2.10 SEQUIM BAY AND DRAINAGES

Sequim Bay and its associated drainages are located in the northern and westernmost portions of WRIA 17, bordering WRIA 18 to the west (Figure 2.10-1). This portion of WRIA 17 has been incorporated into the WRIA 18 watershed plan under a Memorandum of Agreement between the WRIA 17 Planning Unit and WRIA 18 Initiating Governments dated December 9, 1998. The portions of WRIA 17 included in the WRIA 18 Watershed Plan include Sequim Bay, Johnson Creek, Dean Creek, Jimmycomelately (JCL) Creek, Chicken Coop Creek and other small streams draining into Sequim Bay.

This arrangement recognizes a history of planning responsibility for these drainages:

- Clallam County, Jamestown S'Klallam Tribe (JSKT), both WRIA 18 initiating governments, and Clallam Conservation District (CCD) have been heavily involved in developing and implementing watershed plans and restoration activities in this area for many years.
- DRMT, JSKT, and CCD are leading the current reconstruction and restoration of Jimmycomelately Creek and its estuary.
- The eastern boundary of Sequim Bay is also part of the North Olympic Peninsula Lead Entity Group's salmon recovery planning territory.
- Clallam County has established a Clean Water District for shellfish protection and other purposes, with boundaries that include the Sequim Bay watershed.
- The County, JSKT, and CCD are involved in recovery planning for ESA-listed fish in Jimmycomelately Creek, particularly chum.
- A hydrologic connection exists between the Dungeness River and Johnson Creek/Sequim Bay via the Highland Irrigation System.

The JSKT has the only reservation lands in WRIA 17 and has requested that these areas be incorporated into WRIA 18 watershed planning.

2.10.1 Watershed Overview

Chapter 1 (Planning Framework) and Appendix 1-A provide an overview and history of law, regulation, plans and studies bearing on watershed planning in Sequim Bay as well as WRIA 18. Section 2.1 (Natural Environment) includes an overview of the natural environment within and surrounding Sequim Bay and its associated drainages. Some of that information is also summarized below. Section 2.2 (Human Environment) summarizes watershed history, population trends, and land use cover, including Sequim Bay and its associated drainages. Section 2.3 (Water Quantity) includes the Sequim Bay drainages in discussions of water available, water rights, water use, and future water supply.

Geography

Sequim Bay drains an area of approximately 35,813 acres, from Mt. Zion (at the watershed's most southerly portion) north to the Strait of Juan de Fuca, and from the Discovery Bay watershed on its easterly edge to the Dungeness watershed on the west. Mt. Zion, at an elevation of 4,273 feet, is the highest point within the Sequim Bay watershed (PSCRBT 1988). Jimmycomelately Creek is Sequim Bay's primary subbasin;

other significant subbasins draining to the Bay include Johnson, Dean, and Chicken Coop creeks. A series of smaller unnamed creeks between Johnson and Dean Creek also provides runoff to the southern shore of Sequim Bay (Parametrix 2000).

As summarized by the PSCRBT (1988), topography is steep in the upper, forested portions of the watershed with more gentle and flatter slopes toward Sequim Bay. In addition to the subwatershed drainages listed above, water used for domestic and farmland irrigation enters Sequim Bay from the Dungeness River through two ditches and a pipe outfall. Streams, creeks and irrigation ditches drain the upland watershed flowing in and out of each other, diverting and re-charging streams, tributaries, wetlands, and groundwater (Parametrix 2000).

Climate

Sequim Bay experiences prevailing winds from the west. This pattern of air masses and weather moving from west to east is common for much of middle North America. The Sequim Bay climate is mild with cool winters and warm summers, reflecting the moderating influence of winds from the Pacific Ocean. The watershed lies in the rain shadow of the Olympic Mountains. The location of Sequim Bay exposes it to marine air masses that have been conditioned for extended periods over open ocean. Precipitation averages 28 inches over the Sequim Bay watershed and varies from 35 inches in the upper watershed (Mt. Zion) to 15 inches at the lower elevations to less than 10 inches at Sequim Bay. Winter precipitation is primarily rain up to 1,500 feet elevation, with mixed rain and snow between 1,500 and 2,500 feet, and primarily snow above 2,500 feet. Most precipitation falls in the winter.

Geology

Geological processes affecting the WRIA 17 area are described in *the Salmon and Steelhead Habitat Limiting Factors Report* for WRIA 17 (WCC 2002):

> "The retreat of the huge and heavy ice sheets of the Cordilleran glaciations carved the inland waterways of Puget Sound, including those along east Jefferson County and Hood Canal. There is evidence that the termination of the latest glacial episode affecting WRIA 17, the Vashon, was rapid, with the ice sheet thinning, floating, and breaking up in the eastern Straits, as the temperature rose (Jamestown S'Klallam Tribe et al. 1994). As the ice lobe retreated northwards and approached the Strait, there was an isolated drainage route connecting Dabob Bay with Discovery Bay via the Leland-Snow Creek valleys. This glacial history had important consequences. for the evolution of stream drainages, headwater wetland formation, and fish colonization/movement among basins. Another such example in WRIA 17 with wetlands offering fish easy transit routes could be evidenced in a possible Ludlow-East Fork Chimacum link (Ted Labbe, personal communication 2002). The sea-level rise was accordingly rapid and coastal lowlands freed from glacial ice were submerged under marine waters.
>
> The rebound of the earth's crust was more gradual, returning to equilibrium level about 5,000 years ago. At Port Townsend, the rise of the earth's surface has been estimated at nearly 500 feet since the Vashon ice

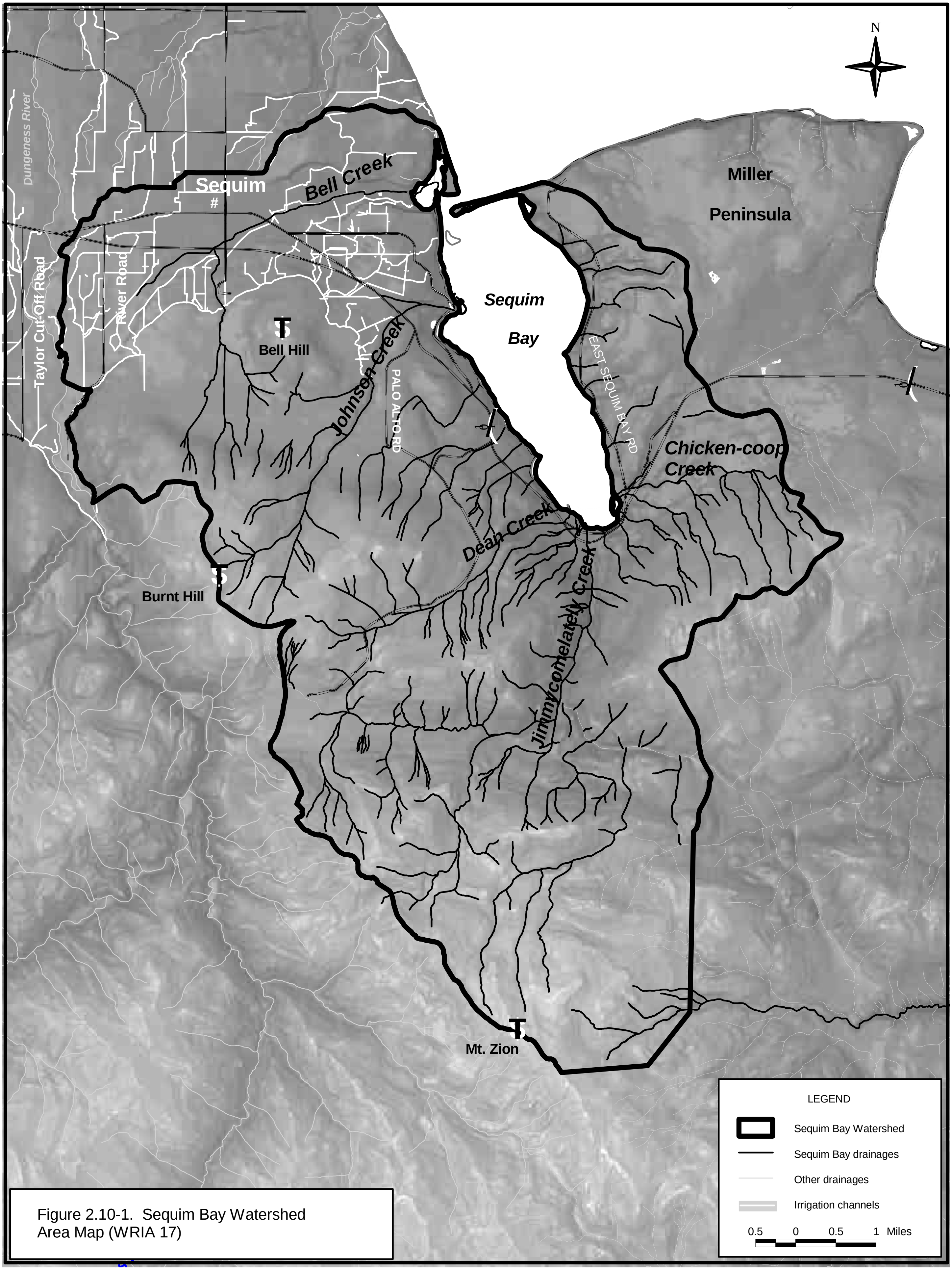

Figure 2.10-1. Sequim Bay Watershed Area Map (WRIA 17)

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> disappeared. The coastal bluffs have formed in the time since the last glaciation, by gradual erosion of the coastline from a combination of wave action and wind erosion (Jamestown S'Klallam Tribe et al 1994)."

Soils

The general soil map (provided in PSCRBT 1988) for the Sequim Bay watershed shows broad areas that have a distinctive pattern of soils, relief, and drainage (SCS 1987). Descriptions of the broad groups and their map units in the following paragraphs were obtained from the report entitled *Sequim Bay Watershed Characterization* prepared by the PSCRBT (1988).

Soils on Terraces

<u>Sequim-Carlsborg</u>

The Sequim-Carlsborg unit is described as very deep, somewhat excessively drained, nearly level soils on terraces. This map unit extends from Sequim Bay directly west through the town of Sequim to the western edge of the watershed. Slope is 0 to 5 percent. This unit makes up about 8 percent of the watershed. It is mainly Sequim soils, 50 percent and Carlsborg soils, 49 percent. The remaining one percent is Dungeness soils and riverwash.

<u>Hoypus</u>

The Hoypus unit is described as very deep, somewhat excessively drained, nearly level to very steep soils on terraces. This map unit occurs in the Blyn area and along Johnson Creek. Slope is 0 to 65 percent. This unit makes up about 9 percent of the watershed. It is mainly comprised of Hoypus soils (91 percent). Hoypus soils are formed in glacial outwash and are somewhat excessively drained. This unit is used as forest and as homesites. Hoypus soils are a source of sand and gravel. They are limited for homesites by steepness of slope and for septic tank absorption fields by poor filtration.

Soils on Hills

<u>Clallam-Catla</u>

The Clallam-Catla unit is made up of moderately deep and shallow, moderately well drained, nearly level to steep soils; on hills. This map unit occurs in the Happy Valley and the northeastern areas of the watershed. Slope is 0 to 35 percent. This unit makes up about 27 percent of the watershed. It is about 51 percent Clallam soils, 32 percent Catla soils, and 9 percent Elwha soils.

Clallam soils are moderately deep. They are formed in compact glacial till to a depth of 28 inches. Catla soils are shallow. They also are formed in compact glacial till, to a depth of 14 inches. Elwha soils are moderately well drained. Of minor extent in this unit are somewhat excessively drained Hoypus soils, somewhat poorly drained Agnew soils, and the poorly drained Bellingham, McKenna, and Mukilteo soils in depressions and drainageways.

This unit is used mainly as forestland. It is also used as homesites. The Clallam soils are also used for hay and pasture. The main limitations of this unit for homesites and septic tank absorption fields are wetness, steepness of slope, and depth to compact glacial till Clallam soils are limited for hay and pasture by doughtiness.

Louella-Yeary-Elwha

These are very deep and moderately deep soils, well and moderately well drained, occurring on gently sloping to extremely steep hills. This map unit occurs in the Bell Hill area and extends across the middle of the watershed south of the Happy Valley area. Slope is 0 to 90 percent. This unit makes up about 33 percent of the watershed. It is about 42 percent Louella soils, 41 percent Yeary soils, and 15 percent Elwha soils. Louella soils are formed in residuum and colluvium derived from basalt and flow breccia. These soils are very deep and well drained. Yeary soils are formed in reworked marine sediment overlying compact glacial till to a depth of 38 inches. These soils are moderately deep and moderately well drained.

Elwha soils are formed in glacial till to a depth of 28 inches. These soils are moderately deep and moderately well drained. This unit is used as forestland and as homesites. It is limited for use as forestland by steepness of slope, while Yeary soils are limited for timber harvest by their muddiness. Wetness and slope steepness are the main limitations of the Elwha soils as homesites. They are limited for septic tank absorption fields by wetness, depth to compact glacial till, and restricted permeability.

Soils on Mountains

Elwha-Soil

These are moderately deep soils, moderately well and somewhat excessively drained, on moderately steep to extremely steep mountainsides. This map unit occurs predominantly in the Olympic National Forest, in the upper watershed. Slope is 5 to more that 65 percent. This unit makes up about 13 percent of the watershed. It is about 55 percent Elwha soils, 14 percent Soil 20, and 13 percent Soil 28. The remaining 18 percent is components of Soil 16, Soil 61, Soil 51, Soil 63, and Soil 25. The Soil 16 is formed in colluvium. The Soil 61 and Soil 63 are formed in marine baslt. The Soil 51 is formed in siltstone and sandstone.

Elwha soils are formed in glacial till to a depth of 36 inches. These soils are moderately well drained. The surface soil is gravelly sandy loam. Soil 20 is formed in glacial outwash. These soils are somewhat excessively drained. Soil 28 is formed in glacial till overlying basalt bedrock. These soils are moderately well drained. Basalt bedrock is at a depth of 24 to 72 inches. This unit is used mainly as forests, limited by steepness of slope. Soils 20 and 28 are limited by doughtiness.

Soil 61

This soil is moderately deep, well drained, on steep to extremely steep ridgetops and mountainsides. This map unit occurs in the Olympic National Forest on slopes of 35 to 90 percent. This unit makes up about 6 percent of the watershed and includes small amounts of Soil 16, Soil 22, Soil 50 and areas of Rock outcrop consisting of basalt. Soil 61 is formed in marine basalt at a depth of 26 inches. This unit is predominantly forested, limited by steepness of slope and depth to bedrock.

Soil 51

This soil is moderately deep, well-drained, on steep and extremely steep ridgetops and mountainsides in the Olympic National Forest. On slopes 35 to 90 percent. This unit makes up about 3 percent of the watershed, and includes small amounts of Soil 22, Soil 16, and Soil 50. Soil 51 is formed in sedimentary rock consisting of sandstone, and siltstone. Fractured sandstone is found at a depth of 29 inches. This unit is used mainly as forests, limited by steepness of slope and depth to bedrock.

Hydrology and Geohydrology

Surface Water

Jimmycomelately Creek is the most significant stream in the Sequim Bay watershed. Other significant streams include Johnson, Dean, and Chicken Coop creeks. Periodic streamflow data has been collected on Jimmycomelately and Johnson creeks; little data exists for the other streams. In general, low summer flows are characteristic in the Sequim Bay watershed. Summer storms must produce in excess of 1 inch of rainfall to show up as runoff in area streams. The rain shadow effect of the Olympic lessens the impact of major storms to the Sequim Bay area. Average monthly precipitation for Sequim is about one inch from May through August (Orsborn and Orsborn 1999). Low stream flows in fall 2002 created passage problems for salmon returning to spawn in the Dungeness, Jimmycomelately Creek, and most other rivers in East WRIA 18.

Stormwater Runoff and Flood Hazard

Flooding is rarely a problem where good forest cover is maintained over the watershed. However, Jimmycomelately Creek experiences annual flooding; flooding in JCL basin has helped drive the restoration/realignment of the creek (discussed in Section 2.10.5). Dean Creek also floods regularly and is the most dredged waterbody in all of Clallam County. Dean Creek flooding will be addressed as part of the overall Jimmycomelately Creek-Lower Sequim Bay Estuary Restoration Project (see Section 2.10.5).

Orsborn and Orsborn (1999) estimated floods for five drainages in the Blyn Basin, east of the Dungeness River. These included Dean, No-Name West, Jimmycomelately, No Name East, and Chicken Coop creeks. Although some streamflow data were available, it was not possible to correlate these sites with USGS gage data for a reference creek. Peak and average daily flood data for the 2-year and 100-year recurrence intervals are summarized in the Orsborn report. The peak 100-year floods range from 29 cfs for No-Name East to 800 cfs for Jimmycomelately Creek; the 2-year floods range from 7 cfs for No-Name East to 185 cfs for Jimmycomelately Creek. Potential problems summarized by Orsborn and Orsborn in these drainages included erosion, gravel and silt accumulation, land development patterns, and a raised bed in Jimmycomelately Creek downstream of the Old Blyn Highway.

Geohydrology

Parametrix (2000) states that the Sequim Bay basin is characterized by extensive areas covered with bedrock, till-covered areas on either side of Sequim Bay, and a moderate-sized recessional outwash delta at the head of the Bay. Beneath the till, the principal aquifer system is relatively stratified and has been characterized in a recent USGS study of the Sequim-Dungeness area (Thomas et al. 1999). The study identified six hydrostratigraphic units overlaying bedrock (see Section 2.1). The shallow aquifer is primarily composed of Vashon glacial sediments. Both the middle and deep aquifer (where present) are composed of pre-Vashon materials, and extend beneath Sequim Bay into the West Sequim Bay sub-basin. Sedimentary textures can vary greatly within the aquifer units identified. The confining beds are generally fine-grained, but may contain discontinuous lenses of water-bearing sand and gravel.

Thomas et al. describe Sequim Bay as characterized by extensive areas covered with bedrock, till covered areas on either side of Sequim Bay, and a moderate-sized recessional outwash delta at the head of Sequim Bay. Beneath the till, the principal aquifer system is relatively stratified. All six hydrostratigraphic units overlying bedrock identified by Thomas et al occur in the subbasin. Both the middle and deep aquifer extend beneath Sequim Bay into the Miller sub-basin. West of the Bay, the principal aquifer system is relatively thin, and only the shallow aquifer occurs. Further north, depth to bedrock increases rapidly with distance from the isolated bedrock exposures. A deltaic recessional outwash deposit at the head of Sequim Bay may function as a local aquifer, however its water yielding characteristics are not documented. A portion of the Miller Peninsula occurs within the subbasin, and Thomas et al (1999) state that the hydrogeologic units they identified were more difficult to discern beneath the Peninsula.

Groundwater use (discussed below) is estimated to comprise approximately 40 percent of total recharge, although data to conclude whether groundwater withdrawal strongly influences streamflow in the Sequim Bay subbasin is insufficient (Parametrix 2000).

Hydraulic Continuity

A relative hydraulic continuity potential (RCHP) preliminary analysis for the Sequim Bay watershed was conducted as a part of the Stage 1 Technical Assessment (Parametrix 2000). Parametrix cautions that the RHCP is not a detailed hydraulic or hydrogeologic analysis but rather an estimated, relative parameter based primarily on surficial geology. The major streams within the Sequim Bay watershed were all assigned a “low” RHCP ranking when flowing across bedrock or till because these materials do not typically contain significant aquifers. It is noted that many of the streams near West Sequim Bay that flow within channels of alluvial or recessional outwash deposits and channels over till are ranked as “medium” RHCP. Recessional outwash sediments near the head of Sequim Bay reportedly thicken into deltaic deposits. Because hydrogeologic characterization was not available to determine if the deltaic deposits function as a principal aquifer, these deltaic sediments were given a “medium” ranking. (However, if it is determined the delta serves as a local principal aquifer a “high” ranking should be assigned. For example, the mouth of Chicken Coop Creek was assigned a “high” RHCP because it may cut into advance outwash sediments at this location.) (Parametrix 2000).

Parametrix (2000) indicates that given the geomorphology of the Sequim Bay subbasin, potential hydraulic connectivity is considered moderate in the lower reaches of Jimmycomelately Creek, Johnson Creek, Chicken Coop Creek, and Dean Creek, where the streams flow over glacial till deposits. Parametrix (2000) indicates that if streams' lower reaches are underlain by the till deposits of a principal aquifer, hydraulic connectivity could be high. It is noted that there are no streamflow data to quantify the hydrographs of any Sequim Bay subbasin streams.

Factors of Change

Human Influences/Major Projects

The Sequim Bay watershed has been significantly altered by human development and has experienced significant problems as a result. Specific human influences are described for each stream in Sections 2.10.3 through 2.10.6.

Soil Erosion and Sediment Load

Sequim Bay has an accelerated sedimentation rate, which appears to be originating from the Johnson Creek watershed (see Section 2.10.3). As of early 2002, the development of an off road vehicle park on Burnt Hill (which drains to both Sequim Bay and the Dungeness Bay) was under consideration by the Washington DNR. Because of the potential for increased sediment input coming from the steep slopes of Burnt Hill as a result of off road vehicle use, the DRMT has been monitoring this project. The specific concerns are that considerable restoration work is occurring and will continue to occur in an attempt to restore the summer chum salmon habitat in these watersheds and their associated subdrainages (DRMT 2002).

Sediment serves as a transport mechanism for bacterial contaminants. Bacteria and viruses adhere to the sediment particles and are deposited in the estuary concentrating the bacterial contamination. Sediment, with its direct association with nutrients and organic matter, can reduce the capability of the freshwater and marine environments to produce shellfish and anadromous fish. Lowered dissolved oxygen levels interfere with survival rates. Silt deposited in stream beds can interfere with spawning, egg development and juvenile survival of anadromous fish. Deposition in estuaries interferes with respiration and feeding of shellfish.

Land Cover and Use

Current land use information is broadly described in Section 2.2. The Sequim Bay watershed is 72 percent forestland (encompassing 25,866 acres), including commercial timber and small private woodlots. Commercial timberland, (owned by federal, state, and private forest industry) totals 18,776 acres. Most of the commercial forestland is controlled by the USFS and State of Washington DNR. Forestry includes all federal (Olympic National Forest), State (DNR), and private lands included in the Clallam County Assessors Tax rolls, designated as "D" (designated), "C" (classified), or "T" (open space timber).

Rural/agricultural land use (22 percent) is split evenly between rural residential (11 percent) and agricultural land (11 percent) used primarily for hay and pasture. The rural residential category includes areas developed at a density of one residential unit per 1.5 to

5 acres. The area classed as agricultural land includes about forty small farms and nine commercial farms. Commercial farms are defined as those operations producing a significant annual income (over $1,000). The agricultural area is used principally for hay and pasture, but there is an increasing amount of revenue-producing cropland. Small farms range in size from 8 to 20 acres with 5 to 10 cows or horses. Commercial operations average 72 acres in size with 30 to 40 head of livestock.

In the Sequim Bay watershed, freshwater (palustrine) wetlands make up less than 1.5 percent of the land base, or 416 acres. Marine (estuarine) wetlands, which include intertidal and subtidal areas within Sequim Bay, cover 3,441 acres (USFWS 1980).

The Sequim Bay watershed is served by U.S. Highway 101 with numerous other paved roads providing access to the rural areas. The 118 miles of forest roads comprise nearly 50% of all roads. The Sequim Bay Watershed contains the historic rural village of Blyn and the Jamestown S'Klallam Tribal reservation.

Water Quality

Surface Water

Some beaches within Sequim Bay are currently closed to recreational shellfishing due to biotoxins and/or pollution (DOH Website). Limited water quality data is available for surface water features in the Sequim Bay basin. The water quality of specific streams is discussed in Sections 2.10.3 through 2.10.6. Based on the 1998, 1996 and 1994 303(d) lists, multiple areas within the Sequim Bay subbasin have been identified by Ecology as requiring water cleanup plans, or TMDLs. To date, no TMDLs have been established or planned for any of the listed water bodies in the Sequim Bay watershed or within the entire WRIA 17.

<u>Streams</u>

Johnson and Chicken Coop Creeks were listed on the 1994, 1996 and 1998 Ecology 303(d) list of impaired water bodies due to failure to meet Washington State standards for fecal coliform (Ecology 2002a). Elevated fecal coliform levels have also been found at the mouth of Jimmycomelately Creek. Sections 2.10.3 through 2.10.6 provide more detailed water quality information.

<u>Sequim Bay</u>

Sequim Bay was listed on the 1994, 1996 and 1998 Ecology 303(d) list of impaired water bodies due to its failure to meet Washington State standards for dissolved oxygen, pH, PAHs and fecal coliform (Ecology 2002a). Sequim Bay is a significant shellfish area and is certified by the State for commercial shellfish harvest at its southern end. Parametrix (2000) reported that DOH closed the northern portion of the Bay to shellfish harvest but the remainder of the Bay is conditionally approved. Fecal coliform levels were below allowable limits for shellfish harvesting, even in areas of significant contribution (e.g., mouth of Jimmycomelately Creek). However, shellfish harvest is still prohibited or only conditionally approved in the Bay because of the proximity to point sources (DOH 1999b as cited in Parametrix 2000). Shreffler Environmental (Shreffler 2000) reports the end of the Bay is characterized by anoxic conditions that discolor clamshells and possibly limit productivity. The Bay is also subject to outbreaks of paralytic shellfish poisoning that close shellfish bed harvest.

Monitoring

Groups including Clallam County, DOH, JSKT, and Streamkeepers have collected sporadic water quality data in Sequim Bay and its associated drainages. Approximately once per month between 1992 and 1995, the DOH measured water temperature, salinity, and fecal coliform at designated sampling stations in lower Sequim Bay and one station at the mouth of Jimmycomelately Creek. Results are provided in Section 2.10.3 and 2.10.6. Based on Shreffler's (2000) communications with Wayne Clifford at DOH, there are no fecal coliform values in the 1992-1995 marine data set that would exceed the state or federal threshold criteria for fecal coliform concentrations.

Streamkeepers (formerly the Eight Streams Project of WSU Cooperative Extension), have been surveying for water quality parameters in Sequim Bay drainages, as discussed further below. As of 2000, the Streamkeepers began taking photos and collecting data on water quality (e.g., temperature, dissolved oxygen, conductivity, pH, turbidity, nitrate), macroinvertebrates, fish and wildlife presence, noxious weeds, and physical habitat (e.g., flow, gradient, cross section, substrate, pools, large wood debris). Each quarter, the Streamkeepers Program makes data summaries available to volunteers, citizens, and local biologists interested in information about the current state of the stream.

According to Parametrix (2000), water quality data is limited spatially and temporally and ongoing ambient monitoring does not exist for freshwater features in this sub-basin. However, partners of the Jimmycomelately Creek Restoration Project (discussed in Section 2.10.5) plan to monitor water quality over 10 years following the Jimmycomelately Creek channel realignment.

Groundwater

Groundwater quality data for the Sequim Bay basin is generally lacking. In 1994, the Sequim-Dungeness Groundwater Committee and Clallam County Department of Community Development (SDGC and CCDCD, respectively) developed the *Sequim-Dungeness Groundwater Protection Strategy*. The WRIA 17 Stage 1 Technical Report (Parametrix 2000) includes limited groundwater quality information for the Sequim Bay subbasin. Well locations exhibiting chloride and nitrate concentrations are shown on Exhibits 4 and 5 of Parametrix 2000 (generally located along the coast). Three of the coastal wells exhibited 250 mg/L of chloride, which suggests localized susceptibility to intrusion. Nitrate concentrations were found in only six wells, and only one reportedly exceeded the natural background range. Parametrix (2000) indicated that no incidents of anthropogenic groundwater contamination have been diagnosed in the Sequim Bay area.

Although is it noted as not being pervasive, seawater intrusion is mentioned around the perimeter of Sequim Bay in Ecology's (1998) *Watershed Approach to Water Quality Management: Needs Assessment for the Eastern Olympic Water Quality Management Area*.

Fish and Habitat

Parametrix (2000) indicated that information regarding stock status and habitat quality in Sequim Bay is available only for Jimmycomelately Creek. The Jamestown S'Klallam Tribe, WDFW, Washington Department of Transportation (WDOT), and the Clallam Conservation District have received funding for habitat acquisition and/or restoration of the lower watershed and estuary. Most properties necessary for habitat restoration have been acquired. Work has begun with reconfiguring the lower watershed to its historic location. While this project focuses on the Jimmycomelately Creek subbasin, the project has the potential to positively affect the health and functioning of the entire Sequim Bay watershed. Discussion of this project can be found in Section 2.10.5 (Jimmycomelately Creek).

Instream Flows

Ecology has not set instream flows by rule for any stream within WRIA 17 (Parametrix 2000). As discussed by Parametrix (2000), and summarized in Sections 2.10.3 through 2.10.6, optimum instream flows developed from Ecology and WDFW investigations (published 1997) using the "toe-width" method are available for Johnson, Jimmycomelately, Chicken Coop, and Dean creeks.

Monitoring and Data Gaps

Data gaps identified by Parametrix (2000) that should be addressed include:

- Assessment of rearing habitat capacity for summer chum salmon in the sub-estuary, including effects of log storage on fry migration and food production.
- Quantification of the effects of scour and deposition on chum salmon and coho salmon egg survival in lower Jimmycomelately Creek.
- Habitat and fish population assessment in other West Sequim streams, e.g. Johnson Creek, Dean Creek, and Chicken Coop Creek.
- Catalog small unnamed streams that have potential to support cutthroat trout and possibly other salmonids.

(Many of these concerns are addressed by the Jimmycomelately Creek Restoration Project, see Section 2.10.5).

2.10.2 Sequim Bay

Geography

Sequim Bay has a surface area of approximately 7.6 mi^2 at mean lower low water (MLLW) (SBWMC 1989). According to the 1983 EIS for the John Wayne Marina, the highest tide is estimated to be 11.5 feet above MLLW at the bay entrance, while the lowest tide is 4.5 feet below MLLW. Sequim Bay is almost totally enclosed by the formation of Travis Spit (outside of Sequim Bay basin) from the east, which forms the northwestern point of Miller Peninsula. The Bay is approximately 3.5 miles in length (north to south) and over a mile wide (at its widest point, just north of mid-bay).

Topographic features on Miller Peninsula bordering the Bay on the east include Travis Spit; Paradise Cove located south of the spit; Hardwick Point jutting out into the Bay along the central east side; and Goose Point located further south. Topographical features on the west side of the Bay include Schoolhouse Point, Rocky Point (site of Sequim Bay State Park), Pitship Point (now the site of John Wayne Marina); Gibson Point is located along the west side, north of Travis Point.

Geology and Soils

General geology and soils information is discussed in Section 2.10.1. However, some localized information is provided in the 1983 John Wayne EIS. The area near Pitship Point is blanketed by glacial drift over glacially compacted lacustrine silts and bedrock.

Bathymetry

The 1983 EIS summarizes the Ecker et al. (June 1979) Technical Supplement regarding the topography and bathymetry of the Sequim Bay area. The 1983 EIS states:

> "An intertidal and shallow subtidal shelf of varying width extends along the entire 11-mile perimeter of the bay, and drops off rapidly into deep water. The deepest area of the bay is off Pitship Point, with depths as great as 126 feet, while the shallowest areas are located at the south end. A flood tidal delta (shoal) called the Middleground is located around 0.3 miles south of the bay entrance. The entrance channel is approximately 1.6 miles long and an average of 500 feet wide, with water depths ranging from 13 to 30 feet below MLLW. National Ocean Survey Charts from 1881, 1926, and 1967 indicate that the width, depths, and configuration of the entrance channel changed very little during the 86-year period. Unless natural conditions at the mouth of Sequim Bay are drastically altered, the long-term stability of the entrance channel will continue."

Flushing and Circulation Patterns

Sequim Bay is described as a modified two-layer system. Well-mixed water from the Strait of Juan de Fuca flows in through the entrance channel in a turbulent fashion during the flood tide, and is normally colder, with more dissolved oxygen than surface water in the Bay. This water sinks under the surface, displaces and the existing water thereby moving it toward the south end of the Bay and up into the surface layer. On the ebb tide, the well-oxygenated water that entered during flood tide becomes trapped by the entrance sill of the Bay, and as a result pushes the surface water out of the Bay. During its exit, the surface water mixes with water in the Strait. This general circulation pattern is accentuated when the tidal exchanges are large, and greater flushing occurs. Conversely, when there is a small tide exchange, flushing is reduced. Flushing is also increased when the surface water temperatures vary the most from the bottom water temperatures, during summer and early fall (1983 EIS).

The lower (south) end of Sequim Bay, where the major sub-drainages enter the Bay, is poorly flushed. The general circulation pattern is counterclockwise. Circulation in the southern portion of the Bay is very weak with little water exchange between northern and southern portions of the Bay. This leads to low dissolved oxygen conditions in the Bay, especially in summer. It is estimated that only about 10 percent of the water entering the Bay on an incoming tide is "new water" that has not previously been in the Bay (SBWMC 1989).

Wave Conditions

Computations of wave conditions based on wind characteristics in Sequim Bay were presented in the 1983 John Wayne Marina EIS.

Groundwater Recharge

Groundwater recharge estimated (Parametrix 2000) for the West Sequim Bay sub-basin is approximately 6,500 af/yr, and averages 3.2 in/yr over the entire area. This relatively low value of recharge is due to the extensive presence of bedrock, which occupies about 75 percent of the subbasin. Recharge estimated for the non-bedrock areas of the subbasin straddles a contact between precipitation “bands”, showing different values on either side of the band. The majority of predicted recharge in till-covered areas ranges from 5-10 in/yr, and values of 10-20 in/yr are noted in outwash areas. In these areas, precipitation is the limiting factor for recharge. Throughout the subbasin, precipitation minus evapotranspiration does not exceed the transmitting capacity of the till. Rejected recharge (runoff) is predicted to be largely absent from till-covered areas due to the relatively low rainfall (Parametrix 2000)

Factors of Change

Human Influences/Major Projects

From 1892 to 2001, a log sorting and transportation operation was in business at the south end of Sequim Bay. About 35 million board feet were sorted annually at the log yard, and at any one time, there were 2 to 35 log rafts in the water. During that period wetlands were filled, and a road and “pier” were constructed across the historical Jimmycomelately Creek estuary to facilitate the handling and sorting of logs. The major impairments resulting from the fill, road, and pier resulted in the disruption of:

- longshore sediment transport; shorebird, waterfowl, and wildlife use of the historical estuary;
- the flow of energy (i.e., tidal and fluvial energy); upstream and downstream fish passage at all tidal elevations;
- downstream delivery of river water, sediment, and detritus to the estuary; and upstream delivery of tidal water and fish.

Creosote-treated pilings were also installed in intertidal and subtidal areas as anchor points for log rafts. The major impairments resulting from the log yard pilings, log rafts, and historical log yard operations are creosote contamination, other impacts to water quality, shading, prop wash, accumulation of wood debris on the bottom, impacts to eelgrass, and disruption of fish and wildlife use of the area.

<u>Shoreline Armoring</u>

As discussed by the WCC (2002), shoreline armoring has occurred along portions of Sequim Bay. The TAG (as cited in WCC 2002) indicated that some small bulkheads exist along the northwest coast of Miller Peninsula, but their location is unknown relative to the high water line. In addition, 10 percent of the shoreline between Paradise Cove and Hardwick Point is armored (WDNR 2001 as cited in WCC 2002). Development in this segment includes three piers and boat slips at Paradise Cove as well five docks with 10 slips between Paradise Cove and Hardwick Point (WDNR 2001 as cited in WCC 2002).

The TAG indicated that shoreline armoring south of Hardwick Point is reportedly located along the high water line. Shoreline armoring has not been described in the Chicken Coop Creek, Jimmycomelately Creek and Dean Creek estuaries, although estuaries associated with these streams have been altered. A significant portion of Sequim Bay's shoreline has been armored between Dean Creek and Pitship Point. The John Wayne Marina shoreline and within the cove south of Pitship Point is armored (WDNR 2001 as cited in WCC 2002).

Soil Erosion and Sediment Load

Prior to the development of John Wayne Marina, longshore sediment transport was analyzed and it is summarized in the 1983 EIS. Parametrix (2000) stated that although it is difficult to determine the "background" level, or natural rate, of sedimentation into Sequim Bay, accelerated sedimentation appears to be originating from the Johnson Creek watershed (see discussion in Section 2.10.3).

Water Quality

The State of Washington lists Sequim Bay as class AA (Extraordinary) marine water. Sequim Bay was listed on the 1994, 1996 and 1998 Ecology 303(d) list of impaired water bodies due to its failure to meet Washington State standards for dissolved oxygen, pH, PAHs, and fecal coliform (Ecology 2002a). The following reports were among those reviewed for information pertaining to water quality in Sequim Bay:

- *John Wayne Marina EIS* (1983), Chapter 2. Affected Environment
- *Salmon and Steelhead Habitat Limiting Factors WRIA 17* (WCC 2002)
- *Stage 1 Technical Assessment as of February 2000-WRIA 17* (Parametrix 2000)
- *Watershed Approach to Water Quality Management, Needs Assessment for the Eastern Olympic Water Quality Management Area* (Ecology 1998)
- *Clean Water Strategy for Addressing Bacterial Pollution in Dungeness Bay and Watershed* (CCBC and Clean Water Work Group 2002)

Sequim Bay is a significant shellfish area and is certified by the State for commercial shellfish harvest at its southern end. The Bay has experienced water quality problems. The DOH has closed the northern portion of the Bay to shellfish harvest, but the remainder of the Bay is conditionally approved (Parametrix 2000). Fecal coliform levels were below allowable limits for shellfish harvesting even in areas of significant contribution (e.g. mouth of Jimmycomelately Creek), however shellfish harvest is prohibited or conditionally approved in the Bay because of the proximity to point sources (DOH 1999b as cited in Parametrix 2000). Shreffler (2000) reports that the end of the Bay is characterized by anoxic conditions that discolor clamshells and possibly limit productivity. The Bay is also subject to outbreaks of paralytic shellfish poisoning that close shellfish bed harvest (Shreffler 2000).

Shellfish Harvesting Standards Overview

The National Shellfish Sanitation Program (NSSP) requires a shoreline survey and a growing area standard to classify a shellfish growing area. The shoreline survey locates and evaluates all significant point and non-point pollution sources along the shoreline and in upland drainage areas. The growing area standard is the same as the fecal coliform criteria listed for marine waters shown in Table 1-A-1 in Appendix 1-A.

A minimum of 30 samples is required from each sampling station to determine the required statistics. Samples are collected six times a year from “Approved” areas and once a month from “Conditionally Approved” areas. Fecal coliform criteria must be met for Growing Area Standard compliance (DOH 1999a, as cited in Parametrix 2000).

Ecology (1998) stated that Sequim Bay has depressed fish stocks and is becoming more anoxic every year. Sequim Bay is on the 303(d) list for PAH problems in sediment, although historic sampling in the Bay has shown numerous stations (52) throughout the Bay that have clean sediments. Ecology (1998) suggested that the source of the Sequim Bay PAH data should be reviewed.

As outlined in the *Clean Water Strategy* (CCBC and Clean Water Work Group 2002) Sequim Bay has several areas that are closed to shellfish harvesting for a variety of reasons. The three closed areas include all of Washington Harbor (at the mouth of Bell Creek); the John Wayne Marina and Johnson Creek area; and a 300-yard radius around the end of the City of Sequim’s wastewater treatment plant outfall. In the sanitary survey prepared by DOH, the reasons for closures are:

- Boat traffic in the area;
- Contributions from John Wayne Marina; and
- Non-point source pollution from Bell Creek and Washington Harbor drainages, including Johnson Creek.

The southern portion of Sequim Bay State Park tidelands is conditionally approved for shellfish harvesting, which means that this area may be seasonally closed by DOH due to both increased usage and septic system pumping.

Historical Water Quality Information

A 1978 field survey conducted by the Washington Department of Social and Health Services for fecal coliform in Sequim Bay is summarized in the 1983 John Wayne Marina EIS. Results indicated fecal coliform levels were well below the Class AA State standards at the time. The 1983 EIS summarizes Sequim Bay fecal coliform, pH, nutrients, temperature, and petroleum hydrocarbons and trash, discussing these parameters from the late 1960s through the late 1970s. In 1988, the PSCRBT summarized water quality studies conducted in Sequim Bay as follows:

> "The two most recent water quality investigations of the Sequim Bay watershed indicate bacterial contamination is posing a threat to the Bay and the Class AA rating. In an analysis of shellfish and water quality done by WDOE in 1986, bacteriological data from Sequim Bay collected since 1977 (source, receiving water, and shellfish tissue) was reviewed and analyzed. Based on this review, shellfish tissue data indicated relatively high bacteriological concentrations near the mouth of the bay, with decreasing concentrations to the south and east. The fecal coliform load from Bell Creek was estimated to be over 500 times higher than that from the Sequim sewage treatment plant. Data was lacking to measure contributions from remaining watershed streams and irrigation return flows. An integrated basin-wide baseline study was suggested.
>
> "Following this study Clallam County Department of Community Development began the Sequim Bay Water Quality Project (1987) to determine nonpoint pollution impacts of the watersheds draining into Sequim Bay. A conclusion of the study was that ninety percent of the fecal coliform loading to the bay is traceable to the lower two miles of Bell Creek. It is attributed to two large-scale beef and dairy farms and the activities associated with them, including animal access to the creeks. A second significant contributor is animal and land management practices occurring upland and along the irrigation ditches. The irrigation systems in the Sequim Bay area flow from the Dungeness watershed through the Bell Creek watershed to the Johnson Creek watershed. The Highland Ditch does not meet state AA-Extraordinary standards for fresh waters during the summer months and, at least in the case of Johnson Creek, water quality violations can be attributed to Highland Ditch impacts. On-site septic systems did not appear to be major contributors to fecal coliform pollution in the project area. Older on-site systems at the extreme south end of the bay, due to the coarse soils and high water tables, were felt to contribute low levels of fecal coliform to the bay."

More recently, Parametrix (2000) provided the following summary:

> "Two water quality studies of Sequim Bay watershed conducted in the 1980s indicated that water quality is primarily degraded by pathogenic bacteria and viruses (WDOE, 1986 and Clallam County, 1987). Fecal coliform is an indicator organism whose presence is associated with viral and bacterial pathogens that can cause infectious hepatitis, gastroenteritis, shigellosis, or other illnesses. Fecal coliform bacteria as well as other potential pathogens come from the intestinal tracts of warm-blooded animals. Consequently, the basic source of bacterial pollution is human sewage or animal fecal matter. Fecal coliform counts in excess of 230 organisms per 100 grams of shellfish tissue can result in closures of shellfish beds. Bacterial contamination threatens the shellfish industry of Sequim Bay. Two temporary closures of shellfish beds have occurred, at Sequim Bay State Park and at Pitship Point."

<u>Dissolved Oxygen</u>

Sequim Bay is listed as water quality limited for dissolved oxygen (DO). This reflects its nutrient status, and the low level of DO observed in the low circulation (southern) portion of the Bay in mid-summer. Excess nutrients may result in toxic algal blooms and can certainly contribute to increased algal densities in contrast to historic levels.

<u>Nonpoint Sources</u>

Non-point sources of pollution in Sequim Bay originate from three general sources: rural residential uses and practices, agriculture operations such as livestock rearing and hay harvesting, and forest practices (Parametrix 2000). Several irrigation ditches in the Bell Creek (in WRIA 18) and Johnson Creek subbasins have been found to contribute to fecal coliform loads entering Sequim Bay. Bell Creek was estimated to contribute 90 percent of the fecal coliform load entering Sequim Bay (DOH 1999b as cited in Parametrix 2000). A study performed by Ecology indicated that Bell Creek was the single largest source of bacteria to Sequim Bay (Ecology 1998b as cited in Parametrix 2000).

Agriculture

Small farms or large lot, rural residential parcels mirror the problems faced by commercial farms. Sixteen percent of the 1.5 to 5 acre parcels surveyed by Ecology have three to four animals; expanding this to the entire population of this parcel size would mean there are 125 parcels with 525 animals. Animal access to streams or irrigation ditches offers opportunities for direct discharge of waste. High stocking rates add too much manure to the land where surface runoff can carry nutrients and bacteria to nearby watercourses. Landowners generally pasture horses or beef, to control grass and as a hobby or as a minor revenue producing activity. The pasture grass is often overgrazed even where the livestock are rotated to other pastures. In some instances hay is provided to overcome inadequate pasture conditions. This intense use of a small parcel could be described as a "small feedlot" operation. Many, if not all, of the parcels lack adequate animal waste handling programs. Typically, manure accumulates in a corner of the pasture or holding area waiting for disposal. Animal manure is sometimes trucked off the parcel for home garden use.

Ecology’s survey indicated that the number of animals per acre tends to decrease with increasing acreage. Those parcels less than 5 acres in size have higher stocking rates than those parcels that are greater than 5 acres. Most of these have access to streams and/or irrigation ditches. About 65 percent of the parcels irrigate by the sprinkler method. The frequency of irrigation or the water application rate is, for the most part, never checked by the user. In essence, there is no water conservation program in place, either by the user or by the irrigation district.

Irrigation

The use and management of irrigation water is negatively impacting other resources. Irrigation diversions are creating low flow and fish passage problems in the lower Dungeness River. Clallam County Health Department has documented poor water quality in the return flows reaching Sequim Bay (CCDCD 1987). There are 57 miles of open irrigation ditches within the watershed. About seven miles flow through agricultural areas where, in most cases, livestock have access to the ditch. Fifty percent of the system flows through either rural residential or urban areas where the ditch is exposed to various possible contaminants.

Forest Practices

Forest practices which may adversely affect the water quality and biota of Sequim Bay include logging, road building and maintenance, and post-harvest activities such as slash burning, reforestation, and herbicide applications. These activities can cause increased sediment loads, elevated water temperatures, chemical contamination, generation of organic debris, and loss of salmonid habitat.

Forestry activities can have a major effect on water quality through impacts on sediment levels. Current logging practices can be expected to increase sediment yield over background levels by a factor of four. Of this increase, 80 percent is attributable to existing and newly constructed roads. Road segments used by more than 16 trucks per day are seen to contribute 130 times as much sediment as roads not subject to truck traffic and 1,000 times as much as roads that have been abandoned (Reid 1981 as cited in PSCRBT 1988). The effects of logging on stream flows are minimal for larger watersheds where timber harvesting is done in small, well-spaced clearcuts. In small headwater watersheds, road building, clearcutting, and other activities such as yarding and slash burning may result in significantly lower minimum flows and increased peak flows (Harr et al. 1976, 79 and 80 as cited in PSCRBT 1988). On-site damage to stream channels and adjacent riparian habitat in small watersheds can occur due to increases in winter peak flows after logging. Except in highly disturbed and compacted areas, infiltration capacity and erodibility can return to a pre-logged state within 3 to 6 years (Johnson and Beschta 1980 as cited in PSCRBT 1988). Winter logging can accentuate these problems without added precautions on road construction techniques.

Additional sediment from timber harvesting creates the water quality problems discussed earlier in this section. Within the Sequim Bay watershed, sediment deposits within the streams appear to be minimal. Large woody debris is plentiful in all the streams observed within the forested areas. Sedimentation of streambeds is not usually observed where large woody debris from logging and natural blowdown create a stairstep channel profile and form plunge pools downstream of debris accumulations (Keller and Swanson 1979 as cited in PSCRBT 1988). Large woody debris tends to direct fine sediment from the channel to the flood plains and stores gravel in the channel. It also provides a source of nutrients, a substrate for biological activity and creates the large high quality pools necessary for rearing juvenile salmonids. In general, the more habitat diversity (pools, riffles, cover, and off-channel habitat) created by LWD, the greater the rearing potential for salmonids.

Point Sources

According to the WRIA 17 Stage 1 Assessment (Parametrix 2000), ten point sources of pollution have been identified based on NPDES permits. The Sequim Bay Sewer Treatment Facility (STF) had been a significant source of untreated sewage to Sequim Bay (DOH 1999b as cited in Parametrix 2000). Shellfish harvesting is approved with conditions in this location due to the outfall of the STF. The City of Sequim Sewage Treatment Plant is now a tertiary treatment plant discharging Class A water into Sequim

Bay and reusing some water for City purposes. Water quality data is routinely collected at the outfall west of Sequim Bay.

The point sources, each with an individual NPDES permit, are:

- Battelle Marine Sciences Lab
- Sequim Bay State Park Sewer Treatment Plant
- Dunlap Towing and Blyn Log Yard (now terminated within the JCL Restoration Project)
- Clallam County Public Works and Blyn Pit
- Washington State Dept. of Transportation Pit Q83
- Jefferson County Public Works, Blyn Pit
- AT&T Blyn
- USWCOM Blyn Td2 Radio Building
- Elwick Dam
- Lucinda Lake Dam

NPDES point source locations provided by Ecology in some cases may give facility names and locations that may not be entirely representative of existing conditions. The Ecology database also does not distinguish between stormwater and/or wastewater permits. No specific monitoring data or compliance problems were available for these specific point sources. As noted in the Phase 1 Assessment conducted by Parametrix (2000), marine water quality and outfall data is not available for the numerous point sources that discharge to Sequim Bay.

The *Sequim Bay Watershed Management Plan* (SBWMC 1989) identified the log yard (discussed above, now acquired and closed as part of the Jimmycomelately Creek Restoration Project) as one of the six most significant sources of pollution into Sequim Bay. There are open, harvestable commercial shellfish beds approximately 150 feet west of the log yard. The main water quality impacts affecting these shellfish beds are addition of wood waste and chemical leachates from logs rafted in water, which contribute organic substances to the water that can lead to oxygen depletion.

Restoration and Monitoring

The JSKT purchased the log yard property from Dunlap Towing in spring 2001. Cessation of logging operations and removal of the log yard pier, the Log Deck Road, portions of the Old Blyn Highway, and wetland fill, are being implemented in 2003/2004 as part of the Jimmycomelately Creek-Lower Sequim Bay Estuary Restoration Project. The partners in this project intend to remove the remaining creosote-treated pilings and associated sediment; remove the log yard pier; and grade the existing shoreline to match the 1870 shoreline. These actions are expected to result in habitat gains (salt marsh, brackish marsh, tidal channels, mudflats, and native upland plant communities), as well as restored estuarine processes and functions in support of fish, shellfish, shorebirds and waterfowl. A further discussion of restoration and monitoring activities planned for Sequim Bay is included in Section 2.10.5.

According to Eric Crecelius (pers. comm, December 2002), Battelle Research Lab collects samples on a monthly basis and submits water quality reports to the City of Sequim in the "zone of dilution" for the City's sewer outfall.

Water Cleanup Plans

As discussed in Chapter 1 and Appendix 1-A, under Section 303(d) of the Federal Clean Water Act, the State of Washington is required to develop plans aimed to identify and correct water bodies which have failed to meet water quality standards set forth by the State. A TMDL, or Water Cleanup Plan, is required for every pollutant that caused the water body to fail the specified water quality standard(s). As of 2003, no TMDLs have been established or planned for any of the parameters of concern for Sequim Bay. However, the *Draft Water Cleanup Plan for Bacteria in the Lower Dungeness Watershed: TMDL Submittal Report* published by Ecology (Hempleman and Sargeant 2002) identifies and briefly describes shellfish closures in Sequim Bay due to fecal coliform levels.

As discussed in Section 2.8.5 (Dungeness Bay Water Quality), Dungeness Bay has exceeded both State and National Marine Sanitation Requirements for water quality standards in commercial shellfish harvesting areas for fecal coliform (Hempleman and Sargeant 2002). As a result, DOH closed prohibited commercial shellfish harvest in about 300 acres of the Dungeness Bay in 2000 and an additional 100 acres in 2001 (for more information, see Section 2.8.5). Clallam County was required to form a shellfish protection district. Subsequently, the Sequim-Dungeness Clean Water District (Clean Water District) was formed in 2001 (CCBC and Clean Water Work Group 2002). In addition to the Dungeness Watershed, the Clean Water District includes other independent tributaries to the Strait of Juan de Fuca, including the Sequim Bay Watershed.

Fish and Habitat

Sequim Bay supports important shellfish and anadromous fish populations. Commercially important marine fish that utilize the Bay include Pacific herring and surf smelt (PSCRBT 1988). Very little is known about resident fish distribution and abundance within the lower Bay. Sequim Bay is a significant shellfish rearing area for commercial and recreational harvest, including littleneck clam (*Protothaca staminea*) and humpback shrimp (*Pandalus hypsinotus*).

The *Salmon and Steelhead Habitat Limiting Factors Report for WRIA 17* (WCC 2002) discusses the nearshore environment of Sequim Bay, from Rocky Point to Pitship Point. The discussion includes drift cell descriptions from Ecology and the WDNR Shorezone Inventory from 2001. The TAG also observed Ecology's 2001 shoreline photos in attempts to understand habitat impacts to nearshore processes and effects on salmon migration, feeding. and rearing.

The partners working on the Jimmycomelately Creek–Sequim Bay Estuary Restoration Project believe that many of the estuarine habitat attributes have been lost or degraded in the lower Sequim Bay estuary. In particular, the log yard is believed to have altered sediment and water quality in the Bay, and resulted in direct losses of fish and wildlife habitat from filling, log storage and handling, and noise. Inadequate data are available to quantify adverse impacts on fish and wildlife resulting from the log yard and associated activities. Preliminary investigations indicated that incremental losses of intertidal mudflat, eelgrass, and salt marsh habitats in the project area have resulted in diminished populations and reduced distributions of many species of anadromous salmonids, demersal fish, clams, oysters, and crabs. A total of 13.6 acres of fill (56,405 yd^3) could be removed and the excavated areas could then be graded and restored to elevations that will support native, connected, more functional estuarine and riverine habitats (Shreffler 2000).

2.10.3 Johnson Creek (WRIA # 17-0301)

Geography

Johnson Creek is the third largest stream within the Sequim Bay watershed (~6.2 mi^2) and the westernmost stream of WRIA 17. Johnson Creek flows in a northeast direction from the foothills of the Olympic Mountains into the west side of Sequim Bay at Pitship Point (near the John Wayne Marina). The east branch originates near the top of Burnt Hill, at an elevation of approximately 2200 ft. The west branch drains an unnamed pond/lake located at an approximate elevation of 400 ft. The total length of Johnson Creek is ~ 7.4 miles. Five river miles are attributed to the mainstem, while two miles consist of tributaries (Parametrix 2000 and WCC 2002). The upper creek flows through a substantial ravine, while the lower two miles are low gradient, rising ~400 feet in two miles (WCC 2002).

Hydrology & Geohydrology (Natural Water Balance)

Hydrology

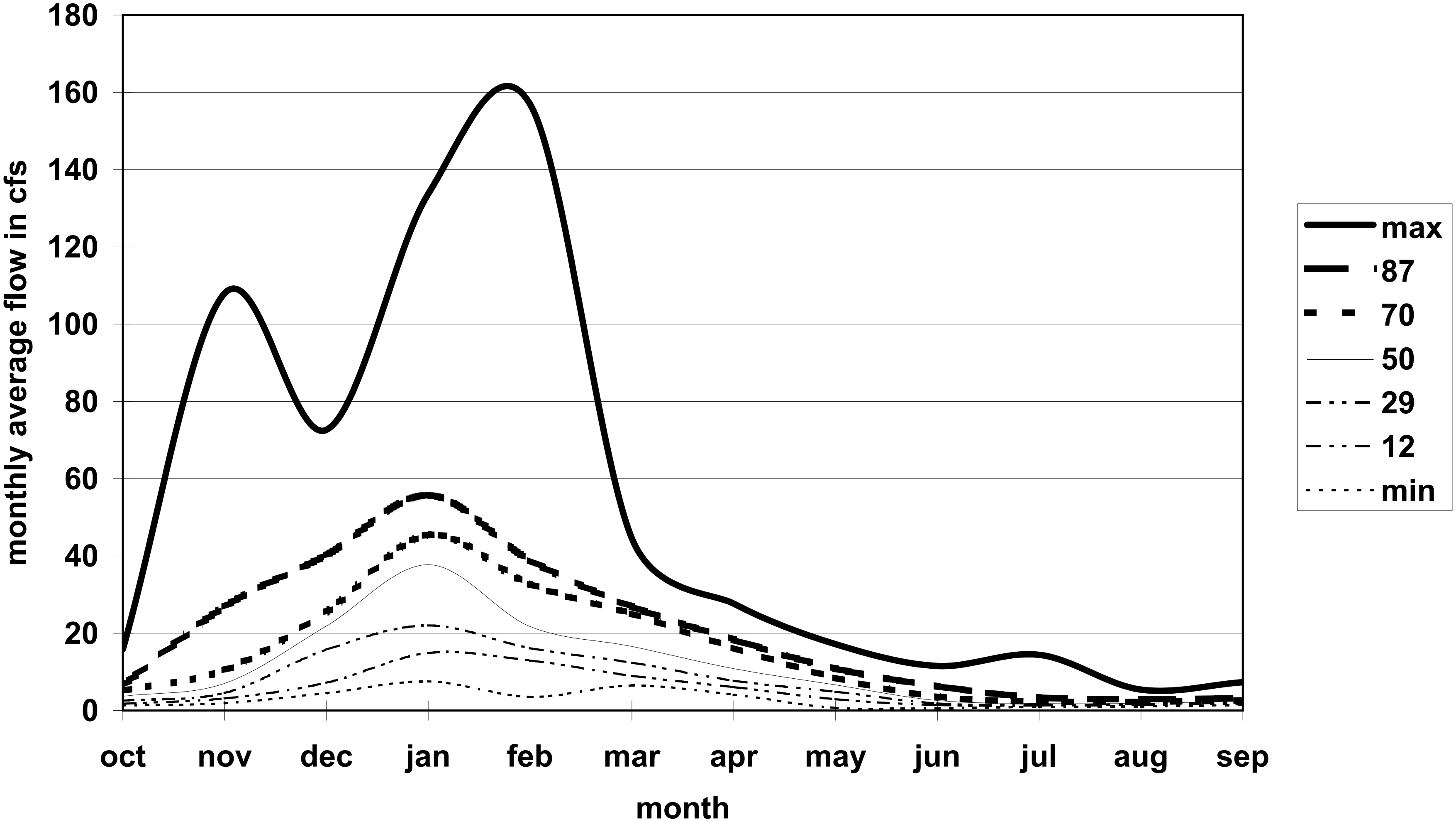
Periodic streamflow data has been collected on Johnson Creek from 1952 to 2002. According to the PSCRBT (1988) historic flow measurements were recorded for Johnson Creek by the USGS from July through October 1952 and May through September 1961, and by Reid, Middleton & Associates in 1976 (frequency of data collection was not provided). The highest flow recorded in 1952 was 5.77 cfs (in July) and the lowest was 0.24 cfs (in August). In 1961, the highest recorded flow was 6.89 (in June) and the lowest was 0.28 cfs (in July). A flow of 8.0 cfs was recorded in August of 1976. The 1994 DQ Plan indicates Ecology took over 100 flow measurements on Johnson Creek mainly from April through October 1968 through 1991.

Figure 2.10-2 illustrates the hydrograph for Johnson Creek, based on modeling conducted by the U.S. Bureau of Reclamation.

Limited streamflow data collected by the Clallam County is also available for Johnson Creek from 1999 through 2002. As summarized by Foster Wheeler (2002), the Streamkeepers recorded a flow range of 1.7 to 6.3 cfs at RM 0.0 (from fall 1999 through spring 2002) and a range from 1.3 to 4.9 cfs at RM 0.6; these numbers are generally consistent with historic ranges.

The USGS (Thomas et al. 1999 as cited in Parametrix 2000) and the Sequim-Dungeness Valley Agricultural Water Users' Association (Jeldness 1996-1998) have reportedly collected periodic data on Johnson Creek beginning in 1996. Some of that data is also summarized in MWG (1999). The DQ Plan (1994) characterized flows in Johnson Creek as generally in the 2 to 5 cfs range, with peaks near 10 cfs and fall low flows of less than 1 cfs. It is the easternmost stream directly influenced by irrigation flows and was closed to new appropriations in 1983. Additionally, Parametrix (2000) indicated that measured flows

Figure 2.10-2 Johnson Creek Hydrograph (at the Coast - % time <)
1952 - 76. Recent data indicate these flows are overestimated.



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for Johnson Creek range from less than 0.1 cfs to about 10 cfs and summer flows generally range from 0.1 cfs to 1.5 cfs. However, dates and actual flow records were not provided.

Geohydrology and Hydraulic Continuity

Specific information for Johnson Creek was not provided in the relative hydraulic continuity potential (RCHP) preliminary analysis for Sequim Bay watershed conducted by Parametrix as a part of the Stage 1 Technical Assessment (2000).

Factors of Change

Human Influences/Major Projects

The PSCRBT (1988) and Parametrix (2000) report a sediment-plugged culvert near the BPA power lines (near RM 2.5). The culvert is located where an old unused road crosses Johnson Creek. At the time of the report (1988) sediment was built up to the level of the road on the upstream side, allowing very little water to pass through the culvert. The majority of water was pouring over the old road crossing and cutting down into the road material. The County expected sediment would erode from the site and eventually deposit in the bay during heavy rainfall events. In 1988, the PSCRBT recommended either removing the old road crossing and culvert or rebuilding the road. Although Parametrix (2000) reports the same information as the County, the WCC indicates no known fish barriers exist on Johnson Creek (2002). Turnbull (as cited in WCC 2002) notes log weirs placed downstream of the culvert at Highway 101.

Modifications to Hydrograph/Fluvial Geomorphology

<u>Channel Conditions</u>

The lower gradient section of Johnson Creek (below Highway 101) has been channelized, heavily armored, and is disconnected from its floodplain (TAG as cited in WCC 2002). Development has eliminated sinuosity and instream structure (TAG as cited in WCC 2002).

<u>Log Jam and Large Woody Debris Removal</u>

Information provided by PSCRBT (1988) indicated that land use along the stream was primarily forested (the uppermost 5.2 miles) at the time. Approximately 0.75 miles of stream corridor in the upper reaches of the watershed had been logged by 1988, leaving no buffer strip. However, development has occurred since then. The WCC (2002) listed large woody debris information as a data gap, although TAG members noted some trees downstream of Highway 101. The condition above Highway 101 is unknown.

Soil Erosion and Sediment Load

A fan-shaped delta occurs where Johnson Creek empties into the Bay at the John Wayne Marina and a plume of sediment can be seen where Highland Ditch empties into the creek. Other sediment sources in Johnson Creek are the plugged culvert near the BPA power lines at river mile 2.5, and poorly constructed logging roads in the upper reaches of the Johnson Creek watershed. A major hillside failure at the Highland Ditch, which empties into Johnson Creek at river mile 1.5, is noted as the most likely source of the turbidity observed immediately this outfall.

A marina and trailer park have been developed in lower Johnson Creek. Incision has been observed in this area, with streambank exposure. Activities associated with construction of a footbridge (dirt moving/grading) may also increase sediment to the stream, although active erosion along the remaining streambanks had not been observed by the WCC (2002). Sediment input, fine sediment, mass wasting, and sediment supply are listed as a data gaps for Johnson Creek.

Water Quality

Surface Water

The State of Washington classifies Johnson Creek as a Class AA (Extraordinary) stream under WAC 173-201 A. Parametrix indicates Johnson Creek was generally assumed to have good water quality (Ecology 1998b as cited in Parametrix 2000). However, Johnson Creek was listed on the 1994, 1996 and 1998 Ecology 303(d) list of impaired water bodies due to its failure to meet Washington State standards for fecal coliform (Ecology 2002a). Violations reportedly occurred at the mouth Johnson Creek.

Water temperature and dissolved oxygen in Johnson Creek were recorded in 1991 and 1992 by Clallam County and between 1997 and 1999 as a part of the Eight Streams Project (WCC 2002). The recorded water temperatures provided in the WCC 2002 are displayed in Table 2.10-1. The WCC (2002) indicates that only one dissolved oxygen reading was greater than 8 mg/L (recorded July 17, 1998).

Table 2.10-1. Limited Water Temperature Data for Johnson Creek.

Location	1991	1992	1997	1998	1999
RM 0.0	15	18	15	14	13.3
RM 0.6	NA	NA	13.5	12	13.3

Note: temperatures are shown in Degrees Celsius
Source: Streamkeepers as cited in WCC 2002

Irrigation ditches located in the Johnson Creek basin have contributed elevated levels of fecal coliform (DOH 1999b as cited in Parametrix 2000).

Stormwater

Stormwater in the Johnson Creek drainage is noted as a water quality concern in the *Draft Water Cleanup Plan for Bacteria in the Lower Dungeness Watershed*: *TMDL Submittal Report* (Hempleman and Sargeant 2002). Detailed information regarding this concern is not provided.

Fish and Habitat

Salmon Distribution, Abundance & Stock

The actual use of Johnson Creek by salmonids is not well documented. Local residents reported having observed salmon in the creek, but neither species nor number of fish have been documented (1983 EIS). Although fish use is unknown, the PSCRBT (1988) indicates chum salmon could spawn in accessible areas of the creek.

Instream Flows

As discussed by Parametrix (2000), optimum instream flows developed from Ecology and WDFW investigations (published 1997) using the toe-width method for Johnson Creek indicate theoretical optimum flows ranging from 5 cfs to 26 cfs for steelhead rearing and spawning. Table 2.10-2 summarizes the theoretical optimum flows developed by Ecology and the WDFW (1997 as cited in Parametrix 2000) for coho, chum, and steelhead life stages for Johnson Creek.

Table 2.10-2. Theoretical Optimum Instream Flow Summary for Johnson Creek (1997).

Time of Year	Theoretical Optimum Flow (cfs)	Species/Life Stage
Nov – Jan	13	Coho & Chum salmon spawning
February	8	
March – April	26	Steelhead spawning
May – June	17	Rearing / incubation
July – October	5	Steelhead rearing

Source: Ecology and WDFW 1997 as cited in Parametrix 2000

USFWS also proposed instream flows for Johnson Creek (Hiss 1993 as cited in Parametrix 2000). The theoretical optimum flows for coho, chum and steelhead are summarized in Table 2.10-3.

Table 2.10-3. Theoretical Instream Flow Predictions for Johnson Creek (1993).

Time of Year	Theoretical Optimum Flow (cfs)	Species/Life Stage
October	4	Coho salmon spawning
Nov – Jan	10	Chum salmon spawning
Feb – June	10	Steelhead spawning
July – August	2	Steelhead rearing

Source: Hiss 1993 as cited in Parametrix 2000

Habitat Use and Availability

Spawning and Rearing Habitat

Although fish habitat within Johnson Creek is discussed in multiple documents, many data gaps exist. The WCC (2002) points out that pool frequency, quality and percent are data gaps for Johnson Creek. Downstream of Highway 101 it is noted that few deep pools with adequate cover exist, and although TAG members reportedly observed some fallen trees, large woody debris data remains a data gap (WCC 2002).

The 1983 John Wayne Marina EIS indicated that potential spawning habitat exists in Johnson Creek for chum and coho salmon and cutthroat trout and steelhead trout. It was noted that Johnson Creek could theoretically support spawning of about seven female coho (based on 1977 WDF formulas) if the first mile was accessible to coho. However, the EIS pointed out that, because of limited rearing habitat, it is likely only chum salmon could successfully spawn and rear in Johnson Creek. Visual surveys conducted in the lower mile of Johnson Creek during May and June in 1981 detected no juvenile salmonids (1983 EIS). Low summer flows probably limit use by species other than chum salmon (PSCRBT 1988).

Habitat Connectivity

Fish Passage Barriers

Although the Johnson Creek system consists of ~7.4 miles of streams and tributaries, both the PSCRBT (1988) and Parametrix (2000) indicated that less than 0.5 mile of the stream is accessible to anadromous fish. The 1983 EIS reported that a cascade near RM 1.0 (downstream of Highway 101) caused by several large logs blocks fish access. The PSCRBT (1988) and Parametrix (2000) indicated that a sediment-plugged culvert was found near the BPA power lines around RM 2.5 that appears to be blocking passage. The PSCRBT (1988) recommended removing the old road crossing or rebuilding the road (cited as the cause of sediment blockage); Parametrix (2000) repeats this recommendation. Since the recommendation is stated in the 2000 report, it appears that it had not yet been resolved. However, the WCC (2002) states there are no known fish barriers in Johnson Creek and that although a culvert exists at Highway 101 it is not a barrier as fish are observed on both sides.

Habitat Fragmentation

The lower gradient section of Johnson Creek below Highway 101 has undergone channelization and armoring. Due to incision in the lower reaches associated with a trailer park and marina, the floodplain is mostly cut off (TAG 2002 as cited in WCC 2002).

Habitat-Forming Processes and Causes of Change

Delivery/Routing of Water

Channelization and streambank armoring on Johnson Creek have altered the natural flow of water, eliminating sinuosity, instream structure, and floodplain access in its lower reaches as well as its estuary function (WCC 2002). The Highland Irrigation District Canal, part of the Sequim/Dungeness irrigation system that diverts water from the Dungeness River, empties tailwater into Johnson Creek that is then used for irrigation downstream (Parametrix 2000).

Delivery/Routing of Sediment

Development and associated channelization and streambank armoring as well as poorly functioning culverts have caused changes in natural sedimentation processes (although sedimentation remains a data gap). Poorly constructed logging roads are most likely one of the primary sources of sediment within the Johnson Creek watershed (Parametrix

2000). A fan-shaped delta of sediment at the mouth of Johnson Creek extends out into Sequim Bay.

As discussed by the PSCRBT (1988) the Highland Ditch empties into Johnson Creek at RM 1.5. A major hillside failure has occurred at this location. Turbidity observed in Johnson Creek immediately below the outfall (before 1988) was most likely from the failure or was conveyed to the creek by the Highland Ditch.

Ecosystem Functions and Conditions

Riparian Corridor and Floodplain

Riparian conditions are listed as good above Highway 101 and between the highway and trailer court. However, aerial photographs indicate farm ponds on a tributary to Johnson Creek above Highway 101 lack vegetation, and riparian buffers from the trailer court to the mouth do not exist (TAG as cited in WCC 2002).

As noted above, the lower gradient section of Johnson Creek below Highway 101 has undergone channelization and armoring. Due to incision in the lower reaches associated with development (trailer court and marina), flows reportedly have no access to the floodplain (TAG 2002 as cited in WCC 2002).

Nearshore/Estuary

The tidally influenced area of Johnson Creek has lost all estuary function because it has been channelized and heavily armored as it flows along a retaining wall alongside the John Wayne Marina (TAG as cited in WCC 2002).

2.10.4 Dean Creek (WRIA # 17-0293)

Geography

Dean Creek is an intermittent stream draining about three square miles. Dean Creek drains the east side of Burnt Hill and the northwest side of Lookout Hill, flowing behind the Jamestown S'Klallam Tribal Casino into the southwest corner of Sequim Bay. The headwaters of Dean Creek begin at an elevation of ~1900 feet, approximately four miles from its mouth (WCC 2002).

Fluvial Geomorphology

WCC (2002) described a lack of streambank stability information for Dean Creek, however the lower half-mile of the creek exhibits bank scour and has no pools. The upper reaches generally have stable banks with a few exceptions. One exception is a left bank slide noted at RM 1.0 that lies within a geologically steep, unstable area. A road that was apparently not maintained or was improperly abandoned has compounded conditions at this site. Turnbull (pers. comm. cited in WCC 2002) indicates a small diversion with evidence of recent maintenance and no fish screen present. A valve with connections to the downstream pipe reportedly controls flow (WCC 2002).

Hydrology

According to an inventory of stream flow data conducted in preparation of the 1994 DQ Plan, peak flow data only has been recorded monthly by the USGS from 1949 through 1970 on Dean Creek, and no gaging efforts are currently present.

Orsborn and Orsborn calculated peak daily flood flows of 45 cfs for the two-year flood and 165 cfs for the 100 year flood. Treated stormwater from the casino enters a tributary to Dean Creek (WCC 2002).

Figure 2.10-3 illustrates the hydrograph for Dean Creek, based on modeling conducted by the U.S. Bureau of Reclamation.

Geohydrology & Hydraulic Continuity

Specific information for Dean Creek was not provided in the relative hydraulic continuity potential (RCHP) preliminary analysis for Sequim Bay watershed conducted by Parametrix as a part of the Stage 1 Technical Assessment for WRIA 17 (2000).

Factors of Change

Human Influences/Major Projects

The PSCRBT (1988) identified minimal impacts to Dean Creek. Clear cuts were identified as several years old and, as of 1988, vegetation appeared to be growing back.

A small diversion observed near RM 1.0 with evidence of recent maintenance, and no fish screen, is noted in the Salmon and Steelhead Habitat Limiting Factors WRIA 17 Assessment (WCC 2002). Additionally, there are at least two culverts, one on US 101 and the other at the power line right-of-way. These culverts are listed as possible migration barriers that should be investigated (WCC 2002).

Modifications to Hydrograph/Fluvial Geomorphology

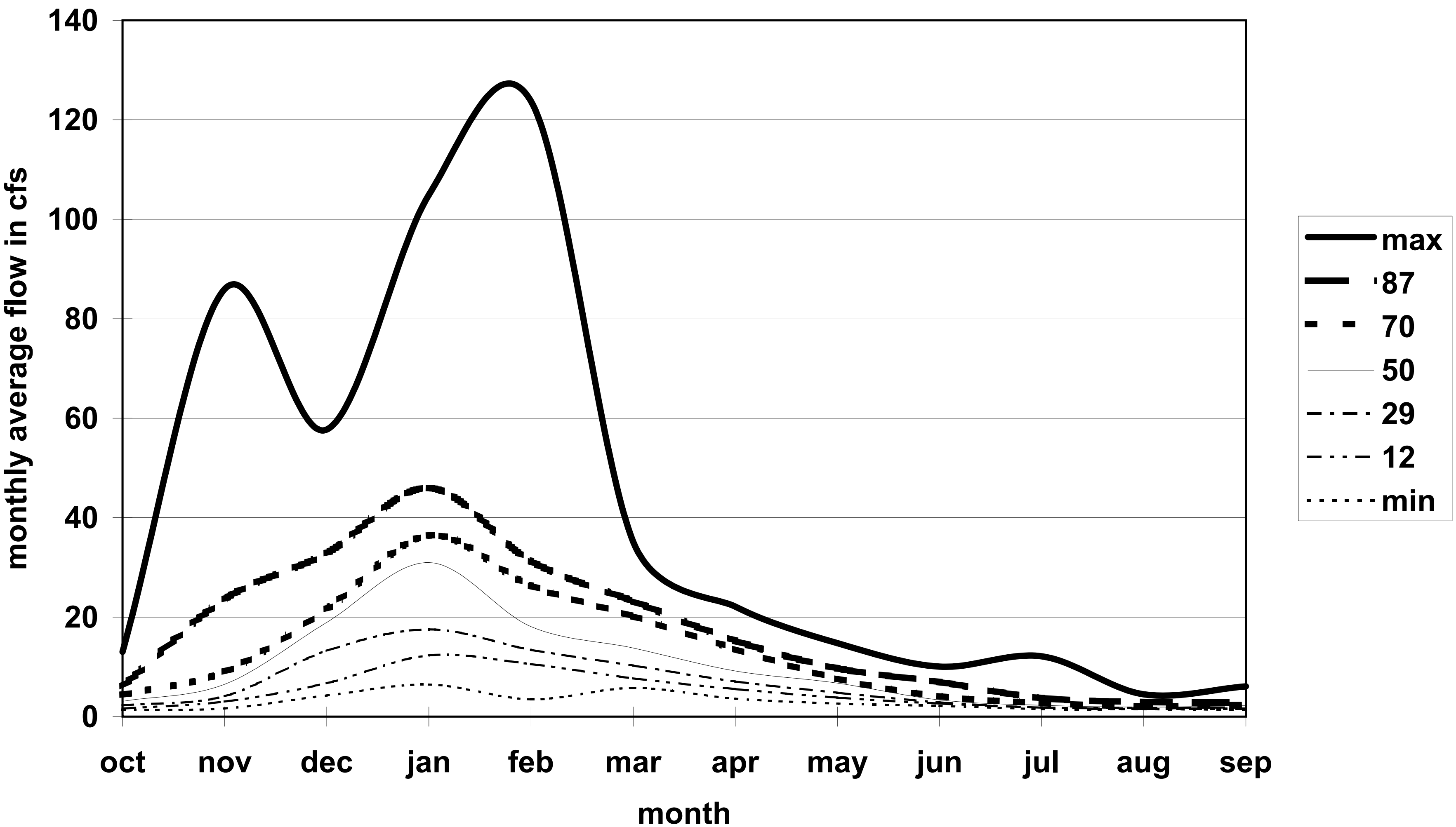
Orsborn and Orsborn (1999) state that Dean Creek appears to go subterranean above Highway 101 due to gravel deposits (aggradation) in the streambed.

As a part of the WRIA 17 Habitat Limiting Factors Analysis (WCC 2002), information pertaining to the Sequim Bay subbasin was collected and summarized. The TAG noted that data gaps exist for fine sediments, pools, and sediment input for Dean Creek. TAG members noted that fines are noticeable as turbidity after slide events (WCC 2002)

Water Quality

The State of Washington classifies Dean Creek as a Class AA (Extraordinary) stream under WAC 173-201 A. The WCC (2002) reports that water temperature data is very sparse and therefore is considered a data gap, along with dissolved oxygen. Dean Creek does not appear on the State 303 (d) list of impaired water bodies.

Figure 2.10-3 Dean Creek Hydrograph (at the Coast - % time <)
1952 - 76. Recent data indicate these flows are overestimated.



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Fish and Habitat

Salmon Distribution, Abundance & Stock Status

As of 1988, Clallam County indicated fish use within Dean Creek was unknown, although chum and coho were listed as potential in the lower 0.5 miles (PSCRBT 1998).

Shreffler (2002) indicated a small amount of data is available from minnow traps installed in Dean Creek. Details including species, sampling site locations, methods, data collection periods, and results had not yet been reviewed.

Shreffler (2002) provided the following regarding restoration strategies for Dean Creek:

> "Dean Creek shares many of the same impairments as Jimmycomelately Creek, but on a smaller scale. Like Jimmycomelately Creek, Dean Creek was straightened and moved into an artificial channel in the past, and culverts and roads (Highway 101, Old Blyn Highway, and Log Deck Road) have constricted both flood flows and tidal action. Non-native vegetation (e.g., Himalayan blackberry and scotch broom) have colonized the creek banks and other associated fill, causing further constriction of the narrow, artificial creek channel. These constrictions have contributed to a cycle of sediment aggradation, flooding of the area roads, and dredging."

Dean Creek, from the Highway 101 culvert downstream to Sequim Bay, will be realigned and restored as part of the Jimmycomelately Creek-Lower Sequim Bay Estuary Restoration Project. Proposed restoration actions for realigning Dean Creek through the log yard are to:

- Realign the Dean Creek channel;
- Place and bury LWD at key locations in the channel and in the creek banks;
- Place streambed spawning gravels in the channel (if necessary);
- Hydroseed in upland areas; and
- Plant native trees, shrubs, and groundcover in upland areas.

Related activities include:

- Construct sediment and erosion control structures;
- Construct a stream bypass to divert flow if the creek is not dry during the construction window; and
- Remove approximately 17,000 cubic yards of fill and dispose (likely offsite).

Expected results of the restoration actions:

- Net gain of approximately 1,000 linear feet of functional creek channel;
- Removal of approximately 17,000 cubic yards of fill;
- Improved hydrology and sediment transport;
- Improved roosting and feeding habitat for shorebirds and waterfowl;
- Improved fish access to upstream habitats;
- Improved feeding and rearing habitat for juvenile salmonids;
- Improved spawning habitat for adult salmonids;
- Increased primary and secondary production;
- Improved detritus transport to the estuary and
- Reduced flooding problems.

Instream Flows

Optimum instream flows developed by Ecology and WDFW (1997) using the "toe-width" method are available for Dean Creek. Theoretical optimum flows for coho salmon spawning are listed as 11 cfs from November through January and 7 cfs from February to April. The optimum flow for steelhead rearing in Dean Creek from May through October is 4 cfs. Table 2.10-4 summarizes these theoretical optimum flows for Dean Creek, developed by Ecology and the WDFW (1997 as cited in Parametrix 2000).

Table 2.10-4. Theoretical Optimum Instream Flow Summary for Dean Creek.

Time of Year	Theoretical Optimum Flow (cfs)	Species/Life Stage
Nov – Jan	11	Coho salmon spawning
Feb – April	7	
May – Oct	4	Steelhead rearing

Source: Ecology and WDFW 1997 as cited in Parametrix 2000

Habitat Connectivity

Fish Passage Barriers

According to the *Sequim Bay Watershed Characterization*, completed in 1988 by the PSCRBT, an impassable fish barrier was listed at RM 0.5. The report indicated the extreme lower 1000 feet above Highway 101 generally lacked adequate pool areas and that fisheries could be improved with careful placement of LWD (PSCRBT 1988).

According to the WCC (2002) possible passage barriers within Dean Creek include a culvert at the power line right-of-way as well as a culvert at US 101. An impassable forty-foot falls is located downstream of the power line near RM 1.2. According to personal communication with Hilton Turnbull (as cited in WCC 2002), resident fish exist between the falls and the powerline.

Although pool habitat information for Dean Creek is lacking, pools are present between gradient areas and, according to Turnbull (pers. comm. as cited in WCC 2002), fish are reportedly present in all pools. Type of fish present was not specified.

Habitat Fragmentation

Channelization and armoring of the streambank, the construction of culverts, and development associated with logging practices in the vicinity of the stream corridor have eliminated the connectivity of aquatic and riparian habitat. Two culverts and one forty-foot waterfall in Dean Creek are listed as known or potential fish passage barriers. Historic wetland communities have been lost through development.

Additionally, road crossings concentrated in the lower watershed, calculated at 3.16 per stream mile, fragment the riparian corridor (PNPTC unpublished data 2002, as cited in WCC 2002).

Habitat-Forming Processes and Causes of Change

Delivery/Routing of Water
Channelization has significantly altered the natural flow of Dean Creek and there is currently no connection to its floodplain within its lower reaches.

Delivery/Routing of Sediment

Dean Creek has undergone channelization and streambank armoring which has in turn contributed to a cycle of sediment aggradation and flooding of the area roads. Dean Creek is presently the most frequently dredged creek in all of Clallam County (Pat McElroy, Clallam County Roads Department, pers. comm. provided by Shreffler 2002). More information is provided in the restoration discussion above.

The WCC indicated that sediment input remains a data gap (2002). Road density is reportedly 4.3 miles of road per square mile of Dean Creek watershed (PNPTC, unpublished data as cited in WCC 2002), but road impacts have not been studied.

Ecosystem Functions and Conditions

Riparian Corridor
The WCC (2002) reported that the existing riparian zone in the lower half-mile consists primarily of willow. Large woody debris and future recruitment is lacking in this area and road crossings fragment the riparian corridor. The riparian corridor improves above RM 0.5, where a mixed stand of deciduous trees and conifers of varying ages provides a multi-story canopy (WCC 2002). In upper Dean Creek, the improved riparian conditions may provide channel stability, erosion resistance and shade; the TAG indicated that habitat is quite good with the presence of large woody debris and pools in between areas of steep gradient in the upper watershed (as cited in WCC 2002).

As discussed in Section 2.10.5 (Jimmycomelately Creek), non-native vegetation (e.g., Himalayan blackberry and scotch broom) have colonized the creek banks within the Sequim Bay watershed and negatively affected stream channel conditions. Activities planned for Dean Creek (as a part of the Jimmycomelately Creek-Lower Sequim Bay Estuary Restoration Project, details outlined by Shreffler in 2001) include realigning portions of Dean Creek and planting native vegetation and hydro-seeding in upland areas.

Floodplain
Floodplain function along Dean Creek has been severely altered due to development in the floodplain and stream channelization. TAG members (as cited in WCC 2002) indicated that Dean Creek has been channelized and its streambanks have been armored below RM 0.5; flows have no access to the floodplain there. Floodplain habitats including historic wetlands, and riparian areas have been lost to parking lots and logging operations. As a result, instream sinuosity and complexity have been eliminated (TAG 2002 as cited in WCC 2002).

Wetlands and Nearshore/Estuary Conditions

The lower watershed and associated estuary have been filled for log yard activities; all historic wetland/salt marsh habitats have been eliminated and as a result, estuary function has been lost (WCC 2002).

Monitoring

As discussed above, Dean Creek will be included in the Jimmycomelately Creek-Lower Sequim Bay Estuary Restoration Project (Shreffler 2002).

2.10.5 Jimmycomelately Creek (WRIA # 17-0301)

Geography

Jimmycomelately (JCL) Creek is the largest stream in the Sequim Bay watershed. It is nearly 9 miles long from its headwaters to its mouth, located at the south end of Sequim Bay. Jimmycomelately Creek drains an extended interior foothill watershed of approximately 16 $mi.^2$ (10,000 acres), with a vertical drop of 2500 feet over 19.8 miles. Bear Mountain and the Gold Creek basin's north ridge border the Jimmycomelately Creek basin to the south; and the divide separating Jimmycomelately Creek from the Snow Creek/Trapper Creek headwaters borders the Jimmycomelately Creek basin to the southeast. Blyn Mountain is the northeast boundary and Sequim Bay borders the watershed to the north (DQ Plan 1994).

Palo Alto, an area described as a broad, flat valley, is the central feature of the creek's upper watershed. A west fork of Jimmycomelately Creek flows east out of the Palo Alto valley/saddle and is joined by a south fork originating from Bear Mountain's southeast-east edge. The creek flows north into the head of Sequim Bay after being joined by a short east fork (originating from Blyn Mountain's south side) (DQ Plan 1994).

The major sub-drainages contributing to the creek are the West Fork and Thicket Creek to the west, and the East Fork, East Fork Tributary, and Mt. Zion Tributary to the east (Donald 1990 as cited in Shreffler 2000). The Jimmycomelately Creek watershed is predominantly federal and state forestland with 8,935 acres containing timber at least 60 years of age or older (PSCRBT 1988 as cited in Shreffler 2000).

The relatively steep, forested portion of the drainage ends approximately 1.8 miles from saltwater, at which point the river enters a more gently sloping area that was historically wetlands (Shreffler 2000). Fish migration is blocked by an impassable falls at RM 1.9 (Shreffler 2000). Below RM 1.0, the land adjacent to the stream is developed for residences and small farms.

Soils

As discussed in more detail elsewhere, Jimmycomelately Creek is the subject of a major restoration project that includes realigning a substantial portion of the lower creek. Two dominant soil types have been identified (by the Clallam Conservation District) along the area to which the creek's channel will be re-routed. The Mukilteo Muck (0 to 1- percent slopes) is primarily found on the south side of Highway 101 upstream for approximately 750 feet along the proposed stream course. Lummi Silt Loam (0 to 3 percent slopes) is identified in the southern portion of the proposed project site, extending north from Corriea

Road for approximately 1,000 feet (Clallam Conservation District 2001 as cited in Shreffler 2001).

Shreffler (2001) indicated that historic soil conditions are unknown but are assumed to have supported forested wetlands (palustrine emergent wetland vegetation) to the head of tidal influence. In this boundary area, the plant community would have shifted to salt-tolerant (estuarine emergent) vegetation (Shreffler 2001).

Fluvial Geomorphology

In an attempt to determine historic channel conditions for Jimmycomelately Creek, the Jimmycomelately Creek-Estuary Restoration Project technical group reviewed U.S. Coast and Geodetic Survey archival maps (1870, 1914, 1926). Shreffler (2000) reported that the Jimmycomelately Creek channel naturally migrated across the alluvial fan and that it was once a sinuous fluvial channel, connected to extensive tidal marshes, that meandered across its floodplain into an extensive estuary. The historic estuary is estimated to be nearly triple the size of its current, disconnected estuary (2000). Diking and rerouting began in the early 1890s when the Milwaukee Railroad was constructed and by 1926, the creek channel had been moved, straightened, and diked into the location it would occupy until the end of the millennium. These human activities have greatly altered the morphology of Jimmycomelately Creek, as discussed throughout this section.

Hydrology & Geohydrology

Hydrology

<u>Surface Water</u>

The 1994 DQ Plan indicates that Jimmycomelately Creek exhibits wide variations in flow because of its extended foothill watershed in the Olympic rain shadow. Spring and early summer records show flows reaching 49 cfs; these often drop to less than 2 cfs in mid-summer/fall (DQ Plan 1994). The average rainfall intensity (which governs the recurrence interval of the peak flood) is reportedly 2 inches in 24 hours (Orsborn and Orsborn 1999 as cited in Shreffler 2000). In fall 2002, Ecology installed a real-time, telemetered stream gage in the creek. Data can be obtained from the Ecology Website. Shreffler (2000) provides the best recent summary of hydrology:

> “The Puget Sound [Cooperative] River Basin Team concluded that Jimmycomelately Creek is characterized by low flows, with an average monthly flow estimated at 9.7 cfs (PSCRBT 1988). Drost (1986) documents ten measured flows in Jimmycomelately Creek between May and September 1961, ranging from a high flow of 12.5 cfs on May 24, 1961 to a low flow of 1.08 cfs on October 10, 1961. Clallam County periodically measured flows in Jimmycomelately Creek at the Old Blyn Highway Bridge between September 1986 and November 1991 (Table 4.1). During that time period: (1) the three lowest recorded flows were on 28 October 1987 (0.52 cfs), 8 May 1991 (0.56 cfs), and 9 August 1988 (0.72 cfs); and (2) the three highest recorded flows were on 17 April 1991 (63.84 cfs), 28-29 January 1987 (57.6 cfs), and 14 March 1989 (40.12 cfs). For 1987 and 1988, the two years in which flows were measured monthly for the entire year, annual low flows occurred between September and November, and annual high flows

> occurred in March. In general, for the complete dataset, flows seem to be highest between December and April (mean = 18.01 - 18.15), lower between May and August (mean = 4.79 - 8.40), and lowest between September and November (mean =3.17 - 3.84). However, the high standard deviations suggest that there is a lot of variability in monthly flows, as would be expected."

Figure 2.10-4 illustrates the hydrograph for Jimmycomelately Creek, based on modeling conducted by the U.S. Bureau of Reclamation.

Stormwater Runoff and Flood Hazard

Severe aggradation in the lower half mile of the Jimmycomelately Creek channel has prompted landowners to build dikes and retaining walls and anchor logs in attempts to control flooding. These flood control structures concentrate flow and increase scour potential. Dredged materials placed on streambanks also function as dikes. Culverts in the upper watershed reportedly caused sediment deposition resulting in upstream fish migration because the culverts are reportedly too small (McHenry et al. 1996, cited in Parametrix 2000). However, the TAG states there are no known culvert barrier problems in Jimmycomelately Creek above RM 3.5 (WCC 2002).

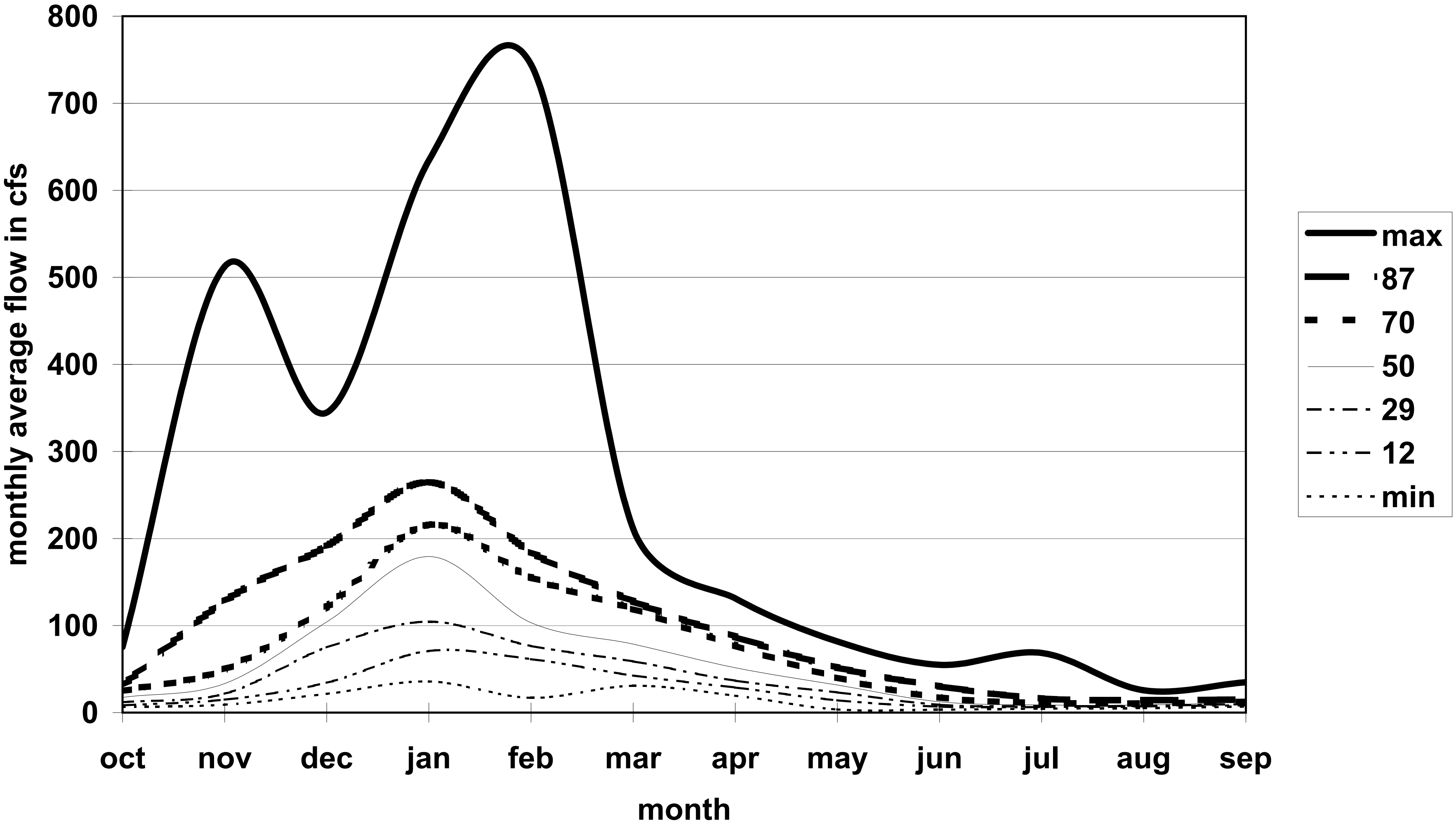
Recurring flooding problems on Jimmycomelately Creek are discussed in *A Preliminary Plan for Restoring Jimmycomelately Creek and the Lower Sequim Bay Estuary* (Shreffler 2000). The study focuses on current and historic conditions of Jimmycomelately Creek to determine causes of present creek conditions. Shreffler points out that the recurring flooding on Jimmycomelately Creek is in part caused by the dramatic sediment aggradation and the resulting increased bed elevations in its lower reaches—which places property owners and local, state, and tribal infrastructure at a recurring risk of flood damage, especially since the early 1990s. The New Year's 1997 flood (explained in greater detail in Shreffler 2000) overtopped Highway 101, caused WSDOT to close the highway for twelve hours and caused considerable damage to private property and residences. Annual flooding near the bridge at Old Blyn Highway reportedly causes road closures for several days each winter.

Orsborn and Orsborn (1999) estimated the existing flood characteristics of tributary streams at the lower end of Sequim Bay (Blyn Basin). They calculated the following flood flows for Jimmycomelately Creek: average 2-yr peak flood at 185 cubic feet/second (cfs), 50-year peak flood at 645 cfs, and 100-yr peak flood at 800 cfs. These flows were calculated using the Snow Creek gage as the base station. Methods and discussions are also provided in *A Preliminary Plan for Restoring Jimmycomelately Creek and the Lower Sequim Bay Estuary* (Shreffler 2000).

Geohydrology and Hydraulic Continuity

Limited groundwater information for the Sequim Bay watershed is summarized in Section 2.10.1. In most of the proposed Jimmycomelately Creek-Estuary Restoration Project area, estimated average groundwater recharge from precipitation, unconsumed irrigation water, and irrigation-ditch leakage during December 1995 to September 1997 was zero to four inches per year (Thomas et al. 1999 as cited in Shreffler 2000).

Figure 2.10-4 Jimmycomelately Creek Hydrograph (at the Coast - % time <) 1952 - 76. Recent data indicate these flows are overestimated.



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Specific information for Jimmycomelately Creek was not provided in the relative hydraulic continuity potential (RCHP) preliminary analysis for Sequim Bay watershed conducted by Parametrix as a part of the Stage 1 Technical Assessment for WRIA 17 (2000). General information regarding this analysis is provided in the Sequim Bay watershed overview section above.

Factors of Change

Human Influences/Major Projects

Jimmycomelately Creek has been severely influenced by human activity since at least the early 1900s. Shreffler (2000) describes Jimmycomelately Creek as "…an unfortunate example of human degradation of natural ecosystems…." Human activity that led to the habitat degradation and fragmentation currently present in Jimmycomelately Creek includes logging, road development, commercial and residential developments, railroad construction, dredging, wetland fill, diking, native vegetation removal, and agriculture (Shreffler 2000). Shreffler states:

> "The cumulative effects of historical logging activities, road failures, and mining in the upper watershed have not been quantified, but these activities have contributed to reduced large woody debris recruitment to the system, reduced pool habitat, increased sediment loads and temperatures in the creek, and reduced physical extent (area) and function of the riparian corridor along Jimmycomelately Creek (Donald 1990).

Modifications to Hydrograph/Fluvial Geomorphology

<u>Channel Conditions</u>

In the early 1900s the lower portion of Jimmycomelately Creek was straightened and moved into an artificial channel, isolating it from its estuary. Dikes, bridges, culverts, and roads have constricted both flood flows and tidal action. In short, human land use over the past century has degraded and fragmented the historically linked riverine and estuarine habitats, and thus Jimmycomelately Creek and the lower Sequim Bay estuary are presently disconnected and dysfunctional systems (Shreffler 2000). The mainstem and west fork are predominantly riffles, characterized by high summer temperature. Comparison with 1978 surveys suggests increased channel width and reduced pool area (McHenry et al. 1996 as cited in Parametrix 2000).

Little information is currently available that assesses the impacts of roads and timber harvest in the upper Jimmycomelately Creek basin on stream habitat. Logging activities and road failures have contributed sediment to the stream, but timber harvest has occurred at a lower rate than in other adjacent drainages (McHenry et al. 1996 as cited in Parametrix 2000).

<u>Log Jam and Large Woody Debris Removal</u>

There are no large conifers along the lower channel of Jimmycomelately Creek, and there is currently very little large woody debris recruitment. Shreffler (2001) indicates the short section of Jimmycomelately Creek that emerges onto the historic floodplain (the lower 1.8 miles) is vegetated with small alders, cottonwood and various herbaceous species.

Historically, old growth forest likely bordered Jimmycomelately Creek before humans inhabited the Blyn area, which would have allowed natural recruitment of large woody debris to contribute to a complex and dynamic channel (Shreffler 2001). Contrasting current conditions, Shreffler (2000) states:

> "[Donald 1990] found that, as a result of forest management activities, Jimmycomelately Creek has less woody debris than would be expected under natural conditions. This has resulted in monotypic riffle habitat, with fewer pools for sediment retention, and increased water temperature due to excessive exposure of sunlight."

The PSCRBT (1988) noted that buffer strips in the forested sections of the stream were adequate on most of the main Jimmycomelately Creek and tributaries, with the exception of 2.5 to 3.0 miles of logged area in the mid level of the creek.

Soil Erosion and Sediment Load

Sediment aggradation is a major problem in Jimmycomelately Creek. Shreffler (2000) summarizes surveys by Orsborn and Orsborn, providing insight into causes of sediment aggradation and the history of the Jimmycomelately Creek channel:

> "On August 18, 1999, Orsborn and Orsborn (1999) surveyed the bridges and culverts on lower Jimmycomelately Creek. At the bridge over [the creek] at the Old Blyn Highway, they found that logs from a failed bank protection effort were blocking the far right section of the channel (looking downstream), and that the width and depth of the channel were constricted by sediment buildup. At Highway 101, Jimmycomelately Creek flows through reinforced concrete, double-box, side-by-side culverts, with each box measuring 8 feet high by 8 feet deep (at time of installation). At the culvert inlet, the survey team found that there was no flow through the left box, and that gravel and silt deposition had reduced the left culvert depth to 51 inches. There was flow through the right box, but the right culvert depth was reduced to 61 inches, mostly due to silt deposition. At the culvert outlet, gravel and silt accumulations were even greater, reducing the culvert depth to 40 inches in the left box, and 50 inches in the right box. In addition, the survey team found that the constriction caused by the old railroad bridge on Jimmycomelately Creek causes acceleration of flow in the channel immediately below the bridge, but when the channel widens downstream the flow is slowed and gravel is deposited."

Land Use and Demographics

Watershed History

Human land use over the past century has degraded and fragmented the historically linked riverine and estuarine habitats of Jimmycomelately Creek. A detailed discussion of the history of the watershed can be found in a number of documents, including *A Preliminary Plan for Restoring Jimmycomelately Creek and the Lower Sequim Bay Estuary* (Shreffler 2000.)

Land Cover and Use

Land use along the Jimmycomelately Creek steam corridor is primarily forested (18.2 mi^2) with 1.6 $mi.^2$ of agricultural/rural residence land use. Rural residential development and agricultural areas are found in the upper- and lowermost reaches of the main fork of Jimmycomelately Creek. The Blyn area, including all of the proposed restoration project area, has been designated a rural center since the adoption of the Clallam County Zoning Code in the early 1980s (SDRCP 1994) (1995 Clallam County Comprehensive Plan).

Farmland, private residences, a tribal casino, a wetland restoration site, commercial seasonal fireworks sales, and an office building are land uses located west of Jimmycomelately Creek to Corriea Road. Current land uses to the east (as far as Woods Road) include private residences, a commercial flower farm, a commercial tavern, and a gravel pit. Current land uses in the South Sequim Bay portion of the proposed Jimmycomelately Creek restoration area include an industrial log yard, shellfish culture and harvest, tribal center and offices, and private residences (Shreffler 2000).

Shreffler (2000) noted that many of the private residences in the project area were built in the Jimmycomelately Creek floodplain on coarse soils in the 1930s and do not meet current setback requirements (SBWMC 1989). He relates that, of the watershed residents, 97 percent live on parcels of 5 acres or less, and, in 1988, 15 percent reported using irrigation water as an untreated primary source of drinking water (SBWMC 1989).

In the lower 1.5 miles of Jimmycomelately Creek, 34 percent of the riparian zone is forested, 12 percent is in agricultural use, and 7 percent is in residential use (Ames et al. 2000). Roads and dikes occupy 10 percent of the riparian zone. Trees are immature (i.e. less than 20 inches dbh) in the existing forested buffer, and 69 percent of the forested buffer is less than 66 feet wide. Bank armoring along the lower 0.5 mile has affected the natural function of the riparian zone.

Water Quality

Stream Channels

The State of Washington classifies Jimmycomelately Creek as a Class AA (Extraordinary) stream under WAC 173-201 A.

Temperature

According to the Limiting Factors Analysis (Parametrix 2000), water temperature data is generally lacking for Jimmycomelately Creek. Parametrix indicated Clallam County collected temperature data in 1991 and 1992, and the Streamkeepers of Clallam County began their data collection in 2000, at river mile 0.1. Temperature is listed as a data gap for other sections of Jimmycomelately Creek (Parametrix 2000). Table 2.10-5 summarizes the available temperature data collected at river mile 0.1 and found in Parametrix 2000.

Table 2.10-5. Water Temperature Data- Jimmycomelately Creek (RM 0.1).

June	July	August	September	Year
N/A		16	16	1991
19	16	18	N/A	1992
N/A	14.8	14.1	N/A	2000
N/A	N/A	12.5	N/A	2001

Source: Parametrix 2000.

Shreffler (2000) reported that the County collected water temperature approximately once a month between April and November 1991 at the Old Blyn Highway Bridge. During that time period reported temperatures ranged from a high of 15.6^0 C (September) to a low of 7.6^0 C (November).

As discussed in Section 2.10.1, DOH measured water temperature, salinity and fecal coliform approximately once a month from 1992 through 1995 in lower Sequim Bay, as well as one station at the mouth of Jimmycomelately Creek. During that time period water temperature ranged from a high of 23^0C in June 1992 to a low of 6^0 C in January 1993. Table 2.10-6, from Shreffler (2000), displays water quality results from the 1992 through 1995 DOH sampling.

<u>Fecal Coliform</u>

Clallam County collected fecal coliform data (as well as water temperature, pH, and dissolved oxygen) approximately once a month between April and November 1991 at the Old Blyn Highway. Fecal coliform counts ranged from a low of 3 in April to a high of 234 in October. The Sequim Bay Watershed Plan (1991) noted that "water samples taken in the Jimmycomelately Creek drainage exceed state bacteria maximum allowable levels by two- to three-fold." DOH measured fecal coliform (and water temperature and salinity) approximately once a month from 1992 through 1995 at the mouth of Jimmycomelately Creek. Table 2.10-6 (extracted from Shreffler 2000) displays results of water quality monitoring collected by DOH from 1992 through 1995. There were no fecal coliform values from the 1992-1995 study that would exceed State or federal standards (Clifton pers. comm. cited in Shreffler (2000).

<u>pH</u>

A mean pH of 7.91 for Jimmycomelately Creek was reported by the Sequim Bay Watershed Plan (1991).

<u>Dissolved Oxygen</u>

DO data collected in 1991 and 1992 by Clallam County and since 2000 by the Streamkeepers of Clallam County show concentrations above 8 mg/L during all collection periods except for September 2001, when the concentration was 7.4mg/L (Streamkeepers, unpublished data 1999-2001, cited in Parametrix 2000). Dissolved oxygen data was not available for Jimmycomelately Creek above RM 0.1.

Clallam County recorded dissolved oxygen levels approximately once a month between April and November 1991 at the Old Blyn Highway. The mean dissolved oxygen level was 10.5 mg/L for the entire sampling period (Shreffler 2000).

<u>Salinity</u>

DOH measured salinity monthly from 1992 through 1995 at the mouth of Jimmycomelately Creek. Table 2.10-6 (from Shreffler 2000) displays the results. Mean salinity was reported to be 29.8 parts per thousand over the entire sampling period.

Table 2.10-6. DOH Water Quality Data 1992-1995 (Station 21 at mouth of Jimmycomelately Creek).

Sampling Date	Water Temperature (^{o}C)	Salinity (ppt)	Fecal Coliform[a]
21-Apr-92	13	30	1.7
13-May-92	14	30	2
24-Jun-92	23	32	1.7
13-Jul-92	18	30	17
5-Aug-92	18	32	33
23-Sep-92	15	32	2
22-Oct-92	12	32	4.5
5-Nov-92	10	no data	1.7
2-Dec-92	9	32	1.7
27-Jan-93	6	3	46
23-Feb-93	7	32	1.8
25-Mar-93	9	33	2
14-Apr-93	13	20	2
10-May-93	15	30	2
16-Jun-93	17	30	7.8
15-Jul-93	16	30	1.7
4-Aug-93	21	30	1.7
17-Nov-93	9	30	1.7
5-Jan-94	8	30	1.7
24-Feb-94	8	32	1.7
15-Mar-94	10	32	2
18-May-94	16	30	1.7
29-Jun-94	17	25	4.5
18-Jul-94	18	35	1.7
1-Aug-94	18	35	1.7
13-Sep-94	16	30	1.7
13-Oct-94	10	35	1.7
16-Nov-94	9	32	22
6-Feb-95	8	18	13
Mean	13.39	29.78	6.16

[a] The fecal coliform data is presented as a statistical measure using the most probable number (MPN) method. The method used to derive a Most Probable Number is usually multiple tube fermentation. This is a different method than a plate count of bacteria colonies.

Source: Shreffler 2000

Nonpoint Sources

The *Sequim Bay Water Quality Project and Basin Planning Study* (CCDCD 1987) concluded that water quality in the Jimmycomelately Creek watershed is impacted by forestry practices, residential land use, and animal keeping. Clearcut areas comprised 6 percent of the forested area in the watershed, and logging practices contributed increased sediment loads to the creek. Residential land use in the lower 0.7 miles of the watershed has diminished water quality due to older septic systems serving those homes. Cattle access to the creek in the upper watershed may explain high fecal coliform counts in the spring, and throughout the summer months. Sedimentation in Jimmycomelately Creek can transport fecal coliform bacteria, and has also been shown to increase survival time and dispersal of fecal coliform bacteria. Since 1992, fecal coliform concentrations in Sequim Bay have been closely tracked by DOH because of active tribal and commercial shellfish culture and harvest, as well as recreational shellfish harvest. The PSCRBT (1988) indicates bacterial contamination and the erosion of sediment would be reduced if animal access was limited or eliminated by fencing the stream corridor.

Fish and Habitat

Salmon Distribution, Abundance & Stock Status

<u>Resident Fish Distribution and Abundance</u>
Shreffler 2000 provides a summary of fish presence in Jimmycomelately Creek:

> "Very little is known about resident fish distribution and abundance within Jimmycomelately Creek or lower Sequim Bay. In 1997, WDFW surveyed the distribution of 12 species of native, non-game stream fish on the Olympic Peninsula (Mongillo and Hallock 1997). However, because of the way the data was reported, it is not possible to determine whether Jimmycomelately Creek was one of the sites that the authors surveyed. The range maps in this report suggest that Jimmycomelately Creek falls within the potential range of prickly sculpin (*Cottus asper*), and three-spine stickleback (*Gasterosteus aculeatus*), as well as Pacific lamprey (*Lampetra tridentatus*), which is actually an anadromous species. Donald (1990) reported that brook trout (*Salvelinus fontinalis*) were stocked into Jimmycomelately Creek in the 1930s by horseback from the Quilcene Hatchery, and that the Kamloops sub-species of rainbow trout (*Oncorhynchus mykiss*) has escaped into the Jimmycomelately Creek system from a private trout farm near the confluence of the West Fork and mainstem."

<u>Salmonid Stocks, Status and Life Histories</u>
Native populations of summer chum salmon, coho salmon, steelhead, and sea-run cutthroat trout are known from Jimmycomelately Creek, but have declined precipitously. In part, these declines are attributable to the reduced availability and suitability of habitat in Jimmycomelately Creek for feeding, refuge, spawning, and osmoregulatory transition from freshwater to saltwater (Shreffler 2000). There is significant concern about summer chum salmon due to the dramatic population declines; they are listed as threatened pursuant to the federal ESA. Summer chum salmon and coho salmon distribution and status are known from annual spawning escapement surveys. The distribution and abundance of winter steelhead and resident cutthroat trout is unknown (though both navigate the cascades at RM 1.9 and may be found upstream (Byron Rot pers. comm. 2004)).

Summer Chum Salmon
Summer chum salmon currently spawn up to RM 1.5. Historically their distribution extended up to the cascades at RM 1.9 (Byron Rot pers. comm. 2004). Genetic analysis of summer chum salmon collected from Jimmycomelately Creek show them to be significantly different from the adjacent stock in Snow Creek and Salmon Creek. They are a native stock, and no hatchery supplementation has occurred. Spawning escapement ranged from several hundred to 1,000 in the 1980s, but declined in the 1990s to less than 100. Because of this short-term, severe decline their status is judged to be critical. The effective population size for the period 1995-1998 was 74 (Ames et al. 2000 as cited in Parametrix 2000), and the count for 1999 was 7 (Byron Rot pers. comm. 2004), so their risk of extinction is high.

Shreffler (2000) provides the following summary of summer chum salmon spawning in Jimmycomelately Creek:

> "In Jimmycomelately Creek, summer chum salmon return to spawn from late August through late October after two to four years of rearing in the northeast Pacific Ocean. The timing of the spawning migration typically coincides with the most frequent annual low flow period in Jimmycomelately Creek between September and November. Based on 14 years of WDFW data, the average spawning escapement timing estimates for Jimmycomelately Creek are 10% completion by 17 September, 50% completion by 26 September, and 90% completion by 9 October (Ames et al. 2000). Summer chum salmon have fecundities of 2,000 to 3,000 eggs/female on average. Eggs reach the eyed stage after 4-6 weeks of incubation in nests in the gravel called "redds", and hatching occurs approximately 8 weeks after spawning. Alevins develop in the redds for an additional 10-12 weeks before emerging as fry between February and the last week of May. Peak fry emergence and downstream migration typically take place between March and April, but the exact timing varies year-to-year and is a function of water temperature and the number of temperature units (TU's) required for hatching and development. During the summer chum emergence period, chum fry recovered in marine areas of Hood Canal range in size from 35-44 mm (Ames et al. 2000).
>
> "According to the *North Olympic Peninsula Lead Entity* (NOPLE) *Strategy* (2001), Jimmycomelately Creek summer chum are among the weakest stocks on the North Olympic Peninsula. These summer chum are seriously imperiled and may become extirpated unless habitat is restored immediately. Jimmycomelately Creek is the only stream within NOPLE jurisdiction that has a run of summer chum; thus it is the best and only opportunity for restoring summer chum."

Coho Salmon

Coho salmon spawning surveys in the lower 1.5 miles of Jimmycomelately Creek have observed between 20 and 40 redds since 1990. From 1985 to 1999, the average cumulative redd count by WDFW was 34.9 redds/year, and the five year mean (1995 to 1999) was 25.8 redds. There have been numerous plants of non-native, hatchery-reared smolts into the drainage, so the stock is of mixed native and introduced origin. The aggregate Eastern Strait coho salmon management unit was judged to be depressed in the SASSI document (WDF et al. 1993 as cited in Parametrix 2000), but more recent evaluation has concluded that this stock is at the critical level.

<u>Harvest</u>

Shreffler indicates the mean annual harvest for summer chum in Jimmycomelately Creek from 1974 to 1999 was 42. Harvest reportedly peaked in 1982 at an estimated 250 spawners and harvest has been effectively zero since 1993. Summer chum are generally not targeted but incidental capture is unquantified (McHenry et al. 1996 as cited in Shreffler 2000).

Reintroduction and Restoration Strategies

Summer Chum Salmon Recovery Project
Shreffler (2000) describes the Summer Chum Salmon Recovery Project:

> "Efforts are underway now to recover the threatened run of summer chum salmon in Jimmycomelately Creek. Genetic analysis indicates that summer chum of JCL Creek are significantly different from the Snow/Salmon Creek summer chum stock (Ames et al. 2000). The JCL summer chum stock is classified as a native stock with wild production at high risk of extinction (Ames et al. 2000). The Summer Chum Salmon Recovery Project is an effort led by WDFW to preserve the run while channel realignment and restoration activities take place, and, ultimately, build the run back to a self-sustaining population of summer chum salmon that will maintain the genetic characteristic of the native stock.
>
> "In 1999, only seven returning spawners were captured in a trap installed upstream from the mouth of Jimmycomelately Creek, magnifying the need for urgent and coordinated recovery efforts. On August 29, 2000, a team of volunteers helped WDFW install a trap to capture returning spawners (Figure 4.7). Between August 29 and October 23, 20000, WDFW collected and spawned 37 returning adults (Figure 4.8). The fertilized eggs were incubated to the eyed stage at Hurd Creek Hatchery, and the fry will be reared in remote site incubators for up to 31 days, and then released in lower Jimmycomelately Creek when they have reached a minimum size of 1-gram. The recovery program is scheduled to continue for three generations, or a total of twelve years. To maximize genetic diversity, the goal is to spawn 25-30 pairs of wild-origin broodstock each year; any additional salmon would be released to spawn naturally in the creek. The recommended summer chum fry production levels needed to produce adult returns equal to historical (1974-1999) average run sizes for JCL Creek is 43,000 to 86,000 (Ames et al. 2000). The critical escapement threshold for summer chum salmon in Jimmycomelately Creek is 200 fish (Ames et al. 2000)."

Instream Flows

Optimum instream flows developed by Ecology and WDFW (1997) using the "toe-width" for both coho and chum spawning (September through January) are 24 cfs for Jimmycomelately Creek, 44 cfs for steelhead spawning (March though April), and 30 cfs for juvenile rearing and incubation (May through June) (Table 2.10-7). For steelhead rearing in Jimmycomelately Creek, the optimum flow is 10 cfs (July through August).

Table 2.10-7. Theoretical Optimum Instream Flow Summary for Jimmycomelately Creek (1997).

Time of Year	Theoretical Optimum Flow (cfs)	Species/Life Stage
Sept – Jan	24	Coho & Chum salmon spawning
March – April	44	Steelhead spawning
May – June	30	Juvenile rearing/incubation
July – August	10	Steelhead rearing

Source: Ecology and WDFW 1997 as cited in Parametrix 2000

USFWS also proposed instream flows for Jimmycomelately Creek (Hiss 1993 cites Beecher 1980b in Parametrix 2000). The optimum flow for spawning from February through June was 30 cfs and for rearing from July through August was 6 cfs for steelhead trout (Table 2.10-8).

Table 2.10-8. Theoretical Instream Flow Predictions for Jimmycomelately Creek (1993).

Time of Year	Theoretical Optimum Flow (cfs)	Species/Life Stage
Feb – June	30	Steelhead spawning
July – August	6	Steelhead rearing

Source: Hiss 1993 cites Beecher 1980b in Parametrix 2000

Habitat Use and Availability

Shreffler (2001) indicated that the present fragmented and dysfunctional condition of the Jimmycomelately Creek channel and estuary limits its ability to provide optimal feeding, rearing, and breeding habitats in support of critical biological resources (including ESA-listed summer chum salmon, other anadromous fish species, shellfish, shorebirds, and waterfowl).

Sediment aggradation has reduced the amount of available habitat in the creek for anadromous fish species, reduced instream flows, and increased barriers to natural upstream and downstream migrations. Flooding has contributed to fish mortality in Jimmycomelately Creek, both directly (due to scouring of eggs out of redds, Bernthal et al. 1999), and indirectly (due to the elimination, or silting-in of suitable spawning gravels resulting from the constant redistribution and regrading of silt and gravel during winter floods).

Parametrix (2000) quotes the Limiting Factors Analysis as follows:

> "The lack of LWD, the loss of side channels, and channel instability in the lower reach have reduced channel complexity and thereby the quality of chum salmon spawning habitat. Riparian buffers were eliminated in the lower reach, and adjacent wetlands were eliminated or isolated from the stream channel. A survey in 1990 found 0.09 pieces of LWD/m. Pool habitat is scarce; it comprises only 30 percent of the channel area, and pool frequency is low (9.0 channel widths). Confinement of the channel within hardened banks and dikes has caused aggradation, increased peak flows, and increased scouring in spawning areas. Redd scour is the dominant limiting factor for chum salmon egg survival. The loss of channel complexity and re-routing of the channel through the lowest reach has decreased the ability of the stream to transport sediment through the system (Ames et al. 2000). These factors have had a high impact on spawning habitat quality (Ames et al. 2000)."

Benthic food production has been reduced in the log storage area, west of the stream mouth, and the containment booms may disrupt the emigration of juvenile chum salmon. Isolation of the floodplain above high tide from the tidal delta has reduced the quality of sub-estuarine habitat and affected the migration of juvenile and adult chum salmon (Ames et al. 2000 as referenced in Parametrix 2000).

Bernthal et al. (1999 as referenced in Parametrix 2000) rated the following limiting factors as having the highest impact to summer chum salmon in Jimmycomelately Creek:

> ***Channel complexity***: In the lower reach of Jimmycomelately Creek, the riparian corridor has been reduced or eliminated, stable log jams are scarce, and side channels and associated wetlands have been eliminated or cut off from the main channel. LWD and pool habitats are scarce. Loss of LWD and confinement of the channel by bank hardening has reduced channel complexity resulting in sediment aggradation, increased peak flows, and increased bed scour. Scour of redds is perhaps the dominant limiting factor for summer chum salmon in the lower reaches of Jimmycomelately Creek.
>
> ***Sediment aggradation***: Rerouting of the Jimmycomelately Creek channel, loss of instream channel complexity, and a decrease in tidal energy have decreased the existing channel's ability to route sediment through the system. Sediment aggradation has highly impacted chum salmon spawning, incubation, and adult migration life stages.
>
> ***Riparian condition:*** The area and functions of the riparian corridor along Jimmycomelately Creek have been severely diminished over the past century, negatively affecting chum salmon spawning and incubation life stages.
>
> ***Estuarine habitat loss and degradation****:* Loss and degradation have occurred in the estuary of Jimmycomelately Creek from diking, filling, log storage, and road causeways. These features have negatively affected juvenile chum salmon rearing and migration.
>
> ***Pools:*** In habitat that provides summer rearing for coho salmon in the mainstem and west fork, pools comprise only 10.4 percent of the channel area (McHenry et al. 1996 as cited in Parametrix 2000).

Habitat Connectivity

In the following passage, Shreffler (2001) eloquently summarizes the current condition of Jimmycomelately Creek:

> "Jimmycomelately Creek (JCL Creek) is an unfortunate example of human degradation of natural ecosystems. In contrast to the network of structurally and functionally connected habitats that historically occurred in Jimmycomelately Creek and lower Sequim Bay, the existing habitats are isolated and fragmented. A century of logging, road development, commercial development, railroad construction, dredging, wetland fill, diking, native vegetation removal, agriculture, and residential developments have resulted in direct loss of wetlands and other historic riverine and estuarine habitats. These human activities have also contributed to reduced floodplain function and the use of present dysfunctional conditions of Jimmycomelately Creek and lower Sequim Bay estuary.

Shreffler (2001) indicates the present fragmented and dysfunctional condition of the Jimmycomelately Creek channel and estuary has the following effects:

- limits the ability of Jimmycomelately Creek and the estuary to provide optimal feeding, rearing, and breeding habitats in support of critical biological resources (including ESA-listed summer chum salmon, other anadromous fish species, shellfish, shorebirds, and waterfowl);
- places property owners and local, state, and tribal infrastructure at a recurring risk of flood damage; and
- highlights the urgent need to develop and implement integrated restoration actions in Jimmycomelately Creek and the estuary.

Habitat-Forming Processes and Causes of Change

Delivery/Routing of Water

Shreffler (2000) describes Jimmycomelately Creek as "…straight, narrow, diked and perched above the surrounding land. Jimmycomelately Creek is hydraulically disconnected from the estuary, and normal hydrological functions (e.g., nutrient and sediment entrapment, flood and stormwater desynchronization, groundwater exchange, and support of stream baseflow) have been lost or altered." There is severe aggradation in the lower half mile of the channel that has prompted landowners to build flood control structures (e.g. dikes, retaining walls, anchored logs) that concentrate flow and increase scour potential. The lower 0.5 miles of the stream was moved into an artificial channel early this century. Dredged materials placed on each bank function as dikes. Non-native vegetation has colonized the dikes, further constricting the channel. Cycles of aggradation, flooding, and dredging have resulted. In 1997, the mouth of the stream was perched well above the estuary, creating a barrier to upstream migration (Ames et al. 2000 as cited in Parametrix 2000).

Delivery/Routing of Sediment

Rerouting of the Jimmycomelately Creek channel, loss of instream channel complexity, and a decrease in tidal energy have decreased the existing channel's ability to route sediment through the system (Shreffler 2000). Sediment aggradation has highly impacted chum salmon spawning, incubation, and adult migration life stages. Sediment aggradation is listed as a limiting factor and considered by Bernthal et al (1999 as cited in Parametrix 2000) to have a high impact on summer chum salmon in the creek. Shreffler (2000) provides a detailed summary of problems in Jimmycomelately Creek.

Delivery of Heat

Temperature is a particularly important factor in determining abundance and distribution of salmonids. The limiting factors analysis (WCC 2002) included a limited summary of water temperature data for the mouth of Jimmycomelately Creek to RM 1.0. Parametrix (2000) indicated that August water temperatures improved in 2001 as they reached a high of 12.5^{0} C, compared to highs of 18^{o} C and 14.1^{0} C in August of 1992 and 2000, respectively.

Natural Disturbances

Stressors to estuarine ecosystems have been widely listed, but are poorly documented through actual studies. Both natural and anthropogenic (human-induced) stressors can alter estuarine processes and functions. Natural stressors operate on a time scale of decades or longer, in comparison to days to years for anthropogenic stressors. From a salmon perspective, the key distinction between natural stressors and human-induced stressors is the fact that salmon have the ability to adapt and survive most natural disturbances. This is because salmon are typically of a temporal or spatial scale that allows for adaptation or recovery, whereas human-induced stressors have, in many instances, disrupted the process that create and maintain the mosaic of estuarine and nearshore habitats, as well as the habitats themselves (Shreffler 2002). In general, natural stressors to systems like Jimmycomelately Creek include:

- Climate;
- Sea-level rise;
- Upwelling;
- El Nino/Southern Oscillation (ENSO);
- Pacific Decadal Oscillation (PDO); and
- Earthquakes, tsunamis, and other natural disturbances.

As discussed above, Shreffler (2001) indicates human disruptions and alterations have greatly influenced the natural disturbance regimes. Examples of human modifications that have altered natural processes include channelization, logging, diking, and the development of roads, culverts, bridges, railroads and residential areas. As discussed in the Habitat Connectivity section above, these activities have fragmented habitats, in many cases eliminating habitat function completely.

Restoration

The importance of the Jimmycomelately Creek ecosystem is widely recognized. Historically, it has been of importance to local tribes, including the Jamestown S'Klallam Tribe, and for gathering shellfish and other food resources for both tribal and non-tribal residents. Water and habitat qualities have both diminished and the resources have become threatened. The creek has become physically and ecologically disconnected from its estuary, and is thus unable to function as a natural river system with an intact connection to its estuary (Shreffler 2000).

Responding to these concerns, the JSKT, Clallam County, WDFW, CCD, WSDOT, EPA, USFWS, DNR, local private landowners and other partners in the Jimmycomelately Creek-Estuary Restoration Project are working to: realign Jimmycomelately Creek into one of its historic, sinuous channels; integrate this channel realignment with improvements in, and restoration of, the estuary functions; and reestablish the pre-disturbance linkage between the fluvial and tidal energy regimes. Specific objectives include:

- Acquisition of needed land for project;
- Re-alignment of creek;
- Removal of log yard and roads;
- Restoration of tidal flats, slough channels and historical salt marshes of South Sequim Bay;
- Reduce flood hazards;
- Restoration of habitat for ESA-listed summer chum; and
- On-going monitoring program.

As a part of the Jimmycomelately Creek-Lower Sequim Bay Estuary Restoration Project, a number of properties have been acquired as a part of the overall restoration of the lower Sequim Bay estuary. In order to accomplish the goals of the project, necessary properties have been acquired or owners have granted an easement for long-term protection or access. The properties, which have been identified for acquisition or easements, represent a total of 38.54 acres.

This project is well underway and should be completed by fall 2005. If successful, this restoration project will provide measurable benefits to waterfowl, shorebirds, fish, shellfish, and the community (Shreffler 2001).

The vision of the many partners in the Jimmycomelately Creek-Lower Sequim Bay Estuary Restoration Project (Jimmycomelately Creek-Estuary Restoration Project) (Shreffler 2001) is to:

- realign Jimmycomelately Creek into one of its historic, sinuous channels and restore functional connection with the floodplain;
- integrate this channel realignment with improvements in, and restoration of, the estuary functions; and
- re-establish the pre-disturbance linkage between the fluvial and tidal energy regimes.

Ecosystem Functions and Conditions

<u>Riparian Corridor</u>
The lowland forest ecology supports numerous coniferous species dominated by Douglas-fir (*Pseudotsuga menziesii*), with Western hemlock (*Tsuga heterophylla*), Western red cedar (*Thuja plicata*), and red alder (*Alnus rubra*) as the subdominant species (Shreffler 2000). The understory is comprised of the following dominant species: salmonberry (*Rubus spectabilis*), devils' club (*Oplopanax horridus*), vine maple (*Acer circinatum*), red huckleberry (*Vaccinium parvifolium*), rhododendron (*Rhododendron macrophyllum*), salal (*Gaultheria shallon*), and Oregon grape (*Berberis nervosa*) (Donald 1990 as cited in Shreffler 2000).

The primary introduced species of concern in the Jimmycomelately Creek watershed are invasive plant species. Of particular concern are reed canary grass (*Phalaris arundinacea*), Canada thistle (*Cirsium arvense*), Scot's broom (*Cytisus scoparius*), Himalayan blackberry (*Rubus discolor*), reedgrass (*Phragmites communis*), and purple loosestrife (*Lythrum salicaria*). The Jimmycomelately Creek-Sequim Bay Restoration Project objective relative to invasive vegetation is to completely eliminate non-native, invasive species from the restoration site.

Shreffler's (2000) preliminary restoration plan states:

> "In 1999, two trained analysts assessed the condition of the riparian corridor along Jimmycomelately Creek using aerial photos at a scale of 1:12000 (Bernthal et al. 1999). The extent, species composition, and stand density of forested habitats, as well as the land use adjacent to these forested habitats, were analyzed within a 200 ft. zone either side of the creek channel, from the river mouth to the uppermost extent of summer chum distribution. These data were not verified in the field. Inspection of historical aerial photos

> indicated that the riparian corridor along the lower 1.5 miles of the creek has diminished in both width and length over the past century. Within the lower 1.5 miles of Jimmycomelately Creek where summer chum spawning occurs, land use is approximately 34% in forested habitats, 38% in forestry, 12% in agriculture, 9% in roads and dikes, and 7% in residential land uses. One hundred percent of the forested riparian corridor is in diameter classes less than 20 in. diameter at breast height (dbh). The riparian species composition was 43% conifer dominated, 42% deciduous dominated, and 15% mixed conifer and deciduous. The ability of a riparian corridor to supply large woody debris (LWD) over time is partly dependent on corridor width: a 50 ft no-cut corridor will supply 32% of LWD at age 200, a 135 ft corridor 77%, and a 210 ft corridor 100% of LWD at age 200 (Bernthal et al. 1999). For Jimmycomelately Creek, sixty-nine percent of the forested riparian corridor is less than 66 feet in width and thirty-one percent between 66 and 132 feet in width; no portion of the existing riparian corridor is within the 210 foot classification that is predicted to supply 100% of LWD at age 200. The loss of riparian habitat along Jimmycomelately Creek can be attributed to forestry, agriculture, railroads, clearing of land for roads, and private residences. Bank armoring along the lower half mile of Jimmycomelately Creek has also reduced the full functions of the riverine-riparian habitat.

Although the riparian corridor has been severely altered, Shreffler points out the shade and habitat value provided by the existing riparian area will be completely lost when the creek is moved into a new channel. Shreffler estimates vegetation planted in the new Jimmycomelately Creek channel should provide adequate riparian functions in 10 to 50 years (2000).

<u>Wetlands</u>

A preliminary wetland survey of the proposed Jimmycomelately Creek project area performed by the EPA in April 2000 concluded that hydric soils and wetland vegetation exists along nearly the entire project corridor, up to 1400 feet south of Highway 101 (Shreffler 2001). The EPA concluded that virtually all of the lower 1.8 miles of Jimmycomelately Creek was historically wetland (Shreffler 2000).

<u>Nearshore/Estuary</u>

The Jimmycomelately Creek, estuary, and floodplain are the subjects of a major restoration and on-going monitoring project. Shreffler (2002) provides the following description:

> "The Estuary Design Group (EDG) for the Jimmycomelately Creek-Estuary Restoration Project calculated that logging operations impacted a total of 7.32 acres. Diving surveys conducted by Battelle Marine Sciences Laboratory (Sargeant et al. 2002) revealed minimal bark, chip, or wood waste on the bottom. Generally the depth of the wood debris was not greater than a small layer of bark resting on the surface. Thus, the potential effects of wood debris accumulation on eelgrass and other benthic and epibenthic flora and fauna at the log yard site are expected to be minimal."

No eelgrass was observed in the intertidal or subtidal portions of the log yard area during the 2002 diving survey (Sargeant et al. 2002 in Shreffler 2002). The authors attributed the absence of eelgrass within the footprint to the continuous human disturbance of the site since its establishment in the late 1800s. However, eelgrass beds are present within approximately 200 m from both the western and eastern edges of the pilings. Sargeant et al. (2002) predicted that natural recolonization of eelgrass into the footprint would be expected to occur gradually through the spreading of rhizomes from existing eelgrass beds, once the existing pilings are removed, and assuming no further log rafting occurs at the site. The minimal wood debris from the historical log yard operations is not expected to inhibit natural expansion of the existing eelgrass beds. The dominant substrates of sand, mixed fines, and mud present within the footprint are known to support eelgrass beds in comparable ecosystems that have not previously been disturbed by logging operations.

Section 2.10.2 also provides a discussion in regards to estuarine habitat in the lower Sequim Bay estuary.

Monitoring

A monitoring plan, specific to the channel realignment portion of the Jimmycomelately Creek-Estuary Restoration Project has been prepared for the Jamestown S'Klallam Tribe and the project partners. This monitoring plan includes pre-project, during construction and post project reporting requirements for hydrology, sediment, channel morphology, water quality, LWD, soils, flood conveyance, riparian vegetation establishment, freshwater wetland vegetation establishment, invasive vegetation removal, salmonid use, and upland bird use, as well as provisions for adaptive management and contingency measures if performance criteria are not met (Shreffler 2001). A comparable plan for the estuary portion of the project is also in place. Data gaps identified by Parametrix (2000) included:

- Assessment of rearing habitat capacity for summer chum salmon in the sub-estuary, including effects of log storage on fry migration and food production;
- Quantification of the effects of scour and deposition on chum salmon and coho salmon egg survival in lower Jimmycomelately Creek;
- Habitat and fish population assessment in other West Sequim streams, e.g. Johnson Creek, Dean Creek, and Chicken Coop Creek; and
- Catalog small unnamed streams that have potential to support cutthroat trout and possibly other salmonids.

2.10.6 Chicken Coop Creek (WRIA #17-0278)

Geography

Chicken Coop Creek enters the southeast corner of Sequim Bay to the northeast of Jimmycomelately Creek. The mainstem is 3.1 miles in length with an additional 3.1 miles in tributaries (Ames and Bucknell 1981 as cited in WCC 2002). The mouth of Chicken Coop Creek shares a high intertidal zone with an adjacent unnamed system just a few meters to the west (Turnbull, pers. comm. 2002 cited in WCC 2002).

Hydrology & Geohydrology

Hydrology

Streamflow information was not available for Chicken Coop Creek. Clallam County (PSCRBT 1988) states that the Chicken Coop Creek system has extreme and at times intermittent flows.

Geohydrology and Hydraulic Continuity

Detailed information regarding the geohydrology and hydraulic continuity in the Chicken Coop Creek system was not reviewed by Parametrix. Parametrix (2000) indicated that major streams in the Sequim Bay watershed were assigned a "low" RHCP ranking where they flow across bedrock or till. However, Chicken Coop Creek was ranked as a "high" RHCP at its mouth where the creek may cut into advance outwash sediments (Parametrix 2000).

Factors of Change

Human Influences/Major Projects

The WCC (2002) reports one water diversion above East Sequim Bay Road and one downstream of the road on Chicken Coop Creek. Multiple culverts are present at road crossings along Chicken Coop Creek, which are discussed further below. The Old Blyn Highway culvert was reportedly not parallel to the stream and, as a result, the stream is headcutting (Turnbull pers. comm. 2002, cited in WCC 2002).

Modifications to Hydrograph/Fluvial Geomorphology

The WCC (2002) reported that limited information regarding Chicken Coop Creek channel conditions. Streambanks were reported as well-vegetated (with invasive species) below Chicken Coop Creek Road; the dense root system was preventing streambank erosion. No riprap was noted as an indicator of bank instability.

Soil Erosion and Sediment Load

WCC listed sediment supply, mass wasting and fine sediment as data gaps for Chicken Coop Creek (2002). Some road-fill erosion was noted by the TAG, caused by leakage at the Chicken Coop Road culvert and headcutting due to a misalignment of the Old Blyn Highway culvert (WCC 2002).

Water Quality

Surface Water

The State of Washington classifies Chicken Coop Creek as a Class AA (Extraordinary) stream under WAC 173-201 A. Chicken Coop Creek was listed on the 1994, 1996 and 1998 Ecology 303(d) list of impaired water bodies due to its failure to meet Washington State standards for fecal coliform (Ecology 2002a). Violations occurred at the mouth of Chicken Coop Creek.

Water quality studies of Chicken Coop Creek by Clallam County (CCDCD 1987, cited in PSCRBT 1988) indicated bacterial contamination in excess of the Class AA (Extraordinary) water quality standards for fecal coliform. Clallam County (PSCRBT 1988) suggested that high fecal coliform levels might be attributable to animal access to the stream. Fencing the stream corridor in areas of animal access was recommended.

According to the WCC (2002), water temperature and dissolved oxygen data were not available for Chicken Coop Creek; water quality data collection is needed.

Fish and Habitat

Salmon Distribution, Abundance & Stock Status

As of 1988, Clallam County indicated fish use within Chicken Coop Creek was unknown, although potential species include coho and chum salmon (PSCRBT 1988).

Instream Flows

Optimum instream flows, developed by Ecology and WDFW (1997) using the “toe-width” method, indicate that the theoretical optimum flow for steelhead rearing in Chicken Coop Creek is 3 cfs year-round. The USFWS also proposed instream flows for Chicken Coop Creek (Hiss 1993 cited in Parametrix 2000). The theoretical optimum flow from October through January (spawning) was 4 cfs and from February through September (rearing) was 3 cfs for coho (Table 2.10-9).

Table 2.10-9. Theoretical Instream Flow Predictions for Chicken Coop Creek (1993).

Time of Year	Theoretical Optimum Flow (cfs)	Species/Life Stage
Oct – Jan	4	Coho salmon spawning
Feb – Sept	3	Coho salmon rearing

Source: Hiss 1993 as cited in Parametrix 2000

Habitat Use and Availability

The TAG (2002 in WCC 2002) reported that floodplain habitat below East Sequim Bay Road, which consists of a forested wetland/wet meadow complex, provides some good habitat for fish.

Habitat Connectivity

Fish Passage Barriers

According to the WCC (2002) there are multiple fish passage barriers within Chicken Coop Creek. One water diversion is present upstream of and near East Sequim Bay Road and one is located downstream. Two culverts, one at Old Blyn Highway and the other at Chicken Coop Road, are listed as total fish barriers. The Old Blyn Highway culvert is five feet in diameter while the bankfull width is ten feet; the stream experiences a four-foot drop at this site.

A culvert at the intersection of Chicken Coop Creek and US 101 is listed as a total barrier but is reportedly scheduled for repair. Replacement of this barrier will provide access to approximately 3,336 square meters of habitat upstream (remedial actions will be needed to improve this habitat, however) (Johnson 2001 as cited in WCC 2002).

According to the *Sequim Bay Watershed Characterization* (PSCRBT 1988), the primary limiting factor for fish in the Chicken Coop Creek system is the extremely low and sometime intermittent flows.

Habitat Fragmentation

Habitat fragmentation within the Chicken Coop Creek system is caused by road crossings and by culverts that are improperly aligned or not functioning properly. Large woody debris is lacking and the streambank is reportedly dominated by shrubs and non-native invasive species (TAG as cited in WCC 2002). The floodplain habitat below East Sequim Bay Road is described as a forested wetland/wet meadow complex that provides some good habitat for fish. However, the low gradient habitat above East Sequim Bay Road deteriorates in quality, dominated by invasive reed canary grass (TAG 2002 as cited in WCC 2002). Multiple fish barriers exist within Chicken Coop Creek, as discussed below.

Habitat-Forming Processes and Causes of Change

Delivery/Routing of Water

Two diversions on Chicken Coop Creek are reported by the WCC (2002). The creek has multiple culverts at road crossings.

Delivery/Routing of Sediment

The culvert at Chicken Coop Road is reportedly leaking through the bottom thereby causing road fill erosion. Additionally, the Old Blyn Highway culvert is reportedly not parallel to the stream and is resulting in stream headcutting (pers. comm. with Hilton Turnbull 2002, as cited in WCC 2002).

Ecosystem Functions and Conditions

Riparian Corridor

Shrubs and non-native invasive species dominate the riparian zone (TAG as cited in WCC 2002). Although the Chicken Coop Creek streambank is well vegetated below Chicken Coop Creek Road, the dense root system that helps limit erosion is comprised of reed canary grass, an undesirable non-native invasive species (WCC 2002). The riparian zone is further fragmented by road crossings, which average 1.95 crossings per mile of stream (PNPTC unpublished data 2002 as cited in WCC 2002).

Wetlands and Floodplains

Floodplain habitat below East Sequim Bay Road is a forested wetland/wet meadow complex that provides some good habitat for fish.

Nearshore/Estuary

The TAG (2002 in WCC 2002) states that Chicken Coop Creek enters onto a sand flat along the southeast shoreline of Sequim Bay.

2.10.7 Other Streams

The remaining other streams in the Sequim Bay watershed are generally forested, short (generally less than 2.0 miles), very steep, and are thought to have very little anadromous fish use. Although fish use has not been surveyed, coho and chum salmon may use accessible areas near the mouths of the streams. Most of these streams are relatively undeveloped and are minimally impacted by nonpoint sources of pollution (CCDCD 1987). Some streams have animal access and require fencing to maintain water quality.