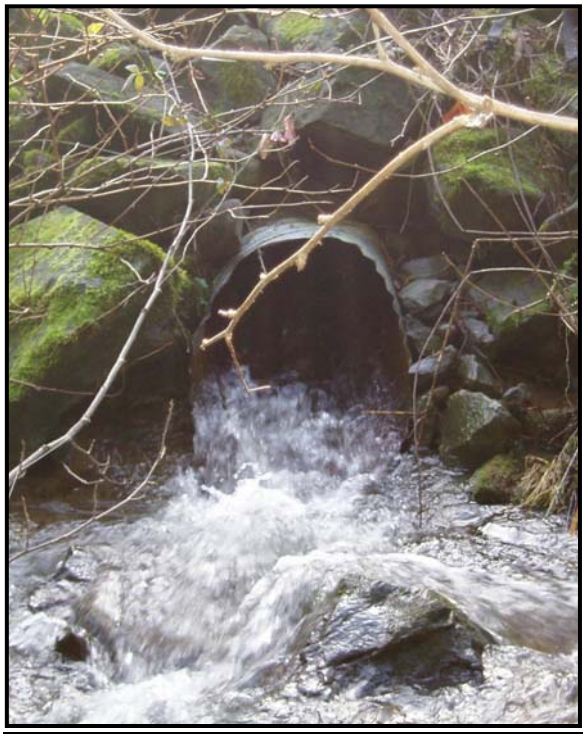

Figure 21. Upper Indian Creek culvert (SR 112), photo looking upstream.

4.2.2.2 INDIAN CREEK SLOUGH

This low gradient stream enters Indian Creek at RM 0.82 (Figure 19) and includes 120 m of low gradient stream habitat. A portion of this stream is tidally influenced, though much of the upper portion is dominated by freshwater vegetation types such as slough sedge (*Carex opnupta).* The culvert on the Farm Road is severely undersized: channel width upstream of culverts averages 4 meters but the culvert diameter is only 0.35 m. Juvenile coho were observed upstream of the culvert. Habitat width increases upstream of the culvert as the stream transitions into a small open water wetland (0.3 acres) which appears to be connected to upper portions of Indian Creek during high flows.

4.2.2.3 RING CREEK

This left bank tributary crosses the M& R 2000 road and enters the Pysht River at RM 1.31 (Figure 19) A perched culvert blocks approximately 170 meters of 4-8% gradient habitat and an additional barrier culvert is located 33 meters upstream. The second perched culvert blocks approximately 100 meters of 4-8% gradient habitat. A large stored sediment wedge is located upstream of this culvert and the stream was dewatered through the zone of stored sediment during the time period when this stream was surveyed.

4.2.2.4 SHOP CREEK

This left bank creek crosses the M& R 2000 road and enters the Pysht River at RM 1.52, in the vicinity of the original Pysht logging camp (Figure 19). This tributary has been significantly altered. The 2000 road culvert is considered a partial barrier due to velocity and slope. A portion of the creek's associated wetland has been filled, disconnecting the wetland from its outlet. There is a culvert which drains this area and diverts surface flow from the stream in the vicinity of the filled wetland. Fish entering the system during high water events appear to become stranded. Fish appear to enter the upper portion of the wetland system (upstream of the 2000 Road) from Ditch Creek to the north during high flows and then try to move downstream becoming trapped.

4.2.2.5 SECTION 9 TRIBUTARY

This tributary flows from a large wetland complex on the right bank of the Pysht River and enters the Pysht at RM 1.77 (Figure 19). A perched culvert forms a total barrier to fish at certain river and tidal stages (Figure 22). The culvert limits tidal exchange with tributary channel and wetland complex upstream. The partial culvert barrier limits fish access to 305 meters of low gradient, low energy stream channel, as well as two large fish bearing forested wetlands (total wetland area 2.1 acres). The upstream forested wetland has been recently logged and the lower forested wetland was logged 10-15 years ago. The SR 112 culvert upstream is 100% passable.

Figure 22. Perched culvert liming fish access and tidal exchange in Section 9 Tributary (Farm Road crossing).

4.2.2.6 CABIN CREEK COMPLEX

This tributary flows from a large wetland complex on the right bank of the Pysht River and enters the Pysht at RM 1.82. A perched culvert on the Farm Road forms a total barrier to fish at certain river and tidal stages. The culvert limits tidal exchange and fish access to 625 m of low gradient, over-wintering habitat, as well as 19.6 acres of fish-bearing forested wetland. Further upstream at the W3000 Road a partial culvert barrier limits access to the forested wetland complex (Figure 23). Cabin Creek Tributary 1 drains a large forested wetland between the W3000 Road and SR 112. Channel enhancement work was conducted in this habitat unit by M&R during the summer of 2003.

Figure 23. Perched culvert acting as a partial barrier to juvenile salmonids at the W3000 Road crossing.

4.2.2.7 ANDIS SLOUGH

This left bank tributary drains a forested wetland and enters the Pysht on the left bank at RM 2.78 (Figure 19). The main issues in this system are habitat connectivity and dewatering. The mainstem Pysht River is incised through this reach. During winter low flows rapid dewatering of habitats was observed. During surveys on February 9, 2005 habitats in Andis Slough and Andis Slough T1 were hydrologically disconnected from one another and from the Pysht River. A slightly perched and undersized culvert drains across the M&R 2100 road. Juvenile coho mortalities were observed in the area upstream of the 2100 Road, where the wetland habitat became dewatered.

4.2.2.8 PILING CREEK

This left bank tributary drains a forested wetland and enters the Pysht on the left bank at RM 3.45 (Figure 24). The M&R 2100 road culvert is a partial barrier: culvert is rusted out, perched, and set at a steep slope. This partial barrier limits fish access to over 400 m of low gradient habitat, including a 3.4 acre wetland complex. Just downstream of the culvert there is a step/cascade that is approximately 1.2 m high (Figure 25; depending upon Pysht River stage). This step may have formed in response to mainstem channel incision.

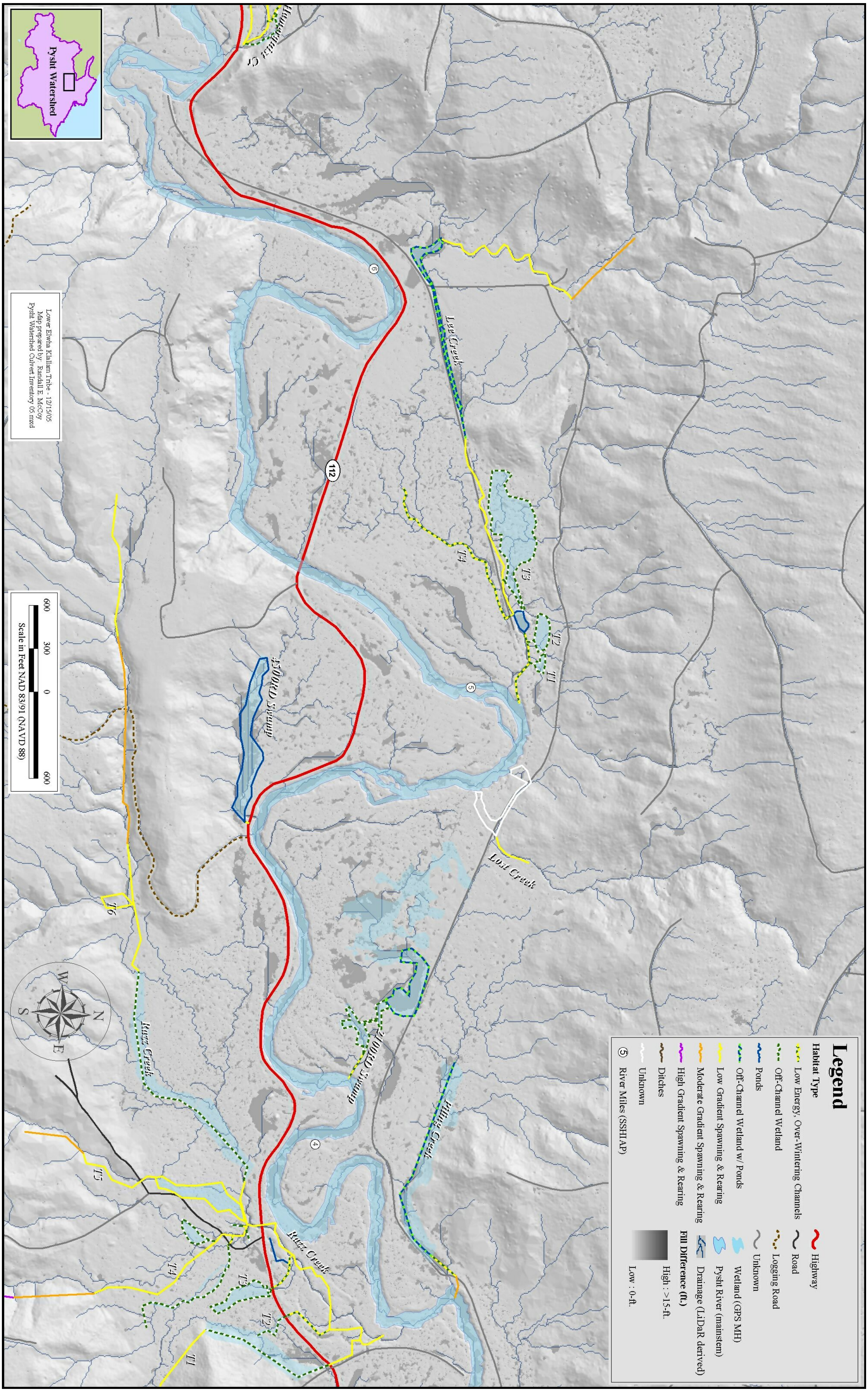

Figure 24. Pysht River floodplain habitats from Piling Creek to Lee Creek.

Figure 25. Piling Creek step-pool feature downstream of 2100 Road.

4.2.2.9 RAZZ CREEK

This creek is also known locally as Barn, Reefer, and/or Fridge Creek. Significant channel alterations are thought to have occurred on this system. This is a complex system that includes a large floodplain tributary with several tributaries. Razz Creek is approximately 2.0 miles long and originates on hillslopes along the south side of the river. Razz Creek parallels the mainstem through a forested channel prior to flowing across the floodplain and eventually entering the Pysht on the right bank at RM 3.55 (Figure 24). Lower Razz Creek has been channelized and contains simplified habitat lacking LWD, cover, and complexity (Figure 26). The middle reaches of Razz Creek flow through wetlands, including formerly occupied beaver ponds. An impassible culvert is located at RM 1.12, where the M&R 4500 Road culvert is perched, set at 3-4% grade, and the bottom is completed rusted out forming a complete fish passage barrier. The culvert limits access to ~300 m of 2-4% gradient habitat, 135 m of 3-6% gradient habitat and several additional streams containing hundreds of meters of 8-12% gradient habitat.

4.2.2.10 RAZZ CREEK TRIBUTARIES

The Razz Creek system includes 5 floodplain tributaries. These tributaries are plagued by undersized, poorly placed culverts which act as partial to complete fish barriers for juvenile salmonids and disconnect significant areas of off-channel habitat. In addition several of these tributaries have high quality over-wintering habitats that have been

affected by one or all of the following: road construction, improperly functioning culverts, and/or channel reconfiguration.

4.2.2.11 RAZZ CREEK TRIBUTARY 1

Razz Creek Tributary 1 is also known locally as Keyes Creek. This tributary enters the lower portions of Razz Creek at RM 0.06 (Figure 24) and includes 901 m of low to moderate gradient habitat. This stream appears to have been channelized and rerouted creating a partial to total barrier to juvenile salmonids (Figure 27). The SR 112 culvert is undersized creating a partial to complete juvenile and adult barrier during fall and winter stream flows. The culvert is incapable of passing the entire stream flow of the creek during peak flow events, causing flooding of road way and sending excess stream flow into flat area potentially trapping fish in the ditch and temporally flooded areas (Figure 28). The culvert limits access to 335 m of low gradient over-wintering habitat including a 2.2 acre forested wetland complex, 270 m of 1-3% spawning habitat, and 181 m of 4-8% fish habitat.

Figure 26. Typical channel conditions observed in lower Razz Creek where a lack of LWD and habitat structure prevails.

Figure 27. Razz Creek Tributary 1, looking upstream at cascades running through channelized reach.

Figure 28. Razz Creek Tributary 1, looking downstream at SR 112 culvert where stream flows across highway during high flows.

4.2.2.12 RAZZ CREEK TRIBUTARY 2

Razz Creek Tributary 2 is a right bank tributary to lower Razz Creek entering at RM 0.12 (Figure 24). This stream system contains 236 m of low gradient habitat. The SR 112 culvert is perched and set at a 4-5% grade. The culvert appears to be a complete barrier to juvenile fish passage and prevents access to a 0.17 acre forested wetland. The channel flows into a relic mainstem channel of Razz Creek and quickly becomes dewatered during normal fall and winter stream flows, trapping fish in upstream habitats and pockets of watered channel within the old Razz Creek channel.

Figure 29. Razz Creek Tributary 2, photo depicting stranded juvenile coho in isolated pool in the old mainstem Razz Creek channel.

4.2.2.13 RAZZ CREEK TRIBUTARY 3

Tributary 3 is a right bank tributary which enters Razz Creek at RM 0.22 (Figure 24). This stream system drains a small forested wetland that has been recently logged. The SR 112 culvert appear passable to fish and this tributary appears to be hydrologically connected to Tributary 1 during high flows. A small tributary drains into lower Tributary 3, 18 meters upstream from the confluence with Razz Creek. This creek (T3_T1) appears to be the old Razz Creek mainstem. During high flows fish move into Razz Creek_T3-T1 and quickly become isolated due to the ephemeral nature of the connection between the two habitat units.

4.2.2.14 RAZZ CREEK TRIBUTARY 4

This tributary enters Razz Creek upstream of SR 112 at RM 0.31 (Figure 24). This stream flows from a moderately confined hillslope across the Pysht River floodplain. The lower reach of this stream contains several small fish-bearing tributaries. A small RBT entering 36 meters upstream from Razz Creek (T4_T3) flows through recently logged, high quality forested wetland habitat. A culvert on Reefer Creek Road is set at 4-5% gradient is a partial barrier, and is likely to become a complete barrier in the near future as it continues to degrade. During field surveys 0.51 acres (length 276 m) of high quality/high fish use habitat was delineated upstream of the culvert (Figure 30).

Figure 30. Example of high quality over-wintering habitat in Razz Creek Tributary 4_T3 upstream of Reefer Creek Road culvert.

4.2.2.15 RAZZ CREEK TRIBUTARY 5

This stream enters the Pysht River floodplain from moderately steep hillslopes on the south side of the valley (Figure 24). As it enters the floodplain the channel becomes an alluvial fan and significant sediment deposition was observed. The channel below this point becomes ephemeral and no fish were observed in the system. Several distributary

channels were identified which enter Razz Creek with the lowest downstream channel entering Razz Creek at RM 0.35. It is not clear if this stream historically supported fish or whether resident fish are present upstream of the alluvial fan reach. Determining the source of erosion and sedimentation was beyond the scope of our field surveys. The length of time that this stream system has been disconnected from other floodplain habitats is unknown.

4.2.2.16 2100 ROAD SWAMP

This left bank tributary is almost entirely wetland and open water pond type habitat (except for the connection to the mainstem) and enters the Pysht River on the left bank at RM 4.11 (Figure 24). This is a large (7.9 acres) and potentially productive winter rearing habitat for fish (Figure 31). The main issues in this system are habitat connectivity and dewatering. During surveys on February 16, 2005 habitats in the 2100 Road swamp were hydrologically disconnected from one another and from the Pysht River. Channel incision along the mainstem of the Pysht River may be lowering the water table of wetland complex. Rerouting of Lost Creek may also play an important role in the hydrology of this wetland complex. Several juvenile coho were found dead in areas of the wetland where dewatering had occurred. Several juvenile coho were also found in isolated pockets of standing water.

Figure 31. Example of some of the high quality open water habitat located in the 2100 Road Swamp complex.

4.2.2.17 LOST CREEK

Lost Creek was likely connected to the 2100 Road Swamp complex. It currently is diverted down the 2100 Road ditch line where significant erosion and sediment delivery has occurred. Lost Creek's connection with the Pysht River currently does not provide fish access (Figure 24) and no fish use was documented in the system but resident fish use may occur upstream of the areas surveyed.

4.2.2.18 4500 ROAD SWAMP

This system contains a large wetland and open water pond complex that enters the Pysht River on the right bank at RM 4.49 (Figure 24). A perched culvert on SR 112 is a 100% barrier to all fish species prohibiting access to a 2.4 acre high quality wetland complex. To provide adequate fish passage a new channel would need to be dug to allow adequate flow for fish passage during normal fall/winter flow conditions.

4.2.2.19 HAMERQUIST CREEK

Hamerquist Creek is also known locally as Bradley Creek. This large left bank tributary enters the Pysht River at RM 6.6 (Figure 32). There are two significant tributaries to lower Hamerquist Creek (Tributary 1 and Tributary 2). Hamerquist Tributary 2 appears to be the most productive over-wintering habitat between the two tributaries. The lowest channel segment of Hamerquist Creek is an alluvial fan and has altered sediment routing, storage, and distribution on floodplain. Loss of LWD upstream of alluvial fan has increased sediment transport and decreased habitat complexity, sediment storage, and floodplain connectivity. Alterations to sediment storage and transport are significantly affected by an undersized culvert on SR 112, as well as the SR 112 road prism which acts as a dike during sediment mobilization events. Excess sediment storage upstream of the culvert has resulted in poor habitat connectivity between Hamerquist Creek and Tributary 2 (Figure 33), as well as the Pysht River. During low flow periods in the winter of 2004-05, hundreds of coho were stranded at the confluence of Tributary 2 and Hamerquist Creek as flows dropped in response to drought conditions (Figure 34).

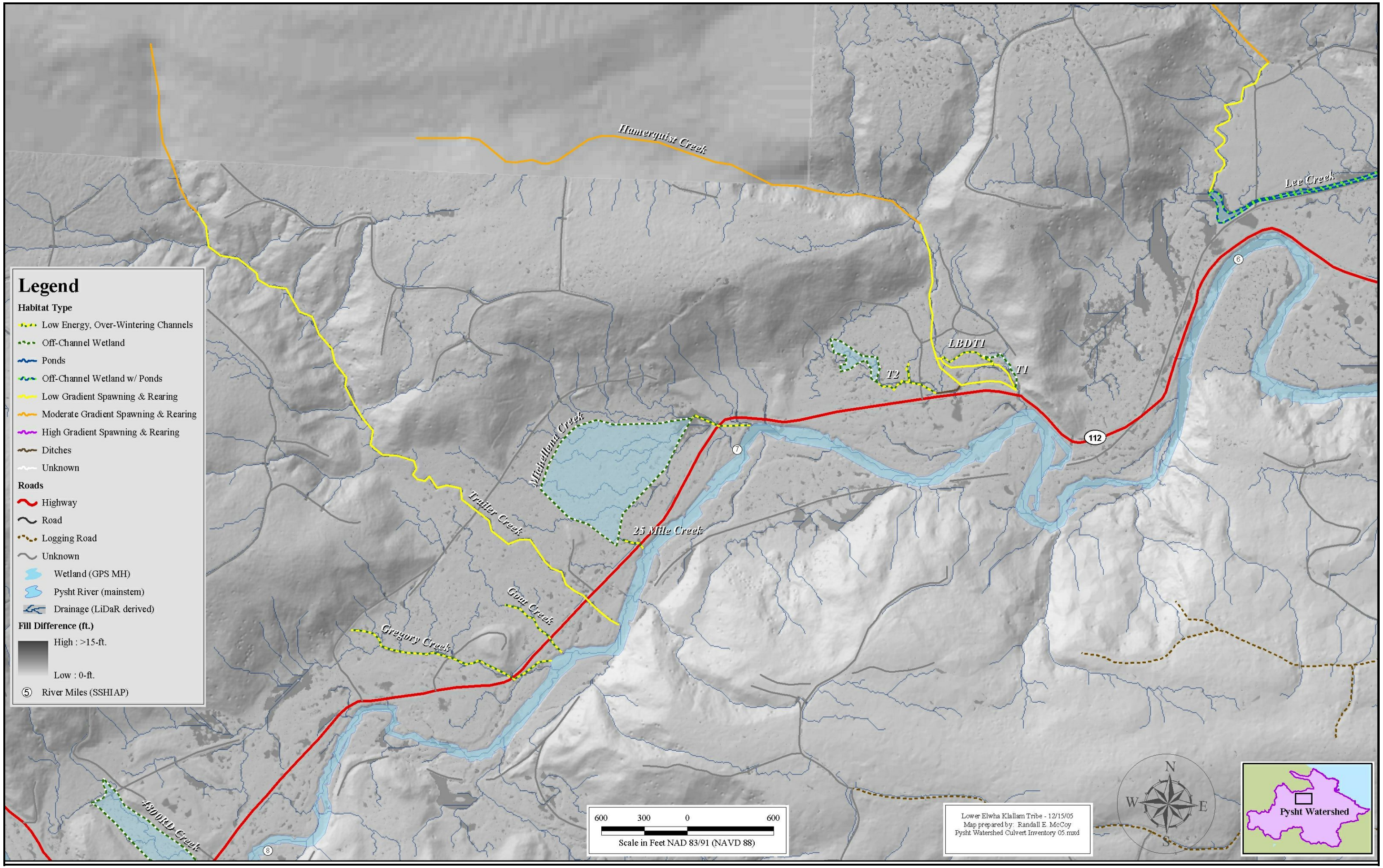

Figure 32. Pysht River floodplain habitats from Hamerquist Creek to Gregory Creek.

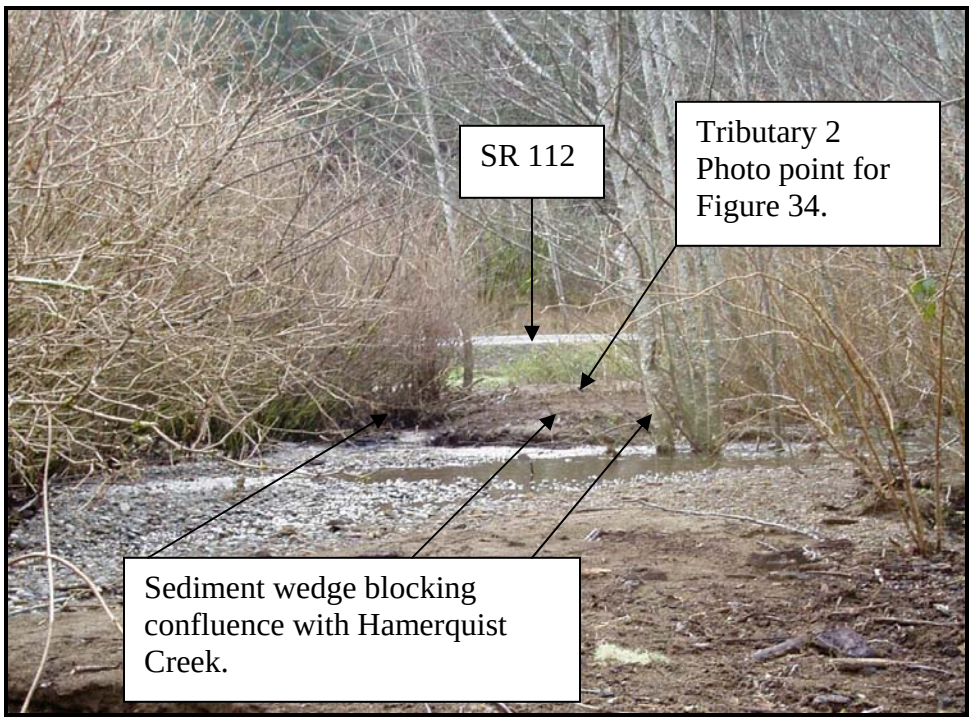

Figure 33. Example of sediment deposition disconnecting habitat between Hamerquist Creek and Tributary 2.

Figure 34. Dead coho which were trapped in Tributary 2 (source: D. Hamerquist).

4.2.2.20 MICHELENA CREEK

Michelena Creek drains a large forested wetland that has been recently logged. It is a left bank tributary that connects with the Pysht at RM 6.96 (Figure 32). The primary impairment to this habitat is limited fish access. The SR 112 culvert is perched 0.5 meters and set at a 1-2% gradient; the culvert acts as a 100% barrier to all fish species prohibiting access to the 11.7 acre wetland complex. There is an additional culvert upstream which is categorized as 100% passable in the WDFW culvert database. Downstream of the SR 112 culvert there is potentially a box culvert or other feature that may limit fish passage- this feature should be further investigated.

Figure 35. Michelena Creek perched SR 112 culvert.

4.2.2.21 25 MILE CREEK

This creek drains a small forested wetland that has been recently logged. It is a left bank tributary that enters the Pysht River at RM 7.15 (Figure 32). The SR 112 culvert is perched 1.7 meters and acts as a 100% barrier to all fish species prohibiting access to a

small wetland complex between Michelena Creek and SR 112. The 25 Mile Creek wetland appears to be connected to the wetland drained by Michelllena Creek; although access limitations prohibited field verification. Replacing the culvert may prove highly difficult because of the close proximity to the mainstem Pysht River.

4.2.2.22 TRAILER CREEK

Trailer Creek is also known locally as Mossyrock Creek. It enters the Pysht River on the left bank at RM 7.28 (Figure 32). Two SR 112 culverts are perched and set at grade (0.15 to 0.2 meters and 3-4% gradient). The perched culverts and steep culvert slopes act are believed to act as a 100% barrier to juvenile salmonids, but adult coho are able to pass the culverts. The double culverts block juvenile fish passage to approximately 1,100 meters of low gradient (<1%), unconfined habitat, as well as 300 to 400 meters of 4-8% gradient habitat. These culverts are currently scheduled for replacement with a concrete box culvert by WDOT during the summer of 2006.

4.2.2.23 4800 ROAD CREEK

This system enters the left bank of the Pysht at RM 8.06 (Figure 36) and includes both low gradient stream habitat (below SR112) and a large wetland complex (above SR 112). SR 112 culvert is perched 0.11 meters and set at a 3-4% gradient and the culvert acts as a 100% barrier to juvenile salmonids prohibiting access to a 2.9 acre wetland complex. During the February 2005 survey this stream had very high densities of juvenile coho downstream of the culvert but no coho were observed upstream of the culvert. One resident cutthroat was observed upstream of the culvert.

4.2.2.24 BURNT CREEK 1

This left bank tributary enters the Pysht River at RM 9.5 (Figure 36). Low gradient reaches flowing across the floodplain provide spawning and rearing habitat, while culverts block moderate gradient and low gradient habitats upstream. The SR 113 culvert is long (64 m) and set at a grade of 5-7%. In addition, the culvert inlets were plugged creating a plunge into the culverts. Collectively these problems act to form what was considered a 95-100% barrier to adult salmonid passage (100% juvenile barrier). Upstream of the culverts the channel has a short cascade reach averaging 9-12% gradient for 37 m. At the end of this short cascade reach there is an additional fish blocking culvert on the 801 Road. It is estimated that the two SR 113 culverts block access to approximately 350 meters of high quality 1-2% gradient unconfined habitat and 101 m (64 m in culvert) of 5-12% gradient habitat.

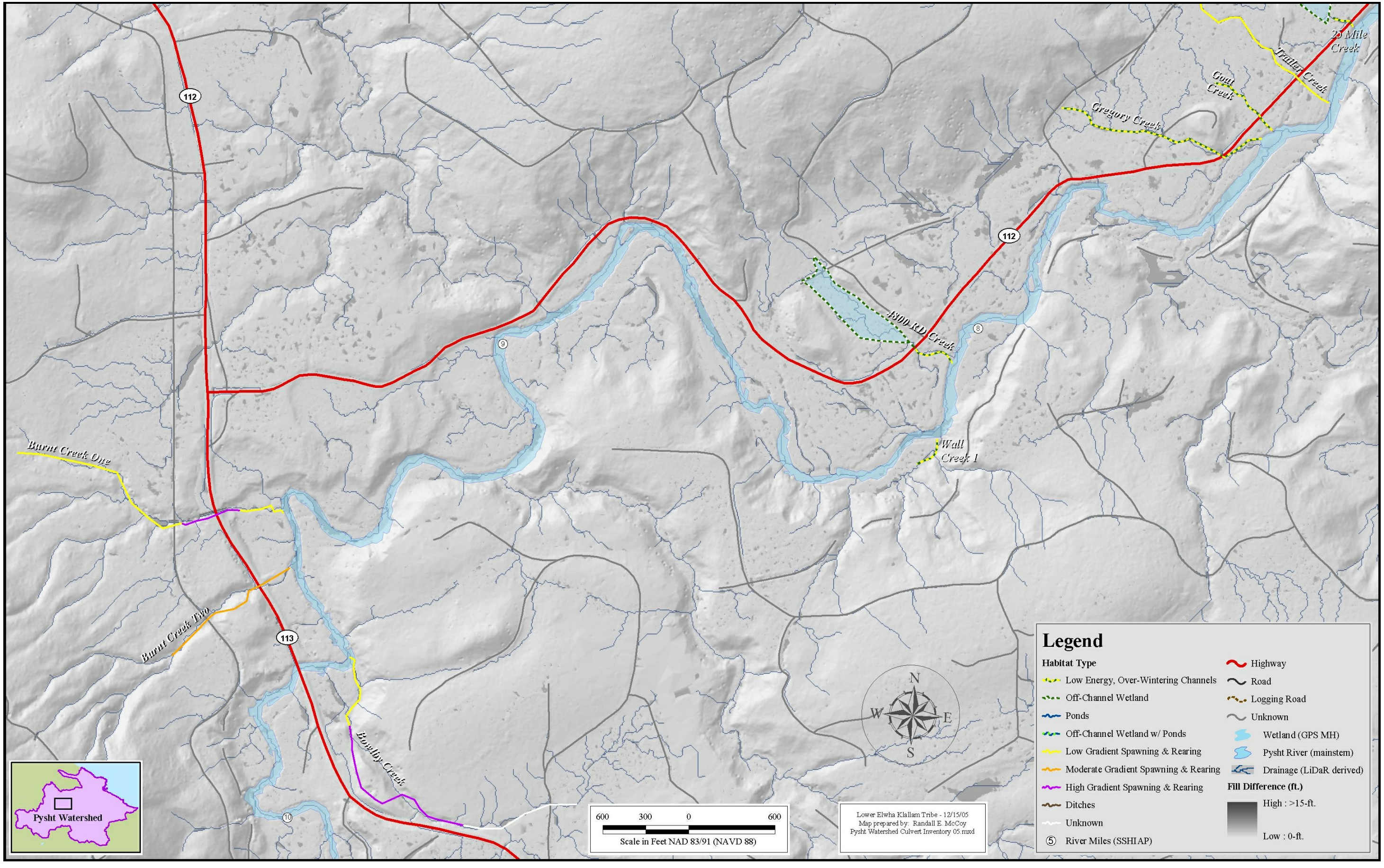

Figure 36. Pysht River floodplain habitats from 4800 Road Creek to Bowlby Creek.

4.2.2.25 BURNT CREEK 2

This left bank tributary enters the Pysht River at RM 9.58 (Figure 36). A short, low gradient reach flows across the floodplain providing a small amount of spawning and rearing habitat. Culverts block moderate gradient and low gradient habitats upstream. The SR 113 culvert is perched 1.2 meters creating a complete barrier for fish passage; blocking 263 meters of 3-8% gradient habitat. Downstream of SR 113, the channel is incised and an old culvert in the channel acts as a partial barrier to fish. An additional culvert 117 m upstream of the SR 113 culvert, at the 801 Road is also a barrier; blocking approximately 100 meters of 3-8% gradient, as well as some additional higher gradient fish habitat.

4.2.3 ESTUARY HABITATS

As described earlier it was not possible to quantify the full extent of estuarine habitat alterations in the Pysht estuary. Aerial photos only extend back to 1951 for this area and therefore pre-development conditions in the estuary are relatively unknown. The lack of aerial photos prior to alterations of the estuary makes it difficult to understand the quantity of habitat alteration that has occurred. A comparison of the 1951 and 2003 aerial photos show some changes in the estuary but don't reveal drastic alterations that are assumed to have occurred in the late 1800s and early 1900s (Figure 37 and Figure 38). The most notable changes between 1951 and 2003 are changes in the shape and length of the spit and the narrowing and filling in of a section of the lower river.

A complete inventory of impaired habitats within the Pysht estuary was not completed. However, a general understanding of habitat alterations and impaired habitats was gained. Multiple disconnected wetlands were identified within the estuary. Some of these wetlands were disconnected because of roads and others were disconnected due to dredge spoil deposits. These habitats should be the focus of any attempted restoration work in the Pysht estuary. Figure 14 depicts the location of all of the wetland habitats that were identified during field surveys. Removal and opening access through spoil deposits will be difficult. It is recommended that a comprehensive plan for estuary restoration be developed prior to conducting work in the estuary to minimize the number entries into this area with heavy equipment and to maximize the quantity of habitat restored.

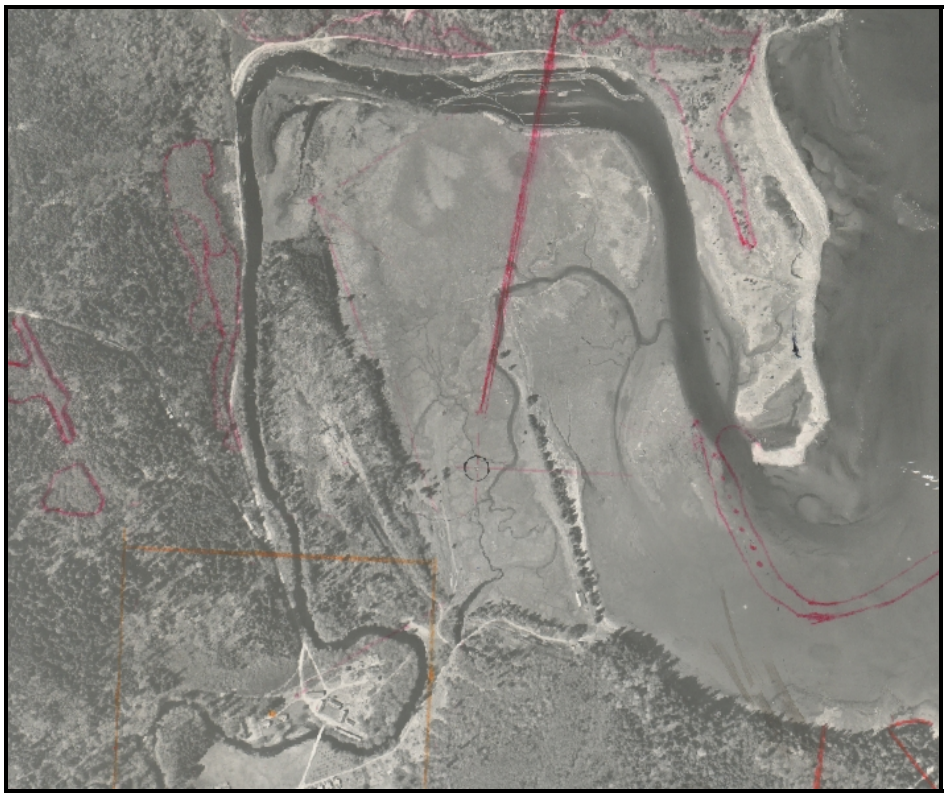

Figure 37. 1951 aerial photograph of Pysht River estuary.

Figure 38. 2003 aerial photograph of Pysht River estuary.

4.3 PRIORITIZED PROJECT LIST

We identified 31 restoration projects in 29 subbasins that collectively comprise the off-channel and floodplain habitats of the mainstem Pysht River. The majority of these projects address habitat connectivity especially through the correction of passage barriers and barriers to lateral migration. In a recent review of watershed restoration projects in the Pacific Northwest, Roni et al.(2002) recommended the reconnection of high quality habitats isolated by culverts or other artificial structures as the second highest priority (behind protecting existing functional habitat) for conducting systematic watershed restoration. Fish passage projects that provide improved access to historically accessible habitats dominate the restoration projects identified in the Pysht River floodplain. Other significant project recommendations include relocation or abandonment of road segments that infringe on the Pysht River floodplain, riparian restoration and additions of large LWD. These projects are ranked in terms of value to spawning and rearing habitat and summarized in Table 6.

Table 6. List of ranked potential floodplain habitat restoration projects (listed from downstream to upstream).

Stream Name	Project Type	Description	Project Rank
Pysht River	Road Relocations	Relocate SR 112 from RM 5.5 to 4.8; investigate other areas for road relocation.	High
Pysht River	Riparian Restoration	Conversion of fields and other non-forested riparian areas back functional riparian areas.	High
Tidal wetlands	Fish Passage/Tidal Connectivity	Reconnect tidal wetlands, remove dredge spoils where feasible. Develop estuary restoration strategy.	High
Indian Creek	Fish Passage/Tidal Connectivity	Replace Farm Road culvert with bridge to allow better fish passage, decrease erosion, and increase tidal connectivity.	Moderate
Indian Creek	Fish Passage/natural sediment transport	Replace SR 112 culverts	Low
Indian Slough	Fish Passage/Tidal Connectivity	Replace Farm Road culvert with bridge to allow better tidal connectivity.	Moderate
Ring Creek	Fish Passage	Replace 2000 RD Culvert	Low
Ring Creek	Fish Passage	Replace 1000 RD Culvert	Low
Shop Creek	Fish Passage/Wetland Connectivity	Replace 2000 RD Culvert, remove fill from wetland or dig new channel around fill.	Moderate
Sec 9_Stream 1	Fish Passage/Tidal Connectivity	Replace Farm Road culvert with bridge to allow better fish passage and tidal connectivity.	Moderate
Cabin Creek	Fish Passage/Tidal Connectivity	Replace Farm Road culvert with bridge to allow better fish passage and tidal connectivity.	Moderate
Cabin Creek	Fish Passage	Replace 3000W RD culvert	Moderate

Stream Name	Project Type	Description	Project Rank
Andis Slough	Habitat Connectivity	Improve habitat connectivity and minimize dewatering, recommend continued monitoring of site.	Moderate
Piling Creek	Fish Passage	Replace 2100 road culvert, determine feasibility and need to adjust channel downstream of culvert to promote fish passage.	Moderate
Razz Creek	Habitat Enhancement	Develop and implement channel enhancement activates including potential channel re-routing, addition of LWD.	Moderate
Razz Creek_T1	Fish Passage, Habitat Enhancement	Replace SR112 culvert, add LWD, reduce cascade step elevations, increase channel sinuosity	Moderate
Razz Creek_T2	Fish Passage, Habitat Connectivity	Replace SR112 culvert, increase habitat connectivity, this may be associated with Razz Creek mainstem work.	Moderate
Razz Creek_T3_T1	Habitat Connectivity	Increase habitat connectivity.	Moderate
Razz Creek_T4_T3	Fish Passage	Replace M&R culvert on unnamed spur road.	Moderate
Razz Creek	Fish Passage	Replace 4500 Road culvert	Moderate
2100RD Swamp	Habitat Connectivity	Somehow address wetland dewatering, Lost Creek channel diversion	High
4500RD Swamp	Fish Passage, Habitat Connectivity	Provide access to wetland complex	Moderate
Lee Creek	Wetland-Habitat Connectivity	Remove old RR grade parallel to Lee Creek. This will enhance habitat connectivity throughout a long reach of Lee Creek	Moderate
Hamerquist Creek	Habitat Connectivity, Sediment Storage, Habitat Complexity	Replace SR 112 culvert with bridge (elevated road-way), add LWD, reroute tributary?	High
Michelena Creek	Fish Passage	Replace SR 112 culvert	High
25 Mile Creek	Fish Passage	Replace SR 112 culvert	Low
Trailer Creek	Fish Passage	Replace SR 112 culverts	Moderate
4800RD Swamp	Fish Passage	Replace SR 112 culverts	High
Burnt Creek One	Fish Passage	Replace SR 113 culverts	Moderate
Burnt Creek One	Fish Passage	Replace 801 Road Culvert	Moderate
Burnt Creek Two	Fish Passage	Replace SR 113 culvert	Low
Burnt Creek Two	Fish Passage	Replace 801 Road Culvert	Low

5 RECOMMENDATIONS

This report describes the first comprehensive survey of floodplain habitats of the Pysht River watershed. We successfully identified 29 independent subbasins, many of which were not on existing water type maps or were incorrectly mapped. Because these areas were not recognized as fish habitat, they have not received protection in land use decisions. Based upon the survey results, recommendations for beginning systematic restoration of the floodplain are offered with an emphasis on the reconnection of historically accessible habitats based upon the recommendations of Roni et al. (2002). While we were successful at physically describing diverse habitat types and their connectivity to the Pysht River floodplain, we were unable to describe their function in relation to mainstem and estuary habitats except in general terms. Based upon the survey results we make general recommendations for future assessment, protection of existing habitat, and restoration of the Pysht River floodplain. These include:

5.1 Assessment

- Determine the link if any between channel incision and floodplain encroachment and potential reductions in ground water levels and their influence on floodplain wetlands and off-channel habitats.

- Conduct comprehensive habitat inventories in the mainstem Pysht in order to describe spawning and rearing habitat quality, with a special emphasis on lost connectivity between the mainstem and off-channel areas as a result of channel incision.

- Assess the spatial-temporal fish usage of off-channel habitats in the Pysht River and particularly in the estuary.

- Attempt to determine the importance of different habitat types upon salmonid productivity by species.

5.2 Protection

- Limit future land use encroachment. Several off-channel habitats identified in this study have not been recognized as fish habitat and were therefore not afforded protection under the Forest Practices Act. Similarly, past agricultural and housing developments have negatively affected the floodplain.

- Assess possibilities for obtaining floodplain conservation easements along the Pysht River corridor. A nearly 1000 acre easement that includes significant

portions of the estuary has recently been negotiated by Cascade Conservancy. Floodplain easements that connect to this core area are a logical strategy for conserving floodplain habitats over the long term.

5.3 Restoration

- Attempt to reconnect floodplain where it is viable, through barrier correction, road relocation, or treatment of mainstem incision. The restructuring of the mainstem Pysht River with LWD, from both natural recruitment and restoration projects likely offers the best approach for treating incision problems.

- Develop a comprehensive strategy to reconnect estuary wetlands and channels where feasible. Examine additional alternatives and actions that can be conducted to enhance estuarine habitats.

- Engage WDOT in future Highway 112 planning to encourage alternative road locations that minimize encroachment on floodplain habitats..

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APPENDIX A

Floodplain Habitat Summary Table

Stream Name	Segment ID	Seg. Length (M)	Wetland Area (acres)	Channel Type	Habitat Type	Gradient	Confinement	BFW	BFD	Wetted Width	Avg Depth	Substrate	Substrate Comp.	Percent Surveyed	Anad Fish
Indian Creek	Indian Creek Seg 0	1,350		Estuarine	LO	<1%	U	U	U	U	U	na	na	50%	Y
Indian Creek	Indian Creek Seg 1	120		Regime	LO	<1%	FC	13.5	-	-	-	Fines- some gravel	Glacially Derived	100%	Y
Indian Creek	Indian Creek Seg 2	155	1.81	OWW	W	<1%	U	U	U	3-5	0.25-0.8	Fines	Mix	100%	Y
Indian Creek	Indian Creek Seg 3	375	3.05	FW	W	<1%	U	U	U	U	U	Fines	Mix	100%	Y
Indian Creek	Indian Creek Seg 4	200		PR	LS	1-2%	U	5.1	0.45	3.9	-	Gravel	Glacially Derived	100%	Y
Indian Creek	Indian Creek Seg 5	225		FPR	LS	2-3%	M	3.8	0.60	-	-	Gravel	Glacially Derived	100%	Y
Indian Creek	Indian Creek Seg 6	385		SP/FSP	HS	5-12%	C	-	-	-	-	Cobble/Boulder	Mix	50%	Y
Indian Slough	Indian Slough Seg 0	35		Estuarine	LO	<1%	U	~2	-	-	-	Cobble/gravel	Mix	100%	Y
Indian Slough	Indian Slough Seg 1	120	0.31	Regime/OWW	W	<1%	U	4.0	-	-	-	Fines	-	90%	Y
Spruce Creek	Spruce Creek Seg 1	127	1.65	FW	W	>1%	U	1.6	0.22	1.0	0.07	Fines	na	100%	Y
Pysht Ponds	Pysht Ponds Seg 1	106		Estuarine	LO	<1%	U	~4	U	U	U	Fines	na	100%	ND
Pysht Ponds	Pysht Ponds Seg 1A	44	0.35	OWW	P	<1%	M	U	U	U	U	Fines	na	100%	ND
Pysht Ponds	Pysht Ponds Seg 2	43	0.12	OWW	P	<1%	M	U	U	U	U	Fines	na	100%	ND
Pysht Ponds	Pysht Ponds Seg 3	8		Regime	LO	<1%	M	~3	U	~2	~0.10	Fines	na	100%	ND
Pysht Ponds	Pysht Ponds Seg 4	39	0.04	OWW	P	<1%	M	U	U	U	U	Fines	na	100%	ND
Ring Creek	Ring Creek Seg 1	177		SP	MS	4-10%	C	3.8	0.33	1.1	0.04	Gravel	Mostly siltstone	100%	Y
Ditch Creek	Ditch Creek Seg 1	30		PB/FW	LO	4%	U/FC	1.2	na	0.6	0.02	Sand	na	100%	Y
Ditch Creek	Ditch Creek Seg 2	80		Ditch	D	2-6%	U/FC	na	na	na	na	Fines	na	100%	Y
Ditch Creek	Ditch Creek Seg 3	41		FW	LO	na	M	U	U	U	U	Fines	na	100%	ND
Ditch Creek_T1	Ditch Creek_T1 Seg 1	200		Ditch	D	0-1%	U/FC	na	na	na	na	Fines	na	100%	Y
Shop Creek	Shop Creek Seg 1	53		FW/Regime	LO	0-2%	U	0.9	0.20	0-0.35	0.02	Fines	na	100%	Y
Shop Creek	Shop Creek Seg 2	30	0.01	FW	W	<1%	U	U	U	U	U	na	na	100%	ND
Shop Creek	Shop Creek Seg 3	72	0.08	FW	W	<1%	U	U	U	U	U	na	na	100%	Y
Shop Creek	Shop Creek Seg 4	230	2.20	FW/OWW	W	<1%	U	U	U	U	U	na	na	100%	ND
Sec 9_Stream 1	Sec 9_Stream 1 seg 1	305		Regime	LO	<1%	U	~3.5	~0.3	~3	~0.15	Fines	na	100%	Y
Sec 9_Stream 1	Sec 9_Stream 1 seg 2	200	1.01	FW	W	<1%	U	U	U	U	U	Fines	na	100%	Y

Stream Name	Segment ID	Seg. Length (M)	Wetland Area (acres)	Channel Type	Habitat Type	Gradient	Confinement	BFW	BFD	Wetted Width	Avg Depth	Substrate	Substrate Comp.	Percent Surveyed	Anad Fish
Sec 9_Stream 1_T1	Sec 9_Stream 1_T1 Seg 1	110	1.10	FW	W	<1%	U	U	U	U	U	Fines	na	80%	ND
Cabin Creek	Cabin Creek Seg 1	138		Regime	LO	0-1%	U	3.0	na	2.0	0.27	sand/fines	na	100%	Y
Cabin Creek	Cabin Creek Seg 2	87		Regime	LO	0-1%	U	2.9	0.47	2.4	0.27	Fines	na	100%	Y
Cabin Creek	Cabin Creek Seg 3	400	19.61	FW	W	<1%	U	U	U	U	~0.3	Fines	na	75%	Y
Cabin Creek_T1	Cabin Creek_T1 Seg 1	390		Regime	LO	<1%	U	3.7	0.33	3.1	0.11	Fines	-	100%	Y
Cabin Creek_T1	Cabin Creek_T1 Seg 2	92		Ditch	D	na	FC	-	-	-	-	-	-	100%	Y
Rymer Creek	Rymer Creek Seg 1	33		Regime	LO	1%	U/FC	1.5	2.00	0.8	na	Fines	na	100%	Y
Rymer Creek	Rymer Creek Seg 2	117	0.26	FW/OWW	WP	<1%	U	1.4	0.28	1.0	0.11	Fines	na	100%	Y
Rymer Creek	Rymer Creek Seg 3	43		Ditch/FW	D	<1%	U	na	na	na	na	Fines	na	100%	Y
Rymer Creek	Rymer Creek Seg 4	97		AF	LS	~3%	U	2.1	0.31	1.3	0.07	Small Gravel	Silt-and sandstone	100%	Y
Rymer Creek	Rymer Creek Seg 5	115		PR/FPR	LS	2-4%	M (FC)	2.8	0.95	1.1	0.14	Gravel	Silt-and sandstone	100%	Y
Rymer Creek	Rymer Creek Seg 6	365		FSP	MS	4-8%	C	na	na	na	na	na	na	10%	Y
Andis Slough	Andis Slough Seg 1	73		Regime	LO	1-6%	U/FC	na	na	na	na	Fines	na	100%	Y
Andis Slough	Andis Slough Seg 2	142	0.62	OWW	P	<1%	U/FC	na	na	na	na	Fines	na	100%	Y
Andis Slough_T1	Andis Slough_T1 Seg 1	45		PR	LS	1-3%	U	1.5	0.20	0.0	0.00	Fines/Gravel	na	100%	ND
Andis Slough_T1	Andis Slough_T1 Seg 2	145	0.24	FW	W	<1%	U	U	U	na	0.25-.75	Fines	na	70%	Y
Piling Creek	Piling Creek Seg 1	32		SP	MS	6%	U/FC	-	-	-	-	Gravel/fines	na	100%	ND
Piling Creek	Piling Creek Seg 2	45		Regime	LO	<1%	U	3.4	0.35	2.4	0.14	Fines	na	100%	ND
Piling Creek	Piling Creek Seg 3	333	3.37	FW/OWW	WP	<1%	U	U	U	U	U	Fines	na	70%	ND
Razz Creek	Razz Creek Seg 1	466		PR	LS	1-2%	U/FC	5.4	1.50	2.8	0.21	Small Gravel	Silt- and sandstone	100%	Y
Razz Creek	Razz Creek Seg 2	155		PR-Regime	LS	0-1%	U/FC	4.7	1.00	2.5	0.12	Gravel/Fines	Silt- and sandstone	100%	Y
Razz Creek	Razz Creek Seg 3	205	1.68	OWW	W	<1%	U	na	na	na	0.2-0.8	Fines	na	100%	Y
Razz Creek	Razz Creek Seg 4	324	2.20	FW	W	<1%	U	na	na	na	<0.25	Fines	na	100%	Y
Razz Creek	Razz Creek Seg 5	256		PR	LS	1-2%	U	3.0	0.50	2.4	0.09	Gravel	Mix	100%	Y
Razz Creek	Razz Creek Seg 6	401		SP	MS	3-6%	C	3.0	0.60	2.0	0.06	Cobble	Glacially Derived	100%	Y
Razz Creek	Razz Creek Seg 7	135		SP	MS	3-6%	C	2.3	0.40	1.2	0.06	Cobble/Gravel	Mix	100%	ND
Razz Creek	Razz Creek Seg 8	300		FPR	LS	2-4%	C	na	na	na	na	Gravel	Mix	100%	ND
Razz Creek_T1	Razz Creek_T1 Seg 1	115		PR/SP	LS	1-9%	U-FC	3.0	0.73	1.4	0.07	Fines/Clay	na	100%	Y
Razz Creek_T1	Razz Creek_T1 Seg 2	335	2.19	FW	W	<1%	U	U	U	U	U	Fines	na	100%	ND

Stream Name	Segment ID	Seg. Length (M)	Wetland Area (acres)	Channel Type	Habitat Type	Gradient	Confinement	BFW	BFD	Wetted Width	Avg Depth	Substrate	Substrate Comp.	Percent Surveyed	Anad Fish
Razz Creek_T1	Razz Creek_T1 Seg 3	270		FPR	LS	1-3%	U/FC	3.0	0.63	1.7	0.11	Gravel	Mixed	100%	ND
Razz Creek_T1	Razz Creek_T1 Seg 4	181		SP	MS	3-8%	M-C/FC	3.1	0.90	1.6	0.10	Cobble	Glacially Derived	100%	ND
Razz Creek_T2	Razz Creek_T2 Seg 1	133		Regime	LO	0-1%	U	0.5	0.25	0.2	0.03	Fines	na	100%	Y
Razz Creek_T2	Razz Creek_T2 Seg 2	103	0.17	FW	W	0-1%	U	U	U	U	U	Fines	na	100%	ND
Razz Creek_T3	Razz Creek_T3 Seg 1	135		Regime	LO	0-1%	U	1.7	0.29	0.8	0.06	Sand/Fines	na	100%	Y
Razz Creek_T3	Razz Creek_T3 Seg 2	131	0.78	FW	W	0-1%	U	U	U	na	0.17	Sand/Fines	na	100%	Y
Razz Creek_T3_T1	Razz Creek_T3_T1 Seg 1	5		Undefined	LO	1-2%	U	U	U	dry	dry	fines	na	100%	ND
Razz Creek_T3_T1	Razz Creek_T3_T1 Seg 2	94	0.09	OWW	P	0%	na	na	na	3.0	0.15-0.5	fines/organics	na	100%	Y
Razz Creek_T4	Razz Creek_T4 Seg 1	273		PR	LS	2%	U	2.6	0.50	1.8	0.07	Gravel	Sand-Siltstone	100%	Y
Razz Creek_T4	Razz Creek_T4 Seg 2	80		AF	LS	1-2%	U	1.8	0.26	1.1	0.08	Gravel	Mix	100%	ND
Razz Creek_T4	Razz Creek_T4 Seg 3	165		FPR/SP	MS	3-5%	M	1.9	0.49	1.2	0.06	Gravel/Cobble	Glacially Derived	100%	ND
Razz Creek_T4	Razz Creek_T4 Seg 4	43		FSP/SP	HS	8-14%	C/M	2.6	na	2.2	0.03	Cobble/Boulder/Gravel	Glacially Derived	100%	ND
Razz Creek_T4_T1	Razz Creek_T4_T1 Seg 1	10		PR	LO	2-3%	U	1.3	0.20	1.0	0.02	Fines	NA	100%	ND
Razz Creek_T4_T1	Razz Creek_T4_T1 Seg 2	50	0.03	FW	W	<1%	U	U	U	U	U	Fines	NA	100%	ND
Razz Creek_T4_T2	Razz Creek_T4_T2 Seg 1	20	0.03	FW	W	<1%	U	0.6	0.15	0.4	0.03	Fines	na	100%	ND
Razz Creek_T4_T3	Razz Creek_T4_T3 Seg 1	35		PR	LO	1-3%	U	1.0	0.17	0.7	0.10	fines	na	100%	Y
Razz Creek_T4_T3	Razz Creek_T4_T3 Seg 2	276	0.52	FW	W	0-1%	U	U	U	U	U	fines	na	100%	Y
Razz Creek_T4_T4	Razz Creek_T4_T4 Seg 1	80	0.32	FW	W	0-1%	U	U	U	U	<0.1	Fines	na	80%	ND
Razz Creek_T5	Razz Creek_T5 Seg 1	233		AF	LS	1-2%	U	1.5	0.30	0.7	0.08	Gravel, Pebbles	Sand-Siltstone	100%	ND
Razz Creek_T5	Razz Creek_T5 Seg 2	179		PR/FPR	LS	2%	M/C	2.4	0.61	1.1	0.06	Gravel/Cobble	Glacially Derived	100%	ND
Razz Creek_T5	Razz Creek_T5 Seg 3	120		SP	MS	4-6%	M/C	1.6	na	1.5	na	Cobble	Glacially Derived	100%	ND
Razz Creek_T6	Razz Creek_T6 Seg 1	80		AF	LS	~2%	U	-	-	-	-	Gravel/Cobble	na	100%	ND
2100RD Swamp	2100RD Swamp Seg 1	75		Regime	LO	1-2%	U/FC	0.6	1.50	0.0	0.00	fines	na	100%	Y
2100RD Swamp	2100RD Swamp Seg 2	170	0.81	OWW	W	<1%	U/FC	U	U	U	U	fines	na	100%	Y
2100RD Swamp	2100RD Swamp Seg 3	575	7.11	OWW	WP	<1%	U/FC	U	U	U	U	fines	na	60%	Y
4500RD Swamp	4500RD Swamp Seg 1	8		?	LO	<5%	U	na	na	na	na	na	na	100%	ND

Stream Name	Segment ID	Seg. Length (M)	Wetland Area (acres)	Channel Type	Habitat Type	Gradient	Confinement	BFW	BFD	Wetted Width	Avg Depth	Substrate	Substrate Comp.	Percent Surveyed	Anad Fish
4500RD Swamp	4500RD Swamp Seg 2	412	2.37	OWW	P	0	U	U	U	U	U	Fines	na	100%	ND
Lost Creek	Lost Creek Seg 1	175		AF	N	1-2%	U	na	na	na	na	Gravel	Mix	100%	ND
Lost Creek	Lost Creek Seg 2	140		FPR	LS	1-3%	M	na	na	na	na	Gravel	Mix	100%	ND
Lee Creek	Lee Creek Seg 1	175		Regime	LO	<1%	U/FC	~3	~1.3	~1.7	na	Fines	na	100%	ND
Lee Creek	Lee Creek Seg 2	45	0.21	OWW	P	<1%	U/FC	U	U	U	U	Fines	na	100%	Y
Lee Creek	Lee Creek Seg 3	413		PR	LS	<1%	U	2.7	0.52	1.4	0.14	Gravel/Fines	Mix	100%	Y
Lee Creek	Lee Creek Seg 4	457	0.77	OWW/Regime	WP	<1%	U	na	na	na	na	na	na	0%	NS
Lee Creek	Lee Creek Seg 5	376		PR	LS	0.02	U	na	na	na	na	na	na	0%	NS
Lee Creek	Lee Creek Seg 6	183		SP	MS	4-8%	C	na	na	na	na	na	na	0%	NS
Lee Creek_T1	Lee Creek_T1 Seg 1	50	0.14	FW	W	<1%	U	U	U	U	U	Fines	na	100%	ND
Lee Creek_T2	Lee Creek_T2 Seg 1	75	0.48	FW	W	<1%	U	na	na	na	na	na	na	0%	NS
Lee Creek_T3	Lee Creek_T3 Seg 1	99	1.06	FW	W	<1%	U	U	U	U	U	Fines	na	100%	Y
Lee Creek_T3	Lee Creek_T3 Seg 2	229	2.48	FW	W	<1%	U	U	U	U	U	Fines	na	90%	Y
Lee Creek_T3	Lee Creek_T3 DT 1	45		FW	W	<1%	U	U	U	U	U	Fines	na	100%	Y
Lee Creek_T4	Lee Creek_T4 Seg 1	410		FW	LO	<1%	U	U	U	~2	~0.05	Fines	na	100%	Y
Lee Creek_T5	Lee Creek_T5 Seg 1	40		FW	LO	<1%	U	U	U	na	na	Fines	na	100%	Y
Lee Creek_T6?	na	na		na	LO	na	na	na	na	na	na	na	na	80%	NS
Hamerquist Creek	Hamerquist Creek Seg 0	0		BW	LO	0%	na	na	na	na	na	na	na	100%	Y
Hamerquist Creek	Hamerquist Creek Seg 1	243		AF/FW	LS	0-2%	U	2.9	0.30	2.5	0.10	Sand/pebbles	na	100%	Y
Hamerquist Creek	Hamerquist Creek Seg 2	342		FPR/PB	LS	2-3%	M	5.0	0.56	2.4	0.10	Gravel/Cobble	Glacially Derived	100%	Y
Hamerquist Creek	Hamerquist Creek Seg 3	1,128		SP	MS	4-7%	M/C	7.3	na	1.9	na	Gravel/Cobble	Glacially Derived	100%	Y
Hamerquist Creek_ LBDT1	Hamerquist Creek_LBDT1 Seg1	130		AF/FW	LO	<1%	U	U	U	0.0	0.00	Fines	na	100%	ND
Hamerquist Creek_T1	Hamerquist Creek_T1 Seg 1	124	0.20	Regime/FW	W	<1%	U	1.5	0.26	0.8	0.08	Fines	na	100%	Y
Hamerquist Creek_T2	Hamerquist Creek_T2 Seg 1	58		Ditch	D	<1%	FC	-	-	-	-	fines	na	100%	Y
Hamerquist Creek_T2	Hamerquist Creek_T2 Seg 2	142		Regime	LO	<1%	U	2.6	0.23	2.0	0.10	fines	na	100%	Y
Hamerquist Creek_T2	Hamerquist Creek_T2 Seg 3	180	0.78	FW	W	<1%	U	-	-	-	-	fines	na	90%	Y
Hamerquist Creek_T2_T1	Hamerquist Creek_T2_T1 Seg 1	35		Regime	LO	<1%	U/FC	0.8	U	0.5	-	fines	na	100%	ND
Michelena Creek	Michelena Creek Seg 1	119		Regime/PR	LO	<1%	U/FC	na	na	na	na	na	na	100%	NS

Stream Name	Segment ID	Seg. Length (M)	Wetland Area (acres)	Channel Type	Habitat Type	Gradient	Confinement	BFW	BFD	Wetted Width	Avg Depth	Substrate	Substrate Comp.	Percent Surveyed	Anad Fish
Michelena Creek	Michelena Creek Seg 2	335	11.73	OWW/FW	W	<1%	U/FC	na	na	na	na	na	na	0%	NS
25 Mile Creek	25 Mile Creek Seg 1	55		Regime	LO	<1%	U	na	na	na	na	Fines	na	70%	ND
Trailer Creek	Trailer Creek Seg 1	1,128		PR	LS	<1%	U	na	na	na	na	Gravel	Glacially Derived	10%	Y
Trailer Creek	Trailer Creek Seg 2	366		SP	MS	4-8%	C	na	na	na	na	na	na	100%	NS
Goat Creek	Goat Creek Seg 1	137		FW	LO	<1%	U	na	na	na	na	na	na	30%	NS
Gregory Creek	Gregory Creek Seg 1	518		Regime/FW	LO	~1%	U	na	na	na	na	na	na	10%	Y/NS
4800RD Creek	4800RD Creek Seg 1	77		Regime/FW	LO	0-3%	U	U	U	~2.5	~0.05	Fines	na	100%	Y
4800RD Creek	4800RD Creek Seg 2	332	2.91	FW	W	<1%	U	U	U	na	na	Fines	na	98%	ND
Wall Creek 1	Wall Creek_1 Seg 1	69		WB	LO	>1%	U/FC	na	na	na	na	Fines	na	100%	Y
Burnt Creek One	Burnt Creek One Seg 1	111		FPR	LS	2%	U	2.9	0.68	1.8	0.07	Gravel	Mix	100%	Y
Burnt Creek One	Burnt Creek One Seg 2	163		Cascade	HS	5-12%	C	3.4	0.60	1.5	0.12	Bedrock/Cobble	na	100%	ND
Burnt Creek One	Burnt Creek One Seg 3	342		PR	LS	1-2%	U	~3	na	1.5	0.06	Gravel	Mix	100%	ND
Burnt Creek Two	Burnt Creek Two Seg 1	82		PB/FSP	MS	4-8%	U/FC	1.7	0.95	0.7	0.08	Gravel/Cobble	Glacially Derived	100%	ND
Burnt Creek Two	Burnt Creek Two Seg 2	263		FSP	MS	2-10%	M	2.1	0.32	0.9	0.05	Gravel/Cobble	Mix	100%	ND
Bowlby Creek	Bowlby Creek Seg 1	170		FPR	LS	2-3%	U/M	3.0	0.39	1.5	0.04	Gravel	Glacially Derived	100%	Y
Bowlby Creek	Bowlby Creek Seg 2	355		SP	HS	8%	C	2.8	0.58	1.5	0.05	Cobble/Gravel	Glacially Derived	100%	Y
Bowlby Creek	Bowlby Creek Seg 3	ND		Regime/FW	N	<1%	U	na	na	na	na	Fines	na	10%	NS
Boulder Creek	Boulder Creek Seg 1	110		SP	HS	8-12%	C	5.2	na	1.7	0.10	Boulder	na	100%	ND
Bridge Creek	Bridge Creek Seg 1	183		SP	HS	5-11%	M/FC	3.4	na	2.1	na	Cobble/Gravel	Glacially Derived	100%	ND
Wall Creek 2	Wall Creek_2 Seg 1	100		WB	LO	1-2%	U	1.7	na	1.2	0.18	Sand	na	100%	Y
Wall Creek 3	Wall Creek_3 Seg 1	80		WB/SC	LO	<1%	U	na	na	na	na	Sand/Gravel	na	100%	Y

Appendix A: definitions, abbreviations, and codes:

Stream Name: name of stream.
Segment ID: segment name, unique identifier.
Segment Length: length of channel or habitat segment in meters.
Wetland Area: area of wetland habitat measured in acres.

Channel Type: estuarine (E), estuarine wetland (EW), open water wetland (OWW), forested wetland (FW), wall-based (WB), regime (R), pool-riffle (PR), alluvial fan (AF), forced pool-riffle (FPR), plane-bed (PB), step-pool (SP), forced step-pool (FSP), cascade (C), or ditch (D).
Habitat Type: low energy over-wintering channels (LO), off-channel wetland habitat (W), ponds (P), off-channel wetland habitat w/pond(s) (WP), low gradient spawning and rearing habitat (LS), moderate gradient spawning and rearing habitat (MS), and ditches (D).
Gradient: field measured stream gradient.
Confinement: channel confinement defined as the ratio of valley or floodplain width to channel width and recorded as either confined (C- less than 2 BFW's between valley walls), moderately confined (M- 2-4 BFW's between confining valley walls) or unconfined (U- greater than 4 BFW's between confining valley walls). Additionally, where channel segments were determined to be highly incised and function as if they were confined, channel confinement was recorded as functionally confined (FC)
BFW: average segment bankfull width measured in meters.
BFD: average segment bankfull depth measured in meters.
Wetted Width: average segment wetted width measured in meters.
Avg Depth: average segment depth measured in meters at cross-sections where wetted width measurements were taken.
Substrate: substrate type classified as one of the following: fines, pebbles, gravel, cobble, boulder, or bedrock (see Section 2.1)
Substrate Comp: substrate composition, this was used to describe the sediment source of the dominant stream substrate.
Percent Surveyed: percent of segment field surveyed.
Anadromous Fish Presence: this was classified as yes (y) if anadromous fish were detected in field surveys, not detected (ND) if anadromous fish were not detected in field surveys, and not surveyed (NS) if segment was not field surveyed.

APPENDIX B
DETAILED SEGMENT LEVEL FLOODPLAIN HABITAT DESCRIPTIONS

Please refer to the following figures for detailed locations of each stream segment: Figure 19, Figure 24, Figure 32, and Figure 36.

Indian Creek

This right bank tributary drains from a forested subbasin, crosses Highway 112 and flows through low gradient forested wetland habitat, eventually emerging on saltmarsh habitat in the estuary near RM 0 (see Figure 19). Seven channel segments were identified within the portion of the channel surveyed. Descriptions for each of the channel segments are included below. Only one of several tributaries entering segment 0 was included in the full habitat inventory.

Indian Creek Segment 0

Approximately 50% of this channel segment was surveyed. Total segment length is 1,350 m (based on GIS measurement). This segment is an intertidal channel which contains several estuarine sloughs, as well as several (we identified at least 6) intertidal channels which drain small low-elevation freshwater wetland habitats. The survey followed the channel to the end of the point, where the channel entered Pysht Bay proper, which is actually slightly downstream of the SSHIAP RM 0 . No field measurements were taken in this segment but several photos were taken to document channel conditions. The length of this channel segment has been truncated by two undersized culverts associated with Farm Road. These culverts have increased localized erosion and resulted in the sediment deposition at the downstream end of the culvert scour pool. This deposition has increased the pool outlet elevation, thus reducing the tidal influence upstream of the pool. Aerial photos depict the length of estuarine habitat extending approximately 100 meters upstream from its current position. Also note that steelhead were observed digging in the pool tailout just downstream of the double culverts during field surveys.

Indian Creek Segment 1

Segment 1 is a transition reach between the tidal zone and the open water wetland located in segment 2. Total segment length is 120 m, BFW averaged 13.5 meters. Banks where exposed are composed of glacial outwash deposits. Where bank erosion was occurring, small gravel deposits were located adjacent to the banks and appeared to be utilized by spawning salmonids. The rest of this segment contained substrate dominated by fines. Culvert removal could totally alter the energy of this channel and potentially create a mostly gravel bottomed channel at the few riffles (associated with LWD deposits) that exist. A breached beaver dam is located 8 meters downstream from the segment 1/2

break (Figure 39). This feature has influenced bank erosion and sediment deposition and resulted in the deposition of some very nice spawning gravel just downstream.

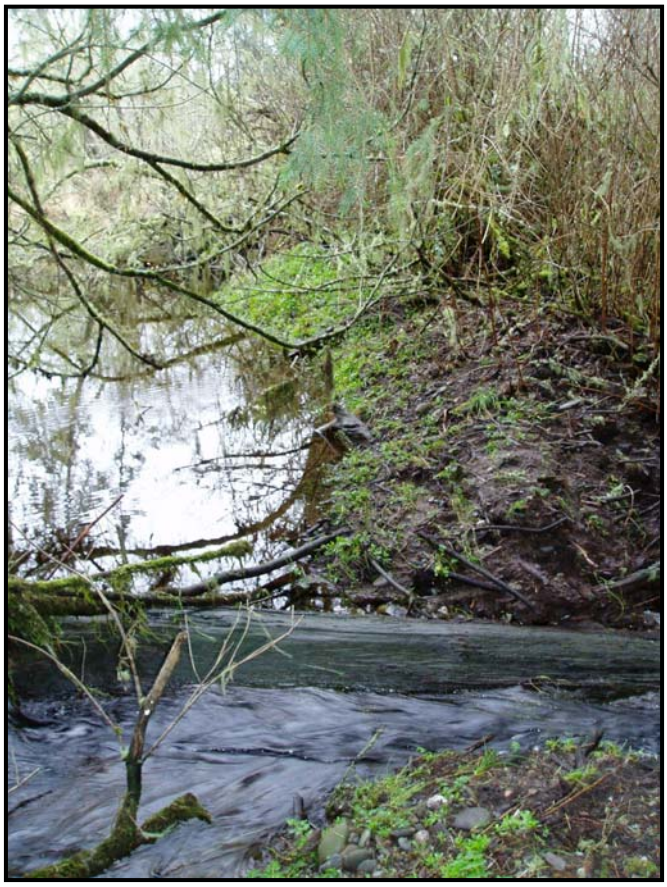

Figure 39. Breached beaver dam located near the Indian Creek segment 1/2 break, photo looking from right to left bank.

Indian Creek Segment 2

Segment 2 is an open water wetland. It appears that beaver activity influences the degree to which this habitat unit is flooded. Currently the lower most beaver dam in breached and the quantity of habitat flooded by open water has recently been reduced. The upstream portion of this segment has begun the process of channel incision. Beaver dams also appear to influence position of transition from forested wetland to open water wetland type habitats. There was a lot of evidence of historic beaver use in this area but no recent beaver activity was detected.

Indian Creek Segment 3

Segment 3 is 375 meters long and is classified as a forested wetland. The channels are a maze through this area; it was impossible to stay along the thalweg of the channel during field surveys. The channels followed averaged average 0.07 to 0.3 m depth. No juvenile coho were observed in the lower 180 meters of this segment. Juvenile coho were observed again at 464 m upstream from the Farm Road. From this point upstream for a length of 136 m all juvenile coho observations were associated with deep pockets in the

channels near rootwads. A steep RBT enters between 50 to 70 meters downstream from the segment 3/4 break.

Indian Creek Segment 4

This segment starts 650 meters upstream from the Farm Road crossing. This pool-riffle segment is 200 meters long, averages 5.1 m BFW, and has an average gradient of 1-2%. Segment 4 appeared to be the best overall salmon habitat in the system. There is extensive spawning habitat, nice pools, and very nice spawning riffles (Figure 40). This segment was absolutely loaded with juvenile salmonids. This segment had the highest juvenile rearing densities of any pool-riffle segment surveyed in the Pysht Watershed. There was no evidence of coho spawning but the survey was conducted at least a month after the spawning season.

Figure 40. Indian Creek Segment 4, typical pool-riffle sequence, note the excellent quality of spawning gravels (765 m upstream of the Farm Road crossing).

Indian Creek Segment 5

Segment 5 is 225 m long, averages 3.8 m BFW, and maintains a gradient of 2-3%. The channel segment was classified as a forced pool-riffle segment where LWD was present and plane-bed where LWD was absent. The channel was a continuous riffle where LWD was absent. Fair to good numbers of juvenile fish were observed. There is a lot of potential spawning habitat in this segment. Channel was moderately entrenched in spots with a small floodplain developing about 0.6 m below what appeared to be the old floodplain.

Indian Creek Segment 6

This segment begins 120 m downstream of SR112 and extends upstream for a total length of 385 m. This segment is a steep step-pool channel. Average gradient measured 5 to 12%. Substrate was primarily composed of cobbles and boulders. Salmon and steelhead utilization of this segment are thought to be fairly limited due to gradient and lack of suitable spawning habitat. Sediment aggradation and instability upstream of SR 112 caused by a bad stream crossing may pose sediment problems downstream, as sediment is eroded during waning flows when stream cuts through a large sediment wedge formed by road crossing. Segment 6 ends at the M&R dam.

Indian Slough

Indian Slough is a small RBT to Segment 0 of Indian Creek. This system enters Indian Creek approximately 30 m downstream of the double culverts on Farm Road (RM 0.82). Indian Slough drains a small, low elevation forested wetland environment. There were no tributaries identified to that flowed into this stream system. Within the portion of this stream system surveyed there were two channel segments. Descriptions for each of the channel segments are included below.

Indian Slough Segment 0

Segment 0 is short, only 35 meters in length. BFW averages approximately 2 meters and gradient is <1%. Channel substrate is primarily gravel. A small (0.35 m) culvert defines the break between segment 0 and 1. This culvert is placed above the streambed and disconnects a portion of the tidal flux upstream of Farm Road. Juvenile coho and three-spine stickleback were observed in segment 0. Based upon a review of 1951 aerial photos it appears that segment 0 extended upstream beyond Farm Road.

Indian Slough Segment 1

Segment 1 is short also, 120 m in length. The culvert on the Farm Road is severely undersized: channel width upstream of culverts averages 4 meters but the culvert diameter is only 0.35 m. A portion of this stream is tidally influenced, though much of the upper portion is dominated by freshwater vegetation types such as slough sedge (*Carex opnupta*). Juvenile coho were observed upstream of the culvert. Habitat width increases upstream of the culvert as the stream transitions into a small open water wetland (0.3 acres) which appears to be connected to segment 2 of Indian Creek during high water.

Spruce Creek

Spruce Creek is a moderate size (1.7 acres) forested wetland complex. Field surveys were unable to locate any hill slope tributaries draining into this complex. The wetland system enters the Pysht River along the left bank at RM 1.05 (see Figure 19). A short (~15m) channel segment connects the wetland to the Pysht River. This system was recently connected to the Pysht River via an impassable culvert which was removed a few years ago. The stream channel now crosses the abandoned road grade via a hardened crossing (Figure 41). This system lacked a well defined channel upstream of the road; instead it contained several short channels leading through the forest. This system

contained some of the highest juvenile coho over-wintering densities in the Pysht Watershed. This is one of few properly functioning forested wetland habitats remaining in the watershed.

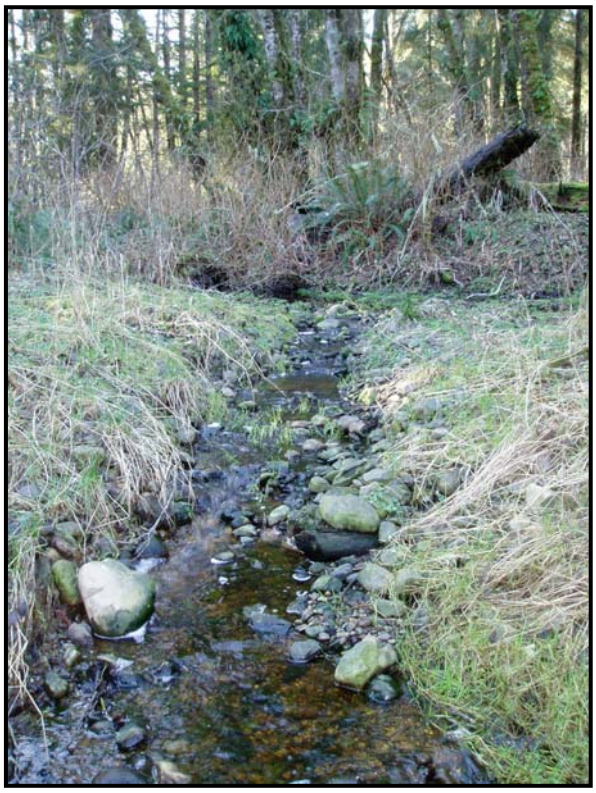

Figure 41. Spruce Creek segment 1 looking upstream at hardened road crossing (photo taken at the confluence with Pysht River).

Figure 42. Typical pool environment within the Spruce Creek forested wetland complex, this pool was full of juvenile coho.

Pysht Ponds

Pysht Ponds are a series of ponds and wetlands which drain a forested area between the right bank of the Pysht River and the estuarine channels which flow into the lower Pysht River. This system enters the Pysht River at RM 1.15 (see Figure 19). There were a total of five habitat segments delineated within the Pysht Ponds system. This entire pond complex was enhanced sometime in the 1990s by M&R to benefit fish and waterfowl habitat. No information regarding the pre-enhancement conditions of this habitat complex is available. Field surveys were unable to identify any tributaries to this system. Descriptions for each of the channel segments are included below.

Pysht Ponds Segment 1

Segment 1 is a short (106 m) estuarine channel segment which connects Segment 1a and Segment 2 to the Pysht River. The channel averages approximately 1.5 to 4 m BFW. Gradient is very low, as the tide was observed to flow into Segment 1a and a fair distance up Segment 1, beyond the confluence with Segment 1a. Substrate conditions varied by location and were composed of fines, sand, and gravel depending upon location. No fish were observed within this channel segment.

Pysht Ponds Segment 1a

Pysht Ponds Segment 1a contains the largest (0.35 acres) of three ponds within this pond system. It is connected to the Pysht River through a connection to Segment 1, 34 m upstream from the Pysht River. The perimeter of the pond was surveyed, no tributaries were encountered. No fish were observed utilizing this pond. Cold temperatures, salinity, and large habitat size were thought to play a role in the lack of fish observations. This habitat unit may play an important role for juvenile salmonid rearing during the winter and/or spring. Additional fish utilization surveys are recommended for this entire habitat complex (Segments 1-4), so that an understanding of what role these features play as habitat for rearing juvenile salmonids can be developed.

Pysht Ponds Segment 2

Pysht Ponds Segment 2 contains the second largest (0.12 acres) of three ponds within this pond system. It is connected to the Pysht River through a connection to Segment 1, 106 m upstream from the Pysht River. The perimeter of the pond was surveyed, no tributaries were encountered. No fish were observed utilizing this pond. This habitat unit may play an important role for juvenile salmonid rearing during the winter and/or spring; as the conditions appear quite good (Figure 43). .

Pysht Ponds Segment 3

Segment 3 is a very short (8 m) stream segment connecting the pond in Segment 2 to the pond in Segment 4.

Figure 43. Pysht Ponds Segment 2 looking upstream at Pond 2.

Pysht Ponds Segment 4

Pysht Ponds Segment 4 contains the smallest (0.04 acres) of three ponds within this pond system (Pond 3). The perimeter of the pond was surveyed, no tributaries were encountered. No fish were observed utilizing this pond. This habitat unit may play an important role for juvenile salmonid rearing during the winter and/or spring.

Ring Creek

This left bank tributary crosses the M& R 2000 road and enters the Pysht River at RM 1.31 (see Figure 19). Only one segment was delineated for this stream system. No tributaries were encountered in the stream segment surveyed. Stream gradient ranged from 4 to 10% and increased slightly in the upstream direction. BFW averaged 3.8 m and substrate was mostly gravel with patches of cobble. Downstream of the 2000 Road there is a short 23 m long section of channel containing a bedrock cascade at most tide and river stages. A perched culvert at the top end of this bedrock cascade blocks approximately 170 meters of 4-8% gradient habitat and an additional barrier culvert located 33 meters upstream also prevents fish access. The second perched culvert blocks approximately 100 meters of 4-8% gradient habitat. A large stored sediment wedge is located upstream of this culvert and the stream was dewatered in the zone of stored

sediment during the time period when this stream was surveyed. No fish were observed upstream of the 2000 Road.

Ditch Creek

This is a unique small stream system which has been highly modified by road construction and road maintenance. The actual presence and historic condition of the stream system is unknown. This stream is a LBT to the Pysht River entering at RM 1.36 (see Figure 19). It contains three channel segments and one tributary stream/ditch. The majority of stream flow within this system appears to come from cut-slopes associated with roads and a small forested wetland/spring complex located at the head end of Segment 3. Descriptions for each of the channel segments are included below.

Ditch Creek Segment 1

This segment is a very short (30 m) and acts to connect the ditch network (segment 2) to the Pysht River. The entire terrain has been modified within this drainage by the road system. This segment appears to have been shaped with an excavator. Very small, entrenched associated floodplain is present in this segment. Gradient was measured at 4%, but habitat appears to be fairly low energy. Dominant substrate is sand. High fish use was observed in this segment; all fish observed were juvenile coho.

Ditch Creek Segment 2

Segment 2 is entirely contained within the ditch network. A total of 80 meters of ditch line are contained in this segment. Ditch gradient ranged from 2 to 6%. High numbers of juvenile coho salmon were observed up and downstream of 2000 Road culvert. Seasonal ditch cleaning by road maintenance crews may directly result in fish mortalities. These activities had recently occurred in the system with no regard for fish presence or protection.

Ditch Creek Segment 3

This short channel segment has the potential to provide a small amount of fair to good fish habitat but is currently blocked by a pile of ditch spoils (Figure 44). Fish were observed ~20 meters downstream of blockage. Segment 3 is a 41 meter long forested wetland/spring fed system consisting of low energy off-channel habitat. The landowner was notified of this blockage and it is assumed to have been fixed shortly after being identified.

Ditch Creek_T1

Ditch Creek_T1 is a RBT tributary to Ditch Creek. It enters Ditch Creek 60 meters upstream from the Pysht River. This ditch contained high numbers of fish for the first 50 meters upstream from its confluence with Ditch Creek and fewer fish upstream. The ditch maintains a gradient of 1-2% for 200 meters before reaching a small point of higher ground and begins to flow away from Ditch Creek and towards Shop Creek. During high flows it appears that this ditch system provides access into the large wetland complex associated with Shop Creek. See description for Shop Creek Segment 3 and 4.

Figure 44. Ditch cleaning spoils blocking access to Ditch Creek Segment 3 (photo looking upstream).

Shop Creek

This left bank tributary crosses the M& R 2000 road and enters the Pysht River at RM 1.52, in the vicinity of the original Pysht logging camp (see Figure 19). This tributary has been significantly altered. There were no hill slope tributaries identified entering this system. Flow is sustained through seeps, springs, and wetland outflows. Fish appear to enter the upper portion of the wetland system (upstream of the 2000 Road) from Ditch Creek_T1 to the north during high flows and then try to move downstream becoming stranded. Within the portion of this stream system surveyed there were four channel segments. Descriptions for each of the channel segments are included below.

Shop Creek Segment 1

This is a short channel segment (59 m long) with an average BFW of 0.9 m. There is a moderate step of 0.8 meters just upstream from confluence with Pysht. This section of the Pysht is tidally influenced but this step is still a barrier at most flows and tidal stages

for small fish. This segment suffers from a lack of adequate flow due to an upstream diversion. One juvenile coho observed in this channel segment.

Shop Creek Segment 2

Segment 2 is another short segment. It provides no fish habitat but instead consists of a filled wetland and a culvert which diverts stream flow to an unknown location. There was no clear connection between Segment 1 and 3. Much of this area was filled and re-contoured, as it is now houses a series of outbuildings used for equipment storage and maintenance.

Shop Creek Segment 3

This segment consists of a small forested wetland segment (0.08 acres) bound by the shop infrastructure, the river, and the 2000RD. The length of this habitat unit is 72 meters. Several juvenile coho were observed in this wetland complex. The perimeter of wetland was walked several times and no clear outlet was found. This habitat unit is connected to Segment 4 by a culvert under the 2000 Road.

Shop Creek Segment 4

This segment continues from the upstream end of the 2000 Road culvert to the margins of the wetland. The segment has a core habitat unit mostly accurately described as an open water wetland with an outer ring of forested wetland. No fish were observed in this segment but it was mostly frozen over with ice (55mm thick in spots). This habitat segment appears to be connected to the upper end of Ditch Creek_T1 during high flows.

Section 9_Stream 1

This tributary flows from a large wetland complex on the right bank of the Pysht River and enters the Pysht at RM 1.77 (see Figure 19). A perched culvert forms a total barrier to fish at certain river and tidal stages. There were no hill slope tributaries identified entering this system. Flow is sustained through seeps, springs, and wetland outflows. Within the portion of this stream system surveyed there were two channel segments and one tributary. Descriptions for each of the channel segments are included below.

Section 9_Stream 1 Segment 1

Segment 1 is 305 meters long and is located between the Pysht River and the SR 112 culvert. The channel segment was classified as a regime channel with a gradient < 1%. Substrate was mostly fine sediment. The first 106 meters of channel flow through a recent clearcut, no riparian buffers were left. The channel in this section is covered in a very dense mat of aquatic vegetation. Upstream the stream flows through reprod from clear cutting that occurred 15-20 years ago and the channel is mostly shaded and the aquatic vegetation is more or less absent. There was good off channel habitat throughout this channel segment. Additional off channel habitat provided is provided in a RB

forested wetland complex. LWD appeared to play an important role in providing cover in this shallow stream. High fish use was observed between the clearcut area and SR 112 (in the reprod section).

Section 9_Stream 1 Segment 2

Segment 2 is located upstream of the SR 112 culvert to end of the forested wetland complex. This forested wetland which has recently been clearcut. No riparian buffers were left and the habitat was logged. The habitat consists of multiple threaded, poorly defined channels (Figure 45). Several channels were followed but most were very short (<30 meters) and none of them leave the area which has been recently clearcut. Total habitat area was estimated (using aerial photos) to be 1 acre. Moderate fish use was observed throughout Segment 2.

Figure 45. Example of typical habitat conditions in Section 9_Stream 1 Segment 2 (note juvenile coho observed in most pool habitat examined in clearcut).

Section 9_Stream 1_T1

This system is a 1.1 acre forested wetland complex. This forested wetland appears to have been logged 15-20 years ago without riparian buffers. The wetland had at least two outlet channels which entered Segment 1 of Section 9_Stream 1 (between 139 and 169 m upstream from the Pysht River). No fish were observed in this forested wetland. Conditions were fairly dry when the survey was conducted. Fish are likely to occupy all

or portions of this habitat unit when conditions permit. No tributaries were identified entering this wetland complex.

Cabin Creek

This tributary flows from a large wetland complex on the right bank of the Pysht River, entering at RM 1.82 (see Figure 19). A perched culvert on Farm Road forms a total barrier to fish at certain river and tidal stages. Within the portion of this stream system surveyed there were three channel segments, one large tributary, and one small distributary–tributary system. Descriptions for each of the channel segments are included below.

Cabin Creek Segment 1

Segment 1 is a constructed channel that leads through the M&R headquarters area. Date of channelization is unknown. Gradient is slightly steeper as the stream approaches the mainstem Pysht River but averages less than 1%. This channel was classified as a regime channel but could also be classified as a drainage ditch. There is absolutely nothing that poses an obstacle to fish passage other than the culvert at the confluence with the Pysht. BFW and wetted width average 3 and 2 meters respectively. Total length of segment is 138 meters. Substrate was composed primarily of sand. Low- to moderate-fish use was observed during the survey. Excellent flow conditions throughout this segment.

Cabin Creek Segment 2

Segment 2 was historically a forested wetland complex. The channel was modified and channelized as part of a habitat enhancement project during the summer of 2003. The total length of Segment 2 is 87 meters. BFW averages 2.9 m, BFD averages 0.49 m. The stream connects to Segment 3 via a perched culvert under the 3000W Road. Juvenile coho salmon were observed throughout this segment. The development of a vegetative mat was observed in the upper third of this segment.

Cabin Creek Segment 3

Segment 3 is a vast forested wetland complex with an estimated area of 19.6 acres. Most of this wetland complex contains intact, older forest conditions. However, the north and south portions of this wetland were clearcut with no riparian protection. Skid trails were observed through portions of the north side of the wetland. The perched 3000W Road culvert is believed to limit juvenile fish access to this system. Overall habitat conditions were excellent, consisting of multiple channels with numerous deep pooled areas with ample cover. Logs and blown-down trees appear to form some of the best habitats. Juvenile coho were observed several hundred meters upstream from the 3000W Road culvert.

Cabin Creek_T1

Cabin Creek_T1 is a right bank tributary to Cabin Creek entering at the bottom end of Segment 2 (right at the upstream end of the SR 112 culvert). Within the portion of this stream system surveyed there were two channel segments. Descriptions for each of the channel segments are included below.

Cabin Creek_T1 Segment 1

Segment 1 was historically a forested wetland complex. The channel was modified and channelized as part of a habitat enhancement project during the summer of 2003. Typical habitat/channel conditions are depicted in Figure 46. A recent clearcut is adjacent to the entire length of Segment 1, no riparian buffer was left. This entire segment appears to be a continuation of what was once a very large forested wetland complex which likely included all of Cabin Creek and Section 9_Stream 1. The total length of Segment 1 is 390 meters. This segment was classified as a regime channel. BFW and BFD averaged 3.7 and 0.33 meters respectively. The lower 43 meters of channel flow through the SR 112 ditch line. Segment 1 ends at the 3000W Road culvert. Several small tributaries, which are actually branches of the old wetland complex, were present throughout Segment 3. Juvenile coho were observed throughout this segment.

Figure 46. Typical channel/habitat conditions within Cabin Creek_T1 Segment 1 (photo looking upstream 62m upstream from confluence with Cabin Creek).

Cabin Creek_T1 Segment 2

This channel segment is a ditch. The main reason it is included in this summary is because of the unique nature of the water source which flows out of several piped channels that a part of what appear to be a large mountain beaver colony. No fish were observed upstream of the 3000W Road culvert. Total segment length is 92 m but the majority of the water flowing down the ditch line at the time of the survey was coming from a hole located 88 meters upstream from Segment 1.

Rymer Creek

Rymer Creek is a left bank tributary to the Pysht River entering at RM 2.12 (see Figure 19). This stream drains from a forested, moderately steep subbasin prior to entering the Pysht River floodplain and then flows parallel to the river for about 150 meters prior to crossing the 2100 Road and entering the Pysht. Within the portion of this stream system surveyed there were six channel segments; no tributaries were identified. Descriptions for each of the channel segments are included below. This stream system had very high juvenile coho densities.

Rymer Creek Segment 1

Segment 1 is a very short channel segment (33 m) connecting the forested wetland in Segment 2 to the Pysht River. Access through this segment has recently been enhanced by the installation of a new fish friendly culvert. The culvert bottom was full of stream substrate, as well as of juvenile coho.

Rymer Creek Segment 2

This segment is 127 meters long and contains a mix of forested wetland and open water wetland habitat. Most of the channel length within this segment is multi-thread or open water wetland. The lower 37 meters of channel was a multi-thread forested wetland channel system which transitions into a beautiful pond approximately 30 meters long (Figure 47). Dozens of large juvenile coho were observed in this pond system. The upstream end of the pond transitions back into a multi-thread forested wetland habitat unit. Numerous coho were observed throughout this segment. In areas where the stream maintained a single channel BFW and BFW averaged 1.4 and 0.28 meters respectively.

Figure 47. Looking downstream at pond, Rymer Creek Segment 2.

Rymer Creek Segment 3

Segment 3 was short, only 43 meters long. Segment 3 contained both forested wetland habitat and a ditch. This section of stream paralleled the 2100 Road. The most accessible channel through this segment was the ditch line. Adjacent to the ditch was a nice FW type channel which split into three channels. The majority of the flow was in a left branch distributary which was not connected via surface flow to segment 4 (this is why the ditch was surveyed as the primary channel). Fairly high quantities of aquatic vegetation were observed in the ditch. Several juvenile coho were also observed within the ditch.

Rymer Creek Segment 4

Segment 4 is 97 meters long with an average gradient of 3%. This segment was classified as an alluvial fan. There were significant amounts of sediment deposition along floodplain. Stream banks are very low and the adjacent floodplain is very active. This small alluvial fan appears to be the cause for the old abandoned distributary channels observed in the upper sections of Segment 3. The channel appears to be accessible to juvenile salmonids. A small series of cascades are present in the middle of the segment. However, there is an active overflow channel along the right bank which appears to be passable if the cascades are too difficult for small fish to navigate. BFW and BFD averaged 2.05 and 0.31 meters respectively throughout this segment.

Rymer Creek Segment 5

Segment 5 is 115 meters long with an average gradient of 2-4%. Channel confinement goes from unconfined to confined at the segment 4/5 break. The channel is wider in Segment 5, (2.75 meters) than observed in the lower 4 segments. Bankfull depth is also significantly higher in this segment, averaging 0.95 (evidence of channel incision is also present). High numbers of juvenile coho were observed in the lower two-thirds of this channel segment. Gradient and confinement are in transition through this segment the lowest portion has gradients around 1-2%, while gradient increases to 4% 80 meters upstream. There is an active FP at the bottom of the segment, where as the channel is totally entrenched at the end of the segment. This segment provides both good rearing and spawning habitat.

Rymer Creek Segment 6

Only the lowest portion of Segment 6 was surveyed due to impenetrable blowdown and brush. We used aerial photos and topographic maps to estimate the upper extent of Segment 6. This segment is confined and the stream gradient is 4-8%, total length was estimated to be 365 meters.

Andis Slough

This left bank tributary drains a forested wetland and enters the Pysht on the left bank at RM 2.78 (see Figure 19). Within the portion of this stream system surveyed there were two channel segments and one tributary. The main issues in this system are habitat connectivity and dewatering. Descriptions for each of the channel segments are included below.

Andis Slough Segment 1

Segment 1 is a short segment (73 m) connecting the pond (in Segment 2) to the Pysht River. Gradient averaged between 1-6%. No barriers or obstacles were observed in this channel segment. During high water events in the Pysht a significant portion of this channel segment are backwatered. It is believed that a portion of this channel segment was cleared to enhance fish passage in the past. This segment suffers from a lack of stream flow. It was observed that the Pysht River channel is incised throughout this area and that could play a role in habitat dewatering. However, the relationship between channel incision and the local water table have not been investigated.

Andis Slough Segment 2

Segment 2 is a narrow pond (0.6 acres) and appears to be an old river bend which has long since been abandoned. This segment appears to provide ideal off-channel habitat with the exception of the outlet which appears to occasionally go dry during winter months. This habitat unit has excellent potential. Total length of Segment 2 is 142 meters.

Andis Slough_T1

This stream system drains a small forested wetland complex and is a left bank tributary to Andis Slough entering Segment 2, 15 meters upstream from Segment 1. Within the portion of this stream system surveyed there were two channel segments delineated. The main issues in this system are habitat connectivity and dewatering. Descriptions for each of the channel segments are included below. .

Andis Sough_T1 Segment 1

Segment 1 is 54 meters long and functions as a connector channel between the forested wetland in Segment 2 and Andis Slough Segment 2. Gradient averages 1 to 3% and BFW averages 1.5 meters. The channel has pool-riffle characteristics but was completely dry during the field survey conducted on February 9, 2005. This channel segment appears to provide very limited, if any habitat for fish. Its sole function as habitat is for migration of juvenile salmonids to the wetland habitat in Andis Slough_T1 Segment 2.

Andis Sough_T1 Segment 2

This segment is a small (0.24 acres) forested wetland complex. The lower end (between the 2100 Road and Segment 1) of this segment contains a large, deep pool (~1 m deep). This segment appears to be fairly nice habitat but the quantity of dry channel downstream is somewhat concerning; may form a significant trap for fish. During culvert inventories on March 11, 2005 dead juvenile coho were observed upstream of the 2100 Road culvert. The upper extent of forested wetland habitat was not field verified; it was estimated based on field data and aerial photos for this segment. The field survey extended upstream of the Segment 1 for 105 m, estimated habitat length is 145 m.

Piling Creek

This left bank tributary drains a forested wetland and enters the Pysht on the left bank at RM 3.45 (see Figure 24). There were no hill slope tributaries identified entering this system. Flow is sustained through seeps, springs, and wetland outflows. Within the portion of this stream system surveyed there were three channel segments. Descriptions for each of the channel segments are included below. No fish were observed in this stream system.

Piling Creek Segment 1

This is a short (32 m) step-pool segment with an average gradient of 6%. The segment extends from the confluence with the Pysht River to upstream end of the 2100 Road culvert. Within this segment there are two significant steps that may hinder fish passage at some stream flows, as well as a culvert that acts as a partial or complete juvenile fish barrier. This first step is short (~0.5m) and right at the confluence with the Pysht. The second step is directly upstream 12 meters; this step is between 1 and 1.2 meters high and is associated with a resistant clay deposit. Both steps are inundated by the Pysht River at

high stream flows but at these times the culvert is likely to act as a 100% barrier. There is one short reach of spawnable gravel between the 2100 Road culvert and the Pysht River.

Piling Creek Segment 2

This is a short (45m) low gradient, mud bottom channel segment that connects Segment 1 to the upstream wetland habitat in Segment 3. BFW and BFD averaged 3.35 and 0.35 meters respectively.

Piling Creek Segment 3

The habitat type varies in this segment from forested wetland to open water wetland with small ponds. In total the wetland area was estimated to cover 3.4 acres. The field survey only extended 225 meters up Segment 3; the total length of this habitat unit was estimated to be 333 m (using field notes and aerial photos). In general this segment appears to have excellent habitat potential (Figure 48), but access appears to be the limiting factor affecting fish use.

Figure 48. Example of small pond habitat unit in Piling Creek Segment 3, photo looking upstream 215 meters upstream from the 2100 Road.

Razz Creek

This creek is also known locally as Barn, Reefer, and/or Fridge Creek. Significant channel alterations are thought to have occurred on this system. This is a complex system that includes a large floodplain tributary with several complex tributaries. Razz Creek is approximately 2.0 miles long and originates on hillslopes along the south side of the river (see Figure 24). Within the portion of this stream system surveyed there were eight channel segments and numerous tributaries which also provide high quality habitat for fish, as well as many non-fish bearing tributaries. Descriptions for each of the channel segments are included below. This stream system contains more habitat complexity than any other Pysht River floodplain tributary surveyed.

Razz Creek Segment 1

This segment is 466 meters long and extends from the confluence with the Pysht River, upstream to the SR 112 culvert. Gradient is 1-2% and average BFW is 5.4 meters. This segment is incised and lacks LWD. Banks are steep (near vertical) and eroding in several locations. The stream channel is entirely disconnected from the floodplain. Gravel conditions are poor, with the majority of gravel highly mobile and composed of silt and sandstone. The upper reaches of the segment are straight and this portion of the stream appears to have been channelized. Juvenile coho were observed in limited numbers in this segment.

Razz Creek Segment 2

Segment 2 is a short (155 m) transition reach from a pool-riffle channel to a regime/wetland type channel. LWD and pool conditions are slightly better in Segment 2 than in Segment 1. Spawning gravel conditions appear quite poor in this segment. Juvenile coho were observed in high numbers throughout this channel segment.

Razz Creek Segment 3

This segment was classified as a seasonally flooded open water wetland. This segment is 205 meters long and includes 1.7 acres of fish-bearing wetland habitat. The lower half of the open water wetland is good habitat, with deep pond like features. High fish use was observed throughout the lower half of this segment. The upstream half of this segment is much shallower and infested with an extensive mat of aquatic vegetation. Adult salmon access through this portion is likely marginal unless stream flows are high and the wetland is deeper. This segment ends at a transition into a forested wetland habitat type.

Razz Creek Segment 4

Segment 4 was classified as a fish-bearing forested wetland habitat unit. Total segment length is 324 m; fish-bearing wetland area equals 2.2 acres. This segment includes a dynamic array of channel and wetland habitats. The lower third of the segment is a typical multi-threaded forested wetland complex; the middle third is transitional between a forested wetland and an open water wetland. The upper third is a transitional alluvial

fan-forested wetland. Observed very limited fish use and a lot of recent sediment deposition in the upper third of this segment.

Razz Creek Segment 5

Segment 5 is 256 meters long. It was classified as pool-riffle habitat type. The lower portions of this segment include some of the transitional alluvial fan features described for Segment 4. However, the stream banks are well defined and the associated floodplain contains of fine grained sediment (versus the gravel deposits observed downstream). BFW and BFD averaged 3.0 and 0.5 meters in the lower half of this segment. In the upper half of this segment the channel shows significant signs of channel incision. Bankfull depth (or height to floodplain) in the upper half of this segment averages 2 to 2.5 meters (Figure 49). Juvenile coho were observed in fair numbers throughout the lower two-thirds of this segment.

Figure 49. Razz Creek Segment 5, photo depicting channel incision in the upper half of Segment 5.

Razz Creek Segment 6

This segment is 401 meters long and was classified as a step-pool habitat unit. Stream gradient averages 3 to 6% and the channel is confined. Cobble and boulders are the dominant substrate in this segment. Pockets of spawnable gravel also exist in some locations. No access problems with the exception of the log jam located 1,254 m upstream from highway 112. Small fish may have problems migrating over a cascade located 974 meters (34 meters upstream from the segment break) upstream from SR 112 during some stream flow conditions. This bedrock cascade acts as the upper extend of the channel incision observed downstream in Segment 5. An impassable culvert at the 3500 Road forms the break between segments 6 and 7. Only resident cutthroat trout were observed in this channel segment.

Razz Creek Segment 7

This segment if 135 meters long and was classified as a step-pool habitat unit. Stream gradient averaged 3 to 6% and the channel is confined. Cobble and boulders are the dominant substrate in this segment. Pockets of spawnable gravel also exist in some locations. This segment has an intact large conifer riparian area. The stream has moderate amounts of LWD forming some high quality habitat units. High numbers of cutthroat trout were observed throughout this stream segment. There are two large right bank tributaries that enter in this segment. The segment break is at the confluence with upstream tributary.

Razz Creek Segment 8

We were unable to get access permission to survey the entire length of this segment. This segment is lower gradient (2-3%) in the areas we were able to access. We used topographic data and aerial photos to estimate the length of this segment. Total estimated segment length is 300 m. Historically this section of stream was utilized by spawning coho salmon (Don Hamerquist, personal communication, 2005), but now salmon are not able to migrate upstream past the 3500 Road culvert.

Razz Creek_T1

Razz Creek_T1 is also known locally as Keyes Creek. This tributary enters the lower portions of Razz Creek at RM 0.06 and includes 901 m of low to moderate gradient habitat. It is the largest of several tributaries to Razz Creek. This stream drains from a moderately steep forested subbasin before entering the floodplain the Pysht River. Within the portion of this stream system surveyed there were four channel segments and one large, steep non fish-bearing tributary. Descriptions for each of the channel segments are included below.

Razz Creek_T1 Segment 1

This segment contains a mix of different habitat types; total segment length is 115 m. Gradient was highly variable ranging from 1 to 9%. This stream segment appears to have

been channelized or constructed. From 14 to 29 meters upstream from the confluence with Razz Creek there is a series of cascades which may limit juvenile fish passage. The cascades are formed in a resistant clay deposit. Upstream of the cascades but below the SR 112 culvert the stream channel is straight and appears to have been dug, similar in appearance to a drainage ditch or irrigation canal. Only three salmonids were observed upstream of the cascades and all appeared to be cutthroat trout. The SR 112 culvert is undersized, creating a partial to complete juvenile and adult barrier during fall and winter stream flows. The culvert is incapable of passing the entire stream flow of the creek during peak flow events causing flooding of road way and sending excess stream flow into flat area, potentially trapping fish in the ditch and ephemerally flooded areas.

Razz Creek_T1 Segment 2

Segment 2 is 335 meters long and contains both forested wetland and alluvial fan type habitats. The wetland area is 2.2 acres. The forested wetland complex at the lower end of the segment has some excellent habitat, although cascades and the culvert in Segment 1 may limit juvenile fish passage. The undersized culvert causes water over roadway and may influence upstream sediment deposition. A rather impressive fan has developed in the top half of Segment 2 (Figure 50).

Figure 50. Sediment deposition associated with alluvial fan in the upper half of Razz Creek_T1 Segment 2.

Razz Creek_T1 Segment 3

This segment is 270 meters long and averages 1 to 3% gradient. This channel segment was classified as a forced pool-riffle channel type. BFW and BFD averaged 3.0 and 0.63 meters respectively. Conditions are variable, good floodplain connectivity was observed in the lower half of the segment but then the channel becomes moderately incised and lacks functionally LWD. Most of LWD in the incised portion of the channel is bridging the channel. No fish were observed in this segment. However, spawning coho salmon have been observed in this channel segment in the past.

Razz Creek_T1 Segment 4

This segment is 181 meters long and averages 3 to 8% gradient. The channel segment was classified as a step-pool channel type. The lower portion of the segment is moderately confined but the stream quickly becomes confined as it enters a steep sided canyon. The channel is highly incised in sections; other sections have small, isolated floodplains. Habitat is fairly marginal for salmon production under its current condition, although there is some potential for spawning in small pockets of gravel. The segment ends at a small cascade/falls. There is more habitat upstream of this feature but the floodplain habitat ends at the segment 3/4 break.

Razz Creek_T2

Razz Creek_T2 is a right bank tributary to lower Razz Creek, entering at RM 0.12. This stream system contains 236 m of low gradient habitat. There were no hill slope tributaries identified entering this system. Flow is sustained through seeps, springs, and wetland outflows. Within the portion of this stream system surveyed there were two channel segments. Descriptions for each of the channel segments are included below.

Razz Creek_T2 Segment 1

Segment 1 is 131 meter long and is positioned between Razz Creek and SR 112. This is a very interesting little stream. The first 15 m or so of the channel is typical of many of the small mud bottomed floodplain channels of the Pysht. However, the channel quickly enters a surface/swale of an old stream system (likely the mainstem channel of Razz Creek). Stream flow appears to be sucked into this surface and flow was spotty at several locations. Under high flows this channel is likely much different. A few juvenile coho were found on this surface but the majority of fish (~75-125 juvenile coho) were upstream of this swale in a small section of channel 31 m long. Fish located in the swale area were stranded and likely died as flows continued to decrease after the stream was surveyed. This segment ends at the SR 112 culvert which was classified as a 100% barrier to juvenile salmonids (culvert is perched and set at a 4-5% slope).

Razz Creek_T2 Segment 2

This segment is 103 meters long and consists of a small (0.17 acres) forested wetland. Habitat upstream of the SR 112 culvert consists of very poorly defined channels and only

marginal connectivity at the flows during the survey. This forested wetland channel system then enters the forested wetland associated with Razz Creek_T1 Segment 2 and becomes indistinguishable. Habitat conditions in this segment were rated as marginal. No fish were observed upstream of the SR 112 culvert.

Razz Creek_T3

This stream is a right bank tributary which enters Razz Creek at RM 0.22. This stream system drains a small forested wetland that has been recently logged. There were no hill slope tributaries identified entering this system. Flow is sustained through seeps, springs, and wetland outflows. Within the portion of this stream system surveyed there were two channel segments and one wetland tributary. Descriptions for each of the channel segments are included below.

Razz Creek_T3 Segment 1

Segment 1 is 135 meters long and is positioned between the mainstem of Razz Creek and SR 112. This segment is low gradient (<1%), mud bottomed, and low energy with fair habitat structure. Typical channel conditions are depicted in Figure 51. The channel segment was classified as a regime channel. BFW and BFD averaged 1.7 and 0.28 meters respectively. High densities of juvenile coho were observed throughout this channel segment. A small tributary enters 18 meters upstream from Razz Creek.

Figure 51. Typical channel conditions observed in Razz Creek_T3 Segment 1, photo looking upstream from photo point located 60 m upstream from Razz Creek.

Razz Creek_T3 Segment 2

This segment is 131 meters long and consists of a small (0.78 acres) forested wetland. Habitat upstream of the SR 112 culvert consists of several poorly defined channels, few fish were observed upstream of the SR 112 culvert. This area has recently been clearcut and extensive mats of aquatic vegetation were chocking the upper sections of this forested wetland complex. The head end of forested wetland channel is very close to Razz Creek_T1 Segment 2, there is the potential for Razz Creek_T1 to avulse into the forested wetland complex. They are likely linked hydrologically at this time.

Razz Creek_T3_T1

Razz Creek_T3_T1 is a very small tributary which enters Razz Creek_T3 18 meters upstream from the confluence with the mainstem Razz Creek. This system consists of a very short (5 m) segment which connects the pond habitat in Segment 2 to Razz Creek_T3. The pond habitat in Segment 2 doesn't appear to be spring fed and only receives limited water inputs from rainfall. This makes the connection between Razz Creek T3_T1 and Razz Creek_T3 ephemeral. The pond habitat in Segment 2 is 95 meters long and consists 0.09 acres of open water wetland habitat. This habitat unit appears to be the old mainstem of Razz Creek. Only a few fish were observed in this habitat unit. This pond has the potential to act as a large population sink by trapping juveniles during waning flows.

Razz Creek_T4

This tributary enters Razz Creek upstream of SR 112 at RM 0.31. This stream flows from a moderately confined hillslope across the Pysht River floodplain. The lower reach of this stream contains several small fish-bearing tributaries. This stream system contains the highest number of tributaries and the most diverse habitat of any of the Razz Creek tributaries. Within the portion of this stream system surveyed there were four channel segments, four fish bearing tributaries, and several high gradient non fish-bearing tributaries. Descriptions for each of the channel segments are included below.

Razz Creek_T4 Segment 1

Segment 1 is 273 m long and averages 1 to 2% gradient. The channel segment was classified as a pool-riffle channel type. There are highly variable habitat conditions in this segment. The lower section of Segment 1 is fairly low energy below the Reefer Creek Road bridge. Upstream of the bridge there is evidence of incision and disconnection from what is believed to have once an associated forested wetland. This area appears to have been logged approximately 12-15 years ago. A small riparian area was left along the stream but the adjacent forested wetland was logged (see Razz Creek_T4_T4). Stream conditions were very brushy, with lots of blowdown and the channel was impossible to survey above bridge. Survey was abandoned 173 meters

upstream from Razz Creek and restarted upstream. Several juvenile coho were observed in this segment.

Razz Creek_T4 Segment 2

This segment is 80 m long and averages 1 to 2% gradient. The channel segment was classified as an alluvial fan. The lower end of the segment descends into the incised portion of Segment 1. The upper end of the segment emerges from the steeper, confined segments upstream. The fan is roughly 12 to 15 meters wide and lacks a well defined channel (Figure 52) and may act as a partial migration barrier to adult and juvenile salmonids.

Figure 52. Alluvial fan in Segment 2 of Razz Creek_T4, photo looking upstream.

Razz Creek_T4 Segment 3

This segment is 165 meters long and is a transitional zone between lower gradient forced-pool riffle habitat and step pool habitat. The gradient within this segment averaged 2-5% and confinement was classified as moderate. BFW and BFD average 1.9 and 0.49 meters respectively. Habitat features appeared fairly stable in the lower half of the segment, upstream the channel steepened. Some fair spawning areas but no evidence of recent spawning. No salmonids were observed upstream of the alluvial fan.

Razz Creek_T4 Segment 4

This segment is very short, only 41 meters. Gradient is steep, averaging 8 to 14%. Habitat was classified as cascade and forced step-pool. The survey ended at a large left bank tributary which was close to equal the size of the mainstem. Fish habitat appears to continue beyond this point but the end of Pysht River floodplain habitat occurred at the end of Segment 2 so the survey was ended.

Razz Creek_T4_T1

Razz Creek_T4_T1 is a very small tributary which enters Razz Creek_T4 4 meters upstream from the confluence with the mainstem Razz Creek. This system consists of a very short (10 m) segment (Segment 1) which connects the upstream forested wetland habitat (Segment 2) to Razz Creek_T4. The total length of the stream system is 60 meters. There is an estimated 0.03 acres of forested wetland habitat in Segment 2. The forested wetland habitat is shallow (<0.1m), and mostly consists of sheet flow with a few deeper pockets of water where trees have blown over, in general this is fairly marginal habitat but totally accessible to juvenile fish. This habitat may function better as spring habitat for emergent coho fry, than for larger over-wintering juvenile coho. No fish were observed within this stream system.

Razz Creek_T4_T2

Razz Creek_T4_T2 is a very small associated forested wetland tributary which enters Razz Creek_T4 24 meters upstream from the confluence with the mainstem Razz Creek. This system consists of a very short forested wetland habitat that lies between the Razz Creek_T4 and Reefer Creek Road. The forested wetland habitat is shallow (<0.1m), and mostly consists of sheet flow with a few deeper pockets of water where trees have blown over, in general this is fairly marginal habitat but totally accessible to juvenile fish. This habitat may function better as spring habitat for emergent coho fry, than for larger over-wintering juvenile coho. No fish were observed within this stream system.

Razz Creek_T4_T3

This stream is a right bank tributary which enters Razz Creek_T4 36 meters upstream from Razz Creek. This stream system drains a forested wetland that has been recently clearcut. There were no hill slope tributaries identified entering this system. Flow is sustained through seeps, springs, and wetland outflows. Within the portion of this stream system surveyed there were two channel segments delineated. Descriptions for each of the channel segments are included below.

Razz Creek_T4_T3 Segment 1

This is a short (35 m) channel segment which connects the forested wetland in Segment 2 to the mainstem of Razz Creek_T4. This channel segment is a low gradient (~2%), low energy, pool-riffle channel type. BFW and BFD averaged 0.95 and 0.17 meters

respectively. The segment is positioned between Razz Creek_T4 and Reefer Creek Road. The Reefer Creek culvert is set at 4-5% gradient and is a partial barrier but it is likely to become a complete barrier in the near future as it continues to degrade (culvert bottom is almost entirely rusted out). Numerous juvenile coho were observed in this segment.

Razz Creek_T4_T3 Segment 2

This segment is 276 meters long and consists of 0.52 acres of high quality forested wetland habitat. This area has recently been clearcut, no riparian areas were left and it appears that no strategies to protect fish or fish habitat were implemented during timber harvest. Forested wetland channels are totally accessible to the end of survey. Fairly high numbers of fish observed in this clearcut area. Every deep spot in the wetland was holding fish, appears to be fairly high quality habitat based upon the number of juvenile coho observed.

Razz Creek_T4_T4

This system is a left bank tributary to Razz Creek_T4. This system is a forested wetland approximately 80 m long containing 0.32 acres of potential habitat. Four outlets feeding Razz Creek_T4 were identified but all appeared to provide marginal access for juvenile fish. Channel incision appeared to play a role in the poor connection between the wetland habitat and the mainstem. This forested wetland was clearcut 12-15 years ago, no riparian buffers were left. The wetland habitat was shallow in most areas, with little if any channelized flow. This system appears to only provide marginal if any habitat value at this time.

Razz Creek_T5

This stream enters the Pysht River floodplain from moderately steep hillslopes on the south side of the valley. Within the portion of this stream system surveyed there were three channel segments delineated. Descriptions for each of the channel segments are included below. No fish were observed in this stream system.

Razz Creek_T5 Segment 1

Segment 1 is 233 meters long and is classified as an alluvial fan. This segment consists of a complex alluvial fan system; several old channel confluences with Razz Creek were identified. The primary field survey was conducted on what appeared to be the only distributary system that had a partial connection with some of the upstream habitat and Razz Creek. This connection had flowing water for the first 40 meters, 46 m upstream from Razz Creek we identified the end of a the defined channel. A deep (0.8 m) scour pool was located 24 meters upstream from the last flowing water. However, there was no clear connection between this point and any channel upstream. Significant quantities of newly deposited sediment were identified just upstream of the scour pool but there was no defined channel. A lower end of a defined channel was located at the upper end of the sediment deposition described above. This channel remained defined for approximately 120 m. Flow was isolated to a few short reaches and pools. At a distance 212 meters

upstream from Razz Creek the defined channel ended. At a distance of 220 meter upstream from Razz Creek we identified a point of channel avulsion. The new channel was followed downstream but the channel fanned out and no water or connection to Razz Creek could be located. The segment 1/2 break was located 13 meters upstream of the point of channel avulsion where the channel became well defined.

Razz Creek_T5 Segment 2

This segment is 179 meters long and maintains a gradient of approximately 2%. BFW and BFD averaged 2.4 and 0.61 meters respectively. An impassable culvert is located 20 meters upstream from the segment 1/2 break. The channel upstream of the culvert was downcutting and significant erosion along the right bank was observed.

Razz Creek_T5 Segment 3

This segment is 120 meters long and averages 3 to 6% gradient. The habitat unit was classified as a step-pool channel. The dominant substrate in this segment is cobble. The survey ended prior to defining the end of the channel segment due to the lack of access found downstream. The stream appeared to maintain a gradient of 6% upstream of the end of survey.

Razz Creek_T6

This stream enters the Pysht River floodplain from moderately steep hillslopes on the south side of the valley. The only portion of this stream system surveyed was classified as an alluvial fan. It is believed that this fan complex that has recently changed significantly. The old channel that enters the mainstem of Razz Creek has been abandoned. This old channel system was surveyed by Chris Northcutt on April 27, 2004 as part M&R pre-timber harvest stream typing protocol. This same channel appears to be completely void of stream flow and a new channel enters Razz Creek slightly downstream. Access to this stream system during our survey was quite poor; it is assumed that a better connection to Razz Creek will begin to develop in the near future.

2100 Road Swamp

This left bank tributary is almost entirely wetland and open water pond type habitat (except for the connection to the mainstem) and enters the Pysht River on the left bank at RM 4.11 (see Figure 24). There were no hill slope tributaries identified entering this system. Flow is sustained through seeps, springs, and wetland outflows. Within the portion of this stream system surveyed there were three channel segments identified. Descriptions for each of the channel segments are included below.

2100 Road Swamp Segment 1

This is a short channel segment (75 m) which connects the upstream wetland habitat to the mainstem Pysht River. The outlet of this channel, at the confluence with the Pysht

was clogged with debris when the field survey was conducted. The channel upstream of the clogged outlet was mostly dry. One small wetted pool was located 27 meters upstream from the Pysht River; there was one stranded juvenile coho in this pool. Gradient averages 1 to 2% in this segment and the channel is entirely accessible when water is present.

2100 Road Swamp Segment 2

This segment is a narrow open water wetland habitat. Total length of this segment is 170 meters; fish-bearing wetland area was estimated at 0.81 acres. When scouted in early February this area was full of water, and even had good numbers of waterfowl swimming about. However, it was dry when it was surveyed in mid-February. Several dead fish were found along with several stranded fish. Bird sign throughout the wetland provide evidence that a significant fish kill occurred here in mid-February. If conditions such as those that occurred during the winter of 2004/05 continue to occur in the future this habitat unit has the potential to result in the mortality of thousands of juvenile coho. The entire area around Segment 2 and the forested wetland portion connecting Segments 2 and 3 was clearcut approximately 15 years ago without leaving riparian buffers.

2100 Road Swamp Segment 3

This segment was segregated from Segment 2 because of the deep pond habitat that exists in this segment (see Figure 31). The total length of fish habitat was difficult to calculate because of the lack of understanding of what portion of the wetland floods during winter. During our surveys habitat extended at least 200 meters from Segment 2/3 break and occupied an area of 7.1 acres. However, this wetland extends several hundred meters beyond this point and is between 12 and 15 acres in size. It appears that Lost Creek may have historically fed this wetland complex but it now diverted down the 2100 Road ditch line and no longer has a connection to this habitat complex.

4500 Road Swamp

This system contains a large wetland and open water pond complex that enters the Pysht River on the right bank at RM 4.49 (see Figure 24). A perched culvert on SR 112 is a 100% barrier to all fish species prohibiting access to a 2.4 acre high quality wetland complex. This habitat unit has a total length of 420 meters. There were no tributaries identified flowing into this wetland system. To provide adequate fish passage a new channel would need to be dug to allow adequate flow for fish passage during normal fall/winter flow conditions. The entire area around the north side of this habitat unit was clearcut without riparian protection about 5 years ago. The forested wetland habitat at the upstream end of this habitat unit was also clearcut.

Lost Creek

This stream drains from a moderately steep forested subbasin before entering the floodplain the Pysht River. This stream currently enters the Pysht River along the left

bank at RM 4.85 (see Figure 24). It is thought that Lost Creek may have been connected to the 2100 Road Swamp in the past. It currently is diverted down the 2100 Road ditch line where significant erosion and sediment delivery has occurred (Figure 53). Lost Creek's connection with the Pysht River currently does not provide fish access and no fish were documented in the system but resident fish use may occur upstream of the areas surveyed. Within the portion of this stream system surveyed there were two channel segments identified. A standard survey was not conducted in this stream due to the lack of connectivity with the Pysht River at the time the survey was conducted. Segment 1 is an alluvial fan which has been diverted down the 2100 Road ditch. This historic course of this stream is unknown. It is highly possible that this fan system was once connected with the 2100 Road Swamp complex. Segment 2 extends upstream from the 2100 Road at a gradient of 2 to 4%. There is only limited potential habitat for salmon in this segment.

Figure 53. Lost Creek looking upstream at channel diverted by the 2100 Road ditch (noted that ditch is aggraded with sediment and stream was recently flowing across the road).

Lee Creek

This is a complex system that includes a large floodplain tributary with several complex tributaries. Lee Creek is approximately 1.5 miles long and originates on hillslopes along the north side of the river and descends onto the valley bottom and meanders extensively

before entering the Pysht River along the right bank at RM 4.93 (see Figure 24). This stream system has been altered and rerouted on several occasions and its historic course and nature are unknown. Within the portion of this stream system surveyed there were six channel segments and five tributaries which also provide high quality habitat for fish. Descriptions for each of the channel segments are included below.

Lee Creek Segment 1

Segment 1 of Lee Creek is 175 meters long and low gradient (>1%). The lower half of the segment is incised as it cuts through the floodplain of the Pysht River. The Pysht River backwaters the lower half of Segment 1 during high water events. No juvenile salmonids observed in this segment in spite of intensive survey effort. The segment ends at a constructed pond 175 meters from the confluence with the Pysht River.

Lee Creek Segment 2

This segment is 45 meter long and is classified as a pond. This pond was constructed in the 1990s by M&R. The pond is deep (>1 m) and appears to provide ideal pond habitat (Figure 54). The perimeter of the pond was surveyed along the left bank, no fish were observed. A smolt trap was operated during the spring of 2000 downstream of this pond and 3,742 coho smolts were captured leaving Segment 2 (Elwha Fisheries, Unpublished smolt trap data).

Figure 54. Lee Creek Segment 2, photo looking upstream at pond habitat.

Lee Creek Segment 3

This segment is 413 meters long and maintains a gradient of less than 1%. This channel segment was classified as a pool-riffle channel type. BFW and BFD averaged 2.7 and 0.52 meters respectively. Habitat conditions are mixed throughout this segment. Substrate in the lower half was composed primarily of fines; the upper half was mostly gravel. This channel segment appears to be modified; as it runs parallel to the railroad grade for several hundred meters. Several nice off-channel habitats enter in this segment. Juvenile coho were only observed in the upper half of this segment and in a side channel 143 meters upstream from the pond.

Lee Creek Segment 4

We were unable to obtain permission from the landowner to survey this channel segment. We used aerial photos, topographic data, and past experience within this stream system to classify and delineate the habitat type and length for this segment. It was estimated that this segment contained 457 meters of wetland habitat, encompassing 0.8 acres of habitat. Almost the entire length is directly adjacent to an unnamed road which appears to be the old railroad grade on aerial photos. A habitat restoration project was conducted on the upper portion of this segment in the late-1990s by the Clallam County Conservation District.

Lee Creek Segment 5

We were unable to obtain permission from the landowner to survey this channel segment. We used aerial photos, topographic data, and past experience within this stream system to classify and delineate the habitat type and length for this segment. It was estimated that this segment contained 376 meters of pool-riffle habitat. A habitat restoration project was conducted on this segment in the late-1990s by the Clallam County Conservation District.

Lee Creek Segment 6

We were unable to obtain permission from the landowner to survey this channel segment. We used aerial photos, topographic data, and past experience within this stream system to classify and delineate the habitat type and length for this segment. It was estimated that 163 meters of 4-8% step-pool habitat exists in this channel segment.

Lee Creek_T1

Lee Creek_T1 is a left bank tributary to lower Lee Creek, entering at RM 0.07. There were no hill slope tributaries identified entering this system. Flow is sustained through seeps and/or springs. This stream system contains 50 m of forested wetland habitat, encompassing 0.14 acres. The connection with Lee Creek is poor. The lower few meters of this system are steep but appear accessible. The connecting channel reach was dry

during our survey making it difficult to judge the potential of the upstream habitat. No fish were observed but there was a lot of ice covering the wetland making it difficult to see fish.

Lee Creek_T2

A complete field survey was not conducted in this stream system. We used aerial photos, and topographic data within this stream system to classify and delineate the habitat type and length. It is estimated that there are 75 meters of forested wetland habitat covering approximately 0.48 acres. This system was open and accessible at the confluence with Lee Creek.

Lee Creek_T3

This system contains a relatively large forested wetland complex. The entire area was surveyed but the habitat was fairly complex and it was difficult to implement our standard survey methods in this system. This wetland has at least three outlets; one enters Lee Creek in Segment 2 and flows over a steep pile of spoils (presumably from the pond construction) into the pond. Access appears marginal through this outlet. The second outlet enters Lee Creek at RM 0.18 (74 m upstream of the segment 2/3 break). The total length of habitat available for fish was estimated to be 330 meters. The third outlet was classified as Lee Creek_T5 (see below). The area of the wetland was estimated from aerial photos to be 3.6 acres. Fish were only observed in the lower 100 meters of this forested wetland. This entire forested wetland was clearcut 12-15 years with no riparian protection. Extensive mats of aquatic vegetation have filled large portions of this habitat unit.

Lee Creek_T4

Lee Creek_T4 is a right bank tributary to lower Lee Creek, entering at RM 0.14. There were no hill slope tributaries identified entering this system. Flow is sustained through seeps and/or springs. This stream system contains 410 m of forested wetland habitat and is bound by SR 112 and Lee Creek. The area of the fish-bearing wetland was not measured due to difficulties determining habitat connectivity. The connection with Lee Creek is through a small cut in the railroad grade just upstream from the pond in Lee Creek Segment 2. The lower section of the channel had extremely high fish use in areas where there was complete canopy cover (this area was completely clearcut in the past 10 years). The system appears to have been severely disturbed; some of the channels appear to be old skid trails, now heavily utilized by elk (Figure 55). Clearcut timber harvest appears to have increased the quantity of aquatic vegetation in this channel system potentially reducing its utilization by juvenile salmonids (Figure 56). Juvenile coho were observed as far as 255 meters upstream from Lee Creek. Water levels were very low during the time period this habitat unit was surveyed (31 days after the last significant rainfall event).

Figure 55. Lee Creek_T4 380 meters upstream from confluence with Lee Creek (note: fish habitat in this area appears to be little more than a muddy game trail).

Figure 56. Lee Creek_T4 123 m upstream from Lee Creek, photo looking upstream at channel choked with aquatic vegetation.

Lee Creek_T5

This stream system is actually another outlet of the Lee Creek_T3 wetland complex. This stream is 40 meters long and provides forested wetland type habitat. Several juvenile coho were observed in the lower portions of the stream. The channel enters Lee Creek along the left bank at RM 0.23.

Lee Creek_T6

This is a wetland located approximately 100 to 150 meters south of the Lee Creek Segment 4/5 break. No formal surveys were conducted in this habitat unit. It is currently not connected to Lee Creek, but may have historically been part of the Lee Creek wetland complex. It is recommended that a profile be run from this wetland to Lee Creek to determine whether there is a potential to connect or re-connect this wetland with the mainstem of Lee Creek.

Hamerquist Creek

Hamerquist Creek is also known locally as Bradley Creek. Hamerquist Creek is approximately 1.1 miles long and originates on hillslopes along the west side of the river and descends onto the valley bottom and fans out prior to entering the Pysht River along the left bank at RM 6.6 (see Figure 32). This is a complex system that includes a large floodplain tributary and two high fish use floodplain tributaries. This stream system has been altered and rerouted. Within the portion of this stream system surveyed there were four channel segments and two tributaries which also provide high quality habitat for fish, as well as one high gradient fish stream and one high gradient non fish bearing tributary. Descriptions for each of the channel segments are included below.

Hamerquist Creek Segment 0

This is a short segment between the SR 112 culvert and the Pysht River. High fish use was observed throughout the winter at the downstream end of this culvert. During moderate and high water events this entire segment is inundated by the Pysht River.

Hamerquist Creek Segment 1

This segment is 243 meters long and is classified as a forested wetland/alluvial fan. The vast majority of this segment is backwatered during high water events in the Pysht River. The SR 112 culvert is small (0.78 m diameter) and significant flow from the Pysht River enters into this stream segment. There are also large quantities of water and sediment that are transported down Hamerquist Creek during high water events. This creates a problem with both flooding and sediment deposition. SR 112 parallels a portion of Segment 1 and acts as a dike, which further aggravates flooding and sediment deposition. Excess sediment storage upstream of the SR 112 culvert has resulted in poor habitat connectivity between Hamerquist Creek and Hamerquist Creek_T2. High fish use was observed throughout this segment when the survey was conducted. This area was

clearcut 10 to 15 years ago, a riparian buffer was left adjacent to the mainstem but the channel avulsed and now flows through a young patch of alder reprod.

Hamerquist Creek Segment 2

Segment 2 is 342 meters long and is classified as a forced pool-riffle channel type. Gradient averages 2 to 3% and confinement was classified as moderate. BFW and BFD averaged 5.0 and 0.56 meters respectively. Loss of LWD in this segment has increased sediment transport capacity and decreased habitat complexity, sediment storage, and floodplain connectivity. Alterations to sediment storage and transport have likely affected the downstream aggradation problem. This segment provides habitat for spawning coho and steelhead. Substrate conditions are dominated by glacially derived gravel and cobble. Habitat and floodplain conditions in this segment could be enhanced with the addition of stable LWD. This segment ends at the confluence with a large left bank tributary.

Hamerquist Creek Segment 3

Only the lower 200 meters of this segment were surveyed. We used aerial photos, topographic data, and past experience within this stream system to classify and delineate the habitat type and length for this segment. It was estimated that this segment contained 1,130 meters of step-pool habitat. Habitat conditions in the section of this stream segment surveyed were quite good. Large logs are numerous throughout this stream. BFW averaged 7.3 meters and gradient ranged from 3 to 6% in the lower 200 meters of this segment. Spawnable gravel was present in high quantities for a stream of this size and gradient. Moderate numbers of juvenile coho were also observed in this channel segment. One high gradient non-fish bearing stream was also identified in the lower 200 meters of this channel segment.

Hamerquist Creek_LBDT1

Hamerquist Creek_LBDT1 is a left bank distributary which splits off the mainstem 230 meters upstream in Segment 1. This channel system is a relic mainstem Hamerquist Creek channel which has almost entirely filled in with gravel and cobble. This channel system reenters Hamerquist Creek 80 m upstream from the SR 112 culvert. The upper 35 meters of this channel were dry, downstream flow was discontinuous. Approximately 98 meters downstream from the where this channel branches off of the mainstem it splits into an array of channels, the lower sections of a few of these distributaries contained rearing juvenile coho.

Hamerquist Creek_T1

Hamerquist Creek_T1 is a left bank tributary to Hamerquist Creek which enters just upstream of the SR 112 culvert. Hamerquist Creek_T1 appears to be an even older relic channel of Hamerquist Creek (than Hamerquist Creek_LBDT1). A total of 124 meters of low gradient forested wetland habitat were surveyed within this stream system. This

stream appears to provide some excellent off-channel habitat for juvenile coho (Figure 57). Fish habitat extends to the end of survey. At this point the stream comes to within a few meters of Hamerquist Creek_LBDT1.

Figure 57. Example of high quality forested wetland habitat in Hamerquist Creek_T1.

Hamerquist Creek_T2

Hamerquist Creek_T2 is a right bank tributary to lower Hamerquist Creek, entering at RM 0.11 (170 meters upstream from the SR 112 culvert). There were no hill slope tributaries identified entering this system. Flow is sustained through seeps, springs, and/or wetland outflows. Within the portion of this stream system surveyed there were two channel segments and one wetland tributary. Descriptions for each of the channel segments are included below. This stream system appears to be one of the main over-wintering habitats in the Hamerquist Creek complex and is considered highly productive.

Hamerquist Creek_T2 Segment 1

This segment is short (53 m) and includes only the section of this stream which has been routed down the SR 112 ditch line. This channel segment has a poor connection with the mainstem of Hamerquist Creek. Excess sediment aggradation in Hamerquist Creek has resulted in the ditch being lower in elevation than the mainstem of Hamerquist. As flows

lower, the connection between these two streams dries up and fish become stranded (see Section 4.2.2.19). A large portion of the ditch is choked with aquatic vegetation reducing its quality as habitat. There is also a cross-drain culvert that diverts some flow across the road during high water events that may also pass juvenile fish across the road and onto the forest floor with no hope to reach the river or another stream connected to the river.

Hamerquist Creek_T2 Segment 2

This channel segment is 142 meters long. This channel segment is a low gradient (<1%), low energy, regime/forested wetland channel type. BFW and BFD averaged 2.6 and 0.23 meters respectively. Very high numbers of juvenile coho were observed in this segment. An unnamed road crosses this segment 50 m upstream from the segment 1/2 break. This culvert was classified as 100% passable. A small left bank tributary enters upstream of the culvert. The upper portion of this channel segment gradually transitions into a forested wetland.

Hamerquist Creek_T2 Segment 3

This segment is 180 meters long and consists of a broad, fish-bearing forested wetland habitat. The entire area was surveyed but the habitat was fairly complex and it was difficult to implement our standard survey methods in this segment. This wetland has a surface area of approximately 0.8 acres. Connectivity between the poorly defined channels of this wetland habitat was difficult to determine under the low flow conditions that were occurring at the time of the field survey. However, it looks like during normal winter time flow conditions the entire wetland area is accessible to juvenile coho. Fish were only observed in the lower 7 meters of this segment. A small section of this wetland was recently logged but the majority of this segment was in a stand of large second growth alder and spruce.

Hamerquist Creek_T2_T1

This is a small left bank tributary to Hamerquist Creek_T2 that enters 136 meters upstream from the confluence with the mainstem of Hamerquist Creek (19 meters upstream from the culvert crossing the unnamed road). There were no hill slope tributaries identified entering this system; stream flow is maintained through seeps and/or springs. This stream system contains 35 m of low gradient habitat. The connection with the mainstem was dry at the time of the survey; no fish were observed in this stream. This stream appears to be yet another relic mainstem Hamerquist Creek channel. There is a small amount of potential habitat within this system.

Michelena Creek

We were unable to obtain permission from the landowner to survey this habitat complex. We used aerial photos, topographic data, and past experience within this stream system to classify and delineate the habitat types and lengths for this stream. Michelena Creek drains a large forested wetland (11.7 acres) that has been recently logged. It is a left bank

tributary that enters the Pysht at RM 6.96 (see Figure 32). Michelena Creek was divided into two habitat segments. Segment 1 consists of a low gradient channel connecting the forested wetland to the Pysht River. Within this segment the SR 112 culvert is perched 0.5 meters and set at a 1-2% gradient; the culvert acts as a 100% barrier to all fish species. Downstream of the SR 112 culvert there is a box culvert or other feature that may limit fish passage- this feature should be further investigated. There is an additional culvert upstream which is categorized as 100% passable in the WDFW culvert database. The entire length of this segment is either modified or within a culvert. Segment 2 is the large forested wetland, as described above this entire area has recently been clearcut. Nonetheless, there is significant habitat potential within this wetland complex.

25 Mile Creek

This creek drains a small forested wetland that has been recently logged. It is a left bank tributary that enters the Pysht River at RM 7.15 (see Figure 36). The SR 112 culvert is perched 1.7 meters and acts as a 100% barrier to all fish species, prohibiting access to a small wetland complex between Michelena Creek and SR 112. The 25 Mile Creek wetland appears to be connected to the wetland drained by Michelllena Creek; although access limitations prohibited field verification. Replacing the culvert may prove highly difficult because of the close proximity to the mainstem Pysht River.

Trailer Creek

Trailer Creek is also known locally as Mossyrock Creek. Trailer Creek is 1.4 miles long and originates on hillslopes along the northwest side of the river and descends onto the valley bottom, eventually entering the left bank of the Pysht River at RM 7.28 (see Figure 36). We were unable to obtain permission from the landowner to survey this habitat complex. We used aerial photos, topographic data, and past experience within this stream system to classify and delineate the habitat types and lengths for this stream. Trailer Creek was divided into two habitat segments. Segment 1 consists of a low gradient pool-riffle channel which contains excellent spawning gravels. This segment is 1,128 meters long and flows across a relatively broad expansive flat prior to climbing the low hills bounding the Pysht River valley. Coho spawning ground surveys are conducted annual in this segment and have averaged 46 coho redds/mile from 1998 to 2004 (Elwha Fisheries, unpublished spawning ground survey data). Segment 2 is a moderate gradient step-pool segment which extends upstream from Segment 1 for 366 meters. For more information on this stream system see Section 4.2.2.22.

Goat Creek

Goat Creek drains a small forested wetland between SR 112 and Trailer Creek. Goat Creek is a left bank tributary to the Pysht River entering at RM 7.38 (see Figure 36). This wetland habitat has been recently logged; no riparian protection was provided during this activity. We were unable to obtain permission to survey this entire habitat complex. The lower portion of this forested wetland lacks a defined channel and near the confluence the wetland splits into several subterranean tunnels which plunge into the

Pysht River. No fish were observed in this system. It is unclear whether fish currently use this habitat complex but the poor connection to the river appears to be a temporary problem which has the potential to change in the future. In 1951 the left bank of the Pysht River was approximately 80 meter further east. Bank erosion and channel migration have shortened the length of habitat within the system and appear to have played a significant role in decreasing the quality of the connection to the Pysht River.

Gregory Creek

Gregory Creek drains a small forested wetland between SR 112 and the hillslopes which define the western boundary of the Pysht valley (see Figure 36). We were unable to obtain permission to survey this entire habitat complex. Our survey was almost entirely conducted from SR 112 downstream. It was estimated that there is a total of 518 meters of low gradient forested wetland/regime habitat in this system. Downstream of SR 112 the stream parallels Pysht River for about 50 meters in a wall based type channel (in the 1951 aerial photos this area appears to have been a pasture). This was the only area with active beaver dam construction found in the watershed. No fish were observed in a small stretch surveyed upstream of the SR 112 culvert. The culvert appears passable to fish but riprap downstream of the culvert may act as a partial barrier under high flow conditions. Juvenile coho have been observed upstream of culvert during other years. There is a considerable amount of high quality habitat upstream of the culvert. A review of the 2003 aerial photos revealed another culvert 150 m upstream from the highway that may hinder fish passage. Upstream of this unnamed road the channel appears to have been rerouted and ditched.

4800 Road Creek

This system enters the left bank of the Pysht at RM 8.06 (see Figure 36) and includes both low gradient stream habitat (below SR112) and a large wetland complex (above SR 112). There were no hill slope tributaries identified entering this system. Flow is sustained through seeps, springs, and wetland outflows. Within the portion of this stream system surveyed there were two channel segments. Descriptions for each of the channel segments are included below.

4800 Road Creek Segment 1

This is a short (77 m) forested wetland/regime habitat segment with an average gradient of ~1%. The segment extends for the confluence with the Pysht River to the upstream end of the SR 112 culvert. This segment contains excellent off-channel rearing habitat (Figure 58). During our survey were observed hundreds of juvenile coho within this segment. The SR 112 culvert is perched 0.11 meters and set at a 3-4% gradient; the culvert was classified as a 100% barrier to juvenile salmonids. The culvert outlet pool was examined on several occasions and each time 40-100 juvenile coho were present, further suggesting that the culvert is a barrier to juvenile coho migration.

Figure 58. Example of high quality off-channel habitat in 4800 Road Creek Segment 1.

4800 Road Creek Segment 2

This segment is a large (2.9 acres) forested wetland that extends 332 meters upstream from the SR 112 culvert. The entire system was surveyed but the habitat was fairly complex and it was difficult to implement our standard survey methods in this wetland. The majority of this forested wetland was clearcut in the late-1980s with only a small stand of alder left in the middle and upper sections of the deepest portions of the wetland. No coho and only one cutthroat trout were observed in this segment. This segment contains excellent off-channel rearing habitat potential but appears to be unutilized at this time due to the SR 112 culvert.

Wall Creek 1

This stream system is a small wall-based off channel habitat which enters the Pysht River along the right bank at RM 8.17 (see Figure 36). Streamflow is sustained primarily by two small, high gradient streams. The upstream most tributary enters the main channel 60 meters upstream from the confluence with the Pysht. Moderate to high fish use observed in this habitat segment. Most of the channel is full of vegetation, primarily grass (Figure 59). The 1951 aerial photos show that this was the right bank of the

mainstem Pysht River in 1951. The river appears to have migrated approximately 35 meters to the north and abandoned this channel in the last 50 years.

Figure 59. Wall Creek 1 looking upstream 44 meters from confluence with Pysht River, note extensive infestation of reed canary grass.

Burnt Creek One

This left bank tributary drains a forested subbasin prior to descending a short, steep, bedrock canyon reach and entering the floodplain of the Pysht River. The stream enters the Pysht River at RM 9.5 (see Figure 36). Within the portion of this stream system surveyed there were three channel segments. Descriptions for each of the channel segments are included below.

Burnt Creek One Segment 1

This is a short (111 m) low gradient (2%) forced pool-riffle channel segment. The first 15 meters of this segment are steep where it joins the Pysht River. Upstream the channel gradient flattens out, as the stream meanders across a terrace. BFW and BFW averaged 2.9 and 0.68 meters respectively. There are some nice spawning gravels present within this stream segment.

Burnt Creek One Segment 2

This segment is 163 meters long and moderate to high gradient, ranging from 5-12%. This segment contains a mix of step-pool and cascade habitats. Two 64 m long culverts set at a 5% slope are located 26 meters upstream from the segment break. These culverts were classified as 99% barriers to adult salmonids and 100% barriers to juvenile salmonids. Upstream of the culverts stream gradient increases and averages 9-12% slope for 37 meters. This short, confined, bedrock cascade reach may pose migration difficulties to salmonids (Figure 60). At the end of this short cascade reach there is another culvert (801 Road) that poses fish passage problems.

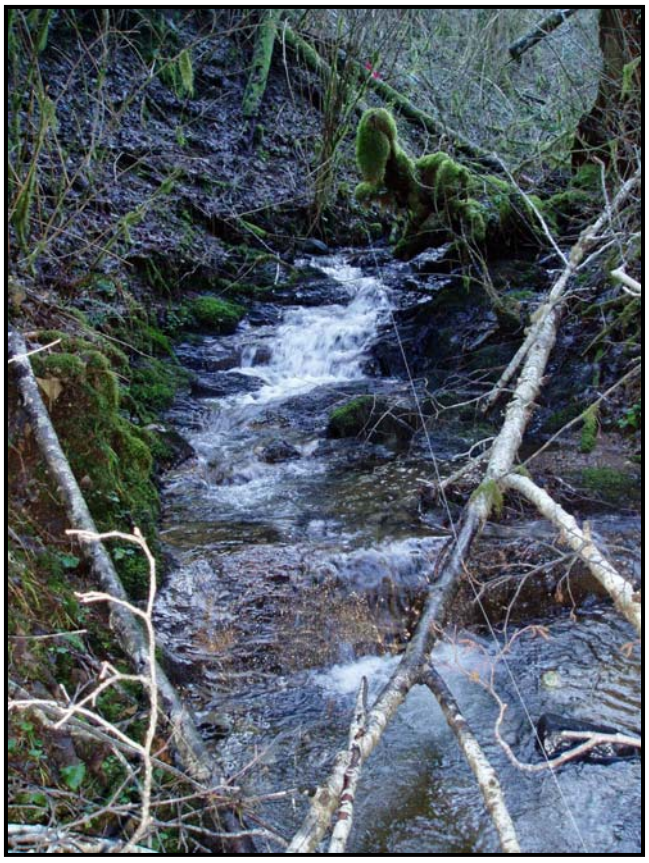

Figure 60. Burnt Creek 1 Segment 2, looking upstream at cascades.

Burnt Creek One Segment 3

Only the lower portion of this segment could be surveyed due to impenetrable brush and blowdown. The segment length was estimated to be 342 meters long. The channel is low gradient, 1-2% slope and contains beautiful pool-riffle habitat with excellent spawning gravel.

Burnt Creek Two

This left bank tributary drains a forested subbasin prior to descending onto the Pysht River floodplain at RM 9.58 (see Figure 36). Within the portion of this stream system surveyed there were two channel segments. Descriptions for each of the channel segments are included below.

Burnt Creek Two Segment 1

This is a short (82 m), moderate gradient (4-8%), highly incised channel segment (Figure 61). The habitat conditions in this segment are quite poor. There is a broken pipe of unknown origin in the channel 38 m upstream from the Pysht that forms a barrier to fish. The degree to which this feature blocks fish passage could not be determined. The segment ends at the downstream end of the SR 113 culvert. No coho were detected in this channel segment but one small cutthroat trout was observed in the scour pool formed by the SR 113 culvert.

Figure 61. Active channel incision in Segment 1 of Burnt Creek Two.

Burnt Creek Two Segment 2

This segment is 263 meters long, moderate gradient (3-10%), and plagued with fish passage problems. The first barrier is located at the segment break with Segment 1. The SR 113 culvert is perched 1.2 meters creating a complete barrier to fish passage. Upstream the channel conditions are fair for about 100 meters. The 801 Road culvert is located 117 meters upstream from SR 113 and is a complete barrier to fish. The bottom of this culvert is completely rusted out and the stream flows out of the road fill about 5 m upstream from the culvert's outlet. Significant erosion has occurred due to improper culvert placement and maintenance at this site. This segment ends 95 meters upstream of the 801 Road culvert, where the channel splits into two, steep, roughly similar sized tributaries. No fish were observed in this channel segment.

Bowlby Creek

Bowlby Creek is a right bank tributary to the Pysht River entering at RM 9.7 (see Figure 36). This stream drains from a forested, moderately steep subbasin prior to entering the Pysht River floodplain. Within the portion of this stream system surveyed there were three channel segments and one steep non fish-bearing tributary. Descriptions for each of the channel segments are included below.

Bowlby Creek Segment 1

This segment is 170 meters long and provides excellent spawning habitat for coho salmon. BFW and BFD averaged 3.0 and 0.39 meters respectively. Gradient averaged 3%. This segment lacks complex pool-riffle structure but contains high quality spawning habitat. Coho spawning ground surveys were conducted in this segment in 1998 and 246 redds/mile were recorded in this short reach. The segment ends at the valley/hillslope interface. This segment is also locally known for going dry in spring and early summer trapping young of the year juvenile coho; this condition has existed for decades (B. Bowlby, personal communication, 2005).

Bowlby Creek Segment 2

This segment is 355 meter long and has an average gradient of 8%. This step-pool segment has abundant old LWD with lots of stable spawning gravel for a channel of this gradient. One coho carcass was recovered 100 meters upstream from the segment 1/2 break on February 10, 2005. Near the segment 2/3 break there is riprap across the channel which appears to be forming a fish passage problem. This riprap is part of the SR 113 road fill and appears to have been placed when this stream segment was rerouted during road construction. There are also several small cascades and jams downstream that may also form partial barriers during some flow conditions.

Bowlby Creek Segment 3

Only a partial survey was conducted in this channel segment due to thick brush and downstream barriers that may prevent fish access to this point in the stream network. Segment 3 is a low gradient forested wetland habitat that has the potential to provide habitat for juvenile salmonids. The quantity of potential habitat in this segment was not determined.

Boulder Creek

Boulder Creek is a steep right bank tributary which enters the Pysht River at RM 10.81. Boulder Creek is not a floodplain tributary but was included in the summary due to the fact that it was surveyed as part of this study. Boulder Creek is steep averaging 8-12% gradient. The survey ended 110 meters upstream from the Pysht River due to impenetrable brush, debris, and blowdown. The lower 60 meters of this channel segment are accessible and there are a few areas with spawnable gravel. BFW averaged 5.2 meters in this stream.

Bridge Creek

Bridge Creek is a left bank tributary which enters the Pysht River at RM 10.88. Bridge Creek is not a floodplain tributary but was included in the summary due to the fact that it was surveyed as part of this study. Bridge Creek is steep averaging 5-11% gradient. The survey ended 183 meters upstream from the Pysht River due to steep gradient. Patches of spawning gravel were identified up to 140 meters from the confluence with the Pysht River, upstream of this the habitat transitioned into predominately cascades. BFW averaged 3.4 meters in this stream.

Wall Creek 2

This stream system is a small wall-based off channel habitat which enters the Pysht River along the right bank at RM 11.02. Streamflow is sustained by a large side-hill spring. The total length of this habitat feature is 100 meters. Channel gradient averaged 1 to 2% slope. This spring-fed wall based system had exceptionally strong flow at the time of our survey. Several weeks without any significant rainfall had occurred prior to the survey but this channel had excellent flow and excellent water quality. High fish use by juvenile coho was observed throughout the entire length of this habitat feature. Figure 62 illustrates the high quality nature of this habitat unit.

Figure 62. Example of the high quality habitat in Wall Creek 2, photo looking downstream 93 meters upstream from the Pysht River.

Wall Creek 3

This stream system is a small wall-based off channel habitat which enters the Pysht River along the left bank at RM 11.37. Streamflow is sustained by seeps and two steep, non-fish bearing tributaries. The total length of this habitat feature is 80 meters. Channel gradient averaged ~1% slope. This habitat feature could be described as either a wall based tributary or a side channel of the Pysht River. This system is in its early stages of development. A large log jam has recently formed just upstream of this feature altering the location of the mainstem Pysht River and forming this habitat unit. High fish use by juvenile coho was observed throughout the entire length of this habitat feature.