2 SITE BACKGROUND AND SETTING

The former Rayonier Mill Site is located in the city of Port Angeles, Clallam County, Washington along the northern coast of the Olympic Peninsula on the southern shore of Port Angeles Harbor in the Strait of Juan de Fuca. A recent (1999) photo of the site is presented in Figure 2-1. The former Rayonier Mill Site, approximately 80 acres, is located in the northwest quarter of Section 11, Township 30 north, Range 6 west, at latitude 48° 07′ 00″ north and longitude 123° 24′ 25″ west. It is bounded on the south by a high bluff and gently slopes north toward Port Angeles Harbor. Residential and commercial properties occur south of the mill. Ennis Creek flows from the Olympic Mountains through the site and empties into the Strait of Juan de Fuca.

The natural deep-water harbor of Port Angeles attracts shipping and both commercial and sport fishing. Logging and timber have long been important industries in the area. The former Rayonier Mill Site was first commercially occupied by a sawmill. In 1930, Rayonier's predecessor began production of dissolving-grade pulps using an acid sulfite process. Rayonier permanently ceased production at the mill in 1997, and the mill buildings and equipment have since been dismantled.

While many historic activities likely influenced the marine and uplands environment close to the former Rayonier Mill Site, Rayonier is working with Ecology and the Tribe to investigate the nature and extent of contamination and risks to receptors potentially impacted by its historic operations.

2.1 DESCRIPTION AND HISTORY OF OPERATIONS

The former Rayonier Mill Site operated between 1930 and 1997, using an acid sulfite process to produce dissolving grade pulps from wood chips. The mill was owned by Olympic Forest Products between 1930 and 1937, when it merged into Rayonier, Inc. Mill ownership shifted to ITT Rayonier, Inc., between 1968 and 1994, after which it returned to Rayonier, Inc. Operations were conducted in various process areas throughout the former Rayonier Mill Site (Figure 2-2). Operations ceased in 1997, and dismantling activities were completed in October 1999.

Mill design and operation are detailed in the Expanded Site Inspection Report (ESI Report) (Ecology and Environment, Inc. [E&E], 1998) and the Current Situation/Site Conceptual Model Report (CS/SCM) (Foster Wheeler Environmental Corporation [Foster Wheeler], 1997). Figure 2-3 presents a process flow diagram of the operations conducted at the mill.

Figure 2-1 Recent Photograph of Site Formerly Occupied by the Rayonier Pulp Mill (Photo Dated 1999).

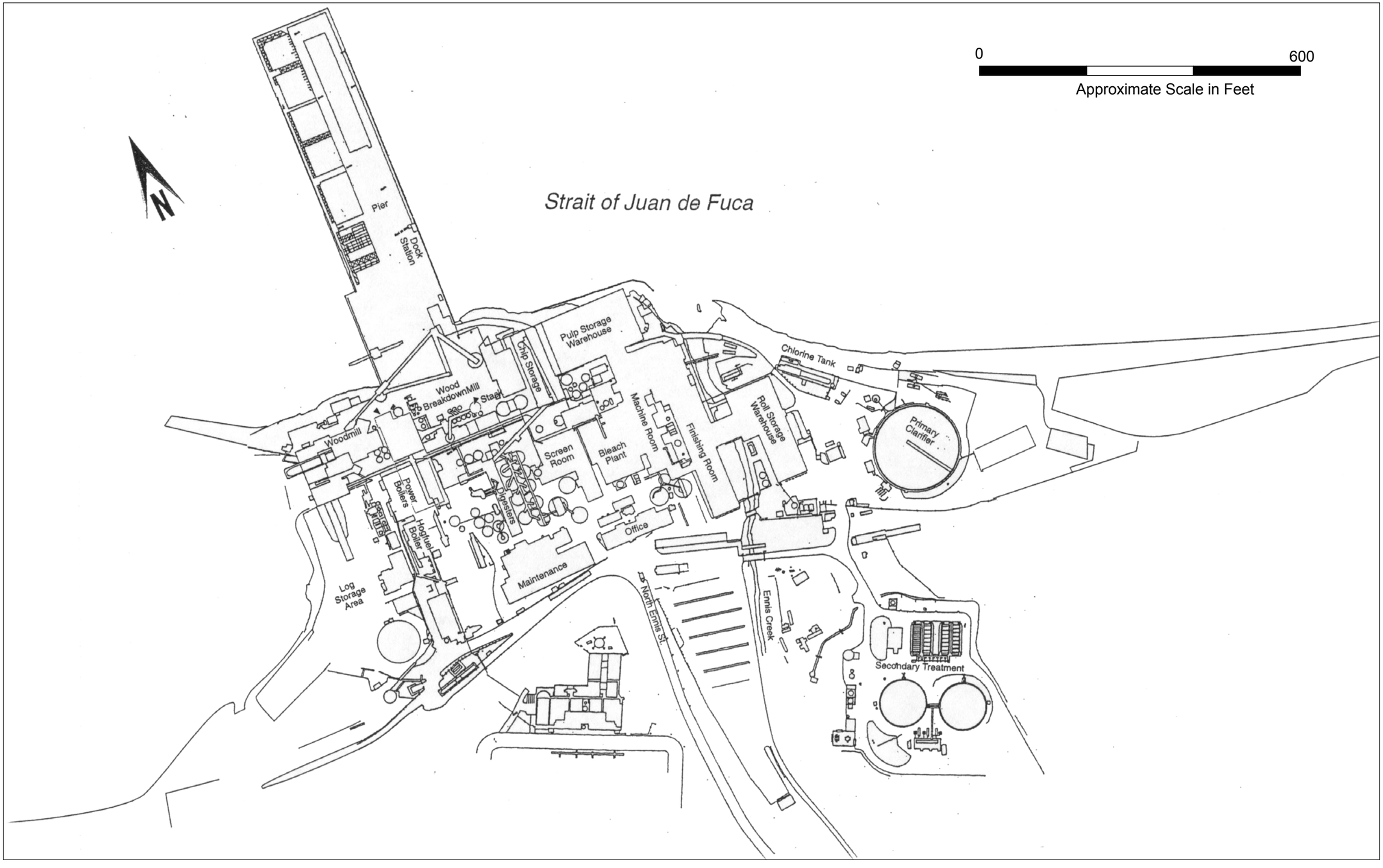


Figure 2-2. Diagram of Former Mill Facilities Depicting Major Operations and Process Areas.

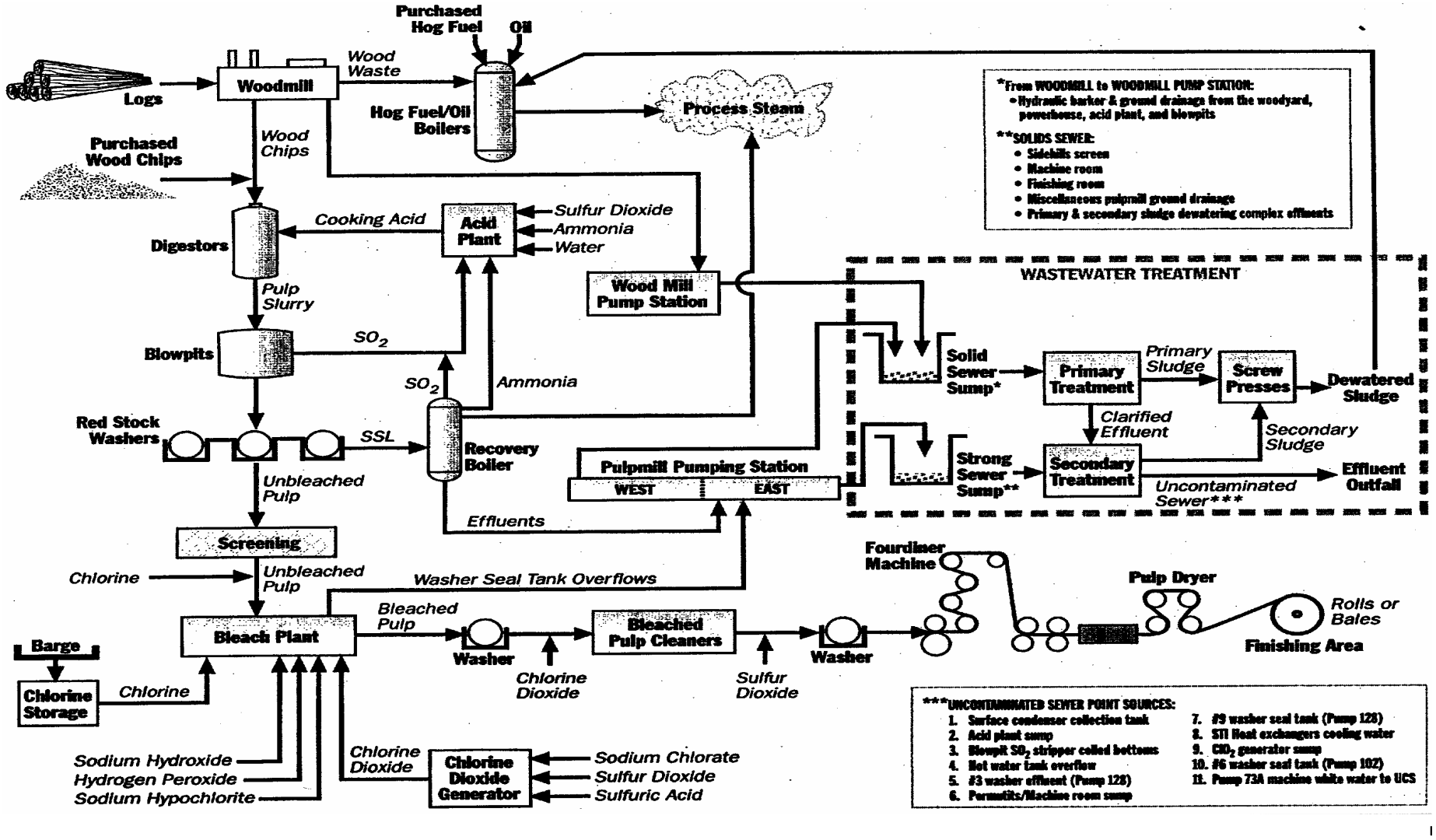


Figure 2-3. Rayonier Mill General Process Flow Diagram at Time of Closing

A description of the typical operations conducted at the mill is provided below.

- Logs were delivered to the mill by raft or truck and staged in its log pond or log yard area before being processed in the wood mill. Up to about 50 percent of the mill's chip supply was purchased directly from sawmills and delivered by truck or chip barge, which docked on the west side of the former Rayonier Mill Site's pier. The dock area was periodically inspected and dredged; the dredged material was then hauled and deposited in Rayonier's off-site landfills.
- Bark removed from the logs and rejected wood chips and debris were transported to the hog fuel pile and burned in the hog fuel boilers. The hog fuel boilers and the recovery boiler generated process steam. When necessary, Bunker C fuel oil was used to supplement fuel demands.
- Water, ammonia, and sulfur dioxide were combined in the acid plant to produce a fortified ammonium bisulfite cooking liquor, which was combined with the wood chips and treated at high pressure and temperature in nine large pressure vessels called digesters. This reduced the wood chips to cellulose fibers (pulp) and water-soluble, non-cellulose wood residuals. Once digestion was complete, pressure was reduced in the digesters by venting steam and gases into condensors. The stored condensate was then fed back to the acid plant and recycled back into the cooking liquor.
- Residual pressure in the digesters was used to blow the pulp into the nine blowpit tanks associated with each digester. Before the blow event, each blowpit was prepared to receive the pulp slurry by being partially filled with a cushioning liquor of digestion chemicals such as spent sulfite liquor (SSL). This reduced the process gases that were released during the transfer process. The mechanical agitation resulting from being blown against a metal plate in the blowpits separated the digested wood into individual fibers. Process gases released during the blow event were recovered, reprocessed, and reused. The pulp slurry was then transferred from the blowpits to the red stock washers, where the digestion chemicals were washed from the pulp. The pulp was screened to remove knots and other undigested wood residue and forwarded to the bleach plant.
- The SSL consisted of approximately 10 percent solids upon leaving the red stock washers. The SSL was filtered and stripped of sulfur dioxide, and the solids content was increased by vapor recompression and multi-effect evaporators. This allowed approximately 95 percent of the SSL to be burned in the recovery boiler to generate steam for the digestion process. The sulfur dioxide was recovered in the boiler flue gas using aqueous ammonia in a large absorber to produce the cooking liquor precursor.
- The SSL was temporarily stored in the SSL lagoon, located on the easternmost portion of the former Rayonier Mill Site, before it was burned in the recovery boiler. The lagoon had a 1- to 2-foot-thick layer of clay (10^{-5} permeability) and was

covered with a 60-mm, high-density polypropylene (HDPE) floating cover over the liquid.

- In the bleach plant, the bleaching process generally consisted of a sequence using chlorine, caustic soda, sodium hypochlorite, chlorine dioxide, and multiple stages of washing. Both chlorine dioxide and sodium hypochlorite were produced on site. The pulp was then transported to the drying machine where water was removed, the pulp was pressed and dried, and the material was made into large rolls. These rolls were then processed into smaller rolls or bales before being transported from the mill to the customer.

As detailed in the ESI Report (E&E, 1998) and the CS/SCM Report (Foster Wheeler, 1997), process wastewater and stormwater at the former Rayonier Mill Site consisted of three types of waste streams: 1) high solids, 2) low solids and high organic loads; and 3) low solids and low organic content (primarily uncontaminated cooling water). From 1930 until 1972, process wastewater and stormwater were discharged directly into Port Angeles Harbor through five nearshore outfalls (Figure 2-4). In 1972, a primary treatment plant and extensive sewer system was constructed at the mill. The treatment system routed all effluent and stormwater to a new outfall (Outfall 001), which extends 7,900 feet into the Strait of Juan de Fuca (Figure 2-5). All nearshore outfalls were then removed from service. The last 940 feet of Outfall 001 is a diffuser section with 48 ports spaced at intervals of 20 feet. A secondary treatment system was also constructed in 1979.

During operations, two major pumping stations and ten smaller sumps collected wastewater on site and routed them to the force mains (detailed in Foster Wheeler, 1997). The largest pumping station was located just south of the pulp storage warehouse and handled both high-solid and high organic content effluent. An average of 39 million gallons of effluent was discharged through Outfall 001 every day.

The three types of process streams were routed as follows:

- Wastewater streams and stormwater runoff with a high solids content (more than 0.3 pound of settleable solids per 1,000 gallons) flowed to the solids sewer system where the solids were settled out in the primary clarifier. This primary sludge was dewatered and sent to the hog fuel pile for use as fuel in the hog fuel boiler.
- Low-solids effluent with high organic chemical loads flowed to the strong sewer system where it was combined with the primary clarifier effluent and introduced into secondary treatment before discharge through Outfall 001.
- Cooling waters (low solids and low organic chemical loads) were combined with the secondary effluent before discharge through Outfall 001. This made up about 40 percent of the daily effluent. (E&E, 1998).

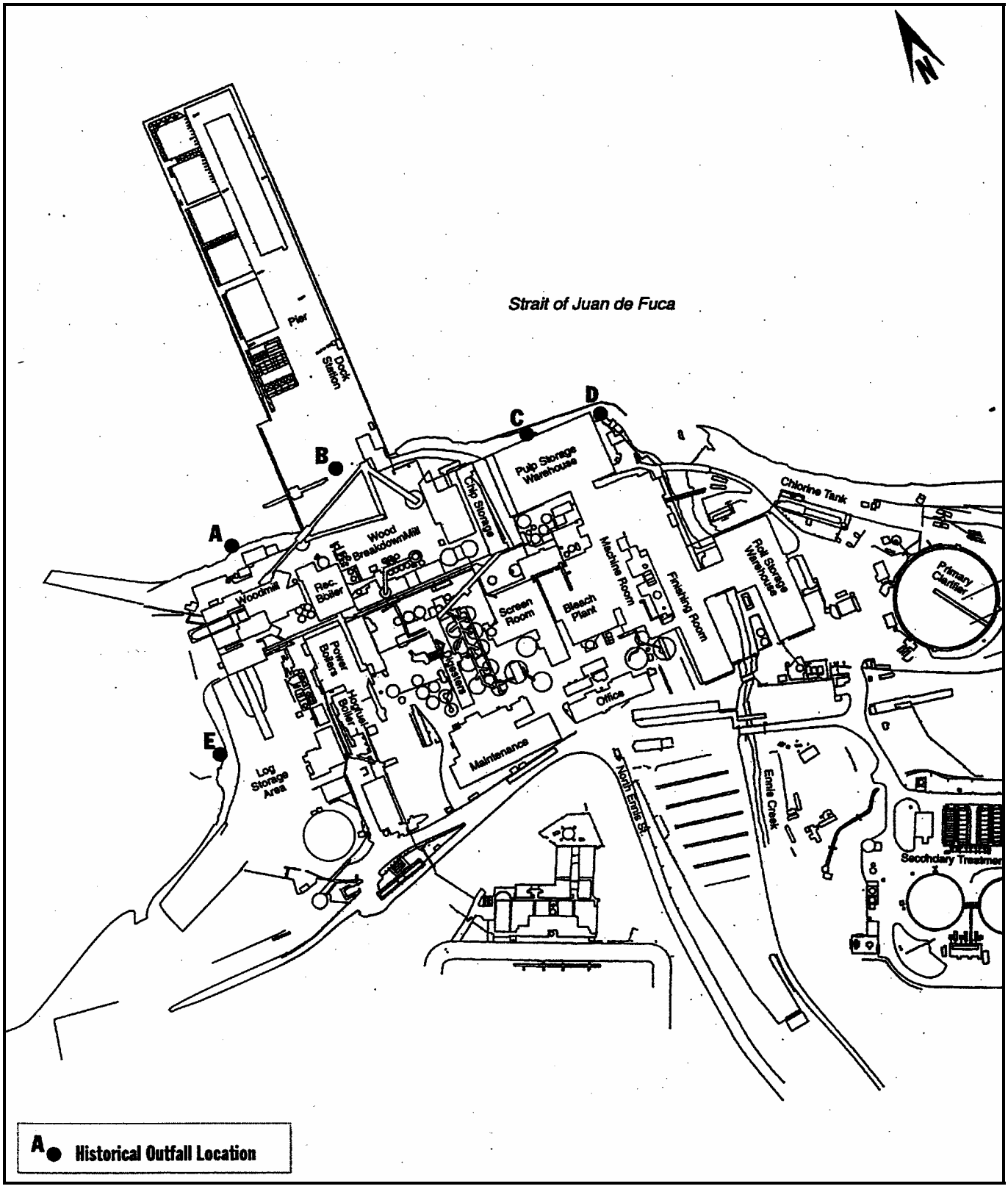


Figure 2-4. Location of Historical Outfalls at the Rayonier Mill Site

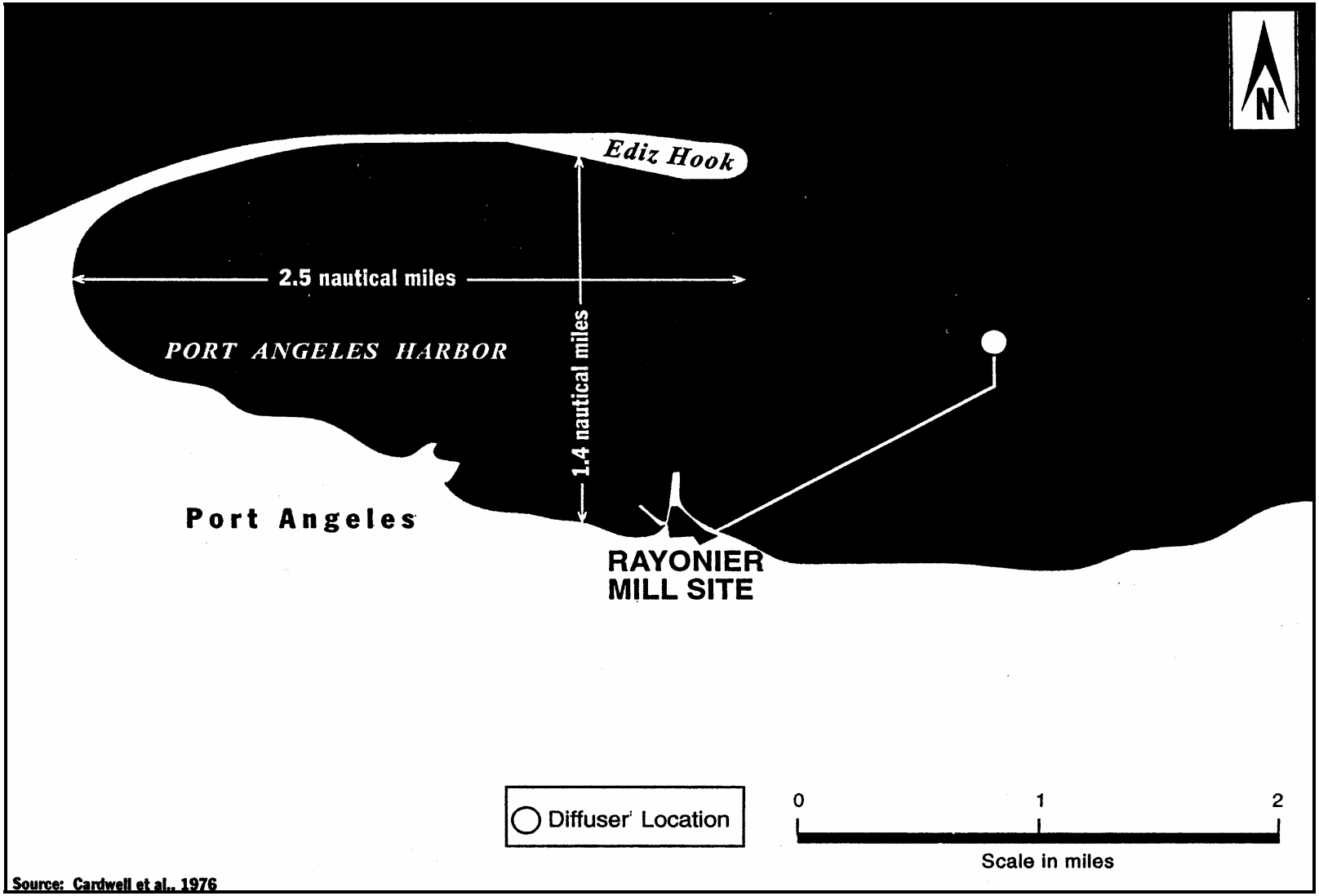


Figure 2-5. Deep Water Outfall

During operations, mill effluents were tested periodically to demonstrate compliance with National Pollutant Discharge Elimination System (NPDES) permit requirements. Testing results for biological oxygen demand (BOD), total suspended solids (TSS), pH, and bioassays from 1978 to 1992, summarized in the CS/SCM Report (Foster Wheeler, 1997).

Between 1989 and 1994, process waters and outfall discharges for dioxins/furans, volatile organic compounds (VOCs), adsorbable organic halides (AOXs), and chlorinated phenolics were also tested. Results of these tests are summarized in the CS/SCM report (Foster Wheeler, 1997). Maximum dioxin/furan concentrations (calculated as a CDD and CDF TEQ[1] per sample) reported in final effluent and extended outfall samples were 136 picagrams (pg)/l TEQ and 370 pg/l TEQ, respectively. Acetone and chloroform were the only VOCs detected in effluent samples, with up to 1,100 μg/L and 100 μg/L, respectively, measured in process water and 43 μg/L and 4.7 μg/L, respectively, measured at the extended outfall. Chlorinated phenolics measured at the extended outfall ranged from non-detected to 8.9 μg/L (2,4,6 trichlorophenol).

The former Rayonier Mill Site generally slopes to the north towards Port Angeles Harbor with areas next to Ennis Creek generally sloping toward the creek. All neighboring properties are located uphill of the former Rayonier Mill Site drainage areas and are not affected by site stormwater. Non-process stormwater was rerouted to the treatment system in 1979. Structural controls and site grading were used to prevent stormwater from flowing directly into the creek and marine environment. A drainage ditch, running east-west and located north of the secondary treatment area, received surface runoff from the treatment area and the bone yard. A sump at the west end of the drainage ditch directed water back into the treatment system. During operations, sumps were also located in the wood mill, log yard, and pulp mill area to divert stormwater into the treatment system.

Currently stormwater from the former Rayonier Mill Site discharges through Outfall 001 and at four discrete outfall locations in Ennis Creek. Rayonier prepared a stormwater management plan (Foster Wheeler, 1999) describing the facilities and procedures for managing stormwater. The stormwater management plan includes the following elements:

- Structural controls (berms, trenches, curbing, etc.) for site drainage areas and infiltration of stormwater through open soil areas.

[1] Dioxin-like compounds, which include chlorinated dibenzo-p-dioxins (CDDs) and chlorinated dibenzofurans (CDFs), are evaluated in terms of relative toxicity using a toxicity equivalency factor (TEF) procedure. This approach constitutes a "relative-ranking" scheme to evaluate mixtures of structurally related CDDs and CDFs based on the most toxic (and well-studied) congener 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). Nonzero TEFs are assigned to CDDs and CDFs (similarly structured) with chlorine substituted in the 2,3,7,8 positions (NATO-CCMS, 1988; EPA, 1989). The TEF is multiplied by the specific congener concentration to express the concentration in terms of a 2,3,7,8 TCDD toxicity equivalent (TEQ). Congener-specific TEQs are summed to obtain a total TEQ for the sample, which then can be combined with toxicity information on 2,3,7,8 TCDD to estimate risks associated with the mixture.

- Structural controls and infiltration for stormwater in areas east of Ennis Creek. During extended wet periods, stormwater is discharged through three separate outfalls in Ennis Creek, using sediment controls before discharge.
- Discharge to Ennis Creek (with drain inlet protection) for parking lot runoff west of Ennis Creek.
- A contained, paved area with a dedicated stormwater collection and treatment system for staging excavated soil before remediation.

2.2 ENVIRONMENTAL SETTING

This section describes the topography, climate, cultural geography and socioeconomics, geology and hydrogeology, and biological setting of the former Rayonier Mill Site.

2.2.1 TOPOGRAPHY

A significant portion of the former Rayonier Mill Site rests on historically filled shallows, beach material, and the former alluvial fan of Ennis Creek. Surface elevations range from sea level to approximately 75 feet above the National Geodetic Vertical Datum (NGVD) (Harding Lawson Associates [HLA], 1993). The terrain rises to approximately 200, 265, and 150 feet above NGVD within approximately 1.0 mile southeast, south, and southwest of the former Rayonier Mill Site, respectively (HLA, 1993). The northern portion of the former Rayonier Mill Site is generally flat, with relatively steep bluffs rising rapidly to approximately 75 feet above NGVD immediately to the southeast and southwest (HLA, 1993). Hills further to the southeast and southwest of the former Rayonier Mill Site gradually rise toward the foothills of the Olympic Mountains (HLA, 1993).

The closest surface water bodies are Port Angeles Harbor, which borders the former Rayonier Mill Site, and White and Ennis creeks, which converge upstream of the site and run through it as Ennis Creek. A rather steep ravine is formed where Ennis Creek cuts through the bluff on the southern end of the property and beyond. A site access road is developed along the western side of this ravine, dropping in elevation from approximately 75 feet to just above sea level.

2.2.2 CLIMATE AND WEATHER

The climate on the northern coastline of the Olympic Peninsula is influenced by winds from the Pacific Ocean. Based on data gathered between 1951 and 1980 (Foster Wheeler, 1997), average temperatures in the area range from 39° F in January to 59° F in July and August. Total annual precipitation (mostly occurring as rain in the lower elevations) is approximately 25.4 inches, ranging from 0.5 inch in July to 4.4 inches in January.

Winds in the area vary seasonally and are influenced by weather patterns approaching the coast. During dismantling and cleanup activities between October 1997 and October 1999, on-site winds were monitored as part of the air quality monitoring program

(Foster Wheeler, 1998). Meteorological conditions during each sampling event and monthly composites were presented in the form of windrose figures. On-site winds during the monitoring program were generally light to moderate, blowing primarily from the northwest.

In 1992, ENSR conducted a study for Rayonier in support of modeling various emission sources at the former Rayonier Mill Site. Wind speed data collected from 3rd and Chestnut Street and from 1st and Chambers Street in downtown Port Angeles were analyzed for primary wind speed and direction. All of the data was sampled in short periods, and the data set was augmented with data extracted from Whidbey Island Naval Air Station and from Quillayute, Washington. A wind rose prepared for the period between 1983 and 1989 indicated wind directions were primarily from the south, south-southeast, and (less frequently) from the west-northwest.

2.2.3 CULTURAL GEOGRAPHY AND SOCIOECONOMICS

In compliance with the Washington State Environmental Policy Act (SEPA) and with conditions of approval for the Port Angeles Planning Department Shoreline and Building permit application necessary for dismantling activities, Rayonier contracted Larson Anthropological/Archaeological Services (LAAS) to conduct a cultural resource assessment of the former Rayonier Mill Site. The assessment consisted of an archival review, Tribal consultation, field reconnaissance, and preparation of a cultural resources assessment report (LAAS, 1997). The report provides a detailed description of the environment and cultural background of the former Rayonier Mill Site and describes a Klallam Indian village on the eastern bank of Ennis Creek that supported a population of hunter-fisher-gatherers before Euro-American contact. The Klallam village site was recorded and listed on the Washington Heritage Register, although no archaeological deposits associated with the former Rayonier Mill Site were recorded.

2.2.4 SOILS AND GEOLOGY

The regional geology of the Olympic Peninsula is characterized by accretionary tectonics and can be divided into two geologic domains: the Olympic Core Terrane and the peripheral Crescent Terrane. The Olympic Core Terrane is comprised of complex deformed packages of Eocene to Miocene age sedimentary rocks with interbedded volcanic rocks. The terrane forms an accretionary prism thrust under the peripheral Crescent Terrane. The Crescent Terrane forms a horseshoe shape around the Olympic Core Terrane and is comprised of the Crescent Formation, an Early to Middle Eocene oceanic tholeiitic basalt with associated interbedded marine sedimentary rocks (Rauch, 1985; Tabor and Cady, 1978; HLA, 1993).

The local site geology is characterized by Tertiary bedrock overlain by Pleistocene-age deposits and recent alluvium deposit. The former Rayonier Mill Site lies in an area of alluvium deposited by Ennis Creek, beach deposits related to the Strait of Juan de Fuca, and fill material. Along the bluffs south of the former Rayonier Mill Site lie deposits of Vashon Till, an unsorted mix of gravel and cobbles in a matrix of sand, clay, and silt that blankets advance outwash deposits and other undifferentiated glacial deposits. Most of

these glacial deposits are related to continental glaciation from the north, with minor amounts related to glaciation in the Olympic Mountains to the south. Depth to bedrock beneath the former Rayonier Mill Site is unknown, but is likely variable in the Port Angeles area, based on local isolated outcrops of the Tertiary Twin River Formation (Tabor and Cady, 1978; HLA, 1993).

In the northwest portion of the former Rayonier Mill Site, previous investigations (Landau, 1991a) encountered gravels, sands, and silts with fragments of shells, wood, brick, metal, and other debris to depths 20 to 25 feet below the ground surface (bgs) underlain by till to about 44 feet bgs, the maximum depth explored. Groundwater was encountered at approximately 4 to 8 feet bgs during the investigations (HLA, 1993).

In the northern portion of the former Rayonier Mill Site near the mouth of Ennis Creek, the subsurface material encountered during investigations (Landau Associates, 1991a) consisted of fill and alluvium underlain by glacial till. The fill was comprised of sand, gravel, cellulose material, and riprap rock along Ennis Creek and was generally less than 6 feet thick. Beneath the fill, 2 to 4 feet of sand, gravel, and silt alluvium was encountered which, in turn, was underlain by till. The maximum depth explored during the investigation was approximately 20 feet bgs, and groundwater was present at approximately 5 to 6 feet bgs (HLA, 1993).

Soil types identified at the former Rayonier Mill Site include beach and fill material along the northern margin, Dystric Xerorthents (coarse-textured soils) along the coastal bluffs, and Neilton very gravelly loamy sand (30 to 70 percent slopes) and Puget silt loam (0 to 3 percent slopes) along Ennis Creek to the south (Soil Conservation Service [SCS], 1987; HLA, 1993). The beach and fill deposits consist of sand, gravel, and cobble-size material reworked by wave action combined with materials used for fill at the former Rayonier Mill Site. Physical characteristics depend on the nature of the deposits and, as a result, are highly variable across this portion of the former Rayonier Mill Site (HLA, 1993). The Neilton very gravelly loamy sand and Puget silt loam are both associated with land features related to Ennis Creek. Puget silt loam is present on the relatively flat terraces of Ennis Creek and is a very deep, poorly drained soil, while the Neilton very gravelly loamy sand is excessively drained and found on the terrace escarpments of Ennis Creek. Both soils are found in the southern portion of the former Rayonier Mill Site (SCS, 1987; HLA, 1993).

Materials in many portions of the former Rayonier Mill Site most likely consist of soils modified through grading, dredging, filling, or facility operations and may vary considerably between locations. Much of the log yard area in the western portion of the former Rayonier Mill Site is fill (personal communication, Bill Jensen, Rayonier, July 1993). In addition to sand and gravel, wood waste, ash, and demolition debris were used as fill materials (HLA, 1993). During the former Rayonier Mill Site dismantling (1997 through 1999), crushed concrete rubble was distributed across some areas of the former Rayonier Mill Site. In 1999, fill material consisting of gravel, rock, and rip rap was imported to reconstruct and prevent further beach and site erosion along the former log pond area beach wall.

2.2.5 HYDROGEOLOGY

Site-specific hydrogeology is based primarily on groundwater data obtained during previous investigations conducted by HLA (1993), Landau (1997), and EPA (E&E,1998). Groundwater conditions observed during previous investigations indicate the presence of unconfined groundwater beneath the former Rayonier Mill Site in a shallow water-bearing zone consisting of near-surface fill and alluvial deposits. The depth to groundwater in this zone ranges from less than 1 foot bgs to 12 feet bgs. The water-bearing zone is variable in thickness; the base (generally defined by the top of the Vashon Till unit) varies from 12 feet bgs to greater than 30 feet bgs. Groundwater elevations are influenced both by tides (E&E, 1998) and, to a lesser degree, by surface water fluctuations in Ennis Creek.

Groundwater elevation measurements made in previous investigations indicate a predominantly northerly groundwater flow direction towards Port Angeles Harbor with a locally variable lateral component towards Ennis Creek. Figure 2-6 presents a groundwater contour map of the former Rayonier Mill Site. Water table contours were extrapolated from available groundwater elevation measurements collected from existing site wells. The gradient after the first high tide was measured at 0.0072 foot per foot and 0.0082 foot per foot after the first low tide (HLA, 1993).

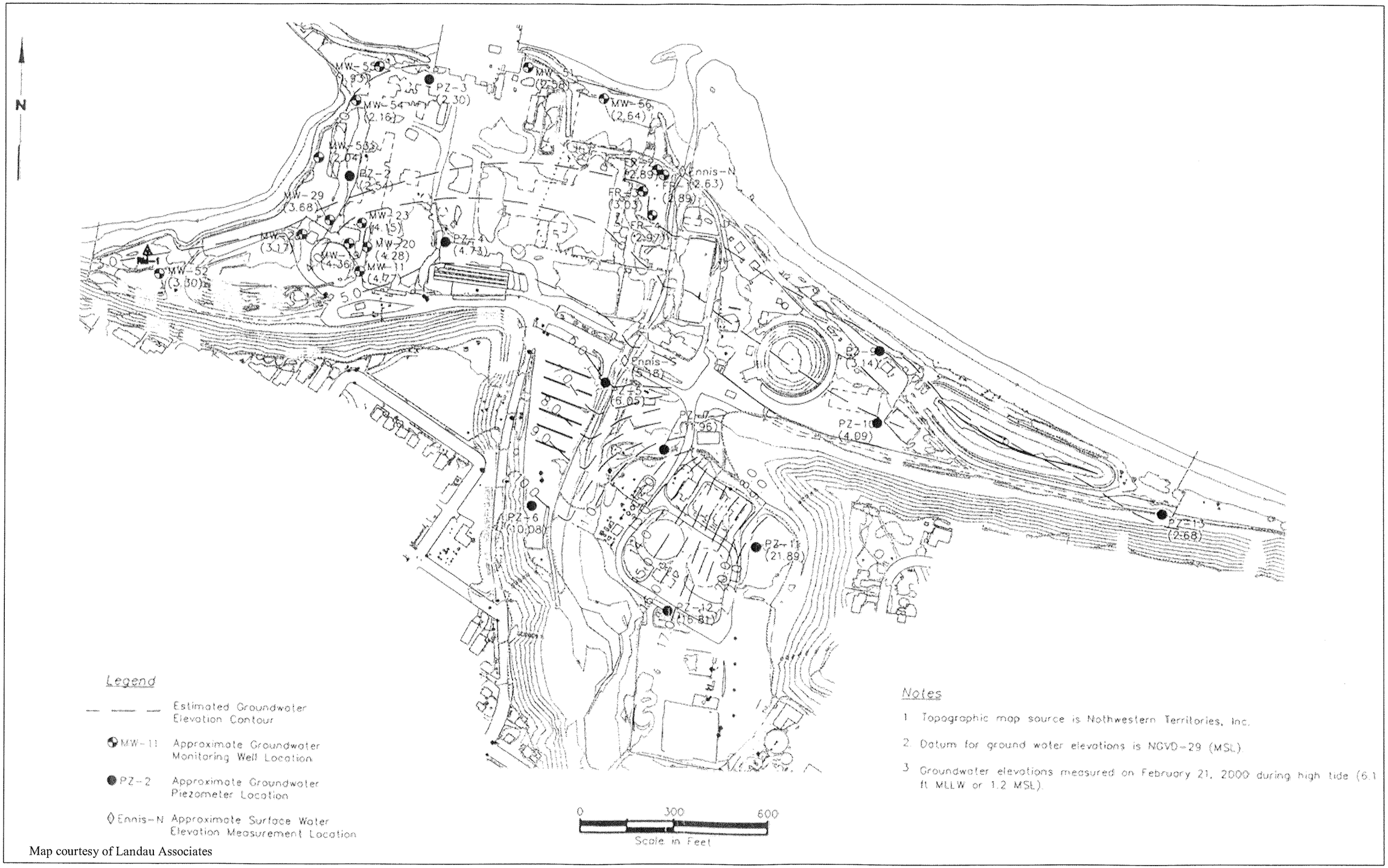
2.2.6 BIOLOGICAL SETTING

The following sections review the upland environment present at the site and identify endangered and threatened species that may be associated with the site.

2.2.6.1 Upland Environment

The former Rayonier Mill Site is located within the Port Angeles city limits and is bordered to the south by residential areas on the high bluff and to the west by a pedestrian pathway following the old railway right-of-way and additional commercial/residential areas. Port Angeles Harbor has a high level of urban, commercial, industrial, and recreational use. Ennis Creek flows through the former Rayonier Mill Site and discharges to the marine waters approximately 500 feet east of 1,000 foot dock.

The uplands portion of the former Rayonier Mill Site is primarily zoned heavy industrial. The Ennis Creek riparian area and marine bluffs contain disturbed forest habitat that provide a corridor of upland wildlife habitat. Typical species that could occur within an urbanized/industrialized area such as this site are listed in Table 2-1 (Personal communication, Russell Link, Urban Biologist, Washington Department of Fish and Wildlife [WDFW], January 31, 2001). This list is not meant to be all-inclusive, but is designed to provide background for some wildlife species that tend to be common within this type of urban/industrial setting.



Map courtesy of Landau Associates

Figure 2-6. Groundwater Contour Map

2.2.6.2 Marine Environment

The marine resources of the Port Angeles area have been described in a number of documents. One of the more comprehensive reviews, by Shea, et al. (1981), evaluated the history, dispersion, and effects of pulp mill effluents on marine waters near Port Angeles. The report evaluated physical, chemical, and biological aspects of the area. Other studies and reports have documented the specific distribution of salmon, marine fish, and shellfish in this area (e.g., Washington Department of Fisheries [WDF], 1992; Goodwin and Shaul, 1978; Goodwin, 1973; Goodwin and Westley, 1969; Kittle, 1976; Ecology, 1976; Bishop and Devitt, 1970; EPA, 1991; EVS Consultants, 1994; Evans-Hamilton and DR Systems, 1987; Simenstad, et al., 1979; SAIC, 1999; E&E, 1998; Rayonier, 1995; Washington Department of Natural Resources [WDNR], 1977). In addition, underwater video surveys along specific transects at the former Rayonier Mill Site were conducted in 2000. The following sections summarize information on marine resources from a number of these publications and from the video surveys.

The former Rayonier Mill Site is located within Port Angeles Harbor, next to the Strait of Juan de Fuca (see Figure 1-1). Port Angeles Harbor is an urban embayment with commercial, industrial, and recreational uses. The harbor is partially protected from the Strait of Juan de Fuca by Ediz Hook. The site is bordered on the north, northwest, and northeast by marine waters. Ennis Creek, a freshwater creek, flows through the former Rayonier Mill Site and discharges to the marine waters approximately 500 feet east of Rayonier's dock.

The aquatic environment of Port Angeles Harbor has been described as an ecological transition zone between purely marine habitat (to the west of Port Angeles) and shallower, lower salinity estuarine-type areas to the east (Shea, et al., 1981). The bottom contours of the southern portion of Port Angeles Harbor are characterized as a bench that generally slopes to deeper areas (more than 90 feet) to the north just on the inside of Ediz Hook. The shoreline along the southern border is characterized by either dock or port facilities in the inner harbor and riprapped shoreline both east and west of the Rayonier plant site. The riprap was placed to protect the now abandoned railroad grade that was along the shoreline. At the Rayonier site, riprap was also used to protect the former Rayonier Mill Site. The beach and subtidal areas of the bench have a variety of soft substrates, including sand, gravel, and mud. No major natural outcrops of bedrock or other large hardrock materials are evident (i.e., rocky shorelines are not present in the immediate area).

Table 2-1. Common Upland Wildlife Species Potentially Occurring in Areas within Urban and/or Urban/Industrial Landscapes

Common Nane (Scientific Name)	Common Name (Scientific Name)
Mammals	***Birds (continued)***
Big brown bat (*Epesicus fuscus*)	Red-shafted flicker (*Colaptes auratus*)
Little brown bat (*Myotis lucifugus*)	Red-tailed hawk (*Buteo jamaicensis*)
Deer mouse (*Peromyscus maniculatus*)	Red-winged blackbird (*Ageliaus phoeniceus*)
Cottontail rabbit-eastern (*Sylvilagus floridanus*)	American robin (*Turdus migratorius*)
Coyote (*Canis latrans*)	Song sparrow (*Melospiza melodia*)
Black-tailed deer (*Odocoileus hemionus columbianus*)	European starling (*Sturnus vulgaris*)
Eastern gray squirrel (*Sciurus carolinensis*)	***Reptiles***
House mouse (*Mus musculus*)	Garter snake (*Thamnophis sirtalis*)
Mole (*Scapanus* spp.)	***Amphibians***
Muskrat (*Ondatra zibethica*)	Pacific chorus (tree) frog (*Hyla regilla*)
Meadow Mouse (*Microtus* spp.)	Western long-toed salamander (*Ambystoma macrodactylum-macrodactylum*)
Norway rat (*Rattus norvegicus*)	***Butterflies and Moths***
Opossum (*Didelphis virginiana*)	Cabbage white (*Pieris rapae*)
Raccoon (*Procyon lotor*)	Painted lady (*Vanessa cardui*)
Shrews (*Scapanus* spp.)	Red admiral (*Vanessa atalanta*)
Spotted skunk (*Spilogale putorius*)	Tiger moth(Wooly bear) (*Isia isabella*)
Striped skunk (*Mephitis mephitis*)	Tiger swallowtail (*Papilio glaucus*)
Birds	***Other Insects***
Barn swallow (*Hirundo rustica*)	Bumblebee (*Bombus* spp.)
Black-capped chickadee (*Parus atricapillus*)	Carpenter ant (*Camponotus ferrugineus*)
Brown-headed cowbird (*Molothrus ater*)	Cricket (*Gryllus assimilis*)
Canada goose (*Branta canadensis*)	Grasshopper (*Orchelimum vulgare*)
Coopers hawk (*Accipiter cooperii*)	House fly (*Musca domestica*)
Northwestern crow (*Corvus brachyrhyncos*)	Japanese beetle (*Popillia japonica*)
Gadwall (*Anas strepera*)	Lady beetle (*Hippodamia convergens*)
Brandt (*Branta bernicla*)	Little black ant (*Monomorium minimum*)
Goldfinch (American) (*Carduelis tristis*)	Mosquito (*Culex pipiens*)
Great blue heron (*Ardea herodias*)	Termite (*Reticulitermes flavipes*)
House finch (*Carpodacus mexicanus*)	Yellow jacket (*Dolichovespula arenaria*)
House sparrow (*Passer domesticus*)	***Other Invertebrates***
Killdeer (*Charadrius vociferus*)	Daddylonglegs (*Leioburum vittatum*)
Mallard duck (*Anas platyrhynchos*)	Earthworm (*Lumbricus terrestris*)
Mourning dove (*Zenaida macroura*)	Sowbug (*Oniscus asellus*)
Downy woodpecker (*Picoides pubescens*)	
Hairy woodpecker (*Picoides villosous*)	
Osprey (*Pandion haliaetus*)	
Pigeon (rock dove) (*Columbia livia*)	

2.2.6.3 Marine Species

The Port Angeles area has a wide variety of species, including salmon, bottomfish, shellfish (crabs and clams), algae, and other marine species. Many of the species (such as salmon) are transients. They either move through the area during migration to the open ocean as juveniles or as adults on their spawning migrations to freshwater areas in

Puget Sound, Canada, and elsewhere. Transient species may also be found feeding in this area when baitfish such as herring or sandlance are present. Other species such as crabs, clams, and bottomfish may have limited (e.g., within a small area) or totally restricted movements. These species may be found in the Port Angeles area year-round with seasonal migrations in depth for some species (e.g., flatfish).

Species such as clams, flatfish, and crabs are found on the subtidal areas of the bench along the southern portion of the harbor. Occasionally, rockfish species may be found around some of the structures such as the Rayonier deep water outfall.

The types of marine organisms that may be found in the Port Angeles area can be grouped into the following categories (Shea, et, al, 1981):

- Phytoplankton and other marine plants
- Zooplankton
- Shellfish
- Other invertebrates
- Fish

2.2.6.3.1 Phytoplankton and other Marine Plants

Phytoplankton and other marine plants can be further divided into the following: 1) phytoplankton, 2) benthic and macroalgae, and 3) seagrasses (Shea, et al., 1981). In general, phytoplankton includes green algae, blue-green algae, euglenoids, diatoms, dinoflagellates, and microflagellates. These are generally considered primary producers that form the basis for other organisms higher in the food web. Food web relationships and energetics have been investigated and described for the Strait of Juan de Fuca and Northern Puget Sound by Simenstad, et al., 1979.

Benthic diatoms which exist in and on the bottom substrate can be found in the Port Angeles area (Shea, et al., 1981); however, little is known about their distribution and abundance.

Macroalgae are also found in the Port Angeles area. In general, macroalgae are attached to the substrate, but may become detached through wind or wave action. In shallow areas, sea lettuce (*Ulva* spp.) and bladder kelp (*Fucus* spp.) may be found. In deeper areas, laminarian kelp (*Nereocystis* spp.) may occur. Large areas of *Nereocystis* (spp.) may be found on the north side of Ediz Hook and in areas along the shoreline east of Port Angeles Harbor (WDF, 1992; Shea, et al.. 1981).

The primary seagrass that may occur in the Port Angeles area is eelgrass (*Zostera marina*). Eelgrass is a rooted flowering plant that grows in sand to mud substrates from mean lower low water (MLLW) to approximately -20 feet MLLW. The primary locations for eelgrass are inside of Ediz Hook and inside Dungeness Spit, which is east of Port

Angeles (Shea, et al., 1981). One small eelgrass plant, consisting of only a few shoots, was observed just east of the Rayonier dock during the video surveys conducted in 2000.

2.2.6.3.2 Zooplankton

Zooplankton are primary consumers that feed mainly on phytoplankton. They are small animals that either drift passively or float in the water. Due to their large numbers, they form a significant amount of biomass that is available for consumption by higher trophic levels such as baitfish, sportfish, or commercial species. Shea, et al., (1981) described three types of zooplankton:

- IIcthyoplankton (eggs and larval forms of fish and shellfish)
- Microzooplankton (microscopic organisms)
- Macrozooplankton (very small, but visible, marine animals)

The abundance and distribution of zooplankton is highly affected by season, tide, location, and other factors. Icthyoplankton from a wide range of marine fish species (e.g., herring, sandlance, flatfish, rockfish, and cod) may be found in the Port Angeles area during certain seasons of the year. Populations of microplankton and macroplankton in the Strait of Juan de Fuca were described by Chester, et al., (1978). The most abundant of the macroplankton species are copepods. Chester, et al., (1978) found about 60 species of copepods in waters next to Port Angeles Harbor.

2.2.6.3.3 Shellfish

Shellfish include clams, crabs, and shrimp species. Clams are filter feeders, whereas shrimp and crabs may consume either living or dead organic materials. Table 2-2, adapted from Shea, et al., (1981) lists the commercial and non-commercial shellfish species that have been identified in the Port Angeles area. Species that are commonly used for human consumption are noted in the table.

2.2.6.3.4 Fish

More than 60 species of marine fish may be found in the Port Angeles area (Shea, et al., 1981). These include species such as salmon, halibut, rockfish, and flatfish that are important in sport, commercial, and Tribal harvests. Also included are important baitfish and forage fish such as herring and sandlance and other species. Table 2-3 lists marine fish species that occur in the Port Angeles area.

2.2.6.3.5 Salmon and Trout

Salmon generally migrate through the Port Angeles area either as adults returning to freshwater areas to spawn or juveniles that are migrating to the open ocean for maturation into adults. Some species (particularly chinook and coho salmon) may be

found in the Port Angeles area year-round, particularly if baitfish are present. The five main species of salmon that may be present are as follows:

- Chinook salmon
- Coho salmon
- Chum salmon
- Pink salmon
- Sockeye salmon

Table 2-2. Commercial and Noncommercial Shellfish Species Found in the Port Angeles Area (Table adapted from Shea, et al., 1981)

Hardshell Clams	
	*Butter clams – *Saxidomus giganteus*
	*Cockle – *Clinocardium nuttallii*
	*Geoduck – *Panopea abrupta*
	*Horse clam – *Tresus nuttallii*
	*Native littleneck – *Protothaca staminea*
Softshell Clams	
	Bent-nose – *Macoma nasuta*
	Macoma – *Macoma* spp.
	Polluted macoma – *Macoma irus*
	*Eastern softshell – *Mya arenaria*
	Truncate softshell – *Mya truncata*
Miscellaneous Clams, Mussels, Urchins, and Sea Cucumbers	
	Blunt jacknife – *Solen sicarius*
	Milky Pacific venus – *Compsomyax subdiaphana*
	Panomya ampla
	Tellen – *Tellina* spp.
	*Blue mussels – *Mytilus trossulus*
	*Green sea urchin – *Strongylocentrotus droebachiensis*
	*Sea cucumber – *Parastichopus californicus*
Oysters	
	*Pacific oyster – *Crassostrea gigas*
Crabs	
	*Dungeness – *Cancer magister*
	*Red rock crab – *C. productus*
Shrimp	
	*Coonstripe – *Pandalus danae*
	*Pink shrimp – *Padalus jordani* or *P. borealis*

*May be used for human consumption.

Table 2-3. Marine Fish Species Occurring the Port Angeles Area (adapted from Shea, et al., 1981)[1/] (Part 1 of 2)

Common Name	Scientific Name
Chinook salmon	*Oncorhynchus tshawytscha*
Chum salmon	*Oncorhynchus keta*
Coho salmon	*Oncorhynchus kisutch*
Pink salmon	*Oncorhynchus gorbuscha*
Sockeye salmon	*Oncorhynchus nerka*
Steelhead trout	*Oncorhynchus mykiss*
Cutthroat trout	*Oncorhynchus clarki*
Northern Anchovy	*Engraulis mordax*
Cabezon	*Scorpaenichthys marmoratus*
Northern clingfish	*Gobiesox maeandricus*
High cockscomb	*Anoplarchus purpurescens*
Pacific cod	*Gadus macrocephalus*
Spiny dogfish	*Squalus acanthias*
Starry flounder	*Platichthys stellatus*
Crescent gunnel	*Pholis laeta*
Kelp greenling	*Hexagrammos decagrammus*
White-spotted greenling	*Hexagrammos stelleri*
Penpoint gunnel	*Apodicthys flavidus*
Saddleback gunnel	*Pholis ornate*
Pacific halibut	*Hippoglossus stenolepis*
Pacific herring	*Clupea pallassii*
Lingcod	*Ophiodon elongatus*
Shiner perch	*Cymatogaster aggregata*
Striped perch	*Embiotoca lateralis*
Bay pipefish	*Syngnathus griseolinatus*
Sturgeon poacher	*Podotheus acipenserinus*
Tubenose poacher	*Pallasina barbata*
Warty poacher	*Occella verrucosa*
Walleye Pollock	*Theragra chalogrammus*
Black prickleback	*Xiphister atropurpureus*
Rock prickleback	*Xiphister mucosus*
Ribbon prickleback	*Phytichthys chirus*
Snake prickleback	*Lumpenus sagitta*
Ratfish	*Hydrolagus colliei*
Pacific sanddab	*Citharichthys sordidus*
Speckled sanddab	*Citharichthys stigmaeus*
Pacific sandlance	*Ammodytes hexapterus*

Table 2-3. Marine Fish Species Occurring the Port Angeles Area (adapted from Shea, et al., 1981)[1/] (Part 2 of 2)

Common Name	Scientific Name
Buffalo sculpin	*Enophrys bison*
Calico sculpin	*Clinocottus embryum*
Darter sculpin	*Radulinus boleoides*
Fluffy sculpin	*Oligocuttus snyderi*
Grunt sculpin	*Rhamphocottus richardsoni*
Manacled sculpin	*Synchirus gilli*
Mosshead sculpin	*Clinocottus globiceps*
Padded sculpin	*Artedius fenestralis*
Pacific staghorn sculpin	*Leptocottus armatus*
Rosylip sculpin	*Ascelichthys rhodorus*
Saddleback sculpin	*Oligocottus rimensis*
Sharpnose sculpin	*Clinocottus acuticeps*
Silverspotted sculpin	*Blepsias cirrhosus*
Smoothhead sculpin	*Artedius lateralis*
Soft sculpin	*Psychrolutes sigalutes*
Tadpole sculpin	*Psychrolutes paradoxus*
Tidepool sculpin	*Oligocottus maculosus*
Longfin smelt	*Spirinchus thaleicthys*
Surf smelt	*Hypomesus pretiosus*
Ringtail snailfish	*Liparis rutteri*
Showy snailfish	*Liparis pulchellus*
Tidepool snailfish	*Liparis florae*
C-O sole	*Pleuronichthys coenosus*
Dover sole	*Microstomus pacificus*
English sole	*Pleuronectes vetulus*
Rock sole	*Pleuronectes bilineata*
Sand sole	*Psettichthys melanostictus*
Three-spined stickleback	*Gasterosteus aculeatus*
Pacific tomcod	*Microgadus proximus*
Tubesnout	*Aulorhynchus flavidus*
Turbot	*Artheresthes stomias*
Copper rockfish	*Sebastes caurinus*
Quillback rockfish	*Sebastes maliger*
Other rockfishes	*Sebastes sp.*

[1] This listing includes most of the species that have been recorded in the Port Angeles area. Additional species of sharks, rockfish, flatfish and other fish may also be present, but are not common. There is wide variation in the abundance, distribution, and seasonal occurrence of these species.

In addition, steelhead, bull trout, and cutthroat trout may occur in the area during migratory periods or while following schools of baitfish that also may move through the Port Angeles area.

2.2.6.3.6 Rockfish or Bottomfish

The term "rockfish" is given to a number of different species that belong to the genus Sebastes (Kramer and O'Connell, 1995). The term "bottomfish" is a much broader definition that the Washington Department of Fish and Wildlife (WDFW) applies to not only rockfish, but also to Pacific cod, Pacific tomcod, Pacific hake, walleye pollock, all species of flatfish (e.g., sanddabs, sole, and flounders) except halibut, lingcod, greenling, ratfish, sablefish, sculpins (e.g., cabezon, buffalo sculpin, great sculpin, red Irish lord, brown Irish lord, and Pacific staghorn sculpin), wolfeel, shark, skate, surfperches, and others.

All of these bottomfish species may occur in the general Port Angeles area. However, the more common and important species (i.e., commercial, Tribal, or sport) within the Port Angeles Harbor or near the former Rayonier Mill Site include the following:

- Lingcod
- Copper rockfish
- Quillback rockfish
- Black rockfish (several species possible)
- English sole
- Dover sole
- Rock sole
- Starry founder
- Sanddabs
- Perch

This particular group tends to have a limited migration and may be found in the Port Angeles area year-round, with seasonal migrations between shallow and deeper waters. Other species such as Pacific cod, Pacific hake, and walleye pollock may be very abundant during certain seasons.

2.2.6.3.6.1 Baitfish or Forage Fish

This general group includes herring and sandlance, which are primary forage fish for other species such as salmon, bottomfish, and other higher trophic level fish. They may also be heavily consumed by marine mammals and birds.

Herring are a popular baitfish for salmon and other species. Eggs of herring are also used for human consumption. Schools of herring may be found in the Port Angeles area throughout the year, but they likely migrate through the area following smaller food organisms. Herring spawning has been recorded in Dungeness Bay, but is limited or does not occur in the immediate vicinity of Port Angeles. Sandlances may be found throughout the Port Angeles area and, as with herring, may be seasonally abundant.

2.2.6.4 Endangered and Threatened Species

Information regarding federal- and state-listed sensitive and candidate Endangered Species Act (ESA) species has been sought from U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), Washington Department of Natural Resources (WDNR) Natural Heritage Program, and WDFW Priority Habitat Species (PHS) List data. No federally listed endangered species were identified in the upland portion of the project area (Table 2-4).

Table 2-4. Species of Concern that Inhabit the Northern Portion of the Olympic Peninsula in Washington State

Common Name	Scientific Name	State Status	Federal Status
Mammals			
Steller's sea lion	*Eumetopias jubatus*	Threatened	Threatened
Pacific harbor porpoise	*Phocoena phocoena*	Candidate	--
Orca whale	*Orcinus orca*	Candidate	--
Birds			
Brown pelican	*Pelecanus occidentalis*	--	--
Bald eagle	*Haliaeetus leucocephalus*	Threatened	Threatened
Merlin	*Falco columbarius*	Candidate	--
Peregrine falcon	*Falco peregrinus*	Endangered	Species of Concern
Common murre	*Uria aalge*	Candidate	--
Marbled murrelet	*Brachyramphus marmoratus*	Threatened	Threatened
Pileated woodpecker	*Dryocopus pileatus*	Candidate	--
Amphibians			
Western toad	*Bufo boreas*	Candidate	Species of Concern
Fish			
Puget Sound chinook salmon	*Oncorhynchus tshawytscha*	Threatened	Threatened
Hood Canal summer chum	*Oncorhynchus keta*	Threatened	Threatened
Bull trout	*Salvelinus confluentus*	Threatened	Threatened
Coho salmon	*Oncorhynchus kisutch*	--	Candidate
Pacific herring	*Clupea pallasi*	Candidate	Candidate
Georgia Basin Pacific hake	*Merlucius productus*	--	Candidate
Copper rockfish	*Sebastes caurinus*	Candidate	Candidate
Quillback rockfish	*Sebastes maliger*	Candidate	Candidate
Brown rockfish	*Sebastes auriculatus*	Candidate	Candidate

Note: Only the bald eagle and the peregrine falcon are likely to be found near the former Rayonier Mill Site located within Port Angeles Harbor on the northern shore of the Olympic Peninsula.

Only the bald eagle, which is listed as threatened, may be found near the project site. No nesting bald eagles are located on or near the project; however, they are known to forage along this stretch of shoreline. The closest nesting territory (Morse Creek #258) is located approximately 1 mile east of the project site (personal communication, Shelly Ament, Wildlife Biologist, WDFW, January 31, 2001). There is also a nesting territory (Angels Point #649) west of the project site.

Wintering bald eagles require perch trees for day use and mature/old-growth forest stands for night roosts. Perch trees are typically dominant live or dead trees situated near a shoreline where a nest or defendable territory is evident or a prey source is abundant. Prey items are primarily fish and waterfowl. Bald eagles do forage along this stretch of shoreline and within the harbor area during the winter months; however, there are no major concentrations or winter night roosts located near the project.

The marbled murrelet is listed as threatened on both federal and state lists and may forage within the bay, but numbers documented during the Puget Sound Avian Monitoring Project (PSAMP) flights are low. Marbled murrelets forage primarily for small fish and invertebrates in the nearshore environment and may forage near the former Rayonier Mill Site on occasion. In western Washington, marbled murrelets nest in large conifer trees and may travel up to 50 miles or more inland to nest (Nelson and Hamer, 1995). The closest known occupied nesting stands are within the Olympic National Forest, located approximately 6 miles south of the project site. No suitable nesting habitat occurs within the project site or its surroundings.

The brown pelican is listed on both state and federal endangered species lists. There have been past reports of a brown pelican near the marina area, but the occurrence would be considered rare (personal communication, Shelly Ament, Wildlife Biologist, WDFW, February 2, 2001).

Other wildlife species that may occur near the former Rayonier Mill Site include the American peregrine falcon, which is now listed as sensitive at the federal level, but is still listed as endangered at the state level, pending the final status report which proposes to remove the endangered status of this species. The peregrine falcon likely uses both terrestrial and marine environments, feeding primarily on shorebirds, waterfowl, and passerine birds.

Other avifauna that may forage within the harbor are various shorebirds, waterfowl, and sea birds. With the exception of reports of brown pelican sightings, however, no other species listed as endangered, either by USFWS or WDFW, occur near this site. The common murre is a candidate species to be state listed. Small groups of murres may forage within the harbor. Other sea birds that may be found near of the former Rayonier Mill Site, primarily during the winter months, are pigeon guillemots and surf scooters as well as various waterfowl and shorebird species.

Certain marine mammals may also be expected to use the area surrounding the former Rayonier Mill Site. It has been documented that harbor seals commonly used the old log boom area as a haul out in the past; however, harbor seals have not been documented lately during the annual PSAMP (personal communication, Tom Cyra, WDFW, Wildlife Biologist, January 31, 2001). River otters have also been documented near of the former Rayonier Mill Site. No otters have yet to be documented east of Neah Bay (personal communication, Tom Cyra, WDFW, Wildlife Biologist, January 31, 2001).

Information regarding listed and candidate ESA fish species in the project area was sought from USFWS, NMFS, WDFW, and the Tribe. There are no federally listed endangered fish species identified in the project area (Table 2-4). Three fish species listed as threatened may be found close to the project area. Six candidate fish species may be found within the area. State listings are similar to and parallel with the federal listings.

The listed threatened species that may be found in the Puget Sound evolutionary significant unit (ESU) within the nearshore environment of the project include the Puget Sound chinook salmon (*Oncorhynchus tshawytcha)* and the Hood Canal summer-run chum salmon (*O. keta*), which may migrate through the area during certain periods of the year. In addition, bull trout (*Salvelinus confluentus*), which may be found in the general area of the project, are listed as threatened in the coastal-Puget Sound Distinctive Segment (PSDS).

Coho salmon (*O. kisutch*), which are a candidate species for listing under ESA, are found in Ennis Creek and may occur in the nearshore environment around the project area. In addition, NMFS is currently considering the ESA listing status of other candidate species in Puget Sound (Table 2-4). These are Pacific herring (*Clupea pallasi*), Georgia Basin Pacific hake (*Merluccius productus*), copper rockfish (*Sebastes caurinus*), quillback rockfish (*S. maliger*), and brown rockfish (*S. auriculatus*). The Pacific herring and Georgia Basin Pacific hake may be found in this area, but would be considered transients that migrate through the area. The three rockfish species would be less migratory and could be located near the project throughout the year.

This page intentionally left blank.