CLALLAM RIVER WATERSHED

STREAM HABITAT INVENTORY

AND

ASSESSMENT

PREPARED FOR:

Clallam County and the Clallam River Restoration Workgroup

PREPARED BY

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Version 2_1

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EXECUTIVE SUMMARY

This watershed-scale habitat assessment was developed to guide restoration efforts in the Clallam River watershed through the development of a prioritized list of actions to help alleviate the identified limiting factors. A prioritized list of restoration actions was identified in the Clallam River watershed. Restoration actions include river mouth options, correction of barriers, road relocation, riparian replanting, and adding large woody debris. The prioritized list of actions was developed based on the amount of habitat improvement, cost, community-alignment, and feasibility.

A Clallam River stakeholder technical group was convened to develop habitat assessment priorities. Following several meetings and the creation of a scoping document, four key assessment elements were identified as high priority habitat parameters:

- Habitat Connectivity
- Channel and Habitat Conditions
- Riparian and Floodplain
- Fish Populations, Biological Processes, and Anadromous Fish Distribution

<u>Watershed Overview</u>
The climate of the northwest Olympic Peninsula can be characterized as temperate coastal-marine, with mild winters and cool summers. Mean annual precipitation ranges from 80 to 100 inches per year (PRISM 2007). The Clallam River drains approximately 31.1 square miles (19,914 acres/80.5 Sq km). The mainstem is over 15.7 miles long.

The upper Clallam River drains a series of moderately steep, low elevation mountains; maximum elevation is approximately 2,650 feet (808m). In the upper watershed (upstream of river mile 7) the river is confined in a narrow valley bound by steep hills and low elevation mountains. Stream gradient remains low, to moderate, up to river mile (RM) 14.3, where stream gradient reaches 13% in a short cascade segment. Valley widths in the upper basin range from 60 to 300 feet. The lower river meanders through a low gradient unconstrained valley bound by low, gently sloping hills. Valley widths are approximately 5,000, 1,350, 1,100, and 300 feet at RM 1, 3, 5, and 7, respectively.

Settlement and agricultural development are generally limited to areas downstream of river mile 6. The town of Clallam Bay, agricultural land use, and rural residential development cover approximately 5% of the watershed.

Timber harvest began in the early 1900s(?); aerial photos taken in 1954 show that much of the watershed was already young forest (less than 40 year-old stands). Large stands of old second growth forest are now common on much of the WDNR land. Virtually all of the old growth forest has been clearcut, a few patches of old forest are still present (typically associated with steep terrain and streams).

Old aerial photos of the watershed provide evidence of large woody debris removal and several small scale gravel mining operations below river mile 6.5. In 1952, a total of 21 log jams were removed from the Clallam River to improve fish passage. Two very large jams were too big to remove and channels were built around the jams.

Salmonid Stock Assessment Review

Currently there are five known species of salmonids that utilize the Clallam River watershed: coho, chum, and chinook salmon, and steelhead and cutthroat trout. Other non-salmonid species present in the Clallam River include: three-spine stickleback (*Gasterosteus aculeatus*), Pacific lamprey (*Lampetra tridentata*), coast range sculpin coastrange sculpin (*Cottus aleuticus*), and prickly sculpin (*C. asper*).

Anadromous Fish Distribution

A total of 232 stream channel segments were inventoried within and/or adjacent to the anadromous fish zone. A total of 62.0 miles of stream channel were included in the inventory of anadromous fish use. Of this length a total of 30.8 miles were field surveyed. All inventoried channel segments were classified based upon the following anadromous fish-use categories: confirmed use, assumed use, potential use, use unlikely, and no use. The table below depicts the total stream lengths within each of the five anadromous fish-use categories. Anadromous fish use was defined as confirmed, assumed, or potential for 52.9 miles of stream channel. Channel segments within the remaining 9.1 miles of stream channels inventoried were classified as no use or use unlikely.

Anadromous Fish Use Category	Miles Stream within Category (km)	Percent of Stream Length Surveyed
Confirmed Use	32.5 (52.3)	80%
Assumed Use	6.6 (10.6)	25%
Potential Use	13.8 (22.3)	20%
Unlikely Use	5.4 (8.6)	9%
No Use	3.7 (6.0)	2%

Habitat Connectivity: Anadromous Salmonid Migration Barriers

Anadromous salmonid migration barriers were inventoried using existing culvert databases and field surveys. Five types of barriers were identified in the Clallam River watershed:

- Impassable Waterfalls
- Cascades (partial and complete barriers)
- Beach Deposits (seasonally partial to complete barrier)
- Perched Logjams (partial barriers)
- Culverts (8 passable, 2 partial, and 6 complete barriers)

The most significant quantities of habitat blocked to anadromous fish migration/emigration were associated with beach deposits, waterfalls, cascades, and perched logjams.

Channel and Habitat Conditions
Anadromous fish habitat was inventoried using both remote sensing techniques (e.g., LiDAR data) and during field surveys. A total of 62 miles of stream channel were inventoried (232 habitat segments), 31 miles of channel were field surveyed in 158 habitat segments. Habitat types were classified as follows:

- Wetland habitat (1.6 miles; 78% field surveyed)
- Wetland with pond habitat (0.4 miles; 100% field surveyed)
- Low-energy overwintering habitat (5.3 miles; 41% field surveyed)
- Low gradient (1-3%) spawning and rearing (31.2 miles; 67% field surveyed)
- Medium gradient (3-8%) spawning and rearing (13.3 miles; 35% field surveyed)
- Medium-high gradient (5-12%) spawning and rearing (7.7 miles; 19% field surveyed)
- Not likely habitat, generally greater than 10-12% gradient (2.6 miles; 2% field surveyed)

Mainstem Habitat Summary
A total of 22 habitat segments were identified and inventoried in the mainstem from the confluence with the Strait of Juan de Fuca to river mile 15.8. Habitat segments 1 through 14 provide both spawning and rearing habitat with confirmed anadromous fish use. Time constraints and lack of landowner permission to access certain stream reaches did not allow 100% of the stream network to be surveyed.

Off-Channel and Overwintering Habitat Summary
Off-channel and overwintering habitat is mostly found below RM 4.0, along the mainstem and in low gradient tributaries (e.g., Last and Pearson Creeks). Some additional off-channel habitat is located up to RM 7.0. Off-channel habitat formation and maintenance is limited by the following factors:

- Channel gradient
- Valley width
- Channel migration
- Bank Armoring

Riparian and Floodplain Assessment
Within the context of the NOPLE and SRFB definitions the objective of Clallam River watershed assessment is to "determine project siting, feasibility, design, or implementation". More specifically the grant proposal objective states, "*We propose a systematic watershed-scale habitat assessment of the Clallam River, building upon existing information. Using this comprehensive assessment, the project will also develop a prioritized list of actions to alleviate limiting factors identified.*" However, the assessment proposal lacks specificity with respect to the assessment. The proposal states that, "*The assessment of salmonid barriers, floodplain condition, and off-channel habitat will provide the information necessary to develop a prioritized project list. The methodology has been used in similar projects, such as the SRFB-funded Salt Creek*

Habitat Assessment conducted by the Lower Elwha Klallam Tribe and North Olympic Salmon Coalition."

In order to develop a better understanding of potential methods to be employed to assess the Clallam River watershed, a meeting was held on April 13, 2006 to discuss the project. Many ideas regarding existing data, new data to be collected, and potential restoration projects were discussed. Key elements of the assessment include:

- Fish Populations and Biological Processes
- Channel Conditions
- Floodplain Conditions
- Loss of Access to Spawning and Rearing Habitat
- Riparian Conditions
- Streambed Sediment Conditions
- Water Quality
- Water Quantity

Initially, during the early phase of project planning there were many ideas for work to be conducted. These ideas were summarized in the first draft of the scoping document (version_1.0). A report outline was developed that incorporated all of the major concepts discussed during the April 13, 2006 meeting and presented within the funding proposal submitted to the SRFB (see version_1.0). The number of monitoring and habitat condition assessment ideas to be included within the watershed assessment exceeded the quantity of work that could feasibly be conducted with the given resources. On May 11, 2006 another meeting was held to discuss assessment priorities. The meeting resulted in a scaled back assessment scope that included fewer habitat parameters and conditions to be evaluated in the field. Four key assessment elements were identified as being a high priority for inclusion in the watershed assessment and they included:

- Habitat Connectivity Assessment (blocking culverts, natural barriers, additional habitat access issues [e.g. channel incision and off-channel habitats])
- Channel and Habitat Conditions Assessment (focusing on pool and LWD conditions, floodplain connectivity and processes, rip-rap inventory, and spawning habitat condition and availability)
- Riparian and Floodplain Assessment (focusing on mainstem Clallam River, includes infrastructure identification and landuse)
- Fish Populations, Biological Processes, and Anadromous Fish Distribution

1 INTRODUCTION

1.1 BACKGROUND

The Clallam River watershed drains 31.1 square miles (80.5 sq km) of mostly forested land on the North Olympic Peninsula. The Clallam River enters the Strait of Juan de Fuca at the town of Clallam Bay, Washington (Figure 1.1). The Clallam River currently supports runs of coho (*Oncorhynchus. kisutch*) and chum (*O. keta*) salmon, as well as steelhead (*O. mykiss)* and cutthroat trout (*O. clarkii*). At least one observation of Chinook salmon (O.) spawning in the mainstem of the Clallam River has been documented in the last decade.

The Clallam River historically supported robust runs of coho and chum salmon, as well as steelhead and cutthroat trout. Little information exists regarding the historical use of the Clallam River by Chinook salmon. Clallam River salmonid runs, particularly mainstem dependent Chinook, chum and steelhead populations have declined from historical levels. Lack of long-term population datasets precludes an accurate estimate of the level of population decline. The coho salmon population, which is more dependent on tributary habitats has increased in abundance over the last decade. It has been hypothesized that a portion of the decline in salmonid populations is a result of habitat degradation and reduced freshwater survival. The primary causes of habitat degradation and reduced freshwater salmonid survival in the Clallam Watershed are thought to have resulted from historic logging, as well as impacts associated with highway construction, railroad grade construction, and channelization (Smith 2000).

No comprehensive assessment of the Clallam River watershed has 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). Within the context of the NOPLE and SRFB definitions the objective of Clallam River watershed assessment is to "determine project siting, feasibility, design, or implementation". More specifically the grant proposal objective states, "*We propose a systematic watershed-scale habitat assessment of the Clallam River, building upon existing information. Using this comprehensive assessment, the project will also develop a prioritized list of actions to alleviate limiting factors identified.*" However, the assessment proposal lacks specificity with respect to the assessment. The proposal states that, "*The assessment of salmonid barriers, floodplain condition, and off-channel habitat will provide the information necessary to develop a prioritized project list. The methodology has been used in similar projects, such as the SRFB-funded Salt Creek Habitat Assessment conducted by the Lower Elwha Klallam Tribe and North Olympic Salmon Coalition.*"

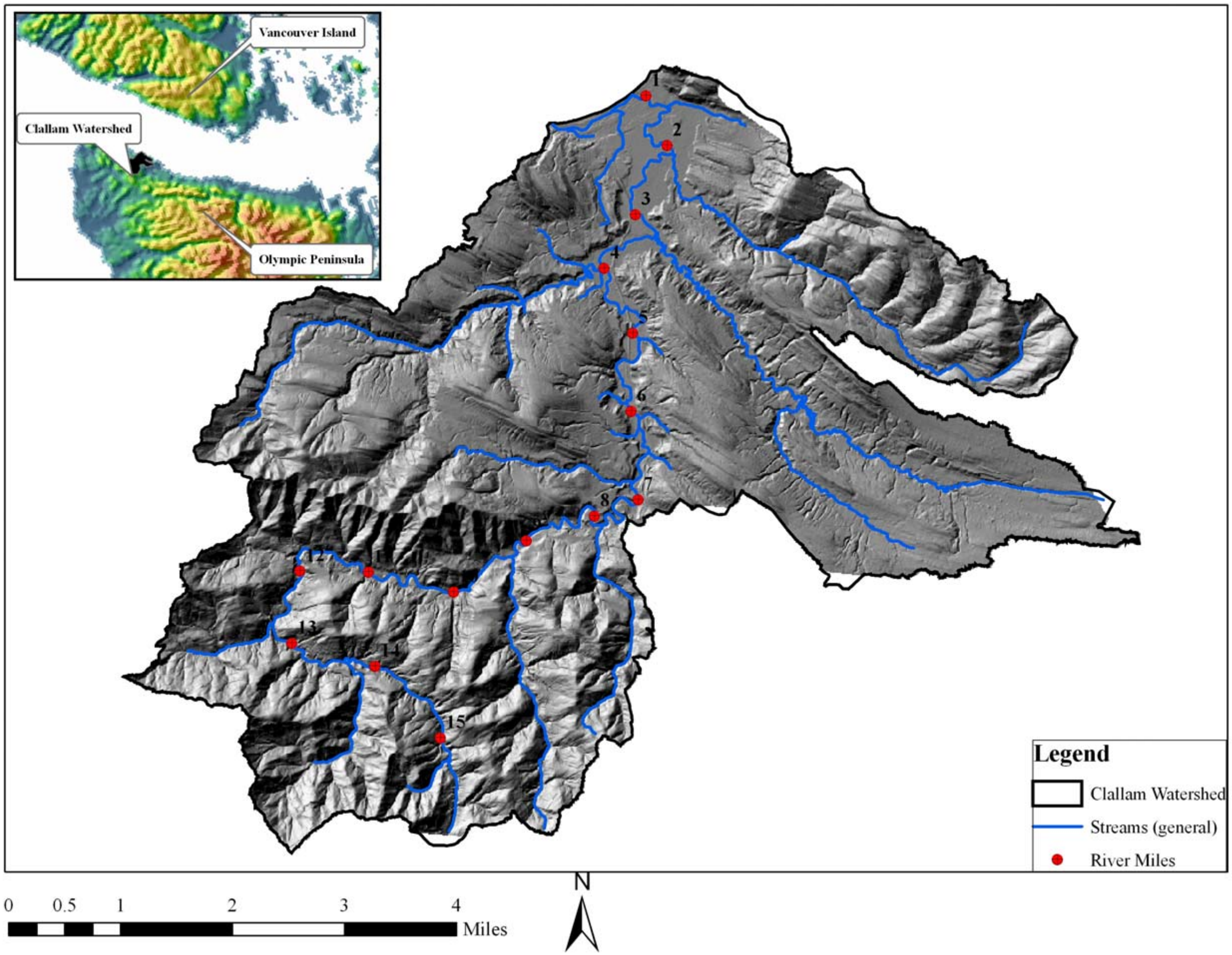

Figure 1.1. Clallam River watershed location map with river miles, study streams, and LiDAR derived shaded relief.

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1.2 PHYSICAL SETTING

The Clallam River drains approximately 31.1 square miles (80.5 sq. km) and has numerous tributaries that vary in size from less than one meter wide to approximately 20 meters. The upper Clallam River drains a series of moderately steep, low elevation mountains. Maximum elevation is approximately 2,650 feet (808m). In the upper watershed (upstream of river mile 7) the river is confined in a narrow valley bound by steep hills and low elevation mountains. Stream gradient remains low to moderate up to river mile (RM) 14.3, where gradients reach 13% in a short cascade reach. Valley widths in the upper river are range from 60 to 300 feet. The lower river meanders through a low gradient unconstrained valley bound by low elevation, gently sloping hills. Valley width is approximately 5,000, 1,350, 1,100, and 300 feet at RM 1, 3, 5, and 7, respectively.

The climate of the northwest Olympic Peninsula can be characterized as temperate coastal-marine, with mild winters and cool summers. No long-term weather stations are located in the Clallam watershed. Mean annual precipitation ranges from 80 to 100 inches per year (PRISM 2007). Most of the precipitation in the watershed falls as rain, between October and March. Clallam 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.

For the purpose of this assessment the watershed was divided into sub-basins associated with significant fish-bearing streams. The largest tributaries to the Clallam River are Last, Charley, Pearson, and Blowder creeks (see Table 1.1; Figure 1.2).

Table 1.1. Summary of Clallam River sub-basin names and watershed areas. Note 6.52 sq. mile drain directly into the mainstem Clallam River from undelineated subbasins.

Sub-Basin/Stream Name	Acres	Square Miles	Square Kilometers
Cannery Creek	99	0.15	0.40
Swamp Creek	330	0.52	1.34
Hatchery Creek	570	0.89	2.31
Pearson Creek	2,341	3.66	9.47
Last Creek	3,522	5.50	14.25
Charley Creek	3,303	5.16	13.37
Simmons Creek	162	0.25	0.66
Cedar Creek	159	0.25	0.64
Elofson Creek	192	0.30	0.78
Smith Creek	150	0.23	0.61
Stinky Creek	671	1.05	2.71
Blowder Creek	796	1.24	3.22
Cougar Creek	1,112	1.74	4.50
Unnamed 19.0144	543	0.85	2.20
Unnamed 19.0145	845	1.32	3.42
Upper Clallam	955	1.49	3.87
Total Clallam Watershed	**19,914**	**31.12**	**80.59**

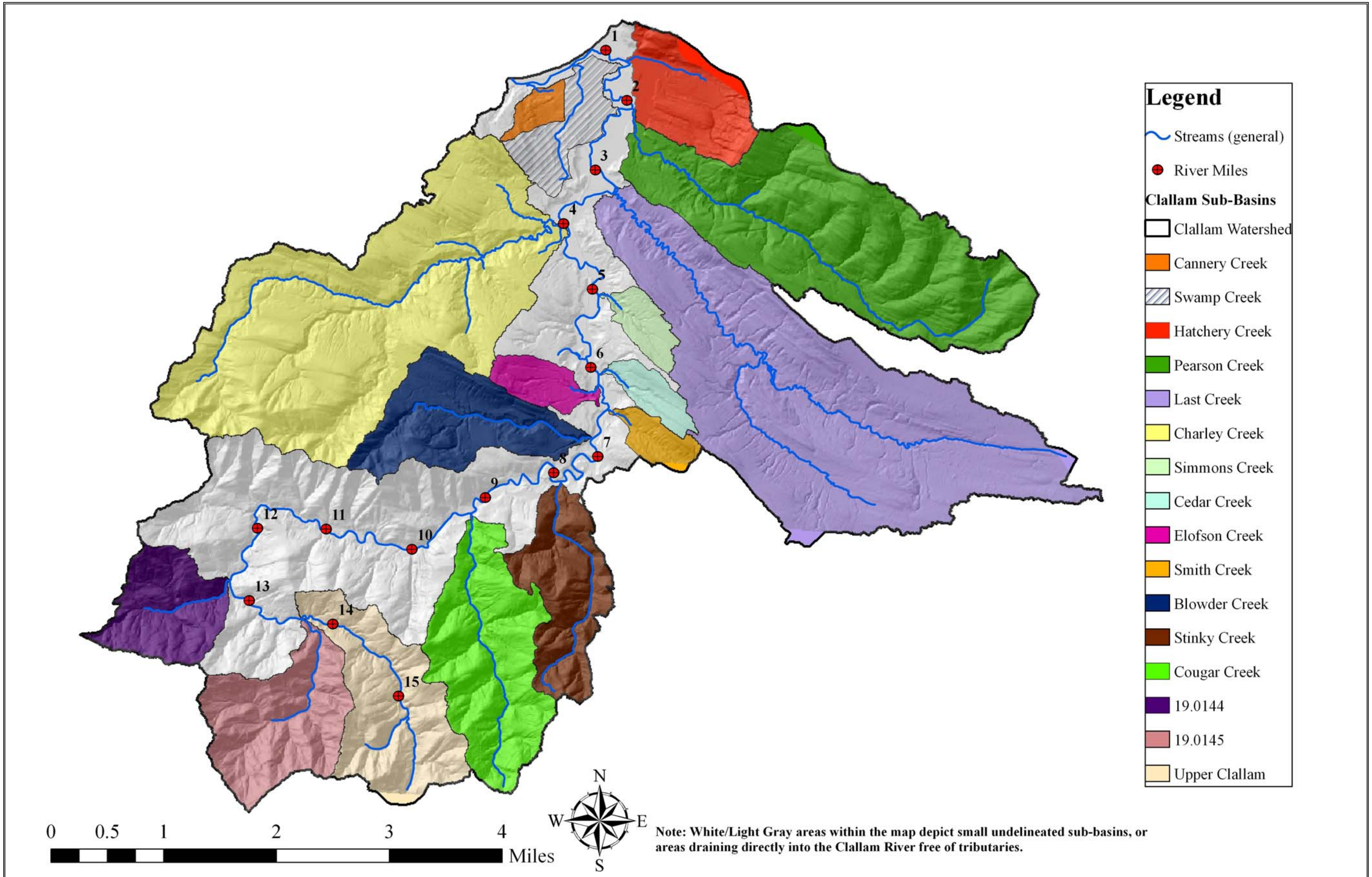

Figure 1.2. Sub-basin map of the Clallam River watershed (generated from LiDAR data and field interpretation).

1.2.1 WATERSHED GEOLOGY

The geologic map of the Clallam River watershed includes the identification and description of six types of surficial deposits and eight primary bedrock formations (Figure 1.3), some of which include one or more recognized and described secondary bedrock units. Surfical deposits include alluvium, beach deposits, landslide deposits, and glacial outwash, till, and drift deposits. Surficial deposits cover 15.5% of the watershed. Alluvial deposits are generally located adjacent to the mainstem and downstream of RM 7.0. These deposits widen from west to east in the downstream direction. Glacial deposits cover 9.8% of the watershed and are generally located at elevations less than 400 feet (122 meters) but are mapped at elevations up to 1,900 feet (580 meters). Bedrock units are orientated generally parallel to the Strait of Juan de Fuca (strike NW/SE; dipping NE), out cropping from northwest to southeast across the Clallam River watershed. These units are youngest (lower Miocene) from the lower watershed and oldest (lower Eocene) in the headwaters. The steepest, most rugged terrain is located in the upper watershed and the underlying bedrock geology covers 18.3% of the watershed [includes the Lyre (2.0%), Aldwell (7.8%), Lizard Lake (2.2%), and Crescent formations (6.3%). The Pysht, Hoko, Makah, and Clallam formations underlie 20.5%, 19.6%, 14.8%, and 11.3% of the watershed respectively.

Alluvium (Holocene and Pleistocene): Sorted combinations of silt, sand, and gravel deposited along rivers and streams, surface relatively undissected by streams, locally includes sand and gravel of low lying river terraces (from Schasse 2003).

Beach Deposits (Holocene): Sand and/or gravel with minor shell fragments deposited along shorelines, locally includes back-beach dune fields and minor estuarine deposits, clasts are typically well rounded (from Schasse 2003).

Landslide Deposits (Holocene and Pleistocene): Poorly sorted and chaotically mixed clay, silt, sand, and gravel in debris flows, which locally include large coherent glide blocks. Mapped only where readily discernible (from Schasse 2003).

Glacial Outwash (Pleistocene): Unconsolidated, well-stratified cobbles in a loose, gravelly sand matrix, boulders are common in poorly sorted deposits (from Schasse 2003).

Glacial Till (Pleistocene): Unsorted, unstratified, compact mixture of clay, silt, sand, gravel, and boulders deposited by the Juan De Fuca lobe of the Cordilleran ice sheet, may contain interbedded stratified sand, silt, and gravel (from Schasse 2003).

Glacial Drift (Pleistocene): Till and outwash deposits from continental glaciers; locally includes lacustrine deposits modified by stream terracing, in most places, contacts between glacial drift and bedrock are inferred (from Schasse 2003).

Clallam Formation (lower Miocene): Sandstone and conglomerate with minor siltstone. Shallow marine sandstone is micaceous, feldspathic, quartzose, and typically thick bedded and locally pebbly, bioturbated, and cross-bedded; commonly mollusk bearing and carbonaceous, locally penecontemporaneously deformed. Conglomerate is composed of rounded pebbles and cobbles of white quartz, dark-gray chert, phyllite, and light-gray felsic tuff (from Snavely et al. 1993; Schasse 2003).

Pysht Formation (lower Miocene-upper Oligocene): Massive and thin-bedded, poorly indurated, olive-gray siltstone and mudstone; mollusk bearing and concretionary with beds of fine-to medium-grained thin-bedded, subfeldspathic sandstone; highly susceptible to landsliding (from Snavely et al. 1993; Schasse 2003).

Conglomerate Member: Channel deposits of thick-to medium-bedded, polymictic conglomerate.

Makah Formation (Oligocene-upper Eocene): Thin-bedded sandstone and siltstone; commonly contains calcareous concretions. Contains four mappable members (only one present [mapped] in the Clallam River watershed) consisting of turbidite sandstone units that range in thickness from 45 to 130 meters interbedded with thin laminated to micro cross-laminated beds of very fine-grained sandstone and siltstone (from Snavely et al. 1993; Schasse 2003). Also contains other mapped members not present in the Clallam River watershed.

Klachopis Point Member (Oligocene-upper Eocene): Thick-bedded to very thick-bedded, micaceous feldspathic sandstone.

Hoko Formation (Oligocene-upper Eocene): Siltstone and sandy siltstone with lenses of pebbles-cobble conglomerate. Also contains iron-stained concretionary siltstone and sandy siltstone with minor thin-bedded, quartzofeldspathic, very fine-grained to medium-grained sandstone beds, pebbly mudstone, mudflow breccia, sandstone dikes, and thin tuff beds occur locally (from Snavely et al. 1993; Schasse 2003).

Turbidite Sandstone Member: Thick- to thin-bedded lithofeldspathic sandstone.

Phyllitic and Basaltic Sandstone Member: Thick- to thin-bedded, carbonaceous, calcite-cemented phyllitic and basaltic sandstone.

Lyre Formation (middle Eocene): This formation is dived into two main units: conglomerate (not present in the Clallam watershed) and sandstone. The conglomerate unit overlies and is interbedded with thick-bedded, well-indurated, lithic, phyllitic, quartzose sandstone and minor thin-bedded sandstone and siltstone. Large siltstone rip-ups and pebbly mudstone are common near the lower contact (from Snavely et al. 1993; Schasse 2003).

Aldwell Formation (middle Eocene): Thin, well-bedded, phyllitic, lithic quartzose and basaltic sandstone and siltstone. Upper part of sequence consists of nonbedded to poorly bedded siltstone with 1 to 1.5 m thick sandstone channels (from Snavely et al. 1993; Schasse 2003).

Basaltic Sandstone and Conglomerate of Lizard Lake (middle to lower? Eocene): Basaltic sandstone and siltstone overlying basaltic conglomerate and mudflows. Sandstone and siltstone are thick- to medium-bedded and locally contain coral, mollusk fragments, and carbonized wood. Conglomerate is massive to thick-bedded, composed almost entirely of detritus eroded from the underlying Crescent Formation (from Snavely et al. 1993; Schasse 2003).

Crescent Formation (middle to lower Eocene): Basalt pillow lava and breccia. Dense to very amygdaloidal, lower part of sequence contains 1 to 5 m thick beds of foraminifera-bearing pelagic red and white limestone and calcareous red and brown siltstone. The upper part of the sequence contains several thick interbeds of forminifera-rich siltstone, basaltic sandstone, basalt breccia or conglomerate (from Snavely et al. 1993; Schasse 2003).

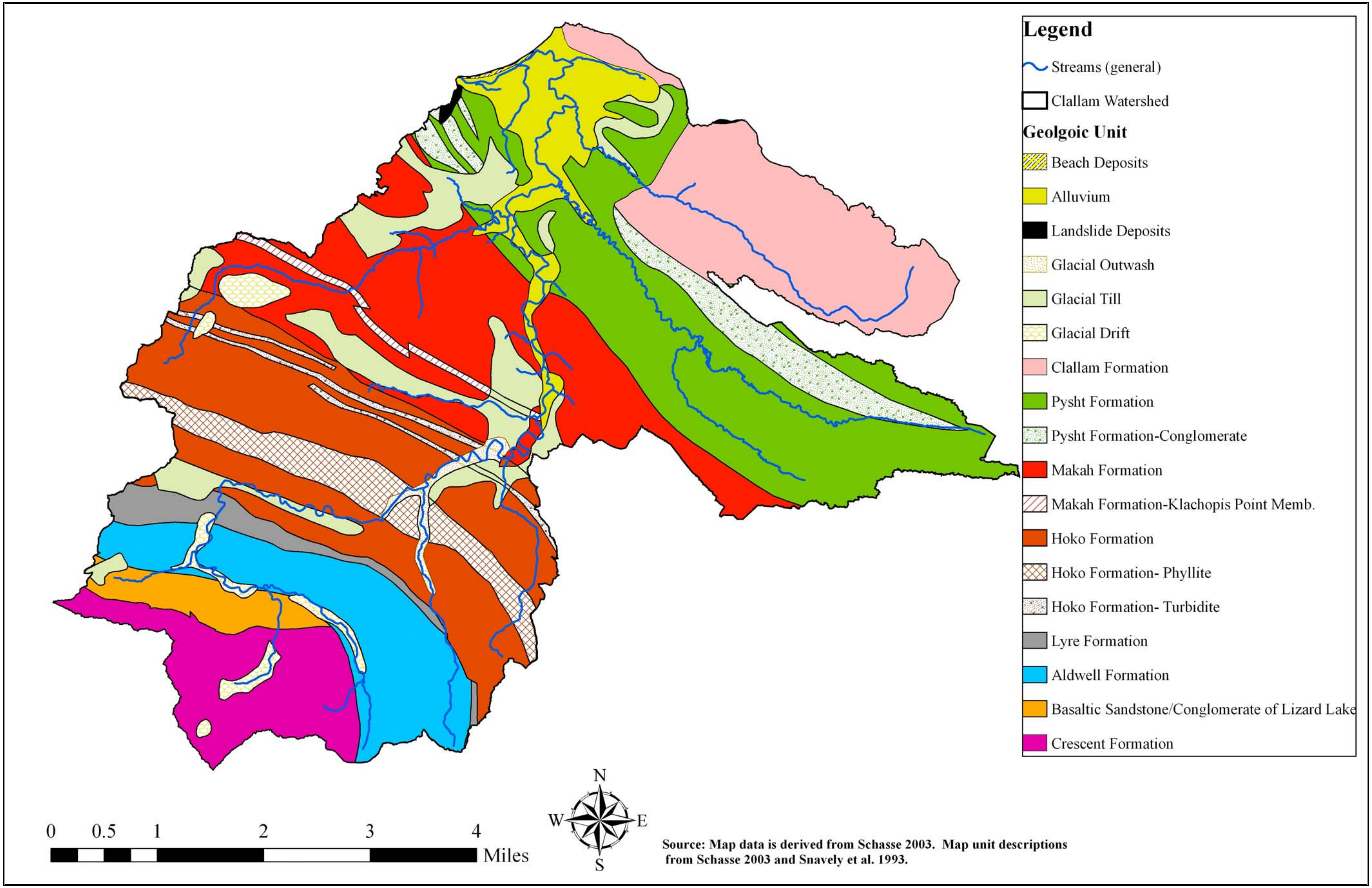

Figure 1.3. Geologic map of the Clallam River watershed (from Schasse 2003).

1.2.2 SETTLEMENT AND AGRICULTURAL DEVELOPMENT

No historical accounts describing the riparian and floodplain conditions could be found for the Clallam River watershed. It is assumed that historical floodplain and riparian conditions were similar to those conditions that existed in adjacent watersheds such as the Hoko River and Pysht River watersheds where the lower elevation forests 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 likely present historically.

The earliest historical descriptions of the Clallam Bay area are included in the 1864 GLO survey describing the opening of a coal mine 2.5 miles east of Slip Point. The 1864 GLO report describes the Clallam River valley as consisting of considerable first-rate land that was generally heavily timbered (Treadway 1864 *in* Todd et al. 2006). Shelton (1892 *in* Todd et al. 2006) describe the valley soils in the Clallam River, and Pearson, Lost, and Charley Creeks as rich black loam capable of producing immense crops of hay grain, vegetables, and fruit. In the late-1800s tannin extraction, logging, coal mining, and farming appear to have been the main economies of the Clallam Bay/Sekiu area. By the late-1800s humans had modified the Clallam River valley and estuary by logging the river valley corridor, rafting logs down river, and developing milling facilities at the spit (Todd et al. 2006). Parts of the estuary and lower river were filled and diked during this same time period, and during the following decades a number of structures were built out on the spit or bridging the spit with the mainland. The beach and spit at Clallam Bay was mined for gravel used in the construction of roads until the 1940s (Shaffer et al. 2003).

Industrial scale logging within the watershed began no later than 1915. Goodyear logging company had an office, railroad, and log dump in the Clallam Bay/Sekiu area and was in business from 1915-1924 (www.content.lib.washington.edu). Kramer (1952) states, "Little if any logging has taken place here [Clallam River] in the near past as this area has an excellent cover of second growth timber" suggesting that much of the area had been logged well before the 1950s. Aerial photos of the watershed taken in 1957/58 show that much of the watershed was young forest (<40 years old). By 1951 much of the lower Clallam River was well inhabited with considerable clearings for agricultural purposes adjacent to the river (Kramer 1952). Kramer (1952) notes that significant erosion is evident along the cleared areas, especially where the clearing has taken place right up to the stream channel. Kramer (1952) also describes difficulty in maintaining the county road (now SR 112) where it follows the river course due to road erosion during high water events. Figure 1.4 depicts the lower Clallam River near the confluence with the Strait of Juan de Fuca and downtown Clallam Bay. The photo date is assumed to be from the 1940s based on the steel bridge that collapsed and was removed from the river by 1952 (see Kramer 1952).Figure 1.4

Figure 1.4. Photo looking at Clallam River and downtown Clallam Bay in the 1940s (source: Forks Timber Museum).

Road and railroad building, rural development, and other landuse practices that affected the quantity and quality of fish habitat within the Clallam River watershed were well advanced by the 1950s. In addition large woody debris removal also played a significant role in altering habitat. In 1952, a total of 21 log jams were removed from the Clallam River to improve fish passage. Two very large jams were too big to remove and channels were built around the jams. Large wood and small jams not affecting fish passage were also removed to help facilitate trash and sewer passage out to the Strait. Figure 1.5 and Figure 1.6 are photos taken in 1952 that provide an example of the large woody debris removal operations in the Clallam River near river mile 4 (note that Kramer/WDFW RM 4 corresponds to approximately RM 6.5 in this analysis).

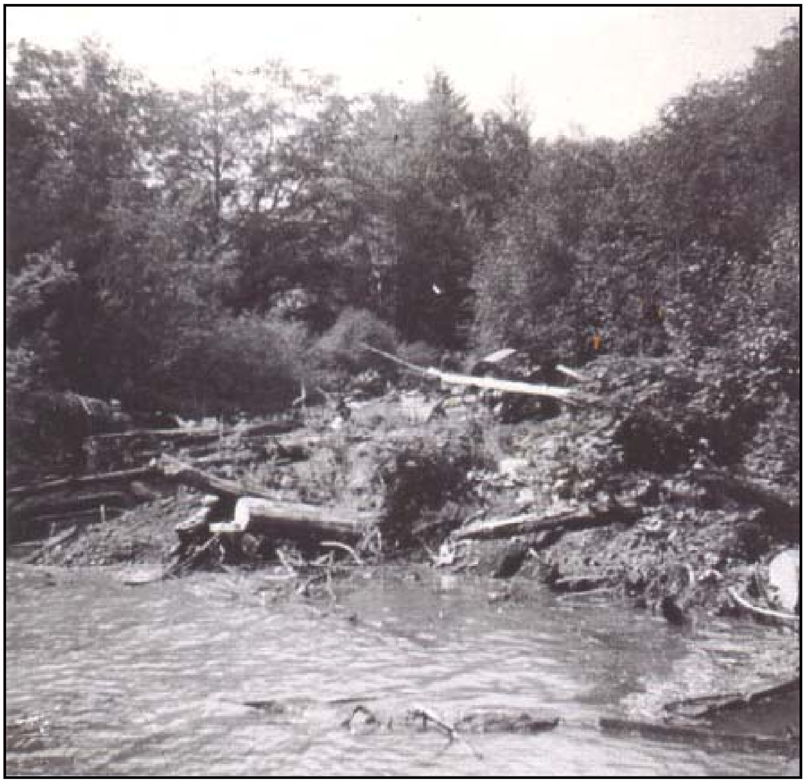

Figure 1.5. Clallam River LWD removal operation near river mile 4 (Kramer 1952).

Figure 1.6. Clallam River LWD removal operation near river mile 4 (Kramer 1952).

1.2.3 LANDOWNERSHIP

As described above, residential settlement and agricultural development are generally limited to areas downstream of river mile 6. The town of Clallam Bay, agricultural land use, and rural residential development cover approximately 5% of the watershed. To better understand the types of landuse within the watershed each parcel of land within the watershed was classified into one of the following categories: Washington State (mainly WDNR), industrial forestry (ownership of greater than 500 acres of commercial forestland), small landowners (less than 100 acres, may include any of these following landuse designations-residential, open space, agricultural land, commercial forest), small landowners (100-500 acres, same landuse designations as described above for small landowners with less than 100 acres), Clallam County, other publicly owned land (e.g., waste water treatment plant, library, school, etc.).

Just over 50% of the watershed area is owned or held in trust by Washington State. Approximately 45% of the watershed area was classified as owned by industrial timber companies (e.g., Merrill and Ring, Rayonier, Bloedel Timberlands). The remaining 5% of the watershed's landownership was classified as owned by: small landowners, other publicly owned lands, Clallam County, or undefined ownership (Table 1.2). Geographically the ownership between public and private forest land almost divides the basin in half from west (WDNR) to east (private industrial forest land). Figure 1.7depicts landownership within the Clallam River watershed.

Table 1.2. Landownership within the Clallam River watershed classified by ownership types.

Ownership Type	Area (acres)	Area (Sq Mi)	Percent of Watershed Area
Washington State (mostly WDNR)	10,028	15.67	50.4%
Industrial Forest Land	8,895	13.90	44.7%
Small Landowner (<100acres)	525	0.82	2.6%
Small Landowner (100-500 acres)	308	0.48	1.5%
Undefined	112	0.18	0.6%
Other Publicly Owned	30	0.05	0.2%
Clallam County	13	0.02	0.1%
Grand Total	**19,913**	**31.11**	**100.0%**

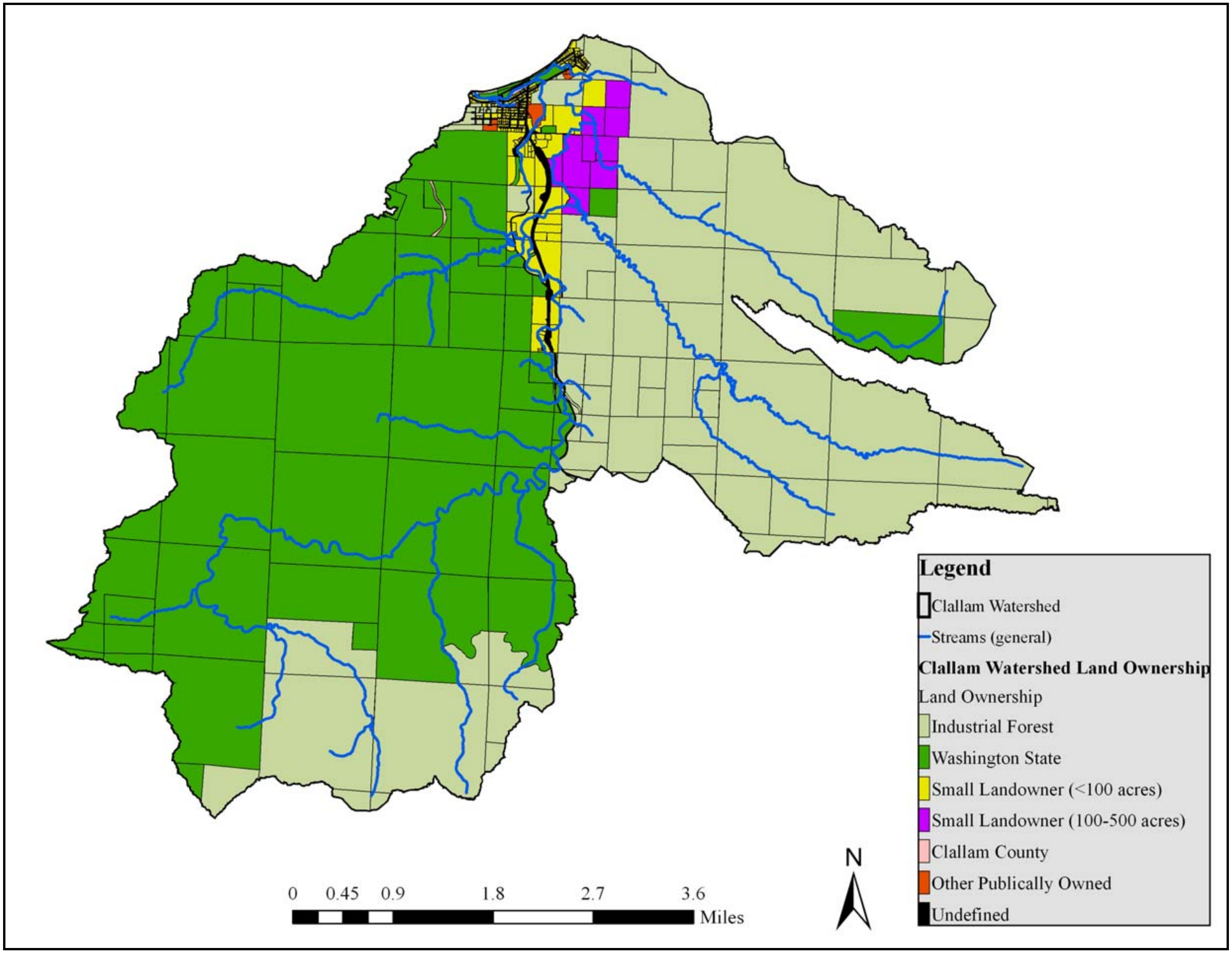

Figure 1.7. Clallam River watershed landownership (source: Clallam County GIS parcel data).

2 METHODS

2.1 FISH POPULATION AND DISTRIBUTION ASSESSMENT

2.1.1 ANADROMOUS SALMONID DISTRIBUTION

Anadromous salmonid distribution was determined based upon a combination of existing information (e.g., spawning ground survey data), field surveys (see also Section 2.2), and remote sensing data (e.g., LiDAR coverage). Anadromous fish use in the Clallam River watershed was classified for all inventoried channel segments as one of the following use categories: confirmed use, assumed use, potential use, use unlikely, and no use. ***Confirmed*** use was defined as habitat where anadromous fish use was confirmed by visually identifying one or more species of anadromous salmonids and/or based on other documented anadromous fish use (e.g., spawning ground survey data). Habitat use was classified as ***assumed*** where either: a) accessible, low to moderate gradient habitat was identified in the field but fish use was not documented, or b) low to moderate gradient habitat was identified using LiDAR and the stream habitat was similar in size and slope as nearby habitat with confirmed use. Habitat was classified as ***potential*** habitat when it was upstream of partial barriers such as cascades or small falls and no anadromous fish use was confirmed upstream. Habitat was also classified as ***potential*** habitat when it was upstream of partial or complete culvert barriers. Habitat was classified as use ***unlikely*** when it was upstream of very challenging falls or cascades and habitat with channel gradients greater than 8%. A channel segment was classified as ***no use*** when it was upstream of well defined anadromous fish barriers, such as falls greater than 12-14 vertical feet or where gradients exceeded known slope classes used by anadromous fish (usually sustained gradient greater than 16-20% slope. In many cases partial or complete fish barriers were identified during field surveys. These barriers are discussed in detail in Section 3.4.

2.1.2 SALMONID ABUNDANCE

Salmonid abundance and trends in abundance were determined, summarized, and synthesized based on past stock assessments (WDF et al. 1994; McHenry 1996; WDFW 2002) and other salmonid population data, including : WDFW 2006 (Appendix A), Bocking 2002, PFMC 1997, WDFW spawning ground survey data and database, and Elwha Tribal spawning ground survey data.

Included in the description of each species in Section 3.1 is a review of hatchery out-planting by species: references include WDF et al. 1994, WDFW 2002, RMIS database query (preliminary query includes HS releases), additional misc release info (e.g. McHenry et al. 1996).

2.2 STREAM CHANNEL AND HABITAT ASSESSMENT

2.2.1 STREAM CHANNEL AND HABITAT SEGMENTATION

Understanding the distribution and quantity of stream channel types is a critical component in accessing watershed conditions, productivity potential, and habitat carrying capacity. Different approaches to habitat restoration, enhancement, and protection will be needed for different types of channels.

Two important datasets containing channel segment data exist: 1) 2005 Salmon Steelhead Habitat Assessment Project (SSHIAP) data, and 2) 2005 Strait of Juan de Fuca (SJF) coho channel segment data. The 2005 SSHIAP database for the Clallam River classifies channel “types” by gradient, confinement, and habitat type. SSHIAP categorizes gradient and confinement are depicted in Table 2.1. SSHIAP habitat type definitions are included in Table 2.2. The SJF coho channel segment data include fish use data and a slightly modified version of the SSHIAP data.

Table 2.1. SSHIAP channel classification coding system.

GRADIENT	CODE	CONFINEMENT	CODE
<1%	1	Confinement > 4 BFW	U
1-2%	2	2BFW<Confinement<4BFW	M
2-4%	3	Confinement < 2BFW	C
4-8%	4		
8-12%	5		
>20%	6		

Table 2.2. SSHIAP habitat type codes and definitions.

Habitat Code	Habitat Type	Habitat Definition
1	Small Tributary	Stream with summer low flow wetted width <6m, OR basin area <23mi2 (~1/2 of a USGS 7.5’ quad).
2	Large Tributary	Stream/river with summer low flow wetted width >6m, OR basin area >23mi2.
3	Side Channel	Persistent secondary channel, typically with a vegetated island or other persistent landform separating it from the main channel.
4	Side Channel Slough	Channel branching off the main stem with >90% pools.
5	Distributary Slough	Channel with >90% pools that branch off a mainstem and flow as part of or into an estuary.
6	Lake/Pond	Habitat with standing water all year. Shown as unbroken blue on USGS maps; verify with aerial photos.
7	Wetland/Pond Complex	Wetland with associated, perennial surface water pond(s). Shown as blue with grass symbols or unbroken blue on USGS maps; verify with aerial photos.
8	Seasonally Flooded Wetland	Wetland that holds water for only a portion of the year. Often have perennial surface water channels and are identifiable with aerial photographs. Shown in white with grass symbols on USGS maps.

Neither of these datasets contain sufficient data to classify all channels and habitat types within the watershed and neither of these datasets include systematically collected field data. In addition the SSHIAP habitat types do not determine the expected habitat use (e.g., spawning, rearing, and migration) for all channel and habitat types. For example, low gradient mud bottomed wetland channels and low gradient gravel bedded channels are not differentiated within the SSHIAP system. Some of the SJF coho segments include notes describing segments with little or no gravel.

The SSHIAP and SJF data along with recently collected LiDAR data were used in conjunction with field surveys to generate a new hydro layer where channel segments were classified based on channel type, habitat type, gradient, and basin position.

Stream segments were surveyed using a handheld GPS, digital camera, string box, clinometer, stadia rod, tape measure, and laser distance meter. Physical channel attributes were measured at intervals (measurement stations) of approximately 5-30 m dependent upon stream width and 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 size, substrate composition, right bank (RB) and left bank (LB) riparian conditions, floodplain presence and connectivity, mass wasting presence, and fish presence and species.

Channel confinement (see also Table 2.1) 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 wetlands 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), cascade (C), or ditch (D). 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 (BLD; >256 mm), or bedrock (BRX). 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). Table 2.3 summarizes the riparian habitat classification system used to define riparian conditions during field surveys (note additional riparian and floodplain habitat characteristics were done for the mainstem using a combination of remote sensing techniques and field data, see Section 2.3.

Table 2.3. Summary of watershed analysis riparian habitat classification (source: WFPB 1997)

Dominant Riparian Condition	Dom. Veg. Type	C > 70%Conifer Dominated	First letter code used in series of three
	Dom. Veg. Type	D > 70% Deciduous	
	Dom. Veg. Type	M = all other cases	
	Average tree size	(S) small < 12 inches DBH	Second letter code used in series of three
	Average tree size	(M) medium >12 in. DBH < 20 in. DBH	
	Average tree size	(L) large > 20 inches DBH	
	Stand density	(D) dense > two-thirds canopy closure	Third letter
	Stand density	(S) Sparse < two-thirds canopy closure	

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, major changes in stream course and other photo points.

In order to quantify the amount and type of different habitats a system to classify habitat types was needed. Since the Clallam River is adjacent to the Pysht River and habitat types are similar it made sense to use the habitat classification system developed for the Pysht River (see Haggerty et al. 2006). This system is uses eight primary habitat types to classify habitat. These habitat units have the potential to contain from one to six different channel types. Table 2.4 depicts the different channels types that may be contained within each of the different habitat types.

Table 2.4. Summary of habitat types and the 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.

2.2.2 HABITAT DATA COLLECTION

Habitat data collection typically began at the same start of survey (SOS) as the channel data collection. The survey team moved from downstream up using the flagging from the channel surveys to note stream position. Each piece of large woody debris (LWD) encountered within the stream channel was categorized by size, type, position, and pool forming attributes. Once a piece of LWD was identified as being within the BFW it was given a LWD "Piece Number" and the distance from the SOS to the midpoint of the log was measured or estimated, and then recorded. The piece was then examined and classified by size (Table 2.5). The initial classification identified the LWD category as either: L+, L/L-, M, or S; L and L- were used interchangeable throughout the surveys. Where rootwads (RW) were attached to a LWD bole the code RW was added to the LWD size category; note this is the only significant deviation from the protocols outlined in the TFW Method Manual for Large Woody Debris Surveys (Schuett-Hames et al. 1999). Often additional data on the pieces position were recorded, such as right bank (RB), left bank (LB), in-flowing stream (IS), across channel (AC), and bridged (B). However, these data were not recorded for all pieces of LWD, so no systematic analysis of these data were conducted at the watershed scale.

Table 2.5. Summary of LWD categories and size requirements.

LWD CATEGORY	LWD SIZE REQUIREMENTS
L+	Large plus is defined as greater than 0.5m diameter at the midpoint of the piece and longer than 5m.
L	Large is defined as greater than 0.5m diameter at the midpoint of the piece and longer than 2m. Typically these pieces were shorter than 5m.
L-	Large minus is defined as greater than 0.5m diameter at the midpoint of the piece and longer than 2m but less than 5m.
M	Medium is defined as 0.2-0.5m diameter at the midpoint of the piece and length exceeding 2m.
S	Small is defined as 0.1-0.2m diameter at the midpoint of the piece and longer than 2m.
KEY/K	Key piece is defined as (1) independently stable in the stream bankfull width (not functionally held by another factor, i.e., pinned by another log, buried, trapped against a rock or bedform, etc.), and (2) is retaining (or has the potential to retain) other pieces of organic debris. Without the Key Piece, the retained organic debris will likely become mobilized in a high flow (approximately equal to or greater than a 10 year event). (From WADNR Watershed Analysis Fish Habitat Module Version 4.0 (1997).
RW	Rootwad, where rootwads were attached to the LWD piece RW was recorded at the end of the piece size: example-Lrw=large piece with rootwad attached.

When a piece of LWD was encountered that had the potential to qualify as a key piece its length and diameter were measured and recorded (no systematic recording system was used for all pieces so piece volume data were not analyzed for all streams). If the piece met the criteria for a key piece (Table 2.5) it was recorded as a yes under the key piece column on the data form. Pool forming function was recorded for each piece of LWD using a yes or no in the pool forming column on the habitat field worksheet. For each piece that was considered a pool forming piece, the number (ID) of the pool it was acting to form was recorded in the habitat field notes. In order for the piece to be considered "pool forming" the pool needed to meet the standards defined in the TFW Monitoring Program Method Manual for the Habitat Unit Survey (Pleus et al. 1999; Table 2.6). Note that LWD inventory methods varied habitat segments where no pool data was inventoried.

Once a habitat unit was identified that appeared to be a pool, the downstream and upstream ends of the unit were identified and the distance from the SOS was measured and recorded at the downstream end of the pool; typically this occurred at the riffle crest. For each pool, the maximum pool depth was measured and recorded. The depth at the pool outlet was then measured. The difference between the two measurements, defined as the residual pool depth, was calculated and recorded in the field. The length of each pool was measured along the longitudinal axis (along the stream's thalweg), from the pool outlet to the upstream boundary of the pool. Where unit boundaries were complex, such as where the upstream end of the pool was oriented diagonally across the channel, the midpoint of the upstream end of the pool was used to measure pool length.

Table 2.6. Minimum qualify pool unit dimensions.

AVERAGE BFW of SEGMENT (METERS)	MINIMUM SURFACE AREA OF POOL (METER^2)	MINIMUM RESIDUAL POOL DEPTH (METERS)
0-2.5	0.5	0.10
2.5-5.0	1.0	0.20
5.0-10.0	2.0	0.25
10.0-15.0	3.0	0.30
15.0-20.0	4.0	0.35
>20	5.0	0.40

Large woody debris cover in each pool was visually estimated and recorded as one of three categories: 0-5%, 6-20%, and >20% woody cover. Data on the factors or agents acting to form the pool were also recorded for each pool. The categories used to define pool forming agents included: LWD, logjams, roots of standing trees, bedrock, boulders, channel bedform, resistant bank, riprap, and beaver dams. In general, only pools within the primary/core habitat zone were measured. In some cases pools in side channels were recorded but noted as secondary habitat units. In situations with multiple pools or scour pockets connected by a common pool outlet (or outlets) the entire channel length connected by the common outlet was defined as a single pool.

2.2.2.1 HABITAT TARGETS AND RATINGS

2.2.2.1.1 LWD TARGETS

Evaluation of habitat data can be complex; there is no single set of standards that can be used to classify habitat data as good or bad. When considering LWD conditions in a stream or stream segment, several different LWD attributes need to be examined to understand the LWD conditions. The most common LWD attribute used to express LWD condition is frequency (LWD/CW or LWD/BFW). Within this region the most common LWD frequency standards used are those found in the WFPB Manual for Conducting a Watershed Analysis (WFPB 1997), where 2 pieces per channel width (CW) are considered good conditions and < 1 piece per CW is considered poor. McHenry (1999) cautions the use of this standard in the nearby Hoh watershed for two separate reasons: a) LWD frequencies in old growth stands within the Hoh Watershed averaged nearly 6 pieces/CW and b) at least two studies have shown that LWD frequencies may not be sensitive to the effects of timber harvesting (Ralph et al. 1994; McHenry et al. 1998). In a study of Hoh River tributaries Cederholm and Scarlett (1997) used a mean piece frequency of 60 pieces/100 meters as an indicator of intact/target piece frequency.

Ralph et al. (1994) present the hypothesis that wood volume is more sensitive to timber harvest than simple piece count. They found that an average of 60% of all LWD in unlogged basins were >50 cm diameter (range 27-95%; calculated by piece count). The percent of LWD >50cm is an important metric used throughout this report because LWD volumes were not measured and the number, frequency, and proportion of LWD > 50 cm are the only indicators of LWD volume within the dataset. Key piece frequency targets (pieces/BFW) defined in WFPB Indices of Resource Condition (1997) define habitat quality conditions based on piece frequency as: poor (<0.15 key pieces/CW), moderate (0.15-0.30 key pieces/CW), and good (>0.30 key pieces/CW) for channels < 10m BFW and poor (<0.20 key pieces/CW), moderate (0.20-0.50 key pieces/CW), and good (>0.50 key pieces/CW) for channels 10-20m BFW. Table 2.7 defines the default LWD habitat condition ratings made for LWD conditions throughout this report. Other LWD metrics may also be used to describe and evaluate LWD conditions.

Table 2.7. Summary of LWD habitat condition ratings.

LWD Attributes	Habitat Condition Rating		
	Poor	Fair	Good
Pieces/100 meters	<40	40-60	>60
Pieces/BFW	<2	2-4	>4
Large pieces/BFW (10-20m BFW)	<1	1-2	>2
Large pieces/BFW (<10m BFW)	<0.5	0.5-1.0	>1.0
Key Pieces/BFW (BFW<10m)	<0.15	0.15-0.30	>0.3
Key Pieces/BFW (BFW10-20m)	<0.2	0.2-0.5	>0.5
Percent of Pieces > 50 cm diameter	<25%	25%-50%	>50%

2.2.2.1.2 POOL HABITAT TARGETS

Several different metrics can be used to describe pool characteristics including: surface area in pools, maximum pool depth, holding pool frequency, residual pool depth, average pool length, percent woody cover in pools, pool frequency, and percent pools formed by LWD. No single pool attribute alone can accurately reflect pool conditions for a stream. Many of the widely used pool habitat targets and rating systems only use the quantity of pool habitat as a measure of pool conditions. Within this report the main rating standards used are those found in the WFPB Manual for Conducting a Watershed Analysis, Indices of Resource Conditions (WFPB 1997; Table 2.8). In addition to percent pool, pool frequency, and wood cover in pools, this analysis uses several other pool quality factors to describe and rate pool habitat. Each pool surveyed was classified by the primary pool forming agent, and evaluated based on the depth, length, cover, etc. to determine the quality of pools at the segment and watershed scale. This assessment of pool habitat weighs both the quantity and the quality of pools to describe the condition of pool habitat.

Table 2.8. Summary of pool habitat condition ratings.

Habitat Parameter	Channel Type	Habitat Quality Rating		
		Poor	Fair	Good
Percent Pool	<2%; < 15m BFW	<40%	40 - 55%	>55%
	2-5%; < 15m BFW	< 30%	30-40%	> 40%
	>5%; < 15m BFW	< 20%	20 - 30%	> 30%
Pool Frequency	BFW < 15m	> 4 CW/Pool	2-4 CW/Pool	<2 CW/Pool
Percent Wood Cover in pools	<5%; < 15m BFW	Most pools in low category 0-5%	Most pools in moderate category 6-20%	Most pools in high category > 20%
Holding Pools	0-5%; <20m BFW	<5 Pools/km	6-9 Pools/km	>10 Pools/km

2.3 FLOODPLAIN AND RIPARIAN CONDITION ASSESSMENT

Floodplain and riparian habitat conditions adjacent to the mainstem of the Clallam River were assessed using geo-rectified high resolution aerial photographs, color orthophotos, high resolution LiDAR data, and field observations From the confluence with the Strait to the end of segment 5 the bankfull edge of the mainstem was delineated for each channel segment. All areas within 60 meters of the bankfull edge were mapped and assessed for riparian condition. Riparian condition was classified as either forested or un-forested. Forest types or stand types were classified using the attributes defined in Table 2.3. A total of 13 stand types were identified in segments 1 through 5. Un-forested riparian areas were classified as one of the following: roads, rural residential (RR), high density housing (HD), un-forested beach deposits (UFBD), pastures (P), pastures with planted trees (PPT), and other disturbed un-forested areas (ODNF). Roads were inventoried and classified as one of the following: private road (PVR), state highway (SH), railroad grade (RRG), or other public road (OPR).

Every portion of the riparian area within 60 meters of the bankfull edge was delineated and mapped as a polygon and classified as described above. Buffers of 10, 20, 30, and 60 meters were then intersected with all of the riparian condition polygons at the segment level. This provided an accurate measure of the area and riparian conditions within each of the 10, 20, 30, and 60 meters buffers adjacent to the river. For simplification purposes a classification of riparian impairment was developed that classified riparian condition impairment as one of the following: un-impaired/slightly impaired riparian function, impaired riparian function, and non-functioning riparian condition (Table 2.9). Forest stand types within the un-impaired/slightly impaired riparian function category included: CLD (conifer large dense), MLD (mixed large dense), and forested beach deposits (FBD). Riparian conditions within the impaired riparian function category included: CLS (conifer large sparse), CMD (conifer medium dense), DLD (deciduous large dense), DMD (deciduous medium dense), MLS (mixed large sparse), MMD (mixed medium sparse), and MMS (mixed medium sparse). Riparian conditions within the non-functioning category included: CSD (conifer small dense), DSD (deciduous small dense), MSS (mixed small sparse), MSD (mixed small dense), UFBD (un-forested beach deposit), P (pasture), PPT (pasture with planted trees), ODNF (other disturbed un-forested areas), SH (state highway), PVR (private road), OPR (other public road), RRG (railroad grade), HD (high density housing), and RR (rural residential).

Table 2.9. Simplified riparian function categories and corresponding riparian conditions.

Riparian Function	Riparian Condition
Un-Impaired/Slightly Impaired	CLD, MLD, FBD
Impaired	CLS, CMD, DLD, DMD, MLS, MMD, MMS
Non-functioning	CSD, DSD, MSS, MSD, UFBD, P, PPT, ODNF, SH, PVR, OPR, RRG, HD, RR

3 RESULTS

This chapter of the report presents the results of field work and summarizes previous studies and assessments conducted within the Clallam River watershed. This chapter is divided into six main subsections.

- Fish Populations and Distribution (Section 3.1)
- Channel and Habitat Conditions (Section 3.2)
- Floodplain and Riparian Conditions (Section 3.3)
- Habitat Access (Section 3.4)
- Streamflow Conditions (Section 3.5)
- Water Quality Conditions (Section 3.6)

3.1 FISH POPULATIONS AND DISTRIBUTION

Currently there are five known species of salmonids that utilize the Clallam River watershed: coho, chum, and Chinook salmon, and steelhead and cutthroat trout. Other non-salmonid species present in the Clallam River include: three-spine stickleback (*Gasterosteus aculeatus*), Pacific lamprey (*Lampetra tridentata*), coast range sculpin coastrange sculpin (*Cottus aleuticus*), and prickly sculpin (*C. asper*).

3.1.1 ANADROMOUS FISH DISTRIBUTION

A total of 232 stream channel segments were inventoried within and/or adjacent to the anadromous fish zone. A total of 62.0 miles of stream channel were included in the inventory of anadromous fish use. Of this length a total of 30.8 miles were field surveyed. All inventoried channel segments were classified based upon the following anadromous fish-use categories: confirmed use, assumed use, potential use, use unlikely, and no use (see Section 2.1.1). Table 3.1 depicts the total stream lengths within each of the five anadromous fish-use categories. Anadromous fish use was defined as confirmed, assumed, or potential for 52.9 miles of stream channel. Channel segments within the remaining 9.1 miles of stream channels inventoried were classified as no use or use unlikely.

Table 3.1. Stream lengths classified by category of anadromous fish use within the Clallam River watershed.

Anadromous Fish Use Category	Miles Stream within Category (km)	Percent of Stream Length Surveyed
Confirmed Use	32.5 (52.3)	80%
Assumed Use	6.6 (10.6)	25%
Potential Use	13.8 (22.3)	20%
Unlikely Use	5.4 (8.6)	9%
No Use	3.7 (6.0)	2%

The distribution of anadromous fish habitat in the Clallam River watershed is depicted in Figure 3.1. No species specific anadromous fish distribution map was generated due mainly to a lack of long-term fish use data.

In 2002, WDFW conducted an extensive statewide stock assessment which identified the following stocks within the Clallam River watershed (review of chum and chinook salmon, and steelhead trout spawning ground survey data is ongoing; coho data 1942-97 currently being reviewed and summarized.

- Clallam River Coho (Healthy)
- Sekiu/Hoko/Clallam Chum Salmon (Unknown)
- Clallam River Steelhead (Unknown)
- Western Strait of Juan de Fuca Cutthroat Trout (Unknown)
- Chinook Salmon Not Included.
- No salmon or trout species in the Clallam River are currently listed under the ESA.

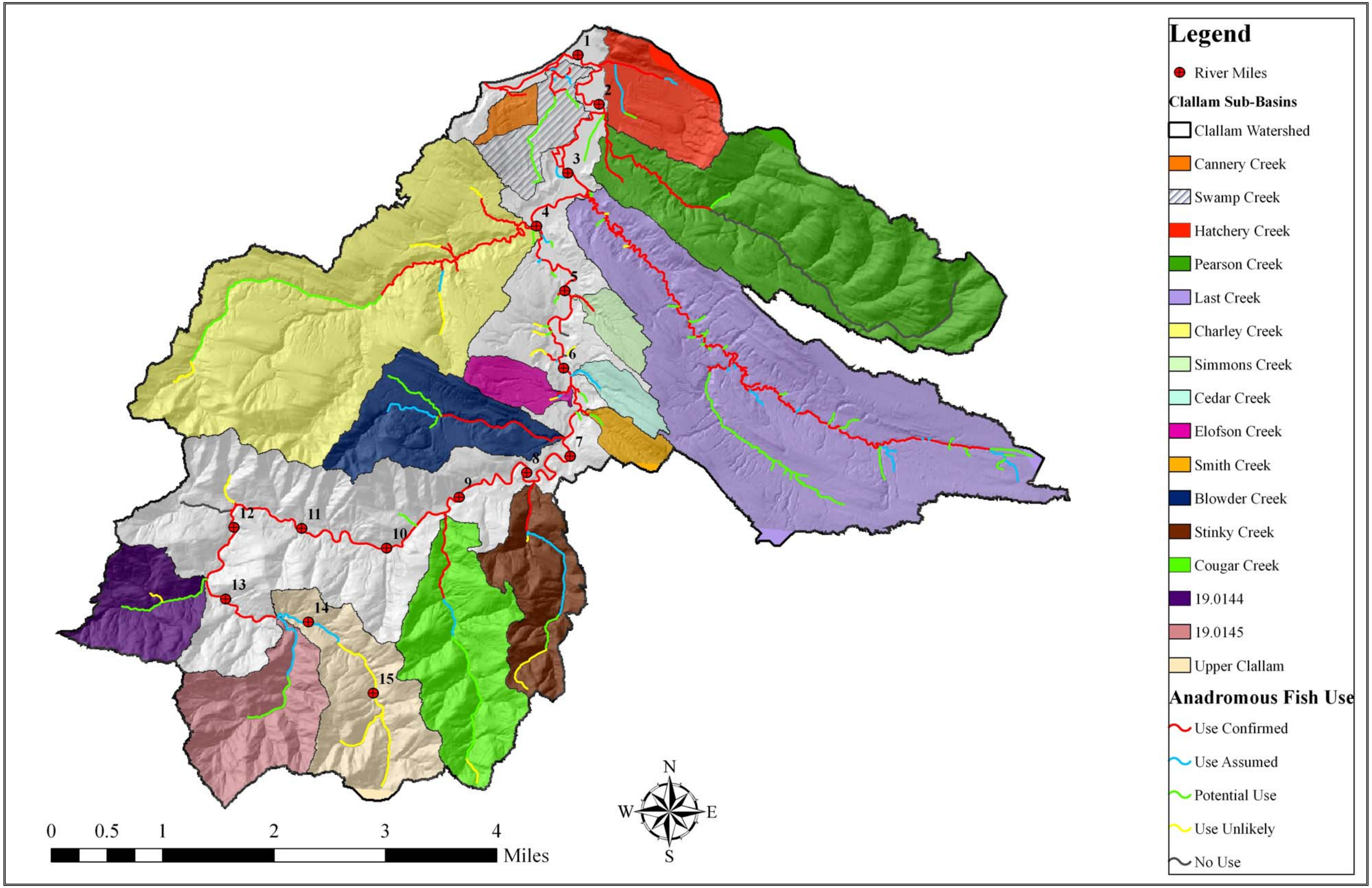

Figure 3.1. Clallam River watershed channel segments and their corresponding anadromous fish use classification.

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3.1.2 *COHO SALMON (O. kisutch)*

Coho salmon are the most abundant species of salmon in the Clallam River. Adult coho salmon begin entering the river as early as September if flows permit. Generally October and November are the peak months for migration into the river. Coho salmon spawn from late-October through January (WDFW unpublished spawning ground survey database, 2007). Peak spawning typically occurs from late-November through mid-December. Coho salmon are generally found spawning in smaller streams than Chinook, and often at higher gradients (Quinn 2005). Coho spawning occurs in numerous tributaries to the Clallam River, as well as in the mainstem. The primary coho spawning tributaries include: Charley, Pearson, Last, South Fork Last, and Blowder Creeks. Figure 3.2 depicts spawning ground survey data summarized as average redds/mile by survey segment for return years (RY) 1998 through 2005.

Fry emergence occurs from February through April with peak emergence during the month of March (based on spawning timing and water temperature it was assumed that egg-to-fry emergence required 100-130 days emergence depending upon temperature). Clallam River stream temperatures from November through March averaged 6.1 and 6.3ºC during return years 2005 and 2006 respectively (DOE unpublished water temperature data). After emergence fry will continue to hide in gravel interstices and under cobbles during daylight hours, but within a few days they progress to swimming near stream banks and take advantage of available cover, often congregating in quiet backwaters, side channels, and small streams (Sandercock 1991). Early stream rearing often occurs in small habitats and very small tributaries no accessible to adult coho.

As spring progresses and the coho fry increase in size they will begin occupying habitats throughout the Clallam River mainstem. Juvenile coho born in tributaries may develop rearing territories locally where they were spawned or they migrate downstream, upstream, or into the mainstem seeking rearing habitat. Juvenile coho may occupy all accessible habitats during the summer and earlier fall months with a preference for small to large pool habitats. Once the fall rains set in and flows increase juvenile coho will seek lower energy habitat with ample cover. Snorkel surveys conducted in the winter of 2001/02 indicated that juvenile coho extensively use undercut banks in the upper mainstem (RM 11.7-10) where in-channel complex habitat is scare and off-channel habitat is absent. Below river mile 7.0 low energy, off-channel habitat is more abundant and juvenile coho have been documented in most of the accessible habitats.

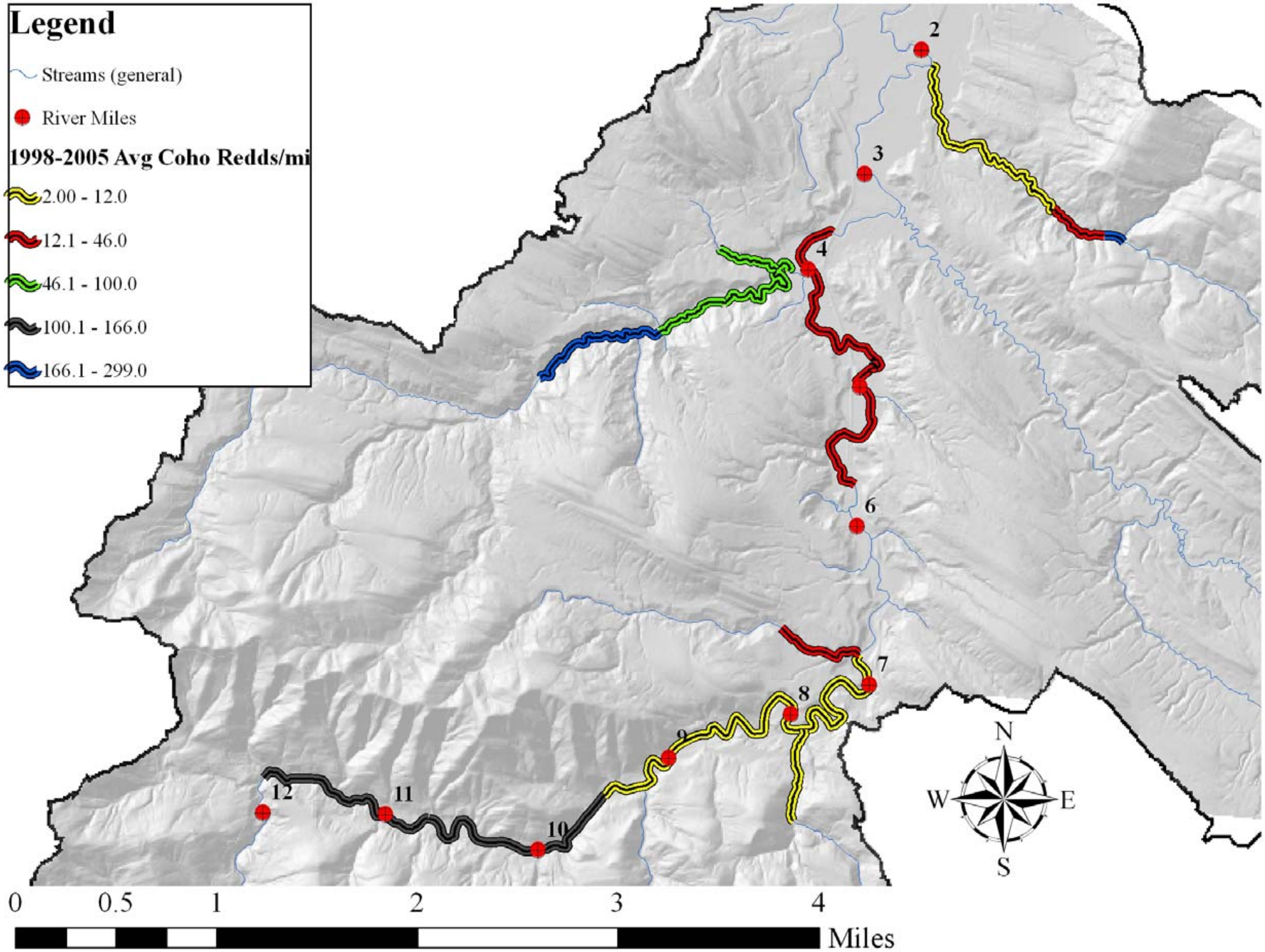

Figure 3.2. Summary of coho spawning ground survey data for return years 1998-2005, summarized as average redds/mile (Lower Elwha Klallam Tribe and WDFW unpublished spawning ground survey data 2007).

Little specific information exists on the movement patterns of age 1+ coho during the spring smolt emigration period. In Johnson Creek, as tributary to the Hoko River coho pre-smolt have been observed moving into the mainstem Hoko River as earlier late-March. In Deep Creek and the East and West Twin Rivers smolt emigration into the Strait of Juan de Fuca begins in April, with peak trap counts usually occurring from mid- to late-May. Smolt trap counts in these three systems usually taper off by late-June. Smolt emigration in the Clallam River is expected to be similar as that observed and documented in nearby watershed draining into the Strait of Juan de Fuca. During years when the Clallam River is bar bound during the months of May and June those juvenile coho that have not left the river will not have access to the Strait until a connection is reestablished between the river and the Strait (see Section 3.4.2). The lack of access to the marine environment may result is large scale mortality of juveniles (e.g., 2004 smolt emigration) and the subsequent lack of adult spawning recruitment (e.g., return year 1999). Coho salmon typically spend one and half years at sea and return to the Clallam River as three-year olds.

3.1.2.1 COHO SALMON FISHERIES

Currently the Clallam River is closed to salmon fishing and therefore freshwater fisheries have a limited affect on the population. Poaching of coho salmon in the Clallam River occurs during some years and may be a significant source of mortality. However, the vast majority of fishing mortality occurs in ocean fisheries. During the early 1980s the west coast Vancouver Island troll fishery expanded rapidly and interception rates for Washington coho increased to as high as 86 percent (McHenry et al. 1996). During the period from 1988 through 1995, the Strait of Juan de Fuca coho stock failed to reach its escapement goal each year (Pacific Fishery Management Council [PFMC] 1997). Coho salmon exploitation rates in the marine environment for return years 1992-1994 averaged approximately 62 percent (based Elwha River coded wire tagged hatchery coho recoveries). Chronic failure to achieve the desired escapement goal necessitated a formal review and assessment of Strait of Juan de Fuca coho under Amendment 10 to the Pacific Fishery Management Council's salmon fishery management plan. This review began in 1995 and resulted in the development of the 1997 over fishing report (see PFMC 1997). The over fishing report concluded that most fishing related mortalities occur in Canadian fisheries, limiting the ability of U.S. management agencies to significantly reduce harvest impacts. The report recommended that the PFMC, State of Washington, and affected tribes develop and implement a fishery management plan that uses an exploitation rate management regime versus using the fixed escapement goal system. This approach along with reduced Canadian fisheries impacts during the last 10 years has resulted in exploitation rates below 40 percent; thereby significantly increasing the number of coho salmon reaching the spawning grounds in tributaries to the Strait of Juan de Fuca.

3.1.2.2 COHO SALMON HATCHERY PRACTICES

The history of hatchery introductions of coho salmon in the Clallam River watershed is poorly documented in the regional salmon literature. WDFW reports that off station releases of yearling coho occurred from 1958 to 1975 (WDFW 2002). In order to determine the history of releases in the Clallam River watershed the Regional Mark Inventory System (RMIS) database was queried (for additional information see www.rmpc.org). Additional releases not included in the RMIS database likely occurred as a result of hatchery releases by the Clallam Bay High School hatchery program. The Clallam Bay High School hatchery program reared and released coho and Chinook salmon during the mid-1970s to the late-1980s. Many of the coho releases included in the database were part of this program but that the records do not appear to be complete. In addition, some juvenile coho were reared in the Clallam River watershed but were then released into net pins in Clallam Bay and therefore not directly counted as releases into the Clallam River watershed.

A total of 1,711,965 coho smolts, fingerlings, and fry were released between 1952 and 1987. These releases were composed of broodstock from the following streams, rivers, and/or hatchery stocks: Dungeness River, Big Soos Creek, Lake Creek (Sol Duc River tributary), Washougal River, Sol Duc River, George Adams hatchery, and Elwha River. A detailed table depicting brood year, release year, weight of fish released, release stage, release location, number released, and broodstock origin is included in Appendix A (Table A- 1). No genetic evaluation of this stock has occurred but it has been suggested that the stock is likely a mixture of the native stock and the non-native introduced stocks (WDFW 2002).

3.1.2.3 COHO SALMON POPULATION STATUS

The Clallam River coho population is part of the Western Strait of Juan de Fuca (WSJF) coho stock complex as defined by WDFW and tribes (WDF et al. 1994). This complex is part of the Olympic Peninsula evolutionarily significant unit (ESU) as defined by NMFS (Weitkamp et al. 1995). The State and tribal stock status review conducted in 1992 determined that the status of the Clallam River stock was unknown (WDF et al. 1994). In 1995 the NMFS conducted an extensive population status review for west coast coho salmon populations and it was determined that the Olympic Peninsula ESU is not in danger of extinction and that it is not likely that to become endangered in the foreseeable future unless conditions change substantially (Weitkamp et al. 1995). In 2002 WDFW completed another stock status review of Clallam River coho and determined that the stock was healthy based upon the upward abundance trend and the robust estimates of total escapement (WDFW 2002).

The majority of trend data used by WDFW in their stock status review came from a short reach of Charley Creek (RM 0.9-1.5) that has been consistently surveyed since 1984 (average of 7.2 surveys/year). Figure 3.3 depicts the total number of coho redds observed in Charley Creek from RM 0.9 to 1.5. The long term trend (1984-2006) indicates that there is a significant ($p<0.05$) increasing trend in the number of coho redds observed. The short term trend in Charley Creek (1998-2006) shows a decreasing trend in the number of redds observed, however, this trend is not statistically significant ($p=0.38$).

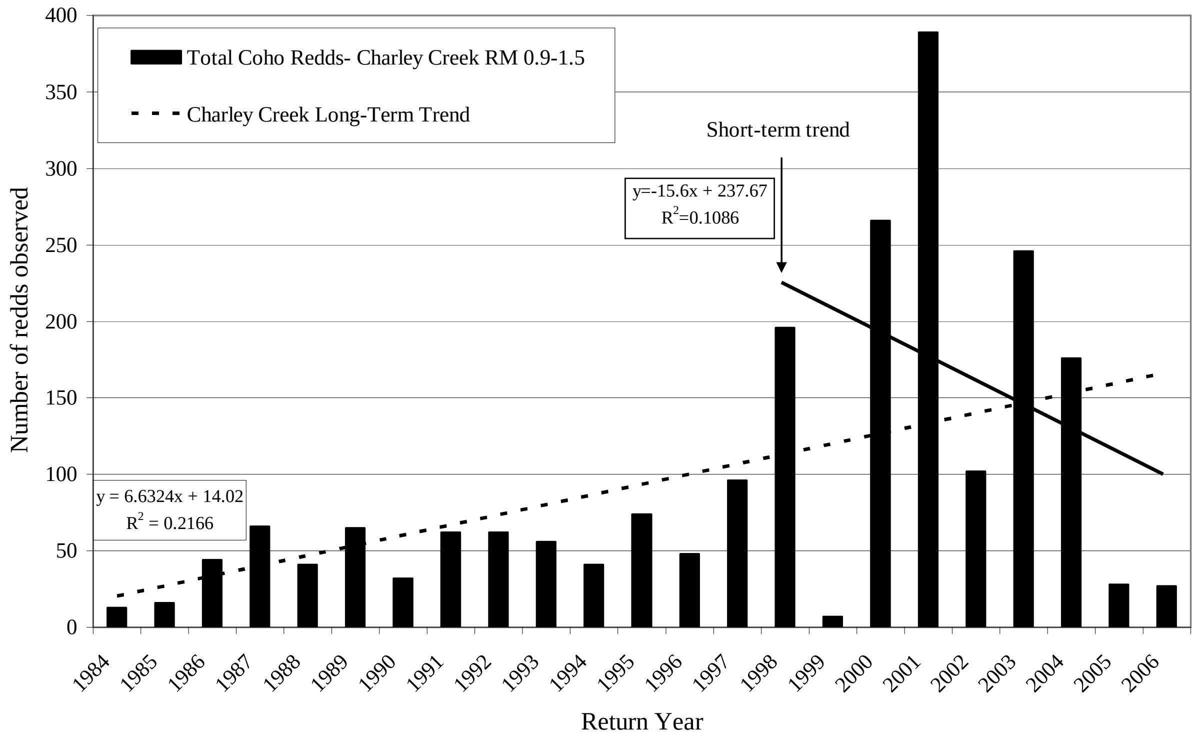

Figure 3.3. Total number of coho redds observed in Charley Creek (RM 0.9-1.5) for return years 1984 through 2006 (source: WDFW unpublished spawning ground survey data).

Coho escapement estimates for the entire watershed are available for return years 1998 through 2005. These data indicate that escapement has ranged from a low of 421 (RY 1999) to a high of 5,509 (RY 2001), averaging 2,892 (Lower Elwha Tribe and WDFW unpublished spawning ground escapement estimates). Figure 3.4 depicts Clallam River, WSJF, and entire SJF[1] coho escapement estimates for the period 1998 through 2005. These data show that the short-term abundance trend of the Clallam River and the WSJF is slightly negative, while the trend for the entire SJF is slightly positive. None of these trends are statistically significant ($p>0.05$). Coho spawning ground data collected in Charley Creek for RY 2006 suggests that the escapement for RY 2006 for the entire Clallam River watershed was similar to that observed in RY 2005.

[1] Escapement estimates for the entire Strait of Juan de Fuca do not include escapement estimates for the Elwha and Dungeness Rivers, as these systems are managed for composite production and escapements and run-sizes are heavily influenced by hatchery production.

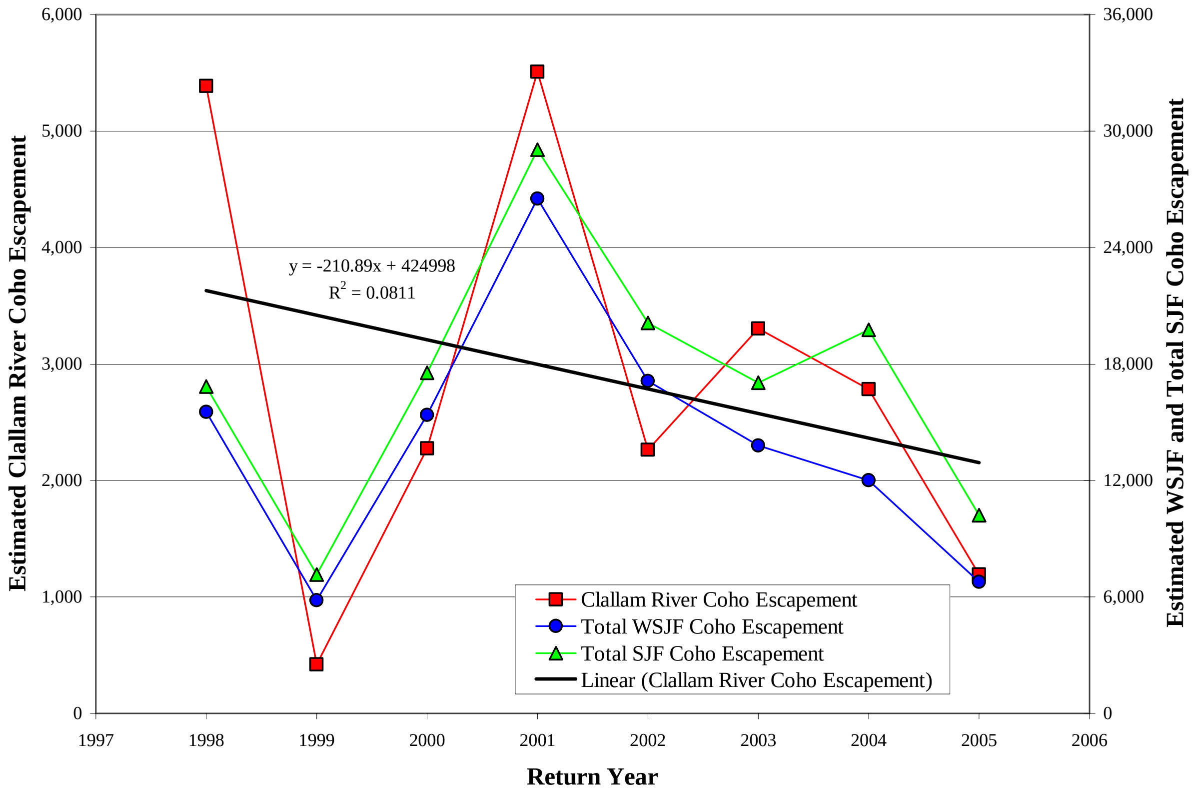

Figure 3.4. Estimated coho spawning escapement for the Clallam River, western Strait of Juan de Fuca production unit, and the entire Strait of Juan de Fuca production area for return years 1998 through 2005 (source: Lower Elwha Tribe and WDFW unpublished spawning ground escapement estimates)

3.1.3 STEELHEAD TROUT

Within the Pacific Northwest steelhead populations can be classified as either winter- or summer-run. Steelhead in the Clallam River are classified as winter-run steelhead. Interestingly during habitat surveys conducted in early-August two ocean bright summer-run steelhead were observed near river mile 10. Within the WSJF streams adult steelhead begin entering the system in November and will continue entering freshwater until May. Spawning takes place from December through mid-June with peak spawning taking place from late-February through mid-April. Steelhead trout primarily spawn in the mainstem of the Clallam River but spawning also occurs in the larger tributaries (e.g., Charley Creek). During habitat surveys in Charley Creek several steelhead redds were observed. Evidence of extensive steelhead spawning was also documented in Cougar Creek (19.0141) where thousands of juvenile steelhead fry were observed during habitat surveys.

Steelhead fry have a protracted fry emergence period due to the long spawning season and variable incubation temperatures. Juvenile steelhead fry typically rear in freshwater for 2 to 3 years before smoltification but may rear in freshwater for1 to 7 years prior to smolting and emigrating (Wydoski and Whitney 2003). Steelhead smolt emigration timing in other WSJF is similar to that of coho salmon and is assumed to be similar in the Clallam River. Generally peak emigration occurs from mid-May to mid-June. Most coastal steelhead trout populations rear in the marine environment for 1.5 to 3.5 years prior to returning to spawn. Steelhead trout that survive after spawning typically return quickly to sea.

3.1.3.1 STEELHEAD TROUT FISHERIES

Currently the Clallam River is open to recreational steelhead fishing, however, the current regulations require the release of all wild steelhead. The season is open from June 1st until the last day of February. These regulations help minimize the impact to wild fish while providing a retention fishing opportunity for hatchery steelhead trout. From 1978 through 2004 sport fishers harvested an average of 57 steelhead per year (total=1,436). From 1986 through 1996 approximately 27 wild fish per year were harvested in the sport fishery (WDFW 2006). Since 1996 less than 3 wild steelhead per year have been harvested. Tribal fisheries from 1986 through 2002 harvested an average of 44 steelhead per year. During the last 10-year period (1993-2002) only 17 steelhead were harvested per year in the tribal fishery (WDFW 2006). Some ocean fisheries may also intercept Clallam River steelhead but no data are available to estimate the number of fish taken in these fisheries.

3.1.3.2 STEELHEAD TROUT HATCHERY PRACTICES

Steelhead trout are a prized game fish and an icon for Pacific Northwest fishers, therefore information regarding hatchery releases are readily available in numerous reports. Annual reports depicting steelhead harvest and hatchery releases have been published since 1950. Not all of these reports are currently available so the Regional Mark Inventory System (RMIS) database was queried (www.rmpc.org) for additional data where reports were unavailable (release years: 1982-1989, 1991-1992, and 1994). Where discrepancies existed between the two datasets data from the RMIS database query was used. A total of 191,662 steelhead smolts were released between 1978 and 2006. These releases were composed of broodstock from the following rivers, and/or hatchery stocks: Bogachiel, Hoko, and Quinault. A detailed table depicting brood year, release year, weight of fish released, release stage, release location, number released, and broodstock origin is included in Appendix A (Table A- 3). No genetic evaluation of this stock has occurred (WDFW 2002).

3.1.3.3 STEELHEAD TROUT POPULATION STATUS

The Clallam River steelhead stock is part of the Strait of Juan de Fuca (SJF) steelhead stock complex as defined by WDFW and tribes (WDF et al. 1994). This complex is part of the Olympic Peninsula steelhead evolutionarily significant unit (ESU) as defined by NMFS (Busby et al. 1996). The State and tribal stock status review conducted in 1992 determined that the status of the Clallam River stock was unknown (WDF et al. 1994). In 1996 the NMFS conducted an extensive population status review for Olympic Peninsula Steelhead and determined that the ESU is not in danger of extinction nor likely to become endangered in the foreseeable future (Busby et al. 1996). In 2002 WDFW completed another stock status review of Clallam River steelhead and determined that the stock status was unknown due to insufficient data to determine stock status (WDFW 2002). Since 2002 additional data has been collected. Escapement estimates for return years 1997/98 through 2005/06 are included below in Figure 3.5. These escapement estimates show a downward trend in abundance but the trend was not statistically significant (p=0.06).

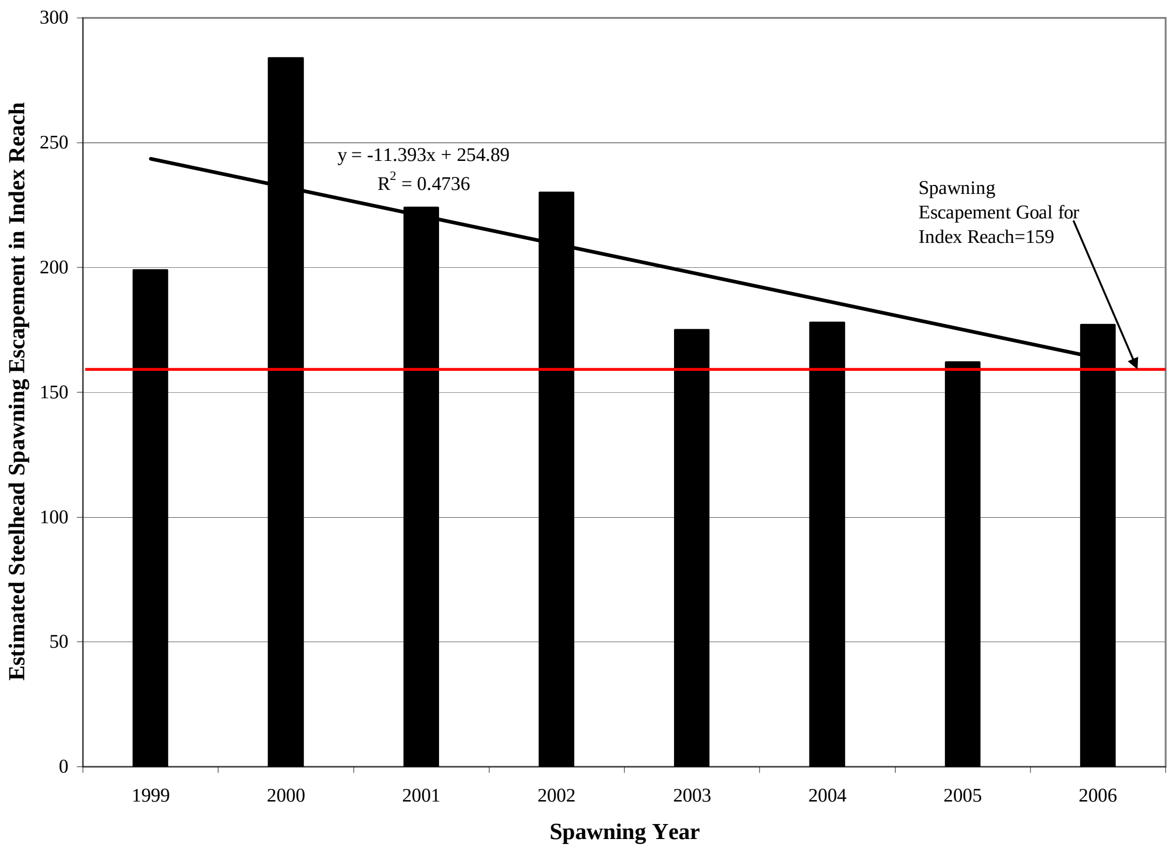

Figure 3.5. Estimated Clallam River steelhead escapement in steelhead index reach (WDFW RM 9.5 to 3.6) for return years 1998/99 through 2005/2006 (source: WDFW 2006; WDFW unpublished draft steelhead escapement estimate 2005/06).

Clallam River steelhead spawning ground survey data summarized as the total number of steelhead redds observed, number of survey days, total number of steelhead redds observed per stream mile, and total number of live and dead steelhead observed per spawning season are depicted in Figure 3.6. The number of steelhead redds observed per mile of stream in the mainstem Clallam River show a downward trend through time. This trend is statistically significant ($p<0.05$).

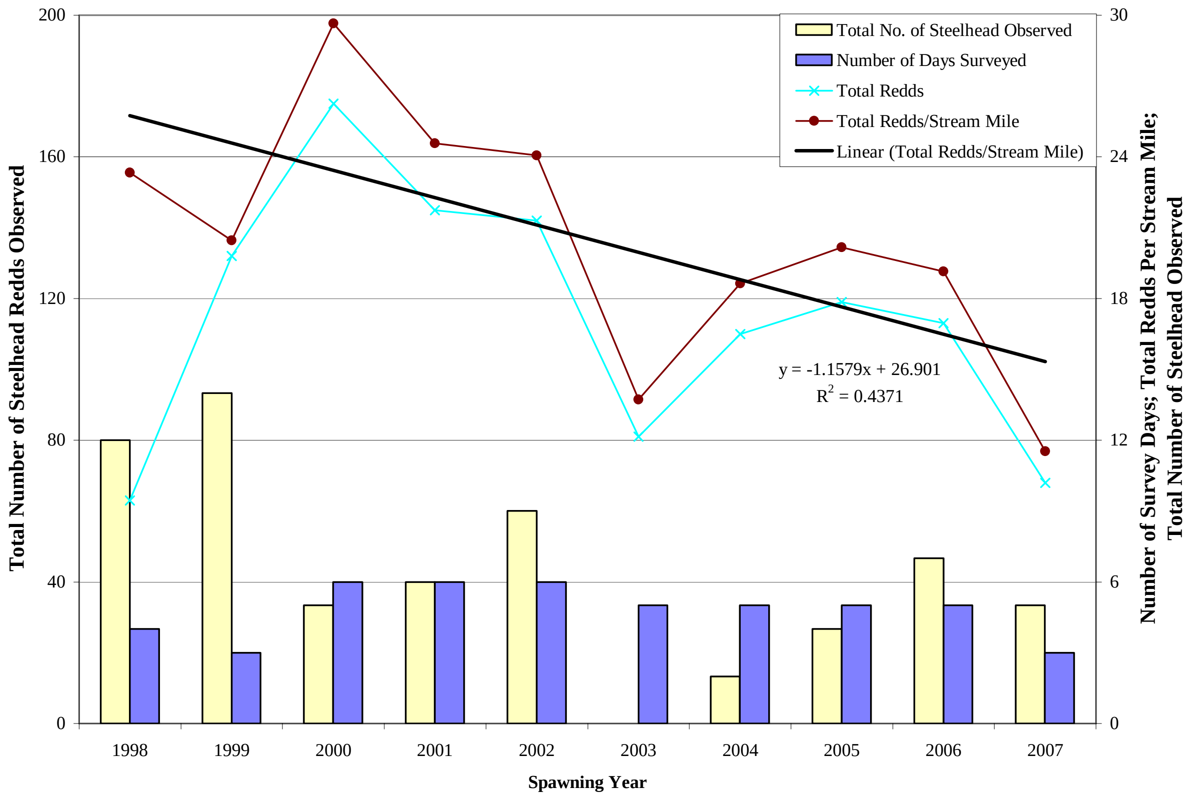

Figure 3.6. Clallam River steelhead spawning ground survey data depicting total number of steelhead redds observed, number of survey days, total number of steelhead redds observed per stream mile, and total number of live and dead steelhead observed per spawning season.

3.1.4 CHUM SALMON (O. keta)

Adult chum salmon return and spawn primarily during the months November and December as 3, 4, and 5 year old fish (based on age at return for other populations within the region). A limited number of spawners in the Clallam River watershed have been documented spawning as late as mid-January. Chum salmon have been documented spawning in the mainstem Clallam River from just upstream of tide water, to river mile 10 (see Figure 3.1). Chum salmon have also been documented spawning in several tributaries including: Hatchery, Pearson, Last, Charley, and Blowder Creeks. Chum salmon have been observed spawning in Charley Creek more frequently than all of the other tributaries listed above. Limited spawning ground survey data indicates that the majority of chum spawn in the mainstem Clallam River between RM 4.0 and 6.0 (WDFW/LET unpublished spawning ground data).

Unlike coho salmon and steelhead trout chum salmon rear in fresh water only briefly (a few weeks to few months) before emigrating to the ocean. Their brief residence time in freshwater differentiates factors that limit their abundance and productivity from species such as coho that require specific habitat types during their extended freshwater rearing residence. Clallam River chum salmon are part of the Hoko/Clallam/Sekiu chum salmon production unit. There are no records of chum salmon being planted in the Clallam River watershed (RMIS database query 2007). No genetic analysis has been done on the Hoko/Clallam/Sekiu chum salmon unit to determine population status relative to regional populations.

This unit, along with the Pysht, Deep Creek/Twin Rivers, Lyre, Elwha, and Dungeness/Eastern Strait production units make up the SJF chum management unit (also includes production from other miscellaneous tributaries to the SJF, e.g., Sail River). Data relating to this stocks interception in ocean fisheries are limited or non-existent (although the stock is managed for in marine area chum fisheries). Currently the Clallam River is closed to salmon fishing and therefore freshwater fisheries have a limited affect on the populations abundance. No spawning escapement or run-size estimates for the Hoko/Clallam/Sekiu chum exist. WDFW currently lists the stock status for this chum unit as unknown. For fisheries management purposes the Co-managers use indicator stocks (Pysht River and Deep Creek) to estimate the abundance of chum salmon in unsurveyed tributaries to the western SJF.

Figure 3.7 depicts recent spawning escapements in the Pysht River and Deep Creek/Twin Rivers chum salmon production units. WDFW currently classifies the status of Pysht River chum as healthy. The population trend in Figure 3.7 is slightly negative but is not statistically significant ($p>0.05$). The status of Deep Creek/Twin Rivers chum is listed as depressed (WDFW 2003) and the trend is markedly negative and is statistically significant ($p<0.05$). Several years of spawning ground survey data are available for a few stream reaches in the Clallam River. These data were analyzed and compared to Pysht and Deep Creek/Twin Rivers to determine if any trend could be detected (Figure 3.8). For years with corresponding data (1997-2003) Clallam River chum salmon annual peak spawner counts generally track peak counts observed in the Pysht River system.

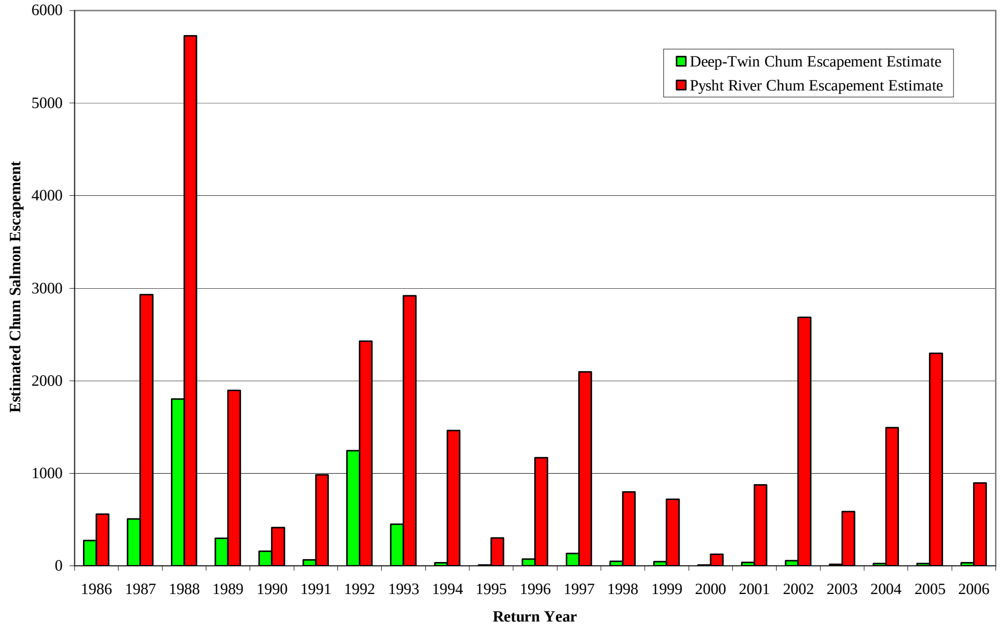

Figure 3.7. Chum salmon spawning escapement estimates for Pysht River and Deep/Twin River chum salmon production units (source: WDFW 2003; unpublished data).

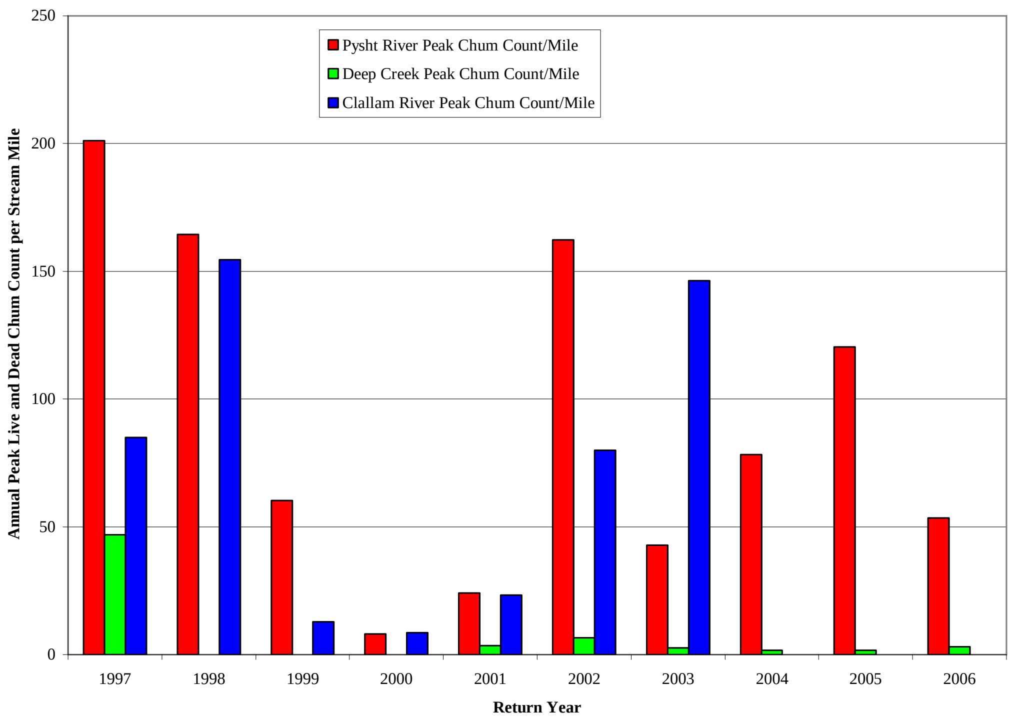

Figure 3.8. Annual peak live and dead chum salmon counts per stream mile for Pysht River, Deep Creek, and Clallam River (Source: WDFW/Tribal unpublished data).

3.1.5 CUTTHROAT TROUT (*O. clarki clarki*)

Clallam River cutthroat trout are part of the Western Strait coastal cutthroat stock complex which extends from the Pysht River west to Cape Flattery (WDFW 2000). This complex is part of the Olympic Peninsula cutthroat trout evolutionarily significant unit (ESU) as defined by NMFS (Johnson et al. 1999). In general, coastal cutthroat trout exhibit four discrete life history forms: sea-run/anadromous, adfluvial, fluvial, and resident (Johnson et al. 1999). Both anadromous and non-anadromous forms are present in the Clallam River. Non-anadromous cutthroat are likely present in most fish bearing tributaries upstream of anadromous barriers, however, it is unknown whether these trout are resident, fluvial and/or adfluvial (WDFW 2000). It has been suggested that this stock complex has a late entry timing with spawning occurring from January through April (WDFW 2002). No distinct spawning populations have been identified within the Western Strait stock complex. There have been no releases of hatchery-origin coastal cutthroat within the Western Strait coastal cutthroat stock complex watersheds. No quantitative abundance data are available for Clallam River cutthroat and therefore the stock status was classified as unknown by WDFW. In 1999 the NMFS conducted an extensive population status review for coastal cutthroat populations in Washington, Oregon, and California and determined that the Olympic Peninsula cutthroat trout ESU is not in danger of extinction and that it is not likely that to become endangered in the foreseeable (Johnson et al. 1999).

The Clallam River cutthroat population abundance may be negatively affected by the freshwater sport fishery. Trout fishing effort on the Clallam River appears to be light in comparison to many North Olympic Peninsula streams. Currently the season is open for fishing from June 1st to the last day of February and allows for the retention of two-fish per day with a minimum 14- inch size limit. The minimum 14-inch size limit was established to protect first time spawners and some repeat spawners. There is no catch reporting system for cutthroat trout and therefore no estimates of the number of fish harvested are available.

3.1.6 CHINOOK SALMON (*O. tshawytscha*)

There remains some debate between local biologists and stakeholders regarding the historical presence of Chinook salmon in the Clallam River watershed. The North Olympic Peninsula Lead Entity recovery strategy states, "…there is no evidence that there ever was Chinook in [the] Clallam." However, Kramer (1952) reports that a small run of Chinook salmon was present in 1952 and that Chinook, chum, and steelhead runs were nearly depleted in the Clallam. The Clallam River is similar in drainage area, size, and gradient to the Pysht and Sekiu Rivers both of which historically had small runs of Chinook salmon; further supporting the hypothesis that Chinook salmon were historically present. The 1992 salmon and steelhead stock assessment defines the Hoko/Western SJF Chinook stock as being made up of spawning Chinook salmon in the Hoko, Pysht, Clallam, Sekiu, and Lyre rivers (WDF et al. 1994). The 2002 salmon and steelhead stock assessment makes no mention of Chinook salmon in the Pysht, Clallam, Sekiu, and/or Lyre rivers.

Within the Hoko River system Chinook begin entering the estuary and lower river as early as late-August and will continue entering the system through late-October to early-November. Upon entering the system Chinook will typically hold until the first significant rainfall event in October and then quickly migrate upstream to suitable spawning habitat. In most years spawning occurs from late-September through late-November. Peak spawning in the Hoko River typically occurs in late-October. Significant numbers of spawning Chinook have been observed into late-November. Fry will emerge in late-winter or early-spring and rear in the mainstem and large tributary habitat through May. Peak juvenile emigration in the Hoko River occurs from late-May to late-June. The Hoko River Chinook population has a complex age structure with spawners returning as two through seven year old fish (Haggerty et al. 2001). The majority of spawners (84%) during return years 1988 through 1999 returned four- and five-year old fish. Average age at return for the run during this period was 1, 9, 38, 46, 6, and less than 1 percent for age 2, 3, 4, 5, 6, and 7 year old fish respectively.

As described above the history of hatchery releases in the Clallam River watershed is poorly documented in the regional literature. In order to determine the history of releases in the Clallam River watershed the Regional Mark Inventory System (RMIS) database was queried (for additional information see www.rmpc.org). Additional releases not included in the database may have occurred but such information is unknown to the author of this report. A total of 3,714,196 Chinook smolts, fingerlings, and fry were released between 1961 and 1975. These releases were composed of broodstock from the following streams, rivers, and/or hatchery stocks: Deschutes River, Big Soos Creek, Finch Creek, Minter Creek, Sol Duc River, Elwha River, and Hood Canal. A detailed table depicting brood year, release year, weight of fish released, release stage, release location, number released, and broodstock origin is included in Appendix A (Table A- 2).

No spawning escapement or run-size estimates for the Clallam River Chinook exist. WDFW currently does not include Clallam River Chinook as part of the WSJF Chinook stock. The 1992 status of WSJF Chinook (including Clallam River) was classified as depressed (WDF et al. 1994). The current status of Hoko River Chinook (WSJF Chinook) is depressed. Since 1983 only a handful of Chinook salmon have been documented during spawning ground surveys.

3.2 CHANNEL AND HABITAT CONDITIONS

Stream channel and habitat surveys were conducted throughout the mainstem Clallam River and in almost all significant tributary sub-basins. The results from these surveys are included below in two main subsections. Section 3.2.1 includes a summary of channel and habitat conditions in the mainstem Clallam River and Section 3.2.2 includes a summary of channel and habitat conditions in the tributaries.

3.2.1 MAINSTEM HABITAT INVENTORY

A total of 22 habitat segments were identified and inventoried in the mainstem from the confluence with the Strait of Juan de Fuca to river mile 15.8. Stream gradient remains less than 0.3 percent from the confluence with the Strait to RM 5.8 (segment 4/5 break). From RM 5.8 (segment 5) to RM 7.8 (segment 7) stream gradient ranges from 0.6 to 0.9 percent. Gradient increases average 1-2 percent from RM 7.8 to RM 12.7 (segment 13). Gradient ranges from 2-3 percent from RM 12.7 to RM 14.4 (segment 15). Stream distance versus elevation above sea level is depicted in Figure 3.9. A summary of the channel segment attributes (length, channel type, habitat type, anadromous fish use category, gradient, channel confinement, average bankfull width, average bankfull depth, average wetted width, average, depth, dominant substrate type, and the percent of habitat surveyed) is included in Appendix B for all channel segments inventoried.

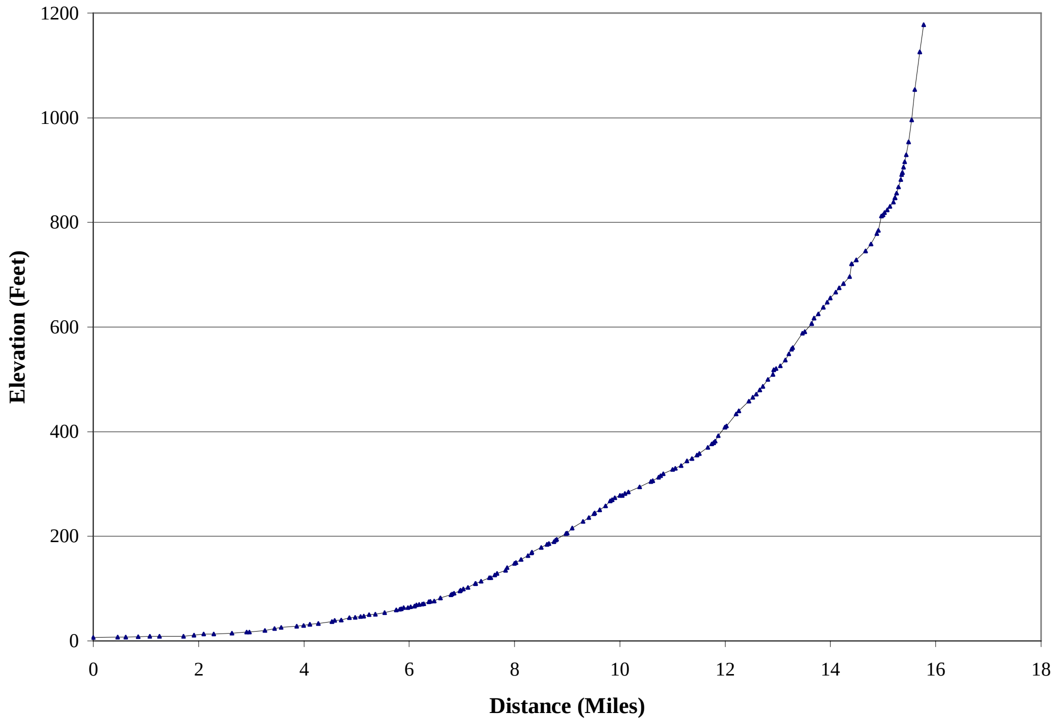

Figure 3.9. Clallam River channel profile from confluence with Strait of Juan de Fuca to river mile 15.8.

The lower river meanders through a low gradient unconstrained valley bound by low elevation, gently sloping hills. Valley width is approximately 5,000, 1,350, 1,100, and 300 feet at RM 1, 3, 5, and 7, respectively. Typical channel cross-sections are included in Figure 3.10, Figure 3.11, and Figure 3.12. In the upper watershed (upstream of river mile 7) the river is confined in a narrow valley bound by steep hills and low elevation mountains.

Typical channel cross-sections are depicted in Figure 3.13 and Figure 3.14. Geology, channel gradient, and channel confinement help define the habitat types present, as well as define the habitat potential for each segment.

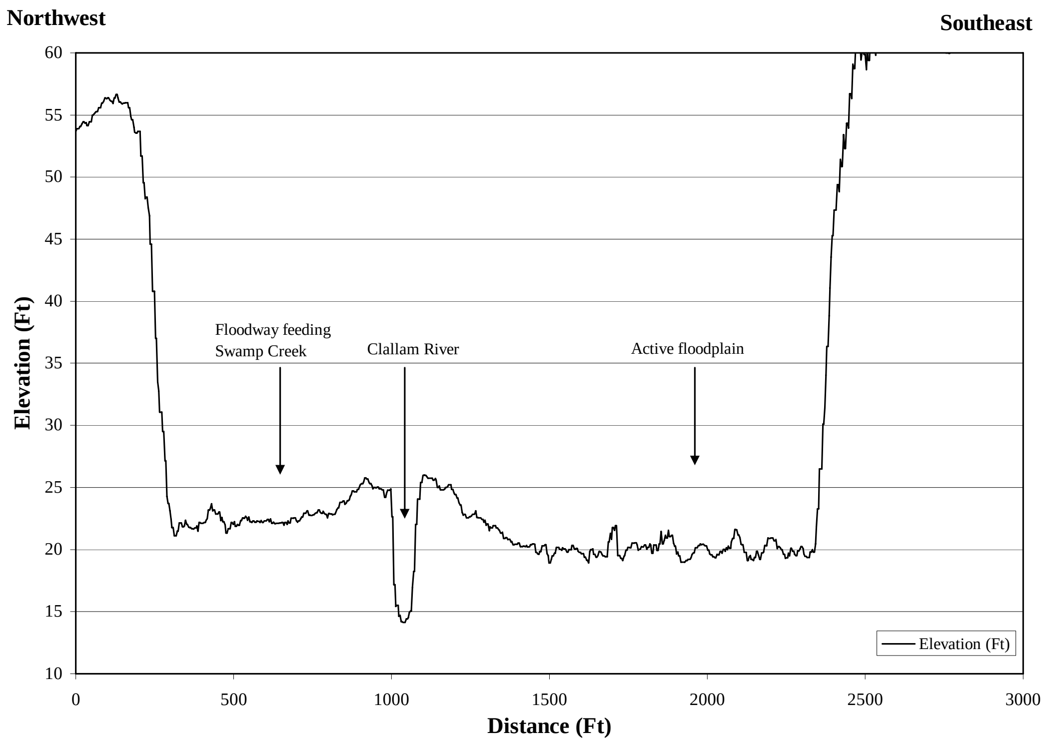

Figure 3.10. Cross-section view of Clallam River in segment 2, cross-section crosses river at RM 2.6.

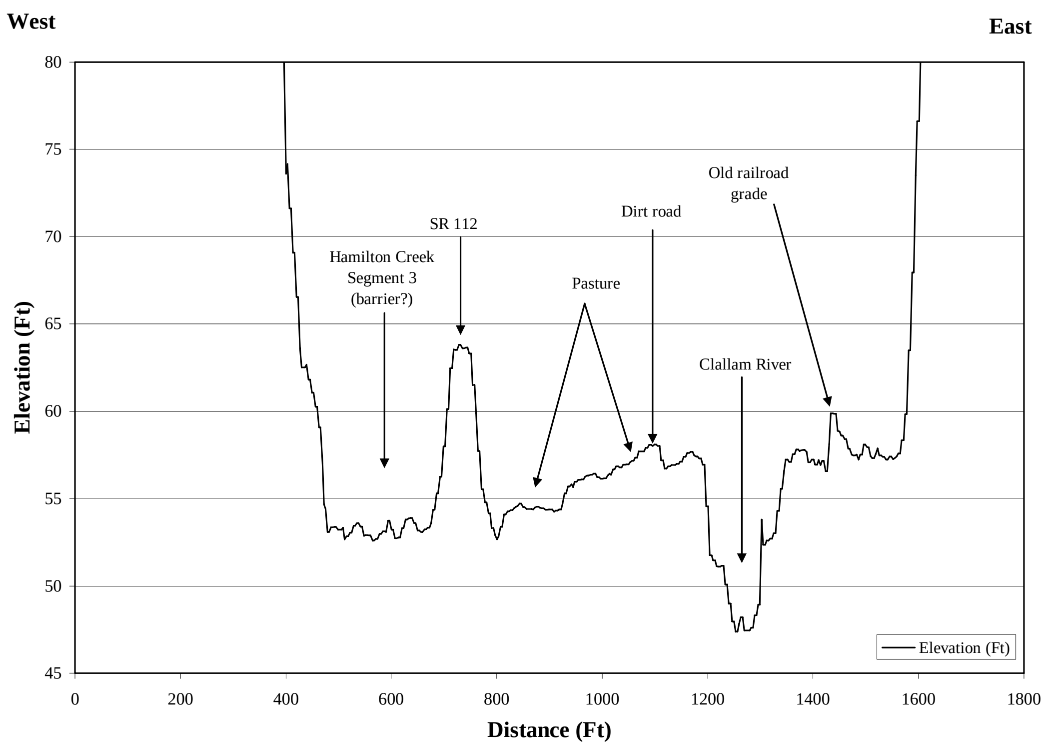

Figure 3.11. Cross-section view of Clallam River in segment 4, cross-section crosses river at RM 5.14.

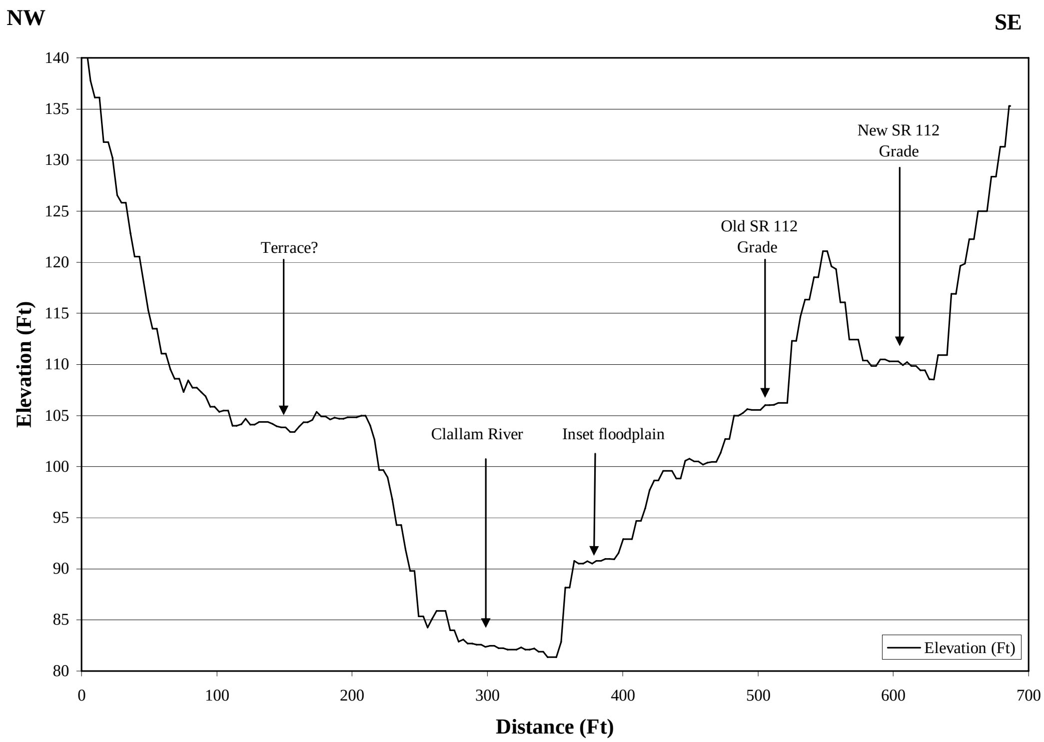

Figure 3.12. Cross-section view of Clallam River in segment 5, cross-section crosses river at RM 6.6.

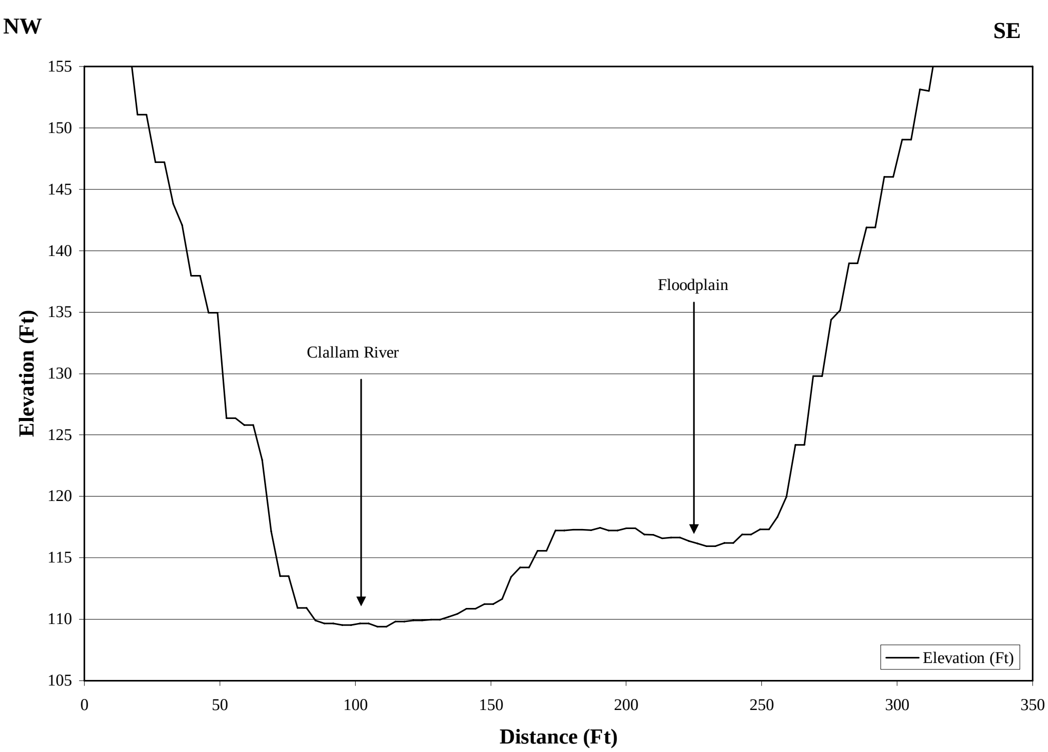

Figure 3.13. Cross-section view of Clallam River in segment 7, cross-section crosses river at RM 7.3.

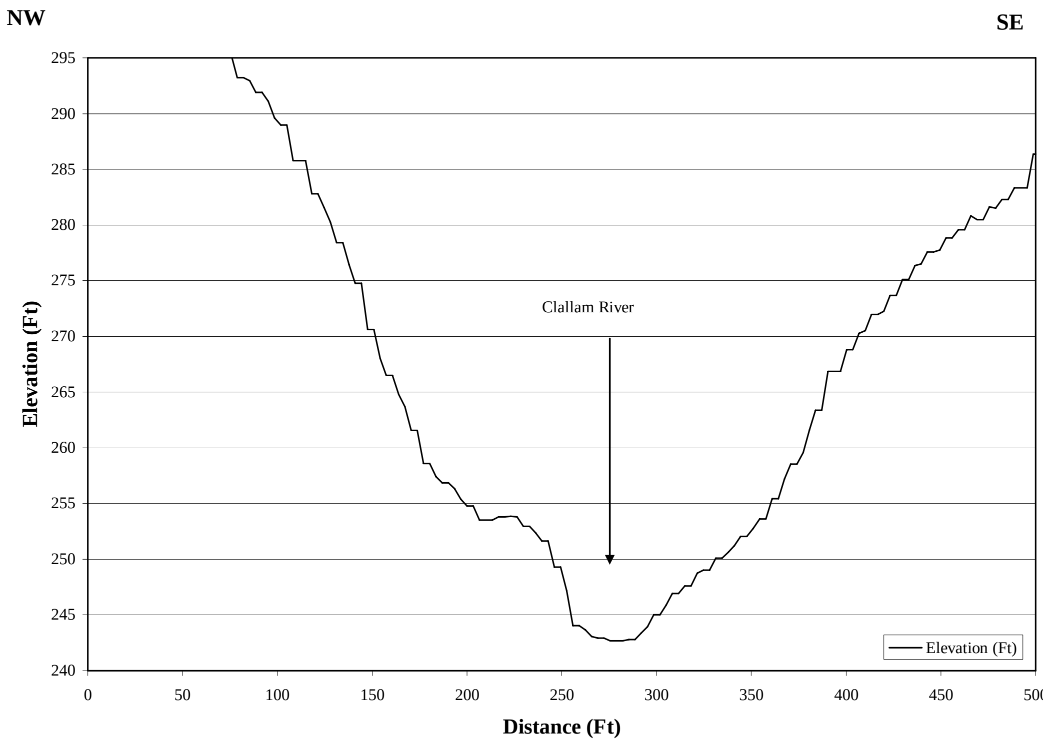

Figure 3.14. Cross-section view of Clallam River in segment 11, cross-section crosses river at RM 9.5.

Each of the 22 mainstem habitat segments delineated are depicted in Figure 3.15. The first habitat segment (Clallam River Segment DT1) provides estuarine rearing habitat, no spawning has been documented in this segment. Habitat segments 1 through 14 provide both spawning and rearing habitat with confirmed anadromous fish use. Segments 1 through 5 are unconfined and low gradient (<0.6%) and have the potential to provide the most spawning and rearing habitat in the mainstem. The stream in these segments average 27 meters bankfull width (BFW) and during our surveys had an average wetted width (WW) of 10.1 meters (measured June 14 and August 8, 2007). Segments 6, 9, and 12 are moderately confined and low gradient (0.9-1.0%) and these segments have the next highest potential habitat quality. These segments average 20 meters BFW and during our surveys (Aug 1st and 2nd 2007) had an average WW of 8.4 meters. Habitat within segments 7, 8, 10, 11, and 13-15 contain the least potential high quality habitat based on gradient and confinement. Bankfull and wetted width both decreased in the upstream direction. Bankfull width averaged 21.5 meters in segment 7, 14.5 meters in segment 11, and 9.4 meters in segment 14. Wetted widths averaged 10.2 (August 2, 2007), 8.2 (August 1, 2007), and 6.0 (May 11, 2007) meters in segments 7, 11, and 14 respectively. The channel size in segment 15 is smaller than 14, but LiDAR data shows that the channel has similar gradient and confinement and should therefore provide similar habitat as segment 14. Anadromous fish use above segment 15 is unlikely based on gradient and confinement in segment 16. We were unable to field verify segments upstream of segment 15 due to time constraints and active logging operations in this area.

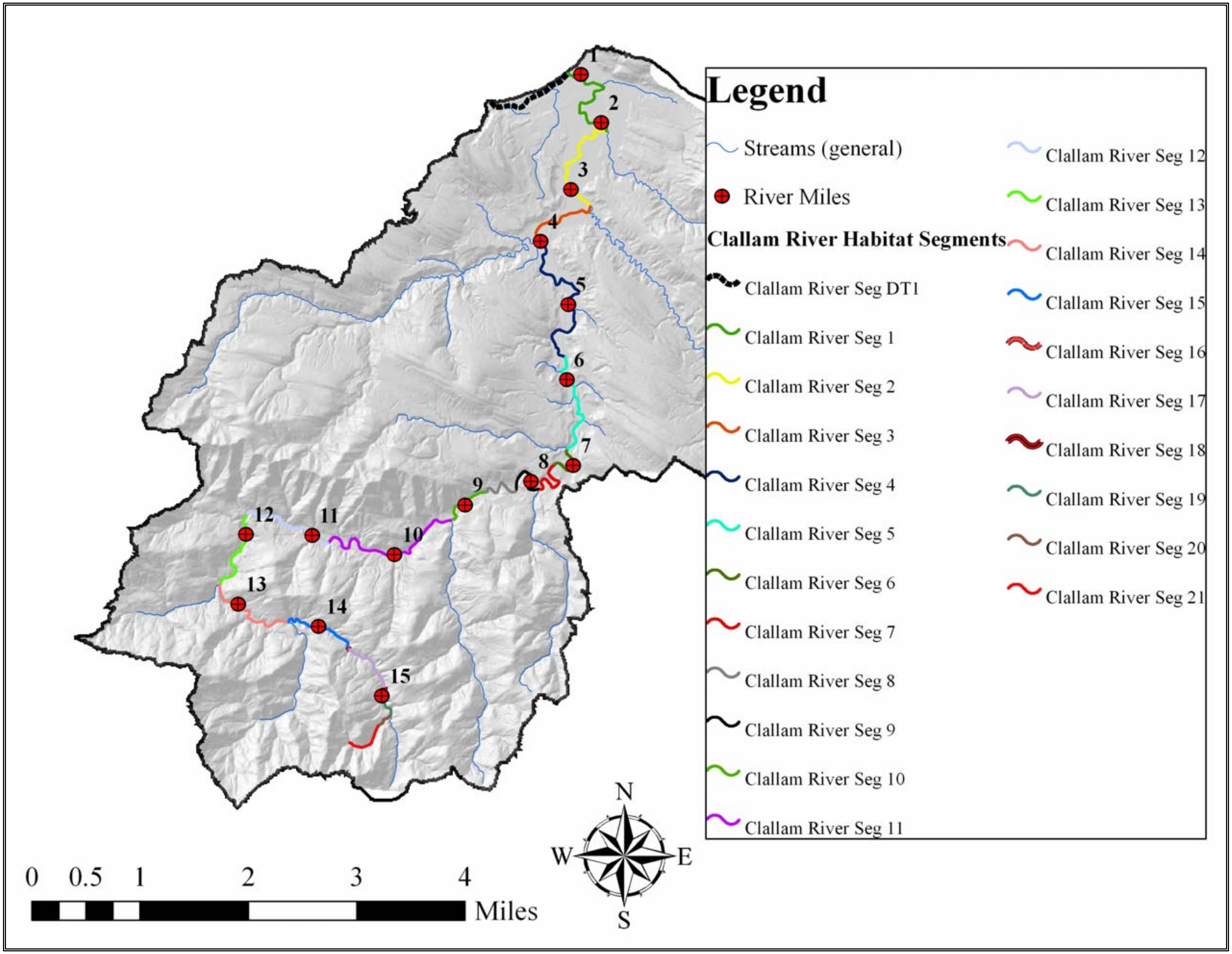

Figure 3.15. Mainstem Clallam River habitat segments and river miles.

3.2.1.1 CHANNEL AND HABITAT CONDITIONS

Channel and habitat condition observations were made from segment DT1 (estuary) to 14 (confluence with unnamed tributary 19.0145) covering a total stream length of 21,960 meters (13.5 miles). Channel and habitat condition observations were made along 16,595 meters (10.3 miles) of this stream length; including slightly more than 75 percent of the stream habitat. Time constraints and lack of landowner permission to access certain stream reaches did not allow 100 percent of the stream network to be surveyed. General channel measurements are summarized in Section 3.2.1 and Appendix B. LWD, pool, and spawning substrate data that were collected (or previously reported) are summarized below in Sections 3.2.1.1.1, 3.2.1.1.2, and 3.2.1.1.3.

3.2.1.1.1 LWD CONDITIONS

Total of 8,423 meters (5.23 mi) of LWD data were collected in segments 2, 5-11, and 13 (see Table 3.2; see also Appendix B). Large woody debris data were collected for a total of 1,025 pieces of LWD. Conifer LWD made up 54% of the total LWD, while deciduous LWD made up just over 46% of all LWD inventoried. Of the 1,025 pieces of LWD inventoried less than 1% were classified as key pieces. Large and L+ pieces accounted for almost 30 percent of the LWD count, while medium (51%) and small (19%) pieces made up the remaining 70 percent. At the segment level, LWD data were evaluated based upon total LWD frequency (pieces/100m and pieces/BFW), key and large (>50cm diameter) piece frequency, the percent of pieces of LWD classified as large (>50cm diameter), pool forming pieces/BFW, and percent of pieces pool forming.

Table 3.2. Summary of LWD conditions in Clallam River habitat segments. Note data is summarized as total length of survey, total number of LWD pieces, average percent of pieces conifer and deciduous, average LWD/BFW, and total number of key pieces, jams, and L+ pieces.

Stream Segment ID	Length of Survey (m)	BFW (m)	Total # LWD	Percent Conifer	% Decid-uous	LWD Pieces per BFW	# of Key Pieces	Key Pieces per BFW	# of LWD Jams	# of Pieces > 50 cm Dia
2	1,313.0	19.9	192	76%	24%	2.91	2	0.03	6	108
5	854.0	30.4	318	63%	36%	11.32	2	0.07	6	91
6	705.6	24.6	52	60%	40%	1.81	0	0	0	14
7	921.9	21.5	75	52%	48%	1.75	0	0	0	18
8	790.1	21.5	62	63%	37%	1.69	0	0	2	18
9	739.6	19.34	73	41%	55%	1.91	0	0	2	19
10	836.4	15.7	41	39%	61%	0.77	0	0	0	4
11	891.6	13.14	67	33%	67%	0.99	0	0	1	6
13	1,370.5	12.6	145	62%	38%	1.33	2	0.02	3	28
Total or Average	**8,422.7**	**-**	**1,025**	**54%**	**46%**	**2.72**	**6**	**0.01**	**20**	**306**

LWD/100 meters rated poor in all nine segments surveyed, the highest count was in segment 5 with 37.2 pieces/100m. LWD/BFW rated good in segment 5, fair in segment 2, and poor in segments 6-11 and 13. Key and large pieces per channel width rated poor in all segments. Large (>50 cm diameter) pieces per channel width rated good in segment 5, fair in segment 2, and poor in all other segments surveyed. Segments 2 and 5 contained 8.2 and 10.7 large pieces per 100 meters respectively. Large pieces per 100 meters ranged from 0.5 (segment 10) to 2.6 (segment 9). The low LWD piece counts and overall low volume of LWD in segments 6-11 and 13 is likely at least partially a function of the higher gradient, more confined nature of these channel segments. The LWD targets for these stream segments may not accurately reflect conditions that are achievable in these channel types.

Pool forming pieces per BFW were 0.6 and 4.2 in segments 2 and 5 respectively, equating to 22 and 37 percent of pieces classified as pool forming. These data were not available for the other habitat segments surveyed. Where LWD jams were present much of the LWD within a segment was contained in jams (see Table 3.3). In total, approximately 30 to 36 percent of LWD was classified as pool forming. Low levels of large LWD were evident throughout the entire stream network; only 5-9 percent of the LWD was classified as greater than 50 cm diameter.

Table 3.3. Summary of additional LWD condition attributes for mainstem habitat segments.

Stream Segment ID	LWD Pieces per 100 M	LWD Pieces per BFW	Large Pieces per BFW	Large Pieces per 100 M	Percent of Pieces Large (>50cm)	Percent of Pieces in LWD Jams	Pool Forming Pieces per BFW	Percent of Pieces Pool Forming
2	14.6	11.3	1.6	8.2	56%	52%	0.6	22%
5	37.2	14.0	3.2	10.7	29%	43%	4.2	37%
6	7.4	6.7	0.5	2.0	27%	0%	na	na
7	8.1	9.7	0.4	2.0	24%	0%	na	na
8	7.8	7.3	0.5	2.3	29%	66%	na	na
9	9.9	7.0	0.5	2.6	26%	38%	na	na
10	4.9	11.8	0.1	0.5	10%	0%	na	na
11	7.5	4.7	0.1	0.7	9%	27%	na	na
13	10.6	8.6	0.3	2.0	19%	27%	na	na

OTHER LWD OBSERVATIONS
SEGMENT 1

High resolution aerial photographs show much higher LWD abundance in segment 1 and the lower 150 meters of segment 2 than in upstream areas of segment 2.

SEGMENT 2

One LWD placement project has been implemented in 125 meter section of segment 2. This treatment area is located approximately 126 meters upstream for the Weel Road Bridge. The goal of the LWD treatment was to reduce bank erosion by protecting an eroding bank, as well as to provide improved fish habitat conditions. It is important to note that greater than 39 percent (74/192) of the total number of LWD pieces measured in segment 2 were introduced LWD within the 125 meter long treatment section. Nearly 69 percent (74 of 108) of the large (>50 cm diameter) LWD in segment 2 was also introduced wood. Stream habitat outside of the restoration project contained far less LWD than what is depicted in the summary tables. For example, LWD/100 meters, large LWD/100 meters, LWD/BFW values become 9.9, 2.9, and 2.0 respectively. Therefore, LWD conditions outside of the project area are rated as poor for all LWD conditions. The riparian conditions definitely play a role in the low levels of LWD in segment, however, continued wood removal and cutting of trees recruited to the river also appears to be a significant factor affecting LWD levels in segment 2. Figure 3.16 provides an excellent example of LWD that has been cut from within the banks of the river. Figure 3.17 is a close up photograph from the same LWD jam showing how the LWD has been cut-in-place.

Figure 3.16. Photograph of LWD jam 1,605 meters upstream from Pearson Creek with cut wood.

Figure 3.17. Photograph showing that LWD in jam photograph above was cut in place.

SEGMENT 3

High resolution aerial photographs show intermediate levels of LWD abundance as compared to segment 1 and 2 the lower 150 meters of segment 2 than in upstream areas of segment 2.

SEGMENT 4

Very little LWD is visible in high resolution aerial photographs in the lower half of segment 4. Significantly more wood is visible upstream of RM 4.8 than downstream. Visible wood appears to increase in abundance in the upstream direction from RM 4.8 to the segment 4/5 break. Field observations made from middle SR 122 bridge to RM 5.0 revealed recent large scale wood cutting from within the banks of the river. A large, channel spanning log jam has developed over the last several years near RM 5.2. Examination of this jam suggests that 2 large trees located along the right bank of the channel were recruited to the channel in a near perpendicular fashion. These trees appear to have been large enough to be stable in the channel. Subsequent to the recruitment of these jam forming trees, mobile LWD was recruited and held in behind these very large trees. In time at least 1 of the trees recruited from the right bank became partially buried in the channel. Evidence of cut-in-place wood in the channel shows that there has been significant effort to cut the jam up and free it (Figure 3.18).

Figure 3.18. Photograph looking at downstream end of logjam at RM 5.2. Note that most of the LWD pieces in photograph have been cut-in-place.

There has been a fair amount of discussion about what formed the jam. It has been argued that the jam was formed primarily by cabled wood that drifted downstream from up river. While it is true that cabled logs floated downstream and were racked into the jam we could find no evidence that these pieces of cabled wood played a major role in forming the jam or stabilizing the jam. Currently the cabled wood is held in place by larger pieces of LWD that are downstream of the cabled wood indicating that the jam was in place prior to the recruitment of the cabled wood. Figure 3.19 shows the current position of the cabled wood within the logjam. Significant erosion (7-20 meters) along the right bank of the channel, presumed to have been activated during the November 6, 2006 has increased channel capacity around the jam and reduced the amount of water flowing towards the left bank where private infrastructure is in jeopardy of being destroyed by the river. Based on channel form and position within the watershed this site would naturally be expected to develop large scale channel forming jams.

Figure 3.19. Photograph illustrating the position of cabled LWD in logjam located at RM 5.2.

3.2.1.1.2 POOL HABITAT CONDITIONS

Pool habitat conditions were only inventoried across 2,167 meters (1.35 mile) of the mainstem. Pool habitat surveys were conducted in segments 2 and 5. The results of these surveys are presented in the following two subsections.

SEGMENT 2

Pool habitat was surveyed from the Weel Road Bridge upstream to the confluence with Last Creek. A total of 22 pools were documented and they covered approximately 80 percent of the stream length. Pool frequency was measured at 3.0 BFWs/pool. Average pool depth was 1.51 meters and average residual pool depth was 1.28 meters. The deepest pool measured ~3 meters deep and the shallowest pool was 0.81 meters deep. Wood cover in pools was classified as 0-5 percent in 60 percent of the pools and 6-20 percent in 40% of the pools. No pools were classified as having greater than 20 percent woody cover. A total of 17 pools were classified as holding pools, resulting in 12.9 holding pools/km. The majority (73%; 16/22) of pools in segment 2 were classified as being primarily formed by LWD. Of the remaining pools 14, 9, and 4 percent were classified as being primarily form by riprap, live tree roots, and natural bedform respectively. Segment 2 pool ratings were good for percent pool, fair for pool frequency, poor for woody cover in pools, and good for holding pools.

In segment 2 the position of the downstream end of each pool was recorded using a GPS and photos were taken looking upstream and downstream at each GPS point. Figure 3.20 depicts is a typical riffle-pool sequence found in segment 2.

Figure 3.20. Photograph looking downstream at riffle-pool sequence (photo taken 1,300 meters upstream from Pearson Creek).

SEGMENT 5

Pool habitat was surveyed from the start of segment 5 upstream for 854 meters. A total of 9 pools were documented and they were present for 66% of the stream length. Pool frequency was measured at 3.1 BFWs/pool. Average pool depth was 1.18 meters and average residual pool depth was 0.99 meters. The deepest pool measured 1.85 meters deep and the shallowest pool was 0.66 meters deep. Wood cover in pools was classified as 0-5 percent in 67 percent of the pools, 6-20 percent in 11 percent of the pools, and greater than 20 percent in 22 percent of the pools. A total of 6 pools were classified as holding pools, resulting in 7.0 holding pools/km. The majority (67%; 6/9) of pools in segment 5 were classified as being primarily formed by LWD. Of the remaining pools 22 percent and 11 percent were classified as being primarily form by live tree roots and riprap respectively. Segment 5 pool ratings were good for percent pool, fair for pool frequency, poor for woody cover in pools, and fair for holding pools. In segment 5 the position of the downstream end of each pool was recorded using a GPS and photos were taken looking upstream and downstream at each GPS point. Figure 3.20 depicts is a typical riffle-pool sequence found in segment 5.

Figure 3.21. Photograph looking upstream at typical pool-riffle sequence in segment 5 (photo taken 355 meters upstream from the segment 4/5 break).

OTHER POOL HABITAT OBSERVATIONS

Pool habitat conditions in segment 1 are tidally influenced and are less influenced by LWD and human infrastructure than other habitat segments in the lower river. Pool habitat conditions in segments 3 and 4 are likely intermediate between those observed in segments 2 and 5. Based on field observations from continuous channel condition surveys pool habitat conditions in segments 6-8, 10-11, and 13 are similar to one another. The best pool structure is likely in segment 6. These segments are high energy and confined. Substrate is typically composed of boulders, bedrock, cobble, and gravel. Figure 3.22 and Figure 3.23 are examples of typical channel structure found in these segments. Pool conditions are significantly better in segments 9 and 12 where stream energy is lower and the channels are less confined.

Figure 3.22. Photograph of pool 477 meters upstream from the segment 7/8 break.

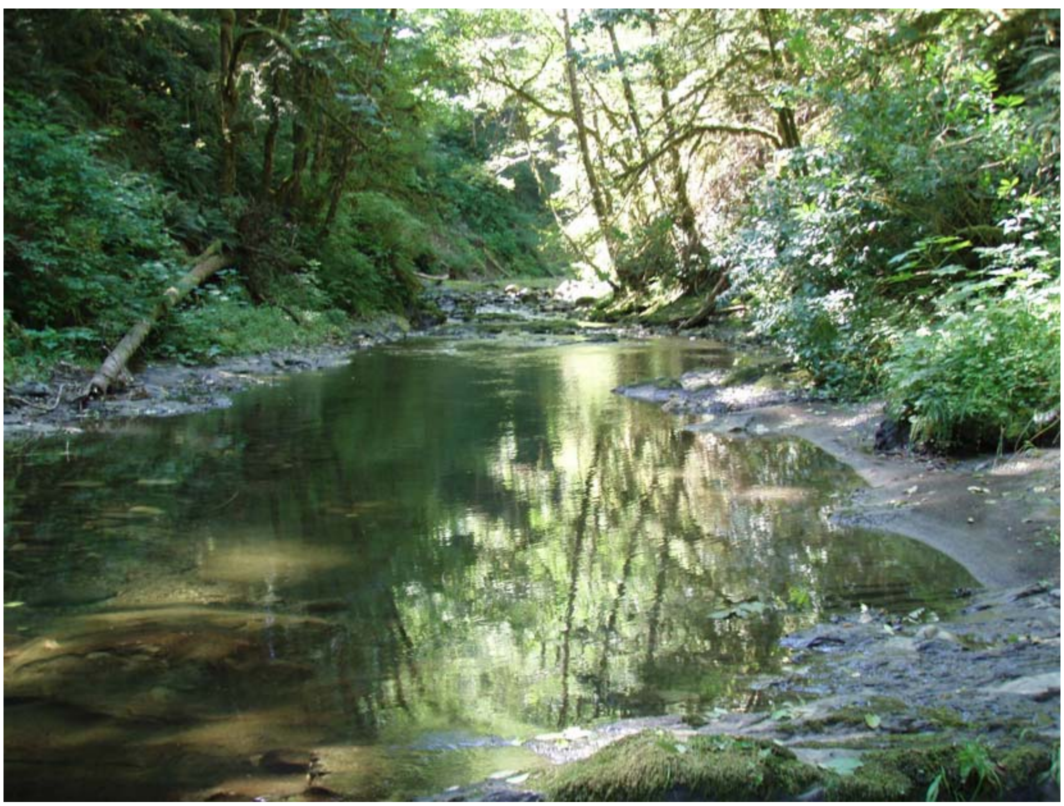

Figure 3.23. Photograph looking upstream at pool 315 meters upstream from segment 9.

Figure 3.24. Photograph looking at pool, 694 meters upstream from segment 8/9 break.

Figure 3.25. Photograph looking upstream at pool from the segment 11/12 break.

3.2.1.1.3 CHANNEL SUBSTRATE CONDITIONS

Channel substrate conditions can be described based on the substrate size and lithology, as well as the quality as spawning substrate (e.g., percent fines in spawning gravel). The observations made during our field surveys only attempted to describe the size and lithology of stream substrate. Stream substrate size was recorded during the mainstem habitat inventories and is summarized in Appendix B. Segments 1 and the lower half of segment 2 are dominated by sand size substrate and are tidally influenced and therefore provide less than ideal spawning habitat. Gravel substrate increases in the upstream direction in segment 2. During field surveys the first steelhead redd observed in this segment occurred 1,340 meters upstream of Pearson Creek (redd was located at RM 2.06). Gravel is the dominant substrate in segments 3and 4. Substrate transitions from mostly gravel to gravel mixed with cobble in segment 5. In segment 6 the substrate size is cobble and gravel. In segment 7 the channel substrate coarsens and dominated by cobble, gravel, and small boulders. Segment 8 is the first segment where bedrock is the dominant substrate followed by boulders and cobble.

Substrate is less coarse in segment 9 and is dominated by cobble and gravel. This is likely a function of the underlying geology of this segment, which is mostly composed of glacial deposits. Bedrock, boulders, and cobble are the dominant substrate in segments 10 and 11. Small pockets of gravel were observed in several locations in segment 10. Substrate size decreases significantly in segment 12 where it is dominated by cobble, gravel, and small boulders. Segment 12 like segment 9 is also underlain by glacial deposits and less confined than segments 6-8 and 10-11. In segments 13 and 14 the substrate again coarsens and is dominated by boulders, bedrock, and cobbles. Occasional gravel pockets were present and usually associated with LWD, logjams, or in some cases landslide deposits. Loss of LWD results in decreased channel roughness that can in turn result in channel in channel substrate coarsening (i.e., adding roughness). Historical LWD conditions are unknown for the Clallam River but the quantity and quality of instream LWD currently is very low upstream of RM 7.

Several observations were made during stream surveys where substrate size upstream of channel spanning obstructions was much smaller than downstream. The most dramatic example was caused by a massive channel spanning logjam at RM 12.9 in segment 14. Figure 3.26 shows a very large, channel spanning logjam at RM 12.9 with large stream substrate in the foreground. Figure 3.27 shows a dramatic change in substrate size upstream of the logjam.

Figure 3.26. Photograph looking upstream at large channel spanning logjam at RM 12.9.

Figure 3.27. Photograph looking at high quality spawning gravels upstream of logjam.

The level of fine sediment in spawning gravel was studied by McHenry et al. (1994) at four sites in the mainstem Clallam River. Gravel samples were collected during the summer of 1991 and 1992. Fine sediment levels in spawning gravel are reported in percent fines less than 0.85 mm. It is important to note that these samples were processed and reported using gravimetric methods which tend to yield results significantly lower than when wet sieve volumetric methods are used. Most of the fisheries habitat literature describes fine sediment levels using the wet sieve volumetric methods. Table 3.6 includes the results for percent fines in spawning gravel at four sites in the mainstem Clallam River. The results presented in Table 3.4 include the results as reported in Table 4 in McHenry et al. (1994) as well as in wet-sieve equivalents. Values for wet sieve equivalents were taken from the appendix of the report. The gravimetric results show increasing levels of fine sediment in spawning gravels in the downstream direction.

Table 3.4. Fine sediment levels in spawning gravel for four sites in the mainstem Clallam River, processed using gravimetric methods (source: McHenry et al. 1994).

McHenry Site	Clallam Study Equivalent Segment / RM	No. of Samples	Percent Fines < 0.85 mm (Gravimetric)	Percent Fines < 0.85 mm (Volumetric)
Mainstem RM 2.8	Seg 3 / RM 3.7	20	12.62%	19.4%
Mainstem RM 4.5	Seg 5 / RM 5.9	20	10.16%	19.8%
Mainstem RM 5.4	Seg 5 / RM 6.6	20	7.4%	10.5%
Mainstem RM 9.5	Seg 12 / RM 11.2	?	4.8%	NA

3.2.2 TRIBUTARY HABITAT INVENTORY

A total of 210 habitat segments were identified and inventoried in the tributaries to the Clallam River. Of these 10 segments were verified as having no anadromous fish use. Each stream segment was classified as one of the six habitat types identified within the watershed. Figure 3.28 depicts all channel segments inventoried and each segments respective habitat type and fish use classification. As described Chapter 1 the Clallam Watershed was 16 main subbasins (excluding the middle and lower mainstem Clallam River). Each of these subbasins is unique in size, direction of flow, topographic relief, and watershed position. The largest tributaries to the Clallam River are Last, Charley, Pearson, and Blowder creeks (see Table 1.1; Figure 1.2)

A summary of habitat types and anadromous fish use classifications is included in Table 3.5.

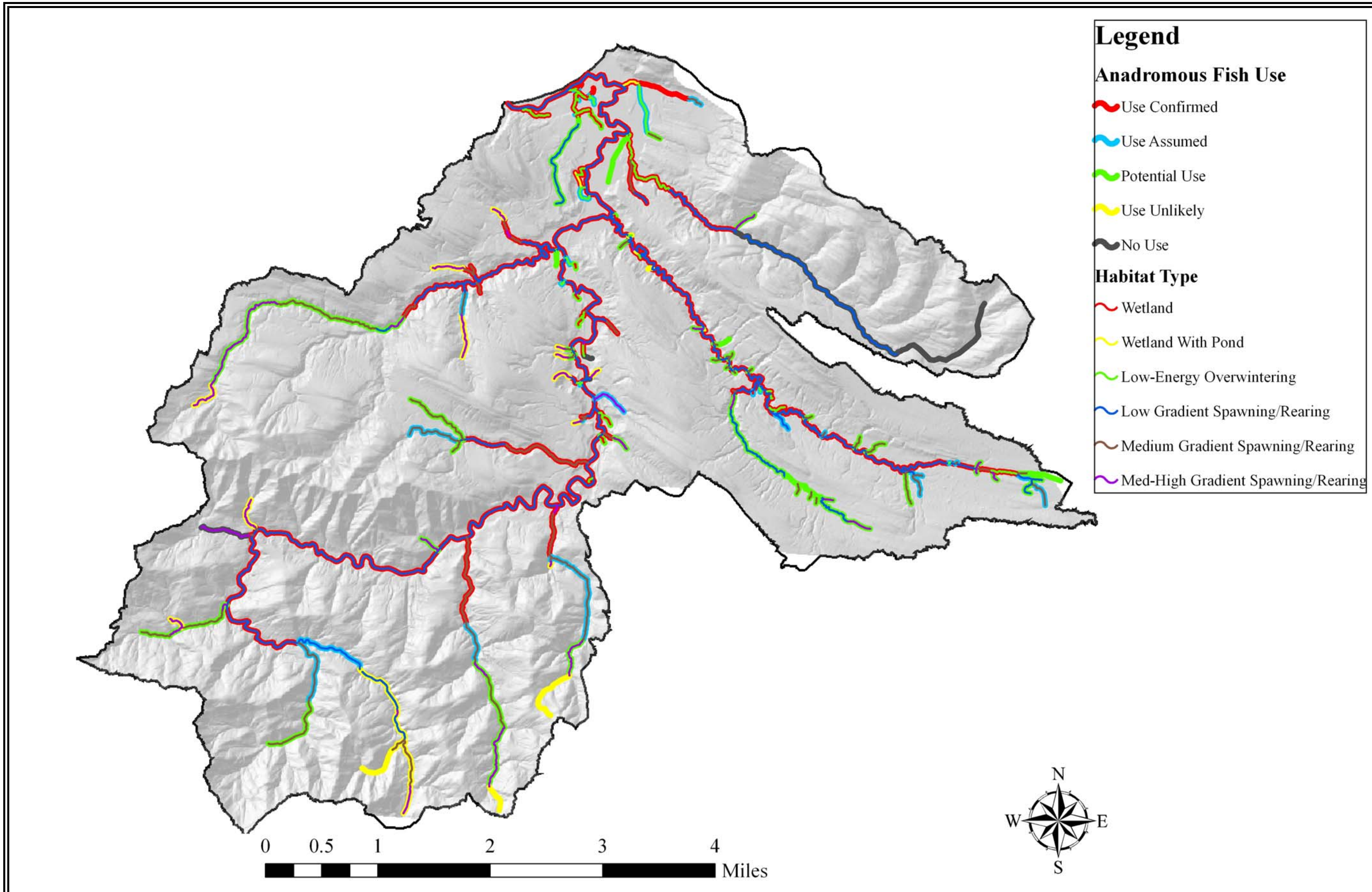

Figure 3.28. Clallam River watershed habitat segments and fish use classification.

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Table 3.5. Summary of habitat types and anadromous fish use.

Habitat Type	Total Number of Segments	No. of Segments w/ Confirmed and Assumed Anad. Fish Use	Total Length of Habitat (Miles)	Percent of Length Surveyed
Low Energy, Over-Wintering Channels	42	35	5.31	41%
Off-Channel Wetland Habitat	16	9	1.56	78%
Off-Channel Wetland Habitat w/Ponds	4	4	0.36	100%
Low Gradient Spawning and Rearing Habitat	35	27	14.14	75%
Moderate Gradient Spawning and Rearing Habitat	61	35	13.09	36%
Mod. To High Gradient Spawning and Rearing Habitat	39	6	7.15	20%

Stream gradient varies within each subbasin but generally those entering the Clallam in the lower watershed were lower gradient. In contrast subbasins in the upper watershed were typically higher gradient stream systems. Those entering the Clallam River in the middle of the watershed were moderate gradient stream systems. Longitudinal profiles for select Clallam River tributaries are included below in Figure 3.29

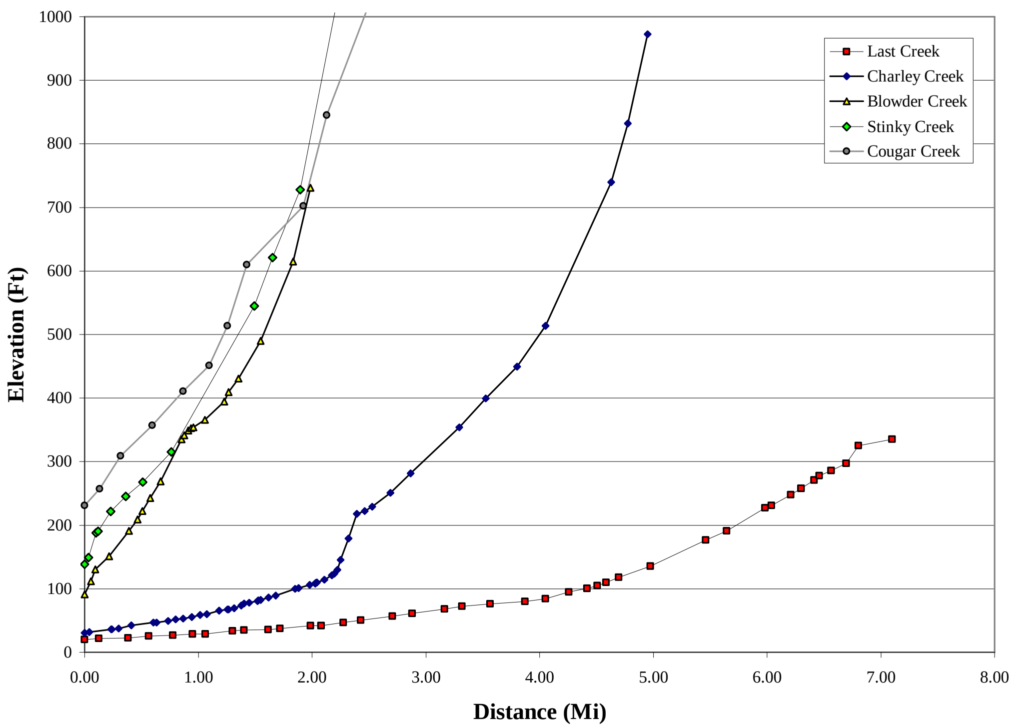

Figure 3.29. Longitudinal profiles generated from Clallam River LiDAR data for Last, Charley, Blowder, Stinky, and Cougar creeks.

Channel cross-section for most of the larger tributaries to the Clallam River are included in Appendix G. Geology, channel gradient, and channel confinement help define the habitat types present, as well as define the habitat potential for each stream segment.

3.2.2.1 CHANNEL AND HABITAT CONDITIONS

Channel and habitat condition data collection and observations were conducted in 130 channel segments covering a total stream length of 32,886 meters (20.43 miles). Field data was collected in 67 percent of the low gradient tributary habitat. Study design, time constraints, and lack of landowner permission to access certain stream reaches did not allow 100 percent of the low gradient stream network to be surveyed. General channel measurements are summarized in Section 3.2.2 and Appendix B. LWD, pool, and spawning substrate data that were collected (or previously reported) are summarized below in Sections 3.2.2.1.1..

3.2.2.1.1 LWD CONDITIONS

Total of 8,423 meters (2.14 mi) of LWD data were collected in Blowder, S.F. Last, Last, Charley, Stinky, and Cougar creeks, as well as in two segments in tributary 19.0135. and 13 (see Table 3.2; see also Appendix B). A total of 1,679 pieces of large woody debris were inventoried. Conifer LWD made up 54% of the total LWD, while deciduous LWD made up just over 46% of all LWD inventoried. Of the 1,679 pieces of LWD inventoried less than 2 percent were classified as key pieces. Large and L+ pieces accounted for just almost 8 percent of the LWD count, while medium (51%) and small (19%) pieces made up the remaining 70 percent. At the segment level, LWD data were evaluated based upon total LWD frequency (pieces/100m and pieces/BFW), key and large (>50cm diameter) piece frequency, the percent of pieces of LWD classified as large (>50cm diameter), pool forming pieces/BFW, and percent of pieces pool forming.

Stream Segment ID	Length of Survey (m)	BFW (m)	Total No. LWD	Percent Conifer	Percent Decid.	LWD Pieces per BFW	# of Key Pieces	Key Pieces per BFW	No. of LWD Jams	No. of Pieces > 50 cm Dia
Blowder Creek S1	390	8.88	240	55%	40%	5.46	6	0.14	11	15
S.F. Last Creek S1	305	7.11	153	58%	34%	3.57	3	0.07	2	9
Last Creek S1	299	8.44	175	51%	48%	4.92	5	0.14	7	10
Charley Creek S2	818	14.36	278	41%	55%	4.88	6	0.11	8	16
Stinky Creek S2	420	8.7	231	60%	35%	4.79	3	0.06	10	23
Cougar Creek S1	699	9.69	456	62%	34%	6.32	7	0.10	12	34
Trib 19.0135 S1	363	4.46	75	20%	80%	0.92	0	0	0	13
Trib 19.0135 S2	157	5.2	71	51%	49%	2.35	0	0	0	9
Total or Average	**3,451**	**8.36**	**1,679**	**54%**	**46%**	**4.15**	**30**	**0.08**	**50**	**128**

Table 3.6. Fine sediment levels (<0.85 mm) in spawning gravels for Clallam River tributaries (source: McHenry et al. 1994).

SITE	NUMBER OF SAMPLES	% FINES < 085MM
Last Creek	10	11.86%
Pearson Creek	10	16.85%
Upper Charley Creek	10	8.75%
Lower Charley Creek	10	10.34%
Stinky Creek	10	7.21%

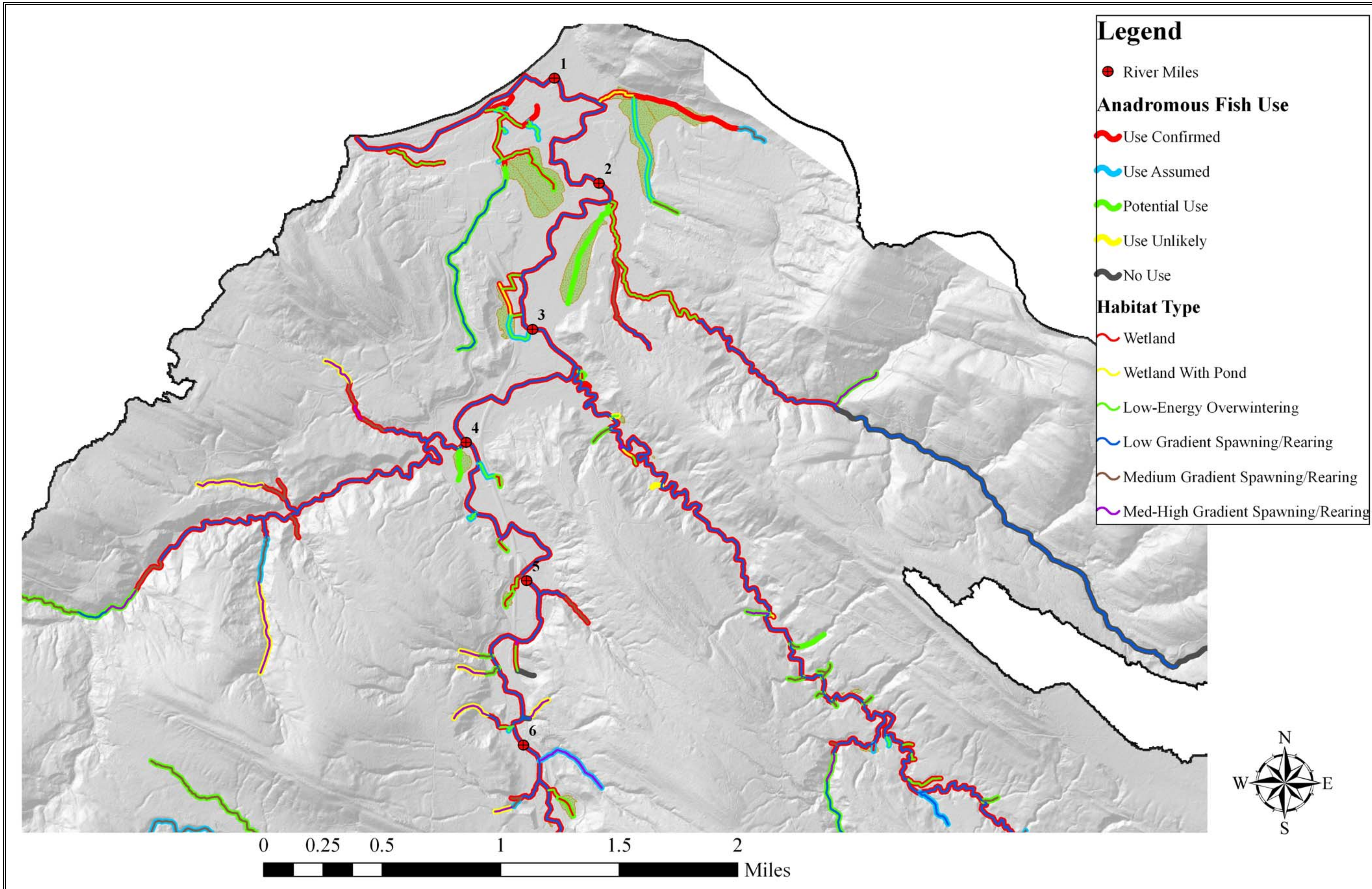

Figure 3.30. Clallam River watershed off-channel habitat and defined anadromous fish use.

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3.3 FLOODPLAIN AND RIPARIAN CONDITIONS

3.3.1 CLALLAM RIVER MAINSTEM

As described in Section 2.3 floodplain and riparian habitat conditions adjacent to the mainstem of the Clallam River were assessed using geo-rectified high resolution aerial photographs, color orthophotos, high resolution LiDAR data, and field observations Detailed data were collected from within 60 meters of the bankfull edge of the river from the confluence with the Strait to the end of segment 5. These six channel segments correspond with nearly all of the low gradient, unconfined and moderately confined mainstem habitat.

Riparian conditions were evaluated within four zones (10, 20, 30, and 60 meters from the bankfull edge) within each of the six channel segments. This provided an accurate measure of the riparian conditions within each of the four zones adjacent to the river. The majority of riparian habitat in all six stream segments was classified as either impaired or non-functioning (see Section 2.3 for definitions). Collectively, 74.1 percent of the riparian area within 60 meters of the bankfull edge from segment 0 to the end of segment 5 was classified as either impaired or non-functioning. Table 3.7 includes a complete summary of riparian conditions by habitat segment within the each of the four zones adjacent to the mainstem. Segments 1 and 5 were the least impaired segments within all four zones. Within the 0-60 meter zone segment 5 and 1 had 54.8 and 38.6 percent of their respective areas classified as un-impaired/slightly impaired. Figure 3.31 through Figure 3.34 depict the site level riparian conditions for segment 0 through 5. A key to the riparian codes in the figures is included in Section 2.3.

Table 3.7. Summary of riparian conditions by habitat segment within 10, 20, 30, and 60 meter distances from the bankfull edge of the mainstem Clallam River.

Zone	Riparian Conditions	Seg 0	Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	All Segs
0-10 Meters	Un-Impaired/Slightly Impaired	27.1%	44.6%	18.1%	10.2%	13.2%	61.8%	28.7%
	Impaired Function	8.5%	18.4%	11.8%	59.6%	32.5%	20.0%	24.3%
	Non-Functioning	64.4%	37.1%	70.1%	30.2%	54.4%	18.2%	47.0%
0-20 Meters	Un-Impaired/Slightly Impaired	25.4%	43.8%	15.8%	10.1%	13.6%	60.4%	27.8%
	Impaired Function	6.5%	13.9%	9.3%	58.2%	27.4%	15.6%	20.7%
	Non-Functioning	68.0%	42.3%	74.9%	31.7%	59.1%	24.0%	51.5%
0-30 Meters	Un-Impaired/Slightly Impaired	24.6%	42.6%	14.2%	10.3%	13.7%	59.3%	27.1%
	Impaired Function	5.6%	11.2%	8.1%	55.4%	23.7%	12.7%	18.2%
	Non-Functioning	69.8%	46.3%	77.7%	34.3%	62.7%	28.0%	54.7%
0-60 Meters	Un-Impaired/Slightly Impaired	25.8%	38.6%	12.7%	9.7%	15.2%	54.8%	25.8%
	Impaired Function	3.5%	9.0%	8.9%	49.0%	19.5%	8.0%	15.2%
	Non-Functioning	70.7%	52.4%	78.5%	41.3%	65.3%	37.2%	58.9%

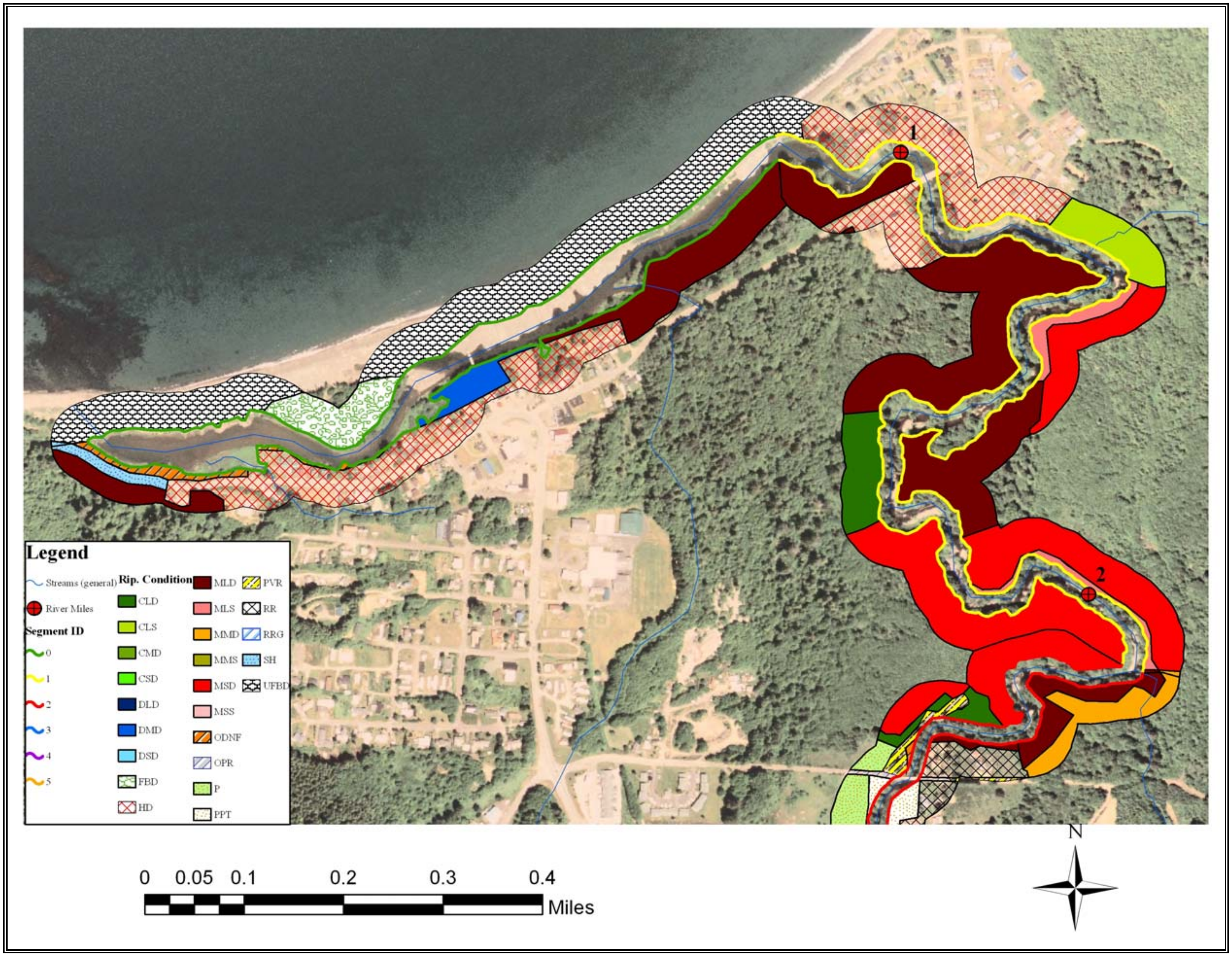

Figure 3.31. Riparian condition map for Clallam River mainstem segments DT1 (segment 0) and 1.

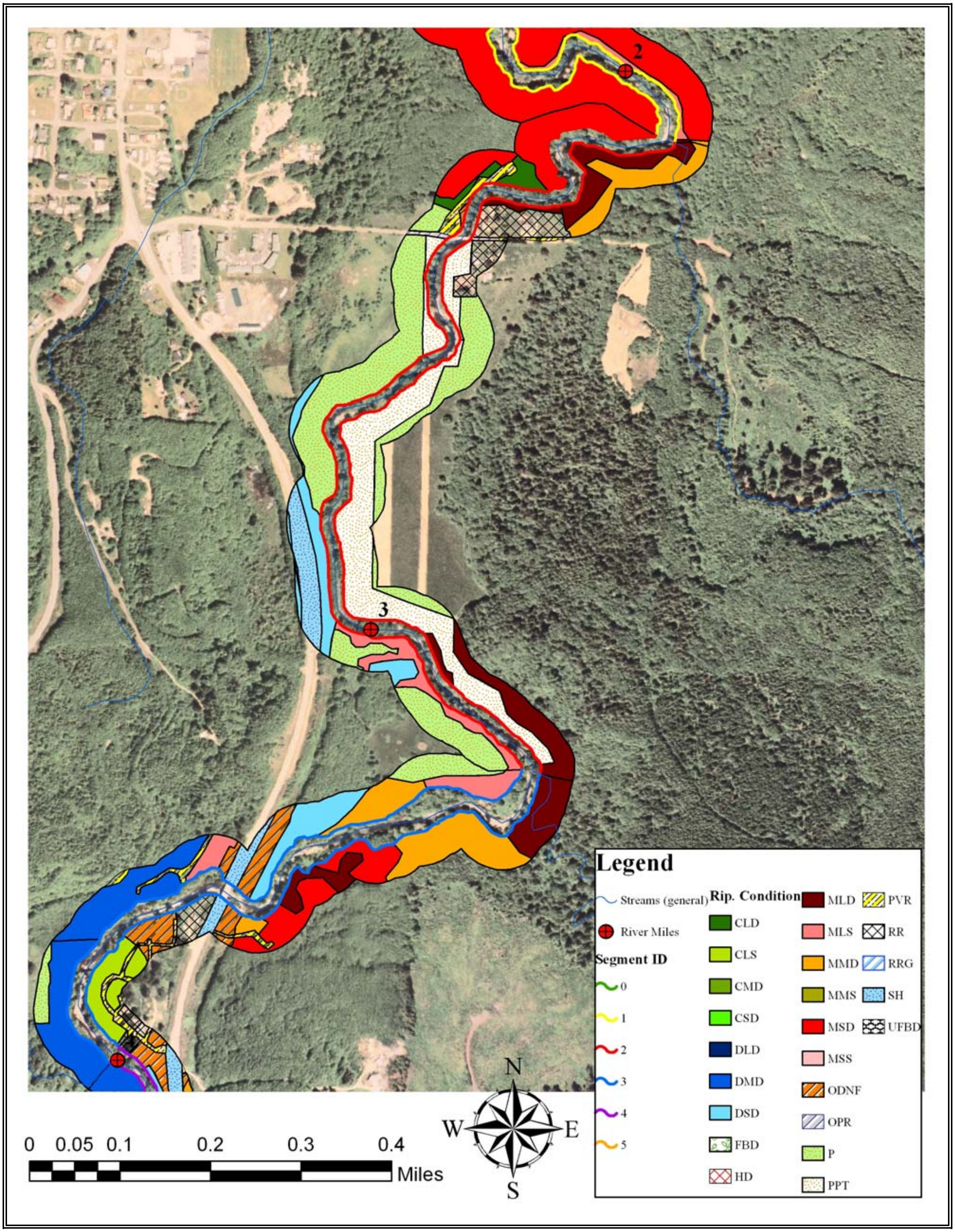

Figure 3.32. Riparian condition map for Clallam River mainstem segments 2 and 3.

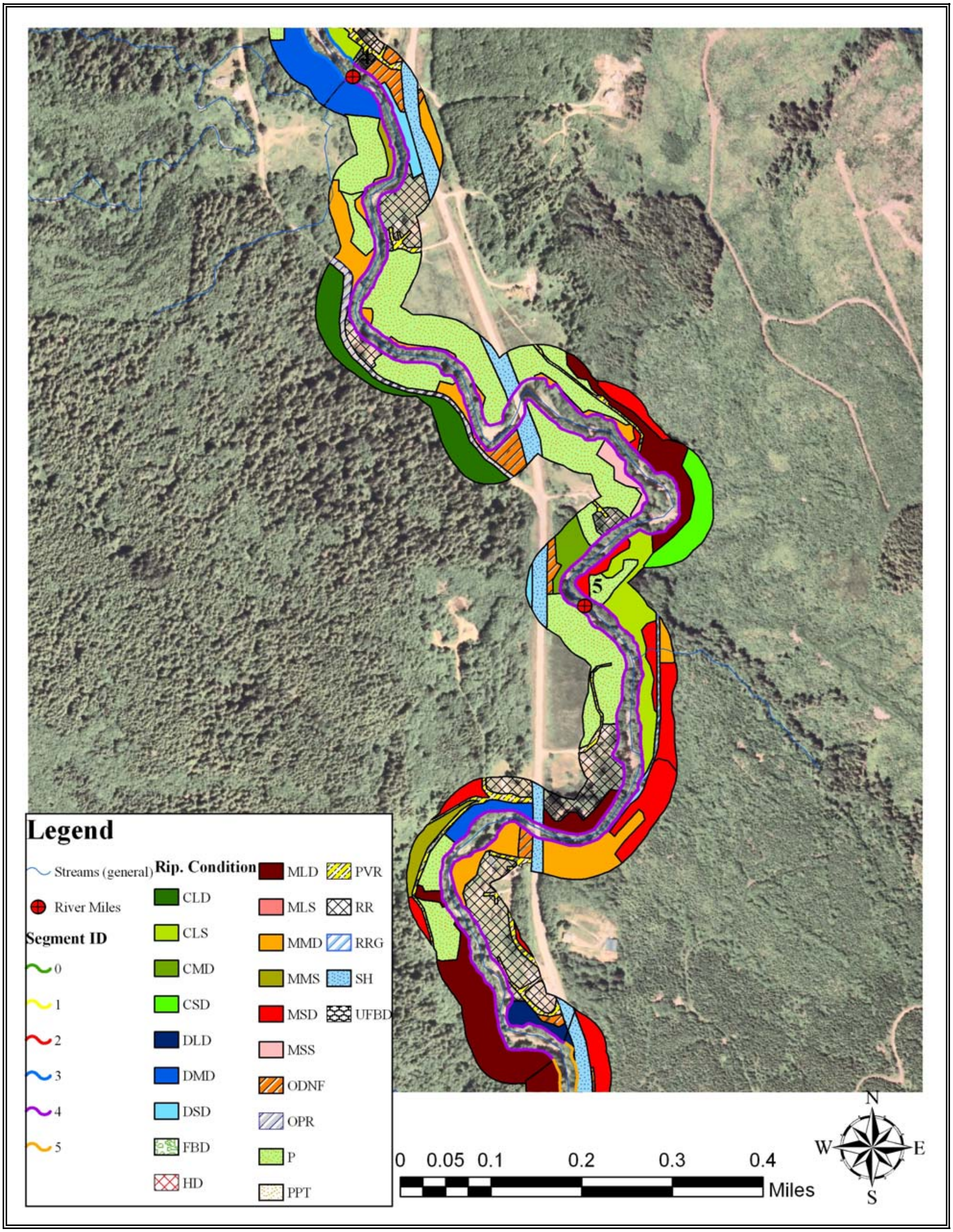

Figure 3.33. Riparian condition map for Clallam River mainstem segment 4.

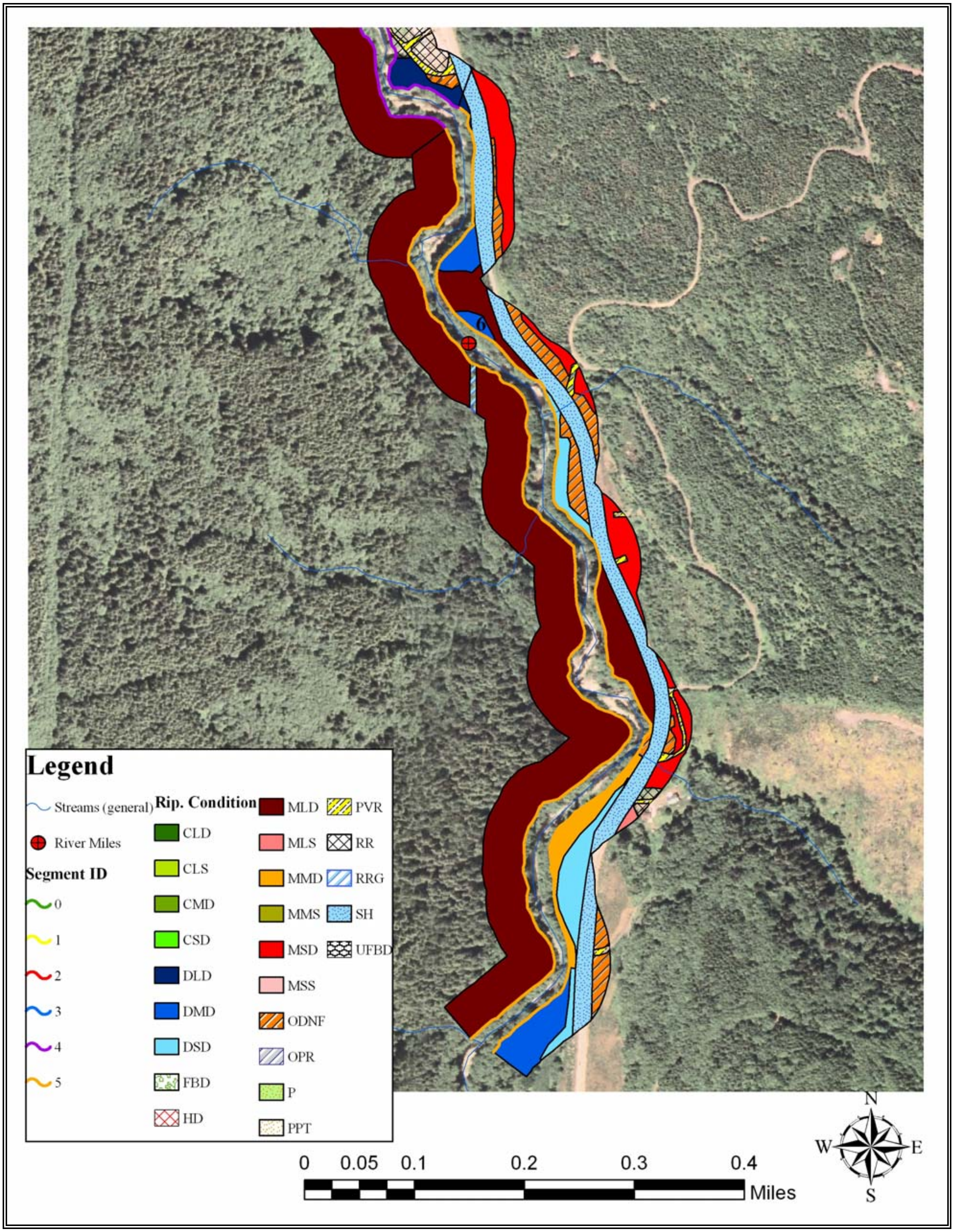

Figure 3.34. Riparian condition map for Clallam River mainstem segment 5.

Riparian habitat that was classified as non-functioning had different levels of short and long-term impairment. Some riparian areas classified as non-functioning are on a long-term trajectory towards functional riparian habitat (e.g., young conifer stands). Other riparian areas classified as non-functioning are not on a trajectory towards improving conditions (e.g., stream parallel roads). Nearly 59 percent of all riparian areas within 60 meters of the bankfull edge were classified as non-functioning riparian habitat. Of this area approximately 32 percent contained young or very young forests, of which about only 24 percent were on a trajectory towards recovery. The remaining 76 percent of young or very young forests were on a trajectory towards becoming alder dominated or mixed stands (greater than 30% deciduous trees).

More alarming is the fact that 68 percent of the non-functioning riparian areas were on a long-term trajectory towards remaining non-functional. Of these areas approximately 14 percent were non-functioning or impaired riparian habitats naturally (e.g., the sand spit at the mouth). Nonetheless, approximately 34 percent of all riparian habitat (58.5% of non-function riparian habitat) from segment 0 to 5 were on a long-term trajectory towards continued non-functional conditions. Road and road prisms cover 7.6 percent of the riparian areas and pastures, high density housing, rural housing, and other disturbed areas cover an additional 27 percent of riparian areas within 60 meters of the bankfull edge of the Clallam River.

Riparian conditions were also summarized for Clallam River segments 6 through 18 based on field surveys and aerial photographs. A summary of riparian conditions for these segments is included in Table 3.8. **Summary of riparian conditions for Clallam River segments 6 through 18.** Conifer dominated stands were generally absent throughout segments 6 through 18. However, few segments were dominated by deciduous stands. The vast majority of riparian stands from segment 6 to 18 were mixed stands and many of these stands were well stocked with conifer. The long-term outlook for most segments is fair based on the current conifer stocking and size of trees.

Table 3.8. Summary of riparian conditions for Clallam River segments 6 through 18.

Stream Segment	Length (m)	Right Bank Riparian Condition	Left Bank Riparian Condition
Segment 6	706	MMD	MLD
Segment 7	922	MMD	MMD
Segment 8	790	MMD	MMD
Segment 9	740	DMD	DMD
Segment 10	836	MMD	MMD
Segment 11	2,458	MLD	MLD
Segment 12	1,534	MMD	MMD
Segment 13	1,418	MMD	MMD
Segment 14	1,586	MMD	MMD
Segment 15	1,162	MMD	MMD
Segment 16	53	CLD	MLD
Segment 17	823	CLD	MLD
Segment 18	84	DMD	DMD

3.3.2 TRIBUTARIES

Riparian conditions in the tributaries were evaluated for just over 26 miles of stream length. Riparian conditions were classified based on field surveys and high resolution aerial photos using the methods described in Section 2.3. A complete summary of riparian conditions for each segment surveyed &/or evaluated is included in Appendix D. Table 3.9 depicts a simplified summary of riparian conditions data based on current riparian functionality. Just over 29 percent of the riparian length evaluated was classified as functional and 54 percent of the length was classified as impaired. Almost 17 percent of the riparian length was classified as non-functional. A large proportion (55%) of the riparian forest classified as impaired was on a trajectory towards becoming un-impaired/slightly impaired. Less than 2 miles (20% of length classified as non-functional; 3.5% of classified riparian forest) of the riparian forest classified as non-functional was on a long-term trajectory towards continued non-functional conditions.

Table 3.9. Summary of riparian conditions for Clallam River tributaries.

Riparian Conditions	Left Bank (Miles)	Left Bank (Percent)	Right Bank (Miles)	Right Bank Percent
Un-Impaired/Slightly Impaired	6.94	27%	8.16	31%
Impaired Function	14.31	55%	14.00	54%
Non-Functioning	4.79	18%	3.88	15%
Total Length	26.04	na	26.04	na

3.3.3 NOXIOUS WEEDS

Noxious weed inventories and control projects have been active throughout various WRIA 19 subbasins. The Clallam River floodplain is infested by at least four species of noxious weeds. Himalayan blackberry, scotch broom, reed canary grass, and knotweed are all present within portions of the Clallam River floodplain. Knotweed mapping has occurred from the confluence with the Strait to river mile 13.7. No knotweed has been identified upstream of river mile 6.0.

Figure 3.35 depicts mapped knotweed sites within the Clallam River watershed from the 2006 knotweed inventory program. Knotweed and other noxious weeds that invade riparian areas may displace and out compete native trees and shrubs. Figure 3.36 depicts a typical knotweed colony that has infested segment 2 of the mainstem Clallam River. Note that the knotweed in Figure 3.36 is 4 to 5 meters tall.

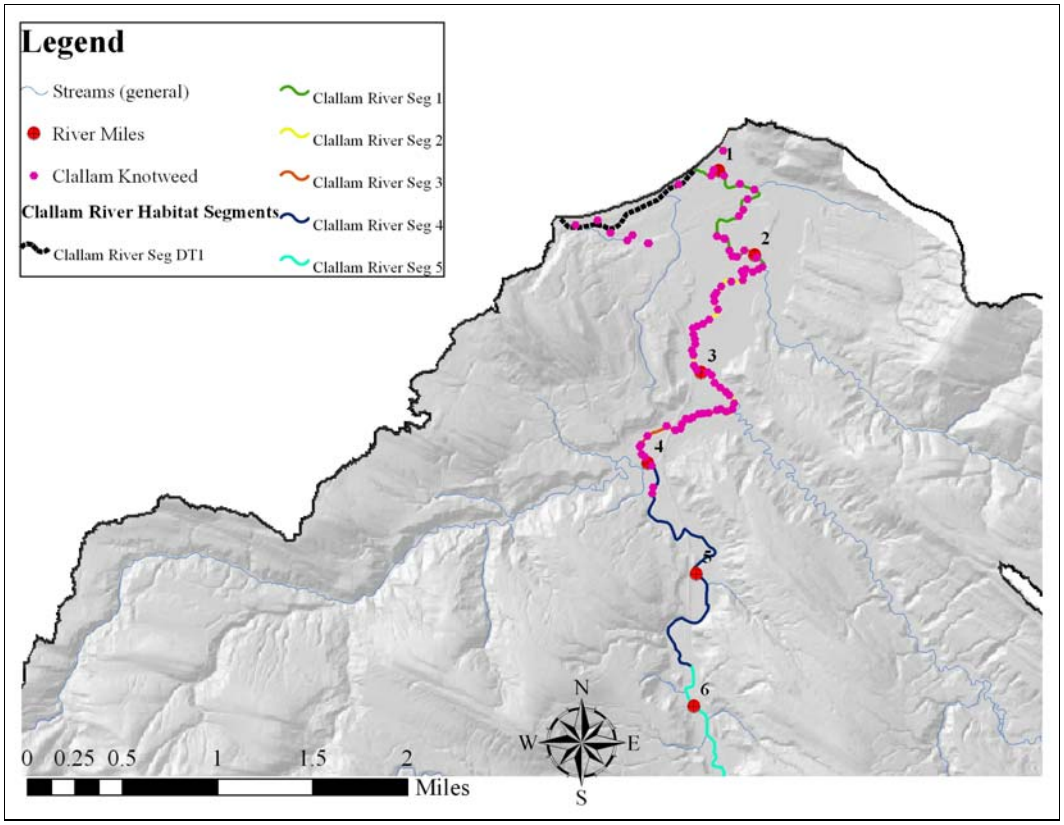

Figure 3.35. Known knotweed sites within the Clallam River watershed (source: Makah GIS knotweed database 2006).

Figure 3.36. Typical knotweed colony infesting Clallam River segment 2.

3.4 HABITAT ACCESS

Anadromous salmonid migration barriers were inventoried using existing culvert databases and field surveys. Five types of barriers were identified in the Clallam River watershed.

- Impassable Waterfalls
- Cascades (partial and complete barriers)
- Beach Deposits (seasonally partial to complete barrier)
- Perched Logjams (partial barriers)
- Culverts (8 passable, 2 partial, and 6 complete barriers)

The most significant quantities of habitat blocked to anadromous fish migration/emigration were associated with beach deposits, waterfalls, cascades, perched logjams and steep gradients. Culverts did block access to some anadromous fish habitat but not to the same degree that waterfalls, cascades, and logjams hindered fish passage to useable habitat.

Figure 3.37 depicts all known anadromous fish barriers within the Clallam River watershed. Several important barriers that blocked significant quantities of low gradient anadromous fish habitat were associated with cascades, waterfalls, and logjams. These are discussed below from downstream to upstream. A discussion regarding the blockage at the mouth of the Clallam River is included in Section 3.4.2.

Swamp Creek

A clay seam at river mile 0.33 partially blocks anadromous fish use upstream of this point in the mainstem of Swamp Creek. No juvenile anadromous fish were observed upstream of the clay seam in the mainstem of Swamp Creek. The clay seam parallels Swamp Creek T5 along the right left bank before Swamp Creek turns to the southeast bisecting the clay seam and forming a partial barrier. No juvenile anadromous fish were observed upstream of the clay seam in the mainstem of Swamp Creek T5. Collectively these barriers block access to almost 27 acres of high quality off-channel habitat consisting of small open water wetlands, shallow forested wetlands, and flooded forested wetlands. The habitat feature upstream of the clay seam is unique since it is actively flooded by the mainstem Clallam River during high water events. There are additional culvert related barriers in the mainstem of Swamp Creek upstream of the wetland habitat described above.

Pearson Creek

A large impassable waterfall at RM 1.74 blocks all anadromous fish use beyond the falls. LiDAR data indicates that stream channel quickly rises 50 to 70 vertical feet at the falls and cascades directly upstream. A total of 1.87 miles of low gradient (2-4%) Pearson Creek mainstem habitat is not accessible to anadromous fish.

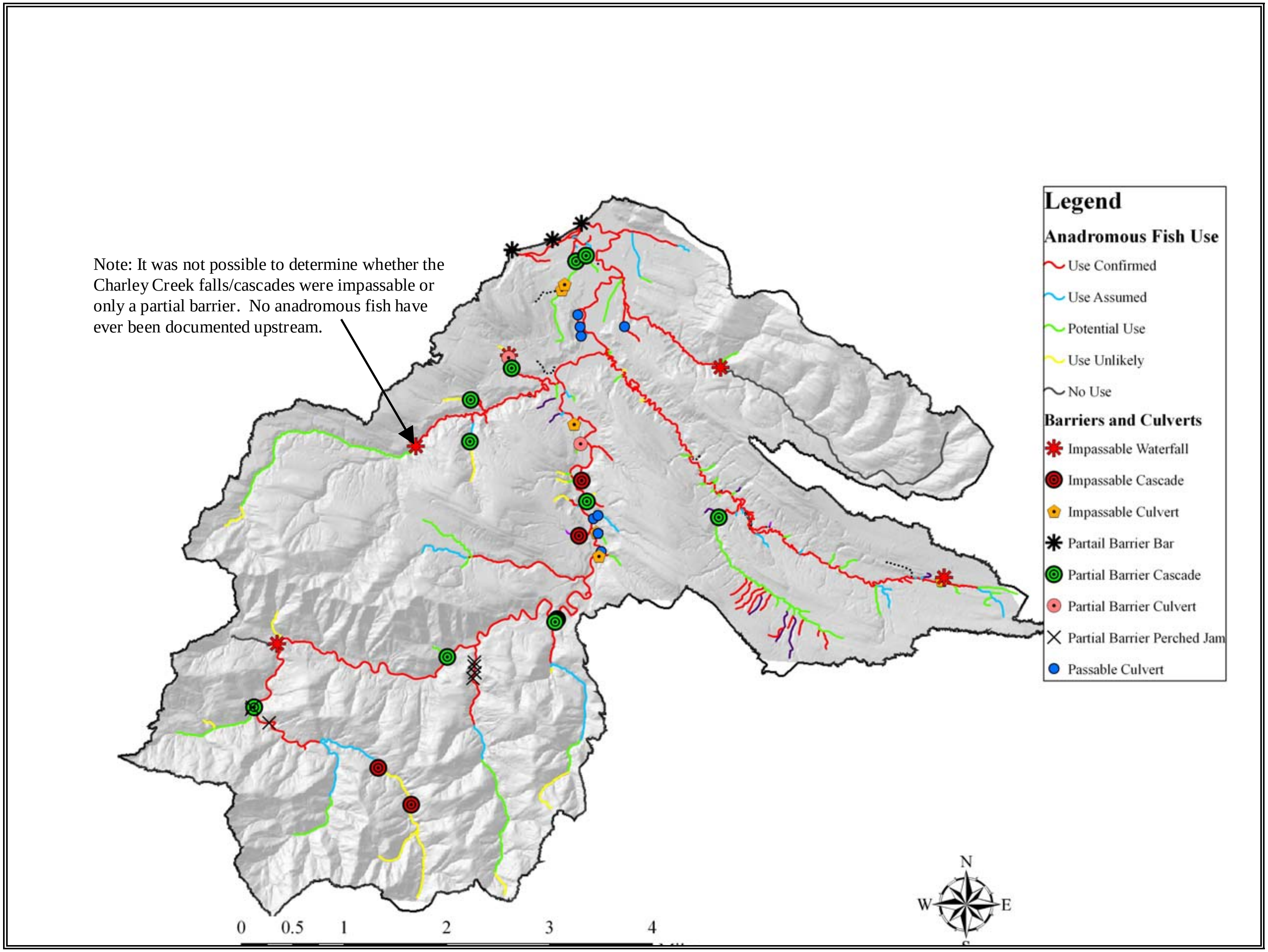

Figure 3.37. Clallam River watershed anadromous fish barriers and fish use.

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S.F. Last Creek

A steep cascade reach with a large debris jam and an inner gorge landslide deposit appears to block anadromous fish use in the S.F. Last Creek upstream of river mile 0.38. From this point upstream the stream maintains a gradient of 8 percent for 0.12 miles and then becomes low gradient, high quality habitat again. A total of 1.72 miles of low gradient habitat (1-4%), including off-channel habitat exist upstream of this barrier. No anadromous fish use was observed upstream of the barrier despite extensive surveys. Past reports of anadromous fish use upstream of this barrier seem logical and this barrier may only block a portion of upstream migrants or block fish only during some years. Further evaluation of this barrier and surveys upstream during the coho spawning season and during juvenile rearing period are recommended.

Charley Creek

A steep cascade reach with a 7 foot waterfall appears to block a anadromous fish use in Charley Creek upstream of river mile 2.21 (see Figure 3.38). Charley Creek segment 6 is 277 meters long and averages 10 percent gradient. The small waterfall depicted in Figure 3.38 is the largest, most challenging falls encountered within segment 6 during field surveys. A good jumping pool exists directly downstream of the falls. The total length of the falls is 13 feet slope distance.

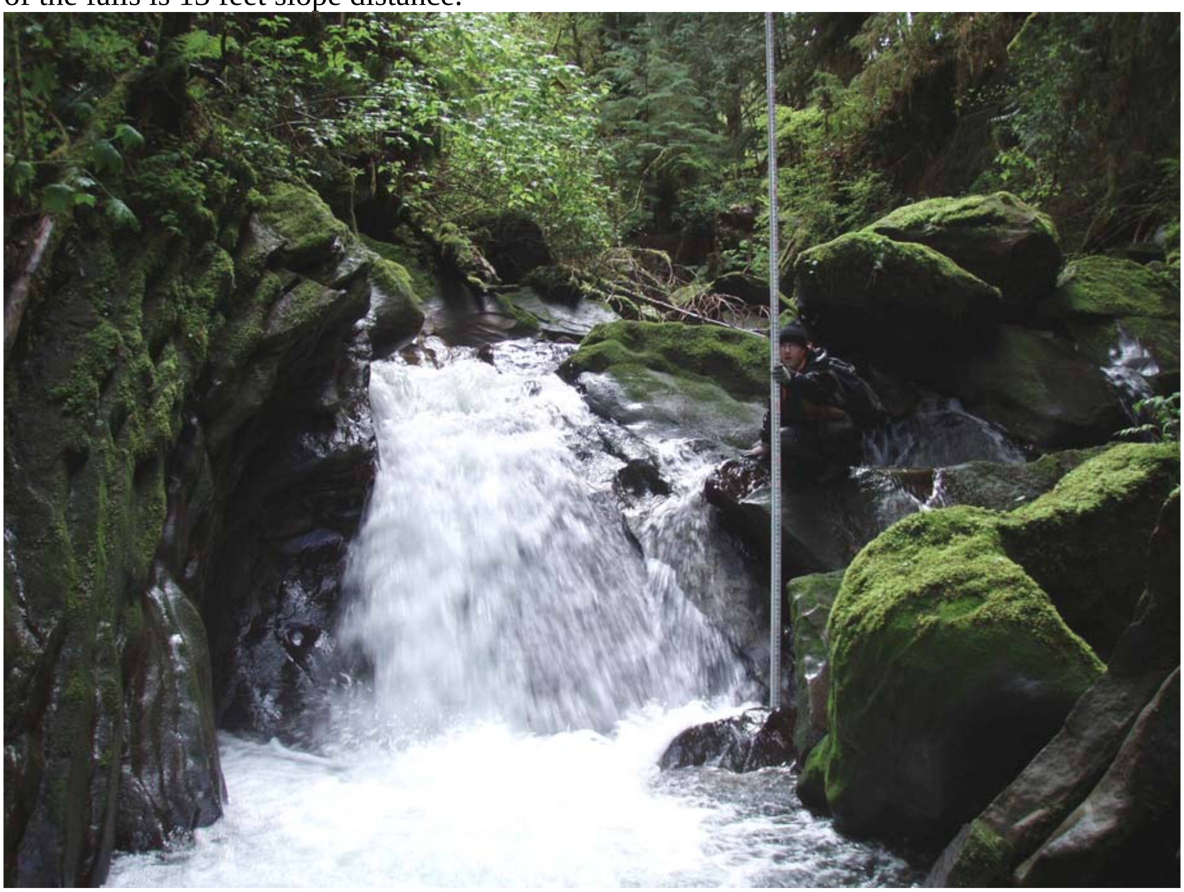

Figure 3.38. Photograph looking upstream at Charley Creek falls.

No anadromous fish use has been document upstream of these falls despite a fair amount of survey effort that includes one year of coho spawning ground surveys. These falls were documented by Phinney and Bucknell (1975) as a partial barrier. A considerable amount of low gradient habitat exists upstream of segment 6. A total of 1.13 miles of low gradient (1-4%) habitat and 1.10 miles of 4-8 percent gradient habitat are located upstream of the falls. In addition there are two fair size tributaries that contain 1.41 miles of 4-8 percent gradient habitat. Additional surveys upstream of the falls are recommended to better define anadromous fish use and the degree to which these falls limit fish use.

Blowder Creek

Phinney and Bucknell (1975) indicate that there is an impassable cascade at RM 0.1 in the mainstem Blowder Creek. During this study we surveyed Blowder Creek to RM 1.2 and found no definitive barriers to anadromous fish. The cascade documented by Phinney and Bucknell (1975) is depicted in Figure 3.39. High numbers of juvenile coho were observed upstream of this feature. It is included here to illustrate an example of a fully passable perched debris jam and cascade feature. The jam is 5 vertical feet and the downstream jumping pool is poor.

Figure 3.39. Photograph looking upstream at Blowder Creek cascade and perched logjam.

Stinky Creek (19.0.140)

Segment 1 of Stinky Creek averages 8 percent gradient over 161 meters, with an 80 meter reach averaging 12 percent gradient. Three very challenging cascades and debris jams appear to limit most anadromous fish from accessing the lower gradient habitat upstream. A few coho have been documented spawning upstream of the cascades during the last 10 years of spawning ground surveys. Figure 3.40 depicts one of the more challenging cascades in segment 1. Upstream of segment 1 there is approximately 0.66 miles of low gradient (2-4%) spawning and rearing habitat and 0.73 miles of 4-8 percent gradient habitat.

Figure 3.40. Photograph looking upstream at second cascade in Stinky Creek (90 meters upstream from confluence with the Clallam River).

Cougar Creek (19.0141)

No definitive barriers were identified in segment 1 of Cougar Creek. However, several logjams perched against the stream's valley walls were identified. The first major perched logjam is located at river mile 0.25. The largest, most significant partial barrier jam was located at river mile 0.33. This logjam has a vertical height of 7 to 10 feet depending upon location across the channel. Figure 3.41 illustrates the relative scale of this feature, the vertical height in the middle of the photo below is 10 feet. No age-0 coho or steelhead were observed upstream of this jam. However, what appeared to be age-1 coho and steelhead were observed upstream of this jam. There is approximately 0.9 miles of high quality 3-76 percent gradient habitat upstream of this jam.

Figure 3.41. Photograph looking upstream at valley spanning logjam at river mile 0.33.

Unnamed Tributary 19.0144

At the confluence with the Clallam River there is a major cascade in unnamed tributary 19.0144. Figure 3.42 depicts the first in a series of cascades in segment 1. Several valley spanning logjams also hinder upstream migration above the initial series of cascades. The origin of the perched jams upstream of the bedrock cascades appears to be related to an upstream channelized landslide. Segment 1 has an average gradient of 13 percent over a length of 0.1 miles. Segment 2 is 0.44 miles long and has an average gradient of 3-4 percent. Numerous cutthroat trout were observed upstream of the first series of cascades. No anadromous fish were identified in this stream.

Figure 3.42. Photograph looking upstream at cascade in unnamed tributary 19.0144.

Clallam River Mainstem

The mainstem Clallam River was surveyed for potential barriers upstream from the confluence with the Strait to river mile 13.7. A partial barrier was identified near river mile 12.9. This partial barrier is a very large valley spanning logjam. The vertical height of the jam varies from 8 to 12 feet. No juvenile coho were observed upstream of this jam. However, two steelhead redds were positively identified upstream of the jam. The logjam is depicted in Figure 3.43. It is assumed that this feature blocked all coho or most coho spawners during the 2006 spawning season.

Phinney and Bucknell (1975) identified a logjam in the mainstem that they classified as a total barrier near river mile 11 (this corresponds to RM 13.3 from our survey). This feature is no longer present. Upstream of the barrier identified by Phinney and Bucknell (1975) there is evidence of a debris flow that traveled down a left bank tributary and temporarily blocked the channel. Most of the debris associated with this failure has been pushed to the channel margins. No other barriers were located in the reach surveyed to river mile 12.9. LiDAR data indicates that there is a short, very steep cascade reach near river mile 14.3 that likely blocks all anadromous fish upstream migration.

Figure 3.43. Photograph looking upstream at valley spanning logjam in the mainstem Clallam River at RM 12.9

3.4.1 CULVERT INVENTORY

The Clallam River is somewhat unique to other nearby watersheds as there are very few stream parallel roads. For the size of the drainage basin there are few road crossings in the tributaries within the anadromous fish use zone. Several of the stream crossings that are present are bridges. We accessed culvert blockages within the watershed by using existing culvert databases, supplemented with field surveys where necessary.

A total of 8 passable, 2 partial barrier, and 6 total barrier culverts were identified within the watershed. A summary of each barrier culvert is included below.

Swamp Creek

Two total barrier culverts were identified by WDOT and are included in the WDOT culvert database. The first culvert (WDOT #15286) is located at RM 0.59 along an abandoned road grade. The barrier consists of a corrugated metal pipe that 36.6 meters long and has a gradient of 1.5%. There is a 0.45 meter drop at the downstream end of the culvert. Just upstream from this culvert the SR 112 culvert at RM 0.68 consists of a 112 meter corrugated metal pipe. The pipe is set at a gradient of 3.5 percent and acts as a total barrier to fish. Upstream of the second barrier culvert there is 0.63 miles of 2-4 percent gradient habitat. A significant portion of this stream runs in a ditch parallel to Charley Creek Road. Also note that there is a juvenile fish barrier downstream associated with clay seam described in Section 3.4.

Last Creek Unnamed Tributary H

A total barrier culvert was identified in this tributary to Last Creek during habitat surveys. A 0.75 m diameter, perched culvert (1.7 m) at RM 0.03 blocks all anadromous fish migration. A total of 76 meters of steep (6-12%) habitat is available for potential use in segment 2, upstream of the barrier culvert. A 4 meter high waterfall blocks upstream migration at the end of segment 2is steep (6-11%) and of limiting quality for spawning fish.

Figure 3.44. Photograph looking upstream at total barrier culvert in an unnamed tributary to Last Creek.

Unnamed Tributary 19.0135

A partial barrier culvert was identified in this tributary to Charley Creek during habitat surveys. A 1.6 m diameter, slightly perched culvert (0.1 m) at RM 0.53 partially blocks anadromous fish migration (see Figure 3.45). The culvert flows under the county road that provides access to the Clallam Bay State Prison. The culvert is rusting out and partially collapsed. Lack of maintenance and poor culvert and road design resulted in the failure of two road crossings downstream of the county road in this stream. Only 15 meters of stream is present between the upstream end of the culvert and at 1.7 to 2.0 meter high cascade/falls that has a small jam perched in the cascade. The falls does not appear passable at this time. Juvenile coho and steelhead were observed in the reach downstream of the culvert. A total of 0.21 miles of 4-8 percent habitat is present upstream of the falls.

Figure 3.45. Photograph looking upstream at partial barrier culvert in unnamed tributary 19.0135.

Spruce Creek

A partial barrier culvert was identified in this tributary to the Clallam River during fish distribution surveys. A 0.47 m diameter, 2.7 percent slope, slightly perched culvert (0.25 m) at RM 0.01 completely blocks juvenile fish migration into a 0.4 acre forested wetland complex located directly upstream from the culvert. This culvert is located on Charley

Creek Road. At the time of the survey a short (13m) stream reach separated the culvert from the Clallam River. No adult salmonid habitat exists upstream of the culvert.

Hamilton Creek

A partial barrier culvert under SR 112 at RM 0.06 on Hamilton Creek may block fish passage into a 1.23 acre forested wetland. At the time of our survey the culvert appeared to be plugged or partially collapsed. The culvert 0.63 m diameter and approximately 23 meters long. It was not possible to measure the slope of the culvert during the survey without a transit and stadia rod. High densities of age 0 and 1+ coho were observed directly downstream of the culvert. No anadromous fish were identified upstream of the culvert. Note this stream is not included in the WDOT/WDFW culvert database and should be included and surveyed as part of the State's fish passage program.

Unnamed Creek WP 450

Unnamed Creek WP 450 is a right bank tributary to the Clallam River entering at RM 5.85. The SR 112 culvert is a total barrier. The culvert is 0.46 m diameter and is 15.5 meters long and has a slope of 6 percent. The culvert is perched and drops 1.15 meters. Little habitat exists upstream of the culvert. There is a significant cascade within 20-30 meters upstream of the culvert that would likely block access to all anadromous fish. The stream has an average gradient of 16% upstream of the culvert.

Unnamed Creek WP 203

Unnamed Creek WP 203 is a right bank tributary to the Clallam River entering at RM 6.24. The SR 112 culvert just upstream from the confluence with the Clallam River is a total barrier. The culvert is a 0.46 m diameter plastic pipe and is approximately 22 meters long. The slope of the culvert was not measured but the culvert outfall drops 1.5 meters. Figure 3.46 depicts the current culvert outfall and downstream channel configuration. Providing fish passage upstream of the road might prove to be difficult and/or costly but is not impossible by any means.

A moderate number of juvenile salmonids were observed downstream of the culvert outfall indicating that this is a fish bearing stream. Currently WDFW and WDOT do not recognize this stream as a fish bearing stream. Road construction and road realignment have totally destroyed this potentially productive salmon stream. WDFW and WDOT have shown blatant disregard for this stream, as the culvert was recently permitted and installed by WDOT. A moderately large 2.85 acre mixed open water/forested wetland currently exists upstream of the culvert but is completely blocked to anadromous fish by the road and culvert. The existing habitat upstream of the culvert may be some of the highest quality off-channel floodplain habitat within the entire floodplain of the Clallam River. An example of the typical habitat within the wetland complex is depicted in Figure 3.47.

Figure 3.46. Photograph looking upstream at culvert out fall on unnamed tributary WP 203.

Figure 3.47. Photograph looking upstream at typical habitat conditions in wetland complex upstream of culvert on unnamed tributary WP 203.

3.4.2 CLALLAM RIVER MOUTH

A full and detailed discussion regarding fish passage issues at the mouth of the Clallam River is beyond the scope of this assessment. Appendix D (Shaffer et al. 2003) and Appendix E include recent technical papers discussing the issues related to seasonal closures of the mouth. Both of these paper do a fine job describing hydro-geomorphic conditions at the mouth of the Clallam River. However, neither of these documents adequately synthesize the biological data nor analyze the biological effects on anadromous salmonids. Large scale mortalities (1,000s) have been documented when juvenile salmonids are unable to emigrate to the marine environment. In 2004, when the Clallam River became bar-bound in May large scale juvenile mortalities were documented when juvenile salmonids were attempting to enter the Strait of Juan de Fuca were left stranded on the bar during the falling tidal cycle (Figure 3.48).

Figure 3.48. Photograph showing example from the May 2004 fish kill at mouth of Clallam River.

The mouth of the Clallam River also became bar-bound during spring of 1998 prior to the majority of salmonid smolt emigration to the Strait. The mouth was opened twice during a two day period and a few thousand of juvenile salmonids were observed entering salt water (Carl Chastain, personal communication 2007). Despite efforts to open the mouth, the mouth quickly closed off. Subsequent adult coho returns to the Clallam River during the fall and winter of 1999 were the lowest ever documented and less than 4% of the long-term mean (22 years of record), despite the aforementioned efforts to allow access to the at least some of the juvenile salmonids to the ocean.

In order to better understand the potential impacts of the 1998 mouth closure on the 1999 coho returns an index of WDFW spawning ground survey reaches for the WSJF was developed using 11 index reaches. The annual relative abundance of each of eleven spawning ground indices was calculated. Over the 22 years of record 14.7 percent of the coho redds documented within the 11 index reaches are attributable to the Charley Creek index. In return year 1999 only 1.3% of the coho redds documented in the WSJF index reaches were in Charley Creek. Figure 3.49 depicts the annual Charley Creek coho salmon relative abundance as defined as the proportion of the mean annual ration of the Charley Creek index to the WSJF index contrasted with the annual relative abundance of the WSJF index.

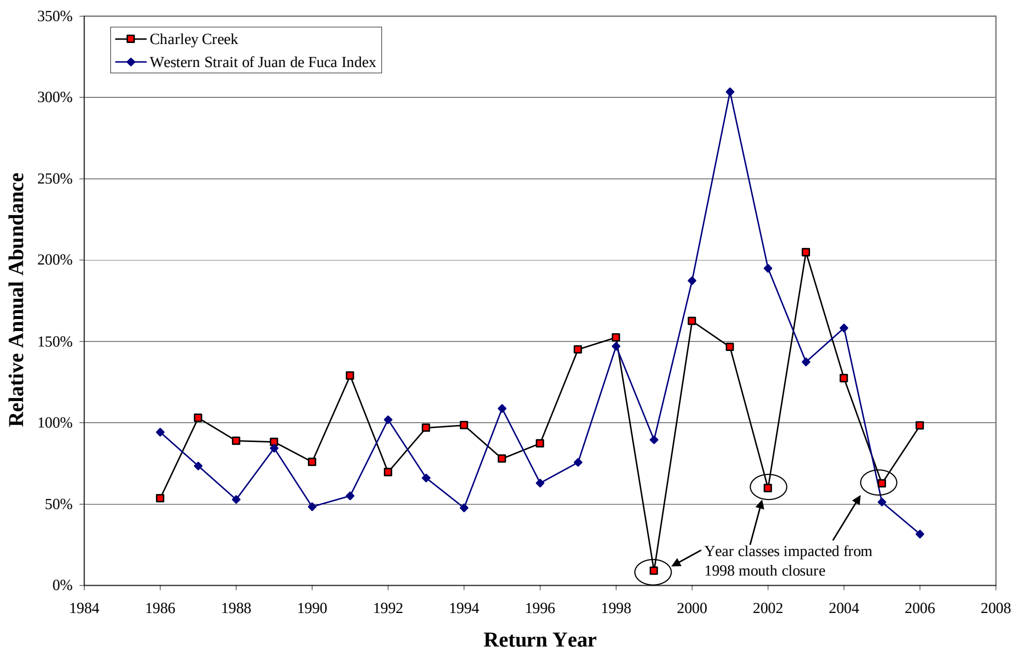

Figure 3.49. Annual Charley Creek coho salmon relative abundance as defined as the proportion of the mean annual ratio of the Charley Creek index to the WSJF index contrasted with the annual relative abundance of the WSJF index.

It has been a long standing management practice to open the mouth of the Clallam River to allow for adequate smolt emigration to the Strait of Juan de Fuca. The first documentation of breaching the mouth is documented in Kramer (1952). No systematic documentation of mouth breaching exists. However, from the 1970s through the late-1980s a small hatchery was operated by the Clallam Bay High School and the school received permits annually to open the mouth of the river to allow smolts access to the Strait (Bill Riedel, pers. comm. 2008). Currently there is insufficient data to adequately assess the impacts of mouth closures at the population scale. Clearly mouth closures that result in large scale mortalities and/or the inability of a large proportion of the smolts to enter the Strait can significantly affect the year class of fish affected. Long-term monitoring of mouth closures, precipitation, stream flow, estuary stage, water quality, and fish populations should provide the information necessary to adequately assess the potential impacts at the population scale. The timing and frequency of mouth closures and the timing of juvenile emigration are the key data that need to be collected, as these factors appear to play the primary role in affecting the population(s) abundance.

3.5 STREAMFLOW CONDITIONS

Summer-time stream flows within the Clallam River watershed can be very low (<10 cfs), where as annual peak flows can be quite high (>1,000 cfs). No systematic analysis of changes in peak or low flows has been conducted within the Clallam River watershed. Ample evidence has been collected and reviewed that shows extensive clearcutting and road building has occurred over the past 100 years. Very little old growth forest remains in the watershed and roads have been constructed throughout the entire watershed. Hydrologic maturity has been improving of the last few decades. Smith (2000) estimate that 60% of the forest was composed of forest stands 40-80 years old.

Washington State Department of Ecology (DOE) continuous stream flow monitoring in the Clallam River began during the spring of 2005. The stream gage is located downstream of Last Creek near RM 3. Three years of data collected in July, August, and September for water years (WYs) 2005, 2006, and 2007 indicate that average streamflow was 23, 7.8, and 19 cfs respectively. DOE estimated an instantaneous low flow discharge of 1.9 cfs in September 2006. The DOE instantaneous low flow in 2005 and 2007 were 3.1 and 3.9 cfs. Peak instantaneous flows in WYs 2007, 2006, and 2005 were 1,200, 2,460 and 1,000 respectively.

EES Consulting (2005) report that based on physical habitat simulation (PHABSIM) modeling work conducted in Clallam River that fish habitat requirements are exceeded during winter months. Existing summer flows were required to meet fish habitat needs. Figure 3.50depicts synthesized dispersed stream flow duration curves for Clallam River at the confluence with the Strait of Juan de Fuca.

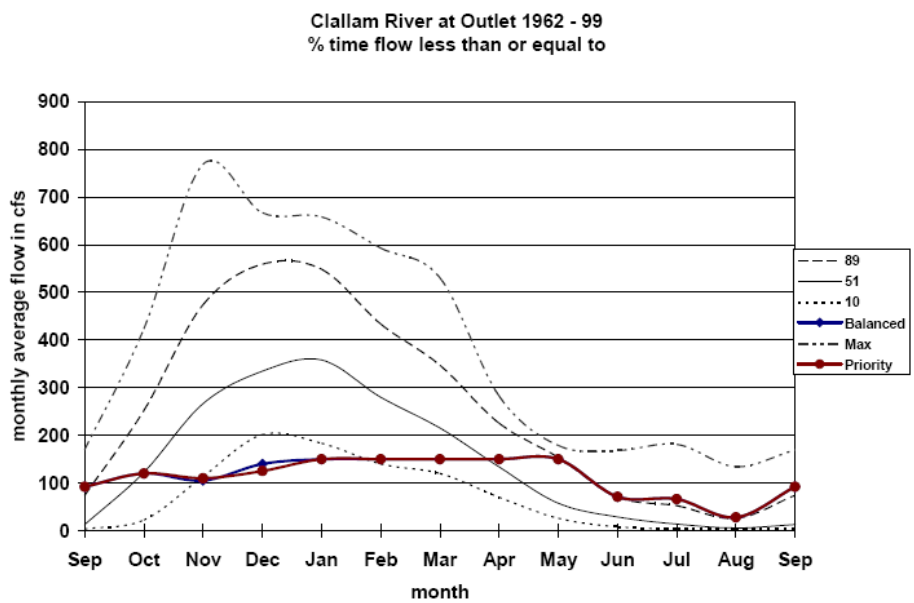

Figure 3.50. Clallam River at confluence with Strait, synthesized annually (1962-1999) dispersed flow duration curve (source: EES Consulting 2005).

3.6 WATER QUALITY CONDITIONS

3.6.1 STREAM TEMPERATURE

Four efforts to collect stream temperature data in the Clallam River watershed have been made during the past 15 years. DNR collected stream temperature data during the 1990s at several sites over a two year period. These data could not be located at the time this report was being prepared. The Lower Elwha Tribe collected continuous stream temperature data at several site during the summers of 1997, 2000, and 2003 (see Table 3.10). Stream temperature data in Charley Creek was only collected in 1997. The maximum stream temperature measured was 16.1ºC. Average stream temperature from July 1 to August 15, 1997 was 13.1ºC.

Stream temperatures in the mainstem were significantly warmer than in Charley Creek. Figure 3.51, Figure 3.52, and Figure 3.53 depict maximum daily stream temperature at several mainstem sites from the summers of 1997, 2000, and 2003 respectively. These data indicate a general trend of increasing stream temperature in the downstream direction. The Weel Road site had consistently higher temperatures during all three years. Maximum stream temperatures recorded during the summers of 1997, 2000, and 2003 were 18.9, 17.8, and 19.5ºC respectively. The maximum seven-day average daily maximum (7-DADMax) stream temperatures at Weel Road for 1997, 2000, and 2003 were 18.2, 17.2, and 18.3ºC respectively. Temperatures were significantly cooler upstream at RM 6.0 where in 1997, 2000, and 2003 the maximum temperatures were 17.2, 16.5, and 18.5ºC respectively. The maximum 7-DADMax stream temperatures at RM 6.0 for 1997, 2000, and 2003 were 16.7, 16.1, and 17.3ºC respectively.

Table 3.10. Summary of Clallam River temperature data collected by Lower Elwha Tribe.

SITE	YEARS SAMPLED
Charley Creek	1997
Clallam River @ RM 0.2	2003
Clallam River @ Weel Rd	1997; 2000; 2003
Clallam River @ RM 2.0	1997; 2003
Clallam River @ Charley Crk	1997
Clallam River @ DNR Camp.	1997; 2000; 2003
Clallam River @ P-1800 Rd	2000

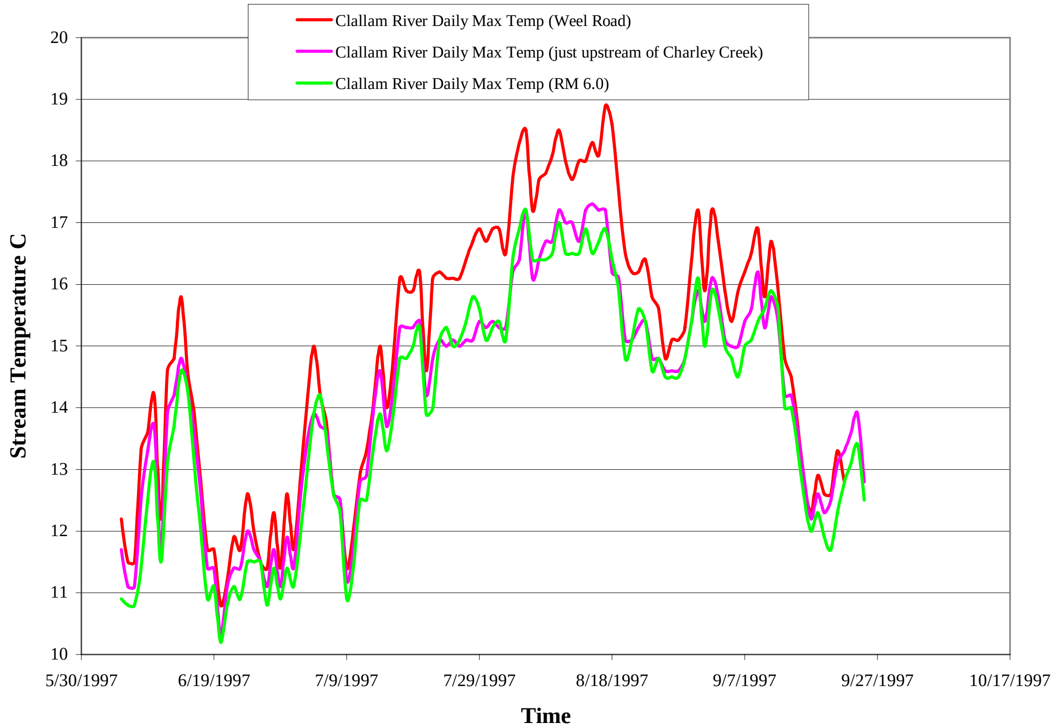

Figure 3.51. Clallam River maximum daily stream temperature at Weel Road (RM 2.3), just upstream from Charley Creek (RM 4.0). and at RM 6.0 (source: Lower Elwha Tribe).

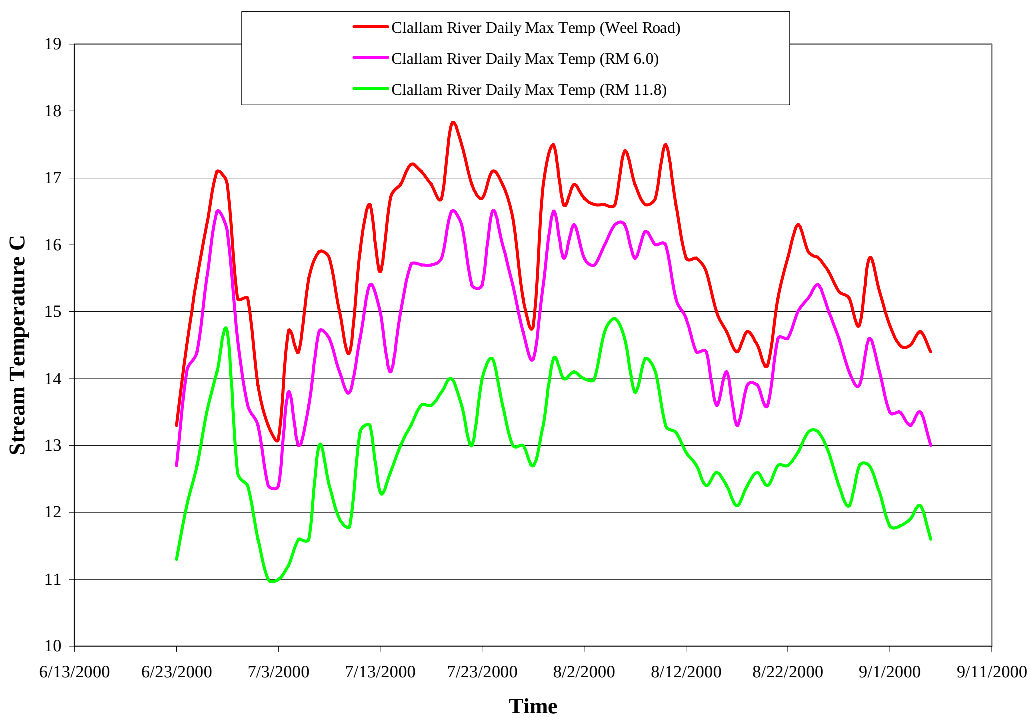

Figure 3.52. Clallam River maximum daily stream temperature at Weel Road (RM 2.3), RM 6.0, and RM 11.8 (source: Lower Elwha Tribe).

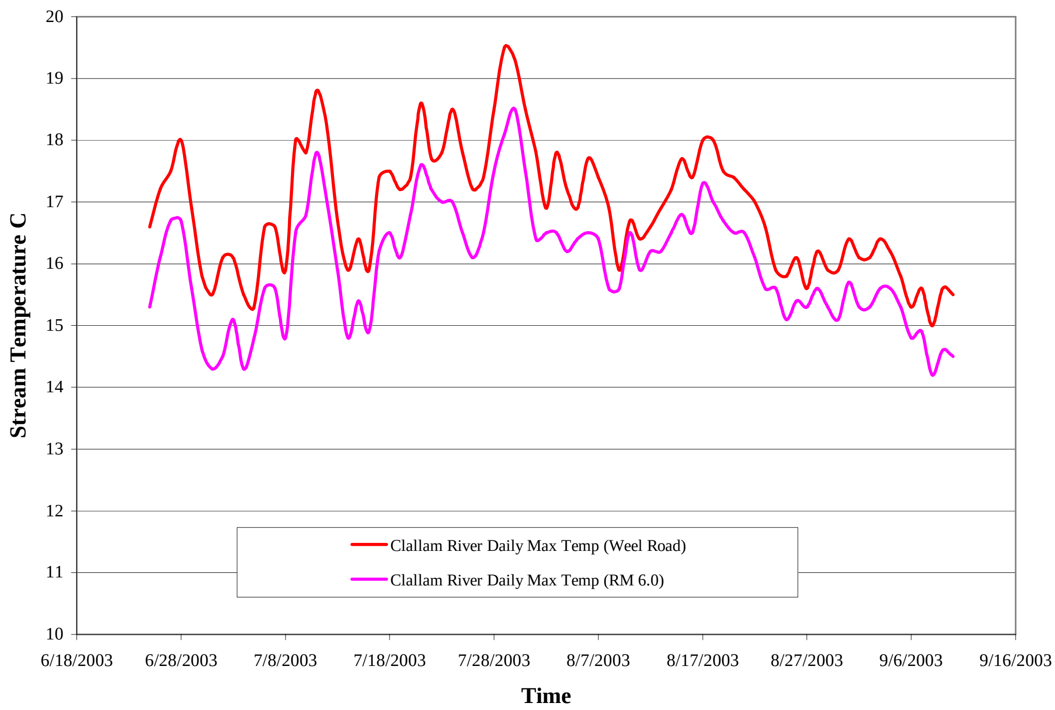

Figure 3.53. Clallam River maximum daily stream temperature at Weel Road (RM 2.3) and RM 6.0 (source: Lower Elwha Tribe).

Stream temperature data were also collected by Streamkeepers during the summer of 2005. Figure 3.54 depicts the 16 sites in the mainstem and tributaries where water and air temperatures were monitored. Several of the thermographs deployed in the Clallam River watershed were vandalized and/or stolen, thus limiting the number of sites where data are available. The thermographs were also not deployed until the first week of August and therefore a significant amount of the warmest portion of the season was not adequately monitored. Nonetheless, these data do provide additional insight into where temperature problems within the watershed occur.

Table 3.11 depicts a summary of the site locations, maximum August temperatures recorded, and average August temperatures. Within the mainstem the highest daily maximum and daily average temperatures were observed at Station A (RM 1) and coolest temperatures were observed at Station S (RM 12). The mainstem sites show a similar trend of increasing stream temperatures in the downstream direction as seen in the three years of temperature data collected by the Lower Elwha Tribe. A few exceptions (sites E, P, F) exists. This could be at least partially explained by cooler stream inputs from Charley Creek, which enters between sites P and F (see Figure 3.55).

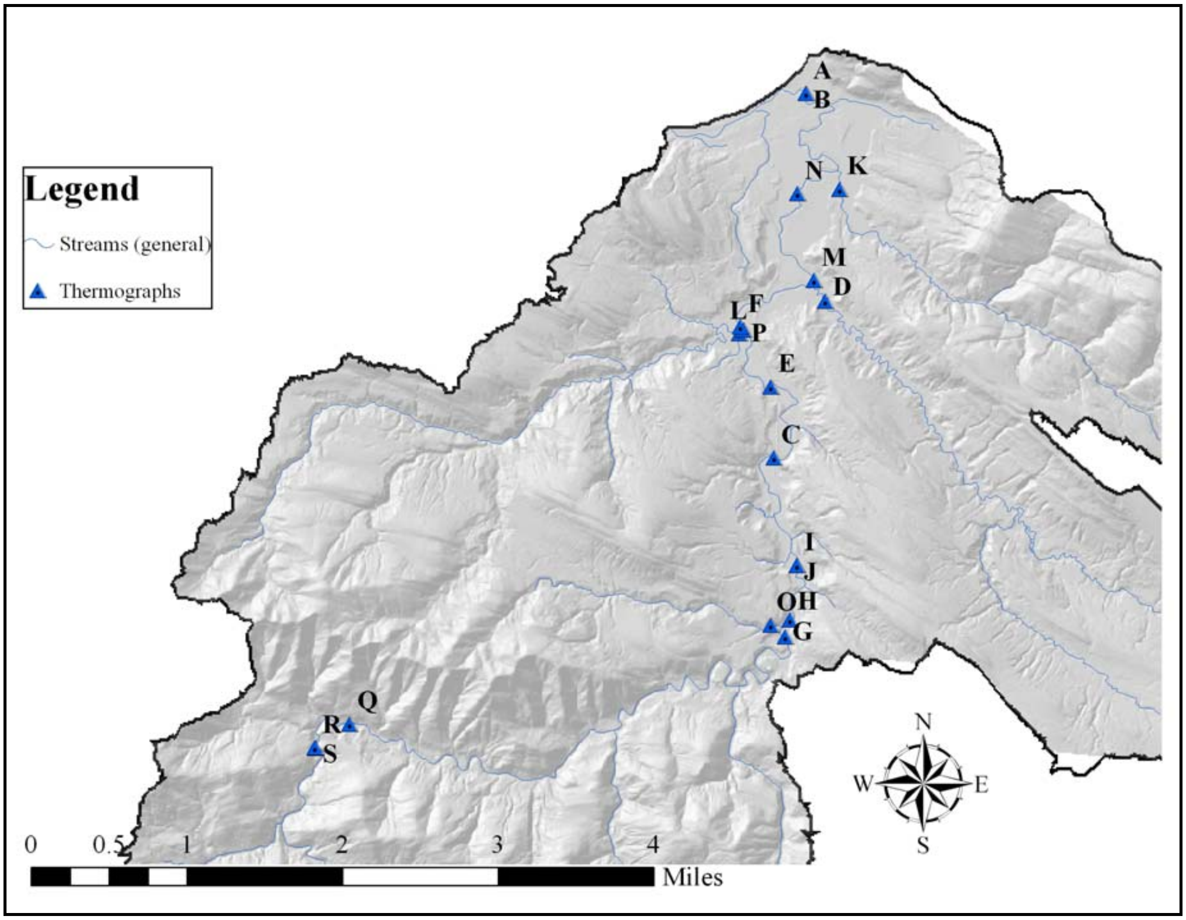

Figure 3.54. Clallam River temperature monitoring sites. Note green, yellow, and red circles denote 2005 Clallam County monitoring sites and black triangles are Elwha Tribe temperature monitoring sites from the EIM Database.

Table 3.11. Clallam River stream and air temperature monitoring stations and summary of August 2005 results.

Stream Name	Site ID	River Mile	August Maximum Temperature (ºC)	August Average Temperature (ºC)
Clallam River (Air)	A	1	17.1	13.4
Clallam River	B	1	17.9	15.5
Clallam River	N	2.5	na	na
Clallam River	M	3.3	na	na
Clallam River	F	3.9	16.4	14.9
Clallam River	P	4	16.7	15.1
Clallam River	E	4.6	17.1	15.3
Clallam River	C	5.4	na	na
Clallam River (Air)	I	6.3	18.8	14.1
Clallam River	J	6.3	na	na
Clallam River	H	6.8	16.7	14.6

Clallam River	G	6.9	16.5	14.6
Clallam River	Q	11.5	na	na
Clallam River (Air)	R	12	na	na
Clallam River	S	12	15.6	13.4
Pearson Creek	K	0.1	14.1	12.8
Last Creek	D	0.3	15.6	13.5
Charley Creek	L	0.1	14.7	13.4
Blowder Creek	O	0.1	14.3	13.2

Stream temperature data from the four tributaries monitored during the summary of 2005 indicate that stream temperatures are relatively cool. Maximum August stream temperatures in Pearson, Last, Charley, and Blowder creeks were 14.1, 15.6, 14.7, and 14.3ºC respectively. Daily average stream temperatures during August 2005 in Pearson, Last, Charley, and Blowder creeks were 112.8, 13.5, 13.4, and 13.2ºC respectively

The DOE has collected continuous stream temperature data at the Clallam River stream gage since June 2005. At this report was being prepared data stream temperature data were available through early-summer 2007. Figure 3.56 depicts Clallam River stream temperature from June 2005 to June 2007. Interestingly the 2005 data indicates that the warmest stream temperatures were recorded prior to the Streamkeepers thermograph deployment in August 2005. The maximum stream temperatures recorded in 2005 and 2006 were 17.6 and 19.1ºC respectively. The maximum 7-DADMax stream temperatures recorded during 2005 and 2006 were 17.3 and 18.4ºC respectively. In 2005 the 7-DADMAX exceeded 16ºC on 25 days. Over the course of the 2006 summer the 7-DADMax stream temperature exceeded 17.5ºC on seven days and exceeded 16ºC on 24 days.

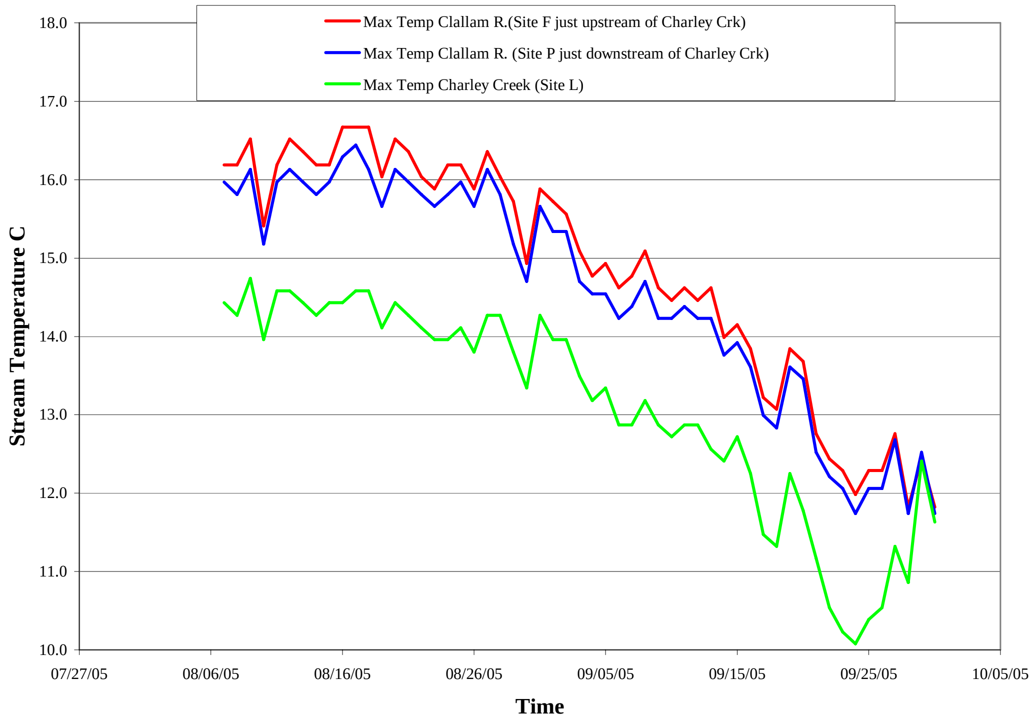

Figure 3.55. Comparison of daily maximum stream temperature just upstream of Charley Creek, just downstream of Charley Creek, and in Charley Creek.

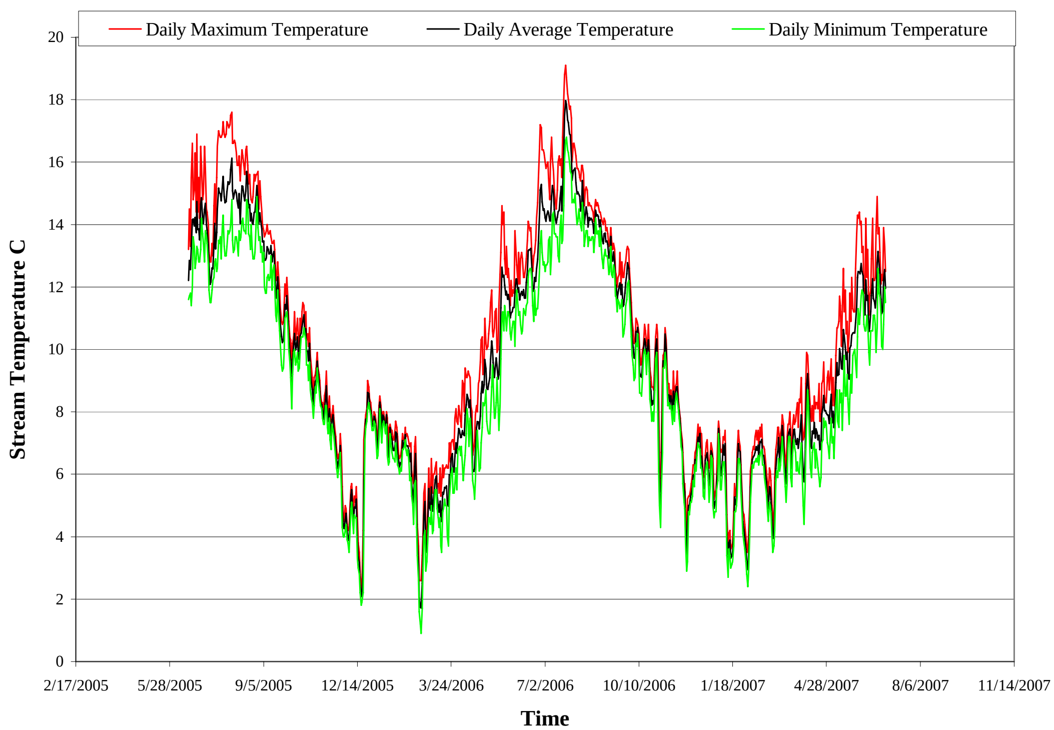

Figure 3.56. Clallam River daily maximum, minimum, and mean stream temperature at the DOE stream gage (source: DOE unpublished stream temperature data).

3.6.2 OTHER WATER QUALITY PARAMETERS

Several additional water quality parameters were measured monthly by Streamkeepers at the sites shown in Figure 3.54. Water quality parameters collected included: temperature, dissolved oxygen, conductivity, turbidity, and salinity. A complete summary of the water quality data is included in Appendix F. Figure 3.57 depicts dissolved oxygen levels (mg/l) for five sites in the mainstem Clallam River. The data show seasonal fluctuations in dissolved oxygen levels that correspond to seasonal temperatures and flow conditions. In general the dissolved oxygen levels appear adequate to support salmonids in mainstem during all months sampled. However, several occurrences were documented where the dissolved oxygen levels were below the State's water quality standard for "core summer habitat". Slightly lower levels of dissolved oxygen were documented at RM 1.0 during summer months. This is likely attributable to the fact that the river is fairly stagnate at this location in the inter-tidal zone during the summer months, when the mouth of the river is bar bound.

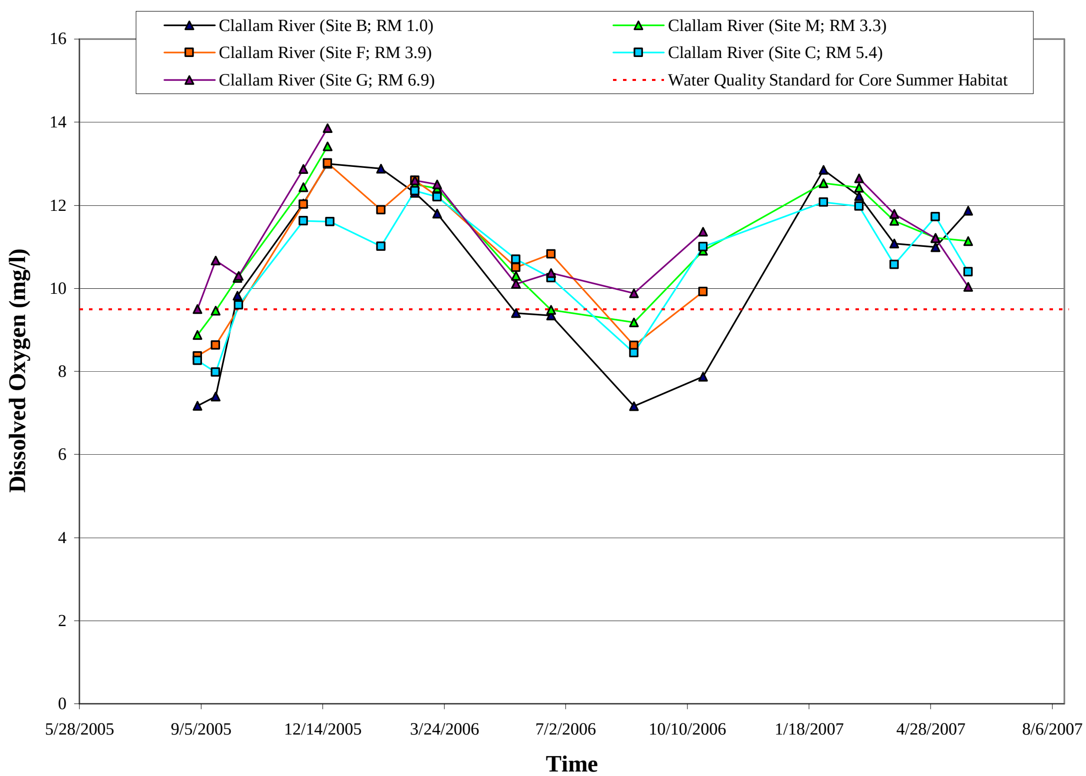

Figure 3.57. Monthly dissolved oxygen levels for five sites on the Clallam River (source: Streamkeepers unpublished data).

Dissolved oxygen levels during the sampling period for Last, Charley, and Blowder creeks are depicted in Figure 3.58. Dissolved oxygen levels in Blowder Creek were good during all sampling events. Dissolved oxygen levels in Charley Creek during summer low flow periods were between 8 and 9.5 mg/l. Sampling in Last Creek clearly shows that dissolved oxygen levels fall far below the quality standard for spawning, rearing, and migration. Weekly or monthly summer-time longitudinal dissolved oxygen monitoring is recommended. Further sampling may help identify the length of stream affect by low dissolved oxygen levels.

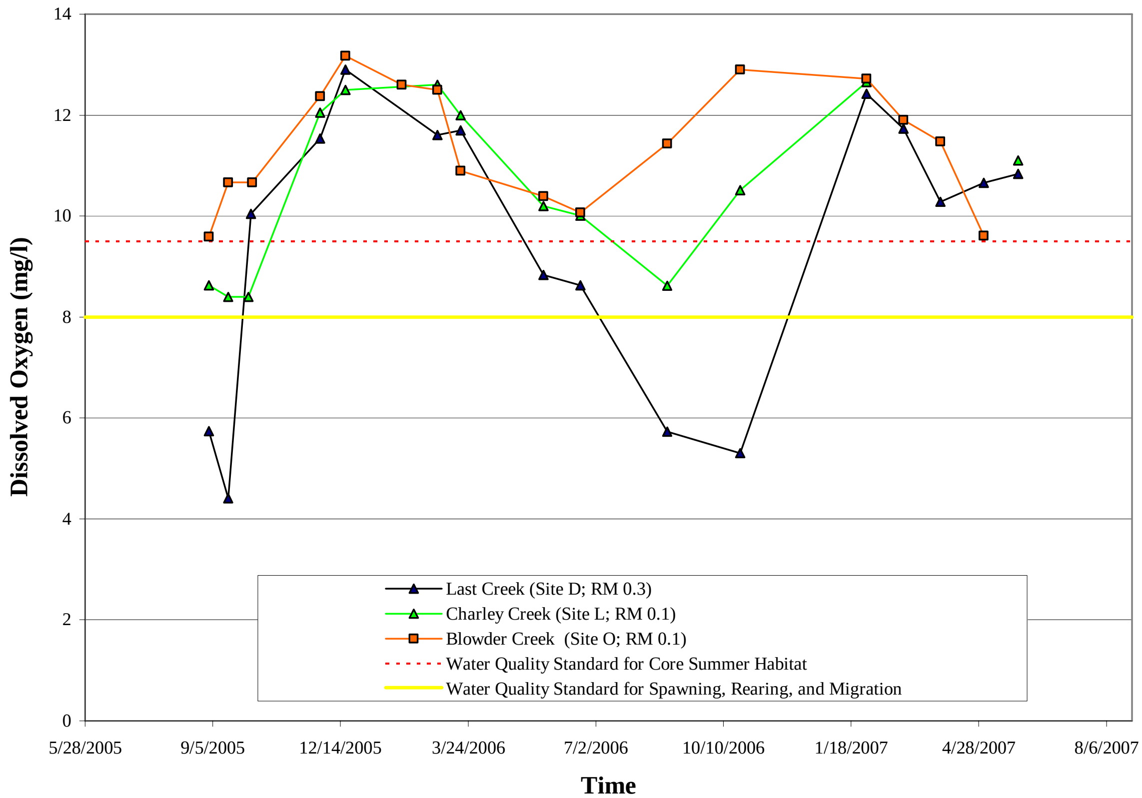

Figure 3.58. Monthly dissolved oxygen levels for Last, Charley, and Blowder creeks (source: Streamkeepers unpublished data).

A Benthic Index of Biological Integrity (BIBI) survey was conducted in 2004. Data were collected at two sites in the Clallam River. The lower site was located near river mile 2.5 and the upper site was located at RM 6.0 (based on GIS coordinates in Tetra Tech/KCM 2005). The upper site had a BIBI score of 42, which rated as “compromised”. The lower site had a BIBI score of 36, which also rated as “compromised” (Tetra Tech/KCM 2005).

4   DISCUSSION

The freshwater life-history stages of anadromous salmonids can be quite complex within a given species. Trying to describe the life-history stages between different species can be complicated and complex. A simplified depiction of the different freshwater life-history phases includes the following stages: adult migration, adult holding, adult spawning, egg incubation, fry emergence and early rearing, juvenile rearing, and juvenile emigration. Species such as coho and steelhead typically rear in freshwater at least one complete year before smoltification and entry into the marine environment. Species such as chum salmon may reside in freshwater for only a few weeks to months before emigrating the ocean.

Natural mortality occurs at each stage thereby reducing the number of individuals within a given population. Typically the majority of freshwater mortality occurs during egg incubation and juvenile rearing stages (Quinn 2005). In order to understand the factors affecting freshwater survival and habitat productivity a basic understanding of how habitat conditions and environmental variability affect survival is needed. The following text is as basic description of the relationship between habitat conditions and potential limiting factors.

4.1 LIMITING FACTORS

Major Limiting Factors:

- River Mouth Closure
- Fine Sediment/Excessive Sedimentation
- Road Density
- Riparian Corridor/Tree Planting
- Lack of LWD
- Temperature/Shade
- Noxious Weeds
- Loss of Saltmarsh
- Open Riparian Area - The altered riparian has contributed to high water temperatures in the summer.
- Floodplain Impacts - Significant floodplain impacts include gravel bar scalping and riparian road impacts
- Severe Peak Flows – It is believed that changes in the age and type of surrounding forests can contribute to the increased frequency and severity of peak flows.

Minor Limiting Factors:

Blockages – Fish passage problems have mostly impacted coho and steelhead habitat. Blockages on commercial forest lands are being removed or repaired under the Forest/Fish HCP and should be completed by 2015.

Riparian areas dominated by hardwoods rather than conifers.

4.2 RESTORATION AND PROTECTION STRATEGY

There are relatively few individual landowners and a low human population density throughout most of the WRIA, which remains relatively undeveloped compared to other WRIAs closer to the metropolitan areas of Puget Sound. Population density increases around the town of Clallam Bay. The Clallam River watershed has a good potential for protection and restoration of landscape processes to support long-term salmon survival.

The strategy used in this recovery plan focuses on the concepts presented in several salmonid habitat recovery planning documents and scientific studies (e.g., Beechie and Boulton 1999; Roni et al. 2002; Beechie et al. 2003; Roni et al. 2005; Stanley et al. 2005). Several scientific studies have illustrated that habitat conditions and aquatic ecosystem function are a result of the interaction between watershed controls, watershed processes, and land use. Scientists and resource managers have recognized that restoration planning that carefully integrates watershed or ecosystem processes is more likely to be successful at restoring depleted salmonid populations (Beechie et al. 2003). The following recovery strategy is based on the relationship between landscape processes and land use, the resulting habitat conditions, and the biological response.

The WRIA 19 conceptual recovery strategy uses a multi-parameter approach to develop specific, process-based strategies for each landscape and/or biological process that is linked to a specific limiting factor.

The voluntary proposed recovery actions used to implement these strategies will be carried out by the agencies, entities, landowners, and others that have authority and resources to implement recovery actions. This recovery plan is non-regulatory. It does not supplant or override any existing authorities or permitting processes. All future actions will need to be implemented in cooperation with all appropriate permitting authorities and in the context of existing permits, regulations, agreements and public processes.

As described above, several scientific studies have shown that habitat conditions and aquatic ecosystem function are the result of the interaction between watershed controls, watershed processes, and land use. Recovery plans and strategies that incorporate watershed processes and/or ecosystem recovery are more likely to result in the recovery of degraded habitat conditions and therefore improve the conditions and factors that limit salmonid populations. Recovery strategies must be based on the restoration of critical processes, inputs, and habitat conditions associated with identified limiting factors affecting salmonid populations. Figure 4.1 illustrates the basic concept of the interaction between watershed controls, watershed processes, habitat effects, and fish population responses.

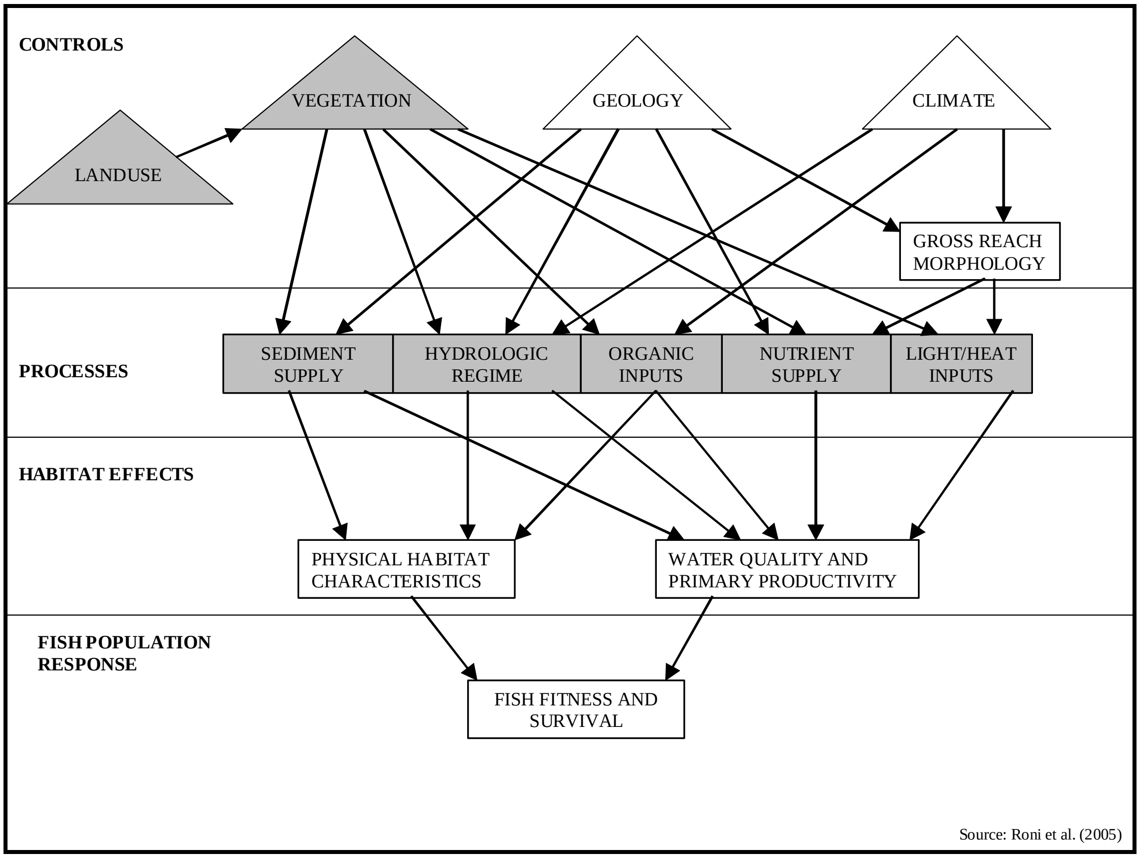

Figure 4.1. Schematic depicting the linkage between landscape controls and land use, habitat-forming processes, habitat conditions, and resulting fish population responses (modified from Roni et al. 2005).

Figure 4.2 contains a flow chart depicting a general hierarchical approach for prioritizing habitat restoration, protection, and enhancement activities with regard to habitat (Roni et al. 2002). This model can then adapted for conditions specific to each species of concern. Within the Clallam watershed, some limiting factors, habitat conditions, and life histories are shared among all species, while others apply to some species and not others.

The recovery flow chart (Figure 4.2) was used to develop the Clallam River watershed recovery strategy hierarchy (see Figure 4.3). All recovery strategies and actions fall within a hierarchal pyramid containing tiers that can be used to sequence and aid in prioritization of strategies and actions needed to restore processes, inputs, and conditions affecting salmonids in the Clallam River watershed

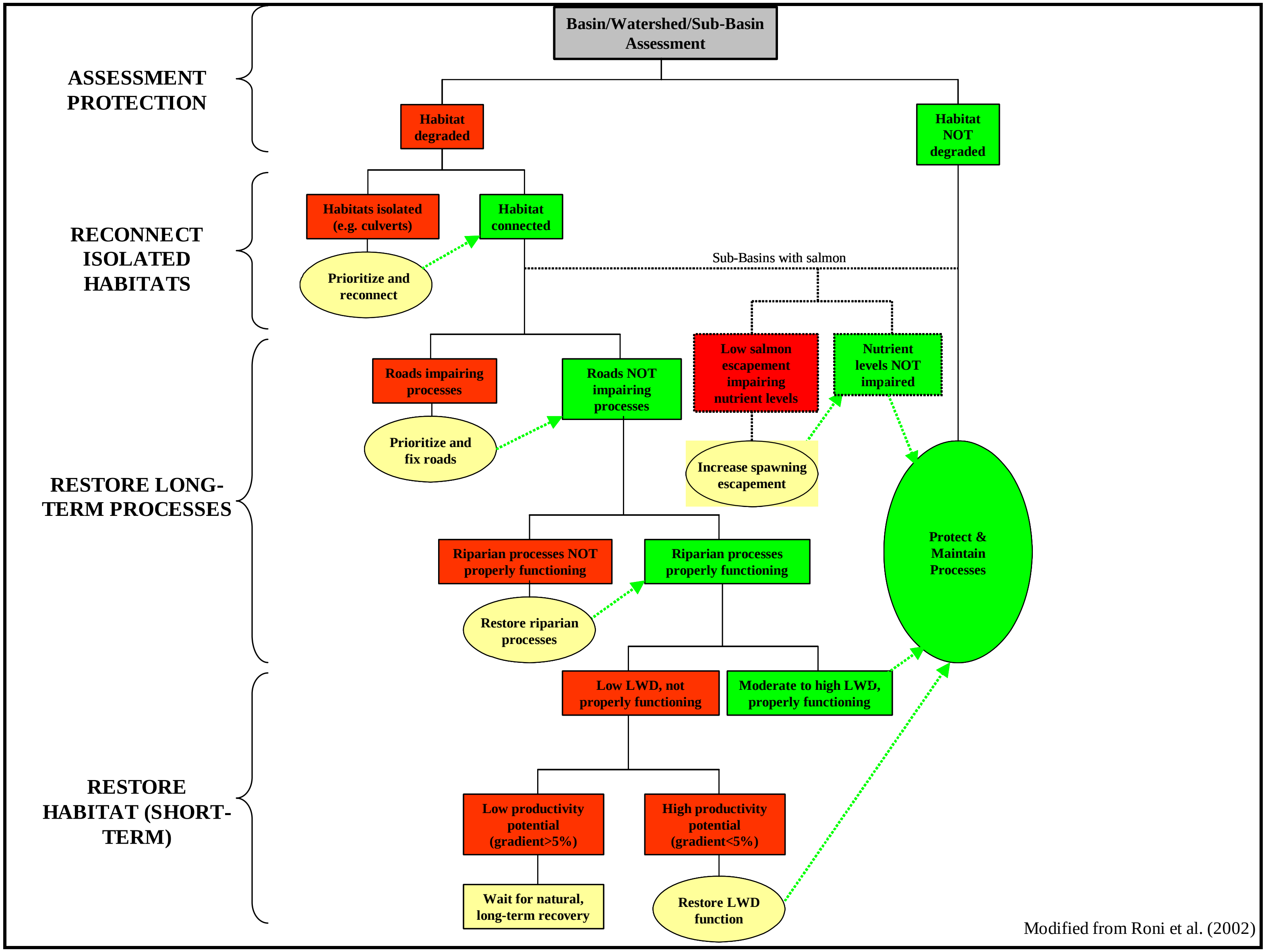

Figure 4.2. Flow chart depicting hierarchical strategy for prioritizing protection, restoration, and enhancement activities. (Note: red rectangles represent impaired processes or conditions, yellow ovals represent the need to develop strategies and implement actions, green rectangles represent restored processes where planners can then move down through the flow chart).

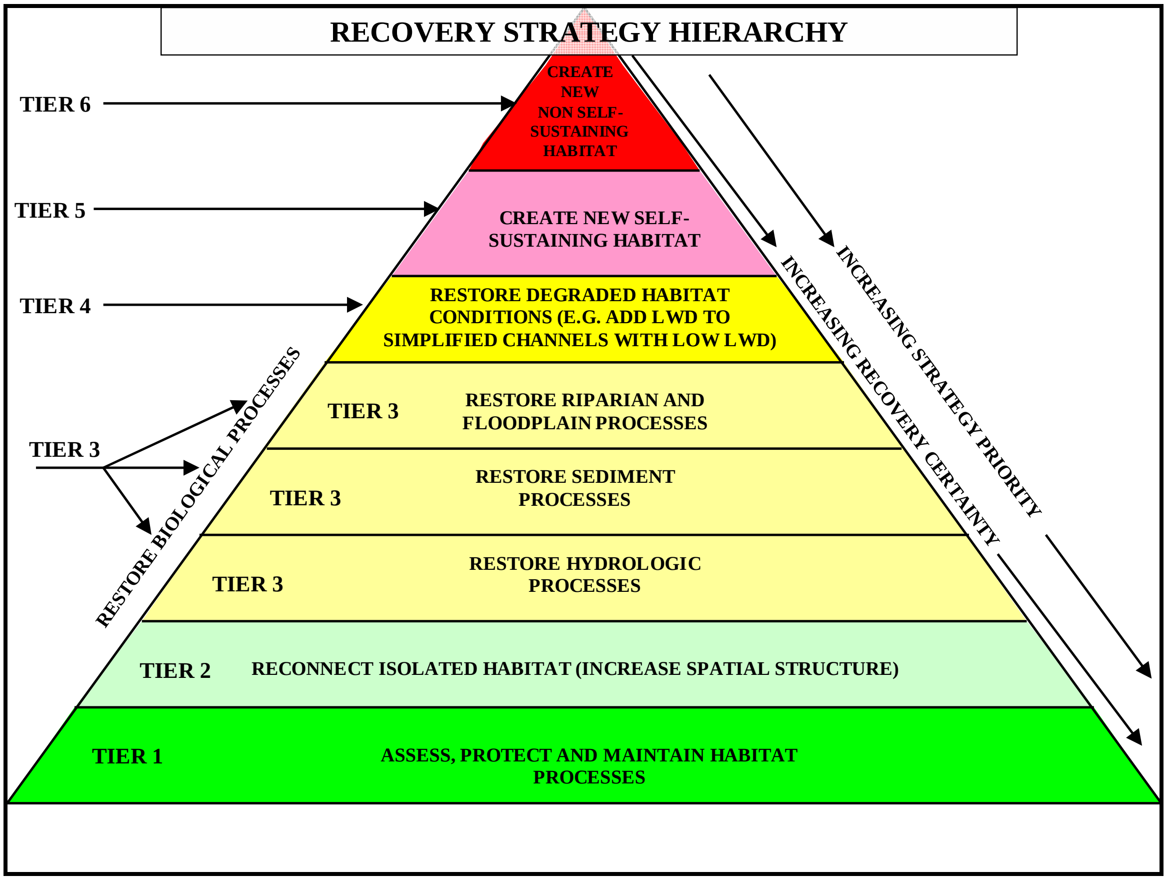

Figure 4.3. Clallam River watershed recovery strategy and action hierarchy.

4.2.1 SUMMARY OF PAST RESTORATION/ENHANCEMENT PROJECTS

Extensive habitat restoration has not occurred in the Clallam River watershed. The list below includes a detailed inventory of recent (last 20 years) restoration, enhancement, and protection projects implemented within anadromous fish use zone in the Clallam River watershed.

- Sadilek LWD project (Elwha Fisheries installed 4 LWD jams along the right bank of the Clallam River)
- Sadilek riparian fencing and tree planting. A total of ~2700 feet of fence were placed 113 feet away from the Clallam River to keep livestock from the river. In addition, a total of 7500 native trees and shrubs were planted (Clallam Conservation District, 2006).
- Washington State Department of Transportation installed one large bank deflector jam at RM 6.1 (2005; DOT).
- Pending information on fish blocking-culvert removal.

4.2.2 PRIORITIZED RESTORATION PROJECT LIST

- River Mouth Closure
- Fine Sediment/Excessive Sedimentation
- Road Density
- Riparian Corridor/Tree Planting
- Lack of LWD
- Temperature/Shade
- Noxious Weeds
- Loss of Saltmarsh

<u>Major Recommendations For Barriers</u>
To the extent feasible, improve the passage problems in their listed priority order.

<u>Data Needs For Loss of Fish Access</u>
Surveys for barriers, including those in estuarine and freshwater habitats are needed throughout WRIA 19. These surveys should include information about the extent of the blockage and the quality of habitat blocked, quantity of habitat blocked, and species/life history stage blocked.

Conduct studies on the blockage problem near the mouth of the Clallam River. Studies should address the causes and solutions for the blockage.

<u>Major Recommendations For Floodplains</u>
Reduce riparian road impacts either by road abandonment or through better road surfacing.

Increase off-channel habitat, particularly in areas vulnerable to scour.

Increase LWD in areas of channel incision to allow sediments to accumulate for reconnection of the river to its floodplain.

Due to time and funding constraints, project prioritization is not complete.

4.2.3 DATA GAPS AND MONITORING NEEDS

<u>Data Needs:</u>
Intermittent River Mouth Blockage
Chum salmon spawning ground surveys
Clallam River mouth monitoring
Water quality and quantity monitoring
Develop maps comparing the current versus historic floodplains

Due to time and funding constraints, needs list is not complete.

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Appendix A- Hatchery Releases

Table A- 1. Clallam River coho salmon hatchery releases from 1953 to present (source: RMIS database query).

Brood Year	Year of Release	Avg. Weight	Release Stage	Release Location	Number Released	Broodstock Origin
1952	1953	0.3	Emergent Fry	Clallam River	19,600	Dungeness River
1956	1958	2.3	Fingerling	Clallam River	24,038	Dungeness River
1957	1959	4.5	Fingerling	Clallam River	37,130	Dungeness River
1960	1962	4.8	Fingerling	Clallam River	75,576	Dungeness River
1961	1963	11.3	Pre-smolt	Clallam River	12,000	Dungeness River
1962	1964	6.3	Fingerling	Clallam River	30,024	Dungeness River
1963	1965	11.9	Pre-smolt	Clallam River	15,000	Dungeness River
1964	1966	10.4	Fingerling	Clallam River	75,010	Big Soos Creek
1965	1967	12.6	Pre-smolt	Clallam River	60,012	Dungeness River
1968	1970	8.9	Fingerling	Clallam River	25,182	Dungeness River
1969	1971	14.0	Pre-smolt	Clallam River	34,100	Dungeness River
1970	1972	28.4	Smolt	Clallam River	32,000	Lake Creek (Sol Duc)
1972	1974	35.3	Smolt	Clallam River	328,007	Washougal River
1973	1975	30.2	Smolt	Clallam River	48,495	Sol Duc River
1975	1976	0.9	Fingerling	Clallam River	148,000	Sol Duc River
1976	1977	0.4	Emergent Fry	Clallam River	200,000	George Adams
1976	1978	21.6	Smolt	Clallam River	50,100	Washington General
1977	1979	18.9	Smolt	Clallam River	243,600	Washington General
1981	1982	0.4	Emergent Fry	Clallam River	84,500	Elwha River
1981	1983	0.6	Fingerling	Clallam River	12,900	Elwha River
1983	1984	0.8	Emergent Fry	Clallam River	94,800	Dungeness River
1985	1987	17.5	Pre-smolt	Clallam River	5,000	Dungeness River
n=20	**n=22**	**14.5**	**-**	**Total Released=**	**1,655,074**	**n=8**

Table A- 2. Clallam River Chinook salmon hatchery releases from 1961 to present (source: RMIS database query).

Brood Year	Year of Release	Avg. Weight	Release Stage	Release Location	Number Released	Broodstock Origin
1960	1961	0.60	Fed fry	Clallam River	109,185	Deschutes River
1961	1962	0.69	Fingerling	Clallam River	254,760	Finch Creek
1962	1963	0.65	Fingerling	Clallam River	246,400	Finch Creek
1963	1964	0.60	Fed fry	Clallam River	302,000	Minter Creek
1964	1965	0.54	Fingerling	Clallam River	1,438,330	Big Soos Creek
1965	1966	2.27	Fingerling	Clallam River	4,600	Big Soos Creek
1967	1968	0.70	Fingerling	Clallam River	208,000	Finch Creek
1968	1969	0.53	Fed fry	Clallam River	249,900	Finch Creek
1969	1970	0.65	Fingerling	Clallam River	161,000	Finch Creek
1970	1971	5.15	Smolt	Clallam River	803,937	Finch Creek
1971	1972	5.74	Smolt	Clallam River	98,987	Hood Cannel/Elwha
1972	1973	5.76	Smolt	Clallam River	172,100	Finch Creek
1972/73	1974	17.31	Smolt	Clallam River	133,684	Sol Duc River, Hood Canal x White
1974	1975	5.18	Smolt	Clallam River	212,250	Sol Duc/Deschutes Rivers
n=15	**n=14**	**3.31**	**-**	**Total=**	**4,395,133**	**n=7**

Table A- 3. Clallam River steelhead trout hatchery releases from 1982 to 2006 (source: RMIS database query; WDFW 2006; and annual steelhead catch and hatchery release summary reports- for additional details see text of report)

Brood Year	Year of Release	Avg. Weight	Release Stage	Release Location	Number Released	Broodstock Origin
1977	1978	na	Smolt	Clallam River	10,200	Unknown
1978	1979	na	Smolt	Clallam River	5,500	Unknown
1979	1980	na	Smolt	Clallam River	5,200	Unknown
1980	1982	100.8	Smolt	Clallam River	8,571	Bogachiel River
1981	1983	128.3	Smolt	Clallam River	10,019	Bogachiel River
1982	1984	87.2	Smolt	Clallam River	10,322	Bogachiel River
1983	1985	92.6	Smolt	Clallam River	10,383	Bogachiel River
1984	1986	91.8	Smolt	Clallam River	10,059	Bogachiel River
1985	1987	81.0	Smolt	Clallam River	5,208	Quinault River
1986	1988	92.6	Smolt	Clallam River	5,145	Bogachiel River
1987	1989	81.0	Smolt	Clallam River	5,068	Bogachiel River
1990	1991	56.1	Smolt	Clallam River	5,927	Hoko River
1991	1992	58.2	Smolt	Clallam River	4,013	Hoko River
1992	1993	56.1	Smolt	Clallam River	6,390	Hoko River
1993	1994	85.6	Smolt	Clallam River	5,247	Bogachiel River
1994	1995	41.3	Smolt	Clallam River	4,300	Hoko River
1995	1996	81.0	Smolt	Clallam River	5,152	Bogachiel River
1996	1997	59.7	Smolt	Clallam River	5,000	Hoko River
1996	1998	75.6	Smolt	Clallam River	5,010	Bogachiel River
1997	1999	75.6	Smolt	Clallam River	5,010	Bogachiel River
1998	2000	82.5	Smolt	Clallam River	5,000	Bogachiel River
1999	2001	87.2	Smolt	Clallam River	5,000	Bogachiel River
2000	2002	68.7	Smolt	Clallam River	5,000	Bogachiel River
2001	2003	82.5	Smolt	Clallam River	5,000	Bogachiel River
2002	2004	75.6	Smolt	Clallam River	5,000	Bogachiel River
2003	2005	83.2	Smolt	Clallam River	10,000	Bogachiel River
2004	2006	na	Smolt	Clallam River	14,835	Bogachiel River
2005	2006	74.50	Smolt	Clallam River	14,838	Dungeness & Elwha R.r
n=24	**n=24**	**79.3**	**-**	**Total Released**	**191,662**	**n=3**

Appendix B- Habitat Segments

Appendix B: definitions, abbreviations, and codes:

Stream Name: name of stream.
Stream Segment Name: segment name, unique identifier.
Segment Length: length of channel or habitat segment in meters.
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), medium to high gradient spawning and rearing and ditches (D).
Gradient: field and/or LiDAR 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 stations where wetted width measurements were taken.
Substrate: substrate type classified as one of the following: fines (F), sand (S), gravel (G), cobble (C), boulder (BLD), or bedrock (BRX).
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.

Stream Name	Stream Segment Name	Length (m)	Channel Type	Hab. Type	Anad Fish Use	Gradient	Chan. Confin.	BFW	BFD	Wetted Width	Avg Depth	Substrate	Percent surveyed
Clallam River	Clallam River Seg DT1	1368	E	LSR	Y	0.0%	U	57.0	-	-	-	S/G	75%
Clallam River	Clallam River Seg 1	2011	E/PR	LSR	Y	<0.1%	U	29.1	2.4	-	-	S/G	90%
Clallam River	Clallam River Seg 2	1863	PR	LSR	Y	0.1%	U	19.9	3.4	9.3	-	G/S	25%
Clallam River	Clallam River Seg 3	1183	PR	LSR	Y	0.3%	U	27.1	2.6	-	-	G	50%
Clallam River	Clallam River Seg 4	2834	PR	LSR	Y	0.3%	U	29.4	3.3	-	-	G	0%
Clallam River	Clallam River Seg 5	1712	PR	LSR	Y	0.6%	U	30.4	2.1	11.0	0.40	G/C	100%
Clallam River	Clallam River Seg 6	706	PR	LSR	Y	0.9%	M	24.6	na	9.4	0.43	C/G	100%
Clallam River	Clallam River Seg 7	922	PR	LSR	Y	0.9%	C	21.5	2.4	10.2	0.37	C/G/BLD	100%
Clallam River	Clallam River Seg 8	790	PR/PB	LSR	Y	1.3%	C	21.5	na	10.2	0.37	BRX/BLD/C/G	100%
Clallam River	Clallam River Seg 9	740	PR	LSR	Y	1.0%	M	19.3	na	6.8	0.56	C/G	100%
Clallam River	Clallam River Seg 10	836	PR	LSR	Y	1.3%	C	15.7	na	7.8	0.49	BRX/BLD/C/G	100%
Clallam River	Clallam River Seg 11	2458	PR	LSR	Y	1.1%	C	14.5	na	8.2	0.40	BRX/C/BLD/G	100%
Clallam River	Clallam River Seg 12	1534	PR	LSR	Y	1.0%	M	17.4	na	9.0	0.26	C/G/BLD	100%
Clallam River	Clallam River Seg 13	1418	PB	LSR	Y	2.0%	C	12.6	na	7.0	0.30	BRX/C/BLD/G	100%
Clallam River	Clallam River Seg 14	1586	PB	LSR	Y	2.4%	C	9.4	na	6.0	0.28	BRX/BLD/C/G	100%
Clallam River	Clallam River Seg 15	1162	PB	LSR	A	2.4%	C	-	-	-	-	-	0%
Clallam River	Clallam River Seg 16	53	C	NA	U	13.1%	C	-	-	-	-	-	0%
Clallam River	Clallam River Seg 17	823	PR	LSR	U	1.3%	C	-	-	-	-	-	0%
Clallam River	Clallam River Seg 18	84	C	MHSR	U	10.0%	C	-	-	-	-	-	0%
Clallam River	Clallam River Seg 19	414	PB	LSR	U	2.6%	C	-	-	-	-	-	0%
Clallam River	Clallam River Seg 20	230	SP	MSR	U	6.3%	C	-	-	-	-	-	0%
Clallam River	Clallam River Seg 21	651	C	NA	U	13.1%	C	-	-	-	-	-	0%
Cannery Creek	Cannery Creek Seg 1	105	E	LO	Y	<1%	U	-	-	-	-	Fines	30%
Cannery Creek	Cannery Creek Seg 2	320	R/FW	LO	Y	1.0%	U	-	-	-	-	Fines	30%
Swamp Creek	Swamp Creek Seg 1	335	E	LO	Y	0-1%	U	12.0	na	5.3	0.22	F	85%
Swamp Creek	Swamp Creek Seg 2	157	E/PR	LO	Y	0-1%	U	9.6	na	4.5	0.22	G	100%
Swamp Creek	Swamp Creek Seg 3	44	PR/C	W	Y	4-6%	U	3.5	na	3.3	na	F	100%
Swamp Creek	Swamp Creek Seg 4	99	FW/R	LO	P	0-1%	U	na	na	na	na	na	25%
Swamp Creek	Swamp Creek Seg 5	460	PR	LSR	P	1-2%	M	na	na	na	na	na	0%

Stream Name	Stream Segment Name	Length (m)	Channel Type	Hab. Type	Anad Fish Use	Gradient	Chan. Confin.	BFW	BFD	Wetted Width	Avg Depth	Substrate	Percent surveyed
Swamp Creek	Swamp Creek Seg 6	1006	FPR/D	LSR	P	2-4%	M	~2	na	na	na	na	15%
Swamp Creek_DT1	Swamp Creek DT1 seg 1	43	PR/SP	LO	A	2-5%	U	1.9	-	0.5	0.08	S/G	100%
Swamp Creek_T1	Swamp Creek T1 Seg 1	132	E	W	Y	0-1%	U	5.2	0.6	4.9	0.60	Fine	100%
Swamp Creek_T2	Swamp Creek T2 Seg 1	44	E	LO	A	0-1%	U	3.9	na	3.4	0.26	Fines	100%
Swamp Creek_T2	Swamp Creek T2 Seg 2	23	FW	W	A	0-1%	U	na	na	6.0	0.15	Fines	100%
Swamp Creek_T3	Swamp Creek T3 Seg 1	85	E	LO	Y	0-1%	U	5.9	na	5.7	1.00	Fine	100%
Swamp Creek_T3	Swamp Creek T3 Seg 2	43	R	LO	Y	0-1%	U	4.2	na	1.6	0.09	Fine	100%
Swamp Creek_T3	Swamp Creek T3 Seg 3	229	FW	W	Y	0-1%	U	9.5	0.2	6.4	0.14	Fine	100%
Swamp Creek_T3_T1	Swamp Creek T3_T1 seg 1	178	R	LO	A	0-1%	U	3.1	na	1.3	0.17	F	100%
Swamp Creek_T3_T1_DT1	Swamp Creek_T3_T1_DT1	43	AF	LO	A	0-1%	U	na	na	na	na	F	100%
Swamp Creek_T4	Swamp Creek T4 seg 1	34	R	LO	A	0-1%	U	2.6	na	1.4	0.04	F	100%
Swamp Creek_T4_T1	Swamp Creek T4_T1 seg 1	8	R	LO	A	U	0-1%	0.5	na	0.3	na	F	100%
Swamp Creek_T5	Swamp Creek T5 seg 1	119	PR	LO	Y	0-1%	U	8.9	na	4.0	0.37	G/S	100%
Swamp Creek_T5	Swamp Creek T5 seg 2	73	R	LO	Y	0-1%	U	6.6	na	5.8	0.86	Fine	100%
Swamp Creek_T5	Swamp Creek T5 seg 3	338	FW	W	P	0-1%	na	Un	Un	Un	Un	Fine	100%
Hatchery Creek	Hatchery Creek Seg 1	270	R/OWW/P	WP	Y	0-1%	U	16.4	na	5.9	0.49	S/G	100%
Hatchery Creek	Hatchery Creek Seg 2	365	OWW/FW	W	Y	0-1%	U	Un	Un	Un	Un	Fines	100%
Hatchery Creek	Hatchery Creek Seg 3	432	FW	W	Y	1-2%	U	Un	Un	Un	Un	Fines	100%
Hatchery Creek	Hatchery Creek Seg 4	214	SP	MSR	A	4-8%	C	1.3	-	0.9	0.25	G/C	40%
Hatchery Creek_T1	Hatchery Creek Seg 1	761	FW	LO	A	0-1%	U	Un	Un	Un	Un	Fines	10%
Hatchery Creek_T1	Hatchery Creek Seg 2	176	FPR	MSR	P	2-4%	C	-	-	-	-	-	0%
Pearson Creek	Pearson Creek Seg 1	1401	PR/R	LO	Y	0.4%	U	9.2	2.1	-	-	-	0%
Pearson Creek	Pearson Creek Seg 2	1005	PR	LSR	Y	0.7%	M	8.6	1.6	-	-	-	0%

Stream Name	Stream Segment Name	Length (m)	Channel Type	Hab. Type	Anad Fish Use	Gradient	Chan. Confin.	BFW	BFD	Wetted Width	Avg Depth	Substrate	Percent surveyed
Pearson Creek	Pearson Creek Seg 3	391	FPR	LSR	Y	2.0%	C	-	-	-	-	-	0%
Pearson Creek	Pearson Creek Seg 4	144	C	NA	N	>20%	C	-	-	-	-	-	0%
Pearson Creek	Pearson Creek Seg 5	2050	-	LSR	N	2-4%	C	-	-	-	-	-	0%
Pearson Creek	Pearson Creek Seg 6	964	-	LSR	N	2-4%	C	-	-	-	-	-	0%
Pearson Creek	Pearson Creek Seg 7	1916	na	NA	N	na	-	-	-	-	-	-	0%
Fern Hill Creek	Fern Hill Creek Seg 1	477	PR	LSR	Y	1-2%	U	-	-	-	-	-	0%
Fern Hill Creek	Fern Hill Creek Seg 2	273	SP	MSR	Y	4-8%	C	-	-	-	-	-	0%
Unnamed 19.0131	19.0131 Seg 1	377	SP	MHSR	P	8-20%	C	-	-	-	-	-	0%
Sadlik Creek	Sadlik Creek Seg 1	760	FW/R	LO	P	0-1%	U	Un	Un	Un	Un	Fines	10%
Icky Creek	Icky Creek Seg 1	87	R/D	LO	Y	1-2%	U	-	-	-	-	Fines	100%
Icky Creek	Icky Creek Seg 2	233	OWW/Pond	WP	Y	0-1%	U	Un	Un	Un	Un	Fines	100%
Icky Creek DT1	Icky Creek DT1	270	R/D	LO	Y	1-2%	U	-	-	-	-	Fines	95%
Icky Creek DT2	Icky Creek DT2	321	R/D	LO	A	1-2%	U	-	-	-	-	Fines	10%
Last Creek	Last Creek Seg 1	2667	R/PR	LSR	Y	0.2%	U	9.0	~3.5	6.4	0.37	F/S/G/LWD	100%
Last Creek	Last Creek Seg 2	2429	PR	LSR	Y	0.4%	U	10.5	-	5.2	0.44	G	100%
Last Creek	Last Creek Seg 3	1342	PR/R	LSR	Y	0.4%	U	7.5	-	4.8	0.44	F/S/G/LWD	100%
Last Creek	Last Creek Seg 4	1119	PR	LSR	Y	0.8%	U-M	8.4	-	4.2	0.22	G	100%
Last Creek	Last Creek Seg 5	1229	PR/FPR	LSR	Y	1.4%	M-C	-	-	-	-	G/C	100%
Last Creek	Last Creek Seg 6	1353	PR/FPR	LSR	Y	1.8%	M	4.5	-	3.0	0.20	G	100%
Last Creek	Last Creek Seg 7	258	FPR	MSR	Y	2.2%	C	2.4	-	1.9	0.21	C/G	100%
Last Creek	Last Creek Seg 8	380	R/FW	LO	Y	1-2%	C-M	2.6	-	1.9	0.16	S/G	80%
Last Creek	Last Creek Seg 9	172	SP	MSR	P	4-8%	C	-	-	-	-	-	0%
Last Creek	Last Creek Seg 10	478	R/FW	LO	P	0-1%	U	-	-	-	-	-	20%
Last Creek_T1	Last Creek T1 Seg 1	4	C	NA	P	42.0%	na	0.5	na	0.2	na	F	100%
Last Creek_T1	Last Creek T1 Seg 2	40	R/FW	LO	P	2.0%	U	Un	na	3.3	0.07	F	100%
Last Creek_T1_T1	Last Creek T1_T1 Seg 1	40	F/FW	W	P	0-1%	U	na	na	1.4	0.04	na	100%
Last Creek_T2	Last Creek T2 Seg 1	5	C	NA	Y	30.0%	-	0.8	-	0.4	0.03	f	100%
Last Creek_T2	Last Creek T2 Seg 2	49	FW/R	W	Y	0-1%	U	2.7	-	1.8	0.03	f	100%
Last Creek_T3	Last Creek_T3 seg 1	47	FPR	LO	U	2-4%	U	-	-	-	-	-	100%

Stream Name	Stream Segment Name	Length (m)	Channel Type	Hab. Type	Anad Fish Use	Gradient	Chan. Confin.	BFW	BFD	Wetted Width	Avg Depth	Substrate	Percent surveyed
Last Creek_T4	Last Creek T4 Seg 1	144	SP	MSR	P	4-8%	C	2.2	na	0.8	0.05	Sand	100%
Last Creek_T5	Last Creek T5 Seg 1	31	SP	MHSR	Y	5-10%	U	na	na	na	na	Fines	100%
Last Creek_T5	Last Creek T5 Seg 2	60	Pond	WP	Y	0-1%	U	6.0	na	5.0	0.50	Fines	100%
Last Creek_T5	Last Creek T5 Seg 3	141	R	LO	Y	0-1%	U	4.4	na	2.3	0.21	Fines	100%
Last Creek_T7	Last Creek T7 Seg 1	70	SP	NA	U	17.0%	U	0.7	na	0.4	0.08	G/F	15%
Last Creek_T8	Last Creek T8 Seg 1	27	PC	LO	Y	2-5%	U	Un	Un	Un	Un	Fines	100%
Last Creek_T8	Last Creek T8 Seg 2	16	Pond	WP	Y	0-1%	U	Un	Un	Un	Un	Fines	100%
Last Creek_T9	Last Creek_T9	153	SP	MHSR	P	10.0%	FC	2.0	-	-	-	-	20%
Last Creek_T10	Last Creek T10 Seg 1	56	PC	na	P	4.0%	na	na	na	na	na	na	100%
Last Creek_T10	Last Creek T10 Seg 2	106	SP	MSR	P	6.0%	M	1.7	na	1.0	0.15	G/S	100%
Last Creek_T11	Last Creek_T11 Seg 1	105	SP	MSR	P	4-8%	C	-	-	-	-	-	0%
Last Creek_T12	Last Creek_T12 Seg 1	106	SP	MSR	P	4-8%	M	-	-	-	-	-	20%
Last Creek_T13	Last Creek_T13 Seg1	60	SP	MSR	P	4-8%	M	0.7	0.0	0.2	-	G	20%
Last Creek_T14	Last Creek_T14 Seg1	45	SP	MSR	P	4-8%	M	0.7	-	0.4	0.14	S/G	100%
Last Creek_T15	Last Creek_T15 seg 1	78	FPR	MSR	P	2-4%	M	2.2	-	1.1	0.06	G/S	100%
S.F. Last Creek	S.F. Last Creek Seg 1	400	PR	LSR	Y	0-1%	U	7.1	-	4.3	0.22	G/S	100%
S.F. Last Creek	S.F. Last Creek Seg 2	206	FPR	LSR	Y	2-4%	C	-	-	-	-	-	100%
S.F. Last Creek	S.F. Last Creek Seg 3	188	SP/C	MHSR	P	8.0%	C	-	-	-	-	-	100%
S.F. Last Creek	S.F. Last Creek Seg 4	457	FPR	LSR	P	2-4%	C	-	-	-	-	-	100%
S.F. Last Creek	S.F. Last Creek Seg 5	995	PR	LSR	P	1-2%	C	-	-	-	-	-	70%
S.F. Last Creek	S.F. Last Creek Seg 6	650	FW/R	LO	P	1.7%	U	-	-	-	-	-	0%
S.F. Last Creek	S.F. Last Creek Seg 7	658	FPR	LSR	P	2.6%	C	-	-	-	-	-	100%
S.F. Last Creek	S.F. Last Creek Seg 8	343	SP	MHSR	P	8.0%	C	-	-	-	-	-	100%
S.F. Last Creek_T1	S.F. Last Creek_T1 Seg1	51	FW	W	A	0-1%	U	Un	Un	Un	Un	Fines	100%
S.F. Last Creek_T2	S.F. Last Creek_T2 Seg1	40	SP	MSR	Y	4-8%	C	-	-	-	-	-	75%
S.F. Last Creek_T15	S.F. Last Creek_T15 Seg1	152	SP	MSR	P	6.4%	C	-	-	-	-	-	0%
S.F. Last Creek_T16	S.F. Last Creek_T16 Seg1	107	SP	MSR	P	4.1%	M	-	-	-	-	-	0%
S.F. Last Creek_T17	S.F. Last Creek_T17 Seg1	111	FPR	MSR	P	3.1%	M	-	-	-	-	-	0%

Stream Name	Stream Segment Name	Length (m)	Channel Type	Hab. Type	Anad Fish Use	Gradient	Chan. Confin.	BFW	BFD	Wetted Width	Avg Depth	Substrate	Percent surveyed
S.F. Last Creek_T18	S.F. Last Creek_T18 Seg1	111	SP	MHSR	P	6.5%	C	-	-	-	-	-	0%
Last Creek_T16	Last Creek_T16 Seg 1	51	R/FW	LO	A	0-2%	U	1.3	-	0.6	0.03	fines/muck	100%
Last Creek_T17	Last Creek_T17 Seg 1	63	R/FW/PC	LO	Y	4.0%	M	Un	Un	Un	Un	Fines	100%
Last Creek_T18	Last Creek_T18 Seg 1	59	FW	LO	Y	0-2%	U	Un	Un	Un	Un	Fines	100%
Last Creek_T19	Last Creek_T19 Seg1	240	WB/FW/OWW	LO	Y	0-1%	U	3.2	-	1.6	0.21	Fines	100%
Last Creek_TX3	Last Creek_TX3 Seg1	315	FPR	LSR	A	2-4%	M	-	-	-	-	-	0%
Last Creek_TX4	Last Creek_TX4 Seg1	103	SP	MSR	P	4-8%	C	-	-	-	-	-	0%
Last Creek_T20	Last Creek_T20 Seg1	74	SP	MSR	A	4-8%	C	1.5	-	-	-	C/G	100%
Last Creek_T21	Last Creek_T21 Seg1	188	SP	MSR	P	4-8%	C	-	-	-	-	-	0%
Last Creek_T22	Last Creek_T22 Seg1	332	SP	MSR	P	4-8%	C	-	-	-	-	-	0%
Last Creek_T23	Last Creek T23 Seg1	167	PB/FPR	LSR	A	2-4%	C	3.2	-	2.9	0.04	G/C	100%
Last Creek_T23	Last Creek T23 Seg2	358	SP	MSR	A	4-8%	C	3.0	-	-	-	C/G	67%
Last Creek_T23_T1	Last Creek_T23_T1 Seg1	140	SP	MSR	P	4-8%	C	-	-	-	-	C/G	10%
Last Creek_T23_T2	Last Creek_T23_T2 Seg1	488	SP	MSR	A	4-8%	C	-	-	-	-	C/G	50%
Last Creek_TE	Last Creek_TE Seg1	15	R/FW	LO	A	0-2%	U	-	-	-	-	Fines	100%
Last Creek_TF	Last Creek_TF Seg1	40	SP	MSR	A	6.0%	M	2.0	-	-	-	C/G	100%
Last Creek_TH	Last Creek_TH Seg1	40	PR	LSR	Y	2.0%	M	2.8	-	1.3	-	G/S	100%
Last Creek_TH	Last Creek_TH Seg2	76	SP	MHSR	P	6-12%	C	-	-	-	-	C/BRX/G	100%
Last Creek_TI	Last Creek_TI Seg1	30	SP	MHSR	P	8-20%	C	-	-	-	-	-	15%
Last Creek_TJ	Last Creek_TJ Seg1	181	SP	MHSR	P	8-20%	C	-	-	-	-	-	10%
Last Creek_TK	Last Creek_TK Seg1	248	FPR	LSR	A	2-4%	M	-	-	-	-	-	0%
Last Creek_TK	Last Creek_TK Seg2	58	FPR	LSR	A	2-4%	C	-	-	-	-	-	0%
Last Creek_TK	Last Creek_TK Seg3	421	SP	MSR	A	4-8%	C	-	-	-	-	-	0%
Last Creek_TK_T1	Last Creek_TK_T1 Seg1	148	FPR	LSR	P	2-4%	M	-	-	-	-	-	0%
Last Creek_TK_T2	Last Creek_TK_T2 Seg1	261	FPR	LSR	P	2-4%	M	-	-	-	-	-	0%
Charley Creek	Charley Creek Seg1	385	PR	LSR	Y	0.5%	U	-	-	-	-	G/S	20%
Charley Creek	Charley Creek Seg2	1651	PR	LSR	Y	0.6%	U	14.4	-	5.8	0.30	G	90%

Stream Name	Stream Segment Name	Length (m)	Channel Type	Hab. Type	Anad Fish Use	Gradient	Chan. Confin.	BFW	BFD	Wetted Width	Avg Depth	Substrate	Percent surveyed
Charley Creek	Charley Creek Seg3	295	PR	LSR	Y	1.0%	M	-	-	-	-	G	100%
Charley Creek	Charley Creek Seg4	936	PR	LSR	Y	1.0%	M	-	-	-	-	G/C	100%
Charley Creek	Charley Creek Seg5	308	PB/FPR	MSR	Y	2.1%	C/M	-	-	-	-	C/BLD/G	100%
Charley Creek	Charley Creek Seg6	277	C	MHSR	P	10.0%	C	-	-	-	-	BLD/BRX/C	80%
Charley Creek	Charley Creek Seg7	217	PR	LSR	P	1.5%	C	-	-	-	-	-	0%
Charley Creek	Charley Creek Seg8	1610	FPR/PB	MSR	P	3.2%	C	-	-	-	-	-	0%
Charley Creek	Charley Creek Seg9	1772	SP	MHSR	P	5.9%	C	-	-	-	-	-	4%
Charley Creek	Charley Creek Seg10	513	C	MHSR	U	13.8%	C	-	-	-	-	-	0%
Charley Creek_T1	Charley Creek_T1 Seg1	222	R/MC	LO	P	<1%	U	-	-	-	-	Fines	0%
Unnamed 19.0135	Unnamed 19.0135 Seg1	363	PR	LSR	Y	1.7%	U	4.5	0.9	2.2	0.17	G	100%
Unnamed 19.0135	Unnamed 19.0135 Seg2	209	FPR	MSR	Y	3.1%	M	5.2	1.0	3.3	0.11	C/G/BLD	100%
Unnamed 19.0135	Unnamed 19.0135 Seg3	118	SP	MHSR	Y	7.7%	C	4.3	-	2.0	0.20	BLD/BRX	100%
Unnamed 19.0135	Unnamed 19.0135 Seg4	205	FPR	MSR	Y	3.2%	C	3.7	1.0	2.0	0.16	G/C	100%
Unnamed 19.0135	Unnamed 19.0135 Seg5	333	SP	MHSR	U	4.8%	C	2.9	-	1.9	0.14	C/G	70%
Trash Creek	Trash Creek Seg 1	122	FPR	LSR	Y	2-4%	M-U	3.4	-	2.3	0.12	G	100%
Trash Creek	Trash Creek Seg 2	181	SP	MSR	Y	4-8%	C	3.8	-	2.2	0.12	C/G/BLD/BRX	100%
Trash Creek	Trash Creek Seg 3	452	SP	MHSR	U	8.0%	C	-	-	-	-	BRX/BLD/C	85%
Trash Creek_T1	Trash Creek_T1 Seg 1	144	SP	MSR	Y	4-8%	M-C	2.5	0.0	0.0	0.00	G/C	40%
Err Creek	Err Creek Seg1	174	FPR/PB	MSR	Y	4.0%	M	3.1	-	1.3	0.11	G/C	100%
Unnamed 19.0136	Unnamed 19.0136 Seg 1	151	FPR	LSR	Y	3.0%	M	4.2	-	2.0	0.12	C/G	100%
Unnamed 19.0136	Unnamed 19.0136 Seg 2	303	SP	MSR	A	7.0%	C	7.0	-	2.4	0.15	C/G	60%
Unnamed 19.0136	Unnamed 19.0136 Seg 3	654	SP/C	MHSR	U	8-20%	C	-	-	-	-	-	0%
Hull Creek	Hull Creek Seg 1	172	D/MC	LO	A	1-2%	U	-	-	-	-	-	0%
Hull Creek	Hull Creek Seg 2	86	FW	W	P	1.0%	U	-	-	-	-	-	0%
Unnamed WP361	Unnamed WP 361 Seg1	82	R/D	LO	A	<1%	U	-	-	-	-	Fines	15%

Stream Name	Stream Segment Name	Length (m)	Channel Type	Hab. Type	Anad Fish Use	Gradient	Chan. Confin.	BFW	BFD	Wetted Width	Avg Depth	Substrate	Percent surveyed
Spruce Creek	Spruce Creek Seg1	25	C	MHSR	Y	13.0%	U	-	-	-	-	Cobble/Culvert	100%
Spruce Creek	Spruce Creek Seg2	92	FW	W	P	1.0%	U	-	-	-	-	Fines	30%
Hamilton Creek	Hamilton Creek Seg1	27	SP	MSR	Y	5.0%	U	-	-	-	-	U	100%
Hamilton Creek	Hamilton Creek Seg2	134	D/R	LO	Y	1.0%	U	-	-	-	-	Fines	100%
Hamilton Creek	Hamilton Creek Seg3	118	FW	W	P	1.0%	U	-	-	-	-	Fines	0%
Simmons Creek	Simmons Creek Seg1	206	PB	LSR	Y	2-4%	U	2.9	-	1.6	0.13	G/C	100%
Simmons Creek	Simmons Creek Seg2	236	SP	MSR	Y	3-7%	C	3.8	-	1.1	0.16	G/C	80%
Dog Creek	Dog Creek Seg1	21	Cascade	MHSR	Y	11.5%	C	2.1	0.0	0.9	0.08	G	100%
Dog Creek	Dog Creek Seg2	188	Ditch	LO	Y	2.0%	C	1.4	0.0	1.3	0.17	fines	100%
Dog Creek	Dog Creek Seg3	117	SP	MSR	N	4-8%	C	-	-	-	-	-	10%
Vogel Creek 1	Vogel Creek 1 Seg1	78	SP	MSR	P	6.7%	M	-	-	-	-	-	0%
Vogel Creek 1	Vogel Creek 1 Seg2	142	C	MHSR	U	8-20%	C	-	-	-	-	-	0%
Vogel Creek 2	Vogel Creek 2 Seg1	102	SP	MSR	P	4.5%	M	-	-	-	-	-	0%
Vogel Creek 2	Vogel Creek 2 Seg2	202	C	MHSR	U	8-20%	C	-	-	-	-	-	0%
Unnamed WP450	Unnamed WP450 Seg 1	48	FPR	LSR	N	2-4%	M	-	-	-	-	-	100%
Unnamed WP450	Unnamed WP450 Seg 2	279	C	MHSR	U	8-20%	C	-	-	-	-	-	0%
Camp Creek	Camp Creek Seg 1	131	FPR	LO	Y	2-4%	U	2.1	na	0.9	0.14	Clay/Silt	100%
Camp Creek	Camp Creek Seg 2	127	FW/AF	LSR	Y	4.0%	U	Un	Un	Un	Un	G/S/F	100%
Camp Creek	Camp Creek Seg 3	278	SP	MHSR	U	8-20%	C	-	-	-	-	-	0%
Camp Creek_T2	Camp Creek T_2 Seg 1	20	R	LO	A	2.0%	U	1.0	na	0.7	0.07	Silt	100%
Cedar Creek	Cedar Creek Seg 1	554	SP/C	MHSR	A	6-20%	C	3.0	-	-	-	C	15%
Elofson Creek	Elofson Creek Seg 1	250	FPR	LSR	Y	1-5%	U	3.9	na	2.4	0.13	G	100%
Elofson Creek	Elofson Creek Seg 2	62	SP	MSR	Y	4-8%	M	3.8	na	2.3	0.12	C/G	100%
Elofson Creek_T1	Elofson Creek_T1 Seg1	83	SP	MSR	A	6.0%	M	-	-	-	-	C/G	20%
Elofson Creek_T1	Elofson Creek_T1 Seg2	128	SP	MHSR	U	8-20%	C	-	-	-	-	-	0%
Unnamed WP 203	Unnamed WP 203 Creek Seg 1	105	R/D	LO	Y	-	U	2.5	-	0.6	0.15	Fines	100%
Unnamed WP 203	Unnamed WP 203 Creek Seg 2	166	OWW/FW	W	P	<1%	U	Un	Un	-	-	Fines	85%

Stream Name	Stream Segment Name	Length (m)	Channel Type	Hab. Type	Anad Fish Use	Gradient	Chan. Confin.	BFW	BFD	Wetted Width	Avg Depth	Substrate	Percent surveyed
Smith Creek	Smith Creek Seg 1	181	FPR	MSR	Y	3.7%	U	3.0	-	-	-	C/G	30%
Smith Creek	Smith Creek Seg 2	248	SP	MHSR	P	13.0%	C	-	-	-	-	-	0%
Smith Creek Two	Smith Creek Two Seg1	270	R/D	W	P	1-2%	U	-	-	-	-	Fines	0%
Blowder Creek	Blowder Creek Seg1	1412	SP	MSR	Y	5.4%	C	8.9	-	4.3	0.25	C/BLD/BRX/G	100%
Blowder Creek	Blowder Creek Seg2	628	PB	LSR	Y	3.3%	M	5.0	-	-	-	G/C	20%
Blowder Creek	Blowder Creek Seg3	913	SP	MSR	A	6.7%	C	-	-	-	-	-	0%
Blowder Creek_T1	Blowder Creek_T1 Seg1	1177	SP	MSR	P	4.3%	C	-	-	-	-	-	0%
Blowder Creek_T2	Blowder Creek_T2 Seg1	197	SP	MSR	P	6.7%	C	-	-	-	-	-	100%
Wall Creek	Wall Creek Seg1	17	R	LO	Y	<5%	U	1.0	-	0.8	0.02	Fines	100%
Wall Creek	Wall Creek Seg2	69	OWW/R	W	Y	0-1%	U	Un	Un	Un	Un	Fines	100%
Stinky Creek	Stinky Creek Seg1	161	SP	MHSR	Y	8.0%	C	7.2	-	3.7	0.24	BLD/BRX/C/G	100%
Stinky Creek	Stinky Creek Seg2	662	FPR/PB	MSR	Y	3.7%	C	8.2	-	4.1	0.19	C/G/BLD	100%
Stinky Creek	Stinky Creek Seg3	403	FPR/PB	MSR	A	3.6%	M	-	-	-	-	-	5%
Stinky Creek	Stinky Creek Seg4	1176	SP	MSR	A	6.0%	C	-	-	-	-	-	0%
Stinky Creek	Stinky Creek Seg5	259	SP	MHSR	P	8.9%	C	-	-	-	-	-	0%
Stinky Creek	Stinky Creek Seg6	369	SP	MHSR	P	8.4%	C	-	-	-	-	-	0%
Stinky Creek	Stinky Creek Seg7	911	SP	NA	U	17.0%	C	-	-	-	-	-	0%
Stinky Creek_T2	Stinky Creek_T2 Seg1	52	SP	MSR	A	6.8%	C	-	-	-	-	-	0%
Stinky Creek_T2	Stinky Creek_T2 Seg2	92	C	MHSR	U	17.0%	C	-	-	-	-	-	0%
Cougar Creek	Cougar Creek Seg1	1396	SP/FPR	MSR	Y	3.9%	C	9.7	-	3.9	0.20	BRX/BLD/G/C	100%
Cougar Creek	Cougar Creek Seg2	365	FPR/PB	MSR	A	3.3%	C	-	-	-	-	-	5%
Cougar Creek	Cougar Creek Seg3	259	SP	MSR	A	7.4%	C	-	-	-	-	-	0%
Cougar Creek	Cougar Creek Seg4	274	C	MHSR	P	10.7%	C	-	-	-	-	-	0%
Cougar Creek	Cougar Creek Seg5	801	FPR/PB	MSR	P	3.5%	C	-	-	-	-	-	0%
Cougar Creek	Cougar Creek Seg6	332	C	MHSR	P	13.1%	C	-	-	-	-	-	0%
Cougar Creek	Cougar Creek Seg7	631	C	MHSR	P	8.9%	C	-	-	-	-	-	0%
Cougar Creek	Cougar Creek Seg8	402	C	NA	U	40.2%	C	-	-	-	-	-	0%
Unnamed WP 426	Unnamed WP 426 Seg 1	320	SP	MHSR	P	10.0%	C	5.0	-	-	-	Brx/C/G	23%

Stream Name	Stream Segment Name	Length (m)	Channel Type	Hab. Type	Anad Fish Use	Gradient	Chan. Confin.	BFW	BFD	Wetted Width	Avg Depth	Substrate	Percent surveyed
Slide Creek	Slide Creek Seg 1	57	FSP	MSR	Y	4-8%	M	4.8	-	2.6	0.15	C/G	100%
Slide Creek	Slide Creek Seg 2	485	FSP	MHSR	U	8-20%	C	-	-	-	-	-	15%
Falls Creek	Falls Creek Seg 1	40	FSP	MSR	Y	4-8%	C	8.1	-	2.1	-	C/G	100%
Falls Creek	Falls Creek Seg 1	789	FSP	MHSR	N	4-8%	C	-	-	-	-	-	5%
Unnamed 19.0144	Unnamed Creek 19.0144 Seg 1	151	FSP	MHSR	P	13.5%	C	7.6	-	3.2	0.19	G/BRX/C	50%
Unnamed 19.0144	Unnamed Creek 19.0144 Seg 2	700	FPR/SP	MSR	P	3.8%	C	-	-	-	-	-	0%
Unnamed 19.0144	Unnamed Creek 19.0144 Seg 3	222	C/SP	MHSR	P	9.7%	C	-	-	-	-	-	0%
Unnamed 19.0144	Unnamed Creek 19.0144 Seg 4	435	SP	MSR	P	7.1%	C	-	-	-	-	-	0%
Unnamed 19.0144_T1	Unnamed 19.0144_T1 Seg1	250	SP/C	MHSR	U	9.2%	C	-	-	-	-	-	0%
Unnamed Seg 14 LBT6	Unnamed Seg 14 LBT6 Seg1	67	C	MHSR	P	11.8%	C	-	-	-	-	-	50%
Unnamed 19.0145	Unnamed 19.0145 Seg 1	228	FPR/PB	MSR	A	3.7%	C	9.1	-	4.4	0.17	C/G/BLD	100%
Unnamed 19.0145	Unnamed 19.0145 Seg 2	232	SP	MSR	A	6.4%	TC	8.1	-	4.2	0.25	BLD/C/BRX/G	100%
Unnamed 19.0145	Unnamed 19.0145 Seg 3	610	FPR/PB	MSR	A	4.3%	C	8.0	-	4.0	-	C/G/BLD	30%
Unnamed 19.0145	Unnamed 19.0145 Seg 4	1038	SP	MSR	P	6.5%	C	-	-	-	-	-	0%
Unnamed Seg 19 Trib 1	Unnamed Seg 19 Trib 1 Seg1	727	SP	MSR	U	5.0%	C	-	-	-	-	-	0%
Unnamed Seg 19 Trib 1	Unnamed Seg 19 Trib 1 Seg2	404	SP	MHSR	U	9.3%	C	-	-	-	-	-	0%

Appendix C- Tributary Riparian Segments

(see Section 2.3 for riparian field code definitions.)

Stream Name	Stream Segment Name	Length (M)	Channel Type	RB Rip	LB Rip
Cannery Creek	Cannery Creek Seg 1	105	E	DMS	DMS
Cannery Creek	Cannery Creek Seg 2	320	R/FW	DMS	DMS
Swamp Creek	Swamp Creek Seg 1	335	E	MMD	MMD
Swamp Creek	Swamp Creek Seg 2	157	E/PR	DMD	DSD
Swamp Creek_DT1	Swamp Creek DT1 seg 1	43	PR/SP	MMD	MMD
Swamp Creek_T1	Swamp Creek T1 Seg 1	132	E	CLD	CLD
Swamp Creek_T2	Swamp Creek T2 Seg 1	44	E	CLD	CLD
Swamp Creek_T2	Swamp Creek T2 Seg 2	23	FW	CLD	CLD
Swamp Creek_T3	Swamp Creek T3 Seg 1	85	E	DLD	MLD
Swamp Creek_T3	Swamp Creek T3 Seg 2	43	R	MLD	MLD
Swamp Creek_T3	Swamp Creek T3 Seg 3	229	FW	MMD	MMD
Swamp Creek_T3_T1	Swamp Creek T3_T1 seg 1	178	R	MMD	MMD
Swamp Creek_T3_T1_DT1	Swamp Creek_T3_T1_DT1	43	AF	DLD	DLD
Swamp Creek_T4	Swamp Creek T4 seg 1	34	R	MMD	MMD
Swamp Creek_T5	Swamp Creek T5 seg 1	119	PR	MMD	MMD
Swamp Creek_T5	Swamp Creek T5 seg 2	73	R	MMD	MMD
Swamp Creek_T5	Swamp Creek T5 seg 3	338	FW	MMD	MMD
Hatchery Creek	Hatchery Creek Seg 1	270	R/OWW/P	CLD	MMD
Hatchery Creek	Hatchery Creek Seg 2	365	OWW/FW	DMD	MLD
Hatchery Creek	Hatchery Creek Seg 3	432	FW	MMD	MMD
Hatchery Creek	Hatchery Creek Seg 4	214	SP	MMD	MMD
Hatchery Creek_T1	Hatchery Creek Seg 1	761	FW	MLS	MLS
Hatchery Creek_T1	Hatchery Creek Seg 2	176	FPR	MSD	MSD
Pearson Creek	Pearson Creek Seg 1	1,401	PR/R	MSD	MSD
Pearson Creek	Pearson Creek Seg 2	1,005	PR	MLD	MLD
Sadlik Creek	Sadlik Creek Seg 1	760	FW/R	MLD	MLD
Icky Creek	Icky Creek Seg 1	87	R/D	DSD	DSD
Icky Creek	Icky Creek Seg 2	233	OWW/Pond	DSD	DSD
Icky Creek DT1	Icky Creek DT1	270	R/D	NONE	DSD
Icky Creek DT2	Icky Creek DT2	321	R/D	MSS	MSS
Last Creek	Last Creek Seg 1	2,667	R/PR	MMS	MMD
Last Creek	Last Creek Seg 2	2,429	PR	MMD	MMD
Last Creek	Last Creek Seg 3	1,342	PR/R	MLD	MMD
Last Creek	Last Creek Seg 4	1,119	PR	MLD	CLD
Last Creek	Last Creek Seg 6	1,353	PR/FPR	CLD	CLD
Last Creek	Last Creek Seg 7	258	FPR	MSD	MSD
Last Creek	Last Creek Seg 8	380	R/FW	CLS	MSD
Last Creek_T4	Last Creek T4 Seg 1	144	SP	MLS	CLD
Last Creek_T5	Last Creek T5 Seg 1	31	SP	DMD	DMD
Last Creek_T5	Last Creek T5 Seg 2	60	Pond	DMD	DMD

Stream Name	Stream Segment Name	Length (M)	Channel Type	RB Rip	LB Rip
Last Creek_T5	Last Creek T5 Seg 3	141	R	DMD	DMS
Last Creek_T8	Last Creek T8 Seg 1	27	PC	MMD	MMD
Last Creek_T8	Last Creek T8 Seg 2	16	Pond	MMD	MMD
Last Creek_T10	Last Creek T10 Seg 2	106	SP	MSD	MSD
Last Creek_T15	Last Creek_T15 seg 1	78	FPR	MSD	MSD
S.F. Last Creek	S.F. Last Creek Seg 1	400	PR	MMD	CLD
S.F. Last Creek	S.F. Last Creek Seg 2	206	FPR	MLD	MLD
S.F. Last Creek	S.F. Last Creek Seg 3	188	SP/C	MLS	MLS
S.F. Last Creek	S.F. Last Creek Seg 4	457	FPR	MLS	MLS
S.F. Last Creek	S.F. Last Creek Seg 5	995	PR	CLD	CLS
S.F. Last Creek	S.F. Last Creek Seg 6	650	FW/R	MLS	MLS
S.F. Last Creek	S.F. Last Creek Seg 7	658	FPR	MSD	MSD
Last Creek_T16	Last Creek_T16 Seg 1	51	R/FW	Brush	Brush
Last Creek_T17	Last Creek_T17 Seg 1	63	R/FW/PC	MSS	MSS
Last Creek_T19	Last Creek_T19 Seg1	240	WB/FW/OWW	CLD	Brush
Last Creek_T20	Last Creek_T20 Seg1	74	SP	MLD	MLD
Last Creek_T23	Last Creek T23 Seg1	167	PB/FPR	CMD	CMD
Last Creek_T23	Last Creek T23 Seg2	358	SP	CMD	CMD
Last Creek_T23_T1	Last Creek_T23_T1 Seg1	140	SP	CMD	CMD
Last Creek_T23_T2	Last Creek_T23_T2 Seg1	488	SP	CMD	CMD
Last Creek_TH	Last Creek_TH Seg2	76	SP	MMD	MMD
Charley Creek	Charley Creek Seg1	385	PR	MDS	MDD
Charley Creek	Charley Creek Seg2	1,651	PR	DLD	DLD
Charley Creek	Charley Creek Seg3	295	PR	DLD	DLD
Charley Creek	Charley Creek Seg4	936	PR	DMD	DMD
Charley Creek	Charley Creek Seg5	308	PB/FPR	DMD	DMD
Charley Creek	Charley Creek Seg6	277	C	MLD	MLD
Charley Creek	Charley Creek Seg7	217	PR	CLD	CLD
Charley Creek	Charley Creek Seg8	1,610	FPR/PB	CLD	MMD
Charley Creek_T1	Charley Creek_T1 Seg1	222	R/MC	None	None
Unnamed 19.0135	Unnamed 19.0135 Seg1	363	PR	MLD	MLD
Unnamed 19.0135	Unnamed 19.0135 Seg2	209	FPR	MMD	MMD
Unnamed 19.0135	Unnamed 19.0135 Seg3	118	SP	CLD	CLD
Unnamed 19.0135	Unnamed 19.0135 Seg4	205	FPR	MMD	MMD
Unnamed 19.0135	Unnamed 19.0135 Seg5	333	SP	CLD	CLD
Trash Creek	Trash Creek Seg 1	122	FPR	DLD	DMD
Trash Creek	Trash Creek Seg 2	181	SP	DMD	DMD
Trash Creek	Trash Creek Seg 3	452	SP	MMD	MMD
Trash Creek_T1	Trash Creek_T1 Seg 1	144	SP	DMD	DMD
Err Creek	Err Creek Seg1	174	FPR/PB	DMD	DMD
Unnamed 19.0136	Unnamed 19.0136 Seg 1	151	FPR	CLD	CLD
Unnamed 19.0136	Unnamed 19.0136 Seg 2	303	SP	MLD	MLD
Hull Creek	Hull Creek Seg 1	172	D/MC	None	None
Hull Creek	Hull Creek Seg 2	86	FW	None	None

Stream Name	Stream Segment Name	Length (M)	Channel Type	RB Rip	LB Rip
Unnamed WP361	Unnamed WP 361 Seg1	82	R/D	None	None
Spruce Creek	Spruce Creek Seg2	92	FW	Road	MLD
Hamilton Creek	Hamilton Creek Seg1	27	SP	Brush	Brush
Hamilton Creek	Hamilton Creek Seg2	134	D/R	Pasture	Road
Hamilton Creek	Hamilton Creek Seg3	118	FW	MMD	MMD
Simmons Creek	Simmons Creek Seg1	206	PB	MMD	DMS
Simmons Creek	Simmons Creek Seg2	236	SP	DMD	DMS
Dog Creek	Dog Creek Seg1	21	Cascade	DMD	Road
Dog Creek	Dog Creek Seg2	188	Ditch	DSD	Road
Camp Creek	Camp Creek Seg 1	131	FPR	MLD	MLD
Camp Creek	Camp Creek Seg 2	127	FW/AF	MLD	CLD
Camp Creek_T2	Camp Creek T_2 Seg 1	20	R	DLD	DLD
Cedar Creek	Cedar Creek Seg 1	554	SP/C	CLS	CLS
Elofson Creek	Elofson Creek Seg 1	250	FPR	MLD	MLD
Elofson Creek	Elofson Creek Seg 2	62	SP	DMD	MMD
Elofson Creek_T1	Elofson Creek_T1 Seg1	83	SP	CLD	CLD
Unnamed WP 203	Unnamed WP 203 Creek Seg 1	105	R/D	None	None
Unnamed WP 203	Unnamed WP 203 Creek Seg 2	166	OWW/FW	MSD	None
Smith Creek	Smith Creek Seg 1	181	FPR	None	None
Smith Creek Two	Smith Creek Two Seg1	270	R/D	NONE	DSD/
Blowder Creek	Blowder Creek Seg1	1,412	SP	MLD	MLD
Blowder Creek	Blowder Creek Seg2	628	PB	DMD	DMD
Wall Creek	Wall Creek Seg1	17	R	DMD	DMD
Wall Creek	Wall Creek Seg2	69	OWW/R	DMD	DMD
Stinky Creek	Stinky Creek Seg1	161	SP	CLD	CLD
Stinky Creek	Stinky Creek Seg2	662	FPR/PB	DMD	MMD
Cougar Creek	Cougar Creek Seg1	1,396	SP/FPR	MMD	CLD
Unnamed WP 426	Unnamed WP 426 Seg 1	320	SP	MMD	MMD
Slide Creek	Slide Creek Seg 1	57	FSP	DMD	DMD
Falls Creek	Falls Creek Seg 1	40	FSP	DMD	DMD
Unnamed 19.0144	Unnamed Creek 19.0144 Seg 1	151	FSP	MMD	MMD
Unnamed 19.0145	Unnamed 19.0145 Seg 1	228	FPR/PB	MMD	MMD
Unnamed 19.0145	Unnamed 19.0145 Seg 2	232	SP	CMD	CMD
Unnamed 19.0145	Unnamed 19.0145 Seg 3	610	FPR/PB	MMD	MMD

Appendix D- Clallam River Mouth Synthesis Document

Clallam Bay River Mouth and Nearshore. 2003 Clallam Bay Technical committee findings.

Synthesis compiled by Anne Shaffer, Washington Department of Fish and Wildlife, Habitat Program, 332 E. 5th Street, Port Angeles, Wa. 98362. 360.457.2634/360.417.3302 fax; shaffjas@dfw.wa.gov

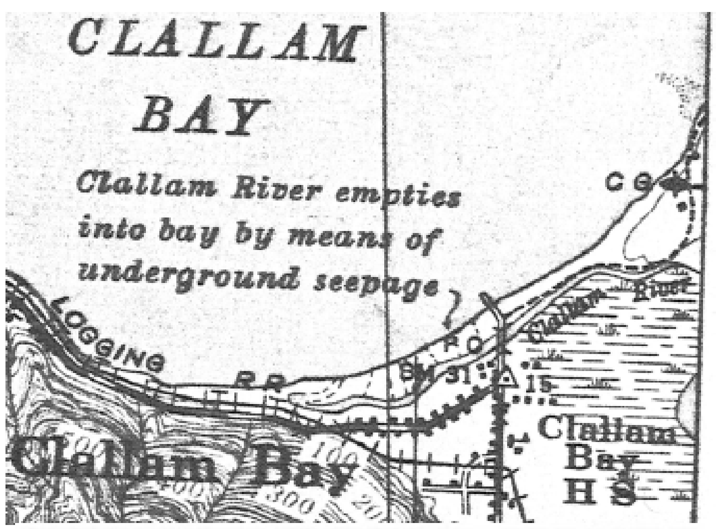
10 March 2003

Technical Committee members: Anne Shaffer, WDFW, convener, Randy Johnson, Tim Rymer, Chris Byrnes, Randy Cooper, WDFW, Dave Parks, Martha Hurd, , DNR, Jeanne Wahler, State Parks, Jeffree Stewart, DoE, Pat Crain and Andy Brastad, Clallam County, Andy Ritchie, Makah Tribe, Mike McHenry, Elwha Tribe. Local citizens attending: Bob and June Bowlby, Don Baker, Patt Ness. Additional attending members: Brian Fairbanks, Sue Patnude, Steve Kawlinoski, WDFW, Craig Jacobs and Joel Winborn, Clallam County, Dave Roberts, DNR

Background

Physical processes. The Clallam River is a tributary to the western Strait of Juan de Fuca. The Clallam River mouth, located in the middle of Clallam Bay, is terminated by a well formed sand spit. The mouth closes off seasonally as a natural process.

While no pre-development characterizations of the mouth of the Clallam River have been located, the seasonal closure of the mouth has been documented on maps as early as 1934-35, in US Army maps. These maps show the Clallam River emptying into the bay by seepage through much of the area that currently makes up the state/county park lands on the spit (Andy Ritchie Makah Tribe, Figure 1).



Prepared under the direction of the Chief of Engineers, U. S. Army, 1934-35.
Horizontal control by U. S. Coast and Geodetic Survey, 1931, and 29th Engineers, U. S. Army, 1934-35.
Vertical control by U. S. Geological Survey, 1917, and 29th Engineers, U. S. Army, (1929 Gen. Adj.) 1934-35.
Topography by Corps of Engineers, U. S. Army, from five-lens aerial photographs, using elevation calculater and stereoscope, and Washington Paper and Pulp Co.
Polyconic Projection. North American Datum 1927.

Figure 1. Excerpt from US Army Corps of Engineers Tactical Map, 1934-1935.

Seasonal closure of spits such as this is common, and characteristic of the interplay between marine and riverine forces. Spit sediment is supplied by rivers and streams, bluff erosion and landsliding, and beach sediments. Sediments that make up such spits are transported by longshore current in drift cells, tidal currents, wave energy, and fluvial deposition from upland sources. Spits such as that at the mouth of the Clallam River typically form near the end of littoral drift cells, and form primarily from large amplitude/low frequency wave swash which transports sediment in the same direction as wave approach. Sediment is transported along the spit by wave refraction, resulting in deposition in lower energy environments.

Spit morphology is defined by the balance between sediment inputs, the volume of sediment stored in spit, and output or net erosion of spit. Seasonal variations in spit morphology are controlled by sediment transport and deposition from wind, waves, and floods. The morphology of the spit, including the location of the river mouth, is controlled by balance between "fluvial" and "coastal" processes. (reprinted with permission by Dave Parks, DNR; Figure 2.)

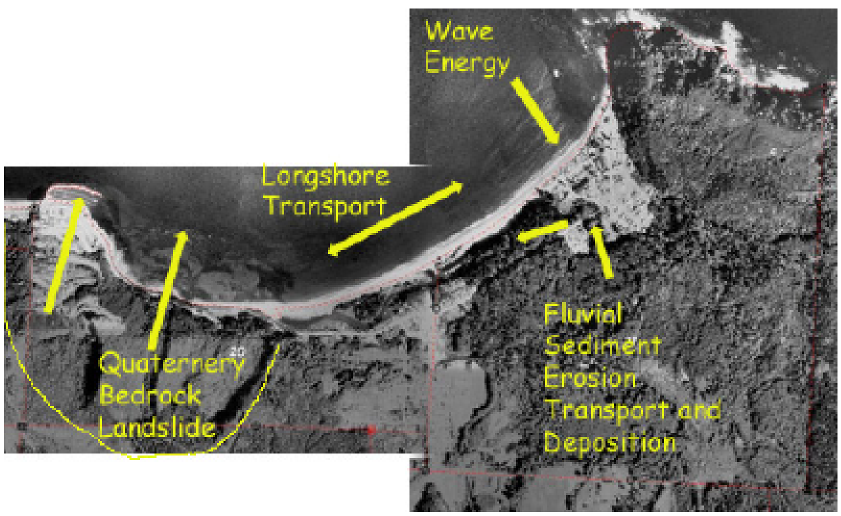


Figure 2. Clallam Bay with geologic and hydrologic processes (Reprinted with permission from Dave Parks, DNR)

The geology of the area is equally complex. (Figure 2). Historically the location of the river mouth has varied from the far western to far eastern ends of this portion of the bay. The western boundary of the river mouth location is defined by a large rotational deep seated land slide. The eastern boundary of the river mouth location is bordered by the town of Clallam Bay (Figure 2).

In summary, the Clallam Bay nearshore and spit are products of complex interactions between coastal and fluvial sediment transport, deposition, and erosion. Clallam Bay Spit experiences natural variability in sediment volume and/or morphology as the relative influence of various geomorphic processes changes seasonally, annually, and decadally. The river mouth responds to these spit changes via changes in both it's location and seasonal closure. The effect of human activities on both the physical processes and river mouth responses (meandering and closing off) is unknown, but important to understand.

Significant anthropogenic changes have occurred in the Clallam River mouth and estuary since the late 19th century. Beginning in the late 1800's, modifications include wood clearing from the lower river, which was used as a staging area for log rafts and a sawmill, filling and diking significant portions of the estuary and lower river channel migration zone, and constructing roads and piers on and over the estuary and spit. An 1890 painting in the Bert Kellogg Collection (not shown) depicts the river mouth filled with bucked logs, and an industrial building (sawmill?) located the spit, with its dock overhanging the river. Gravel was mined from Clallam Bay beaches for road fill until the mid 1940's.

Biological resources The Clallam River supports a number of anadromous fish stocks including coho (*Oncorhynchus kisutch*), fall chum (*O. keta*), steelhead (*O. mykiss*), and sea-run cutthroat trout (*O. clarkii*) populations, numerous bird species, and complex nearshore habitats. Details of each follow.

Clallam River supports healthy stocks of spawning coho and steelhead. A total of 1,210 coho redds were counted in the river in 2001. River production for coho over the last 10 years has been steadily increasing (Figure 2. Randy Cooper WDFW, McHenry, Elwha S'Klallam Tribe unpublished data). Estimated coho escapement in 2001-2002 (Brood Year 2001) to the Clallam River was 7,896 fish, a short-term historical high number (McHenry, pers. comm.). Coho spawning occurs throughout the Clallam River watershed and generally begins in late October with 50% of the spawning occurring by early December (WDFW files). Spawning is usually complete by early January but may continue through the end of the month. Coho fry emerge from the gravel beginning around March each year, but emergence timing can vary year to year due to water temperatures. Most juvenile coho rear in freshwater for one year before migrating downstream the following spring to saltwater as smolts. After spending a period of 16 to 18 months at sea adult coho return to spawn during the late fall and early winter. Precocious males or "jacks" and females ("jills" or "jennies") return to the rivers after spending only one summer in saltwater.

Fall chum have been observed spawning in the lower Clallam River drainage at the same time as coho. Briefly, fall chum emerge from the gravel and migrate promptly downstream to estuarine waters from February to June. The entry timing of chum into saltwater is related to the warming of nearshore waters and plankton blooms. Chum feed in nearshore marine habitats until the prey resources have declined. When they have attained sufficient size, chum move offshore to feed on larger organisms. Chum will spend 3 to 5 years in the ocean before returning to their natal stream to spawn.

Wild adult steelhead entry timing in the Clallam River is in late November or early December with their numbers increasing in February and continuing into May. Steelhead spawning occurs throughout the Clallam River watershed and generally begins in late February and is done by late May to early June. Steelhead may return to spawn more than once with female steelhead surviving as repeat spawners more often than males. Adults returning to saltwater after spawning are known as "kelts". Wild steelhead juveniles spend 1 to 4 years in freshwater before migrating to sea as smolts but the majority of steelhead smolts are 2 year olds. When steelhead smolts enter saltwater they will move offshore quickly and will spend 1 to 4 years in the ocean before returning to their natal streams to complete the cycle.

Sea-run cutthroat will enter freshwater from July through August but fish returning to small rivers and streams draining directly to saltwater begin entering in November and peak in January-February. They try to avoid competition with other species such as steelhead and coho by spawning in headwater streams and in small tributaries of large and small streams. Cutthroat are capable of being repeat spawners. Spawn timing occurs from late winter and spring and can vary by geographic location. Cutthroat juveniles will rear in freshwater usually one to four years before migrating downstream as smolts. In saltwater, cutthroat will feed and migrate along the shoreline. Their run timing may coincide with the availability of salmon eggs in the stream.

Smolt migration timing in the Clallam River is assumed to be similar to that of similar-sized rainfall-dominated streams along the Western Strait of Juan de Fuca. Coho, steelhead, and cutthroat smolts have been monitored by WDFW at Snow Creek in Discovery Bay since 1977. Tribal and state fisheries staff have also documented smolt migration in other streams such as McDonald Creek, Siebert Creek, Ennis Creek, Valley Creek, Tumwater Creek, Little Hoko River, Deep Creek, and JimmyComeLately Creek. Smolt migration can begin as early as late March and typically peaks in May. Migration is completed by mid-to-late June.

The nearshore of Clallam Bay, including the estuary and spit, supports a number of diverse assemblages. All are defined by their high seasonal variability (Shaffer 2000). Nearshore habitats include mixed *Nereocystis/ Macrocystis/Egregia* spp. kelp beds, eelgrass (*Zostera marina*) beds, and mixed sand/gravel beds that are documented spawning areas for surf smelt, which spawn during spring and summer months, and sand lance, which spawn in winter and early spring months. Collectively known as forage fish, these are considered critical species for a number of salmonid and bird assemblages. The WDFW therefore manages for no net loss of spawning habitats of these species (WAC 220.110). The nearshore of Clallam Bay is also critical habitat important for migrating juvenile and adult salmonids and forage fish (Shaffer 2002, Moriarty et al 2002). A diverse array of bird species depend heavily on the lower Clallam River. Eagles use the area regularly. Numerous diving and dabbling marine and freshwater ducks and shorebirds depend on the lower river, side channel, and nearshore areas for foraging and refuge. More information on the biological function of this area would be very useful in understanding the biological linkages between the river, the nearshore, human activities along the lower river, and how they interact.

Management issues

The lower river and mouth have been repeatedly altered over time. Beach gravel was mined for road fill primarily from the eastern portion of the bay by private timber companies and Clallam County from the 1800's to as recently as the 1940's (Don Nordstrom, WADOT, and Bob Bowlby, pers comm.). The river mouth was also proposed for gravel mining in the early 1950's but the proposal was shelved due to local concerns that the mining, which would result in a dedicated river mouth to the east of the historic pier, would impede the river's ability to flush sewage and garbage dumped into the river by local citizens (Kramer 1952). The lower river area was heavily used for logging support operations, including rail and pier structures during the early 1900's. The lower river alterations still in place include fill material, channelizing, diking, and undersized culverts and diversions.

Seasonal closures of the river mouth have been documented repeatedly over the last 100 years. It is not known if human activities have altered the frequency, timing, or duration of these closures. While a natural process, seasonal closure of the river mouth has been an ongoing concern for fish passage. To address fish passage concerns, permits for digging a river mouth were requested seven times between 1977 and 2002. All of these proposals received hydraulics permits, and all but one (a mitigation action performed by Crown Zellerbach) were funded with state or county public moneys. During this time all river mouth excavations were done in response to fish passage being completely blocked during the period of springtime out migration of smolts and kelts or in anticipation of the fall adult salmon returns. (Randy Johnson WDFW, pers comm.). In most instances the river mouth re-closed within days of being opened. The last man made breach closed back off within 24 hours (Rymer, pers comm.).

In addition to seasonally closing off, the river mouth meanders. It is the perception of local citizens that the river appears to have lost it's zeal for remaining at the western end of this portion of the bay and has migrated back and forth across the bay at an accelerated rate since the mid 1990's.

If they are occurring, reasons for change in river meander as well as change in frequency and duration of the river closing off may include: 1)Increase in sediment loads from forest practice activities; 2) Change in river hydrodyamics, including decreased dry-season river discharge due to changes in watershed hydrologic maturity and surface water withdrawals in the basin; 3) Alteration in the lower river course, including wood removal, culverts and dikes along the lower river, and associated decrease in floodplain connectivity and tidal prism and; 4) Change in elevation of the western portion of the bay due to rotation of a deep seated landslide.

Implications of seasonal closure and meandering of the river mouth to biological, and recreational resources

Biological. Salmonid spawning survey data over the last decade indicate that fish passage does not appear to be a compelling fish management issue for coho or steelhead stocks in the Clallam River during the low flow months when the river is bar bound. Coho spawning has been documented in a section of Charley Creek, a Clallam River tributary, since 1987 and Figure 3 shows the trend in the coho redd counts.

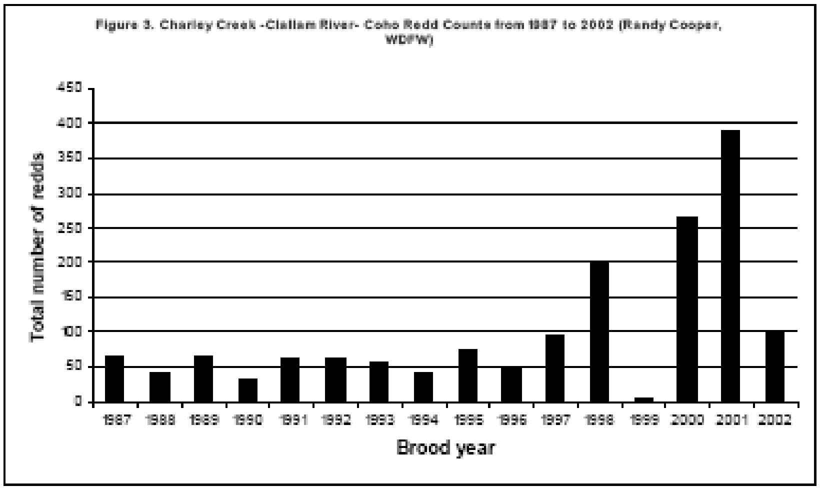


Figure 3 shows the distribution and coho redd densities (redds per mile) in Clallam river during the 2001-02 season. A total of 1,210 coho redds were counted in index sections surveyed by the Elwha S'Klallam Tribe and WDFW fisheries staff.

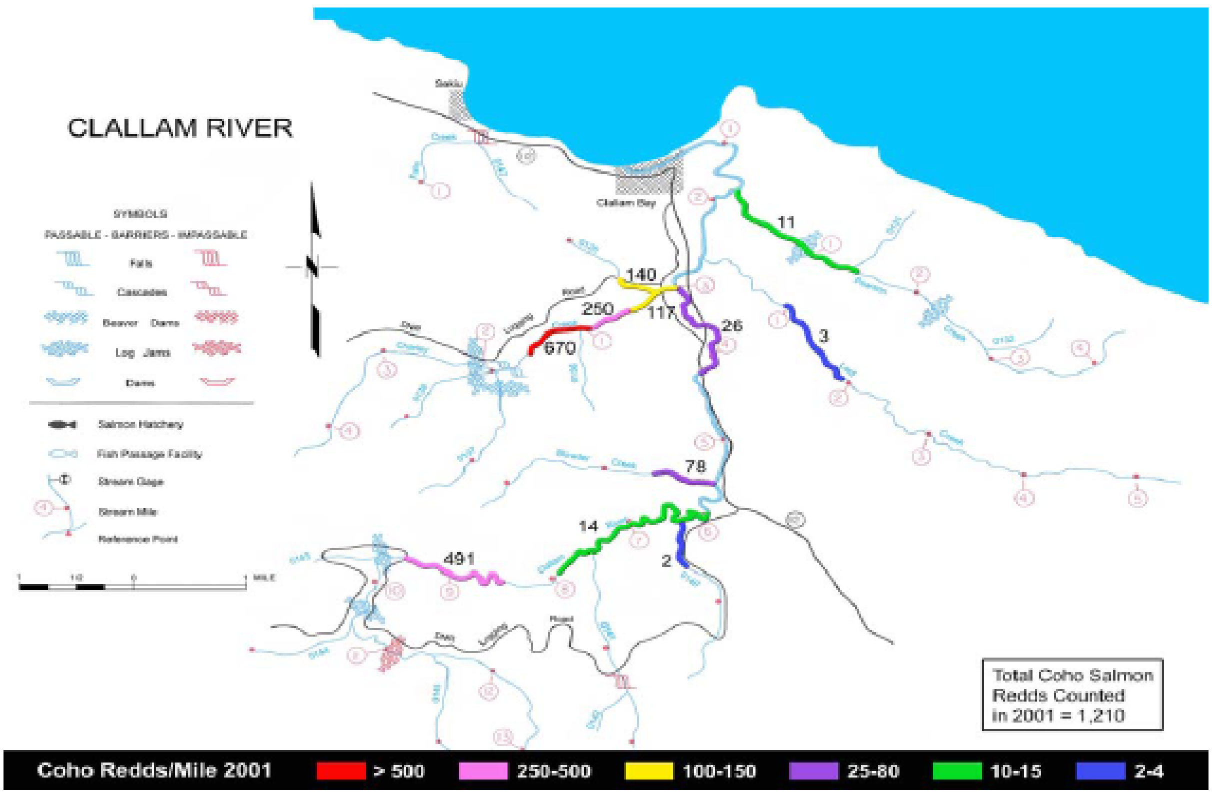


Figure 4. Clallam River 2001 coho spawner survey map, Mike McHenry, Elwha S'Klallam Tribe Randy Cooper, WDFW.

The Clallam River continues to support healthy coho stocks, and in fact, Charlie Creek, a tributary of the Clallam River, has among the highest coho spawner densities of any stream on the Olympic Peninsula. (Table 1. Randy Cooper, WDFW).

Table 1. Cumulative coho redd counts in index sections of Charley Creek (Clallam River tributary), Hoko River, Sekiu River tributaries, Pysht River tributaries, and Sadie Creek (East Twin River tributary) from 1987 to 2002.

Year	Charley Creek Coho redd count	Hoko River Coho redd count	Sekiu River tribs Coho redd count	Pysht R. tribs Coho redd count	Sadie Creek Coho redd count
1987	66	76	19	94	11
1988	41	69	8	67	6
1989	65	55	17	107	34
1990	32	23	11	110	26
1991	62	29	9	77	11
1992	62	115	26	132	7
1993	56	35	24	137	10
1994	41	42	13	112	3
1995	74	108	37	221	20
1996	48	70	41	127	3
1997	96	54	14	125	8
1998	196	227	68	219	3
1999	7	103	53	220	12
2000	266	257	47	177	30
2001	389	375	94	440	44
2002	102	234	73	250	38
Average	100.2	117.0	34.6	163.4	16.6
Average/ mile	167/mile	55.7/mile	66.36/mile	108.9/mile	27.6/mile

(WDFW Coho Redd Count Index Sections; Charley Creek Index (Clallam River) = River mile 0.9 to 1.5; Hoko River main stem Index = River mile 20.4 to 22.5; Sekiu River tribs Index = East Fork Carpenter Creek River mile 0 to 0.5 plus Carpenter CreekRiver mile 0 to 0.6; Pysht River tribs Index = South Fork Pysht River from River mile 5.7 to 7.2 plus Green Creek from River mile 1.0 to 2.2; Sadie Creek (East Twin River) =from Rivermile 1.6 to 2.2)

Autumn freshets are very important for upstream migrating adults. Sandercock (1991) reported that adult coho gather at the mouths of small coastal streams that have insufficient flows during the late summer and early autumn. Under these conditions, there is not enough energy from river flows to breach the sand bars that have accumulated across the mouths of the streams by wave action. Adult coho began moving upstream after the first high water event. A similar situation occurred in many streams in western Washington during 2002. Coho were observed congregating near the mouths and bays of smaller streams and in the lower reaches of larger river systems. At Snow Creek in Discovery Bay, adult coho showed a similar behavior. Although the mouth of Snow Creek was open during the low flow period, coho did not move upstream into the WDFW Snow Creek fish trap located at river mile 0.8 until the first autumn freshet on November 7. Due to the dry conditions of the surrounding watershed, Snow Creek flows quickly dropped and returned to low levels within a couple of days. New adult coho did not move upstream into the trap until a month later when the next major freshet occurred. In a larger river system, coho and fall chinook (*O. tshawytscha*) were observed staging in large numbers in the lower Sol Duc and Quillayute rivers because of the extremely low river flows. After the November 7 rainfall, coho and chinook moved quickly upstream. Similarly, low water flows in Clallam River will also prevent fish from accessing spawning areas even if the mouth is open (Randy Cooper, WDFW, pers.comm.). This is a yearly event on several other streams here on the North Olympic Peninsula such as Siebert and McDonald Creeks.

Smolt outmigration and upstream and downstream migrating adult steelhead and cutthroat occur during March, April, May, and June. Spawned out steelhead and cutthroat (kelts) return in small numbers to saltwater, important because of their potential to return as repeat spawners. The river mouth does not completely close off during this critical time period very often but it should be monitored (Randy Cooper, WDFW, pers. comm.).

Local biologists have identified a number of limiting factors within the freshwater habitats that could be addressed to further increase productivity of Clallam River salmon populations. These include riparian restoration, in-channel large woody debris restoration projects, improving access though culvert removal/replacement, development of off-channel areas, removal of floodplain constrictions, and floodplain acquisition.

Sand lance spawning was documented in February 2003. Surf smelt spawning was documented on this beach summer in 2002, and juvenile smelt and salmon migration occurred along the kelp beds of this area of Clallam bay in 2002 (Moriary et al 2002, Shaffer 2002). These beaches are therefore critical habitat and must be managed according to state hydraulics guidelines.

Local citizen/recreational management concerns.

Recreational issues: In the course of the last year the river mouth has migrated west down the beach to just in front of the Clallam Bay state park foot bridge. This bridge is the pedestrian access to the beach from the park bathrooms and parking lot. At the request of Clallam County, WDFW issued a permit to Clallam County in September of 2002 to place large wood strategically to reduce river and marine energy on the bridge and path. DNR agreed the work should occur. The work was not conducted, and the landing and a portion of the foot path were lost. While the bridge is still sound, the path along the spit at the end and to the west of the bridge was temporarily eroded (portions subsequently began filling back in naturally), which affected pedestrian access. This led some local citizens to insist that the river mouth be reconstructed and maintained at the western border of the bay (Figure 5). These citizens feel this action will relieve riverine pressure at the foot of the bridge, reduce flooding in the side channel areas, and alleviate the perceived water quality problem in the lower river. It is important to note that some residents of the lower river take the opposite position, and are concerned about erosion of their shorelines if the western mouth is re-opened (Arstad et al. 2003, Appendix A).

An aerial photo shows flood damage to Clallam Bay Community Park's bridge, over the waterway at bottom left, where high waters from the Strait of Juan de Fuca breached Clallam River Spit and eroded the trail. The river normally flows to its traditional mouth, far right, where community residents have dug a trench from the river to Clallam Bay.

Figure 5. (Clallam River mouth, 9 January 2003; reprinted with permission from the Peninsula Daily News)

WDFW convened a technical committee with members of local, tribal, and state management agencies and interested local citizens (attendance list attached) to go over the technical and recreational issues of the river. The group met twice in January and February. Concerns with the citizen proposal to move the river mouth identified by the technical committee include:

1) The minor and temporary nature of erosion on the spit, which is a natural process;
2) Increased erosion to landowners along the lower river just upstream of the proposed river mouth location that would occur if the river mouth was moved to the identified location (Arstad et al. 2003, Appendix A). This is supported by WDFW permitting records, which reflect numerous bulkheading activities along these properties when the river mouth was in the proposed location (Johnson, pers comm.);
3) Disruptions to physical processes due to altering the river mouth, which may disrupt transport of riverine sediments and thereby result in the river closing off earlier in the year. This could disrupt biological functions that are currently intact as well as exacerbate both erosion and flooding of the lower river areas.
4) Environmental consequences of moving the river mouth, including impacts to smolt outmigration and steelhead migration, and surf smelt and sandlance habitat from trenching activities, as well as long term maintenance activities including armoring of lower river, dredging and armoring of lower river, and river mouth;
5) Economical economic consequences of long term maintenance, including channelizing, armoring, and dredging, all of which would likely be required to dedicate the river mouth to the western end as some citizens would prefer.

State and local officials agreed that moving the location of a river mouth for access was not an emergency, everyone agreed that maintaining access for recreation in a manner that does not impact the high quality functioning nearshore habitat is a top priority. The following short-term action was taken with this aim. On the group's recommendation, Clallam County revised its proposed project to rebuild access, and WDFW permitted the revised work. Work occurred within the last three weeks, and included reconstructing the path and landing using native fill. Wood was anchored along the reconstructed area in an attempt to deflect future wave and riverine energy.

The local citizens have also submitted a JARPA to dig a 100' wide by 10' deep channel connecting the estuary with the western portion of the bay. Clallam County is the SEPA lead on this application. The WDFW has sent a SEPA hold letter to the citizens, as the project is incomplete until a SEPA determination has been made by the County. Long term work associated with breaching the bar would require a Shoreline Conditional Use Permit from Clallam County. An Emergency declaration could be declared by the County; however, after the emergency (high water season) passed, the work would have to be undone and the area restored, or the required shoreline permit applied for. Work in waters of the State also requires 401 Certification and breach proposals would need to be reviewed by the Corps of Engineers (Stewart, DoE, ,pers comm..).

Recommendations for long-term management of Clallam River and nearshore.

The group recommends the following priorities:

1) Diversify access so the beach can still be used if the bridge is closed. Access sites that are top priority include the Spring Tavern and private parcels between the lagoon and the highway. Pat, Bob, and June have had informal discussions with these land owners who are amenable to discussing selling;
2) Secure funding for acquisition of key properties that will allow restoration of lower river hydrologic processes;
3) Secure funding for monitoring of physical and biological processes in the estuary, including water quality and fish use;
4) Secure funding for monitoring of the deep-seated landslide on the western edge of the river mouth to determine its role in the relocation of the river mouth.

In summary, the Clallam River and nearshore is a highly functioning, highly-valued system. Meandering and seasonal closing of the river mouth are natural processes that are likely influenced by human alteration in many areas of the river. Historically, public agencies have permitted, and largely funded, activities to open the seasonally closed river mouth to alleviate fish passage concerns. Modification of the river mouth in attempt to alleviate public concerns over public access, however, is not recommended due to the minor and temporary impact to public access structures, and the significant environmental, liability, and economic concerns associated with the proposed modifying of the river mouth. The group as a whole will work to diversify access, restore lower river function, and further understand how the lower Clallam River ecosystem and humans interact for long term successful management of this highly functional and locally prized area.

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Appendix A. Arestad et al. February 2003 Land owner letter to Clallam County.

[illegible]

To Craig Jacobs
Clallam Co. Public Works
223 E 4th ~~Suite~~ ~~[illegible]~~
Port Angeles Wash ~~[illegible]~~

Pg 1

In light of recent interest to reopen the original mouth of the Clallam River, some interested parties would like to reopen the original mouth. Due to erosion of the Clallam Bay Park. "As land owners" on the South side of the Clallam River near the original mouth listed below feel otherwise! We wish to keep the mouth closed, as further erosion to our property might occur in the future. We would like nature to take its natural course, where the mouth of the river is now east of the park bridge. Also a great abundance of water fowl has accumulated on the west end of the slew making great bird watching for park viewers.

See page two for names & address of land owners

Pg 2

[illegible] Catrina Ware
16523 Hy Wy 112
Clallam Bay Wash 98326
mail - P.O. Box [illegible], Wash 98381

TED ARESTAD
16511 HIWAY 112 W
CLALLAM BAY WA 98326
[illegible]

Judith L. Fickel [illegible]
[illegible] HWY 112
Sekiu, WA 98381

James S. Rowe [illegible]
16611 Hywy 112 W. P.O. BOX 169
Clallam Bay WA. Clallam Bay 98326

Edward J. Massol
P.O. Box 176
Clallam Bay, WA 98326
16543 highway 112

SHIRLEY B BROWN Shirley B. Brown
[illegible] HWY 112
CLALLAM BAY
WA 98326

Appendix E- Hydrogeomorphic Assessment of the Clallam River Mouth

MAKAH TRIBE

P.O. BOX 115 • NEAH BAY, WA 98357 • 360-645-2201

2006 Hydrogeomorphic Assessment of the Clallam River Mouth

Jeff Shellberg
Hydrologist
Makah Indian Tribe
3/17/2006

This assessment of the hydrogeomorphic conditions of the Clallam River mouth is a combination of material written by Shaffer et al. 2003, with additions from more recent data on channel migration through 2006. In the near future, these data could be utilized to update Shaffer et al. 2003 into a living document of what is scientifically known about the Clallam River mouth, estuary, and nearshore marine areas. Text directly from Shaffer et al. 2003 is highlighted in italics, while more recent information is not.

Physical processes

The Clallam River is a tributary to the western Strait of Juan de Fuca. The Clallam River mouth, located in the middle of Clallam Bay, is terminated by a well-formed sand spit. The mouth closes off seasonally as a natural process and forms a brackish lagoon.

While no pre-development characterizations of the mouth of the Clallam River have been located, the seasonal closure of the mouth has been documented on maps as early as 1934-35, in US Army maps. These maps show the Clallam River lagoon *emptying into the bay by seepage through much of the area that currently makes up the state/county park lands on the spit (Andy Ritchie Makah Tribe, Figure 1).*

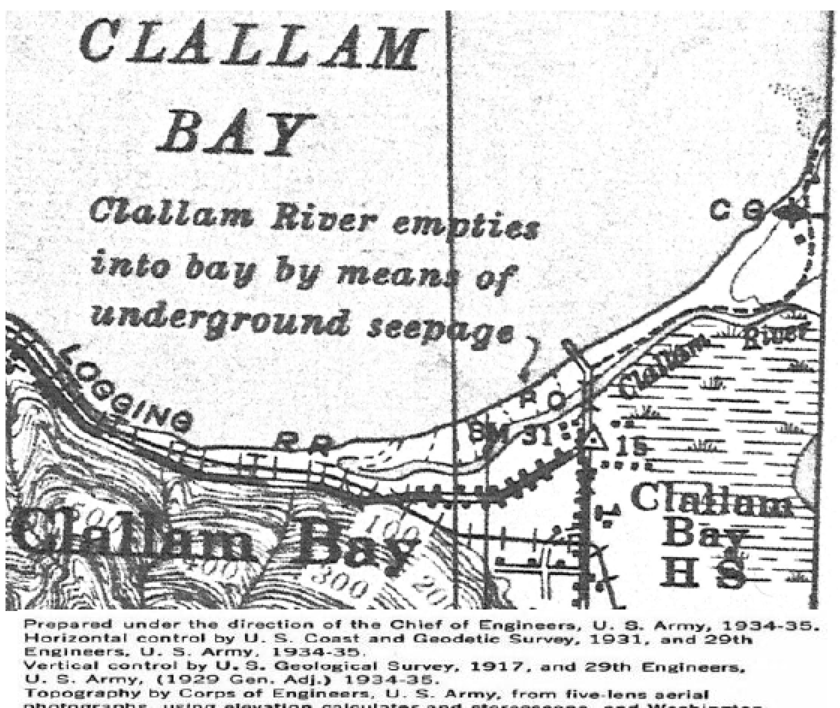


Figure 1. Excerpt from US Army Corps of Engineers Tactical Map, 1934-1935.

Seasonal closure of spits such as this is common, and characteristic of the interplay between marine and riverine forces. Spit sediment is supplied by rivers and streams, bluff erosion and landsliding, and beach sediments. Sediments that make up such spits are transported by longshore current in drift cells, tidal currents, wave energy, and fluvial deposition from upland sources. Spits such as that at the mouth of the Clallam River *typically form near the end of littoral drift cells, and form primarily from large amplitude/low frequency wave swash which transports sediment in the same direction as wave approach. Sediment is transported along the spit by wave refraction, resulting in deposition in lower energy environments.*

The Washington State Department of Ecology's GIS database on drift cells describes the Clallam Bay drift cell at the mouth of the Clallam River. It states: "Originating at Slip Point, this cell has a southwesterly net shore-drift which terminates at a promontory west of the Clallam River mouth. Indicators of the southwesterly transport direction are sediment interruption by drift logs, increasing beach width and presence of fine sands to the west, and the nearly 2 kilometer diversion of the Clallam River mouth. The small nap area east of Slip Point is characterized by no appreciable net shore-drift as offshore deep water impedes the shore drift."

Spit morphology is defined by the balance between sediment inputs, the volume of sediment stored in spit, and output or net erosion of spit. Seasonal variations in spit morphology are controlled by sediment transport and deposition from wind, waves, and floods. The morphology of the spit, including the location of the river mouth, is controlled by balance between "fluvial" and "coastal" processes. (reprinted with permission by Dave Parks, DNR; Figure 2.)

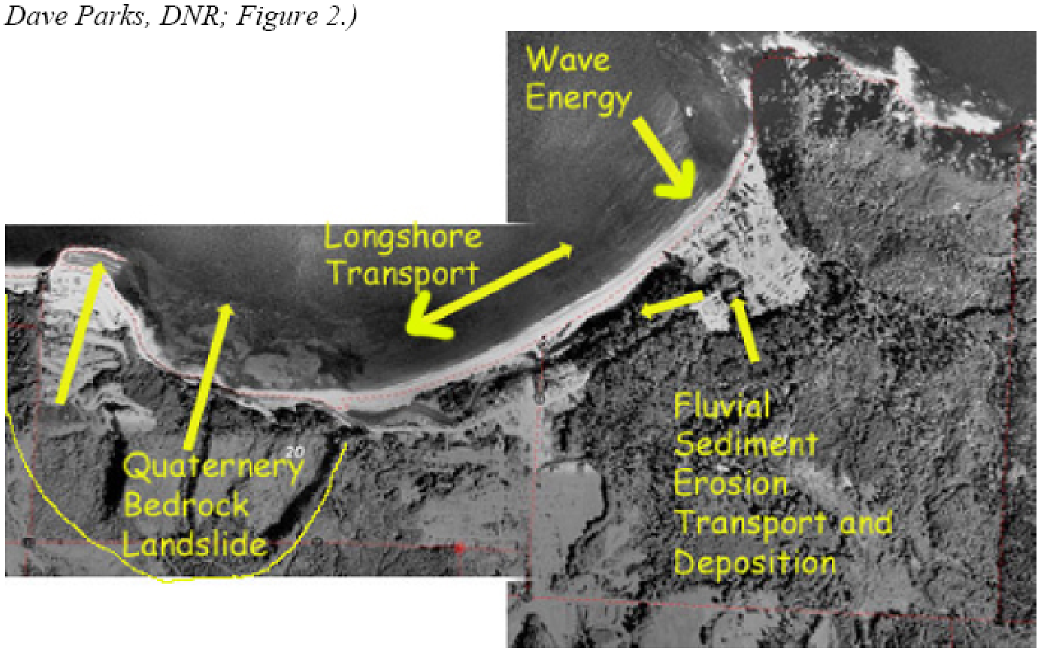


Figure 2. Clallam Bay with geologic and hydrologic processes (Reprinted with permission from Dave Parks, DNR)

The geology of the area is equally complex. The western boundary of the river mouth location is defined by a large rotational deep-seated landslide, consisting of sandy siltstone and mudstone (Pysht Formation: Miocene and Oligocene). The center valley that the river flows down and which the town of Clallam Bay surrounds, consists of unconsolidated quaternary alluvium (silt, sand, and gravel; Holocene and Pleistocene).

This alluvium makes up both the river floodplain and low terraces. *The eastern boundary of the river mouth* at Slip Point consists of conglomerate and sandstone (Clallam Formation: Miocene).

Historically the location of the river mouth has varied from the far western to far eastern ends of this portion of the bay. More recently, the river has been prevented from migrating to the far eastern end of the bay or southern part of the valley, due to river and floodplain alterations such as fill, channelization, and bank amourment on the edges of development in Clallam Bay. Historical air photos are currently being sought for the river mouth. Currently, rectified air photos only exist for the time period 1994 to 2006. Air photos extending back to 1953 do exist. In addition, one oblique air photo exists from the 1950's (Figure 3). This photo indicates that the river mouth was likely located at the far western edge of the bay.

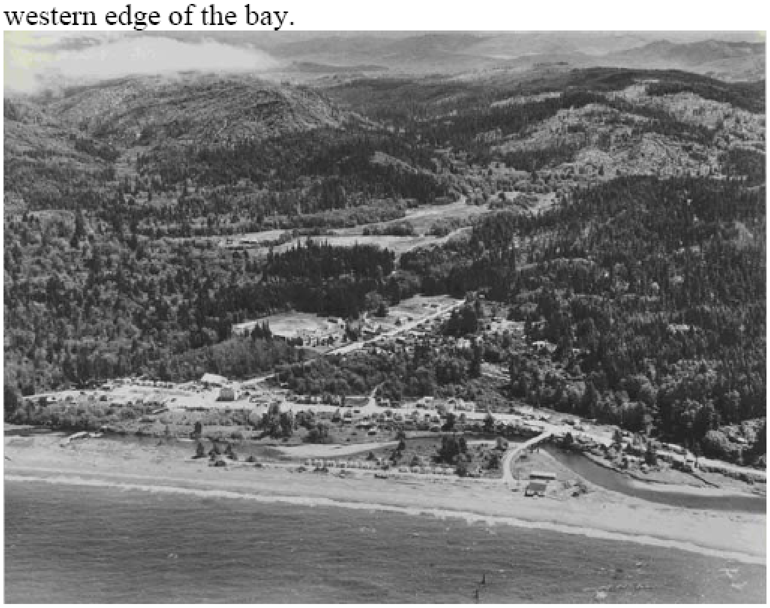


Figure 3. Clallam Bay oblique air photo from the 1950's (source unknown at this time).

The degree of channel shifting of the outlet location between the 1950's and 1990's is unknown. In addition, episodic channel shifting between air photo dates cannot be detected. It is highly possible that between 1950 and 1994 that the outlet of the river shifted during large flood/tidal/wind events and exited the estuarine lagoon at various locations such as the far east end of the lagoon.

Air photo coverage between 1994 and 2006, supplemented by ground photos and GPS, is sufficient to describe a <u>partial</u> picture of the possible range of geomorphic channel changes and outlet locations. Figure 4 displays Clallam River channel locations between 1994 and 2006. In 1994, the outlet of the channel was located at the far western edge of the valley, which is presumed to be its most common contemporary channel location (1950's to 1990's). During large flood/tidal/wind events, the outlet of the channel episodically shifted to other locations, typically breaching the beach bar further east near where the river first encounters the beach interface. This last occurred following large flood events during water years (WY) 1996 and 1997 (Figure 5). By 1998, the river outlet was located at the eastern edge of the lagoon, near where housing development confines the river from migrating further east. After about the mid 1990's, the western portion of the historic channel location (lagoon) experienced significant fine sediment aggradation and channel infilling, presumably due to increased watershed sedimentation transferred to the estuary by the major floods of the 1990's. This infilling has partially prevented the channel from reoccupying is historic channel.

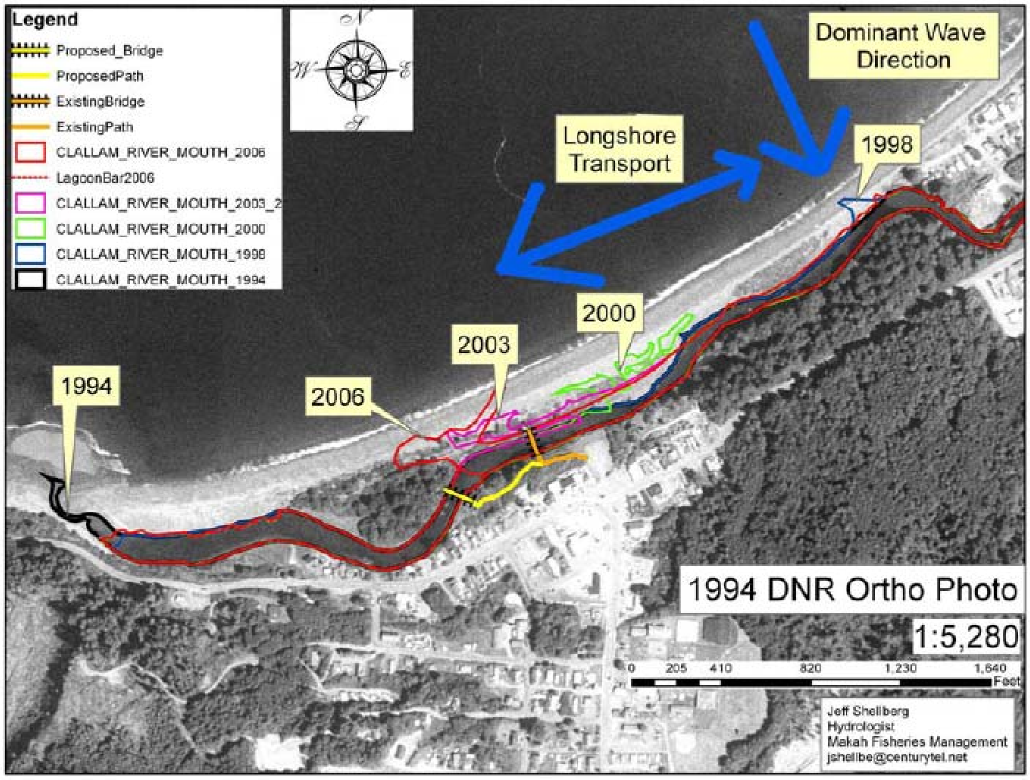


Figure 4 Clallam River channel locations between 1994 and 2006.

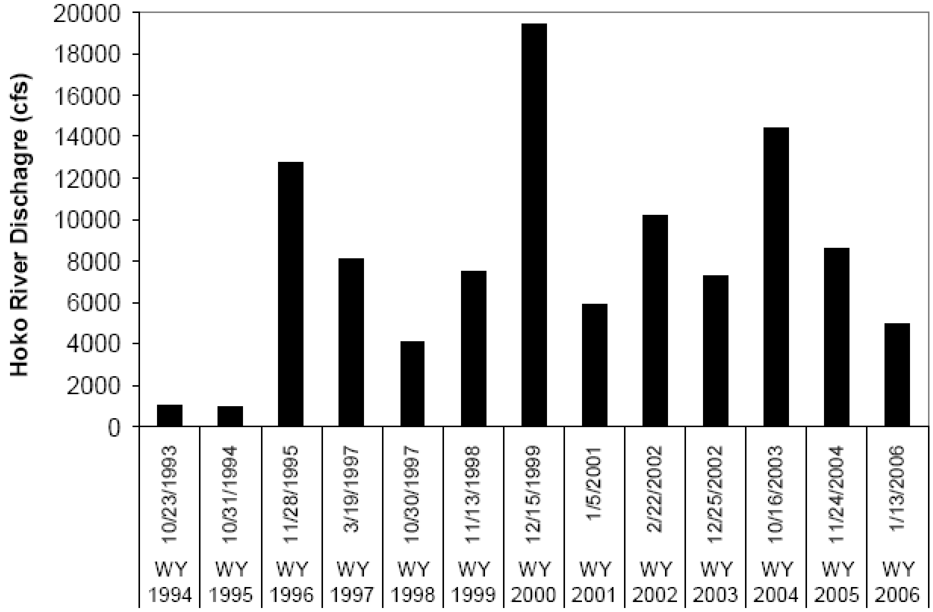


Figure 5 Hoko River annual peak discharge magnitude, used as a surrogate for Clallam River annual peak discharge magnitude. Note, the Clallam River watershed (31.6 mi^2) is 62 % the size of the Hoko watershed at the USGS stream gage (51.2 mi^2). Between 1998 and 2000, the river outlet migrated west approximately 1346 feet (Figure 6 and Table 1). Observations during this time indicate that this migration did not occur at a uniform rate (673 feet/year), but rather most migration occurred during major flood/tidal/wind events. It is presumed that the river outlet during moderate flows lingered locally and variability at the eastern end of the lagoon between the large floods in WY 1996/1997 and the flood of record in December 1999. By summer 2000, the river outlet was located near the historic bridge and pier location, just upstream of the current parking lot, as indicated by the recent closure location shown in the summer 2000 air photo.

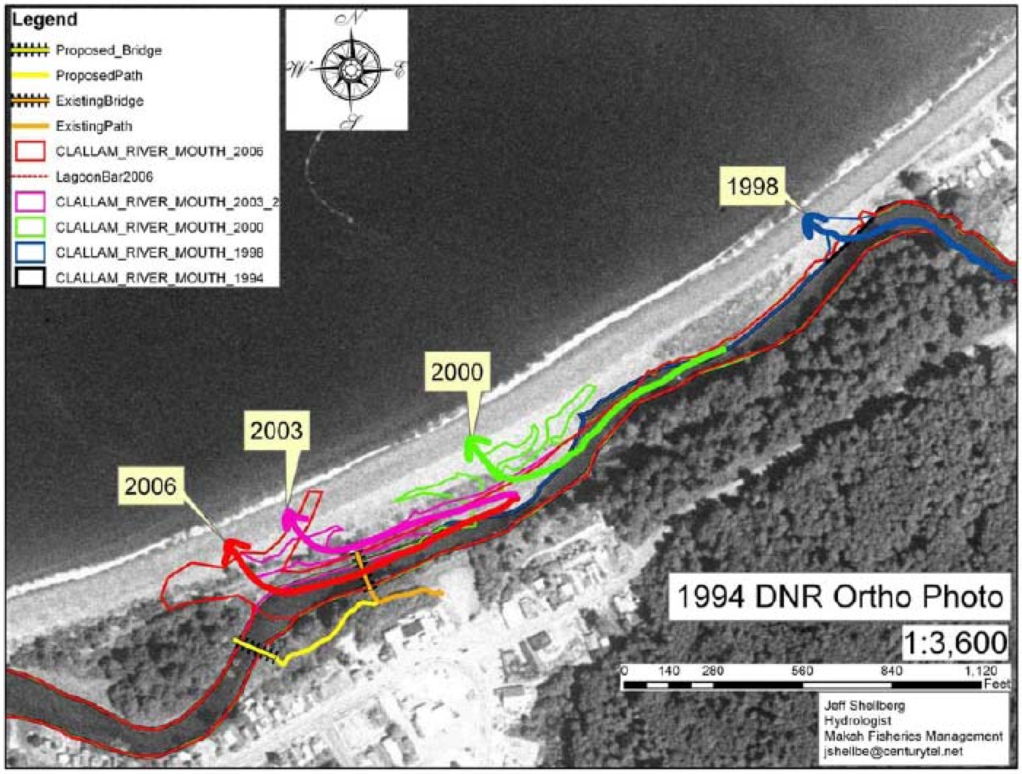


Figure 6 Clallam River channel locations between 1998 and 2006.

Following the 1999 flood event, the river outlet continued to migrate west. By 2002/2003, the outlet was threatening the beach bar that right bank abutment of the existing footbridge was located on (colored orange in Figure 6). This erosion prompted the concerned community to attempt to stabilize the eastern (upstream) head and edge of the beach bar with cabled rootwads, to protect the bridge abutment. By the summer 2003 air photo, the river outlet location had migrated 649 feet from the 2000 location, or 216 feet/year (Figure Table 1).

On October 16, 2003 (a 20-year recurrence interval flood on the Hoko River; Figure 5), the right bank abutment of the existing footbridge failed and one section of the bridge deck was washed to sea (currently located on Third Beach on the Makah Reservation). Following this 2003 flood, the river outlet remained locally variable but did not migrate significantly until the large flood/tidal/wind events during January 2006 (Figure 5). During January 2006, the river outlet migrated 275 feet west, or 91 feet per year between 2003 and 2006 (Figure 7 and Table 1). The existing footbridge (minus one section) is once again completely spanning the river, with the river flowing directly under it. Currently (2006), the outlet of the river channel is actively eroding into the vegetated island west of the existing footbridge.

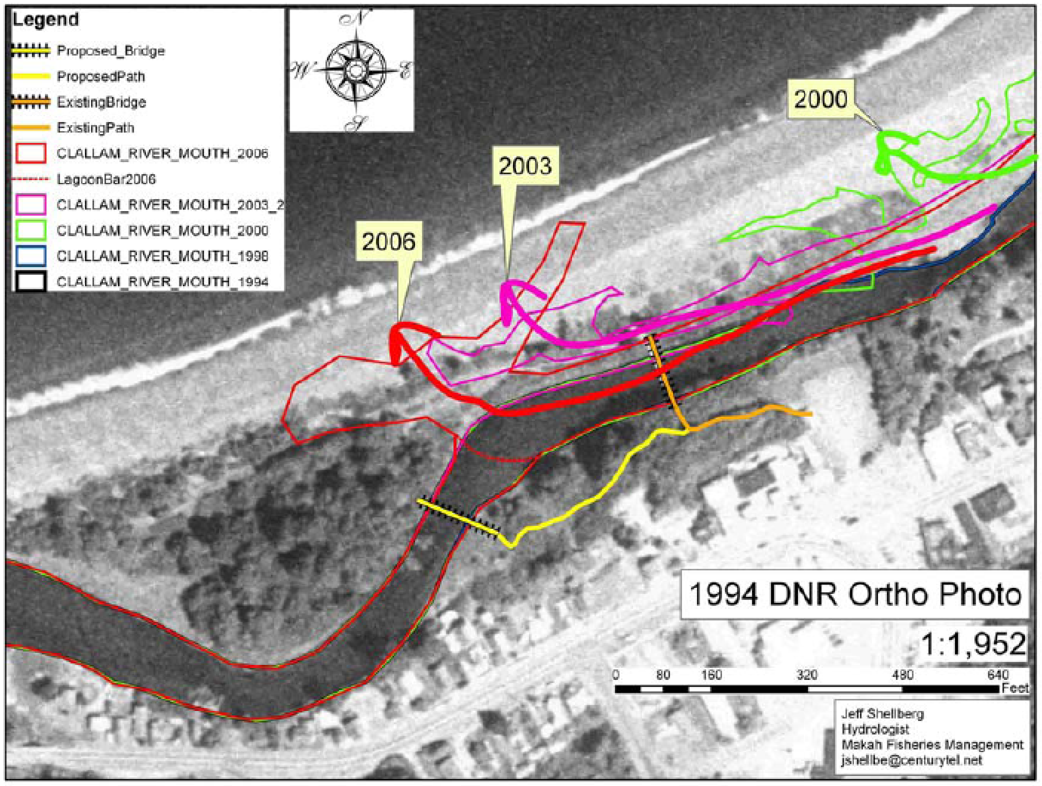


Figure 7 Clallam River channel locations between 2000 and 2006.

The island west of the existing footbridge is vegetated at its core with mostly upland species including Douglas Fir, Sitka Spruce, Western Hemlock, Red Alder, salal, fern and other species. The origin of this vegetation is partially displayed in the historic 1950's photo (Figure 3), which indicates that the island was only partially vegetated with tree species in the 1950's, and mostly covered by shrub and emergent wetland species. Species such as Douglas fir were likely planted among the historic cabins access via the Fitzpatrick bridge. In addition, the island has been at least partially graded by man (e.g., the road network), and experienced at least some fill. Bank exposure around the island indicates that the island has clay deposits at depth (i.e., thalweg of existing channel outlet), which are overlain by sand and gravel beach deposits, silt and sand flood deposits around the island margins, and variable depths of fill on some of the surface. Future coring is needed. Currently, the island appears to be only rarely inundated, mostly along the fringes. The core center part of the island shows no sign of inundation (vegetative or soils), which likely has been the case for the last 50 years. The inundation frequency of the island before human modification (cabin/camp site and road construction) is unknown, but the 1950's photo suggests that it was inundated more frequently than present.

There currently is no historic (post 1950's) precedent for the river outlet located where the island currently sits, nor is there historic data for channel migration through it. This is also true for the current channel location. Sediment cores through the island would help define its geomorphic history. However, the past only partially reveals the potential for future channel migration, especially under the current circumstances where the watershed and estuary are significantly disturbed by human activity. Currently, the east end of the island has eroded within the Clallam River channel migration zone (CMZ), over 800 feet in recent years. The erosion has recruited trees and large woody material that are still buried in the beach, aiding future beach stabilization.

Future rates of erosion into the island are unknown, as is the future river outlet. At any time, a future episodic flood/tide/wind event could either relocate the river outlet further east, or the river/tide/wind could continue to focus their energy on the east (upstream) head of the island. Air photo data from 1998 to 2006 indicate the tendency for the river to continue migrating west, in an attempt to regain its historic channel location and morphology (shape). This is also supported by the net southwesterly longshore sediment transport by the drift cell (Figurer 2). Figure 8 displays the channel locations for 2003 and 2006. During these years, the morphology of the outlet and the balance between fluvial and coastal processes becomes very evident. Dominant wave energy is from the northwest, while dominant river energy is from the northeast. These two dominant energy vectors tend to combine to deflect the river channel west. Hence the historic (e.g., 1994) channel location. In addition, the river or tidal prism often has enough flow to breach the beach berm or spit, but when wave energy is high, the river outlet channel is deflected once again parallel to the beach along the ocean face of the beach. This deflection is evident in Figure 8. During recent storms between 2003 and 2006, river energy eroded the east (upstream) face of the island, while combined river and wave energy eroded the ocean face of the island due to the westward deflection.

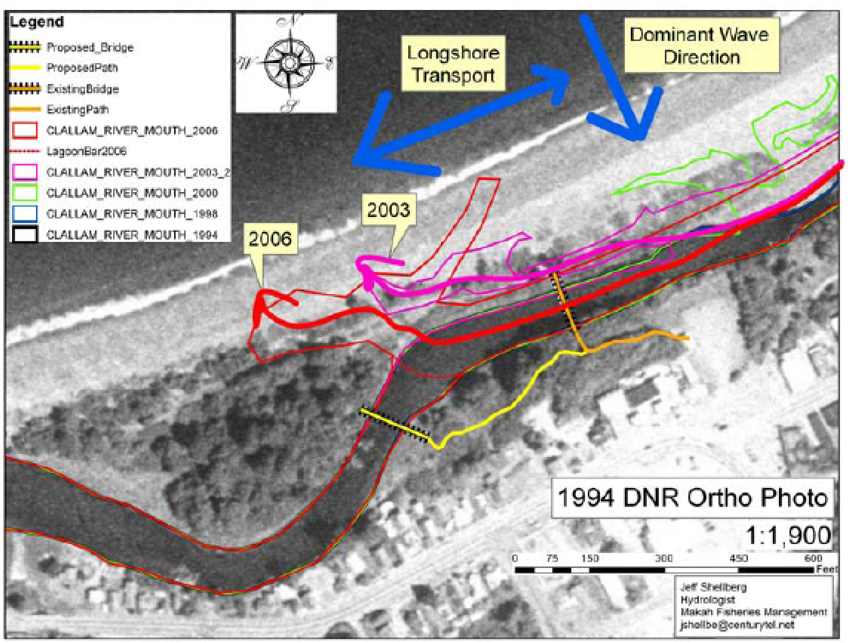


Figure 8 Clallam River outlet channel deflection along the beach face.

With these two battling energy sources (fluvial and coastal), the future tendency of the river will be to erode through the island, especially on its upstream and ocean faces, rather than reoccupy its historic channel. At longer unknown timescales, it is likely that the river will eventually regain its historic location and shape, after eroding through the center or front of the island. Again, future rates of erosion into the island are unknown. However, some rough estimates of erosion rates and time periods for erosion can be calculated. Between 1998 and 2006, the slowest erosion rate was 91 feet/year, while eroding through the head of a wood armored island and bridge abutment. This rate estimate can be used to predict erosion time frames into the future. However, since the river will be eroding into a vegetated island with some mature trees, erosion rates may be reduced by recruited large woody debris at the erosion face and root strength. As a more conservative estimate, the observed 2003-2006 erosion rates (91 ft/yr) was reduced by 70% to 20 ft/yr. Obviously, on any given year, erosion rates will be much greater or less than these averages due to episodic flood/tide/wind storms.

Using these erosion rate estimates, the dimensions of the vegetative island, and locations of existing and proposed structures, the time period (years) that it might take the river channel to erode into a structure or through the island can be calculated. These data are displayed in Table 1. These estimates suggest that it would take 10 to 40 years to erode through the island, and 5 to 20 years to erode to the old Fitzpatrick bridge.

Migration Period	Migration Distance (feet)	Average annual migration rate (feet/year)	Distance (feet)	Years to Migrate through feature at 20 ft/yr (90 ft/yr)
1998-2000	1346	673		
2000-2003	649	216		
2003-2006	275	91		
1998-2006	2270	284		
Current Island Length-Parallel to Beach			800	40 years (8.8 yrs)
Current Island Width (max)-Perpendicular to Beach			340	
Distance from east island edge to Fitzpatrick bridge			430	21.5 years (4.7 yrs)
Distance from east island edge to proposed bridge			115	5.8 years (1.3 yrs)

Table 1 Clallam River mouth migration distances and rates.

In summary, the Clallam Bay nearshore and spit are products of complex interactions between coastal and fluvial sediment transport, deposition, and erosion. Clallam Bay Spit experiences natural variability in sediment volume and/or morphology as the relative influence of various geomorphic processes changes seasonally, annually, and decadally. The river mouth responds to these spit changes via changes in both it's location and seasonal closure. The effect of human activities on both the physical processes and river mouth responses (meandering and closing off) is unknown, but important to understand.

Significant anthropogenic changes have occurred in the Clallam River mouth and estuary since the late 19^{th} century. Beginning in the late 1800's, modifications include wood clearing from the lower river, which was used as a staging area for log rafts and a sawmill, filling and diking significant portions of the estuary and lower river channel *migration zone, and constructing roads, bridges and piers on and over the estuary and spit. An 1890 painting in the Bert Kellogg Collection (not shown) depicts the river mouth filled with bucked logs, and an industrial building (sawmill?) located the spit, with its dock overhanging the river. Gravel was mined from Clallam Bay beaches for road fill until the mid 1940's.*

Appendix F- Clallam Watershed Monthly Water Quality Data

Site	Sampler	Date	Time	Temp	Oxygen %	Oxygen mg/l	Conductivity	Turbidity	Salinity	Notes
B	CB	9/2/2005	1545	17.1	73%	7.17	166.8	-	-	
B	CB	9/17/2005	1615	13.2	71%	7.4	149	-	-	
B	CB	10/5/2005	925	9.6	87%	9.82	708	-	-	Conductivity value bold and underlined in original data
B	CB	11/28/2005	1535	5.4	95%	12.04	47.9	2	-	
B	CB	12/18/2005	1200	2.5	97%	13	166.5	2	-	
B	CB	1/31/2006	1220	7.2	104%	12.88	27.8	17	-	
B	CB	2/28/2006	1135	5.5	98%	12.3	47	3	-	
B	CB	3/18/2006	1330	5.9	98%	11.8	40	3	-	
B	na	5/22/2006	1945	12.8	89%	9.4	78	2	-	
B	CB	6/20/2006	1155	12.6	92%	9.34	212.5	1	-	
B	CB; SN	8/27/2006	1230	16	73%	7.16	164.1	3	0.2	
B	CB; JM	10/23/2006	1405	8.9	68%	7.87	80	1	0.2	
B	CB	1/30/2007	1300	4.2	98.7%	12.85	40.5	3	0.0	
B	CB; SB	2/28/2007	1310	5.2	92.0%	12.22	36.6	4.0	0.0	
B	CB; SB	3/29/2007	1210	7.4	92.7%	11.08	40.2	3	0.0	
B	CB; SB	5/2/2007	1240	8.9	94.8%	10.99	37.7	-	0	Turbidity meter stopped working
B	CB; SN	5/29/2007	1330	12	110.3%	11.87	249.1	2	0.2	
C	CB	9/2/2005	1145	14.9	82%	8.26	74	-	-	
C	CB	9/17/2005	1640	13.5	77%	7.98	81	-	-	

Site	Sampler	Date	Time	Temp	Oxygen %	Oxygen mg/l	Conductivity	Turbidity	Salinity	Notes
C	CB	10/6/2005	1030	9.3	91%	9.6	73.9	-	-	
C	CB	11/28/2005	1515	5.3	92%	11.62	43.9	2	-	
C	CB	12/20/2005	1510	6.7	98%	11.61	39.34	5	-	
C	CB	1/31/2006	1250	7.2	98%	11.01	32.1	7	-	
C	CB	2/28/2006	1410	5.5	98%	12.35	38	1	-	
C	CB	3/18/2006	1550	6.3	99%	12.2	38	2	-	
C	na	5/22/2006	1800	10.3	95%	10.7	61.3	1	-	
C	CB	6/20/2006	1130	11.5	94%	10.25	55.1	1	-	
C	CB; SN	8/27/2006	1650	16.5	87%	8.45	87.3	1	0.1	
C	CB; JM	10/23/2006	1610	8.3	92%	11	75.2	1	0	
C	CB	1/30/2007	1540	4.5	97.2%	12.07	39	2	0.0	
C	CB; SB	2/28/2007	1435	4.7	93.7%	11.98	36.4	3.0	0.0	
C	CB; SB	3/29/2007	1345	8.3	89.8%	10.57	42.4	2	0.0	
C	CB; SB	5/2/2007	1405	9.7	103.1%	11.72	42.3	-	0	Turbidity meter stopped working
C	CB; SN	5/29/2007	1615	13.4	99.4%	10.4	58.3	1	0	
D	CB	9/2/2005	1405	13.4	55%	5.74	66.3	-	-	
D	CB	9/17/2005	1400	10.4	39%	4.41	65.1	-	-	
D	CB	10/5/2005	1115	9	87%	10.04	49.9	-	-	
D	CB	11/28/2005	1350	5	90%	11.54	31.1	3	-	
D	CB	12/18/2005	1310	2.4	94%	12.9	34.5	3	-	
D	CB	1/31/2006	na	-	-	-	-	-	-	Snow and high water made it impossible to sample most sites

Site	Sampler	Date	Time	Temp	Oxygen %	Oxygen mg/l	Conductivity	Turbidity	Salinity	Notes
D	CB	2/28/2006	1320	5.6	93%	11.6	29	4	-	
D	CB	3/18/2006	1430	6.1	94%	11.7	29	2	-	
D	na	5/22/2006	1720	11.4	80%	8.83	33.3	4	-	
D	CB	6/20/2006	1730	12.1	80%	8.63	46.1	1	-	Turbidity value bold and underlined in data
D	CB; SN	8/27/2006	1520	15.8	58%	5.73	78.9	2	0.1	
D	CB; JM	10/23/2006	1500	7.6	44%	5.3	66.4	3	0	
D	CB	1/30/2007	1400	4.4	95.9%	12.42	30.3	5	0.0	
D	CB; SB	2/28/2007	1410	5.3	92.6%	11.73	27.4	3.0	0.0	
D	CB; SB	3/29/2007	1310	7.7	86.2%	10.28	33.5	3	0.0	
D	CB; SB	5/2/2007	1315	9.1	92.0%	10.66	30.4	-	0	Turbidity meter stopped working
D	CB; SN	5/29/2007	1420	10.6	97.5%	10.84	42.3	2	0	
E	CB	9/2/2005	1210	14.9	79%	7.94	79.6	-	-	
E	CB	9/17/2005	1645	13.3	81%	8.5	76.8	-	-	
E	CB	10/6/2005	1100	10.4	92%	10.1	71.3	-	-	
E	CB	11/28/2005	1515	5.3	92%	11.62	43.9	2	-	
E	CB	12/20/2005	1450	6.9	97%	11.78	38.8	5	-	
F	CB	9/2/2005	1300	14.9	83%	8.37	78	-	-	
F	CB	9/17/2005	1250	12.5	81%	8.63	74.7	-	-	
F	CB	11/28/2005	1255	4.9	95%	12.02	44.2	2	-	
F	CB	12/18/2005	1345	3.1	97%	13.02	46	2	-	
F	CB	1/31/2006	1310	7.2	98%	11.89	32.1	10	-	
F	CB	2/28/2006	1220	5.3	100%	12.6	38	2	-	

Site	Sampler	Date	Time	Temp	Oxygen %	Oxygen mg/l	Conductivity	Turbidity	Salinity	Notes
F	CB	3/18/2006	1505	6.5	100%	12.22	38.6	2	-	
F	na	5/22/2006	1640	11.6	92%	10.5	61.5	1	-	
F	CB	6/20/2006	1820	13.1	95%	10.83	50.31	1	-	
F	CB; SN	8/27/2006	1605	13.7	83%	8.62	67.1	1	0.1	
F	CB; JM	10/23/2006	1540	9	86%	9.92	70.2	1	0.3	
F	CB	1/30/2007	1450	5	98.2%	-	40.8	3	0.0	
F	CB; SB	2/28/2007	na	-	-	-	-	-	-	River to high to safely get to sites F, L, and P.
F	CB; SB	3/29/2007	na	-	-	-	-	-	-	Water to high to do sites F, L, and P without tresspassing.
F	CB; SB	5/2/2007	na	-	-	-	-	-	-	Water to high to do sites F, L, and P without tresspassing.
F	CB; SN	5/29/2007	1530	12.7	103.9%	11.17	54.8	1	0	
G	CB	9/2/2005	1040	14	93%	9.5	73.2	-	-	
G	CB	9/17/2005	1120	11.1	105%	10.67	103	-	-	
G	CB	10/6/2005	945	8.9	93%	10.3	73.9	-	-	
G	CB	11/28/2005	1400	5.5	101%	12.87	42.3	1	-	
G	CB	12/18/2005	1525	2	100%	13.86	43	1	-	
G	CB	1/31/2006	na	-	-		-	-	-	Snow and high water made it impossible to sample most sites
G	CB	2/28/2006	1510	5.4	99%	12.6	39	1	-	
G	CB	3/18/2006	1630	6.2	101%	12.5	37	2	-	
G	na	5/22/2006	1855	10.5	92%	10.1	58.3	1	-	
G	CB	6/20/2006	1025	11.5	96%	10.37	46.2	1	-	

Site	Sampler	Date	Time	Temp	Oxygen %	Oxygen mg/l	Conductivity	Turbidity	Salinity	Notes
G	CB; SN	8/27/2006	1740	16.4	97%	9.88	84.1	1	0.1	
G	CB; JM	10/23/2006	1710	8	96%	11.36	68.3	1	0	
G	CB	1/30/2007	1640	4.4	95.6%		41.9	2	0.0	
G	CB; SB	2/28/2007	1515	4.4	97.4%	12.65	35.8	3.0	0.0	
G	CB; SB	3/29/2007	1428	8	99.6%	11.79	42	2	0.0	
G	CB; SB	5/2/2007	1450	9.5	98.2%	11.21	40.8	-	0	Turbidity meter stopped working
G	CB; SN	5/29/2007	1740	11	91.1%	10.04	54	1	0	
H	CB	9/2/2005	1105	14.3	99%	10.1	80.3	-	-	
H	CB	9/17/2005	1140	10.9	110%	12.7	76.4	-	-	
H	CB	10/6/2005	1000	9.1	9280%	10.43	63.4	-	-	
H	CB	11/28/2005	1425	5	94%	12	41.2	1	-	
H	CB	12/18/2005	1515	2.1	100%	13.82	43	1	-	
H	CB	1/31/2006	na	-	-	-	-	-	-	Snow and high water made it impossible to sample most sites
H	CB	2/28/2006	1530	5.4	98%	12.4	37	1	-	
H	CB	3/18/2006	1625	6.2	100%	12.4	37	2	-	
H	na	5/22/2006	1840	10.5	92%	10.1	52.8	1	-	
H	CB	6/20/2006	1045	11.4	95%	10.43	49.4	1	-	
H	CB; SN	8/27/2006	1730	14.5	95%	9.72	84.1	1	0.1	
H	CB; JM	10/23/2006	1655	8.1	92%	10.91	68.5	2	0	
H	CB	1/30/2007	1635	4.4	95.3%	12.35	42	2	0.0	
H	CB; SB	2/28/2007	1510	4.4	94.9%	12.31	36.4	3.0	0.0	

Site	Sampler	Date	Time	Temp	Oxygen %	Oxygen mg/l	Conductivity	Turbidity	Salinity	Notes
H	CB; SB	3/29/2007	1425	8	99.4%	11.77	42.1	2	0.0	
H	CB; SB	5/2/2007	1451	9.5	97.6%	11.16	40.6	-	0	Turbidity meter stopped working
H	CB; SN	5/29/2007	1730	12.5	91.2%	9.72	56.0	1	0	
J	CB	9/2/2005	1130	14.5	92%	9.87	90.2	-	-	
J	CB	9/17/2005	1200	12.3	84%	8.97	80.4	-	-	
J	CB	10/6/2005	1015	9.1	95%	11.1	68.3	-	-	
J	CB	11/28/2005	1450	4.8	95%	12.21	42.5	1	-	
J	CB	12/18/2005	1445	2.3	103%	14.08	43.6	1	-	
J	CB	1/31/2006	na	-	-	-	-	-	-	Snow and high water made it impossible to sample most sites
J	CB	2/28/2006	1450	5.4	97%	12.2	37	2	-	
J	CB	3/18/2006	1600	6.3	99%	12.2	38	2	-	
J	na	5/22/2006	1810	10.9	92%	10.7	53.4	1	-	
J	CB	6/20/2006	1105	11.5	97%	10.55	46.3	2	-	
J	CB; SN	8/27/2006	1705	16.3	86%	9.41	90	1	0.1	
J	CB; JM	10/23/2006	1625	8.2	91%	10.64	71.6	1	0	
J	CB	1/30/2007	1550	4.4	93.0%	12.07	41.8	2	0.0	
J	CB; SB	2/28/2007	1450	4.5	96.5%	12.47	36.1	4.0	0.0	
J	CB; SB	3/29/2007	1400	8.1	99.4%	11.74	42.2	2	0.0	
J	CB; SB	5/2/2007	1410	9.7	102.7%	11.67	42.1	-	0	Turbidity meter stopped working
J	CB; SN	5/29/2007	1625	13.7	91.7%	10.35	58.1	1	0	
L	CB	9/2/2005	1250	13.2	82%	8.63	73.1	-	-	

Site	Sampler	Date	Time	Temp	Oxygen %	Oxygen mg/l	Conductivity	Turbidity	Salinity	Notes
L	CB	9/17/2005	1245	11.4	77%	8.4	68	-	-	
L	CB	10/3/2005	1240	11.4	77%	8.4	68	-	-	
L	CB	11/28/2005	1245	5	94%	12.05	44.2	1	-	
L	CB	12/18/2005	1355	3.5	94%	12.5	47.1	1	-	
L	CB	1/31/2006	na	-	-	-	-	-	-	Snow and high water made it impossible to sample most sites
L	CB	2/28/2006	1225	5.9	99%	12.6	39	2	-	
L	CB	3/18/2006	1510	6.6	98%	12	38.3	2	-	
L	na	5/22/2006	1650	11.1	93%	10.2	59.6	1	-	
L	CB	6/20/2006	1810	12.1	98%	10.01	50.6	1	-	
L	CB; SN	8/27/2006	1605	13.7	83%	8.62	67.1	1	0.1	
L	CB; JM	10/23/2006	1545	8.3	86%	10.51	69.1	1	0	
L	CB	1/30/2007	1455	5	99.0%	12.65	18.1	2	0.0	
L	CB; SB	2/28/2007	na	-	-	-	-	-	-	River to high to safely get to sites F, L, and P.
L	CB; SB	3/29/2007	na	-	-	-	-	-	-	Water to high to do sites F, L, and P without tresspassing.
L	CB; SB	5/2/2007	na	-	-	-	-	-	-	Water to high to do sites F, L, and P without tresspassing.
L	CB; SN	5/29/2007	1540	11.9	102.9%	11.1	53.3	1	0	
M	CB	9/2/2005	1425	16.1	90%	8.88	80.4	-	-	
M	CB	9/17/2005	1340	13	91%	9.46	76.3	-	-	
M	CB	10/5/2005	1055	9.9	91%	10.25	58.4	-	-	
M	CB	11/28/2005	1330	4.7	96%	12.43	44.3	2	-	

Site	Sampler	Date	Time	Temp	Oxygen %	Oxygen mg/l	Conductivity	Turbidity	Salinity	Notes
M	CB	12/18/2005	1250	2.6	99%	13.42	45.7	2	-	
M	CB	1/31/2006	na	-	-		-	-	-	Snow and high water made it impossible to sample most sites
M	CB	2/28/2006	1330	5.6	100%	12.5	39	3	-	
M	CB	3/18/2006	1420	6.4	100%	12.4	39	2	-	
M	na	5/22/2006	1710	12.6	98%	10.3	63.8	1	-	
M	CB	6/20/2006	1710	13.6	91%	9.48	59.2	1	-	
M	CB; SN	8/27/2006	1530	17.4	95%	9.18	82	2	0.1	
M	CB; JM	10/23/2006	1445	9.1	95%	10.9	70	1	0	
M	CB	1/30/2007	1345	4.7	97.5%	12.53	30.4	3	0.0	
M	CB; SB	2/28/2007	1400	5.5	98.5%	12.42	37.5	4.0	0.0	
M	CB; SB	3/29/2007	1305	8	98.2%	11.62	42.3	3	0.0	
M	CB; SB	5/2/2007	1325	9.4	98.1%	11.22	42.7	-	0	Turbidity meter stopped working
M	CB; SN	5/29/2007	1424	13.3	106.6%	11.14	58.5	2	0	
N	CB	9/2/2005	1500	16.2	85%	8.4	80.7	-	-	
N	CB	10/6/2005	950	8.3	96%	10.89	53.2	-	-	
O	CB	9/2/2005	1050	14.1	92%	9.59	97.8	-	-	
O	CB	9/17/2005	1127	10.9	97%	10.67	76.4	-	-	
O	CB	10/6/2005	950	10.9	97%	10.67	103	-	-	
O	CB	11/28/2005	1415	5.5	98%	12.37	38.4	1	-	
O	CB	12/18/2005	1540	2.9	98%	13.17	43.7	1	-	

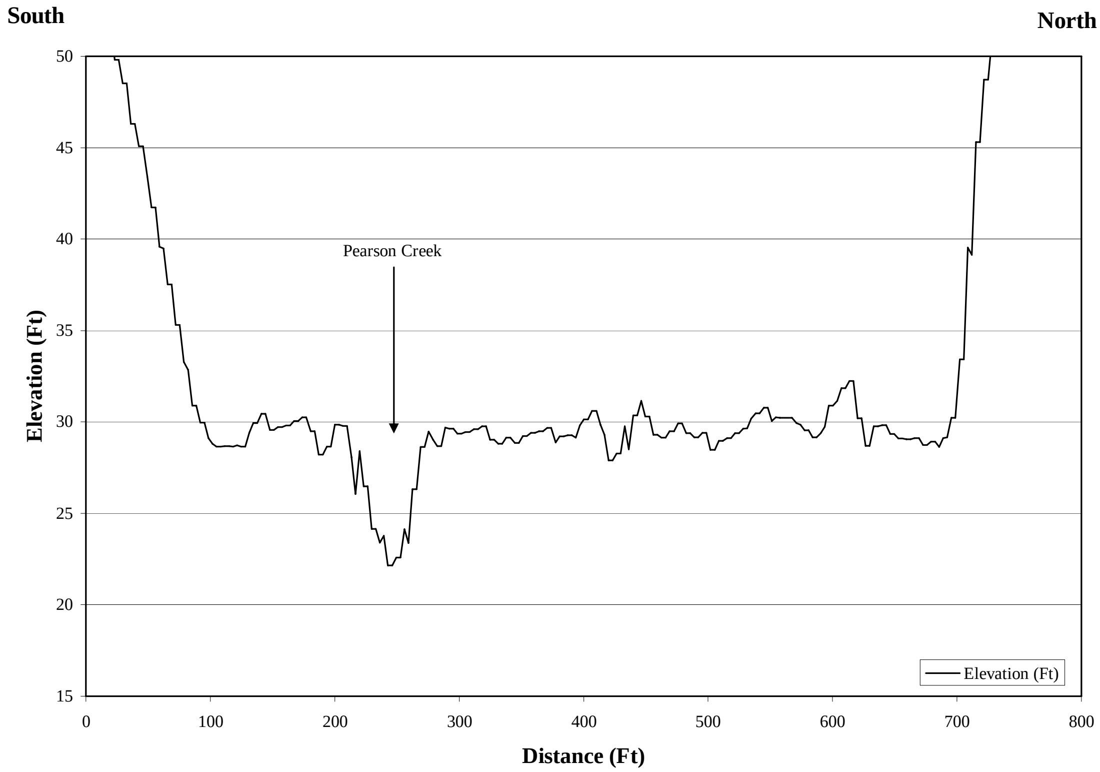
Site	Sampler	Date	Time	Temp	Oxygen %	Oxygen mg/l	Conductivity	Turbidity	Salinity	Notes
O	CB	1/31/2006	na	-	-	-	-	-	-	Snow and high water made it impossible to sample most sites
O	CB	2/28/2006	1500	5.4	99%	12.6	38	2	-	
O	CB	3/18/2006	1620	6.2	101%	12.5	36	1	-	
O	na	5/22/2006	1845	10.1	92%	10.9	59.6	1	-	
O	CB	6/20/2006	1035	11.2	97%	10.39	53.1	1	-	
O	CB; SN	8/27/2006	1545	12.6	95%	10.07	108.3	1	0.1	
O	CB; JM	10/23/2006	1710	8	97%	11.43	96.1	2	0.1	
O	CB	1/30/2007	1650	5	101.1%	12.9	34.2	2	0.0	
O	CB; SB	2/28/2007	1525	4.5	98.3%	12.72	32.3	4.0	0.0	
O	CB; SB	3/29/2007	1430	8.1	100.6%	11.9	35.4	2	0.0	
O	CB; SB	5/2/2007	1446	8.7	98.5%	11.48	35.6	-	0	Turbidity meter stopped working
O	CB; SN	5/29/2007	1545	12.6	90.3%	9.61	56.1	1	0	
P	CB	9/2/2005	1240	15.1	84%	8.46	78.8	-	-	
P	CB	9/17/2005	1235	12.6	86%	9.08	74.7	-	-	
P	CB	10/3/2005	1235	12.6	86%	9.08	74.7	-	-	
P	CB	11/28/2005	1310	4.6	98%	12.65	42.6	2	-	
P	CB	12/18/2005	1405	2.6	100%	13.57	45.5	1	-	
P	CB	1/31/2006	na	-	-	-	-	-	-	Snow and high water made it impossible to sample most sites
P	CB	2/28/2006	1230	5.6	100%	12.5	39	3	-	
P	CB	3/18/2006	1515	6.2	99%	12	38.3	2	-	

Site	Sampler	Date	Time	Temp	Oxygen %	Oxygen mg/l	Conductivity	Turbidity	Salinity	Notes
P	na	5/22/2006	1655	12.2	93%	10.3	67.2	1	-	
P	CB	6/20/2006	1830	12.9	94%	10.01	50.86	1	-	
P	CB; SN	8/27/2006	1615	15.5	88%	8.78	79.6	1	0.1	
P	CB; JM	10/23/2006	1550	9	92%	10.62	70.2	1	0	
P	CB; SB	1/30/2007	na	-	-	-	-	-	-	
P	CB; SB	2/28/2007	na	-	-	-	-	-	-	River to high to safely get to sites F, L, and P.
P	CB; SB	3/29/2007	na	-	-	-	-	-	-	Water to high to do sites F, L, and P without tresspassing.
P	CB; SB	5/2/2007	na	-	-	-	-	-	-	Water to high to do sites F, L, and P without tresspassing.
P	CB; SN	5/29/2007	1535	12.9	104.0%	10.99	58.1	1	0	
Q1	CB	9/2/2005	na	-	-	-	-	-	-	
Q1	CB	9/17/2005	1315	10.3	100%	11.2	55	-	-	
Q1	CB	10/3/2005	na	-	-	-	-	-	-	
Q1	CB	11/28/2005	na	-	-	-	-	-	-	Could not collect Q1 and Q2 due to snow
Q1	CB	12/20/2005	1330	7.1	115%	13.92	35.1	4	-	
Q1	CB	1/31/2006	na	-	-	-	-	-	-	Snow and high water made it impossible to sample most sites
Q1	CB	2/28/2006	1210	4.3	102%	13.21	40.3	2	-	
Q1	CB	3/18/2006	1220	5.4	91%	11.55	33.9	2	-	
Q1	na	5/22/2006	1440	10.5	109%	12.17	53.3	1	-	
Q1	CB	6/20/2006	1500	11.8	98%	10.64	50.4	1	-	

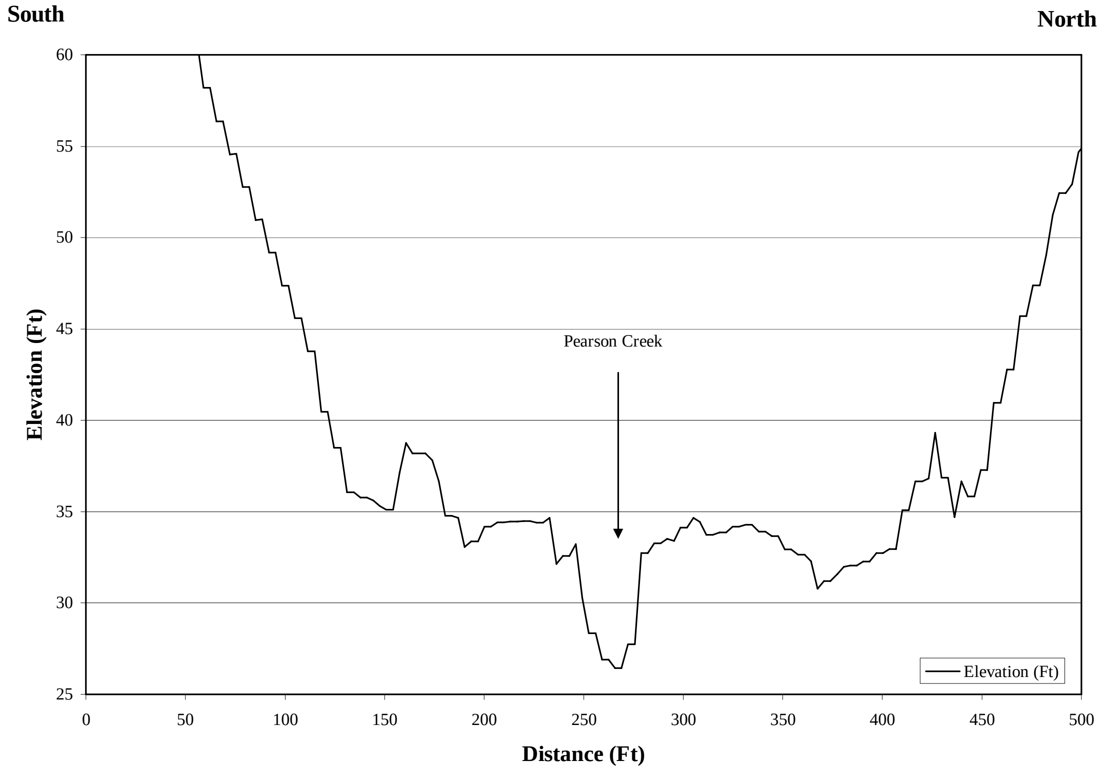
Site	Sampler	Date	Time	Temp	Oxygen %	Oxygen mg/l	Conductivity	Turbidity	Salinity	Notes
Q1	CB; SN	8/27/2006	na	-	-	-	-	-	-	DNR Road 1000 was closed, unable to reach 2 upper sites (Q1 and Q2)
Q1	CB; JM	10/23/2006	1145	7.4	98%	11.77	58.9	1	0	
Q1	CB	1/30/2007	1135	4.5	94.0%	12.1	39.7	1	0.0	
Q1	CB; SB	2/28/2007	1110	4.5	97.7%	12.64	33.2	3.0	0.0	
Q1	CB; SB	3/29/2007	1045	6.7	100.5%	12.29	34.3	1	0.0	
Q1	CB; SB	5/2/2007	1110	7.5	98.5%	11.79	37.4	1	0	
Q1	CB; SN	5/29/2007	1215	9.5	102.7%	11.72	46.6	1	0	
Q2	CB	9/2/2005	na	-	-	-	-	-	-	
Q2	CB	9/17/2005	1400	10.5	100%	11.1	63	-	-	
Q2	CB	10/3/2005	na	-	-	-	-	-	-	
Q2	CB	11/28/2005	na	-	-	-	-	-	-	Could not collect Q1 and Q2 due to snow
Q2	CB	12/20/2005	1350	7.1	106%	12.78	34.3	4	-	
Q2	CB	1/31/2006	na	-	-	-	-	-	-	Snow and high water made it impossible to sample most sites
Q2	CB	2/28/2006	1220	4.5	121%	15.64	39.2	2	-	
Q2	CB	3/18/2006	1220	5.4	91%	11.55	33.9	2	-	
Q2	na	5/22/2006	1440	10.2	101%	11.27	51.5	1	-	
Q2	CB	6/20/2006	1515	11.8	97%	10.52	50.3	1	-	
Q2	CB; SN	8/27/2006	na	-	-	-	-	-	-	DNR Road 1000 was closed, unable to reach 2 upper sites (Q1 and Q2)

Site	Sampler	Date	Time	Temp	Oxygen %	Oxygen mg/l	Conductivity	Turbidity	Salinity	Notes
Q2	CB; JM	10/23/2006	1150	7.4	102%	12.25	57	1	0	
Q2	CB	1/30/2007	1130	4.4	93.0%	12.05	35.5	1	0.0	
Q2	CB; SB	2/28/2007	1130	4.4	97.3%	12.62	30.9	2.0	0.0	
Q2	CB; SB	3/29/2007	1055	6.6	101.6%	12.45	37.2	1	0.0	
Q2	CB; SB	5/2/2007	1120	7.5	99.0%	11.86	36.9	1	0	
Q2	CB; SN	5/29/2007	1205	9.1	106.0%	12.21	45.8	1	0	

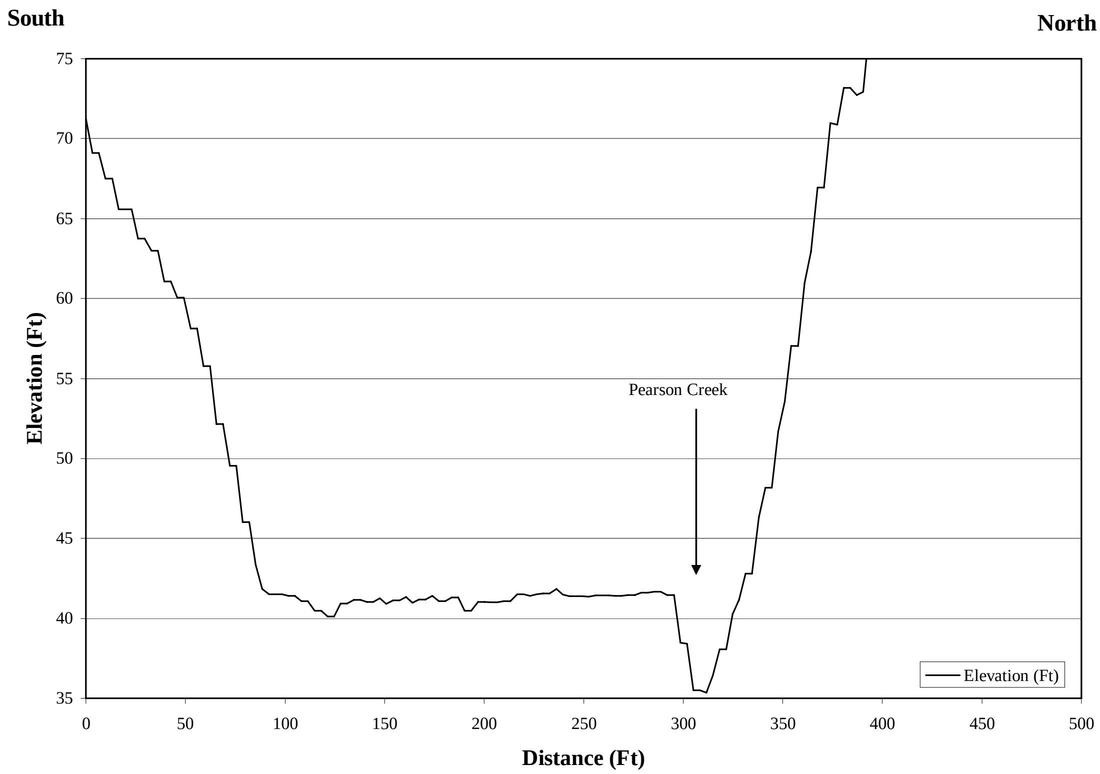
Appendix G- Clallam River Tributary Cross-Sections



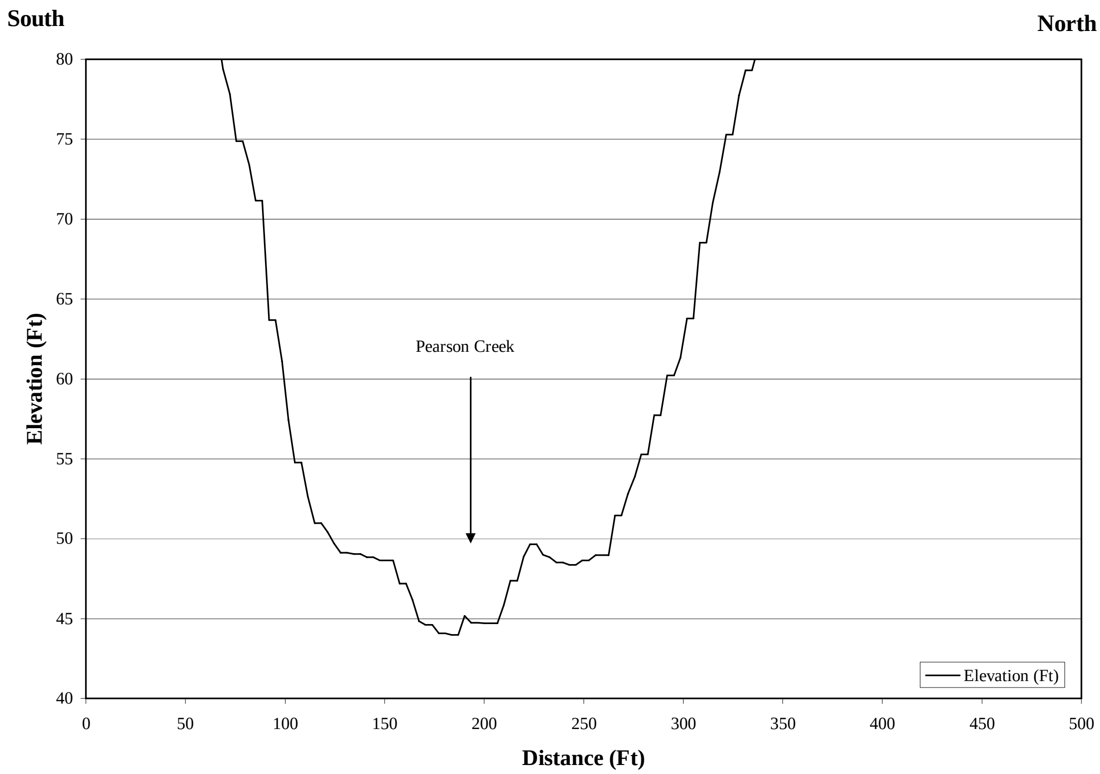
APP G-Figure 1. Pearson Creek cross-section Segment 1, RM 0.5.



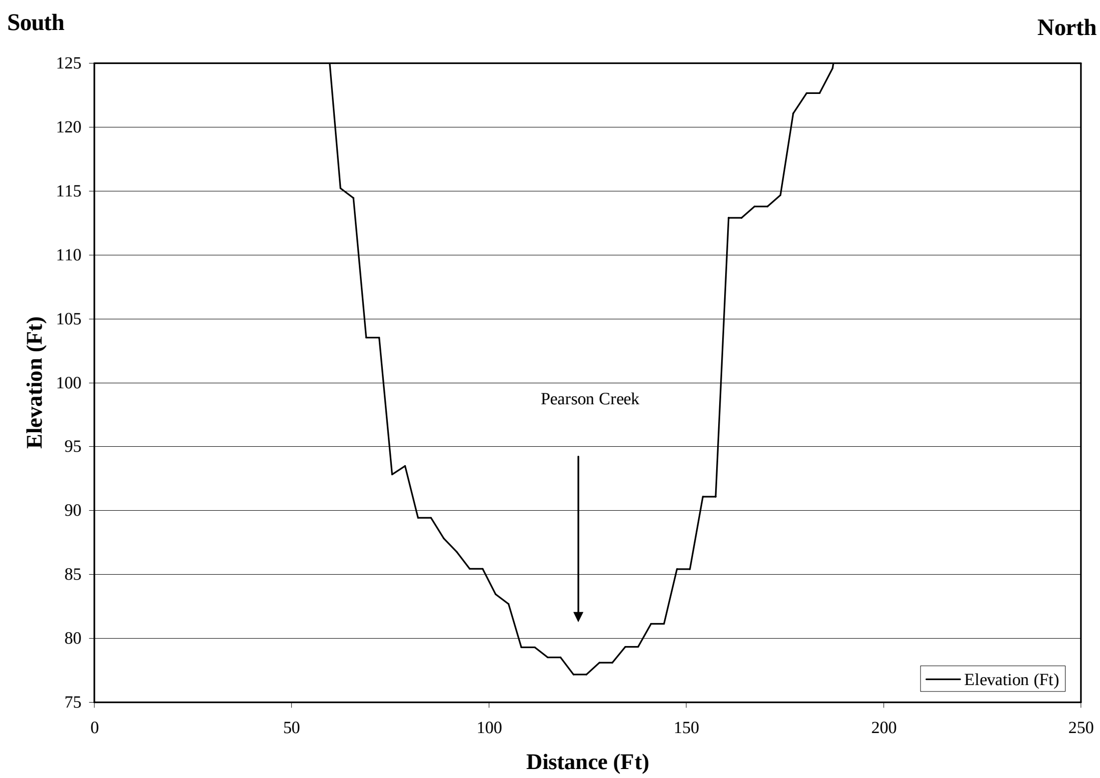
APP G-Figure 2. Pearson Creek cross-section Segment 1, RM 0.7.



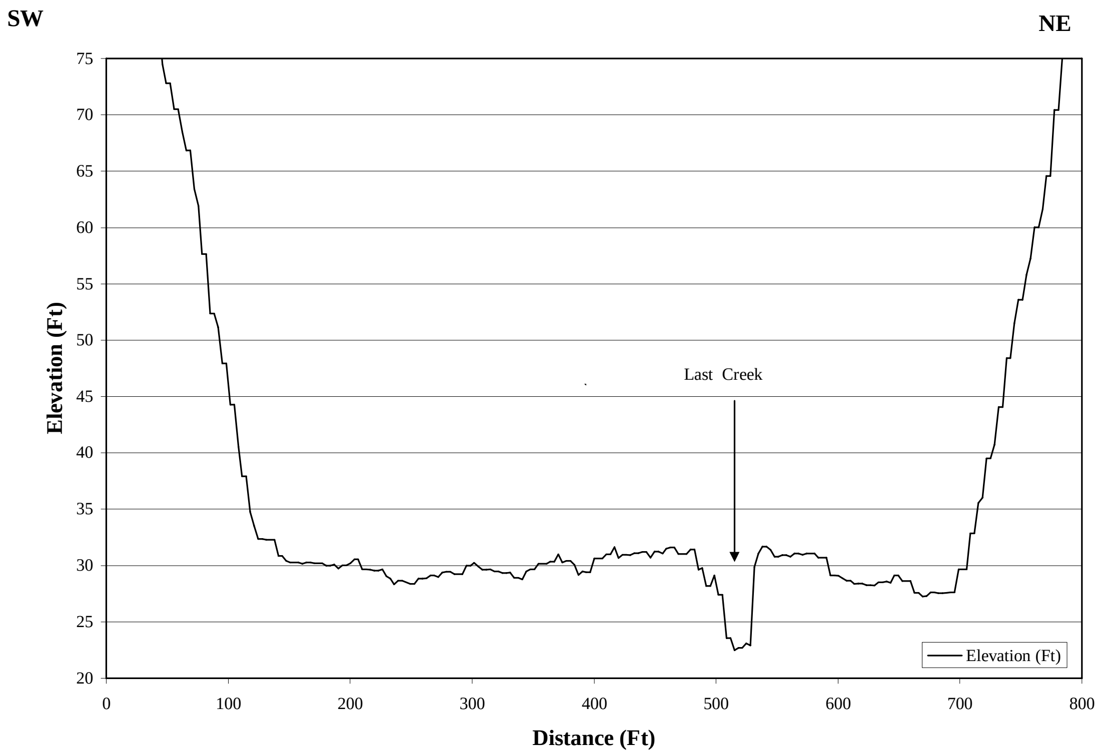
APP G-Figure 3. Pearson Creek cross-section Segment 2, RM 1.1.



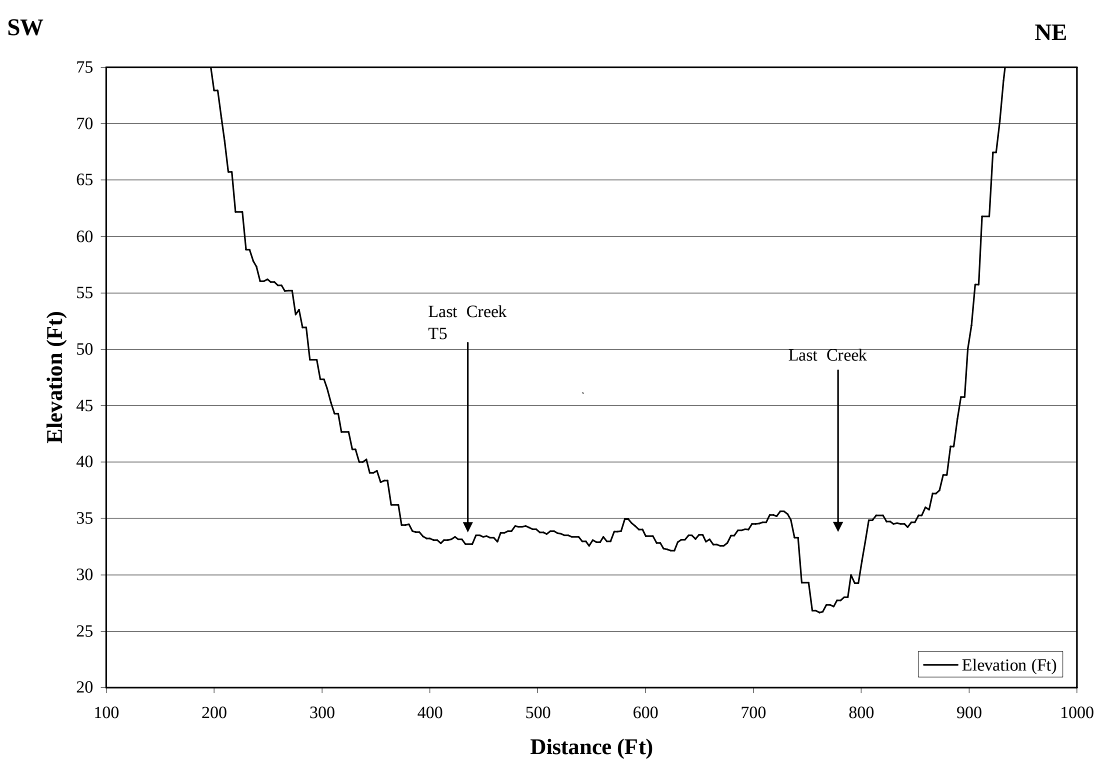
APP G-Figure 4. Pearson Creek cross-section Segment 2, RM 1.4.



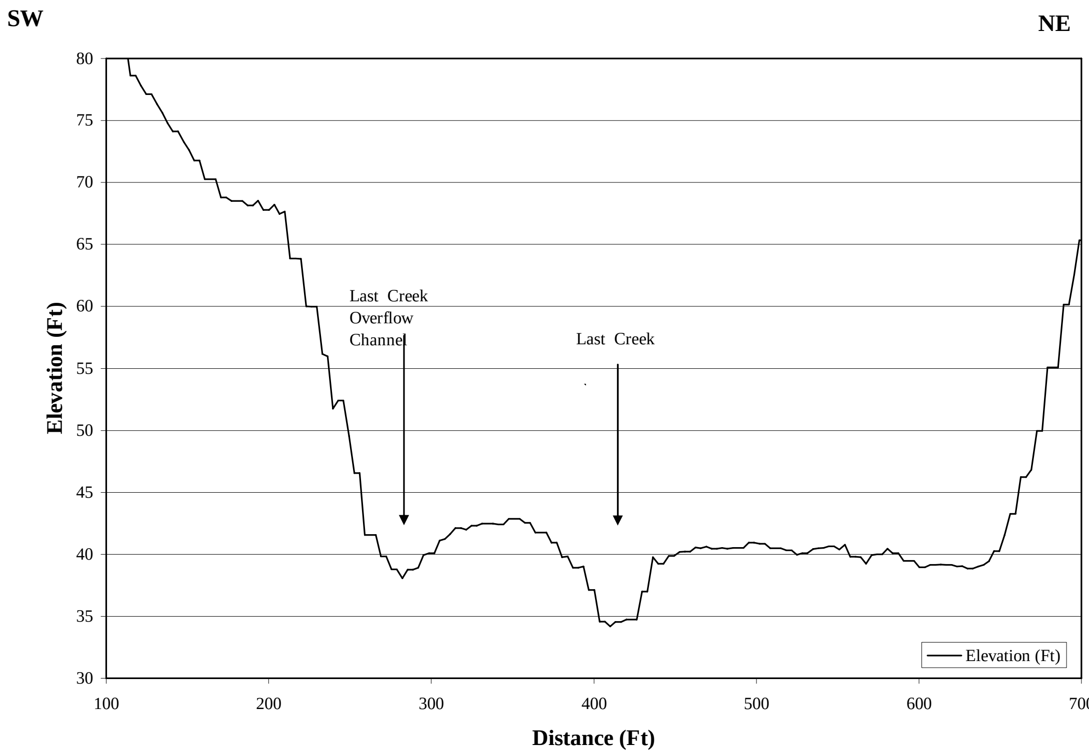
APP G-Figure 5. Pearson Creek cross-section Segment 3, RM 1.7.



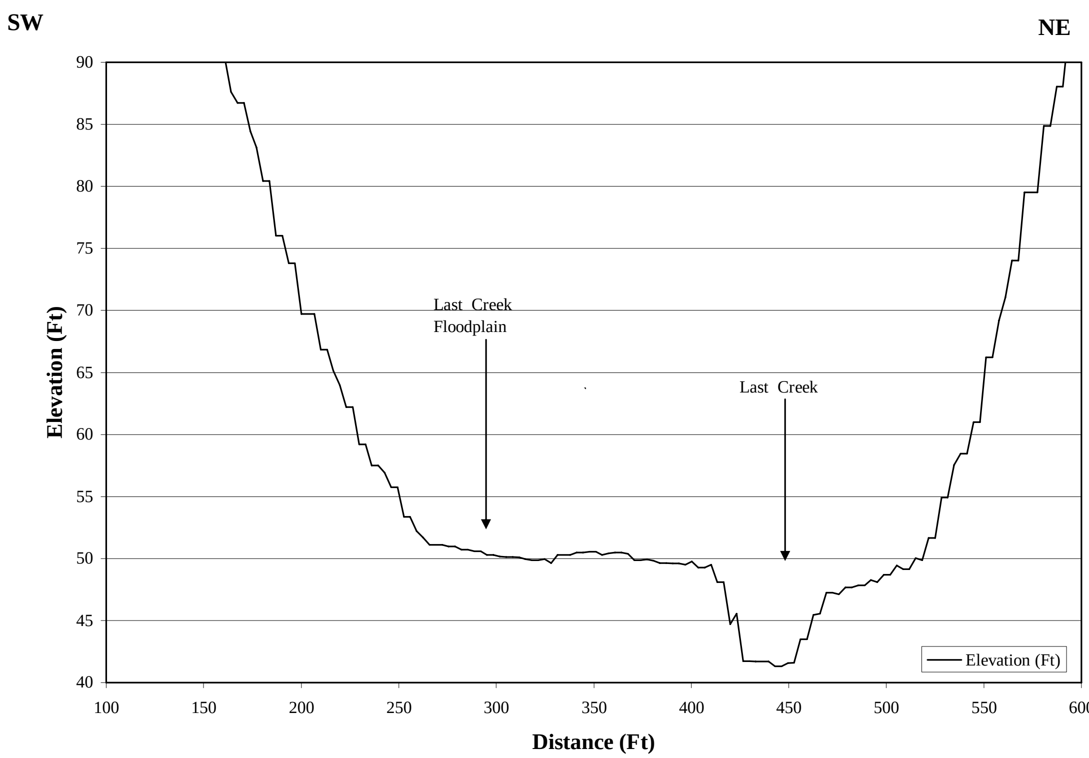
APP G-Figure 6. Last Creek cross-section Segment 1, RM 0.4.



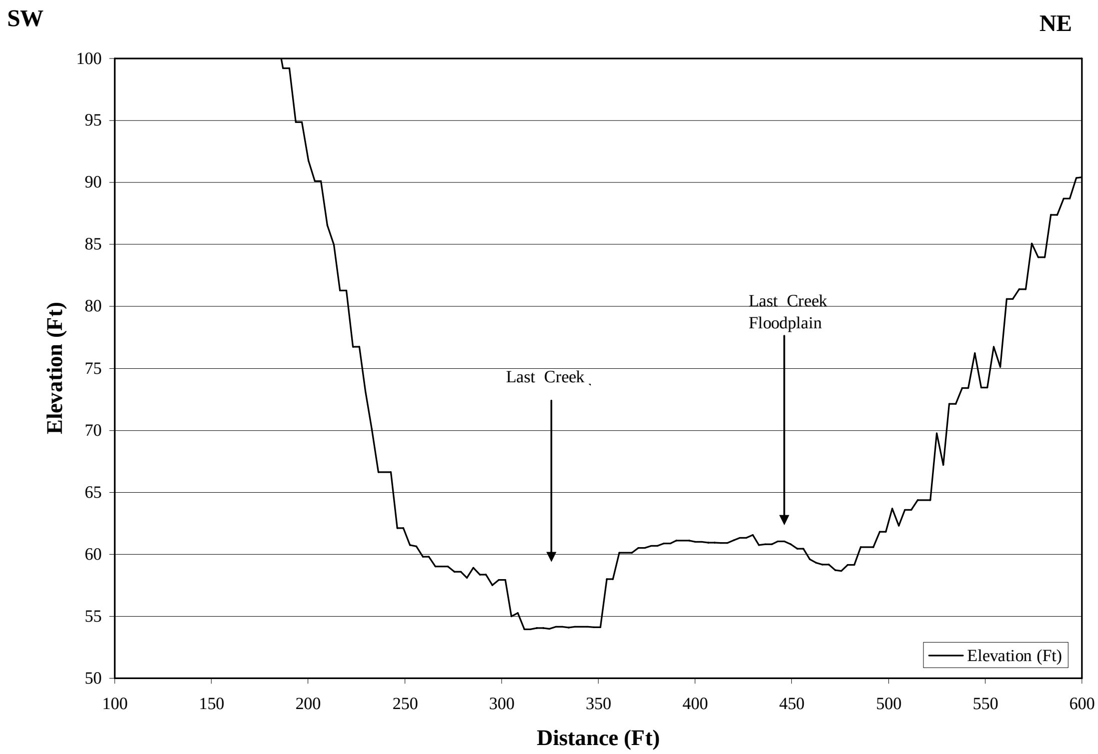
APP G-Figure 7. Last Creek cross-section Segment 1, RM 0.8.



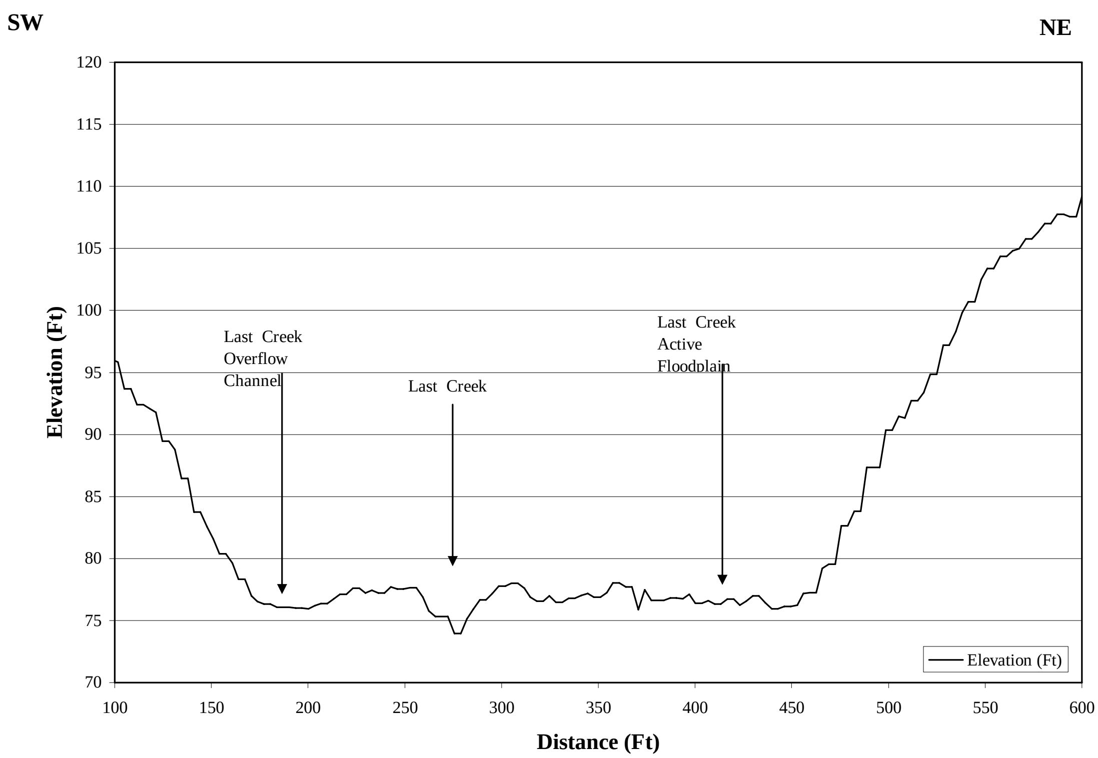
APP G-Figure 8. Last Creek cross-section Segment 1, RM 1.4.



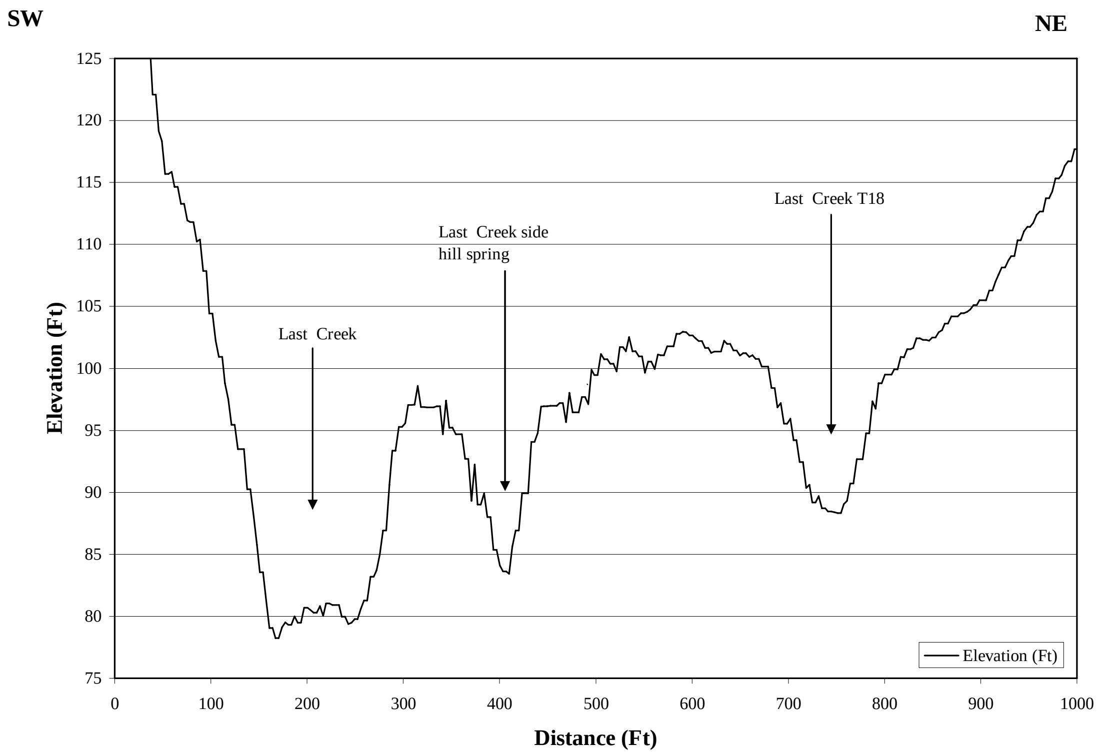
APP G-Figure 9. Last Creek cross-section Segment 2, RM 2.0.



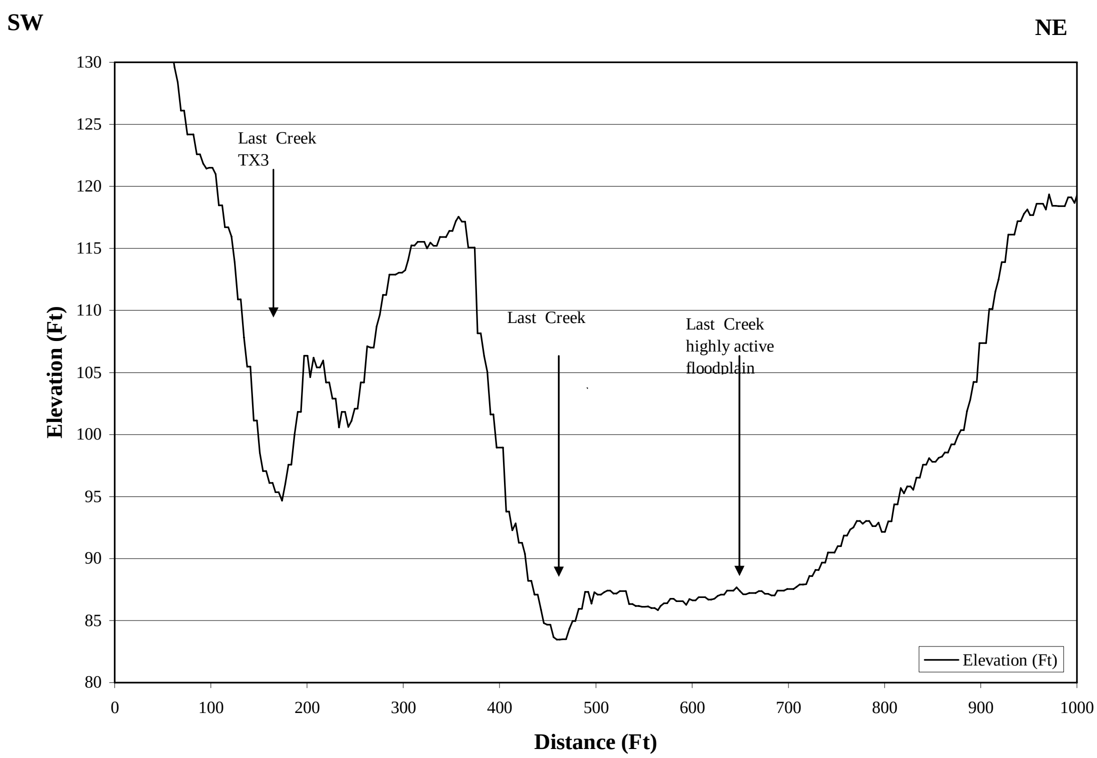
APP G-Figure 10. Last Creek cross-section Segment 2, RM 2.6.



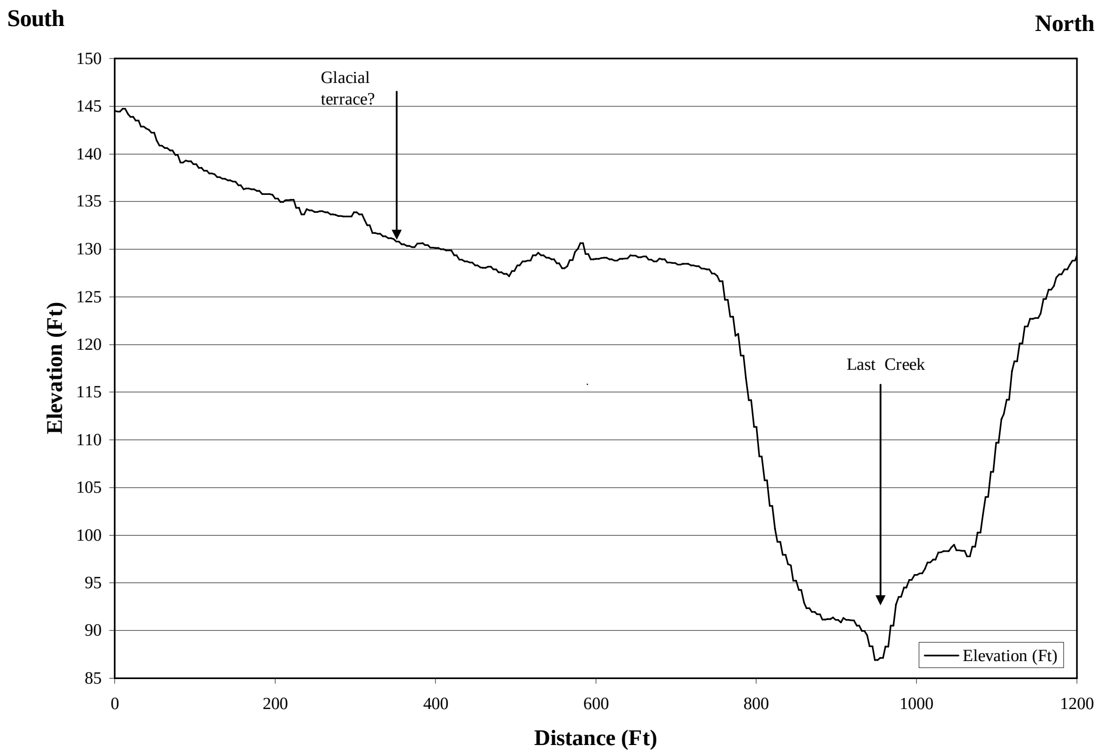
APP G-Figure 11. Last Creek cross-section Segment 3, RM 3.44.



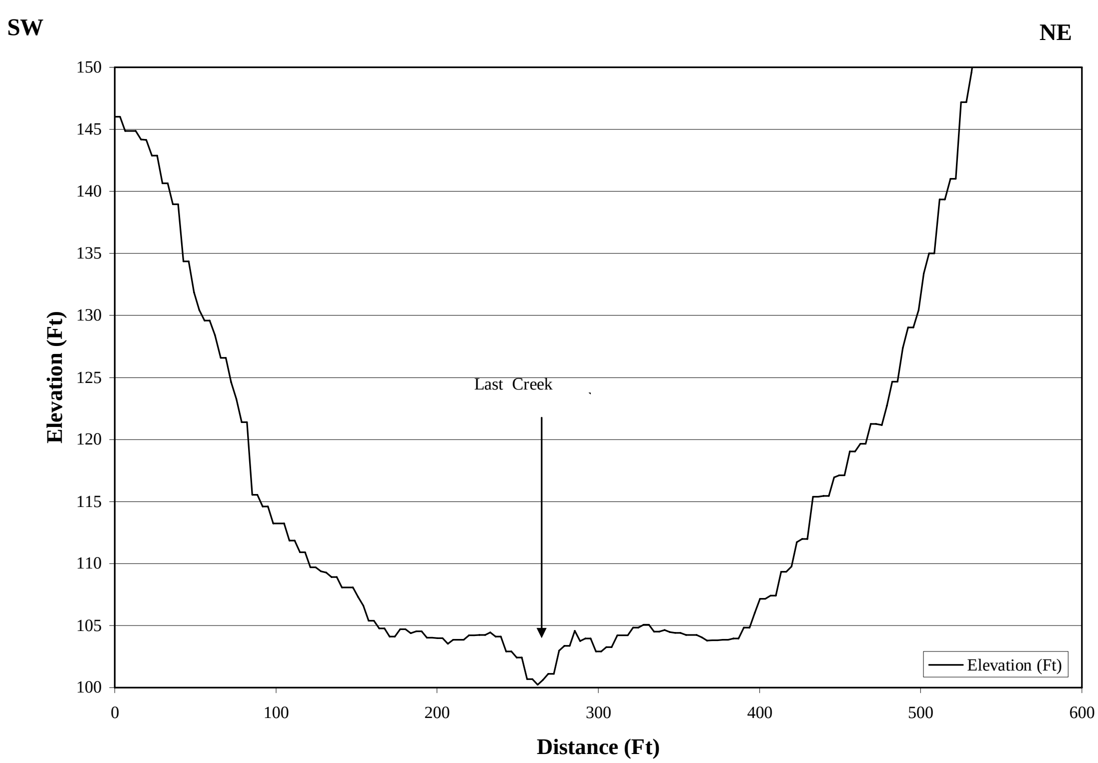
APP G-Figure 12. Last Creek cross-section Segment 3, RM 3.7.



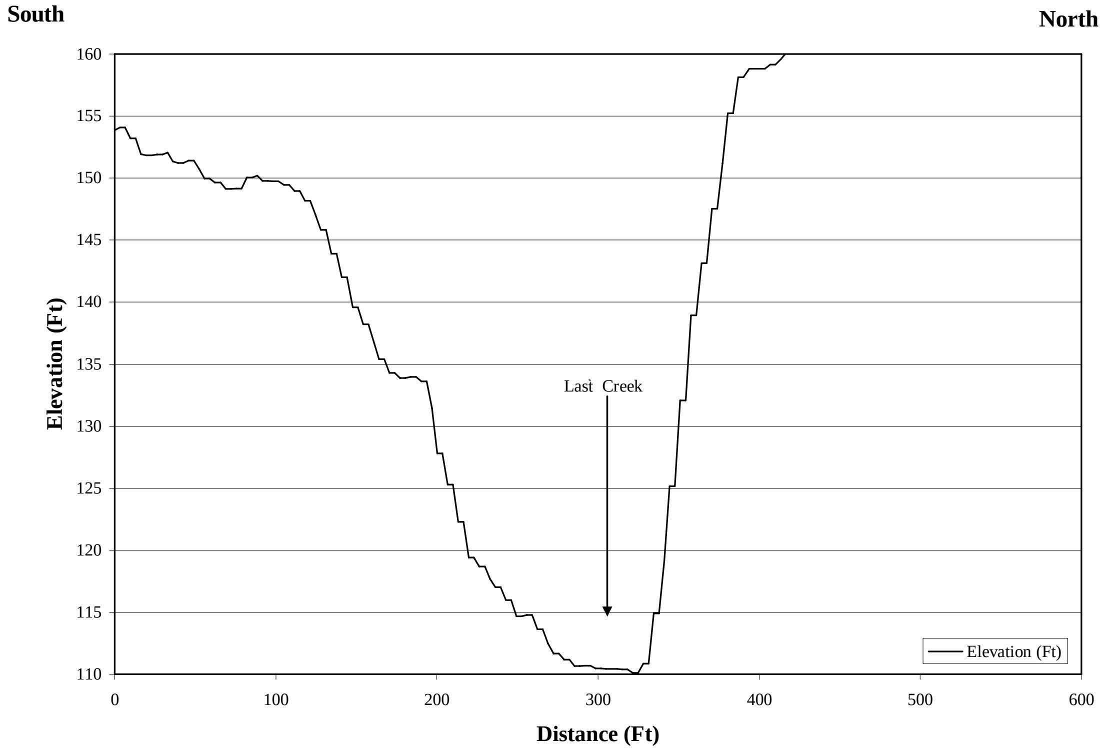
APP G-Figure 13. Last Creek cross-section Segment 3, RM 3.9.



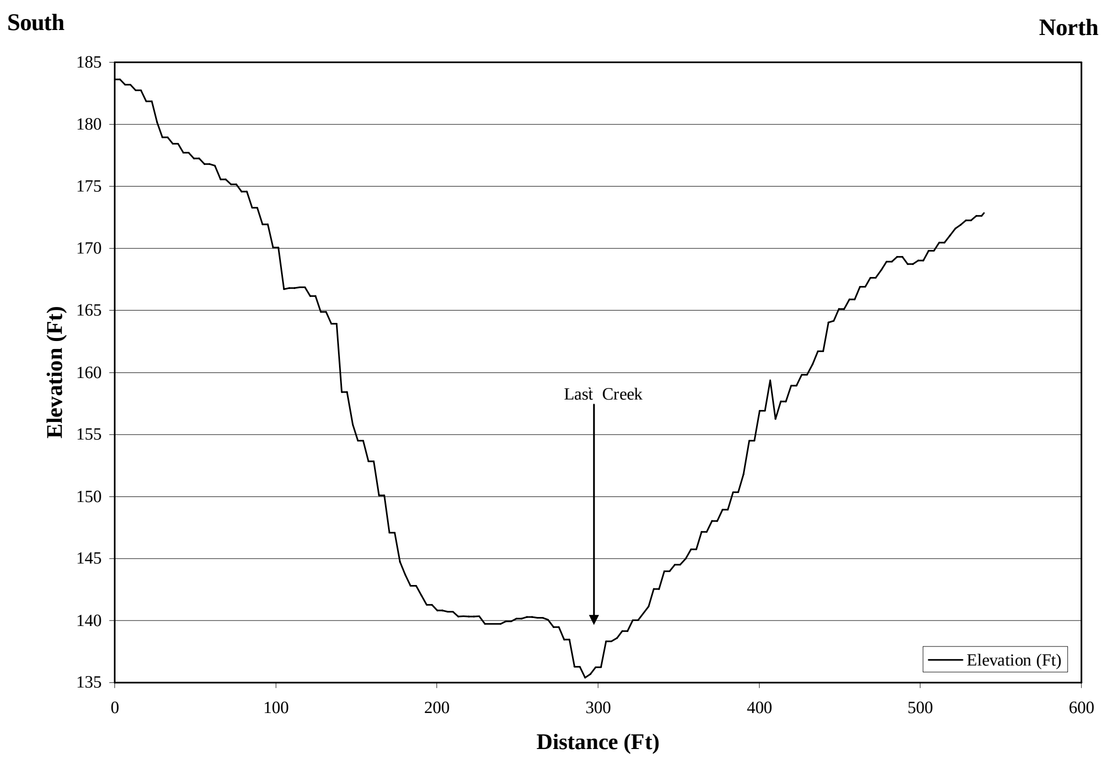
APP G-Figure 14. Last Creek cross-section Segment 4, RM 4.1.



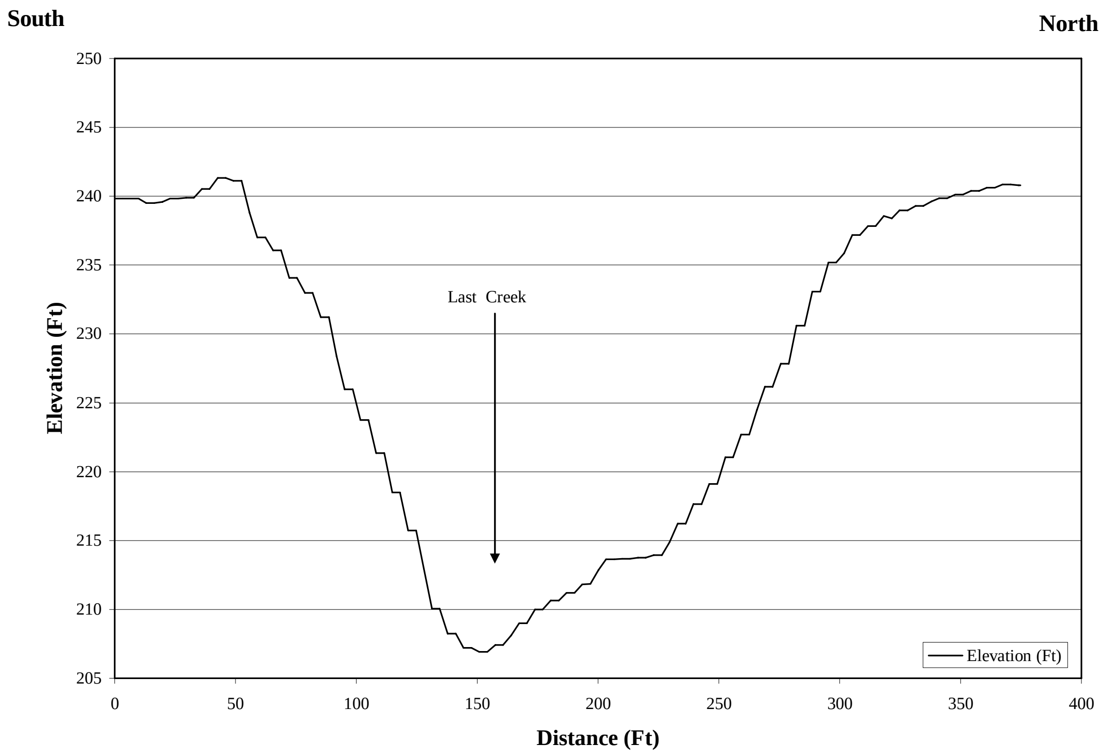
APP G-Figure 15. Last Creek cross-section Segment 4, RM 4.4.



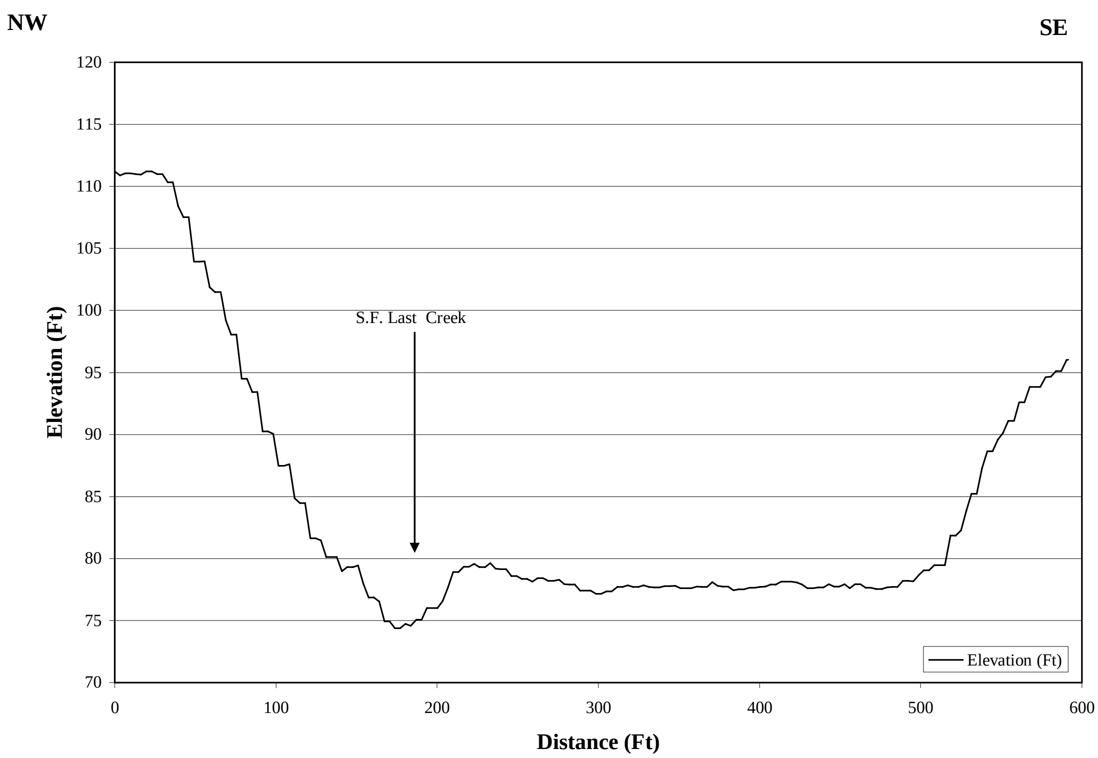
APP G-Figure 16. Last Creek cross-section Segment 4, RM 4.7.



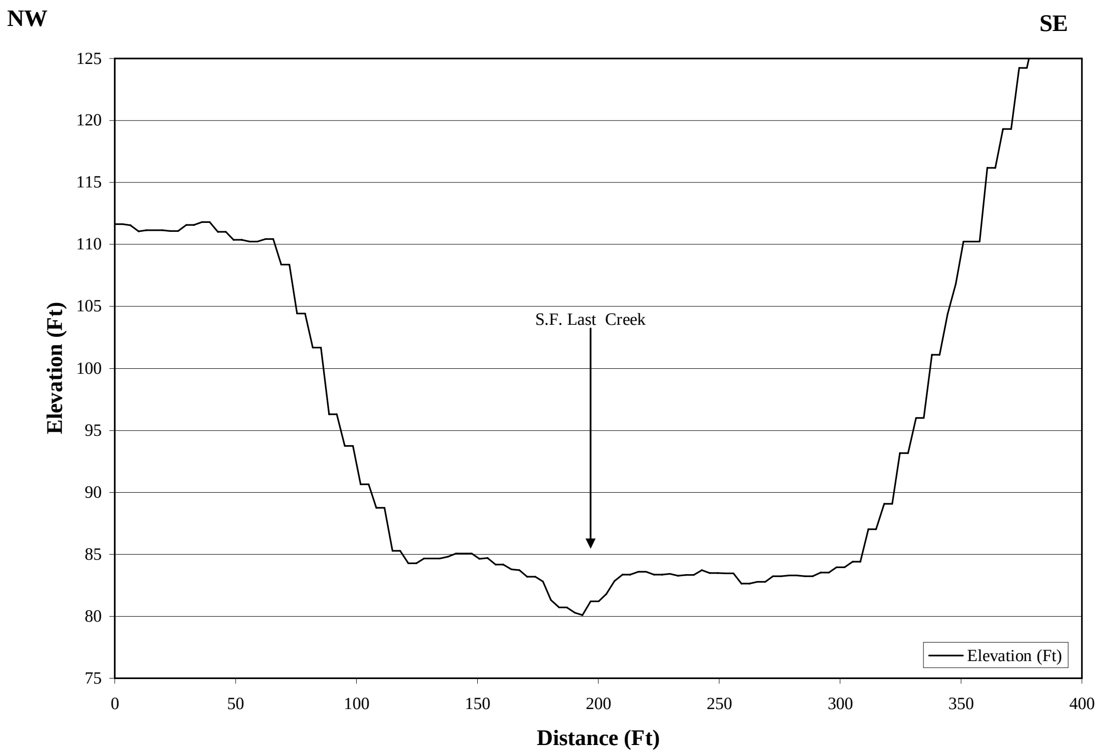
APP G-Figure 17. Last Creek cross-section Segment 5, RM 5.0.



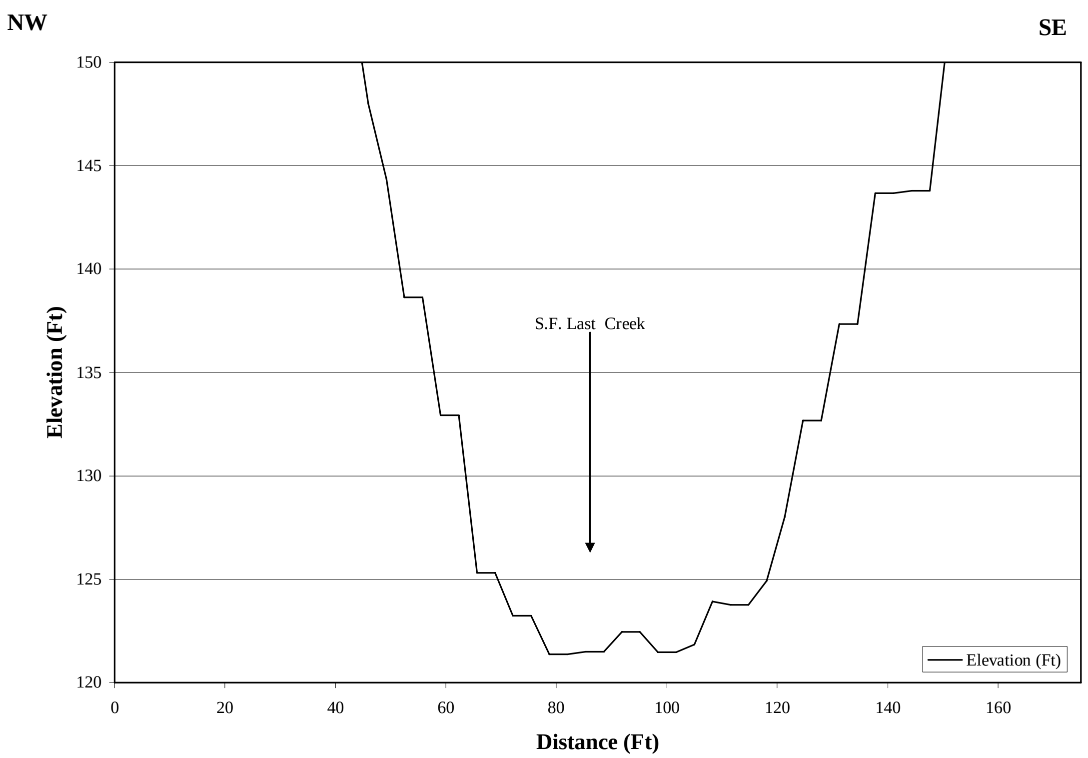
APP G-Figure 18. Last Creek cross-section Segment 6, RM 5.8.



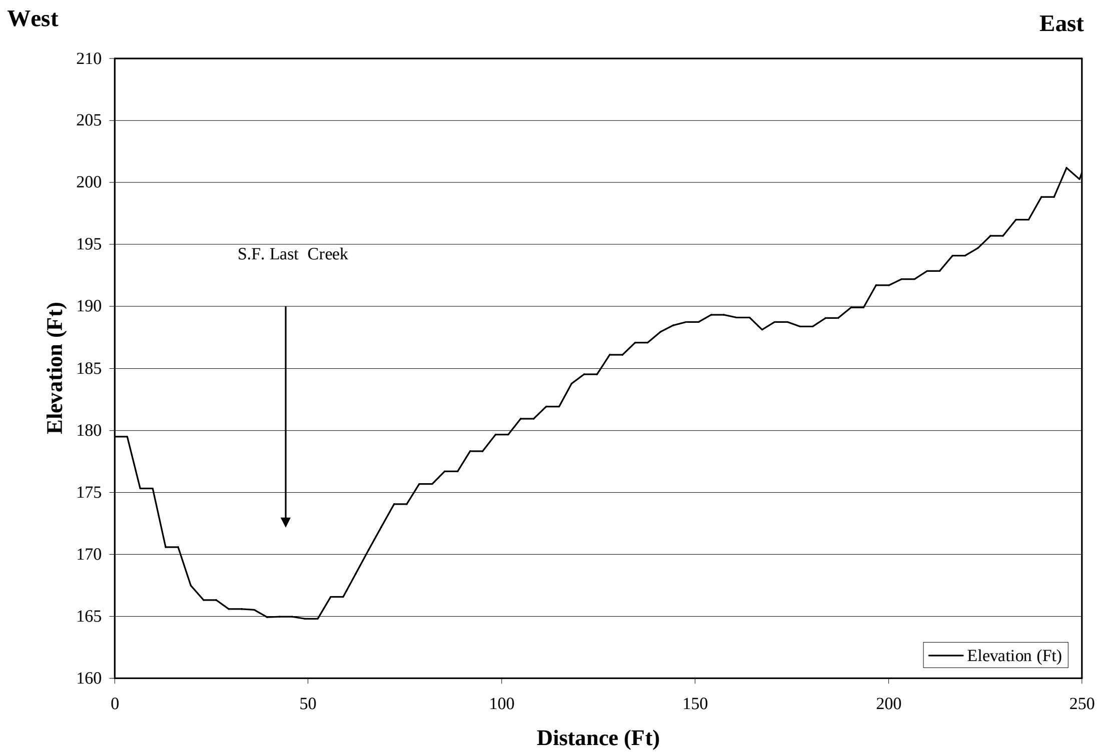
APP G-Figure 19. S.F. Last Creek cross-section Segment 1, RM 0.1.



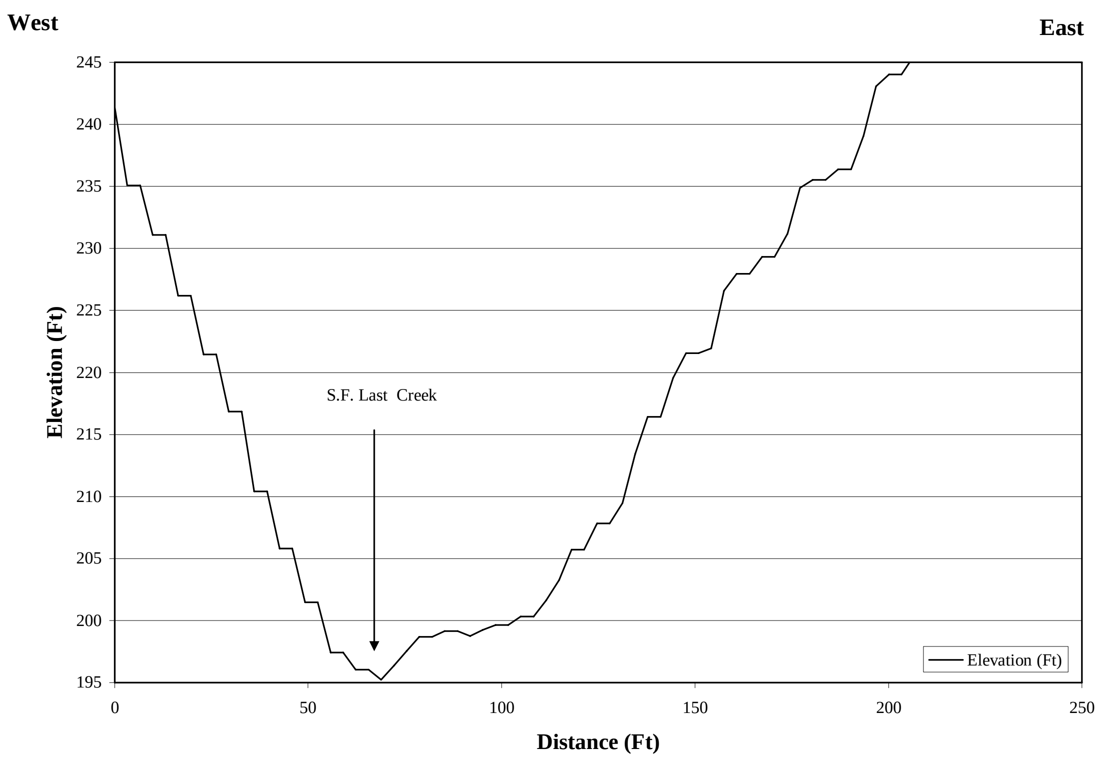
APP G-Figure 20. S.F. Last Creek cross-section Segment 1, RM 0.2.



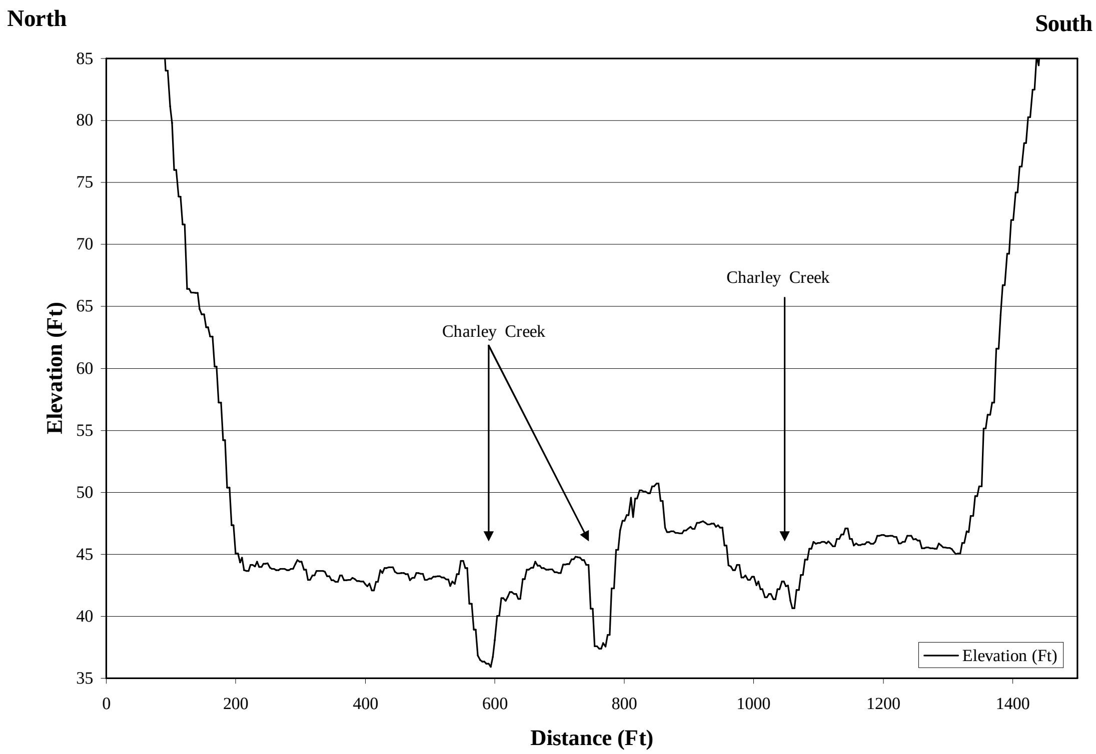
APP G-Figure 21. S.F. Last Creek cross-section Segment 3, RM 0.4.



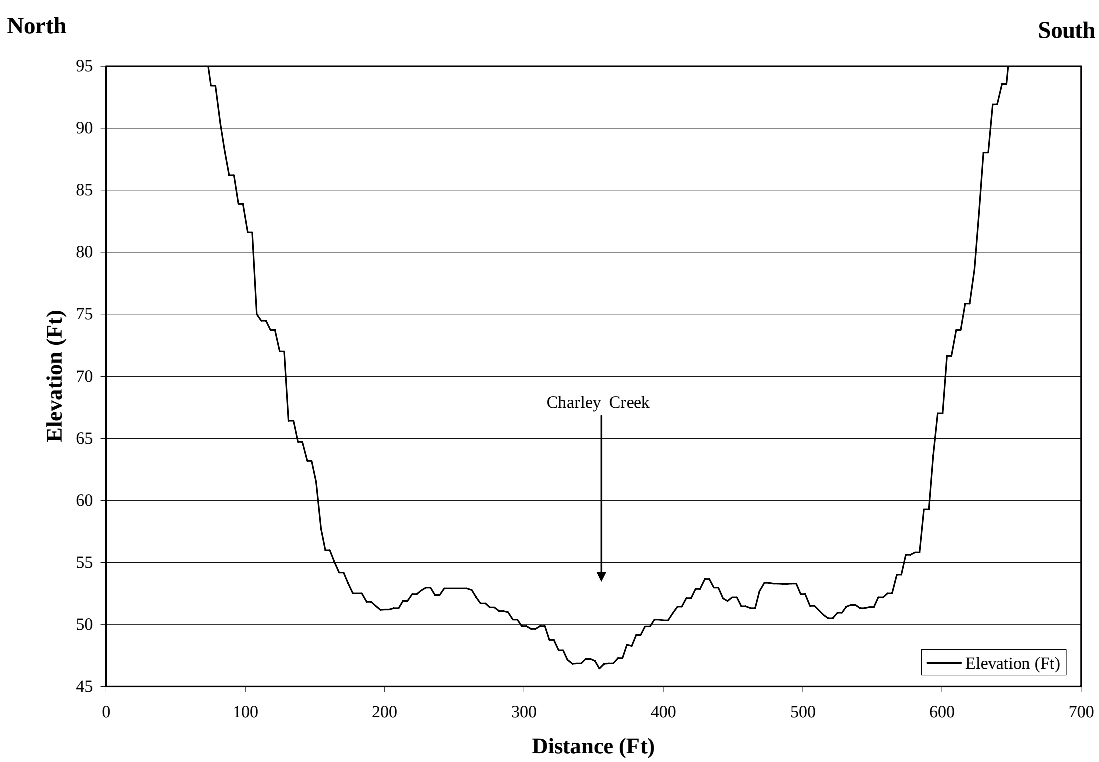
APP G-Figure 22. S.F. Last Creek cross-section Segment 4, RM 0.6.



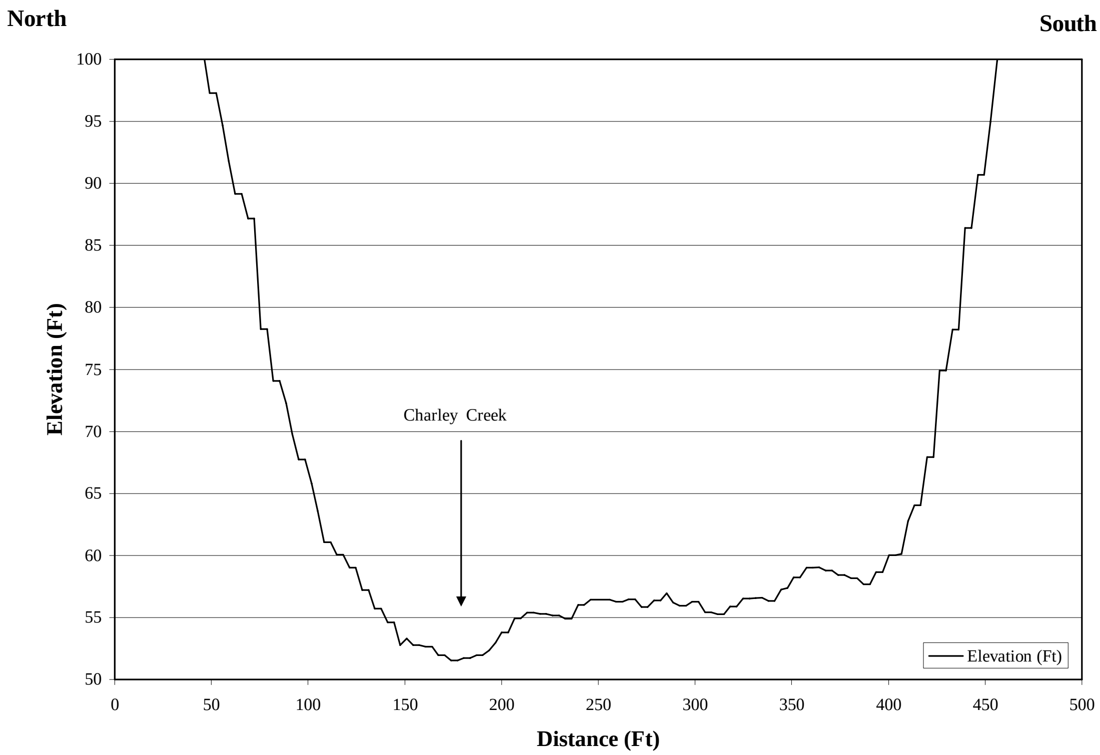
APP G-Figure 23. S.F. Last Creek cross-section Segment 5, RM 0.8.



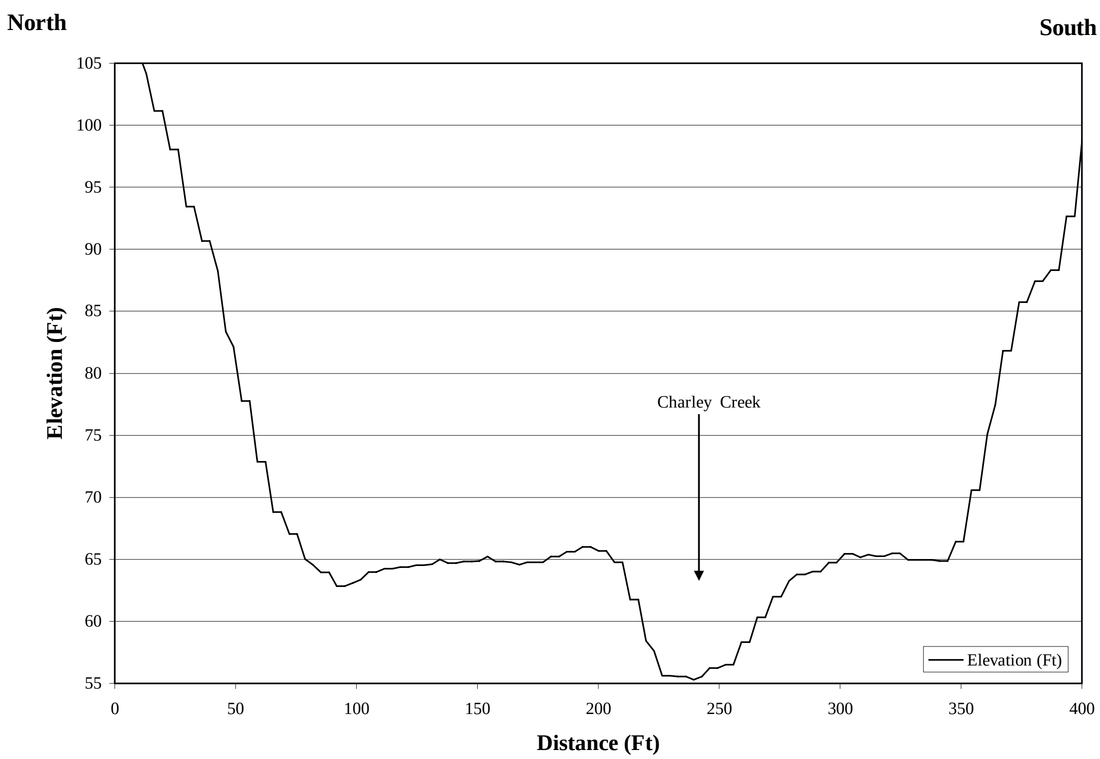
APP G-Figure 24. Charley Creek cross-section Segment 1 and 2, intersects stream at RM 0.23, 0.30, and 0.41.



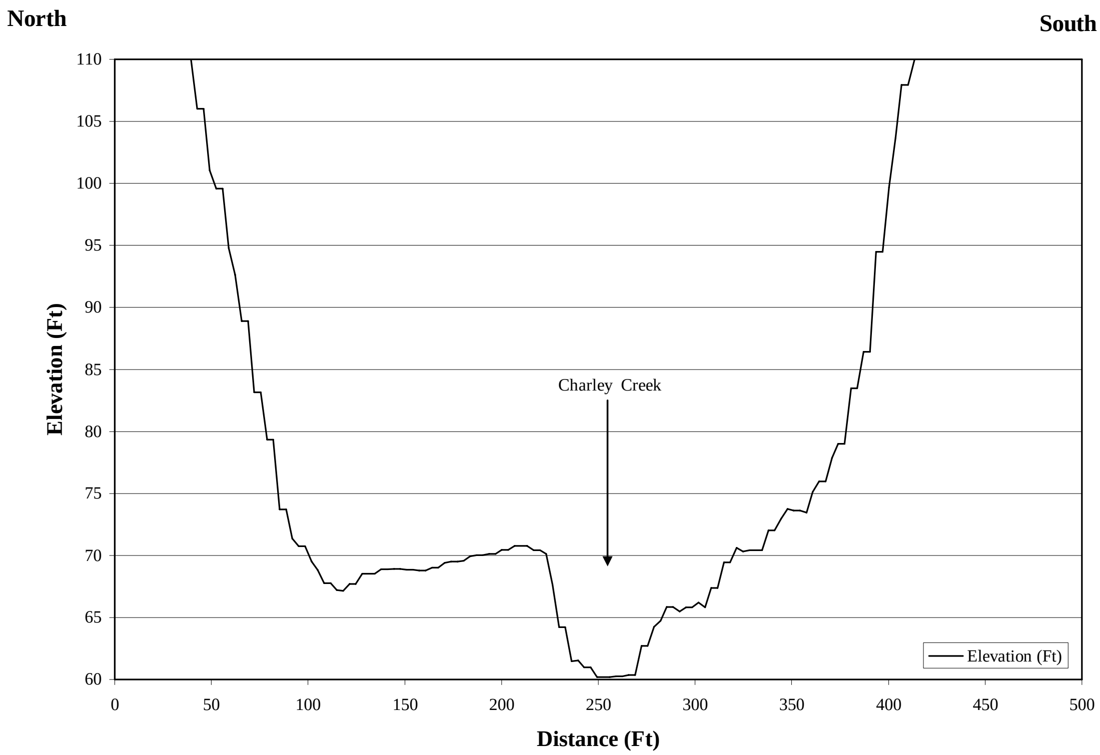
APP G-Figure 25. Charley Creek cross-section Segment 2, RM 0.6.



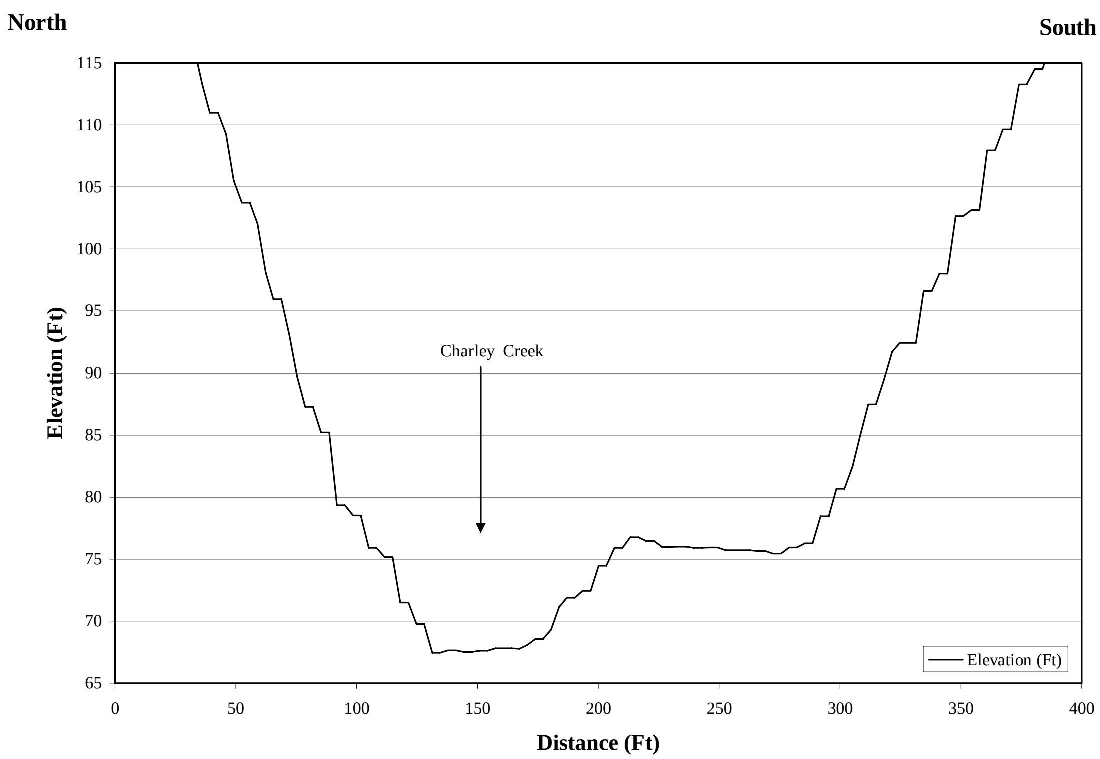
APP G-Figure 26. Charley Creek cross-section Segment 2, RM 0.8.



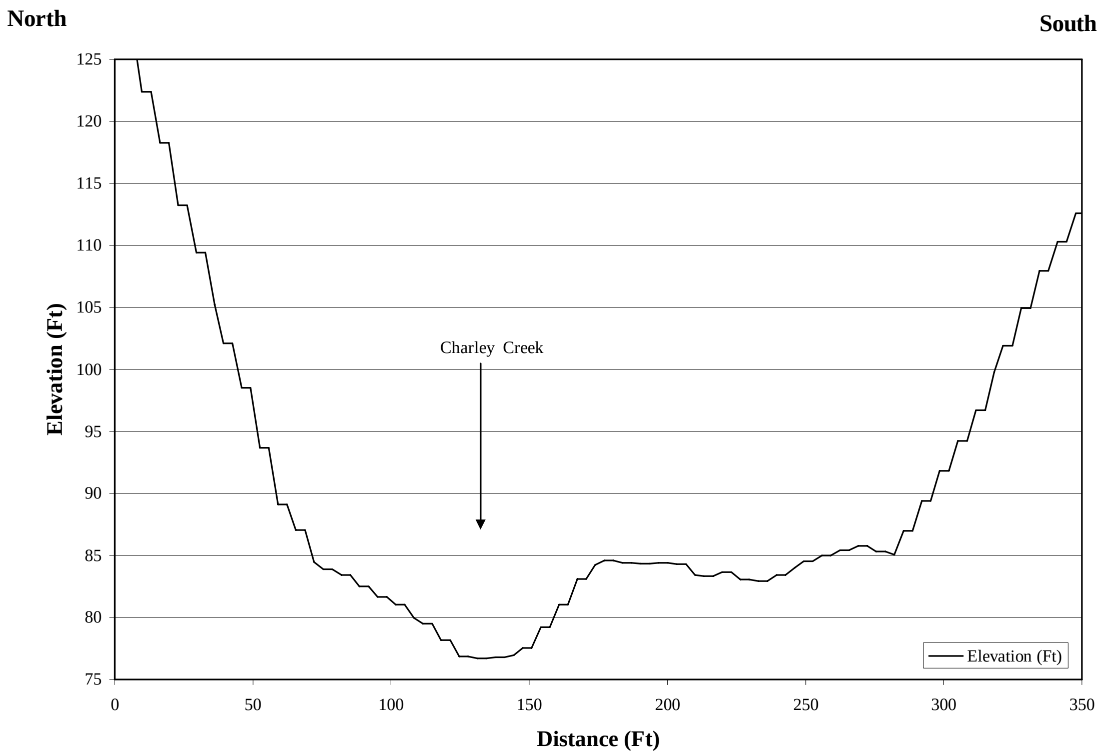
APP G-Figure 27. Charley Creek cross-section Segment 2, RM 0.95.



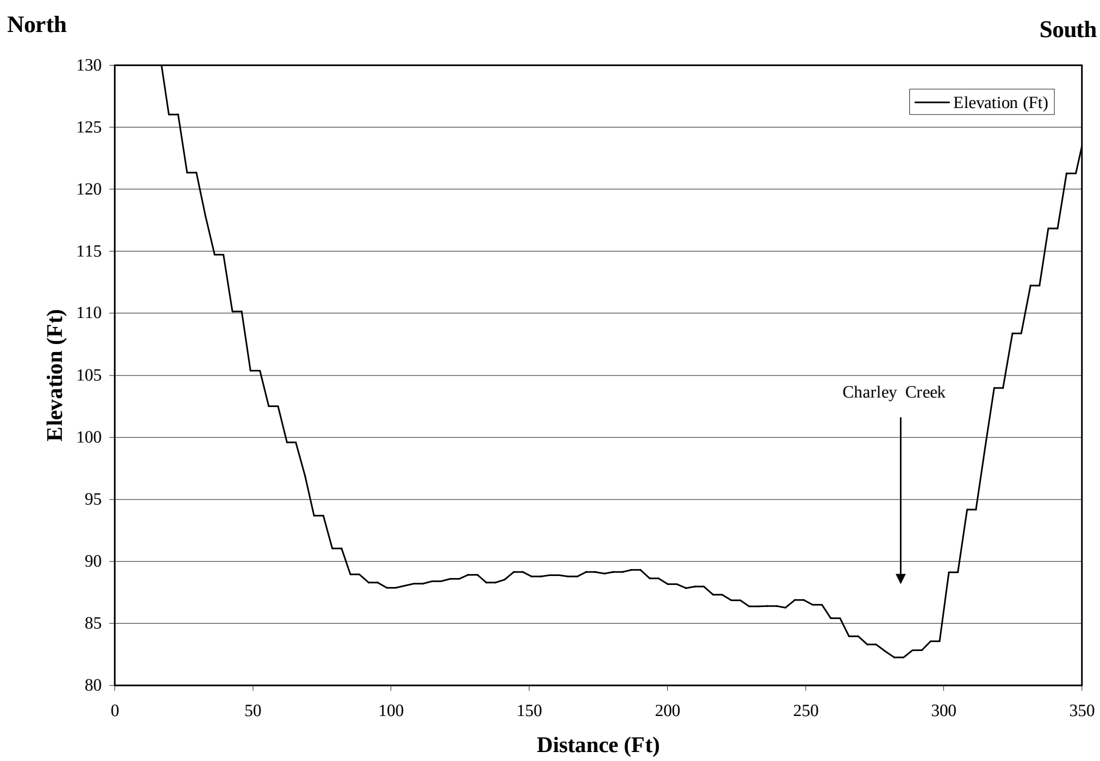
APP G-Figure 28. Charley Creek cross-section Segment 2, RM 1.1.



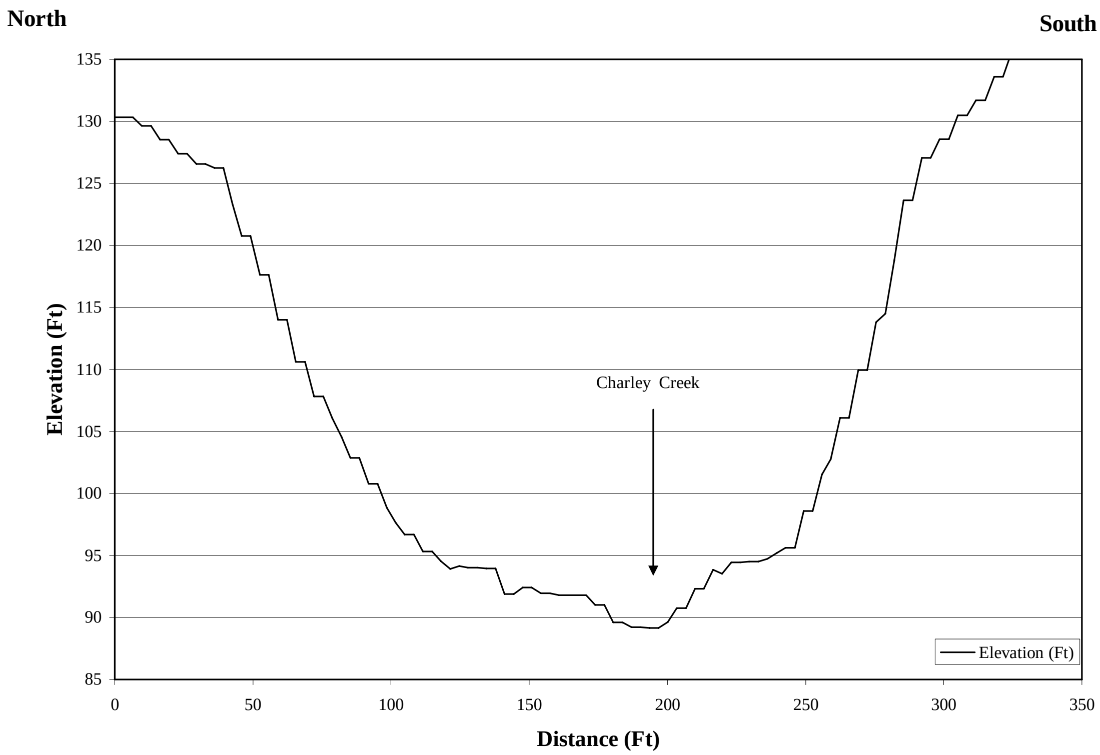
APP G-Figure 29. Charley Creek cross-section Segment 2, RM 1.26.



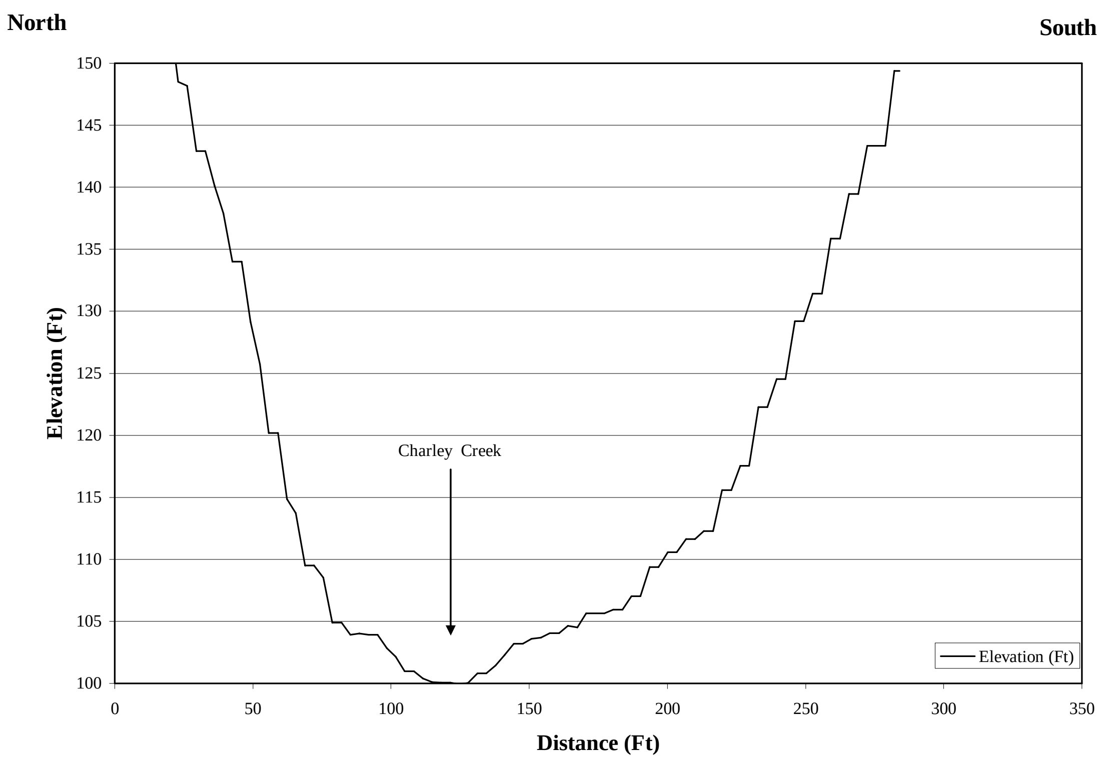
APP G-Figure 30. Charley Creek cross-section Segment 3, RM 1.41.



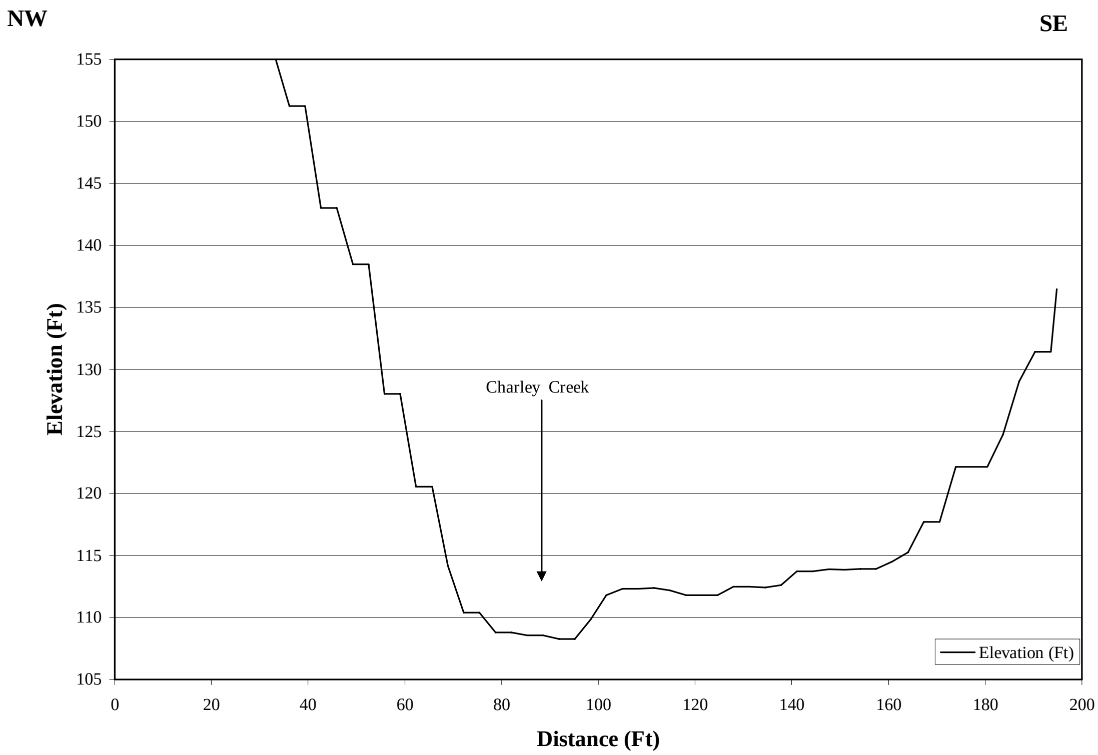
APP G-Figure 31. Charley Creek cross-section Segment 4, RM 1.56.



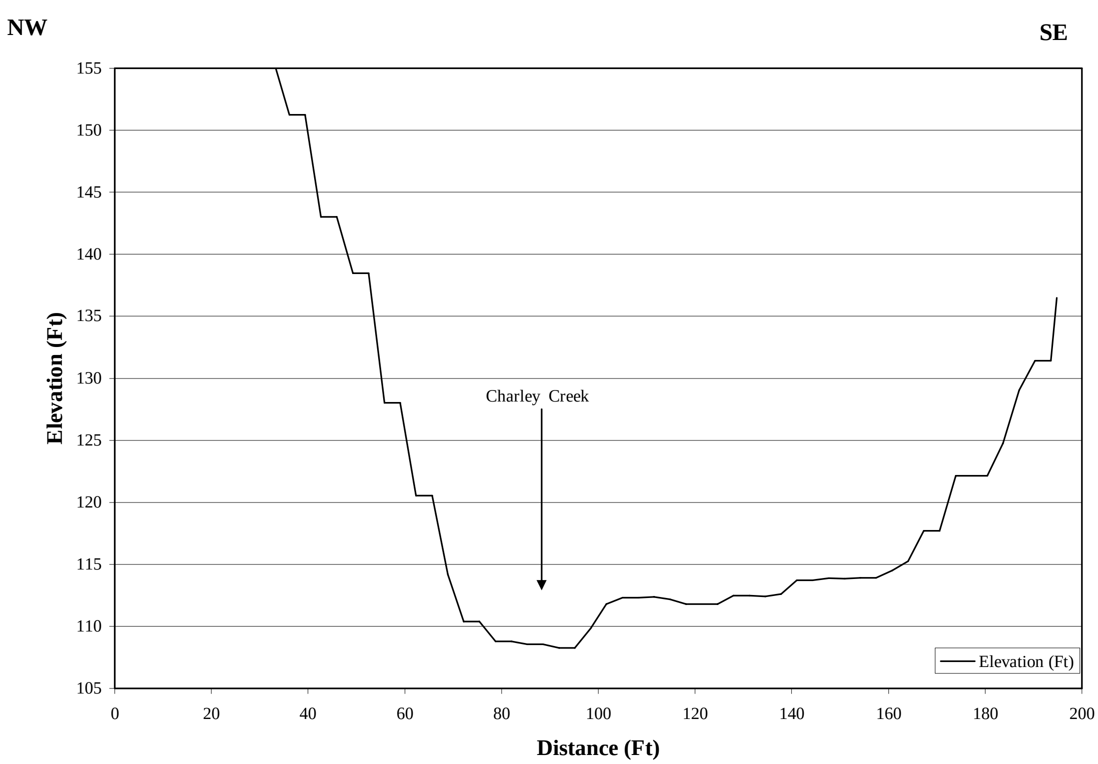
APP G-Figure 32. Charley Creek cross-section Segment 4, RM 1.7.



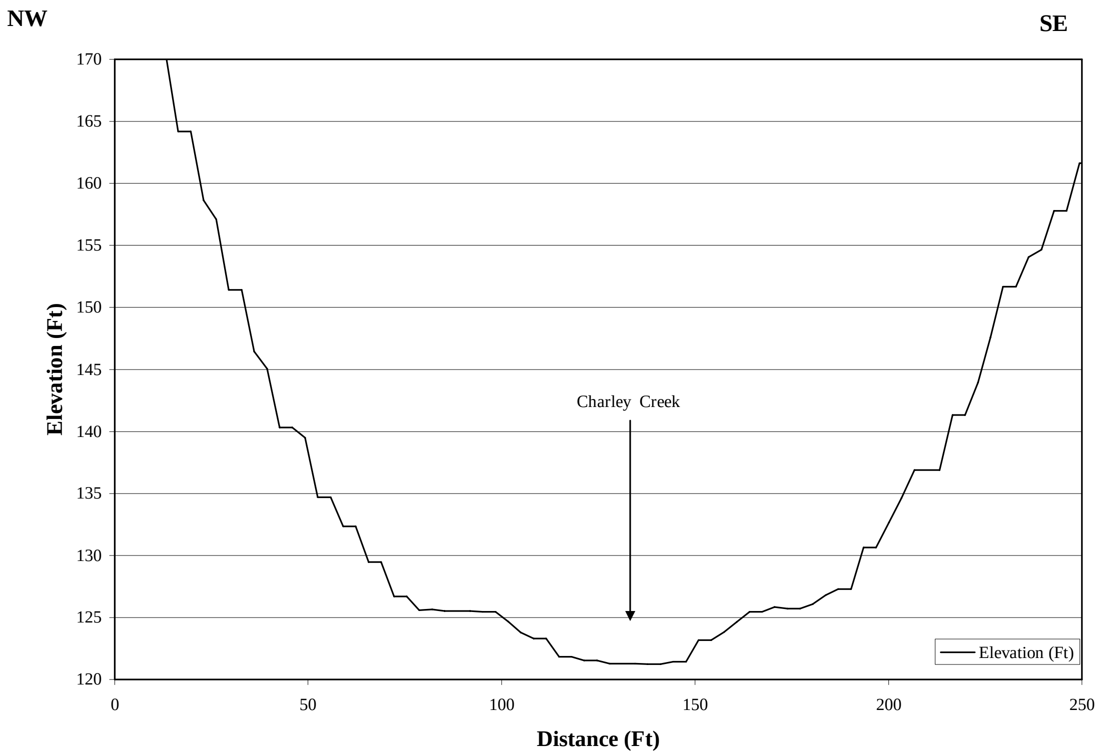
APP G-Figure 33. Charley Creek cross-section Segment 4, RM 1.86.



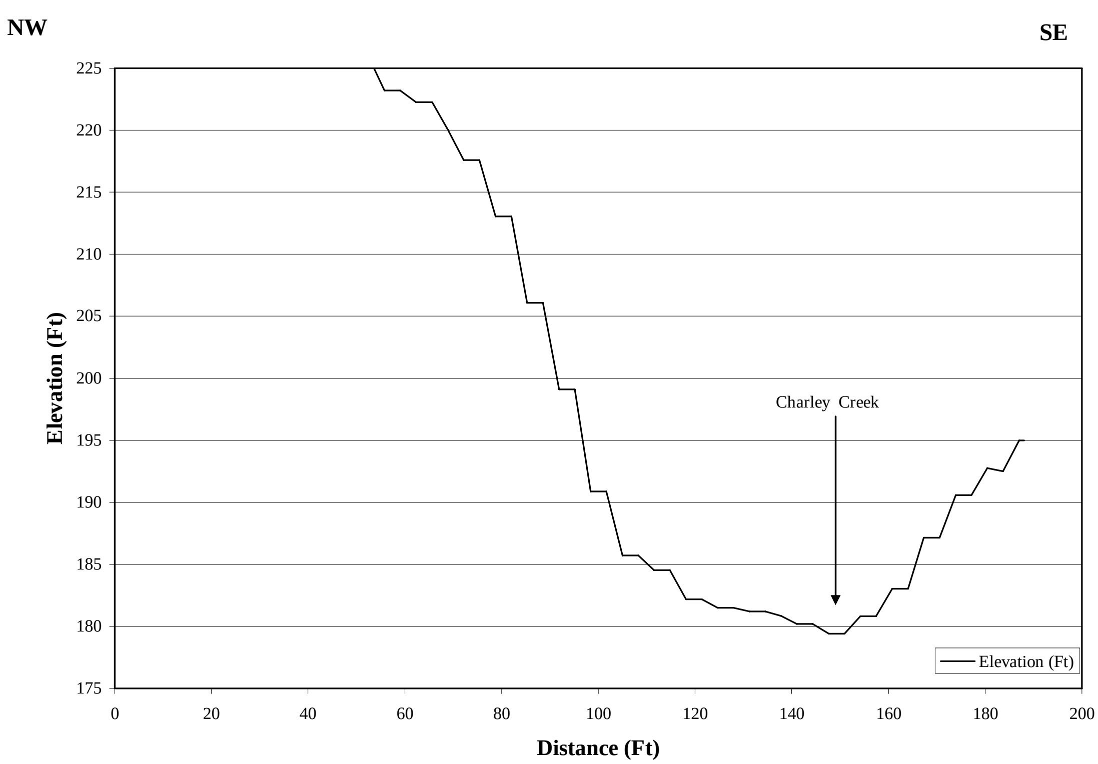
APP G-Figure 34. Charley Creek cross-section Segment 4, RM 2.04.



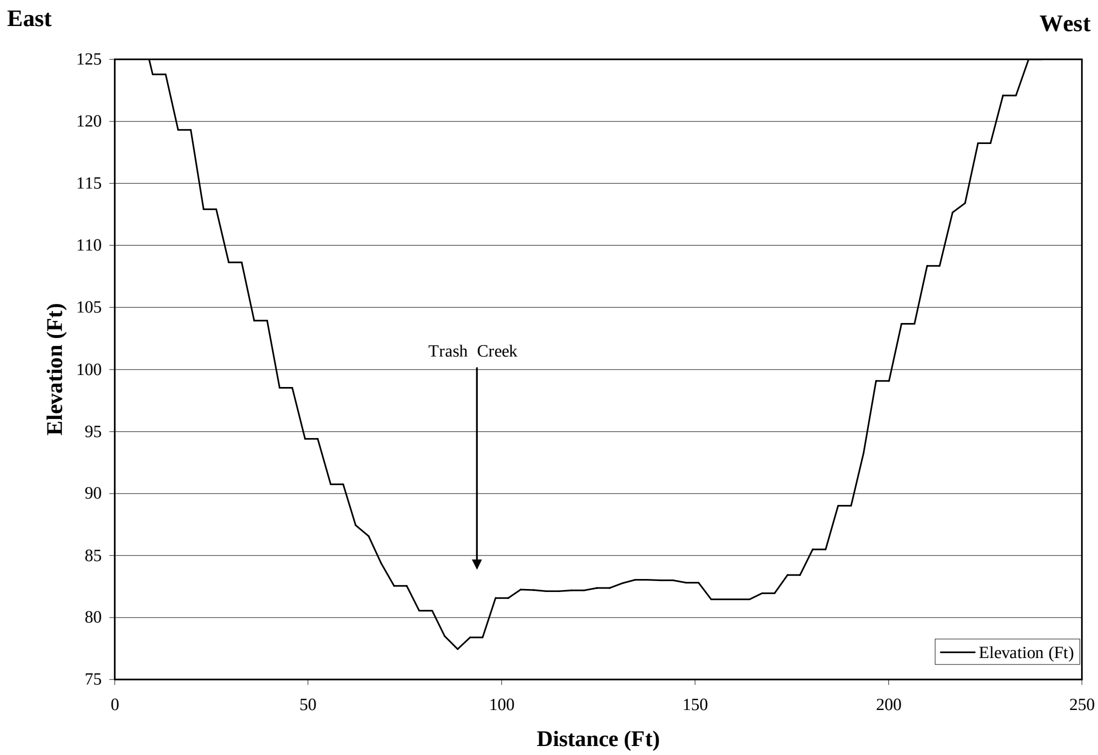
APP G-Figure 35. Charley Creek cross-section Segment 5, RM 2.2.



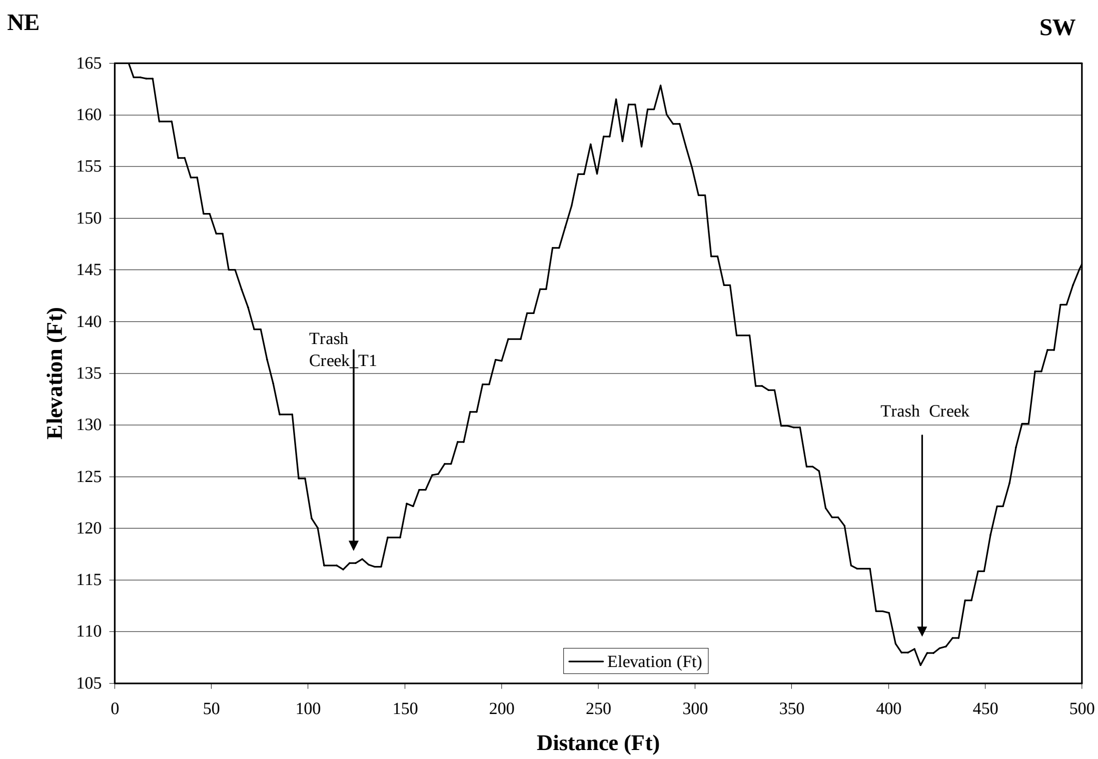
APP G-Figure 36. Charley Creek cross-section Segment 6, RM 2.6.



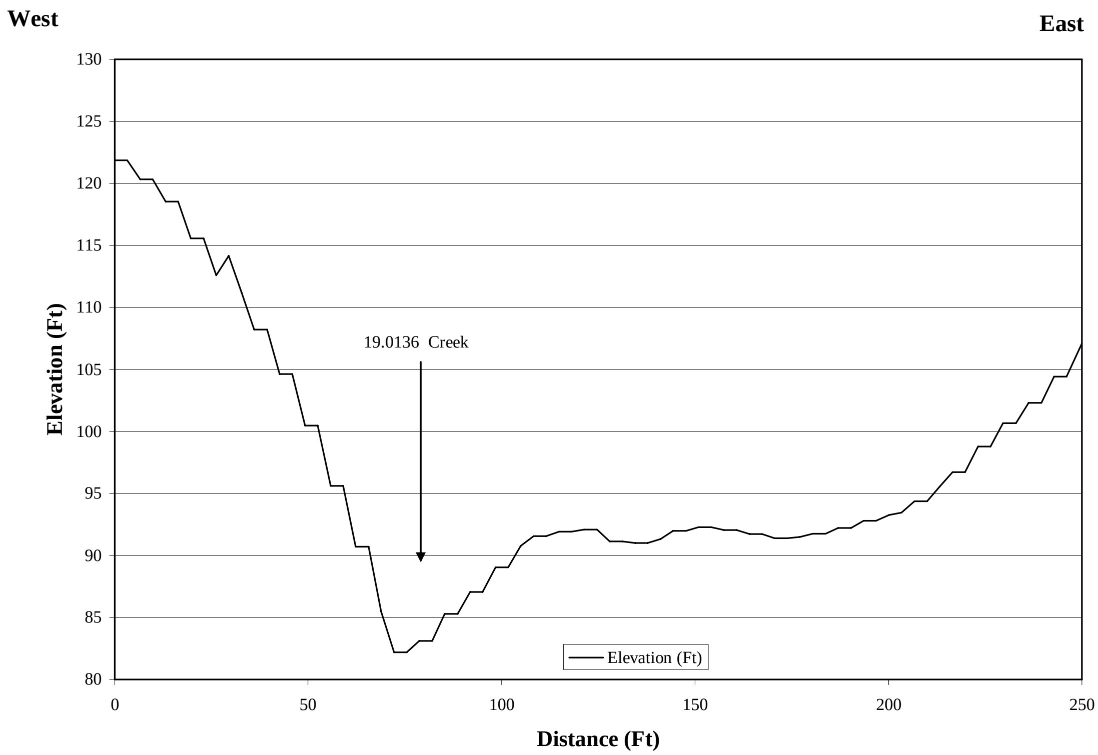
APP G-Figure 37. Charley Creek cross-section Segment 6, RM 2.33.



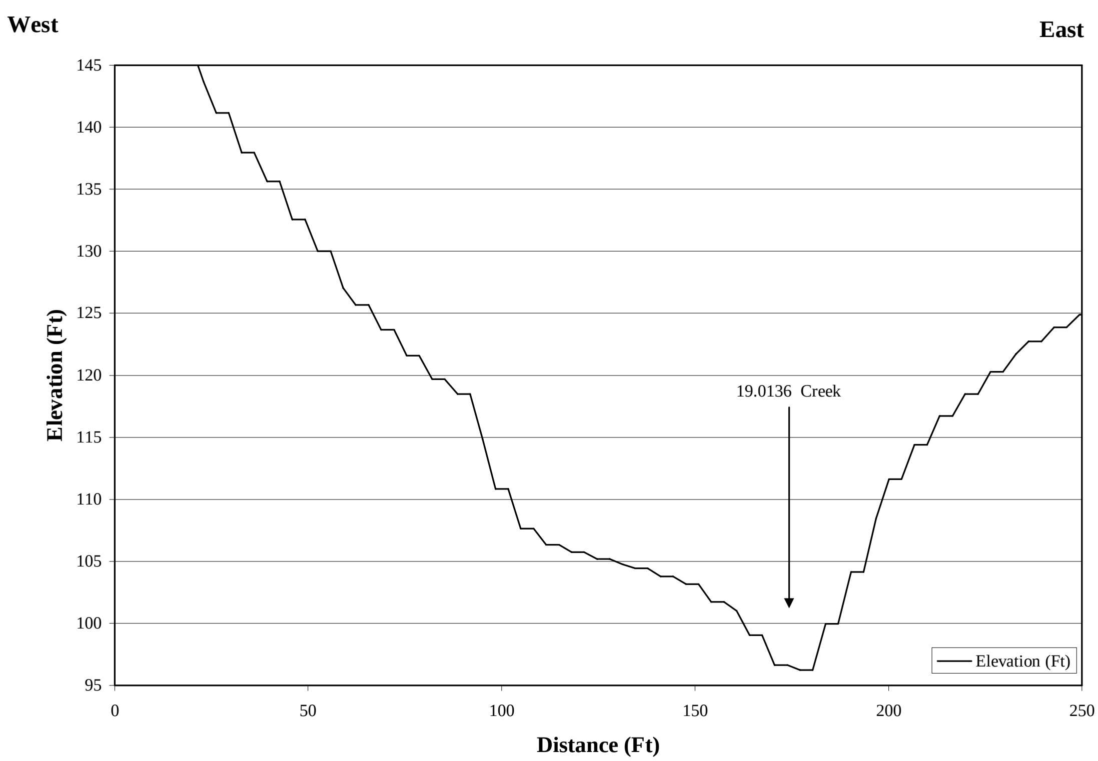
APP G-Figure 38. Trash Creek cross-section Segment 1, RM 0.05.



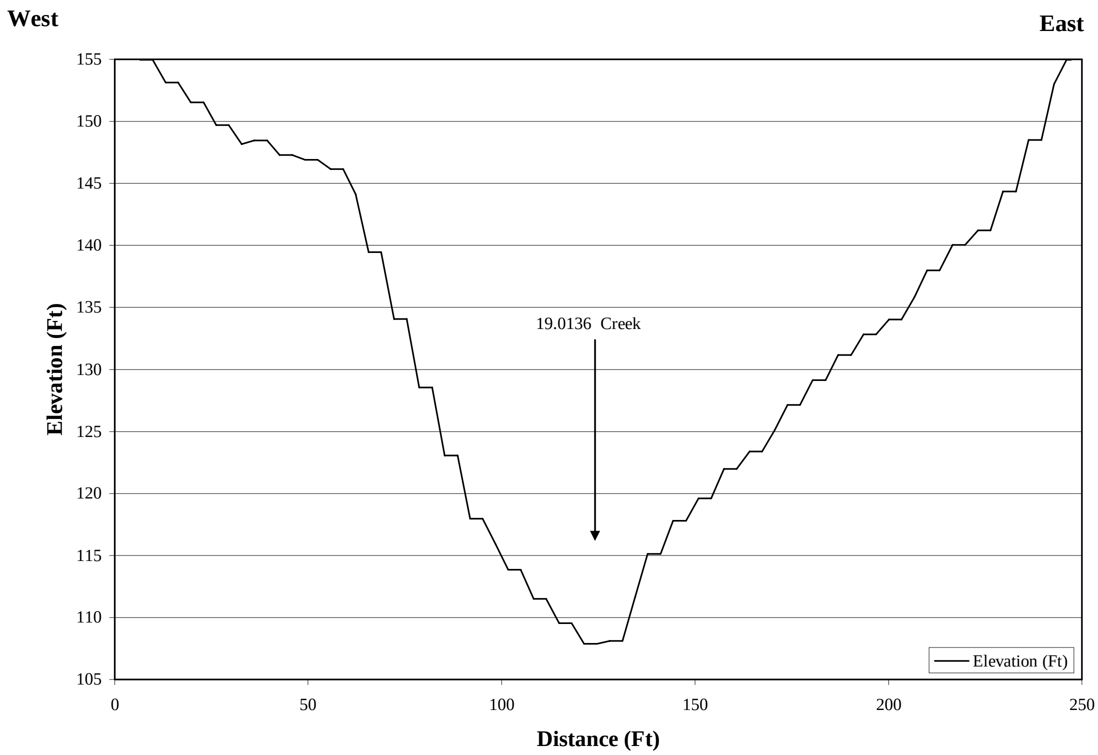
APP G-Figure 38. Trash Creek cross-section Segment 2, RM 0.16.



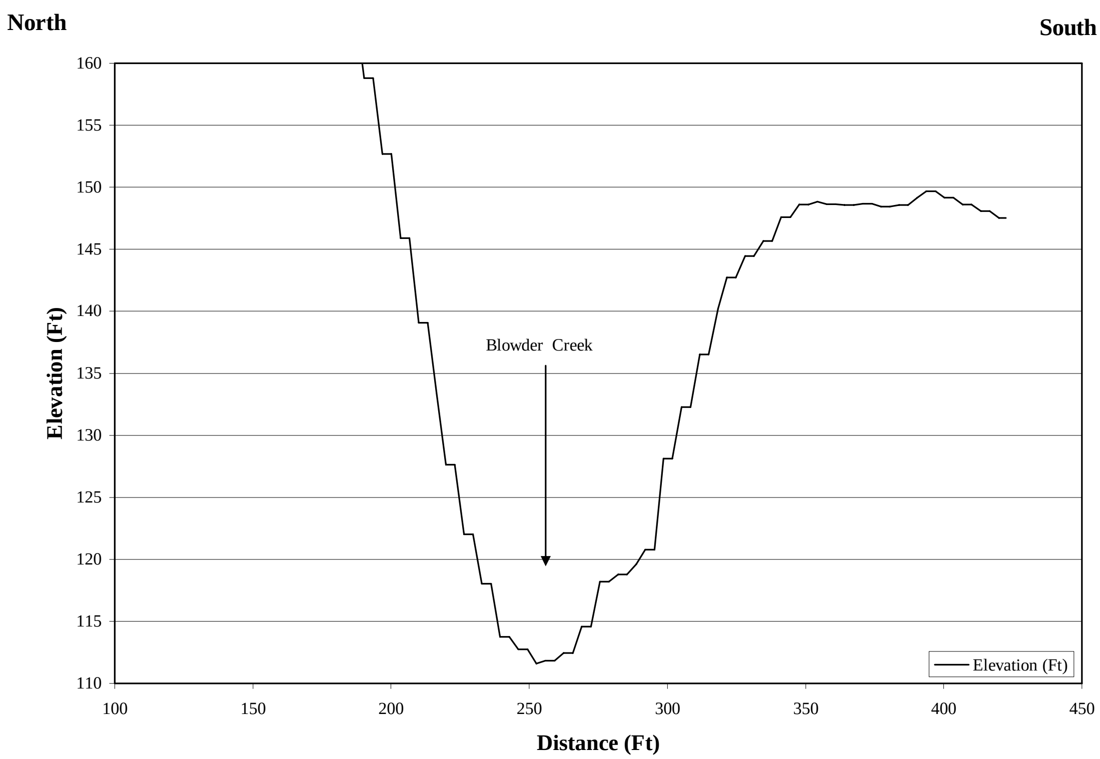
APP G-Figure 39. Unnamed Trib 19.0136 cross-section Segment 1, RM 0.03.



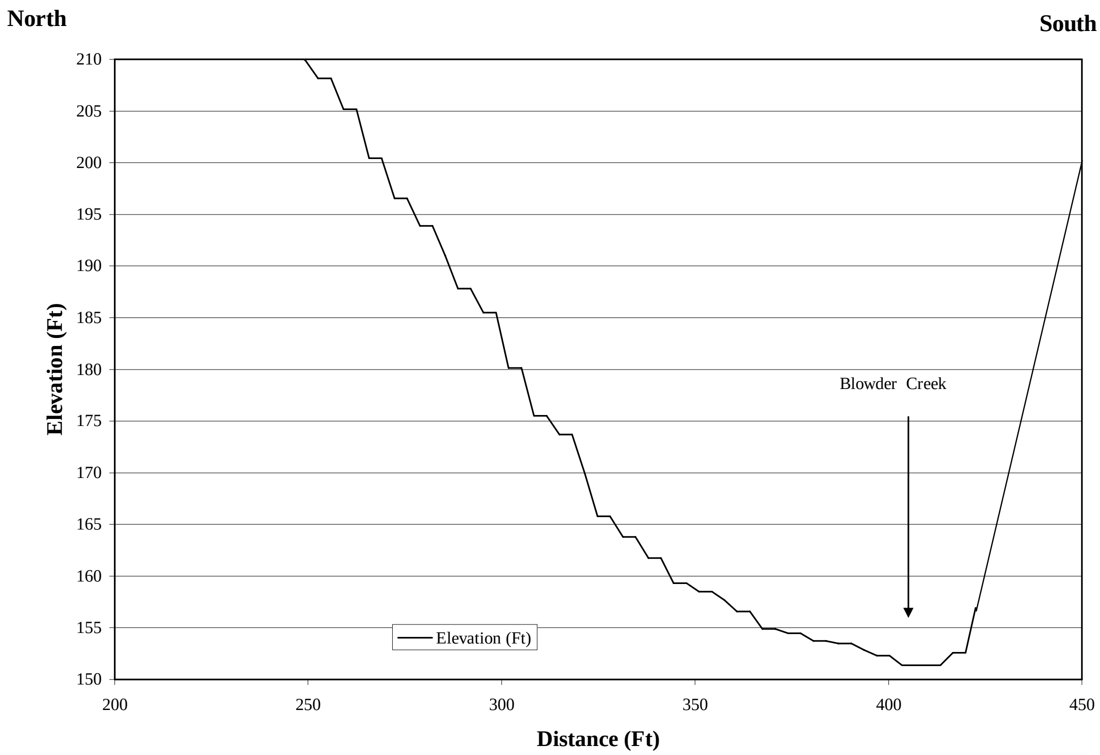
APP G-Figure 40. Unnamed Trib 19.0136 cross-section Segment 1, RM 0.09.



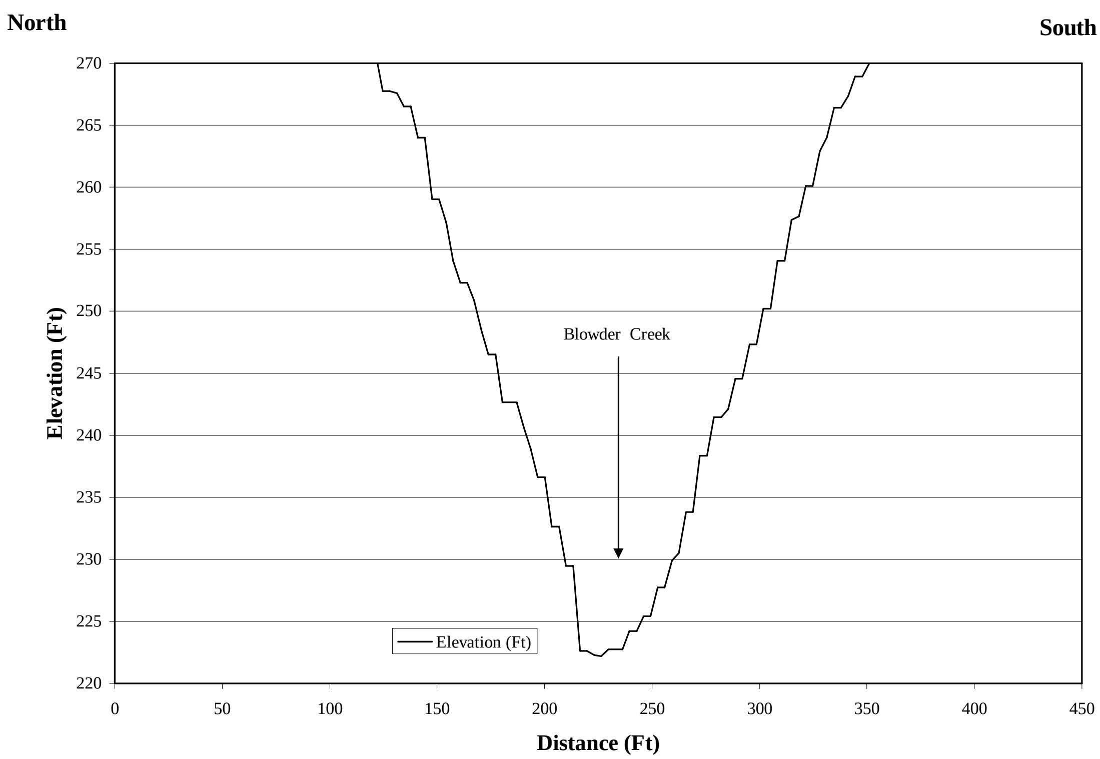
APP G-Figure 41. Unnamed Trib 19.0136 cross-section Segment 2, RM 0.15.



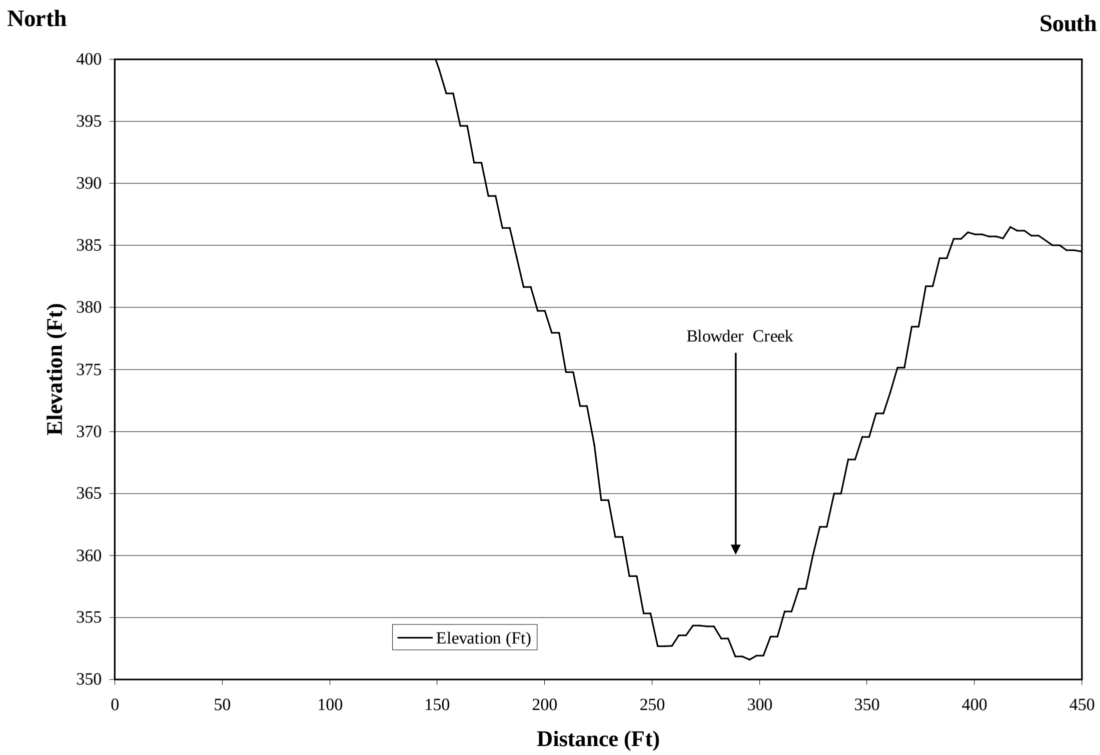
APP G-Figure 42. Blowder Creek cross-section Segment 1, RM 0.06.



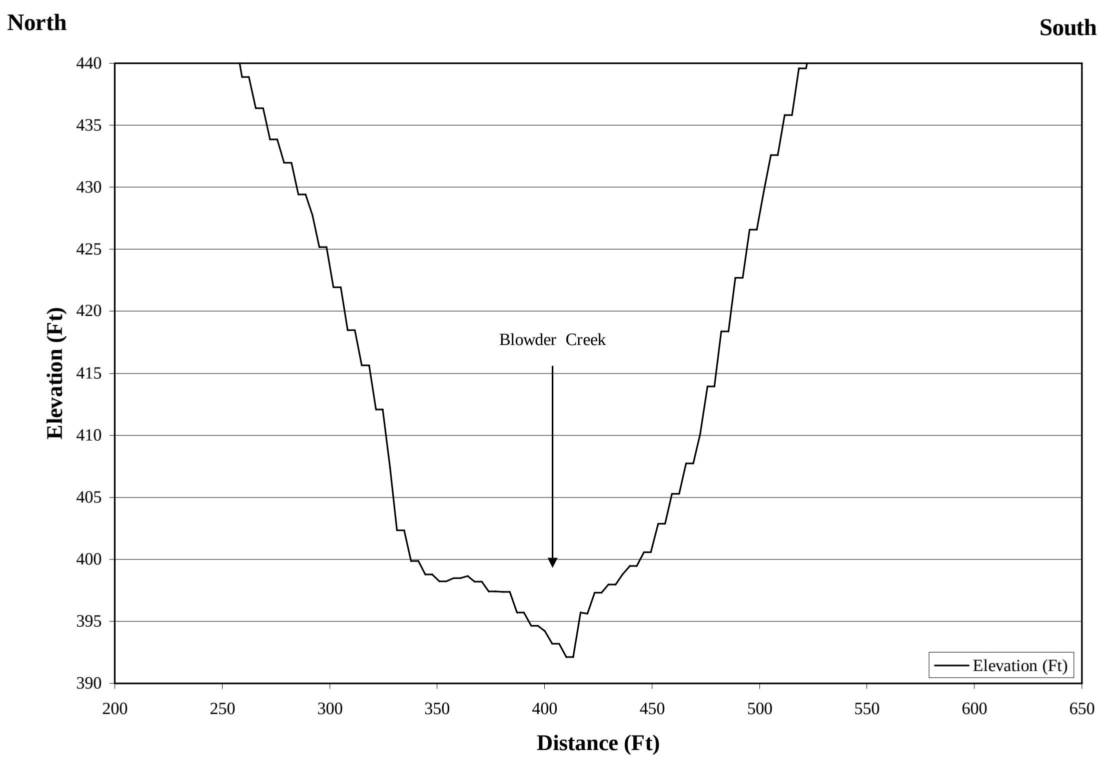
APP G-Figure 43. Blowder Creek cross-section Segment 1, RM 0.22.



APP G-Figure 44. Blowder Creek cross-section Segment 1, RM 0.52.



APP G-Figure 45. Blowder Creek cross-section Segment 2, RM 0.94.



APP G-Figure 46. Blowder Creek cross-section Segment 2, RM 1.24.