Cherry Point Aquatic Reserve Management Plan

Appendices A - G

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WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES

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List of Acronyms

AIS	Automatic Identification System
ANeMoNe	Acidification Nearshore Monitoring Network
AOP	Air Operating Permit
ARCO	Atlantic Richfield Company
BBWARM	Birch Bay Watershed and Aquatic Resources Management
bp	bp Cherry Point Refinery
CP	Cherry Point
CPAR	Cherry Point Aquatic Reserve
CSC	Citizen Stewardship Committee
DNR	Washington State Department of Natural Resources
DOH	Washington State Department of Health
Ecology	Washington State Department of Ecology
EGC	European Green Crab
ELW	Extreme Low Water
EPA	United States Environmental Protection Agency
ERM	Environmental Resources Management
ESA	Endangered Species Act
ESB	Estimated Spawning Biomass
GIS	Geographic Information System
IQR	Interquartile Range
LPG	Liquefied petroleum gas
MESA	Marine EcoSystems Analysis
MHW	Mean High Water
MHHW	Mean Higher High Water
MLLW	Mean Lower Low Water
MLW	Mean Low Water
MRC	Marine Resources Committee
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
PAH	Polycyclic aromatic hydrocarbon
PAR	Photosynthetically Active Radiation
PCB	Polychlorinated biphenyl
PCFA	Pacific Coast Feeding Aggregation
PHS	Priority Habitats and Species
PM	Particulate Matter
PSAMP	Puget Sound Ambient Monitoring Program

PSC	Puget SoundCorps
PSE	Puget Sound Energy
SGCN	Species of Greatest Conservation Need
SNP	Single Nucleotide Polymorphism
SOG	Strait of Georgia
SRKW	Southern Resident Killer Whale
SSS	Southern Salish Sea
SVMP	DNR Submerged Vegetation Monitoring Program
UGA	Urban Growth Area
USCG	United States Coast Guard
VEAT	Vessel Entries and Transits
VTRA	Vessel Traffic Risk Assessment
WAAQS	Washington Ambient Air Quality Standards
WAC	Washington Administrative Code
WDFW	Washington State Department of Fish and Wildlife
WRIA	Water Resource Inventory Area
WWW	Western Washington University

Appendix A – Cherry Point Site Characteristics

Appendix Organization

Summary

The Cherry Point Aquatic Reserve encompasses a dynamic coastal landscape featuring nearshore ecosystems with diverse physical habitats of varied substrates and vegetation types. Physical habitats contributing to the structural environment in the aquatic reserve include high unconsolidated bluffs, sandy tidal flats, intertidal beaches to shallow subtidal areas composed of mixed fine to mixed coarse substrates, cobble and gravel beachface areas, along with intermittent boulders and boulder fields. Aquatic vegetation includes eelgrass, mixed macroalgae beds including floating bull kelp and non-native *Sargassum muticum*, and an adjoining emergent salt marsh. These habitat areas are recognized as vital contributors to the reproductive, foraging, and rearing success of many fish, invertebrate and bird species that use the aquatic reserve. A primary motivation for creating this reserve was to preserve critical herring spawning habitat. Several decades of uncertainty regarding factors negatively affecting the Cherry Point herring stock has promoted protection of herring spawning habitat as a crucial resource issue at this site and throughout the Salish Sea.

Part 1—Environmental Setting— the major physical processes described in Part 1 provides a broader overview of the physical and biological characteristics within or adjacent to the aquatic reserve. The major physical processes described are tidal regime, circulation, wave and current exposure, net shore-drift, sediment and freshwater input. These processes — coupled with landforms, sediment types, and anthropogenic influences — provide the foundation and constraints for the biological community within and adjacent to the Cherry Point Aquatic Reserve. A brief description of the primary habitat types, species and their distribution summarizes the ecological conditions at the site. Understanding the processes and functions in the Cherry Point aquatic reserve and vicinity helps guide aquatic land management actions that may influence the reserve and its associated ecological relationships.

Part 2—Current Environmental Conditions and Ecosystem Stressors— discusses our collective knowledge of the current physical, biological and environmental conditions affecting the health of the aquatic reserve, with particular focus on the ecosystem stressors contributing to these conditions.

All references for the citations in Appendix A can be found in the Management Plan Section 7–References.

Part 1 – Environmental Setting

Physical Environment

Background

The Georgia Basin originated about 150 million years ago when colliding continental plates created the Georgia Depression. The Puget Sound and the Strait of Georgia were created by the repeated advance and scouring of glacial ice-sheets, the most recent of which moved into the area around 18,000 to 11,500 years ago (Kovanen et al. 2020). This glaciation, referred to as the Fraser

Glaciation, flowed through the Fraser Valley and formed the Strait of Juan de Fuca and the Strait of Georgia. The Fraser Glaciation moved as far south as Olympia, with huge glaciers forming the hills, valleys and islands that characterize the Georgia Basin today and depositing the Vashon Till that covers much of the region (Williams et al. 2001).

Geographic Context

Washington's marine ecosystems can be divided into three primary systems - the Columbia River Littoral Cell, the Olympic Coast region, and a region delineated as the inner marine waters of Washington. Since 2009, the official designation for the latter region and southwestern British Columbia is the Salish Sea emphasizing the shared geological context and ecosystem commonality of water, air, and species within this greater marine ecosystem. The Southern Salish Sea (primarily Washington's inland marine waters) encompasses the Puget Sound, Hood Canal, the Strait of Juan de Fuca, and the southern Strait of Georgia. The Strait of Georgia is the marine water body between Vancouver Island and the British Columbia mainland. The Canada-US border runs through the southern part of the Strait. Extending along the eastern shores of the southern Strait of Georgia in northwestern Whatcom County, the Cherry Point Aquatic Reserve incorporates the nearshore waters of the Strait with its coastline stretching from Neptune Beach northward to Cherry Point. The shoreline shifts direction trending to the northwest along the Cherry Point reach and then around Point Whitehorn. The reserve encompasses the south shore and shallow subtidal areas of Birch Bay ending near the western boundary of Birch Bay State Park.

Regional Physiography

Geomorphic characteristics in the region feature glacially deposited sediments forming prominent high to moderate, steep sea cliffs fringed by rock strewn gravel beaches gradually sloping into tidal benches or flats. The glacial topography along with moderate post-glacial "uplift" (1.17 mm/year, Zervas et al. 2013), mesotidal ranges, considerable fetch (exposure) and wave action create a dynamic landscape. These processes and components sustain a distinctive beach face often dominated by coarse gravels and scattered boulders and boulder patches with mixed sand and pebble infill. Bluffs are the predominant landform outlining the upland terrain bordering the aquatic reserve. Along the south shore of Birch Bay, at the eastern reserve boundary, the coastline gradually rises from sea level to moderate bluffs, progressively elevating westward to the high bluffs of Point Whitehorn and vicinity. Point Whitehorn forms the headland at the northwestern edge of the aquatic reserve. From Point Whitehorn heading southeast along the Strait of Georgia coastline, the high exposed bluffs maintain an elevated profile through to the less discernible promontory of Cherry Point. At this point, the shoreline trends more southeastly with the high contours retreating inland while the coastal bluff descends to sea level. Here, a relatively slight topographic depression creates a low, wider backshore area with a barrier berm on the seaward side above the beach face. A small stream estuary along with emergent marsh vegetation occupies most of the backshore area. The backshore depression and berm run parallel to shore for approximately 1200 feet until they are both cut-off by Gulf Rd. Gulf Rd turns south and continues alongshore slightly above the beach. On the landward side, the terrace is still present, but filled, modified and devoid of marsh vegetation. This stretch of shoreline around Gulf Rd is the only non-bluff area in the reserve. After about 1000 feet, the road angles upland away from the beach, with the low backshore area tapering to a narrow berm below reestablished coastal bluffs. To the south, high bluffs resume the dominant profile, interrupted by two separate, short gaps, excavated for the structural footings of long piers. Although three piers, one north of Cherry Point, are a substantial presence in this otherwise natural stretch of shoreline, they are spread-out along the CP reach with most of their associated development and infrastructure inland. From the southern pier, the bluff descends to a low beach face that continues southward as a wide longshore spit ending at Sandy Point. Altogether, the dramatic vegetated high bluffs, and long span of mostly natural shoreline with rich marine coastal habitat areas present a robust and diverse aquatic reserve landscape.

Nearshore Bathymetry

Moving waterward, extensive sandflats rippled with ephemeral alongshore bars or shoals are recurrent on most low tidal bench areas in the reserve. In Birch Bay, the flats gently slope seaward maintaining relatively shallower depths in the inner bay, increasing to more than 30 feet MLLW towards the mouth of the bay, north of Point Whitehorn. The width of the lower intertidal/shallow subtidal bench varies along the CP reach with the widest intertidal exposure around Point Whitehorn. Tidal bench topography along the CP outer reach, gradually slopes deeper into the shallow subtidal zone where both scattered boulders and large glacial erratics are common in nearshore areas. Around the bp terminal, just north of Cherry Point the wider shallow subtidal terrace begins to narrow with a steeper drop-off occurring at about 60 feet MLLW near the outer bp docks. The greatest depths, adjacent to the aquatic reserve occur seaward of bp's southern wing pier in a deep trough charted at 204 feet. This deep trough, relatively close to shore is a unique feature in this part of the Strait of Georgia. The tongue shaped-trough gradually shoals as it parallels the southeasterly trend of the shoreline. Offshore from Gulf Rd, the narrowest intertidal/subtidal area along the coastline drops-off precipitously integrating with the inshore terminal basin of the trough. Heading south, a broader subtidal terrace between 30 - 60 ft continues for the length of the reserve, forming a contiguous shelf through to Hale Passage and the north end of Lummi Island. See Appendix C, Map C-1 for the bathymetry map of the reserve area.

Climate

Northwestern Whatcom County and the aquatic reserve region experiences a mid-latitude marine west coast or modified-Mediterranean climate, characterized by cool, wet winters and warm, dry summers (Downing 1983). The Pacific Ocean acts as a temperature moderator while changing pressure systems determine the overall weather and wind direction. Temperatures rarely reach higher than 90°F (about 32°C) or lower than into the teens in the region. The warm season lasts for three months, from mid-June to mid-September, with an average daily high temperature above 66°F (18.9°C) (Weather Spark n.d.). The cool season persists for a little longer than three months, from mid- November to about February 24, with an average daily high temperature below 49°F (9.4°C).

Variations in local air temperature best explain variations in Sound-wide water temperatures (Moore et al. 2008). The coldest day of the year January 2, has an average low of 36°F (2.2°C) and high of 43°F (6.1°C). In Birch Bay, there is an annual rainfall of 38.0 inches (965 mm). Winter has significantly more rainfall than in summer with the most precipitation occurring during a 31-day period centered around November 18, averaging 7.2 inches (183 mm). July is the driest month of the year with an average of 0.8 inches (20 mm) of precipitation (Weather Spark n.d.). Local climate and weather conditions can exert a strong influence on marine water conditions in addition to the influences of longer-term large-scale climate patterns (Moore et al. 2008).

Freshwater

Entering the southern Strait of Georgia in British Columbia, the Fraser River is one of the greatest sources of freshwater in the Puget Sound–Georgia Basin. The Fraser River is the dominant freshwater input into the regional marine environment; approximately two thirds of the freshwater entering into greater Puget Sound (the central basin, San Juan Islands and the northwest Straits combined) comes from the Fraser River (Parametrix and Adolfson Associates, Inc. 2006). During periods of higher run-off, the Fraser River freshwater plume is easily observed on satellite photos extending into the San Juan Islands (WA Ecology 2014).

The vast majority of the plume dissipates through tidal mixing as it eventually disperses throughout the waters of the straits and the southern Salish Sea. Hence, as the primary freshwater influence in the northern marine waters of Whatcom County, the Fraser River has a profound effect on water flow and water quality, with seasonal fluctuations in salinity levels. Salinity and water density are most strongly influenced by the higher level of freshwater inflow during winter and spring from precipitation and snowmelt. Variations in salinity are greatest in the surface waters.

Watershed-Drainage Basin Description

Water Resource Inventory Area (WRIA) 1 is located in the northwest corner of Washington State and is bounded by the Strait of Georgia to the west, British Columbia to the north, and the Skagit River Basin to the south (Appendix C, Map C-2). The Nooksack River represents the primary watershed and a significant freshwater source for much of the upland areas in Whatcom County and the southern portions of the WRIA-1 marine shorelines. The mainstem of the Nooksack River feeds into Bellingham Bay, with the Lummi River slightly to the north, feeding into Lummi Bay. Freshwater from both the Nooksack and Lummi rivers enter the nearshore marine system and flow southward, therefore having a minimal influence on the waters and beaches of the Cherry Point Aquatic Reserve area. There are several hundred individual surface water drainages and sub-drainages located in WRIA 1. Whatcom County divided WRIA 1 into logical management areas primarily based on hydrology; CPAR shoreline is part of a sub watershed management area which includes Cherry Point, Lake Terrell, Finglason, and Semiahmoo. This area has only a few small drainages that flow directly to the coast. Terrell Creek is the largest drainage in the watershed and drains into Birch Bay.

Surface Water and Runoff

Just northeast of the reserve boundary, the Terrell Creek drainage encompasses approximately 17 square miles maintaining year round flow into Birch Bay. Terrell Creek is 8.7 miles in length and forms a pocket estuary near the small delta entering the bay. This creek maintains year-round flow and provides feeding, refuge, and other regulatory functions for juvenile salmonids (Parametrix & Adolfson Associates, Inc. 2006). It also supports fair to good populations of coho salmon with some chum salmon utilization.

Only a few other unnamed freshwater streams flow directly into the actual reserve area, two of which are numbered 01.0100 and 01.0101 under the WRIA stream-naming convention. Stream 01.0100 is 1.25 miles long and drains 800 acres. The stream is characterized (according to WAC 222-16-030) as a Type 4 (water may be intermittent) below Henry Road and and a Type 5 (water is intermittent) in the upper reach above (Shapiro and Associates 1994). Field surveys suggest that few fish species use this stream. However, based on previous reports the only anadromous fish likely to use the stream are cutthroat trout (Shapiro and Associates 1994). During annual beach walks from 1999 through 2008 that have included the mouths of these two streams in each year, Michael Kyte's personal observations are that stream 01.0100 is ephemeral at its mouth and usually dry in the spring. Kyte concludes that it is unlikely that this stream supports any finfish, especially anadromous species (Kyte, M. personal communication 2009). Southeast of Cherry Point, a perennial stream, 01.0101 drains through the north end of the Gulf Road marsh complex, supporting a small delta emptying into the reserve area along the Cherry Point reach. Other flows intermittently supply freshwater to the more central and southern portions of the marsh. A few more seasonal drainages and drainage ditches fill and actively flow onto reserve beaches during periods of high precipitation and saturation in the rainy season. Otherwise, the remaining local freshwater input to the reserve area is through seepage, runoff, or tight-lines draining residential properties as well as, municipal and industrial stormwater outfalls.

Groundwater

Beneath and west of the Mountain View Upland area a non-surficial discontinuous aquifer in permeable (primarily sand and gravel) Vashon and pre-Vashon glacial sediments is the primary groundwater source influencing the reserve area. Although classified as "discontinuous", the aquifer appears to be locally extensive beneath this upland area. Towards the Cherry Point reach, the groundwater flow direction in this aquifer is generally to the southwest. Subterranean flow continues southwesterly to just south of the Cherry Point area with a gradual shift to more westerly flow farther south. In some areas the aquifer appears to discharge through the slopes or to the seawater (Bandaragoda et al. 2013).

Groundwater saturation causing seeps, as well as increasing internal pressures within the glacial strata along the shoreline (reducing cohesiveness) may result in debris flows, slumps and at times, major slope failure (Easterbrook 1973).

Upland Surficial Geology

The Cherry Point reach is mostly a cliffed shoreline approximately 10 km long from Point Whitehorn to Neptune Beach. Much of the shoreline is comprised of Quaternary, glacially-derived geologic deposits including glacial outwash, glacial marine drift, and terrace deposits (Terich 1977). Although it appears relatively uniform along its entire length, a closer inspection reveals some differences. Bluffs 30 to 40 meters high rise steeply from the beach and are mostly composed of Vashon Till and Deming sand overlain by glaciomarine drift (Easterbrook 1973). However, a single deposit from ice advances that occurred well before the most recent glaciation (and deposits), is exposed in this vicinity along the bluffs of Cherry Point. This older deposit is composed of horizontally laminated clay and silt with small amounts of sand and is called Cherry Point silt. The overlying Vashon Till is a compact impermeable deposit of pebbles in a matrix of clay, silt and sand and has a thickness of 3 to 10 meters. The compact composition of sand, silt, clay, pebbles and a few boulders, which characterizes Vashon Till, is the result of compression by the overriding Vashon ice flow. Deming sand consists of stratified sand, clay, and gravel. Both Vashon Till and Deming sand deposits occur in most sea cliffs along the eastern Strait of Georgia.

The complexity of soils in this area is directly related to the glacial history. Glacial ice deposited a variety of substrates which have weathered differently because of size of soil particles, permeability and characteristics of the material or matrix two to three feet below the surface. Nearly half the soil types represented are varieties of silty loam. Secondary types are loam, silty clay loam, and peat. The silty loams are found mostly upland overlying glacial remnant terraces and hills and are moderately permeable.

Shoreline Characteristics

The general shore types found throughout this region include bluff-backed beaches, armored shorelines, depositional beaches, and backshore berms associated with backshore emergent salt marsh habitat. Prominent steep coastal bluffs composed of erodible gravels and sand are the predominant landscape feature fronted by gently sloped, mixed coarse gravel and sand beaches. Numerous debris flows and slump failures occur along the shore bluffs. A few beach areas include coarser gravel/cobble substrate with clusters of boulders and occasional large glacial erratics (large boulders deposited by glaciers).

Residential fill and armoring, such as “riprap” and concrete bulkheads, are common along the southern shoreline of CPAR in Birch Bay. Often associated with this shoreline development is the removal of riparian vegetation. A few backshore areas along the outer CP reach include several residential bulkheads in the northern reach, about 1000 feet of low elevation backshore area with a road bed and fill, and three substantial pier footings and bulkheads. Otherwise, the continuous stretch of beach from Point Whitehorn to the southern extent of the reserve is mostly natural supporting broad lower intertidal flats.

Intertidal and Subtidal Substrate

The prominence of “feeder” bluffs adjacent to the reserve, sustain a diverse sediment supply to the local beaches and nearshore habitat areas. Waves and currents sort and redistribute eroded sediments into zones. Intertidal substrates within Cherry Point area include sand, gravel, mixed fines and mixed gravel/cobble sediments, with areas of scattered boulders in the lower intertidal zone (Appendix C, Map C-20). Under ten percent of the overall upper intertidal shoreline in the reserve is armored with artificial substrates such as concrete, steel, riprap, and creosote wood pilings. Although the residential area in Birch Bay has a greater amount of linear shoreline armoring, the coverage of intertidal area from fill and artificial substrate associated with the industrial pier bulkheads creates a formidable footprint. A significant build–up of sand and gravels are deposited on the updrift side of these structures. Otherwise, mixed sand and gravel sediments are the most common substrate throughout the upper intertidal shoreline in the aquatic reserve. In addition, the coarse sand to fine pebble substrate that commonly supports forage fish spawning is seasonally present along the upper beach face in Birch Bay. Correspondingly, along the outer reaches south of Point Whitehorn, similar, but less pervasive bands of spawning substrate is present in the north. From Gulf Rd area south, a continuous band of sand/pebble substrate supports documented surf smelt spawning habitat to the southern boundary of the reserve. Generally, downslope sediments in the mid to lower intertidal areas include an assortment of sand and mixed gravels in more protected areas to mixed coarse gravels, featuring cobble and boulders with patchy pebble and sand infill along the more exposed outer coastal reaches. In these reaches, around the mid-tidal level of the foreshore, wave action removes smaller sized materials leaving cobbles behind. In some areas, this creates a “cobble-armored” beach face.

At the beach slope break (approximately 0 elevation - MLLW), sand and gravel substrate are again more prevalent with cobbles interspersed. The lower intertidal flats and low tide terraces vary with shifting sands forming bars and swales. Common in several locations in the lower intertidal zone are clusters of large boulders with some scattered larger glacial erratics.

On the eastern side of Point Whitehorn, Birch Bay encompasses large, predominantly sand to mixed fine tidal flats—extending from approximately +2 feet MLLW to approximately -4.0 feet MLLW. Patches of mixed coarse substrates including boulders occur in the mid to low intertidal areas farther west and south in the bay toward Pt Whitehorn. In this general location, significant coarsening of substrate on the beach faces and flats are the result of a sediment-starved intertidal zone.

Many of the same physical sediment characteristics, substrate types and distribution that occurs in intertidal areas extend into shallow subtidal areas and grade to finer sediments in the deeper nearshore zone. This zone encompasses from extreme low water (ELW) to the limits of the photic zone, which is commonly considered down to sixty feet below MLLW in this region. The substrates in this zone are seldom exposed to wind-driven energy and typically grade to primarily finer sediment. This is most evident in Birch Bay, where the primary intertidal sediment type is sand with varying amounts of pebble and silt. In the deeper subtidal flats of the bay, the substrate consists of a higher proportion of mixed fine sediment grading into mud in some locations. Along the Cherry Point reach, sediments in the upper subtidal zone, are generally sandy with mixed gravels and some cobble. Below approximately -3 meters (-10 feet) MLLW, the sediments become more uniformly sandy, with patches of gravel and in several areas interspersed with large boulders (Berger 2000). The sedimentary subtidal habitat throughout the surrounding area is generally depositional, with medium to coarse sand prevailing; deeper areas also have mixed fine sediments including mud.

Physical Oceanographic Processes

Oceanographic processes in northernwestern Whatcom County along the southern Strait of Georgia are controlled by estuarine circulation, seasonal variability in tidal forcing from the ocean, and variable coastal ocean processes (Thompson 1994). However, the primary control is estuarine circulation. Estuarine flow is characterized by a net (daily-averaged) seaward outflow in the upper portion of the water column and a net landward inflow of the lower portion of the water column (Thompson 1994). The northern marine waters of Whatcom County are linked to the Pacific Ocean through the broad reaches of the Rosario Strait and Strait of Juan de Fuca (referred to as the Northwest Straits). Concentrations of nutrients are consistently high throughout most of the region, largely due to the flux of oceanic water entering the basin (Harrison et al. 1994; Gustafson et al. 1997). The southern Strait of Georgia and the Northwest Straits area is oceanographically distinct from the main body of Puget Sound - south of the sill at Admiralty Inlet. The more direct oceanic inflow in this northern region accounts for much greater oceanic influence than that of the more restricted/protected Puget Sound. The complex bathymetry in Admiralty Inlet interrupts natural oceanic inflow from the Pacific Ocean through the Strait of Juan de Fuca and thus, the fresher water outflow from Puget Sound. Because residence times of tidal flushing are much lower in the main Puget Sound basin, certain oceanic flora and fauna are more common in the Northwest Straits area compared to central Puget Sound.

Many areas in the Southern Salish Sea are difficult to categorize as either estuarine or marine. The Cherry Point area exhibits transitional water regime characteristics, between marine and estuarine. In these transition areas, generally higher salinities of greater than 25 ppt are prevalent but fluctuate seasonally. In the southern Strait of Georgia, the strong influence from the Fraser River can at times create significant drops in salinity.

Preliminary salinity data taken near the surface during WDFW Cherry Point herring spawn surveys in the late spring of 2018-2020 ranged from 17.9 to 30.5 ppt. The salinity range values for these nearshore areas are useful as an indicator of an estuarine regime.

In “A Marine and Estuarine Habitat Classification System for Washington State”, Dethier simplified the characterization for determining the oceanographic regime in transition areas, such as the Cherry Point coastal region, by establishing a geographical demarcation for the estuarine/marine boundary. “All waters to the east of a line from Green Point, on Fidalgo Island, to Lawrence Point on Orcas, are considered estuarine habitat and waters to the west are marine (with some exceptions).” (Dethier 1990). Due to its geographic location, salinity profile, and occasional freshwater flushes from the Fraser River, Cherry Point area is characterized as an estuarine water regime (Dethier 1990).

Water Temperature

The average annual surface water temperature for the shallow waters in Birch Bay is 10.8°C (51.44°F). Corresponding with the warmest air temperatures for the area, water temperatures are generally highest in August, reaching an average of 13.9°C (57.02°F) and lowest in January measured at 7.2°C (44.96°F). (Climate-Data.org). Water temperatures along the Cherry Point reach are considerably lower than in the bay.

Tides

Tides in the Salish Sea are a mixed semi-diurnal tidal cycle with two ebbs (low tide) and two floods (high tide) per day of different sizes. Successive ebbs and floods are of unequal strength and the tidal range in the area is meso-tidal. For Cherry Point, the mean tidal range, defined as the average difference in height between Mean High Water (MHW) and Mean Low Water (MLW), is approximately 5.70 feet (1.5 meters). The diurnal tide range, defined as the average difference in height between Mean Higher High Water (MHHW) and Mean Lower Low Water (MLLW) is 9.15 feet (2.79 meters) (NOAA 2020).

Water Currents

Tidal currents within the Strait of Georgia are primarily driven by the regions strong tidal exchange, wind, and river flow. In addition to the tidal range, a larger range between spring high and low tides means stronger currents - tidal current rates are also largely controlled by local bathymetry. The open waters of the southern Strait of Georgia experience reduced tidal flows because of the increased cross-section and depths of the strait (current speeds generally decrease with increasing depth). These tidal currents are regular and predictable. Low to moderate tidal currents have been observed throughout the shores of CPAR from Point Whitehorn to Sandy Point (Schwartz et al. 1972). Surface currents near Point Whitehorn measured by Schwartz et al. (1972) generally ranged from 0.7 to 1.2 feet per second, but reached a maximum of 1.9 feet per second. Eddies occur down-current from points, such as near and to the south of Point Whitehorn. Tidal currents in the deeper waters of this region are 0.7 to 1.0 feet per second and are directed to the northwest during flood tide or southeast during ebb tide. Other bathymetric features that influence oceanographic conditions in the reserve area include the tidal flats of Birch Bay, and four deep channels that connect the system with Rosario Strait.

Winds and river flow generate secondary currents in the Cherry Point area. Prevailing and predominant winds in the region are from the south, but winds are also funneled by landforms, channels, and basins surrounding the Strait of Georgia-Juan de Fuca system creating local variations of wind direction.

Wave Energy

Cherry Point Aquatic Reserve's exposure and fetch distances are fairly long for westerly, northerly, and southerly winds. Winds in the region are dominated by two major seasonal atmospheric pressure systems centered in the North Pacific Ocean; the North Pacific High pressure system, which dominates in summer and the Aleutian Low, which prevails in the winter. From October to March cyclonic winds associated with the Aleutian Low produce mostly southeasterly winds, while anticyclonic winds associated with the North Pacific High produce northwesterlies during the spring and summer months (Thompson 1994). Although the average wind direction at Cherry Point varies seasonally, the wind is most often from the south, with occasional stronger winds and wave energy originating from the northwest. Northwesterly waves travel down the Strait of Georgia and are refracted around Birch Head into Birch Bay. Within the reserve area, these waves travel most strongly toward Point Whitehorn and dissipate as they travel along the eastern shore of the reserve in Birch Bay (EVS 1999). The fetch to the northwest of CPAR is more than 100 km coming down the Strait of Georgia. A northwesterly wind of 20 knots with a duration longer than 2 hours can generate waves greater than 2 meters (6 feet) high, however this is an uncommon occurrence.

Energy classifications as applied by Bailey et al. (1993) describe the relative degree of physical energy from waves and currents. These energy definitions are from Dethier 1990 and are applied to broad areas to describe landscape-level characterization of intertidal energy. Since Cherry Point Aquatic Reserve's exposure and fetch distances are long from predominant wind directions, the overall energy classification for the outer CPAR coastline along the Strait is "Open". While the shoreline area in Birch Bay is protected from southerly winds, and the northwesterly waves are mostly refracted or diffused by headlands, this area is considered as "partly-enclosed."

Net shore-Drift

Net shore-drift, or littoral drift is the long-term, net effect of beach sediment movement occurring over a period of time along a particular coastal sector, also referred to as a drift cell (Jacobsen and Schwartz 1981). A drift cell is defined as consisting of three components. Firstly, a site that serves as the sediment source and origin of a drift cell, i.e., eroding bluffs (referred to as feeder bluffs) are the primary source of beach sediment in CPAR and their natural erosion is essential for maintaining down-drift beaches and nearshore habitats. Secondly, a zone of transport, where wave energy moves drift material alongshore; and thirdly an area of deposition that is the terminus of a drift cell. Deposition of sediment occurs where energy is no longer sufficient to transport the sediment in the drift cell (Johannessen and MacLennan 2007).

Only two drift cells are mapped within the aquatic reserve area (Appendix C, Map C-4), with a divergence zone off the northwest side of Point Whitehorn. A northwesterly fetch from the Strait of Georgia moves sediment south creating this narrow divergence zone. Flowing from the northwest tip of Point Whitehorn, this primary drift cell includes the entire western shore of the aquatic reserve -- south along the Cherry Point reach, continuing to Neptune Beach and terminating at Sandy Point. This southward littoral drift sector forms the spit at Sandy Point. Whatcom County's Shoreline Inventory and Characterization (2006) examined sediment transport along this coastline, finding that connectivity to feeder bluffs as the primary sediment source are abundant within this drift cell, attributing to more than 54 percent of the shoreline along the Cherry Point reach. Actively eroding at regular intervals, "exceptional" feeder bluffs make up approximately 9 percent of those sources. While "moderate" supply feeder bluffs make up the remaining 45 percent of the supply. Landslides are common along this reach.

Along the Birch Bay shoreline flowing eastward from feeder bluffs at Point Whitehorn, net shore-drift continues along the length of the reserve shoreline, terminating around the east end of the bay. Bluff erosion at Point Whitehorn is substantial and has significantly contributed to creating the broad accretionary sand flats of Birch Bay. However, along the upper beachface to the south much of the finer sediment is depleted because sediment supply and input has been interrupted by shoreline modifications in updrift areas. Limiting the flow of natural sediment sources has caused a coarsening of the beach substrate in this section of the bay. Although, approximately only 9% of the total reserve shoreline has been armored, the majority of the armoring is along the shoreline of Birch Bay associated with the residential development (Appendix C, Map C-3).

Biological Environment

Habitat Resources

For the purposes of this report, we are specifically focusing on the ecosystem continuum of nearshore habitats adjacent to or within the boundaries of the aquatic reserve. The processes presented in the previous sections—such as tidal regime, circulation, wave and current exposure, net shore drift, fresh water and sediment input, coupled with landforms, sediment types, and anthropogenic alterations—

provide the foundation and constraints for the biological community within and adjacent to the reserve. Nearshore areas serving key habitat functions within or adjacent to the reserve range from adjoining backshore estuary and depression, berms, bluffs, rich intertidal beaches and flats, subtidal terraces, to the deep-water sandy bottoms of the reserve boundary at 70 feet MLLW.

Habitat Areas

Habitat is a critical ecosystem component - it provides living space for permanent and transitory species, and supports primary production, food webs, and other ecosystem functions. The dynamic physical regime and associated processes, along with a relatively low amount of human intervention, provides the sustenance for productive habitat supporting a high level of biodiversity and species abundance in CPAR. Several distinct habitat areas exist within the aquatic reserve area. The warm shallow waters in Birch Bay support one of the largest contiguous eelgrass areas in the county, as well as, one of the largest recreational shellfish areas in the southern Salish Sea. The lower energy flats support productive micro- and macroalgal species and provide prime habitat areas for juvenile salmonid prey resources like harpacticoids, copepods, and amphipods (*Corophium* spp.) (Healey 1980; Simenstad et al. 1982). Additionally, extensive intertidal flats in the bay and along the Cherry Point reach provide foraging, nursery, and resting grounds for resident and migratory shorebirds, waterfowl, flatfish and other juvenile fishes.

Upper intertidal areas within the bay include mixed fine to gravel/cobble beach areas and artificial hard substrates such as riprap, concrete, and creosoted log bulkheads. Critical habitat areas in the upper intertidal zone include patches of finer gravel and sand providing spawning habitat for surf smelt and Pacific sand lance. Salmonids, specifically steelhead, sea-run cutthroat and possibly anadromous bull trout are likely to utilize the low energy mixed gravel and cobble beaches of the bay for foraging and shelter (Healey 1982). In addition, areas of sand and mixed fine bottom substrate within the lower intertidal zone (from approximately +2 feet above MLLW to approximately -4 feet below MLLW) along the outer reach, support patchy to lush growths of eelgrass (*Zostera marina* and *Nanozostera japonica).* Macroalgae persists throughout most areas of the intertidal and shallow subtidal zones in the reserve with varying degrees of abundance and diversity depending on the substrate type. Lower intertidal and subtidal habitat areas include mixed sand and gravel with scattered boulders and cobble providing anchoring substrate for seaweeds and a myriad of invertebrate species.

Subtidal habitat zones encompass from extreme low water at -4.5 feet MLLW in this region, to the limits of the photic zone, which is at approximately 60 feet MLLW for Puget Sound. Many of the same physical characteristics and vegetation types of the lower intertidal zone extend and proliferate into shallow subtidal areas. Near Cherry Point, a shallow subtidal bench with a relatively flat gradient extends approximately 1,000 feet seaward to about -30 feet MLLW, where the slope steepens (Berger 2000). This relatively flat bench provides the appropriate amount of light, diverse substrate types, and consistent flushing by long-shore currents to support eelgrass and a robust macroalgae community including bull kelp. In addition to providing substrate for invertebrates and seaweeds, many fishes are attracted to the more complex rugged structure present with the varied large boulders interspersed throughout this habitat area. In deeper subtidal areas, where currents are minimal, the substrates are dominated by mixed fine sediments with fine sands, silts and muds.

Open water habitat within and adjacent to the reserve serves as a major migratory corridor for marine mammals, fish and bird species, supports feeding and propagation, and acts as a sink for nutrients and a thermal buffer for nearshore waters. Other key physical properties provided by these areas are more constant temperatures, reduced salinity variation, and floatation area for a wide variety of organisms. Vast numbers of planktonic plants and animals offer an abundant food source and are the foundation for a complex and highly productive food web for a myriad of other species. Many of the open water animals regularly observed feeding, resting, or migrating through the reserve area include a variety of birds, forage fish, salmonids, squid, jellyfish, loons, harbor seals, sea lions, and whales. Deepwater marine habitat is not included in this discussion since it is outside the boundaries of the reserve.

Aquatic Vegetation

A rich and complex community of submerged aquatic vegetation persists throughout the intertidal and shallow subtidal areas of the Cherry Point Aquatic Reserve. The aquatic vegetation in and adjacent to the reserve include eelgrass, green, red, and brown macroalgae – highlighted by bull kelp, emergent salt marsh and spit/berm vegetation (see Appendix B, Table B-6 for a list of species). Extensive areas of native eelgrass (*Zostera marina*) and rich mixed macroalgal beds are recognized as essential contributors to the reproductive, foraging, and rearing success of many bird, fish, and marine mammal species that frequent the area.

Eelgrass

Several distinct intertidal and shallow subtidal areas within Birch Bay and along the CP reach support lush growths of the native eelgrass and the non-native Japanese eelgrass (*Nanozostera japonica*). Both species are common in the reserve area, with the native eelgrass being more abundant and having greater spatial and tidal distribution. Eelgrass is considered to be a "foundation" or habitat forming species because it creates a highly structural habitat area (Ort et al. 2014). With extensive eelgrass beds in Birch Bay and patchy or fringing beds along the outer CP reach, eelgrass is a key habitat component of the aquatic reserve. As a primary habitat type, eelgrass supports multiple ecological functions and ecosystem services in the area, including:

- Providing substrate for epiphytic algae, epifauna, and substrate structure for spawning of Pacific herring.
- Providing rearing and refuge habitat for juvenile salmon, crab, numerous invertebrates, and other juvenile fishes, by supplying shelter and an abundance of prey species.
- Altering the physical environment by modifying current and wave energy.
- Providing shade and thus cooler water and higher dissolved oxygen during summer low tides.
- Contributing to food webs—food for herbivores and detritivores via primary production.
- Providing carbon sequestration, and buffering the local waters by sustaining lower levels of pH alteration (Horwith, M., Washington DNR, personal communication, 2019).

The more protected, shallower areas in the reserve tend to accumulate finer-grained sediments that are the most suitable for sustaining eelgrass and allowing these areas to consistently support larger eelgrass beds. The extensive tidal flats of Birch Bay support a large eelgrass meadow. Since the sand flats of the bay are relatively protected from storms, the eelgrass beds extend out into the shallow subtidal flats to a depth of about -12 feet MLLW. Eelgrass contributes critical spawning habitat for the declining Cherry Point herring stock. Historically, herring spawn was found wherever eelgrass existed in the Cherry Point/ Birch Bay area, even in places where eelgrass was only sparsely distributed (Penttila 2009).

Often a variety of epiphytes and other macroalgae grow in association with eelgrass. These areas generally include fines with more mixed gravels present providing the substrate to support intermixed eelgrass and macroalgae. The type and abundance of macroalgae changes seasonally, varying from red algae— more dominant in winter and early spring—to greater amounts of soft brown kelps and green algae in later spring and summer.

Several efforts to map or monitor vegetated habitat areas in Whatcom County have included the aquatic reserve area. DNR's Nearshore Habitat Program has conducted two assessments that incorporate the shorelines of the reserve: the 1995 Whatcom County Intertidal survey and the 2001 ShoreZone Inventory project. A third and ongoing program— the Submerged Vegetation Monitoring Program (SVMP)—has monitored a few sites in the reserve over the past decade (Appendix C, Map C-5). In the summer of 1997, DNR's ShoreZone Inventory (DNR 2001) project collected aerial videography for the entire aquatic reserve shoreline showing either continuous or patchy eelgrass and two short stretches of absent (no eelgrass). Birch Bay was mapped as a continuous bed by the ShoreZone Inventory (Figure A-1B). In the 1995 Whatcom Area Intertidal survey of Birch Bay, eelgrass density and spatial distribution was more variable. Although there was a large contiguous meadow, some locales showed eelgrass in wide parallel swaths, reflecting swales and troughs from deflecting wave patterns. These distinctions are a function of the different type of mapping techniques. The ShoreZone mapping system "provides a broad-brush characterization of habitat abundance and distribution by summarizing biophysical shoreline features for segments of shoreline on a digital GIS line coverage." (Ritter et al. 1999). This data classification is based on aerial videography observations of how consistently a resource, i.e., eelgrass, was present directly seaward from an alongshore 'unit' or segment. Resources visible within each unit area such as, eelgrass, other aquatic vegetation, substrate type, geomorphological features, beach type, and some organisms were recorded in a database. This inventory is considered data rich rather than spatially explicit. Compared with the 1995 Whatcom County Intertidal mapping that is derived from plane-mounted multispectral scanner imagery and is considered a medum-resolution "spatially explicit" mapping method representing the actual shape or polygon of the resource, i.e., an eelgrass bed. Both surveys only provide a snapshot in time of the distribution of resources.

In contrast, DNR's SVMP is a continuous regional research program specifically dedicated to long-term monitoring the abundance and depth distribution of seagrass to determine status and trends in the Southern Salish Sea through analyzing underwater video transects (WDNR NHP 2020). The SVMP has been monitoring eelgrass in the reserve since 2001. Between 2009 and 2013, eelgrass in Birch Bay was monitored annually and found to be stable. Bart Christiaen, lead scientist with SVMP, conducted a trend analysis of eelgrass monitoring at three sites within the aquatic reserve from 2000-2012 (Figure A-1A). Most eelgrass was found between -0.5 and -2 meters depth at MLLW and all sites contained sparse eelgrass patches with approximately 0.4 ha per site (Table A-1). Eelgrass has a more limited depth distribution in the southern Strait of Georgia, as opposed to the Strait of Juan de Fuca. Eelgrass status appears relatively stable over time in the reserve area (Figure A-2) and throughout the eastern portion of the southern Strait of Georgia (Christiaen, B. personal communication 2020).

Overall, SVMP data suggests that in the southern Salish Sea (Puget Sound-wide) the seagrass status has remained relatively stable over the 20-year period (through 2020). Despite this region-wide result, DNR has identified significant eelgrass losses at smaller spatial scales. Because of these losses in both depth and spatial distribution of eelgrass in other areas of the Southern Salish Sea and due to uncertainty regarding factors limiting herring populations in Cherry Point area and elsewhere, WDFW and DNR consider protecting eelgrass and other herring spawning habitat to be a critical resource issue statewide.

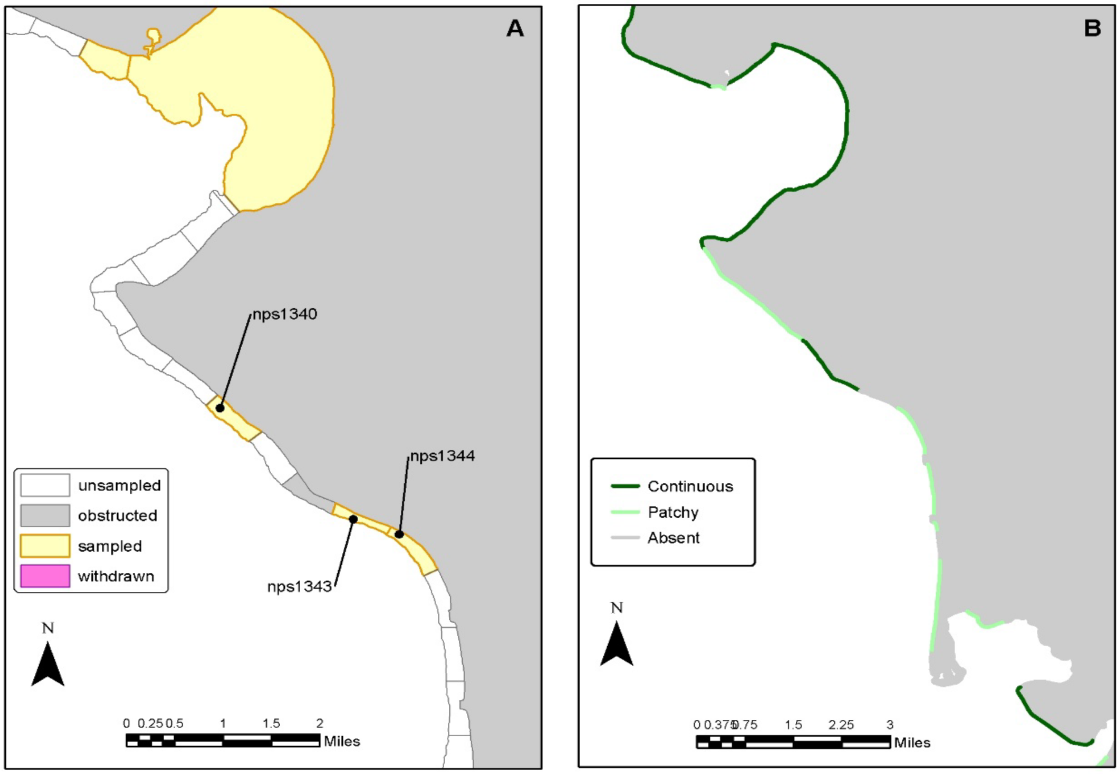

Figure A-1. A. Map of DNR's SVMP eelgrass monitoring locations near Cherry Point. Each site segment represents 1000 m along the shoreline. B. Map of Shorezone data.

Table A-1. Maximum depth and eelgrass area measured at each SVMP site near Cherry Point from 2000-2012. Site nps1344 was only sampled from 2005 to 2009.

Site	Max eelgrass area (ha)	Deepest eelgrass (m MLLW)
nps1340	0.418	-2.92
nps1343	0.302	-4.25
nps1344	0.440	-3.67

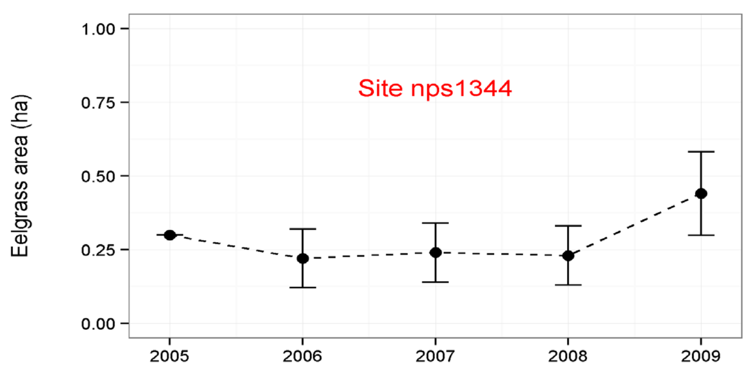

Figure A-2. Eelgrass area for SVMP site nps1344 between 2005 and 2009. No significant trend was found at this location.

Macroalgae

Most of the reserve area contains a high diversity of macroalgal species which represent another key habitat component of the Cherry Point Aquatic Reserve. Macroalgae functions in much the same way as eelgrass, providing structural habitat, nursery grounds and foraging areas that support salmon, herring and other forage fish, Dungeness crab, and numerous other species. As with eelgrass, macroalgae is an important component of primary production contributing to the higher productivity of diverse nearshore ecosystems. Overall, the macroalgae species distribution and coverage provides a broader distribution both vertically and laterally than eelgrass. Since 2017, more than 30 species of mostly intertidal/shallow subtidal macroalgae have been documented by WDFW during herring spawn rake surveys (Sandell 2020a). The most regularly encountered species in these surveys include large bladed non-floating brown macroalgae, such as *Saccharina latissima* (*Laminaria saccharina), Alaria marginata* and *Desmarestia ligulata,* many varieties of foliose and filamentous red algae, several species of ulvoids and other green algae, as well as, the pervasive non-native brown alga - *Sargassum muticum. Sargassum* is common in most areas of the outer CPAR lower intertidal zone where coarse gravels and cobble substrate persist, and generally occurs in relatively dense bands. Elsewhere in Puget Sound, it more commonly occurs in both the lower intertidal and shallow subtidal areas (Kyte 2020a). *Sargassum* is considered an invasive floating alga which is widely distributed throughout the south Salish Sea, and is often preferentially used as herring spawn substrate (Sandell 2020a).

Within the upper intertidal areas of the reserve, on hard substrates starting below approximately 6 feet MLLW, areas of dense seaweed are prevalent and are dominated by the perennial rockweed, *Fucus* spp.*, Porphyra* spp., *Mastocarpus* spp. and ulvoid-like species. Moving downslope on the beach face, the predominant seaweed assemblage in both intertidal and subtidal areas of unconsolidated mixed fine sediment are green algae, such as *Ulva* spp., *Ulvella* spp. and where freshwater seeps enter the intertidal area *Enteromorpha* spp.is common. Primarily in summer, these species are commonly present throughout intertidal areas often extending below MLLW and into eelgrass beds. These species provide a variety of beneficial functions including supporting microhabitats for juvenile crab and other invertebrates and releasing nutrients back to the marine environment. However, at times, high biomass blooms of ulvoids can present a nuisance by physically smothering burrowing invertebrates, epibenthic crustaceans, other mollusks and crabs, and reducing physical access and prey availability. A variety of red algae species, such as *Gracilaria pacifica* and *Gracilariopsis sjoestedtii* are frequently found intermixed with and adjacent to eelgrass beds which also provide a substrate for herring spawn deposition.

Other lower intertidal and shallow subtidal areas with scattered hard substrates support large-bladed laminarian kelps, with the most common species being *Saccharina lattisima, Costaria costata* and the brown algae *Desmerestia* spp. and *Sargassum muticum.* Juvenile fishes including salmon, as well as Dungeness crab utilize the shallow subtidal macroalgae beds, for nursery, refuge and foraging areas.

Bull Kelp

While many species of kelp occur in CPAR, bull kelp (*Nereocystis leutkeana*) is the sole species that forms a floating surface canopy. Bull kelp is common in rocky shallow subtidal areas along the Strait of Georgia coastal reach of the reserve (see Figure A-3). It grows intermixed with other species of algae and seagrass, and the canopy often forms a visible floating band along the deep edge of shallow subtidal nearshore vegetation.

Bull kelp is an ecosystem engineer that creates habitat for diverse species and also supports the food web through primary production. Kelp exhibits high interannual variability, and high abundance is often associated with cooler climate conditions. Limited studies suggest that kelp is declining within portions of Puget Sound (Berry et al. 2021). Bull kelp is easier to monitor than other kelp species because the floating canopies can be more easily surveyed from above water.

The DNR Nearshore Habitat program has mapped bull kelp canopies in the Cherry Point Aquatic Reserve annually since 2011. Between 2011 and 2019, bull kelp canopy area showed extreme differences among years, suggesting a pattern of decline and subsequent rebound (Figure A-3). Canopy area was relatively moderate between 2011 and 2013 (ranging from 12-18 ha), extremely

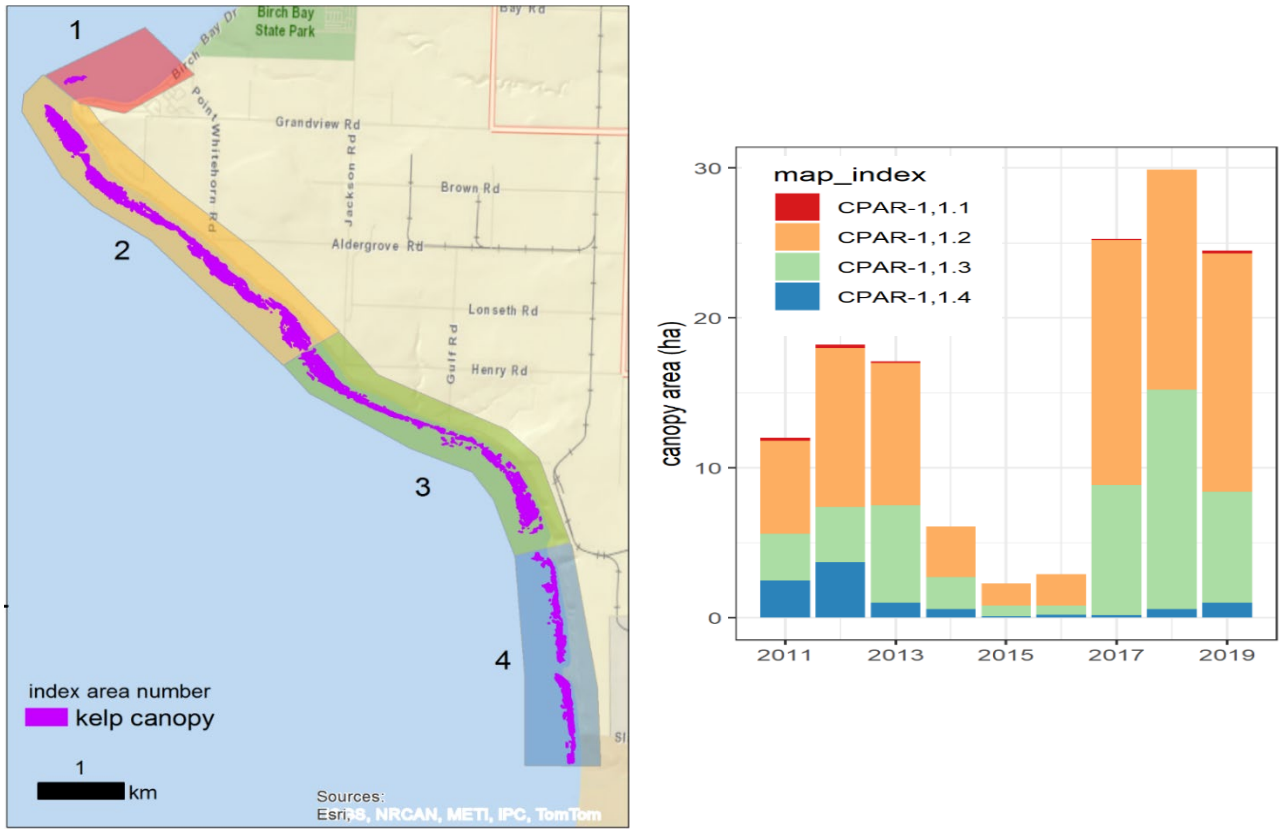

Figure A-3. 2011-2019 bull kelp bed (total planimetric) area in CPAR (left) and associated map index bull kelp canopy area (right).

low between 2014 and 2016 (ranging from 2 to 6 ha), and relatively high between 2017 and 2019 (ranging from 25 to 30 ha) (Berry 2020). The extreme drop in bull kelp abundance in the reserve in 2014 was also observed at other locations, including the Strait of Juan de Fuca and the open Pacific Ocean coast (Pfister et al. 2018), including northern California (Rogers-Bennett and Catton 2020). This regional-scale decline is generally attributed to extreme climate conditions, including El Nino and a marine heat wave in the northeast Pacific Ocean known as the “blob”. Seastar wasting disease may also have played a role in kelp bed declines by decreasing predation on kelp grazers (Berry 2020).

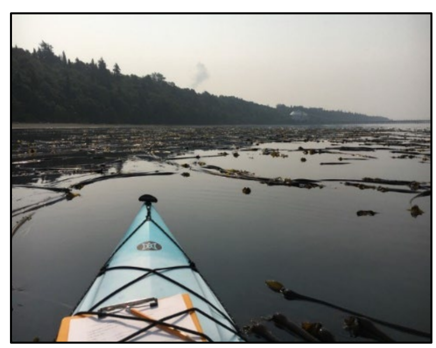

Figure A-4. Floating kelp kayak survey. Photo by Eleanor Hines.

In 2017, bull kelp canopy area in the reserve rebounded to levels higher than in 2011-2013. Canopy area remained relatively high 2018 and 2019. This rebound is generally associated with the easing of the extreme climate conditions correlated with the “blob”. A similar rebound in kelp canopy area was observed along the Strait of Juan de Fuca in 2015, the earlier timing could be associated with its relative proximity to cool, nutrient rich water. In contrast, kelp populations in northern California have yet to recover (Berry 2020).

Volunteer kayakers with the Whatcom MRC have also mapped bull kelp beds at two sites in CPAR since 2016. Located at Point Whitehorn and Gulf Road, annual kayak surveys are conducted during low tide events between July and September (Hines, E. personal communication 2020). Kayak surveys provide detailed snapshots of bull kelp bed perimeter size and shape in subareas. In these initial years, the area estimates from these surveys are not strictly comparable across years because site boundaries changed and varied slightly (Figure A-5).

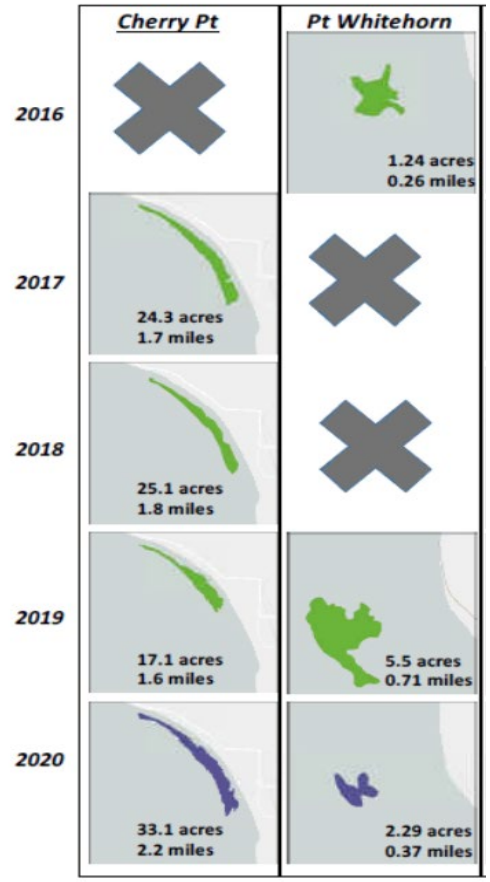

Figure A-5. Bull kelp bed area between 2016 and 2020 at two sites in CPAR, measured by Whatcom County MRC volunteers. For more detailed maps of kelp surveys see https://www.whatcomcountymrc.org/projects/bull-kelp-monitoring/.

Salt Marsh

Directly landward and adjacent to the aquatic reserve, a backshore depression area with an emergent wetland complex is a unique shore zone feature providing a limited and critical habitat type along the Cherry Point reach (see Chapter 1, Figure 2). This backshore marsh contains a nine-acre Category 1 wetland that includes 3.5 acres of primarily native emergent salt marsh that is tidally controlled. Category 1 wetlands represent a rare or unique wetland type or are relatively undisturbed and contain ecological attributes that are impossible to replace within a human lifetime or provide a high level of functions (Hruby 2004). The remaining wetland complex is comprised of emergent brackish and freshwater wetland vegetation creating a rich and diverse habitat mosaic. The entire length of the marsh area is protected from waves and currents from a barrier berm on the seaward side. Flowing through the northern portion of this area, a perennial stream maintains a narrow channel and outlet forming a small delta on the reserve beach. Near the stream outlet in the backshore area, drift logs bridge helter-skelter across the pooled-stream, along the banks, and piled-up in a pocket-sized cove at the northwestern perimeter of the “depression”. During high tide cycles, the marine water likely infiltrates, but also intrudes via this one channel with a network of small tidal sloughs carry tidal water throughout most of the lower marsh area. The primary stream and other small intermittent freshwater inputs, along with narrow tidal sloughs provide regular flow and connectivity to adjacent freshwater marsh and upland areas. In addition, on a number of occasions, coho salmon fry were observed at the mouth of this stream. Michael Kyte states that coho may use this stream for spawning and initial rearing, citing research by Williams et al. (1975).

The salt marsh area is multilayered and characterized by low, middle and high emergent salt marsh vegetation. The lower flats maintain more saline conditions and are dominated by a common salt marsh plant community with pickleweed (*Salicornia virginica*) and seashore saltgrass (*Distichlis* *spicata*) as the co-dominant species. Salinity varies throughout the marsh with subtle changes in surface elevation often exhibiting different emergent wetland species. At slightly higher elevations other salt marsh species present are fleshy jaumea (*Jaumea carnosa*), Pacific silverweed (*Potentilla anserina*), and three-square bulrush (*Schoenoplectus americanus*) - more typically found in low salt marsh areas, however integration or overlap between low and high marsh species commonly occurs. Dispersed throughout the wetland area, hummocks and terraces feature tufted hairgrass (*Deschampsia cespitosa*) and Douglas aster (*Aster subspicatus*). Higher terraces grade into brackish transition areas where tufted hairgrass and spikerush (*Eleocharis palustris*) are more common, then freshwater emergent herbs on the upland fringes with scrub /shrub plants, such as willows, Douglas spirea (*Spiraea douglasii*), and small alders.

During wet months the wetland area has varying levels of standing water that changes depending on the amount of precipitation, higher intensity storms, and tidal infiltration. In the drier months of summer most of the higher ground in the marsh area is relatively dry, but tidal inundation and freshwater input is sufficiently balanced to maintain a healthy perennial wetland plant community. Along with the perennial stream entering into the northern area of the marsh, minimal year-round seeps from an upslope aquifer and a culvert from the south side of Gulf Rd, support areas of persistent freshwater wetland species such as cattails (*Typha* spp.) (Hitchman, M. personal communication 2020).

In a few other locations along the reserve shoreline, small patches of salt marsh plants are present. These areas include mostly pickleweed and seashore saltgrass, as well as an occasional show of Lyngbye's sedge (*Carex lyngbyei*), saltwort (*Glaux maritima*) and sea-side arrow grass (*Triglochin maritima*). Slightly north and east of the aquatic reserve boundary, running along eastern Birch Bay, Terrell Creek features a narrow barrier berm and estuary intermittently fringed with Lyngbye's sedge and pickleweed. Areas allowing for broader marsh flats are dominated by seashore saltgrass, pickleweed and fleshy jaumea. Moving south and farther upstream, along the inner edge of the Terrell Creek dike is a narrow band of obligate salt marsh vegetation indicating saltwater seepage through the dike towards the creek channel.

These estuarine habitat areas are critical to the reserve by providing transitional habitat for salmonids, and furnishing connectivity to freshwater and terrestrial systems adjacent to the reserve. This habitat also serves the functions of providing an impediment to erosion, and a source of tidally exported detritus and nutrients. As a unique habitat type for this reach of coastline, the backshore wetland and tidal estuary furnishes varied habitat areas for refuge, feeding and rearing for fishes, birds, invertebrates and other wildlife.

Freshwater Wetland

Moving upstream along the Terrell Creek estuary from Birch Bay, the wetland areas transition from saltwater dominant to brackish, then merging into extensive freshwater wetlands near the reserves' eastern boundary. In addition to providing feeding and rearing for salmonids, juvenile fishes, a variety of birds, invertebrates and other wildlife, this habitat area is a rare feature for this reach of coastline. The Terrell Creek freshwater wetland is a mostly a monoculture of cattails (*Typha* sp.), however, as with most wetlands, it provides multiple critical functions. Other highly valued contributions include buffering from storms, water retention and filtration buffer, storing excess nutrients, potentially improving water quality, and slowing erosion.

As mentioned in the salt marsh section, the wetland complex at Gulf Road includes freshwater wetland areas. At the toe of the upland slope, landward of the marsh is a characteristic fringing tree and shrub plant community tolerant of freshwater inundation, but not limited to this habitat regime.

Along this fringe are typical scrub-shrub wetland plants including some alders, willows, spirea, and red osier dogwood. A few conifers perch on the elevated edge of the marsh and on larger finger-like hummocks intruding into the marsh., A culvert draining the southern portion of the Gulf Rd access area provides a regular supply of freshwater to a lower terraced wetland directly north of Gulf Rd. This flow supports a small area dominated by cattails (*Typha* sp.). Several other common freshwater emergent marsh species create a mosaic that outline the freshets or cluster on mounds and higher ground throughout the marsh. Some of the more common species present include *Oenanthe sarmentosa*, *Aster subspicatus*, *Deschampsia cespitosa* and *Eleocharis palustris*.

Berm Vegetation and Spit/berm Habitat

Berm areas are beyond the reach of the highest tides, and are infrequently inundated by salt water but are considered — in the "spray zone". Since these locales are subject to salt spray and seldom get inundated, a different plant community persists in this zone. Landward of the reserve boundary and the ordinary high water level, narrow fringes and patches of berm habitat and vegetation are interspersed along the toe of the bluffs or bulkheads. These areas occur more regularly south of Gulf Rd with the most typical vegetation noted as American dunegrass (*Leymus mollis*). A more prominent and extensive berm habitat area landward of the reserve provides a barrier for the Gulf Rd backshore wetland. Well established berm vegetation and drift logs foster substrate stability and help sustain the berm structure while protecting the backshore marsh area. The substrate is composed predominately of gravels and coarse sands with a few scattered cobbles allowing for infiltration. The berm extends approximately 1400 feet along this reach of coastline with the southeasterly extent at Gulf Rd. American dune grass, gumweed (*Grindelia integrifolia*), yarrow (*Achillea millefolium*), and ambrosia (*Ambrosia artemisiifolia)* are common along with few other notable vegetation types. Shrubs and grasses predominate at slightly higher elevations toward the south end where a second berm angles inshore. Shrubs here include Nootka rose, blackberry, and Douglas spirea on the berm crest and lower inner slopes. Other more sparse berm vegetation observed on the shoreward side at lower elevations includes *Atriplex patula*, *Cakile* spp. (searocket), *Vicia* spp. and *Ambrosia* spp.

Fish and Wildlife

Most of the aquatic lands within the aquatic reserve area support a wide range of migratory and resident birds, fish, and marine invertebrates. The extensive eelgrass beds are used annually in the late winter, by a small, and in recent years, barely present herring spawning stock. Additionally, Cherry Point area is identified as a juvenile and larval rearing ground for Dungeness crab, salmonids, herring and other marine fish. A large number of great blue herons feed in the area year-round and substantial numbers of migratory birds are found throughout the reserve vicinity in the winter. Extensive tidal flats and emergent marsh attracts shorebirds and juvenile fishes while the long undeveloped beaches are important for forage fish spawning and marine mammal haul out and refuge areas. Birch Bay supports habitats and species similar to the other significant bays in the area, such as Drayton Harbor and Lummi Bay. A list of fish species observed in Cherry Point area can be found in Appendix B, Table B-x.

Salmon

Of all the drainages in WRIA 1, the Nooksack is the largest and produces the greatest abundance of salmonids and the greatest number of salmonid stocks. As many as 19 different salmon, steelhead, bull trout, and cutthroat trout stocks are currently identified within the Nooksack Basin, including 4 possible stocks of chinook, 2 native chum stocks, coho, 3 pink stocks, 1 riverine sockeye stock, 4 steelhead stocks, 1 cutthroat stock, and 3 Dolly Varden/bull trout stocks. Terrell Creek also provides habitat for coho, chum, steelhead, coastal and resident trout, as well as other fish species. Although there is no published information on the occurrence of bull trout around Cherry Point, the area is known to contain essential features of designated federal critical habitat, such as prey species like forage fish in nearshore areas, a primary constituent of critical habitat (Federal Register 2005, 2016). Limited observations have been made on salmonid distribution and abundance within the reserve area. Local eelgrass beds provide shelter and an abundant food supply for smaller juvenile salmon. Juvenile salmon also utilize the shallow subtidal macroalgae beds and the low energy tidal flats that are well known foraging areas for amphipods, such as *Corophium* spp. Even though the broader mudflats without eelgrass may support an abundant prey base, they are less used by juvenile salmon since they lack cover for refuge. Other species of salmonids, especially sea-run cutthroat, and anadromous bull trout may utilize the low energy mixed gravel and cobble beaches in the area for foraging and shelter.

Forage fish

Forage fish are a vital link in the food chain and constitute a major portion of the diets of many species of salmon, seabirds, marine mammals, and other fishes. Four species of forage fish are found in CPAR marine waters and three species utilize intertidal and shallow subtidal areas for spawning habitat. Pacific herring (*Clupea pallasi*), surf smelt (*Hypomesus pretiosus*), and Pacific sandlance (*Hexapterus personatus*) are obligate spawners in nearshore habitat areas. While northern anchovy (*Engraulis mordax*) school in the deeper waters just offshore of the reserve. This makes these species particularly vulnerable to the cumulative negative impacts of a wide variety of shoreline development activities. This vulnerability has resulted in this species group being given special regulatory attention. Also, the group’s ecological importance and their critical habitat vulnerability have led to their inclusion in the species and habitat lists of the WDFW’s Priority Habitats and Species (PHS) Program (Penttila 2007).

Pacific herring (Clupea pallasi)

The Cherry Point herring stock is unusual in Washington State because of its late “spring” spawning timing (typically running from mid-April through late May). Several studies (Beacham et al. 2002, 2008; Small et al. 2005; Mitchell 2006; Petrou 2019) examining DNA microsatellites or SNP (single nucleotide polymorphism) genotyping have identified the Cherry Point (CP) stock as being genetically distinct from British Columbia and other Southern Salish Sea stocks sampled to date, justifying its management as a discrete stock. The CP herring stock has undergone a dramatic and prolonged decline in biomass since the early 1970s. A decrease in available spawning habitat has not been documented for this stock and it does not appear to be habitat limited. Potential causes for the stock’s precipitous decline and lack of recovery include changes in predator/prey abundance, disease, pollution and climate change. However, toxicological studies of Cherry Point herring showed lower levels of polycyclic aromatic hydrocarbons (PAHs) relative to stocks spawning along residential bays in central Puget Sound; “It is possible that open shorelines such as Cherry Point may dilute or disperse local PAH sources” (West et al. 2014). Also, Cherry Point herring embryos show much higher temperature tolerance compared to other SSS stocks (Marshall 2011), which may be related to their late spawn time and may provide an important advantage in a time of rapid environmental change. Important data gaps for understanding the lack of recovery for Cherry Point herring include egg survival (avian predation is significant at CP), larval herring dispersal, retention and survival, and stock age structure.

In 2016-17, with funding from DNR’s Aquatic Reserves Program, WDFW initiated an adult spawner study using variable mesh gillnets to capture adults throughout the spawning season and determine the age structure of this stock; age structure information had been unavailable since acoustic trawl surveys ended in 2011 (2009 for all other stocks). The gillnet sampling revealed the presence of spawning herring up to age 8, with a skewed bell curve typical of healthy stocks where younger fish outnumber older fish. This type of age distribution and structure has not been present in CP herring population since the 1980s (Sandell et al. 2018). The complete methodology and results of that study are available in an independent report submitted to DNR.

Adult herring (pre-spawners) use the open water habitat west and north of the reserve to congregate before spawning. Prespawner holding areas were primarily determined from past acoustic/trawl surveys or other information. The prespawner holding area depicts the location (in yellow) most usually adjacent and offshore from the spawning ground where ripening adult herring congregate and "hold" prior to spawning (Stick and Lindquist 2009, from Trumble et al. 1982). Schools of prespawning adults typically begin concentrating three to four weeks, or more, before the first spawning event (Figure A-6).

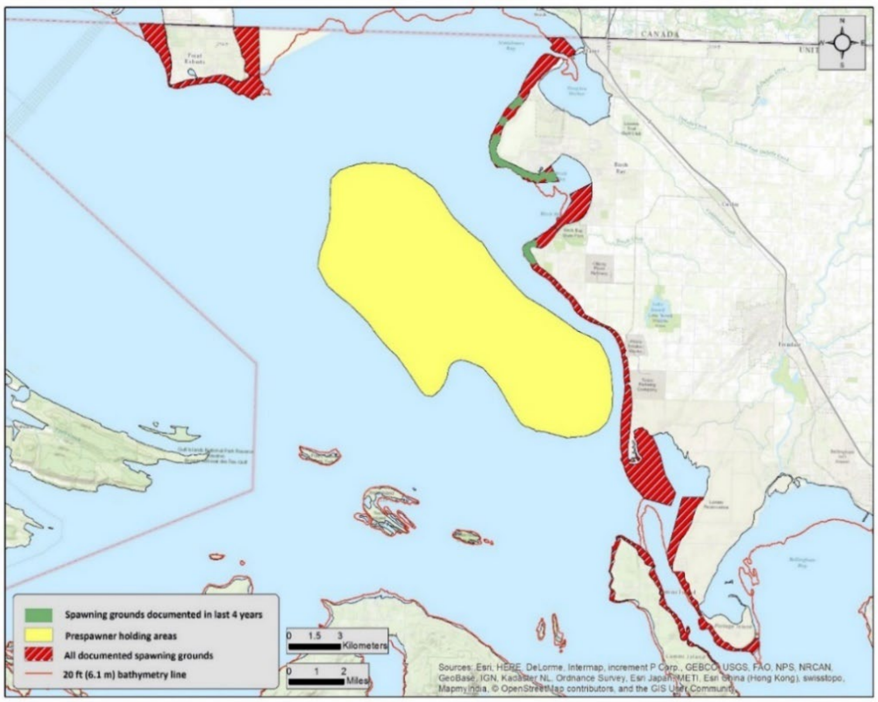

Figure A-6. Map of the areas at Cherry Point with spawning activity from 2013-2016 (greenshading), historically utilized spawning areas (red shading), and prespawner holding grounds (yellow shading).

Cherry Point Herring: 2010-2019

Over the past decade, the Cherry Point herring stock—once the largest in Washington State—continued to contract in spawning area utilized (since 2016, now focused completely around Birch Head; see Figures A-6, A-7 and Appendix C, Maps C-7, C-8, C-9) and remains under 3% of the initial estimated spawning biomass (ESB) documented in 1973. While the decline continues a gradual, downward trajectory, slight increases in ESB have occurred 3 times (2011, 2014, 2019) in the past decade (Figure A-8), with a 16 percent increase in 2019 (290 mt). In 2020, the Cherry Point herring stock was considered "depressed" by the metrics used to classify the condition of herring stocks in the WDFW quadra-annual herring reports (comparison with the previous 25-year rolling average; Sandell et al. 2019) (Table 1). However, "given the overall decline from their previous abundance, this stock is considered to be at a "critical level" (Sandell 2020b).

An oddity of the CP herring is their spawning behavior. Over the past five years, the herring which spawned on the Birch Bay side of Birch Head (southeast - SE) have consistently spawned earlier (mid-April to early May) than those spawning on the Semiahmoo Bay side (northwest - NW; see Figure A-6 for a map of the area). No fresh spawn has ever been detected in June, as eggs recovered in June had spawn dates in late May when examined microscopically. Although aquatic vegetation in the vicinity of Birch Head is abundant, with several bands of vegetation in deeper water, the earlier

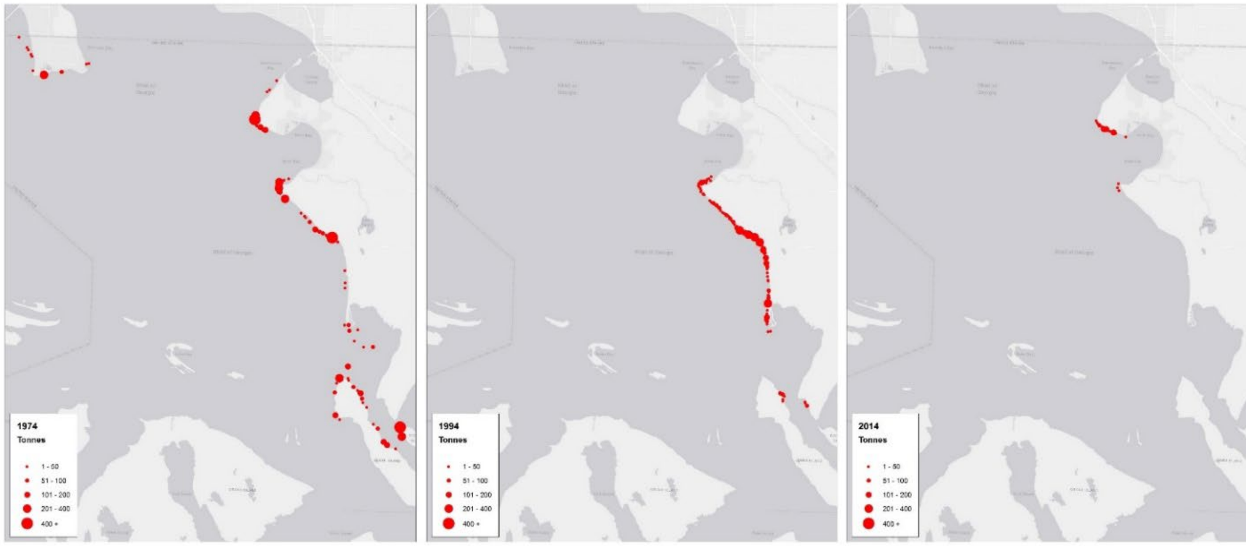

Figure A-7. Maps of Cherry Point herring spawn deposition documented in 1974, 1994, and 2014. Red circles indicate locations where eggs where observed. Note the contraction and northerly shift of the spawning area utilized. Since 2016, most spawning has occurred in the vicinity of Birch Head.

spawning fish (SE side) almost always spawn on *Sargassum* and a variety of other macroalgae. Spawning occurs in very shallow water at or above mean low low water (MLLW), leaving their eggs exposed at very low tides. As a result, the eggs from the early spawning herring appear to suffer intense bird predation (principally from scoters, Brandt's geese, Bonaparte gulls, and others), a topic of ongoing investigation. Later spawning herring (NW side of Birch Head) tend to spawn farther offshore, on eelgrass, at a time when there are fewer avian predators in the area. In 2020, the spawning pattern was similar to that described above, with one earlier survey detecting eggs shortly before the arrival of thousands of scoters. Three days later, a follow up survey found almost no spawn remaining - another piece of evidence suggesting that bird predation upon the herring eggs is significant. While it is tempting to conclude that the later spawners have better survival, that conclusion is presently untenable: we have no data on larval survival or dispersion patterns in the area (Sandell 2020b). A larval light trap study, planned for the 2021 season by DNR and the Lummi Nation will hopefully address this data gap in the near future.

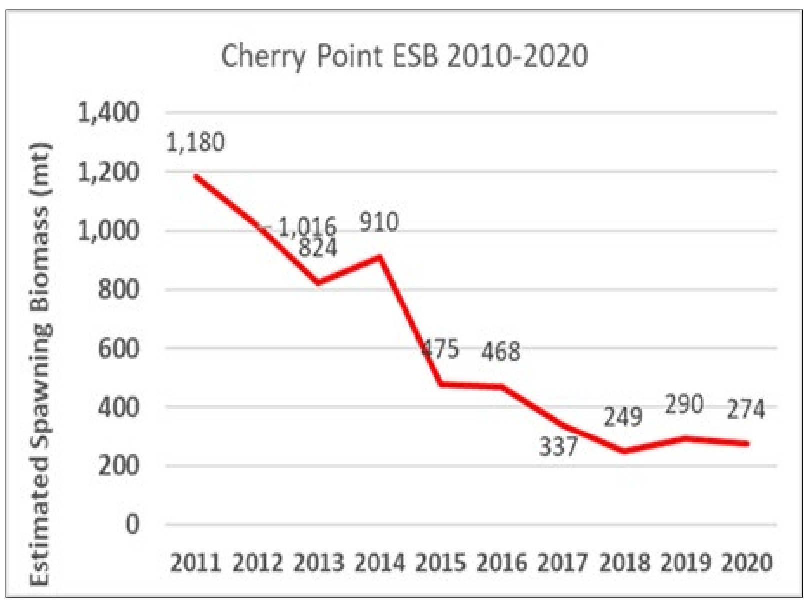

Figure A-8. Estimated spawning biomass of the Cherry Point herring stock over the past decade.

Cherry Point Herring: Recent Events (2020)

Although the 2020 spawning survey season at CP was interrupted by the COVID-19 shutdown on March 16th, shore-based surveys at low tide detected a number of spawning events on both sides of Birch Head. Egg samples were collected from these spawning events and await ageing. Boat-based surveys resumed on May 18th, 2020 and detected some additional spawn, primarily NW of Birch Head. In 2020 the estimated spawning biomass for CP herring is approximated at 274 metric tonnes (mt) (Sandell 2020b).

Despite a startling increase in the ESB for the entire Southern Salish Sea (SSS) herring population in 2020, the estimate, (without data for CP), is over 17,000 mt (an underestimate due to the COVID-19 survey shutdown). The 2020 total is the highest ESB since 1980, but it is important to note that, in 1980, CP (8,463) made up 42% of the total herring spawning biomass for the SSS; in 2019, that percentage fell to 4% (290 mt) of the total (7,724 mt). The Cherry Point herring stock was the largest in the state until 1998.

Other Forage Fish Species

Surf smelt (*Hypomesus pretiosus*) are an important forage fish in the Salish Sea. Surf smelt spawn at middle to upper intertidal elevations (in Cherry Point area from + 5 feet MLLW to +8 feet MHHW) on fine gravel and coarse sandy beaches. Spawning beaches are common along the Cherry Point reach and in Birch Bay (see Appendix C, Map C–6). Spawning tends to occur during late spring through the summer and focused during July in this vicinity. WDFW and the DNR aquatic reserve Puget SoundCorps team have conducted periodic beach spawner surveys in CPAR. In the Birch Bay portion of the reserve, in spite of extensive armoring, the remaining narrow, patchy strips of suitable substrate at the base of armored shoreline are still utilized for spawning. This habitat and substrate area is very vulnerable to disturbance and continued erosion, for lack of sediment replenishment. Appendix C, Map C–6 illustrates the extensive distribution of documented surf smelt spawning habitat in CPAR. Little is known of the larval and post-larval life history of surf smelt in the area.

Pacific sand lance (*Ammodytes personatus*) also spawn in the upper intertidal areas throughout the south Salish Sea. In northern Whatcom County, documented Pacific sand lance spawning areas are sparse, but include beaches in Drayton Harbor, south Birch Bay, and the south side of Gooseberry Point. The spawning window for sand lance in this region is generally from early November through mid-February with eggs present into March. Sand lance tend to utilize similar substrate as surf smelt, and often spawn on some of the same beaches. Preferred spawning substrate includes pea gravel, shell hash, and sand at slightly lower tidal elevations than surf smelt spawning areas. In addition, sand lance demonstrate a preference for well-aerated soft sand. As of April 2019, sand lance eggs (spawn) in CPAR have been found from two separate spawning events, in basically one location. The limited documented sand lance spawning area in the reserve has been identified on the southwest shoreline of Birch Bay (see Appendix C, Map C-6).

The northern anchovy (*Engraulis mordax*) has resident populations throughout the Puget Sound basin, generally secondary in abundance to those of co-occuring herring. This species releases its distinctly oval eggs directly into the plankton, where they hatch within three days. The northern anchovy spawning season in Puget Sound is May-September. Anchovy eggs have been found in plankton samples throughout western Whatcom County, from Semiahmoo Bay to Bellingham Bay, including the Cherry Point area (Sandell 2020b).

Other Marine Fish

Several groundfish species occur in Whatcom County. Groundfish live mainly on or near the bottom of the water column for most of their adult lives. Key groups of groundfish are: flatfish such as, sole and flounder, skate, dogfish and surf perch; other pelagic species including polluck, whiting and cod. Groundfish contain many links in the food web, connecting nearshore and midwater components to the benthos (PSAT 2007). They are also economically important. Other types of groundfish are found within Whatcom County, but their habitat preference makes it less likely to find them in the reserve area as adults, particularly lingcod, various rockfish species, cod, hake and pollock. At Cherry Point, WDFW found that flatfish dominated the catch at a nearby site finding Dover (*Solea solea*), English (*Parophrys vetulus*), and rock soles (*Lepidopsetta bilineata*), starry flounder (*Platychythyus stellatus*), and Pacific and speckled sanddabs. This is consistent with the results of earlier trawls by Kyte (1990), who found a majority (more than 90%) of flatfish, taken in samples with many juveniles less than 100 mm in length. Occasionally, adult butter sole (*Isopsetta isolepsis*) have been seen along diving transects or caught in trawls in the vicinity (Hanson and Van Gaalen 1993). Lingcod (*Ophiodon elongatus*) adults are found in nearby rocky habitat areas around the reef at Point Roberts and on Alden Bank, with juveniles more likely along the shorelines of Birch Head, Cherry Point, and Lummi Island (Whatcom County MRC 2007).

Most adult rockfish are associated with high-relief, rocky habitats, so are unlikely to be common in the reserve area, but larval and juvenile stages of some rockfishes make use of open water and nearshore vegetated habitats as they grow. Nearshore vegetated habitats, most commonly kelp and eelgrass, are particularly important for several common species of rockfish, such as Copper, Quillback, and Brown rockfish. These areas serve as young-of-the-year settlement refuge and nursery areas for juvenile rockfish. Also, in bull kelp beds, the coarse gravels and cobble rocky substrates provide safe corridors and connecting pathways for movement to adult habitats. Rockfishes are prey for a variety of predators including lingcod and other marine fishes, marine mammals, and marine birds.

WDFW has not focused any specific surveys on marine fishes in Cherry Point area. However, the sand flats and shallow embayment of Birch Bay are considered the most important habitat areas for flatfish species. Many flatfish—such as starry flounder, English sole, speckled sanddab and sand sole—show a distinct preference for shallow waters in the bay and may remain near the shore even as adults. Flatfish spawn is found in small quantities within the bay. The two flatfish in the area of greatest commercial importance are starry flounder (*Platichthys stellatus*) and English sole (*Pleuronectes vetulus*). For a list of fish observed in the reserve, see Appendix B, Table B-2.

Marine Invertebrates

The diversity of substrates and structure, including submerged aquatic vegetation with large expansives of prime intertidal and shallow subtidal habitat areas create a robust environment supporting a myriad of invertebrate species. Many species of marine worms, snails, clams, crabs, small crustaceans, and other invertebrates provide a vital link in the southern Salish Sea food chain by providing a plentiful resource for local and migratory populations of birds, fish and mammals. Benthic invertebrate assemblages in the CPAR are primarily determined by substrate type. In the uppermost, loose sands and gravels near the mean higher water level, amphipod species are found amongst drift logs and leaf litter, as well as inhabiting drift vegetation. Low intertidal areas in sand and mixed gravel substrates provide rich habitat for clams and other burrowing organisms (discussed below). Under and between mixed gravels small shore crabs (*Hemigrapsus* spp.), polychaete worms (*Nereis* spp., *Neanthes* spp.) and shrimp (families *Crangonidae* and *Hippolytidae*) are resident. Gravel with cobble and boulders irregularly dispersed throughout the intertidal and shallow subtidal areas in western Birch Bay and along the Cherry Point reach provide sessile habitat area for a plethora of invertebrates such as, barnacles (*Balanus glandula*, *Semibalanus cariosus, Chthamalus dalli*), snails (*Nucella lamellosa*, *Littorina scutulata*), limpets (*Collisella strigatella, Lottia pelta*), mussels (*Mytilus trossulus*), chitons (*Mopalia* spp.), anemones (*Metridium* spp.) and seastars (*Pisaster ochraceus, Leptasterias hexapterus*). Red rock crab (*Cancer productus*) and helmet crabs (*Telmessus cheiragonus*) are also present foraging in these areas or burrowing in adjacent sand and pebble. (EVS 1999; Parametrix & Adolfson Associates, Inc. 2006).

The abundant mixed fine and sandy substrate areas of lower intertidal beaches, tidal flats, and of eelgrass beds are inhabited by annelid worms (capitellid polychaetes and oligochaetes), burrowing anemones (*Anthopleura artemisia*), amphipods, and several bivalve species, including cockles (*Clinocardium nuttallii*), native littleneck clams (*Leucoma staminea*), and butter clams (*Saxidomus gigantea*) (EVS 1999; Whatcom County 2006).

Dungeness crab are widespread throughout the Cherry Point area and are expected to use all habitats below a depth of approximately 2 feet above MLLW. Red rock crab, a variety of shrimp and seastars (*Pisaster brevispinus*, *Evasterias troschelii*), as well as a wide variety of infauna such as polychaetes, and other bivalves also inhabit subtidal habitats, which contains mixed macroalgae including kelp beds where there is coarser gravelly substrate. Softer mixed fines including silt and mud in subtidal areas includes the sea pen (*Ptilosarcus guerneyi*), nudibranchs, Dungeness crabs (*Metacarcinus magister*), tanner crabs (*Chinocetes* spp.), sea cucumber (*Eupentacta pseudoquinquesemita*), and small crangonid shrimp. Geoduck clams (*Panopea abrupta*) are present in some subtidal areas in the reserve (EVS 1999).

Systematic data collection on intertidal invertebrates is limited for the reserve. Since 2013, in an effort to establish baseline data for intertidal species in the reserve, the CP Citizen Stewardship Committee implemented intertidal beach surveys. Surveys have been conducted seasonally from 2013 through 2019 at three locations along the western shore of the CP reach. These data are contributing up-to-date baseline information for plant and animal presence and distribution. Baseline information can be used for natural resource damage assessment, reserve management, serve as early detection of invasive species, and protection of critical habitats and protected species (Hines and Jaeren 2018). A full listing of marine invertebrates observed in or adjacent to the aquatic reserve, see Appendix B, Table B-5.

Shellfish

Beaches along Cherry Point reach are characterized by habitat that support substantial numbers of shellfish. The nearby Birch Bay State Park is classified as a "Land Access Beach with abundant clams and some oysters" for public shellfish sites of Puget Sound (WDFW n.d.a). The sandy tidal flats, as well as mixed sand and gravel beaches of Birch Bay are important habitat for several species of clams — including native littleneck (*Leukoma staminea*), Japanese littleneck (*Venerupis philippinarum*), and the cockle (*Clinocardium nuttallii*). The butter clam (*Saxidomus gigantea*), horse and gaper clam (*Tresus* spp.), are found at lower elevations. Data from surveys also note other species including, Eastern soft-shell clams (*Mya arenaria*), *Macoma* spp., and the non-native purple varnish clam (*Nuttallia obscurata*). Hard-shelled clams are also found on other beaches along the Strait of Georgia in lower intertidal areas containing an appreciable amount of gravel mixed with sand and silt. Shellfish harvest is popular and occurs on several beaches throughout the reserve. The geoduck *(Panopea abrupta*) is likely to be present in the deeper regions of Birch Bay, although WDFW has not conducted any geoduck surveys in the area. Provided with the appropriate substrate types, mainly sand and silts, geoducks are generally found from the lower intertidal zone to at least

360 feet in depth. The presence of geoduck is likely within Birch Bay in less disturbed subtidal areas with sand to silt sediment.

Shellfish perform a number of important ecological functions including nutrient cycling, substrate stabilization, habitat structure (e.g., oyster reefs), water quality enhancement (filtering and retention), and provide food for a wide variety of marine invertebrates, birds, fish and mammals.

The Olympia oyster (*Ostrea lurida)* is the native oyster once found at scattered sites throughout Puget Sound including Cherry Point area. Birch Bay has favorable habitat conditions and unlike other bays in the area is free from a significant population of Pacific oysters, and the associated, devastating Japanese oyster drills (Dinnel et al. 2005).

Dungeness crab (*Metacarcinus magister*) are present throughout the state's waters, but in the south Salish Sea are most abundant in the northern portions including the Cherry Point vicinity. Dungeness crabs, in particular, serve importance as both predator and prey in the Cherry Point food chain. As larvae they are planktonic and provide food for fish and other invertebrates; once settled in shallow intertidal areas, they are voracious feeders in the benthic food web. Adult Dungeness crabs are common along the Cherry Point shoreline and support recreational and commercial fisheries in the area. Adults are found primarily in the subtidal zone in soft sediments, but the juveniles rely heavily on intertidal habitats with structural complexity, such as eelgrass beds (Dethier 2006). They move between estuaries and offshore waters seasonally (WDFW 2009).

Over-wintering ovigerous (bearing or carrying eggs) female Dungeness crabs may occur in significant numbers in nearby local shallow bays including Birch Bay, Lummi Bay and Drayton Harbor. Female crabs spend most of a 3-to 4-month period between November and April buried in the sediment in eelgrass from 1.6–13.1 feet deep MLLW. The unique importance of this sensitive life stage and proximity to Cherry Point area reinforces the importance of minimizing negative impacts to these habitats.

Dungeness crab larvae spend several months in the water column before returning to nearshore areas to settle. Dungeness crabs are an important predator and prey organism at all life history stages. Their pelagic larvae are prey for many fishes, including copper rockfish, coho and Chinook salmon, halibut, dogfish, hake, and lingcod. Being planktivorous, the larvae may be exposed to pollutants that are present in the water column and plankton. Once they molt into juvenile stages, they live on the bottom, generally in shallow waters, feeding on the benthic organisms or debris. Young-of-the-year Dungeness crabs use eelgrass beds, macroalgal beds, and shallow intertidal areas with an abundance of broken shell material in Birch Bay and the reserve vicinity as rearing habitat before moving to deeper waters. They can readily adjust their diet, but the younger/smaller crabs generally eat mollusks, progressively adding other organisms such as shrimp and then small fish as they age and grow. Dungeness crabs are relatively short-lived with a maximum lifespan of 8 to 10 years.

The Cherry Point reach vicinity is highly valued by the Dungeness crab commercial fishery operated by the Lummi and Nooksak Tribes. Recreational crabbing is a popular pursuit in Birch Bay, and offshore from Neptune Beach. Several crabbing methods are employed in the sport fishery, depending on local conditions; they are caught intertidally by hand or subtidally by crab pots, nets, or even hook-and-line. Cherry Point aquatic reserve is open for recreational harvest of Dungeness and red rock crab subject to WDFW regulations and openings for Marine Sub Area 7 North – Bellingham to Pt. Roberts. In spite of the popularity of this fishery, there are no regularly surveyed WDFW index stations for Dungeness crabs in the Cherry Point area.

Birds

Cherry Point area is part of a larger area that is recognized as one of the most important waterfowl and seabird wintering spots along the Pacific flyway. The area provides critical habitat connectivity for migratory and overwintering seaducks and seabirds. Considered one of 18 significant concentration areas for bird habitats in the south Salish Sea, Cherry Point was deemed to have the highest bird densities with more than 13,000 birds per square mile kilometer estimated by Marine EcoSystems Analysis (MESA) in 1984. A comparative study done in 2004 by Western Washington University in conjunction with MESA has shown a density decline of 79.1%.

The Cherry Point area offers a plentiful food supply for waterbirds[1], including forage fish, herring spawn, juvenile salmon, shellfish, other small invertebrates, and eelgrass (the preferred food source for brants). Large populations of wintering brant are documented in Cherry Point area and exclusively depend on eelgrass as fodder. They also need shallow areas to pull themselves out of the water and collect gravel for digestion. Dabbling ducks (American wigeon, mallards, pintails, and canvasbacks) primarily feed on eelgrass and other submerged aquatic vegetation.

Eelgrass and macroalgae beds along with the shallow waters of Birch Bay are important for diving and surface-feeding ducks, large flocks of brants, gulls, and shorebirds as well. The outer reach between Sandy Point to Point Whitehorn possesses important habitat during all seasons, supporting high numbers of scoters, and fish-eating loons, grebes and alcids, along with diving ducks. Peak avian activity levels occur in late winter, but last through late spring, coinciding with herring spawning. Herring spawning activity starts in northern areas beginning with the Semiahamoo herring stock, spawning as early as mid-January and the Cherry Point stock lasting through late May. Huge concentrations of birds, particularly scoters, cormorants, and gulls, show up to feed on herring roe in the shallow waters just offshore. Among the many non-marine bird species present throughout the reserve shoreline are great blue herons, bald eagles, and peregrine falcons.

Three large-scale bird surveys have covered the Cherry Point area. The Marine EcoSystems Analysis (MESA), occurred during the late 1970s and early 1980s. MESA was the first comprehensive effort to assess marine bird populations in Puget Sound, funded by the EPA and administered by NOAA. MESA researchers used a number of methods to document density, including transect counts from ferries and aerial surveys. The MESA survey results showed that Cherry Point registered the highest counts of birds per square kilometer in Puget Sound. MESA observers counted more than 13,000 birds per square kilometer at and adjacent to Cherry Point. Herring spawn-related flocks of surf scoters included 22,400 at Point Whitehorn (23 April 1978); 22,135 off Lummi Bay (30 April 1978) and 16,037 at Cherry Point on 27 April 1979 (Wahl et al. 1981). Another result of the MESA surveys was the recognition of how important Lummi Bay and Birch Bay were as significant bird habitats; Birch Bay had second highest bird use rating (Wahl et al. 1981).

The Puget Sound Ambient Monitoring Program (PSAMP) conducted surveys between 1992-1999 and continued annually with trend data through 2006 to compare many of these bird counts to the MESA results. Survey transects were designed so that they were nearly identical to 54 transects flown during the MESA Puget Sound Project, allowing for a statistical analysis of bird species and numbers over a 30-year period (Nysewander et al. 2005). PSAMP comparisons revealed significant

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[1] Waterbirds: The term waterbird is used to describe birds that occupy and use shallow inland marine bays and salt marsh habitats. These include marine diving ducks and alcids, shorebirds of all kinds, dabbling ducks, gulls, and Brant.

findings for marine birds throughout Puget Sound and the surrounding area. Many populations have decreased - grebes, cormorants, loons, pigeon guillemot, marbled murrelets, scoters, scaup, long-tailed ducks, and brant. Some populations appeared stable or slowly decreasing- rhinoceros auklets, goldeneyes, bufflehead, and several gulls species. There may be some degree of increase in harlequin ducks and probably mergansers (Nysewander et al. 2005).

Data on non-breeding birds in the Strait of Georgia was also collected during 2003-2004 and 2004-2005 for comparison to the PSAMP and MESA results. Western Washington University (WWU) has conducted shore-based and ferry-based counts (Bower 2009) in the Strait of Georgia. As part of the study, National Audubon Society Christmas Bird Counts were considered from 11 sites. The results were then compared to both PSAMP and MESA surveys. This latest survey is called the WWU/MESA comparison (Bower 2009).

There are limitations to comparing PSAMP data to MESA counts. These limitations include, but are not limited to how often the transects were flown, how loud the airplane was (may disturb birds), and the difficulty of identifying birds from an airplane. Scientists from WWU, with funding from Washington Sea Grant and other sources, began conducting shore and ferry-based marine bird counts that closely replicated the 1970s MESA research. WWU scientists, with help from students and volunteers, conducted monthly land and water surveys between September and May in the inner marine waters of north Puget Sound and south Strait of Georgia. Data from Audubon Christmas Bird Counts was also collected. The goal was to provide a more robust count for comparison to the 1978-1979 MESA data.

The results of the WWU/MESA comparison showed that 14 of the 37 most common over-wintering species in the Strait of Georgia are experiencing significant declines, including 10 species declining over 50%. Detailed examination of the causes of the changing species remain unknown (Bower, J.L., 2009, unpublished). The largest declines were spread across different species, and included the common murre (*Uria aalge)* (92%), western grebe (*Aechmophorus occidentalis)* (81%), red-throated loon (*Gavia stellate)* (73.9%), and the Bonaparte's gull (*Larus philadelphia)* (72.3%) (Bower 2009). The observed species trends from the WWU census were similar to those previously reported by PSAMP, with the exception of double-crested cormorant, pigeon guillemot, common loon and harlequin duck (Puget Sound Update 2007).

For Cherry Point specifically, two sites were monitored. Combined totals for both sites showed a 79.1% decline in species documented when WWU compared data to the MESA study (Bower 2009).

In 2013, the Cherry Point Aquatic Reserve Citizen Stewardship Committee (CSC) began shore-based marine bird surveys at three locations in the reserve vicinity initially focusing on seven target species (see Appendix C, Map C-19 for locations). The objectives of this study are to monitor bird abundance, determine changes in abundance by comparing results with relevant data from previous studies, and make data available for scientific and educational purposes. Comparison of the data collected by the Cherry Point Aquatic Reserve CSC with the MESA and WWU studies are mostly consistent with those observed between the late 1970's and 2000's, particularly large decreases in surf scoter abundance. Since the 2003-05 WWU study, abundance for six of the seven species stayed relatively stable, while bald eagle numbers have nearly doubled (Bower 2016). By 2016, emphasis shifted to monitoring 29 species – most of the same species as the early MESA study. Thus far, three seasons (2016-2018) of monthly surveys between September and May have identified the largest presence in the area are surf scoters, with the other two most abundant species around in the area as brandt and bufflehead. Continued monitoring over the coming years will allow for better comparison and abundance trends of marine birds in the Cherry Point Aquatic Reserve (Hines and Jaeren 2018).

Bird species that rely on Cherry Point Aquatic Reserve habitats and are classified as Endangered, Threatened, or Sensitive by the state include: marbled murrelet (*Brachyramphus marmoratus*), common loon (*Gavia immer*), double-crested cormorant (*Phalacrocorax auritus*), Brandt's cormorant (*Phalacrocorax penicillatus*), bald eagle (*Haliaeetus leucocephalus*), peregrine falcon (*Falco peregrinus*), common murre (*Uria aalge*), surf scoter (*Melanitta perspicillata*), great blue heron (*Ardea herodias*), western grebe (*Aechmophorus occidentalis*), osprey (*Pandion haliaetus*), cavity nesting ducks, and subspecies of these listed birds.

General status and habitat descriptors for bird species listed as Endangered, Threatened or Sensitive species:

1) *Marbled Murrelet.* The marbled murrelet is a federally Threatened and state Endangered species. It forages within 2 to 5 kilometers of shore in coastal and nearshore waters, and within the top 50 meters of the water. Generally solitary, individuals have been documented where Pacific herring are spawning (USFWS 2006; Speich and Wahl 1989). Marbled murrelets are unlikely to nest in the immediate vicinity of CPAR because most forests are extensively fragmented, small, and of second-growth class. Marbled murrelets are documented flying into forests near the Canyon Creek drainage of the North Fork Nooksack River, near the United States-Canadian border and about 37 miles (60 km) from Cherry Point. This was considered to be the nearest known murrelet nesting area to Cherry Point for quite some time (ENSR 1995). Marbled murrelets have also been documented off of central and southern Cherry Point, approximately 5 to 10 kilometers offshore. The 2005 PSAMP surveys observed 1 – 2 animals off the northern boundary of Cherry Point, in the Point Whitehorn vicinity, during summer surveys (Whatcom County 2006; Nysewander et al. 2005).

2) *Common Loon.* A state Candidate species that utilizes the shallow protected areas of the reserve for staging and wintering. Loons are very reliant on nearshore resources during the winter months, and are flightless during winter, leaving them at a potentially higher risk to a variety of impacts in the marine and nearshore environment. The WWU/MESA survey found that the percentage change for the common loon was a statistically significant increase (+48.8%) compared with the MESA data and was not statistically significant when compared with Christmas Bird Count data (Bower 2009).

3) *Cormorants.* Three species of cormorants inhabit the waters off of Cherry Point, and two are located there year round. Double-crested cormorants utilize the Cherry Point coastal habitat areas year round. Population numbers declined dramatically in the 1960s and 1970s due to contaminants acquired from fish. Since the ban of DDT, populations have been increasing. The WWU/MESA survey found that the percentage change for this species was a statistically significant increase (+97.7%) compared with the MESA data and when compared with Christmas Bird Count data (+171.1) (Bower 2009).

   Brandt's cormorants (*Phalacrocorax penicillatus*) are listed as state Candidate species. The WWU/MESA survey found that the percentage change for this species was not statistically significant (Bower 2009). The pelagic cormorant (*Phalacrocorax pelagicus*) has experienced significant increases in the Washington population between 1976 and 1992 (Seattle Audubon Society n.d.), and pelagic cormorants may still be increasing. The WWU/MESA survey found that the percentage change for this species was a statistically significant increase (+87.7%) compared with the MESA data; there was no statistically significant change when compared with Christmas Bird Count data (Bower 2009).

4) *Bald Eagle.* Until 2018, the bald eagle was federally listed as a Species of Concern. Present status has been down-graded. Bald eagles use shorelines for feeding and nesting, often building large stick nests in dominant trees near water. Eagle nests are most numerous near marine shorelines, but nests are also found near many of lakes, reservoirs, and rivers. Fish are usually the most common prey taken by breeding bald eagles throughout North America, but bald eagles also capture a variety of birds (Stalmaster 1987). Bald eagles are present in SOG, and were documented during the 1992 – 1999 PSAMP summer marine bird surveys as "Other species observed." (Nysewander et al. 2005). Bald eagles are sometimes seen disrupting cormorant and heron colonies in marine and nearshore areas. WDFW has identified seven eagle nest locations comprising three distinct territories along Cherry Point.

   Whatcom County references the value of this habitat to bald eagles in their Shoreline Characterization and Inventory Plan (see section 3.3: *Terrestrial Wildlife Habitat* - Whatcom County, 2006). In addition to resident breeding pairs observed nesting along Cherry Point and Terrell Creek, sub-adult non-breeders occur year-round. Migratory and wintering eagles are found in seasonally higher numbers along the reserve shoreline where they scavenge in intertidal areas, fish in open water or hunt ducks and gulls (Eissinger 1994).

   WWU/MESA survey found that the percentage change for this species was a statistically significant increase (+187.0%) compared with the MESA data and there was no statistically significant change when compared with Christmas Bird Count data.

5) *Peregrine Falcon.* Peregrine falcon is a state listed Endangered species and federally listed as a Species of Concern. It is typically found hunting in open areas, especially along the coast and near other bodies of water that provide habitat for their prey. CPAR is located directly along the migratory corridor between Alaska and Washington State. Knowledge of the peregrines that use this corridor, often during fall, is somewhat limited (Hayes and Buchanan 2002), but it is thought that the Peregrine falcon uses the Cherry Point area for foraging. The WWU/MESA survey did not cover this species.

6) *Common Murre*. The common murre is a large auk that spends most of its life at sea, coming to land only to breed on rocky cliff shores or islands. It is a Washington State candidate under the Migratory Bird Treaty Act. These birds can be seen outside of breeding areas year round, including deep-water, inland and marine habitats (Seattle Audubon Society n.d.). The PSAMP summer marine bird surveys documented the presence of murres off the north shore of Cherry Point, at 10 - 25 Murres/km^2. Along the nearshore birds were counted at 0 - 5 murres/km^2 (Nysewander et al. 2005). The WWU/MESA survey found that the percentage change for the common murre was a statistically significant decline compared with the MESA data (- 92.4%) and when compared with Christmas Bird Count data (83.7%) (Bower 2009).

7) *Surf Scoter.* Surf scoters are often seen diving synchronously to locate small invertebrates such as mollusks, crustaceans, and polychaetes in shallow nearshore areas. At night, they often rest in large flocks outside bays and estuaries in which they feed during the day. Surf scoters are typically present along Cherry Point in winter; PSAMP winter surveys counted 10 – 50 scoters/km^2 in the northern portion of the reach, and upwards of 50 – 250 scoters/km^2 in the central to southern portion (Nysewander et al. 2005). Numbers of scoters in the area increase dramatically when herring spawn is available, although the size of these scoter aggregations has declined concurrently with declines in spawning herring.

Anderson et al. (unpublished manuscript, 2009) studied the role of herring spawn in movements and energetics of scoters, focusing on differences in the value of spawn to surf scoters versus white-winged scoters (*M. fusca*). Their research indicated four main results:

a. Both surf and white-winged scoters gain mass by consuming spawn during late winter and spring.
b. The number of each scoter species that aggregates to consume spawn is positively related to the size of the spawning event (i.e., the biomass of spawning herring).
c. Numbers of surf scoters are especially abundant at spawning sites that occur later in spring (April to May), because migrating surf scoters use these sites as staging areas before their northern migration inland.
d. Spawn is a preferred food for white-winged scoters, but appears much more important to surf scoters because they often lose critical fat reserves over winter that are needed for the long northward migration inland.

The second and third results are particularly relevant to CP herring spawning events. Specifically, spawning activity occurs later in spring (April through early June) than at other spawning sites in the southern Salish Sea (January to mid-April). Thus, spawn of the Cherry Point herring is used by surf scoters to acquire reserves for migration and breeding. However, concurrent with declines in the biomass of spawning herring at Cherry Point, numbers of scoters observed foraging on spawn there declined from about 60,000 to 6,000 in the period 1980–1999 (Nysewander, D. R., unpublished data). During spring migration of surf scoters in late-April to May, no feeding opportunities equivalent to historical levels of spawn at Cherry Point are known to exist in the Puget Sound-Georgia Basin.

Herring spawn is profitable to scoters for two main reasons: (1) it is highly aggregated and in shallow water areas and thus reduces foraging effort (Lewis et al. 2007), and (2) spawn has no shell matter, which likely increases nutrient and energy gain relative to some foods scoters consume earlier in winter[2] (Anderson, E.M. et al., unpublished manuscript, 2009).

8) *Great Blue Heron.* One of the largest heron rookeries in the Pacific Northwest was locally referred to as the “Birch Bay Colony”, but was abandoned sometime between 2007-2009. The rookery was located approximately one mile east of Birch Bay State Park on a riparian corridor along Terrell Creek. This colony was first identified in 1983 and until 2007 grew to support an average of more than 300 breeding pairs. Additionally, this colony contained the unique Pacific Northwest subspecies, *Ardea herodias fannini*, that resides in the area year-round (Eissinger 1994). Research has shown that members of this colony included Birch Bay, Drayton Harbor, Semiahmoo Bay, Lummi Bay, and Lake Terrell in their range (Eissinger 1994). Present day, the colony has dispersed to other regional rookery areas, but still utilizes the intertidal habitat areas of CPAR. The WWU/MESA survey found that the percentage change in this general area for this species was not statistically significant. Foraging areas include marine shorelines, the intertidal zone, wetlands, streams, riparian areas, and upland fallow fields. The most concentrated foraging during the nesting season occurs in the intertidal areas in Birch Bay (Shapiro and Associates Inc. 2003). WDFW recommends priority habitat protections for seasonal aggregation (nesting) areas

[2] Mussel soft tissue and herring spawn have approximately the same nutritional value. However, 85 – 90% of a whole mussel is shell, which must be processed and excreted because scoters ingest whole bivalves

(WDFW PHS Species List 2008).

9) *Western Grebe.* Western grebe is a state candidate species and identified as Species of Greatest Conservation Need (SGCN) under the State Wildlife Action Plan (WDFW 2015). Western grebes are found in large numbers in marine waters, often preferring deeper waters with relatively low currents such as bays or inlets. In the south Salish Sea during winter and summer; flocks often return to the same general area each year (Nysewander et al. 2005). Cherry Point is located in the northern portion of the Western grebes non-breeding winter habitat, and adjacent to migratory routes (Seattle Audubon Society n.d.). The PSAMP winter marine bird surveys documented western grebes in moderate to high densities (ranging from 25 to 1,954 animals per square kilometer) along the intertidal and nearshore area of central and southern Cherry Point, extending to approximately 5 kilometers offshore (Nysewander et al. 2005). Comparison of nearly identical transects surveyed during the MESA time period (1978 –79) and the PSAMP time period (1992 – 99) indicate this species could potentially be decreasing by as much as 95%, a conclusion further supported by the 2004 study funded through Washington Sea Grant study on marine bird population in western Washington (Donovan and Bower 2004). The WWU/MESA survey found that the percentage change for this species was a statistically significant decrease (81.3%) compared with the MESA data and also when compared with Christmas Bird Count data (85.9%).

10) *Osprey.* The osprey is a unique bird, the only species in its family, and it is found throughout western Washington around large rivers, lakes, and estuaries (WDFW 2005). Waterbodies (e.g., Nooksack River) in the Cherry Point vicinity support breeding habitat for the osprey. Osprey are seen regularly feeding on fish from the waters of the Cherry Point area.

11) *Cavity nesting ducks.* Habitats identified as important wintering areas for harlequin ducks are located in the CPAR area, and were identified during the PSAMP marine bird surveys. Local eelgrass and kelp beds combined with rocky and cobble substrates, support a diverse mix of benthic invertebrate species that make up a prey base for these birds. The PSAMP summer marine bird surveys also documented high numbers in the northern portion of the area – between 50 – 65 animals/km^2, and 0 – 5 in the central portion of the nearshore area (Nysewander et al. 2005). Overall, for the entire survey, comparison of nearly identical transects surveyed during the MESA time period (1978 – 79) and the PSAMP time period (1992 – 99) indicate fluctuating numbers in this species. The WWU/MESA survey found that the percentage change is not statistically significant for this bird (Bower 2009).

Marine Mammals

Several species of marine mammals use the southern Strait of Georgia including the open waters adjacent to the Cherry Point Aquatic Reserve. Based on observations in the reserve area or their presence in the southeast Strait of Georgia, species include the harbor seal (*Phoca vitulina*), Stellar sea lion (*Eumetopias jubatus*), California sea lion (*Zalophus californianus*), Pacific harbor porpoise (*Phocoena phocoena*), Dall's porpoise (*Phocoenoides dalli*), gray whale (*Eschrichtius robustus*), Pacific minke whale (*Balaenoptera acutorostrata*) and killer whales (*Orca orcinus*).

The harbor seal, Stellar sea lion and California sea lion are the most common species of pinnipeds found in the southern Salish Sea. They can be found in nearshore areas as well as a variety of "haulout locations" including intertidal sand bars, rocks, beaches and marina docks. The harbor seal is the most frequently sighted marine mammal in the reserve. Harbor seals use approximately 8,500 feet of the rocky intertidal beaches south of Point Whitehorn for "haulout" areas. Along this reach, sites are used year-round as resting and molting areas, and serve as pup rearing sites from mid-June through mid-August (Jefferies et al 2000). Harbor seals frequently forage in shallow waters on a variety of fish and cephalopods, and pups are seen in the bay during the summer months. Stellar sea lion was delisted from state threatened status in 2015 (Stocking and Wiles 2021). Both sexes of Stellar sea lion are found in the Southern Salish Sea, with most haulout sites along the Strait of Juan de Fuca on Vancouver Island and the outer Washington coast. Occasionally, Stellar sea lions are found foraging in the southern Strait of Georgia and on navigation buoys, docks, or log booms (Jeffries et al. 2000; Wiles 2015). California sea lions are the more commonly observed sea lion in the Southern Salish Sea. Haulout sites are located on jetties, offshore rocks and islands, logbooms, marina docks, and navigation buoys. This species may also be seen floating on the surface with their flippers in the air or (rafted) together in groups in open water. Only male California sea lions migrate into northwest waters. Both these sea lions species utilize the open waters offshore of the reserve, most probably as transients moving through the area.

Among other marine mammals, harbor porpoises were considered a common and frequently sighted cetacean in Washington inland waters in the 1940s, after which their numbers experienced serious decline through the 1970s. Since then, the harbor porpoise population has increased in the Southern Salish Sea. it is now considered common in Washington's inner marine waters and are often seen in the southern Strait of Georgia offshore from the aquatic reserve. This species is identified as a Priority Species under WDFW's Priority Habitat and Species Program (WDFW 2021). Priority species require protective measures for their survival due to their population status, sensitivity to habitat alteration, and/or recreational, commercial, or tribal importance. The Dall's porpoise remains year round in the Puget Sound. They are also identified as a Priority Species under WDFW's Priority Habitat and Species Program (WDFW 2021). These cetaceans most frequently feed on a variety of fish and cephalopods. Although gray whales have become regular summer residents in the enclosed marine waters of Washington since the species recovery, early records do not document historical numbers of gray whales for these inland and coastal waters. These "seasonal residents" in the Puget Sound are part of the Pacific Coast Feeding Aggregation (PCFA), and have been documented feeding in inland waters along Vancouver Island since the 1970's (Darling 1984). Sightings of gray whales in northern Puget Sound and the southern Strait of Georgia (i.e., Samish Bay) continued to reveal that this region is used as a springtime feeding area for a small, regularly occurring group of gray whales (Calambokidis et al. 2009). Minke whales have also been reported from the transboundary area in the southern Strait of Georgia and occasionally in the waters of the aquatic reserve.

Killer whale (Orcinus orca)

Two groups of killer whales (*Orcinus orca*) occupy the inland coastal waters of Washington State and southern British Columbia. These groups—northern and southern resident killer whales and transients—are distinguished by diet, behavior, morphology, and other characteristics (Dungan 2016). Among these, the southern resident (SRKW) and transient killer whales are commonly found in the southern Salish Sea. Three pods make up the SRKW stock – J, which is commonly found inshore during the winter months, and the K and L pods, often located farther offshore. The SRKW J Pod are more likely observed in the Cherry Point Aquatic Reserve vicinity. The frequent occurrence of SRKWs in the southern Salish Sea throughout the summer months has been well documented over the past 40 years. Between late spring to early fall, this population typically spends most of their time in Haro Strait and the southern Strait of Georgia. The SRKWs periodically transit to the outer coast through the Strait of Juan de Fuca. A significant difference between SRKWs and transient killer whales is their choice of food; the term "*Killer Whale*" was earned by the transients, who are well known for incorporating other marine mammals into their diet. More than 22 different species of marine mammals have been identified from the stomach of transients. Southern residents killer whales appear to prefer Chinook Salmon (*Oncorhynchus tshawytscha*), and follow the runs of these salmon in their area (NMFS 2008; Flaherty 1990).

Given the importance of the Fraser River as the region's largest source of salmon, all three pods concentrate around major salmon migration corridors, including Haro Strait, Boundary Passage, the southern Gulf Islands, the eastern end of the Strait of Juan de Fuca, and several localities in the Southern Strait of Georgia. Historically, the pods expand into Puget Sound in early fall, following chum and Chinook Salmon runs. Killer whales have been observed foraging within 50-100 m of shore and using steep nearshore topography to corral fish (Wiles 2004).

The SRKW stock were listed as endangered in 2005 by the NMFS. The southern residents face at least three major known threats to their survival: noise and disturbance by ships and boats, pollutants, and lack of food, especially chinook salmon, their preferred prey. As of December 31, 2020, the population count was only 74 wild members in all, counting the three relatively new babies born in 2020 (Center for Whale Research 2021). A siting occurred of a young male SRKW - J57. He was seen with Tahlequah, his mother, on the evening of Sept. 22, 2020 near Point Roberts, Whatcom County. Photos were taken from a whale watching boat and examined by local researchers documenting the young whale is male. Present day (fall 2020), there are 39 females and 34 males in the southern resident population, according to data provided by Ford. Additionally, there is one two-year old of unknown gender, L124 born early in 2019. Bringing the total SRKW number to 75, a new baby, L125 was born in early 2021 and first sighted on February 19, 2021- the sex of the baby is not yet known. There are 27 reproductive age females (age 10 to 42) and 17 potentially reproductive males. The rate the population can increase is limited by the number of females in the local population.

Other non-marine mammals are often seen along the shoreline, foraging on the beaches adjacent to the aquatic reserve. River otters, raccoons and black-tailed deer are regularly seen in the bay and along the CP reach shore. Mink and long-tailed weasel have been observed transitioning from the bay to the beach.

Part 2 – Current Environmental Conditions and Ecosystem Stressors

This section presents current physical, biological and environmental conditions contributing to the health of the aquatic reserve, with particular focus on the ecosystem stressors affecting organisms and ecosystems of the reserve. Ecological Stressors are physical, chemical, and biological stimuli that impact the condition and integrity of ecosystems and can change the trajectories of species and ecosystems. Stressors can be natural, such as, drought, storms, insect or disease outbreaks, or anthropogenic (human-caused), like climate change, pollution, shoreline alteration, or trampling Since the effects of climate change (sea level rise, warming, ocean acidification, and precipitation) act as an overlay on exiting local stressors, a summary of anticipated influences or changes of climate change is presented first. Where relevant, a discussion of restoration and mitigation actions conducted that may help reduce the effects of a stressor are presented along with any information on anticipated added stressors due to climate change.

Effects of Climate Change

Changing climate poses a myriad of potentially new, intensifying, or compounding stressors for the organisms and habitats of the reserve. Therefore, likely changes are described below, along with anticipated impacts and associated stressors.

Physical, biological and chemical changes to the marine environment associated with climate change will intensify naturally occurring events and conditions in the Cherry Point Aquatic Reserve area. Current trends in climate change may contribute to the following ongoing fluctuations in ocean conditions (Snover et al. 2013), all of which could have an impact on existing physical and biological resilience in the aquatic reserve:

- Sea level rise and storm surge will inundate low-lying areas adjacent to the reserve.
- Sea level rise will further submerge current subtidal and intertidal habitat areas, having the potential to adversely affect fish and wildlife resources and associated habitat.
- Rising water temperatures will create additional stressors on marine organisms. No significant warming has been detected for the general region of the Pacific Ocean offshore of North America, but warming has been detected for the Strait of Georgia and off the west coast of Vancouver Island. Average for the top 330 ft: +0.4°F/decade (1970- 2005) (Masson and Cummins 2007).
- Lower dissolved oxygen concentrations, related to increases in water temperature, will create additional stressors for fish and at extreme levels can be fatal.
- More frequent and heavy precipitation events can contribute more pollutants and alter water chemistry.
- Increased nutrient loading can cause eutrophication[1], which intensifies the effects of decreased pH and low dissolved oxygen.
- Ocean waters on the outer coast of Washington and the Puget Sound have become about +10 to +40% more acidic since 1800 (decline in pH of −0.05 to −0.15) (Feely et al. 2012). There is a demonstrated decrease in the upper-ocean pH by 0.1 units and this decline is expected to continue. The rate of ocean acidification is accelerating from anthropogenic carbon emissions and is currently ten times faster than anything the earth has experienced during the past 50 million years (IUCN web site: https://www.iucn.org/resources/issues-briefs/ocean-acidification 2021).

Ocean acidification can interfere with shell and skeleton building for calcifying organisms, such as oysters, clams and other shellfish. This could include key components of the marine food web, such as zooplankton. It can also affect biological processes such as bio-sensory functions in salmon and forage fish, inhibiting their ability to locate natal areas, food sources, and to detect predators.

Sea-level rise due to human-caused climate change is predicted to increase in the Puget Sound Region. Projections for the Cherry Point area range from a -0.5 to +9.4 foot rise in average sea level by 2050. Localized data on sea level projections for Cherry Point can be seen on the University of Washington Climate Impacts Group web site: http://wacoastalnetwork.com/chrn/research/sea-level-rise/.

Compounding the effects of sea-level rise, are increasing storm intensity and frequency that will also produce greater wave energy, more wave run-up, more extreme storm surges, and potential rises in groundwater levels (USGS Puget Sound Coastal Storm Modeling System). These combined effects will cause erosion and alterations to the shoreline and the physical structures adjacent to the aquatic reserve and throughout Birch Bay.

Since Birch Bay is a relatively shallow, “U-shaped” bay, it is more vulnerable to the impacts of increased storm intensity and frequency. The developed and armored bluffs adjacent to the reserve, as well as other areas of Birch Bay also intensify effects and limit opportunities to buffer these impacts. This could result in altered substrate composition, changes to nearshore bathymetry, increased scour, and undermining at the toe of bluffs and bulkheads. Other armored/developed areas adjacent to CPAR include a few limited residential bulkheads south of Point Whitehorn, the two refineries and the Petrogas facility south of Cherry Point. Additional repercussions could include damage or destruction to adjacent upland infrastructure and vegetation. These conditions may lead to a need for increased armoring to protect infrastructure. The shoreline armoring and physical location of adjacent infrastructure in Birch Bay already creates a classic “coastal squeeze” phenomenon, intensifying effects and limiting opportunities to buffer the impacts described above.

Increased coastal erosion will also dramatically affect changes to habitat types, species abundance and distribution. Submerged aquatic vegetation is especially vulnerable to burial or reduced light availability. A reduction in the availability of tidal flat habitat and tidal marshes, such as the large brackish marsh habitat complex found along Gulf Road south of Cherry Point are likely to occur. Intertidal biota, including shellfish species (e.g., oysters and clams), juvenile fishes and crabs, and migratory shorebird populations that utilize these flats for nursery and foraging habitat may also decline.

The Port of Bellingham is currently working with the U.S. Geological Survey to develop a more detailed sea level rise model, incorporating wave and storm surge data for the area to better inform the community about potential impacts. Research efforts to better prepare for and mitigate some of the adverse physical and biological effects of climate change are ongoing in the aquatic reserve. DNR’s Acidification Nearshore Monitoring Network (ANeMoNe) was established in 2015 to assess climate change and ocean acidification in nearshore environments and to test practical management options to reduce the negative impacts of changing ocean conditions on state-owned aquatic lands. Now spanning 10 sites, ANeMoNe supports research that aims to enhance the resilience of marine aquatic resources. ANeMoNe measurement instruments were deployed in 2018 at CPAR in Birch Bay. At each site, sensors take measurements inside and outside of eelgrass, to test the potential of these plants to counteract acidification at local scales. Analysis of eelgrass and shellfish data will explore the effects of warming and acidification on critical natural resources ANeMoNe overlaps with the WDNR Aquatic Reserves program at Cherry Point, Fidalgo Bay, Maury Island, and Nisqually Reach (Horwith, M. personal communication 2019).

ANeMoNe also serves as a foundation for a growing number of peer-reviewed publications on topics that range from investigations of practical management options to buffer against acidification to explorations of the causes of shellfish stress (Horwith, M. personal communication 2019).

The State legislature has acted to slow down climate change. In 2008, the Legislature adopted reduction targets for greenhouse gases (commonly known as GHG or carbon pollution). Washington's current targets are to:

- Reduce overall greenhouse gas emissions to 1990 levels by 2020.
- Reduce overall greenhouse gas emissions 25 percent below 1990 levels by 2035.
- Reduce overall greenhouse gas emissions 50 percent below 1990 levels by 2050.

Ecology publishes a greenhouse gas report that helps track progress toward meeting the state’s reduction limits, the Washington State Greenhouse Gas Emissions Inventory: 1990–2015: https://apps.ecology.wa.gov/publications/SummaryPages/1802043.html. In 2015, Washington’s largest contributors of greenhouse gases were:

- Transportation sector — 42.5 percent

- Residential, commercial, and industrial sector — 21.3 percent
- Electricity sector — 19.5 percent

Shoreline Modifications and Overwater Structures

Historic shoreline modifications including armoring, filling of intertidal and salt marsh areas, along with effects from overwater structures may continue to alter natural processes in the aquatic reserve, potentially contributing to environmental stressors. All the industrial facilities possess wharves and piers for commerce of their materials; in-water development directly adjacent to the reserve includes three large piers supporting the major industrial facilities (EVS 1999), a derelict conveyor structure at Gulf Road, a few boat ramps, and one municipal outfall. Location and orientation, design, as well as management, dictate the level of potential impact on ecosystems from these structures. The extent of the impacts from shading by piers depends on the height and orientation of the structure, the substrate below it, as well as the bathymetry of the site.

Shoreline Modifications

Despite the presence of three large industrial piers, the Cherry Point Aquatic Reserve has much less shoreline modification than many other comparable areas in the southern Salish Sea. Only 9% of the shoreline in the reserve area has been significantly modified (calculated using Puget Sound Nearshore & Restoration Project Change Analysis geographic information system data). This is far less than the southern Strait of Georgia region, where 32.6% of the shoreline has been modified (Berry et al. 2001). Shoreline modifications occur in several locations within the reserve, potentially influencing ecological characteristics of the shoreline at Cherry Point. The primary forms of armoring are bulkheads in the areas southeast of Point Whitehorn on Birch Bay. In addition there is a segment of armoring along Gulf Road. In areas adjacent to the reserve, there are two large rock revetments and fills at the Phillips 66 and Petrogas piers.

Physical and Biological Effects

Because armoring structures can bury, modify or cut off habitat or the natural sediment supply and water flow to the shore zone area, they eventually alter the habitat structure and the biological community at many levels. The culpable physical stressors include shifts to higher wave energy levels that erode the beach face, removing the finer sediments and therefore the base for many organisms to live in. In a few locations in Birch Bay, the surface sediment has been eroded enough to severely coarsen the substrate, which eliminates forage fish spawning substrate and habitat for infaunal organisms, such as clams. Studies have shown that clam populations may be negatively affected by bulkheading (Yoshinaka and Ellifrit 1974). Alteration in sediment supply and distribution has also been shown to affect the distribution of submerged aquatic vegetation, such as the removal of mixed fines and sands that provide eelgrass habitat. In addition to changing the configuration of the substrate, shoreline development and armoring often includes the removal of riparian vegetation and large woody debris. Riparian vegetation and large woody debris in backshore and upper intertidal areas provide a multitude of functions – structural and biological (Brennan 2007). The loss of available "terrestrially-derived" organic debris, nutrients and insects, as well as shade to upper intertidal areas distress the local ecosystem and species. Shade derived from shoreline vegetation maintains more stable upper intertidal substrate temperatures, protects against desiccation, and moderates conditions for infauna. Penttila (2001) found significantly higher surf smelt egg mortality on unshaded beaches than adjacent shaded beaches. Several dietary studies of marine fish show that salmon benefit the most from riparian vegetation. During out-migration, juvenile salmonids are known to be dependent upon shallow, nearshore waters where insects from the terrestrial environment are important prey species (Brennan 2007). The cascading effect of this type of habitat loss can have long-term consequences, since so many organisms, at several life stages, are dependent on vegetated marine habitat.

Overwater Structures

Overwater structures can include any object placed on or above aquatic lands such as jetties, groins, docks, piers, individual pilings, or concrete boat ramps. Although not in the aquatic reserve, the largest overwater structures in the area are the three industrial piers and the revetments that support them. The adverse effects from piers are complex, but include loss and reduction in marine habitat area, shading effects on intertidal vegetation and biota, disruption to sediment and water flow, and contamination from creosote pilings that support some of the structures. Design details, including height above the water, orientation, spacing and use of materials, level of use, and management, dictate the potential impacts on the ecosystem. There are indirect effects and potential impacts from vessel traffic, noise, prop wash, ballast water and waste discharges, fuel spills, hydraulic fluid spills, material spills, and other activities associated with these facilities that may directly and indirectly impact aquatic flora and fauna (Nightingale and Simenstad 2001).

At this time, little information is available regarding the environmental effects of the existing piers or their operations. Light shading, a potential impact from overwater structures, is the alteration of light in the surrounding area. During the day, light under the piers may be limited due to shading. This is a function of the width of the dock and its orientation. At night, security and operational lights on the dock or moored vessels may brighten the otherwise naturally dark waters. Alteration of light conditions in the nearshore has been shown to alter fish migratory behavior and distribution, and affect the ability of predatory fish to see their prey (Simenstad et. al 1999). Loss of submerged aquatic vegetation is a proven consequence from other piers and docks in the south Salish Sea, both from removal during construction or maintenance and potential shading from the structure. A study by Grette and Associates (2007) in Bellingham Bay discussed how shading is a primary concern because it reduces the amount of light available for photosynthesis by aquatic vegetation, which can have implications for habitat structure, complexity, and for the surrounding food web.

Studies in the Puget Sound region have suggested that under-pier light limitations could result in the following behavioral changes: 1) migration delays due to disorientation; 2) loss of schooling in refugia due to fish school dispersal under light-limited conditions, and 3) increased predation risk due to changes in migratory routes to deeper waters to avoid light changes (Nightengale and Simenstad 2001). This behavioral relationship makes sense since fish depend upon sight for feeding, prey capture, and schooling. The underwater light environment determines the ability of fishes to see and capture their prey. There are also species-specific differences to consider with respect to how fish react to light. Species that occupy and defend stream territories, such as coho, tend to be quiescent at night while species that disperse to estuaries, such as chinook, pink and chum typically school, show nocturnal activity, and demonstrate an aversion to light (Nightengale and Simenstad 2001).

Nighttime attraction to artificial lighting has been studied extensively at the Bangor Submarine Base Explosives Handling Wharf in Hood Canal (Prinslow et al. 1979). No significant difference in catch of chum was detected during periods of lights on or lights off. However, at high levels of lighting, chum appeared to congregate, delaying migration (Prinslow et al. 1979).

Nightengale and Simenstad concluded that during daylight hours, at very minimum, under-dock light levels must be maintained at levels above 0.5 PAR to avoid this behavioral interference. They point out that this lower threshold of light level only addresses migration delays and behavioral alterations associated with required visual adaptation to light intensity variations and transitions from cone to rod vision. Cone vision is often the only form of vision for larval marine fishes. Within juvenile cone vision development stages, there are also varying levels of sensitivity to the full spectrum of ultraviolet wavelengths. As visual development proceeds, juvenile marine fishes are known to behave and feed in response to specific ultraviolet wavelengths, as compared to forms of artificial light, such as fluorescent lights. Note that artificial lighting does not contain both UV-A and UV-B spectra. Evidence reveals that juvenile fish, such as salmonids, feeding in shallow nearshore waters utilize natural ultraviolet wavelengths for prey capture. Therefore, Nightengale and Simenstad (2001) conclude that by allowing the transmission of increasing levels of natural light, and thus ultraviolet light spectra, to the under-dock environment this will reduce structural interference with fish ability to capture under-dock prey.

Wave Shading

Wave shading, also known as the breakwater effect, may impact sediment transport, vegetation, local temperature, and water quality. Few site-specific studies have been conducted at any of the existing marine facilities along Cherry Point pertaining to the impact of wave structures on wave sheltering and their effects on sedimentation. In 1999, DNR commissioned a risk assessment to investigate the potential impacts of ARCO/bp's request to build an addition to its existing pier to increase the efficiency of loading and unloading activities on the Cherry Point herring stock. EVS performed a risk assessment based on a study provided in the Gateway Pacific Terminal Draft Environmental Impact Statement (EVS 1999). The study used a wave model that included various oceanographic processes, such as wave climate, currents, tides, sediment and beach characteristics, and wave breaking, to determine the sheltering effects of the piled structures on wave propagation.

The potential impacts of the existing marine facilities were generally assessed by considering the reduction of wave energy on the sheltered side of structures and docked vessels, and then considered how this change in wave energy might influence sediment transport behavior. Most winds (and therefore wave energy) come from the south, but there are major wind events occasionally from the west and west-northwest. The model indicated that waves would not be substantially attenuated by the piles for the proposed Gateway PacificTerminal. Waves from the west-northwest are estimated to undergo substantially more attenuation because they would need to propagate past many rows of piles, however, these waves are usually smaller. According to Whatcom County (1996), the estimated wave transmission coefficients for the Gateway Pacific Terminal were expected to underestimate the wave conditions on the sheltered side because some wave energy would also propagate into the sheltered area by diffraction around the ends of the wharf, and this was not taken into account in the estimates.

The ARCO/bp, Petrogas, and Phillips 66 piers are similar to the proposed Gateway Pacific Terminal pier in that they each have approach trestles extending to the wharfs used for berthing cargo vessels. The wharfs are generally substantially shorter than the approach trestles. All of the wharfs are roughly parallel to the shoreline while the approach trestles are perpendicular to the shoreline. EVS (1999) concluded that results would be similar to those for the Gateway Pacific Terminal pier, such that there is probably no significant reduction in wave height resulting from any of the existing facilities.

The Gateway Pacific Terminal draft EIS did not address potential effects of moored ships and barges on wave propagation and sedimentation. Ships and barges moored at existing piers along the Cherry Point reach can interfere with wave propagation, the extent of this influence depending on the number of ships and barges visiting a facility per year, their length, and the total time vessels are moored. As an example, from the years 1982 through 1998, an average of 229 vessels per year called at the ARCO/bp facility (EVS 1999). Assuming each vessel was moored for at least 24 hours, this represents, at a minimum, 229 days out of the year that vessels moored at the ARCO/bp facility would interfere with wave propagation. EVS examined the sheltering effects of vessels to be docked at the proposed facility and wind and wave data, conducted an analysis of wave sheltering from the vessels, and modeled wave refraction and diffraction. From this analysis, he concluded that the impacts on the shoreline from the numerous vessels to be docked at the proposed facility would be small and estimated that the impacts of docked vessels at the existing structures would be very small, as the number of vessels docked at the existing facilities is much smaller.

Reduction in wave energy could lead to the deposition of material in the "sheltered areas" (Whatcom County 1996). In assessing the impact of the proposed Gateway Pacific Terminal pier on sedimentation, Whatcom County (1996) reported that waves propagating from the south, southwest, and west would not be expected to result in significant sediment deposition at the beach. Waves from the west and northwest were expected to give rise to the greatest reduction in wave energy on the sheltered side of the pier, with the potential for some sediment accretion there. However, this was not expected to be significant (Whatcom County 1996).

The orientation of the existing piers and the proposed Gateway Pacific Terminal pier are generally north-south to northwest-southeast. Because of the proximity of the piers and their similar orientation, EVS concluded that sedimentation on the sheltered side of the piers would not be significant. However, there have been no studies done to verify this. The ARCO/bp, Petrogas and Phillips 66 piers are much shorter (20-25 percent) and much farther offshore (1.5-1.8 times as far) than the proposed Gateway Pacific Terminal pier. In addition, processes such as wave refraction and diffraction were not considered in the original wave sheltering study. These processes would tend to cause rebuilding of the waves behind the individual structures. EVS concluded the impacts on beach processes from these individual structures to be even less than projected for the Gateway Pacific Terminal pier.

EVS (1999) concluded that existing structures and docked vessels along the Cherry Point reach would not likely cause substantial wave sheltering or increases in sedimentation. Furthermore, when compared to the total shoreline available along the Cherry Point reach, approximately 14.5 km (9 mi), the combined influence of these three piers would represent only a fraction of the available habitat. Thus any potential effects due to wave sheltering and sedimentation would be expected to be minimal when compared to the available habitat.

Changes in Epibenthic Assembles

Haas et al. (2002) found a statistically significant difference in the epibenthic assemblages that exist around large overwater structures when examining ferry terminals in Puget Sound. These differences were demonstrated in both density and composition of the epibenthos at three ferry terminal structures, both over time (stratified-monthly sampling) and at several tidal elevations and habitat types (stratified-monthly sampling, eelgrass sampling, and cross-terminal sampling). While differences existed, the exact feature or features of the overwater structures which caused these differences was not determined in the study. Haas et al. concluded that decreases or changes in epibenthos density, diversity, and assemblage composition are probably caused by the following four interacting factors: (1) direct disturbance and/or removal by regular vessel disturbance; (2) reduced benthic vegetation or compromised benthic vegetation function due to shading and physical disturbance; (3) physical habitat alterations (e.g., altered grain-size distribution from propeller wash or piling effects), and (4) biological habitat alterations (e.g., increased shell hash from sea star foraging and reduced eelgrass density due to benthic macrofauna disturbance). However, while recognizing that nearshore vegetated habitats are highly productive and play an important role in ecosystem food chain support, the U.S. Army Corps of Engineers calls for further studies to gain a clear understanding of the overall importance of eelgrass and kelp habitats for food web productivity in the Pacific Northwest (Blackmon 2006). More information is needed regarding epibenthic conditions around the Cherry Point piers before conditions can be evaluated.

Restoration, Enhancement and Mitigation of Impacts (for shoreline armoring)

Restoration actions occurring in and adjacent to the reserve can drive observed ecological conditions and remediate for potential negative impacts. For example, many creosote pilings have been wrapped or removed from the existing industrial pier structures at Cherry Point. Removing creosote pilings, including the hundreds remaining that support both the Phillips 66 and the Intalco piers, eliminates a source of local contaminants and improves local long-term sediment and water quality. Planting trees and other native riparian vegetation in altered backshore areas can promote slope stability, increase shading and nutrient supply, as well as improve other habitat functions. In addition, design improvements to freshwater drainage can also contribute to sediment and slope stability while remediating point source water quality failures. Removing fill and old bulkheads and replacing them with “soft shore” protections which include well-designed placement of rocks or logs anchored to the beach in a more natural configuration could help reduce shoreline erosion while enhancing ecosystem function. Other complimentary actions, such as strategically renourishing beach habitat or restoring submerged aquatic vegetation, could provide greater spawning opportunity for forage fish and improve foraging activity for juvenile salmonids and other wildlife in the area.

More specifically, a few projects along the Birch Bay shoreline near Point Whitehorn and several projects in the southern portion of the CP reach are identified as top or high priority by the WRIA 1 Nearshore Assessment and Restoration Prioritization (2013). These projects propose removing or modifying armoring to restore the sediment supply for downdrift accretion, improving habitat areas in Birch Bay and along the CP reach. See the list below for projects included in the Birch Bay Water management Unit (WMU).

1. Restoring historic wetlands, particularly in Semiahmoo and Birch Bay, to provide areas for nutrient retention and removal.
2. Enhancing existing wetlands through planting to improve habitat conditions for wetland-associated wildlife.
3. Protect the off-channel habitat at the upper end Reach 1 of Terrell Creek from future encroachment and channelization.
4. Restoring and enhancing riparian wetlands within the Birch Bay and Fingalson Creek drainages.
5. Enhance the monotypic plant communities in the wetlands associated with Terrell Creek at Birch Bay State Park.
6. Removing bulkheads and other nearshore structures in the Birch Bay and Cherry Point reaches that are known to impede alongshore movement of sediment and negatively affect adjacent beaches.
7. Protect sediment sources that supply large accretionary beaches and marshes, such as Semiahmoo Spit, Birch Bay, and the Gulf Road pocket estuary.
8. Remove old and failing structures, possibly in conjunction with large-scale beach nourishment in the Birch Bay reach. This would include removing groins and bulkheads along Birch Bay Drive to restore upper beach and backshore habitats.

9. Restore historic marsh areas where possible and create a riparian buffer along the Birch Bay shore.
10. Remove bulkheads, including unauthorized bulkheads, between Birch Bay State Park and Point Whitehorn.
11. Restore littoral processes in the Cherry Point reach by re-introducing impounded sediment on the north side of the pier base fills, and excavating and bypassing the accreted sediment south of the two southern industrial piers at Cherry Point (which could also create coastal wetlands in the backshore). When and if the marina entrance channel at Sandy Point is dredged, sediment could be bypassed to the south.

Potential larger scale projects in CPAR area, could include partnering with NGO's, Tribes, or local government to acquire adjacent lands for conservation or restoration. An example of this type of project would be securing the properties (upland and/or aquatic lands) around the Gulf Rd beach access area. In addition to providing more formal protection of the backshore marsh complex, this could potentially create a permissible public access area for the reserve. Integrating other local organizations also promotes opportunities for smaller restoration projects to further enhance the area (i.e., removal of non-native species from the marsh and berm areas and planting native vegetation). Other more extensive associated projects, could include relocating the failing Gulf Road bed landward and restoring a more natural, sustainable backshore and beachface area. The removal of the derelict conveyor structure would also contribute to recovering a more natural shoreline in the area. Upland of the present road and derelict conveyor, in the leveled, cleared area, a larger, more comprehensive restoration project could involve removing fill, restoring hydrology, planting riparian vegetation and recreating native marsh habitat. Although many of the projects listed or proposed above are outside the boundary of the aquatic reserve, the actions would continue to improve and restore ecological processes, functions and habitat areas along the Cherry Point reach and northern Whatcom County marine shorelines.

A multitude of benefits result from restoration projects. Biological and physical resilience within the area is enhanced; and processes and ecological functions all improve by cleaning up and restoring habitat. This is especially true for forage fish spawning habitat and eelgrass beds. These actions increase primary productivity, enrich species diversity, help rebuild organism populations, and provide a sediment supply to replenish depleted down-drift-cell locations. Cultural benefits include improving the overall aesthetic value of the area, providing better public access, renewing community involvement and pride, and providing educational venues for learning about CPAR and the value of maintaining healthy ecological systems.

Effects of Climate Change on Shorelines and Structures

Shoreline modifications and overwater structures will be physically affected by future climate change due to increased intensity and frequency of storm events, particularly increased sea level elevation in the bay (see 'Climate change' section above). This will demand more regular maintenance of structures, and possibly re-designing and rebuilding structures. Anticipating these changes creates opportunities for potentially reducing stressors by planning for and accommodating these impacts.

Water and Sediment Quality

Ecological stressors from impaired water quality can affect many organisms in close proximity to pollutant sources. Water quality impairments or contaminants eventually may settle out into sediments, affecting sediment quality and benthic organisms regularly in contact with, or making their home in sediments. Contaminants such as heavy metals from past industrial activity and organic compounds from creosote pilings can also directly impair sediment quality.

Sediment Quality

A handful of sediment sampling efforts have been conducted in or near the reserve over the years. In general, chemical concentrations in sediments at Cherry Point are relatively low.

In 2011, Amec Environment & Infrastructure, Inc. conducted a baseline sediment report for the proposed Gateway Pacific Terminal. The survey consisted of 45 marine sediment samples collected from stations near the proposed terminal. All results were compliant with the Washington State Sediment Management Standards Marine Sediment Quality Standards and screening levels of the Dredged Material Management Program for metals and organic chemicals (AMEC 2012).

Ecology's marine sediment program conducts long-term monitoring of Puget Sound benthos. Between 1997 and 2019, there have been six sampling events at locations within or near to the reserve (Appendix C, Map C-14). Results from these events have found no impairments to the benthic communities and overall good sediment chemistry (Weakland, S. personal communication 2020). One of their core stations is located west of Cherry Point, in the middle of the Strait of Georgia and has been sampled almost every year since 1989. Trends at this site have shown a general increase over time with species abundance, compliance with sediment management standards, a decrease in high molecular weight PAHs, and an increasing trend in total organic carbon, chromium, copper, and zinc. Interestingly, the long term results have shown that the benthic invertebrate communities at the Strait of Georgia station are most strongly correlated with temperature and the percentage of fine sediment (Patridge et al. 2018).

Since 2014, DNR has conducted sediment sampling at three intertidal locations within the reserve approximately every other year (Appendix C, Map C-14). The sampling effort was designed to determine ambient sediment quality conditions and to collect pre-oil spill sediment that could be used as a baseline in the event of an oil spill.

Threats to Sediment Quality

Legacy sources of sediment contamination from historic, unregulated waste disposal exist on upland areas adjacent to the reserve. One site of concern is the TreOil Industries Limited located at 4242 Aldergrove Rd, approximately 1.8 miles from the shoreline. The site is currently inactive, however was previously used for tall oil processing, as a biodiesel refinery, and other miscellaneous industrial operations. Several inspections from Ecology between 1991 and 2017 found deteriorating safety and environmental conditions on the property. This led to the U.S. EPA's removal of thousands of gallons of hazardous waste in 2017. However, the threat of current groundwater and surface water contamination remains as oil pockets were found within excavated sediment below the storage tanks. The EPA final report concluded that the depth of potential contamination within the soil was unknown and required an archeological assessment prior to further excavation (WA Ecology and Environment Inc. 2017). The report also documented the pathways of potential overland flow, with surface water from the TreOil site ultimately entering the Strait of Georgia through an unnamed stream located at the west end of the Gulf Rd marsh. The TreOil site is currently ranked 2 (moderate-high risk) on Ecology's Hazardous Sites List and is awaiting further clean-up (Donaldson 2021). Ecology continues to monitor the site for progress and compliance.

Ecology's Toxic Cleanup Program lists two additional sites that are upland of the reserve and are either awaiting cleanup or have started cleanup for contaminated sediment. PSE Whitehorn Generating Station is documented as having two previous oil leaks: a petroleum leak in 2008 and a diesel fuel leak in 2018. This site is listed by Ecology as awaiting cleanup. Tenaska Cogeneration Plant had an oil leak in 2014 and is listed as cleanup started. The threat of contaminated sediments from either of these sites reaching the aquatic reserve is unknown but likely limited as initial cleanup efforts minimized environmental exposure.

Another threat to sediment quality in the reserve is the existence of creosote pilings. Creosote-related contaminants have been documented to be toxic to some marine biota including Pacific herring embryos and can readily leach into the aquatic environment (Duncan et al. 2017; Vines et al. 2000; Xiao et al. 2002). Once released, heavy PAHs sink and can accumulate in marine sediments which poses a threat to some bottom dwelling organisms (Malins et al. 1985). Within the last decade 1,497 creosote pilings existed within close proximity to the Cherry Point Aquatic Reserve. Of the 1,497 pilings, 709 have either been removed/treated or plan to be within the next 5 years. Although there have been significant efforts by the industries to remove and/or wrap creosote pilings within their leaseholds, the remaining pilings will continue to cause ecological exposure and potential impacts from creosote-impaired water quality, and contaminated sediments adjacent to the pilings.

Water Quality

Water quality concerns include contaminant sources from stormwater runoff, oil spills, and direct discharges. These sources may affect water quality parameters such as temperature, turbidity, dissolved oxygen, fecal coliform bacteria, as well as heavy metals and organic contaminants, among others.

Stormwater

Stormwater is considered one of the biggest contributors to water pollution in urban areas of Washington State because it is ongoing and damages habitat, degrades aquatic environments, and can have serious impacts on the long-term health of Puget Sound (Lanksbury et al. 2017). Laboratory tests of stormwater on Pacific herring embryos have shown effects that are similar to oil-exposed herring, including developmental and heart problems (Harding et al. 2018).

Residential development adjacent to the reserve is concentrated around Point Whitehorn and within the Birch Bay urban growth area. In 2007, Whatcom County Council established the Birch Bay Watershed and Aquatic Resources Management (BBWARM) District to address concerns about flooding and erosion, declining water quality, and loss of aquatic habitat around Birch Bay. The BBWARM stormwater program along with Whatcom County Public Works Department Stormwater Division, created the Birch Point, Terrell Creek Urban Area, and Point Whitehorn Subwatershed Master Plan to identify and improve stormwater issues in the subwatershed (Tetra Tech 2016). The plan identified 20 drainage related problems in the Point Whitehorn sub basin that were related to inadequate conveyance, failing infrastructure, maintenance, and water quality. The plan also inventoried three ocean outfalls that discharge stormwater into waters of the reserve: one outfall off Holeman Ave, one off Birch Bay Dr, and one south of the Maple Way and Koehn Rd intersection. In 2013, the Birch Bay urban growth area was added to Whatcom County's National Pollutant Discharge Elimination System (NPDES) Phase II Municipal Stormwater Permit coverage area and requires standards of system maintenance and compliance with state water quality standards.

Water Quality Monitoring Efforts

Water quality monitoring programs are established to the north and south of the reserve, but most sample locations do not fall within the reserve boundaries. BBWARM conducts routine water quality monitoring in Birch Bay and Terrell Creek as part of a comprehensive water quality monitoring program led by Whatcom County Public Works Natural Resources. This effort is done monthly and bimonthly and fecal coliform results are posted on Whatcom County's website: http://www.whatcomcounty.us/2608/Routine-Monitoring-Results. The August 2020 report shows 6 out of the 29 freshwater sites exceeded the geometric mean water quality standard for fecal coliform bacteria in waters entering Birch Bay for the last 3 year period. These results are used to determine long term trends as well as identify priority areas that require further water quality improvement efforts. The Washington State Department of Health (DOH) routinely samples nine marine sites within the Birch Bay Shellfish Growing Area, with 1-2 sites falling within reserve boundaries. All sites passed the National Shellfish Sanitation Program water quality standards for fecal coliform bacteria in 2019 (Jahraus 2019). South of the reserve, the Lummi Nation conducts a comprehensive water quality program throughout the reservation with focus on surface and groundwater. Results from the 2014 to 2017 monitoring period concluded a 47% compliance with fecal coliform criteria at marine sites (Lummi Water Resources Division 2019). Within Lummi Bay, most sites had low fecal coliform densities despite many freshwater inputs with elevated bacteria levels. Lummi Bay was also found to have high temperatures and low dissolved oxygen, however the natural environment and circulation within Lummi Bay is very different than that of the reserve.

Several short-term water quality studies have been conducted within the reserve boundaries and have found minimal to no contamination. Amec Environment & Infrastructure, Inc. conducted a baseline water quality characterization study in 2013 for the proposed Gateway Pacific Terminal (AMEC 2014). The study consisted of five offshore sites along the 60ft MLLW depth contour within the proposed terminal area and water samples were collected over two days in March of 2013. Composite samples were collected from multiple depths at each site as well as depth profiles for conventional parameters. All results for dissolved metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and in-situ parameters fell within Washington's marine water quality standards (WAC 173-201A). Three sites exceeded the total residual chlorine chronic water quality standard criterion. Bioassays on Pacific herring embryos were also run and concluded that water sampled from the project area had no significant impact on percent hatch or percent normal development.

In 2014, the Aquatic Reserves Program led a comprehensive survey of existing stormwater outfalls and tightlines to develop a better understanding of possible stormwater impacts to the reserve. Of the six outfalls that were sampled (Appendix C, Map C-21), all results for heavy metals and hydrocarbons were either below detection limits or at very low concentrations far below state water quality standards. Results for fecal coliform bacteria were more variable, however the number of samples collected did not meet the minimum criteria for calculating a geometric mean which is necessary to compare to state water quality standards. The maximum concentration (300 cfu/100mL) was from an outfall off Unick Rd which was sampled March 28, 2014. When sampled again the following December, the Unick Road outfall had a concentration of 14 cfu/100mL. Fecal coliform bacteria is highly variable and requires a long-term monitoring approach to identify potential sources of contamination. The samples collected from tightlines were only analyzed for fecal coliform bacteria. Of the 23 samples collected from tightlines during March and December of 2014, only three samples were elevated (> 100 cfu/100mL) and nearly half of all samples were below the method detection limit. The higher concentrations came from samples collected at two locations: Birch Bay Dr near Jill St (420 cfu/100mL in March), and southwest of the Maple Way and Koehn Rd intersection (673 cfu/100mL in March and 114 cfu/100mL in December). Overall, the survey was successful in providing an initial characterization of stormwater entering the nearshore habitat within the reserve and concluded that the Cherry Point area has natural wetlands that provide extra storage and treatment of stormwater in many areas prior to discharge.

The Puget Sound-wide Mussel Watch Program conducted by WDFW includes several locations within reserve boundaries. In 2012, WDFW promoted a pilot expansion to the NOAA National Mussel Watch program to use transplanted mussels as indicators of contamination in nearshore habitats. During the winters of 2013, 2016, and 2018, mussels were transplanted and then analyzed for a suite of persistent organic pollutants (PAHs, PCBs, PBDEs, organochlorine pesticides) and metals (arsenic, cadmium, copper, lead, mercury, and zinc) at three or four sites along the western beaches within the reserve (Appendix C, Map C-14). In 2016 and 2018, only three sites were used within the reserve; one at the south end of Birch Bay, one just south of the bp terminal, and one at the southernmost end of the reserve. Data on mussel ingestion of waterborne contaminants in the reserve has shown generally low concentrations of organic contaminants (DDTs, PAHs, PBDEs, PCBs), especially in comparison to more urban areas such as Elliott Bay and Commencement Bay (Figure A-9A). Results for heavy metals were also generally low except for aluminum at the Cherry Point North site in 2018, located northwest of Gulf Rd, which fell into the "high" category meaning it was in the top 25 percent of all Puget Sound results (Figure A-9B). The concentration of aluminum in the northern Birch Bay mussels fell into the "low" category, or bottom 25 percent. Recently, WDFW established "baseline" condition categories based on the quartile ranges from the 2013-2016 Puget Sound data for organic contaminants and from the 2018 data for metals as the 2013-2016 laboratory method for metals differed (Langness and West 2020). All results for organic contaminants fell within the low or intermediate range (Figure A-10), meaning that contamination was low to

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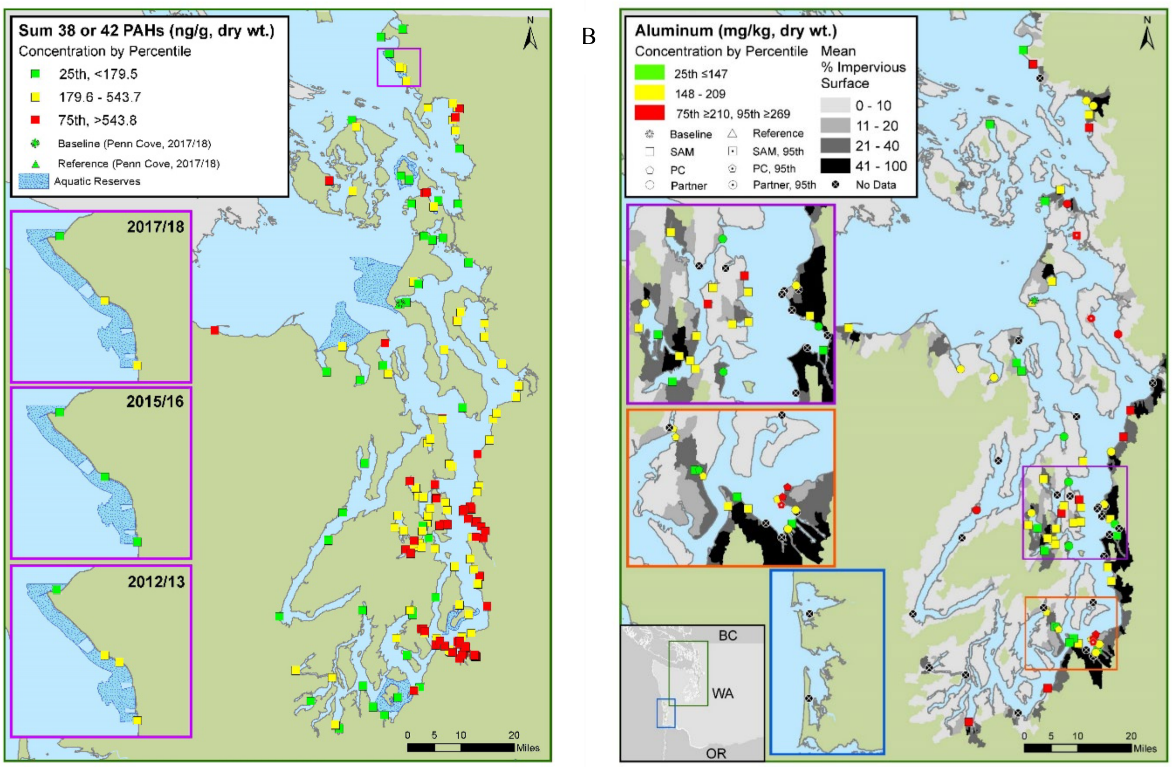

Figure A-9. Results of PAHs (A) and aluminum (B) concentrations from transplanted mussels throughout Puget Sound as part of WDFW's 2018 Mussel Watch program. The insets on map A show specific results for sites within the Cherry Point Aquatic Reserve for all three years of data collection and percentile categories were calculated from the 2012-2013 and 2015-2016 Puget Sound-wide data pool. Map B presents 2018 data results and percentile categories were calculated using 2018 data only. Maps and analyses were done by (A) Mariko Langness, WDFW and (B) published in the 2018 Final Report (Langness and West 2020).

intermediate compared to other sites in Puget Sound. Despite low concentrations, all 2018 results for heavy metals and organic contaminants in the reserve exceeded baseline concentrations (Figure A-10), indicating that the transplanted mussels accumulated additional contaminant loads from within the reserve. Metals were not analyzed at the southernmost site in 2018 due to limited funding and aluminum was only added as an analyte in 2018. It is important to note that the range categories were intended for site comparisons and do not reflect thresholds for human or shellfish health (Langness, M. personal communication 2020).

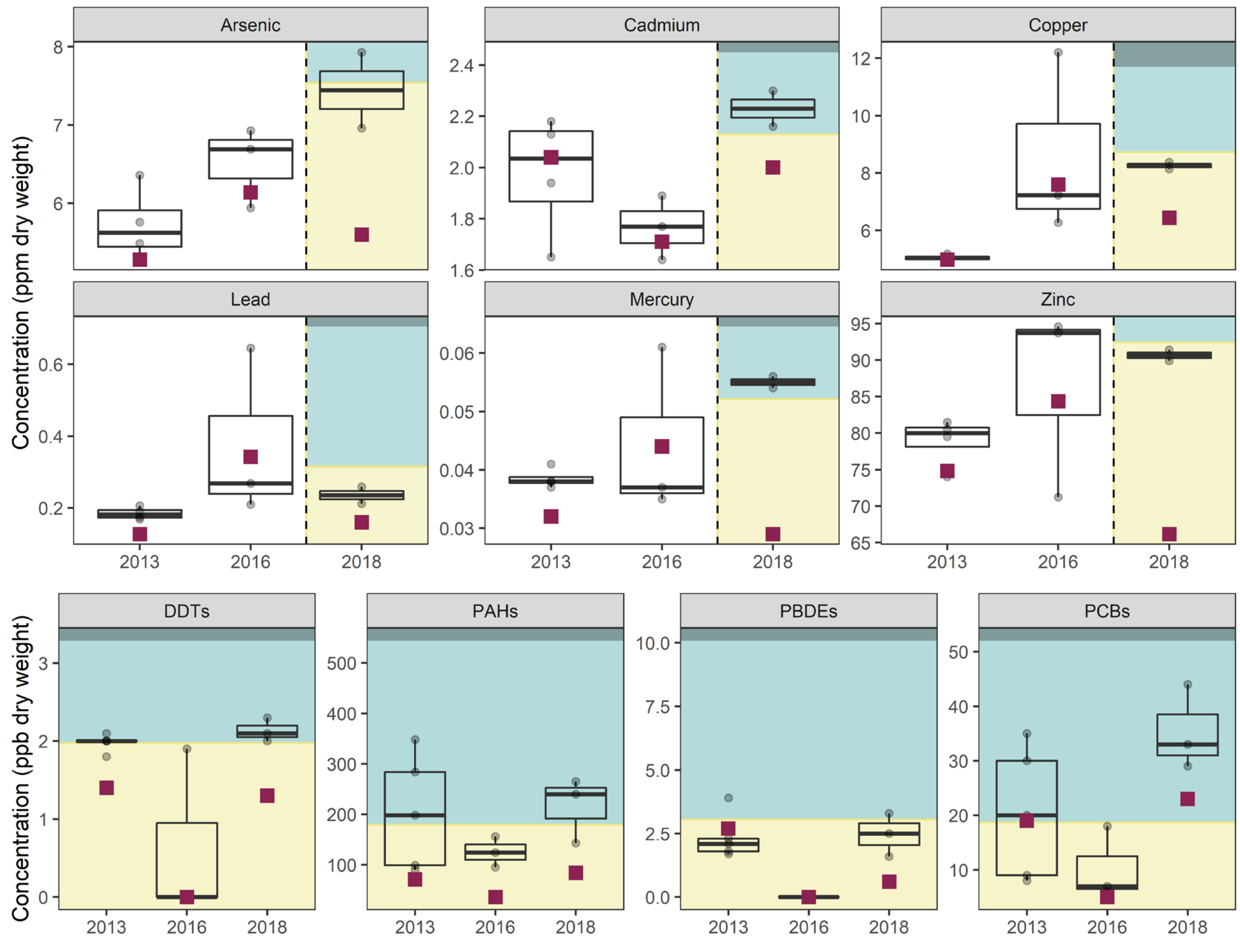

Figure A-10. WDFW Mussel Watch results for heavy metals and organic contaminants from transplanted mussels at sites within the Cherry Point Aquatic Reserve. Boxplots depict the interquartile range (IQR, 25th to 75th percentile), whiskers extending to 1.5*IQR, outliers in grey circles, and the median as the black line. Baseline concentrations (at time of transplantation) are shown as purple squares. The background colors represent the concentration categories that were established by Mussel Watch for comparison to Puget Sound-wide results; yellow represents the low category (<25th percentile), light teal the intermediate category (25th-75th percentile), and dark teal the high category (>75th percentile). Due to a laboratory method change for metals in 2018, the categories can only be applied to 2018 data and temporal comparisons were cautioned (Langness and West 2020). Raw data were received from WDFW.

NPDES Permits

Through the National Pollutant Discharge Elimination System (NPDES) Program, Ecology issues permits for water pollution from point sources that enter surface waters of Washington State. Table A-2 lists the current NPDES permits for outfalls immediately within, adjacent to or near the aquatic reserve (i.e. within 200m of shoreline).

Table A-2. NPDES permits issued* as of February 2023 for discharges within 200m of the Cherry Point Aquatic Reserve.

NPDES Permittee	Permit Number	Permit Status	Permit Type	Address	Effective Date	Expiration Date
bp Cherry Point Refinery	WA0022900	Active	Industrial IP	4519 Grandview Rd	7/1/2022	6/30/2027
Intalco Aluminum Corp Ferndale	WA0002950	Active	Industrial IP	4050 Mountain View Rd	2/1/2015	1/31/2020
Phillips 66 Ferndale Refinery	WA0002984	Active	Industrial IP	3901 Unick Rd	4/1/2014	3/31/2019
PraxAir Inc. Ferndale CO2 plant	ST0501315	Active	Industrial (IU) to POTW/PRIVATE SWDP IP	4466 Alder Grove Rd	11/1/2018	10/31/2023
PraxAir Inc. Ferndale CO2 plant	WAR000558	Active	Industrial SW GP	4466 Alder Grove Rd	1/1/2020	12/31/2024
Chevron Ferndale Storage Terminal	WAR301376	Active	Industrial SW GP	4100 Unick Rd	1/1/2020	12/31/2024
Birch Bay Water and Sewer District	WA0029556	Active	Municipal IP	7096 Point Whitehorn Rd	3/1/2021	2/28/2026
Puget Sound Energy Whitehorn Generating Station	WA0030601	Active	Industrial IP	4930 Brown Rd	1/1/2017	12/31/2021
Puget Sound Energy Ferndale Generating Station	WA0031291	Active	Industrial IP	5105 Lake Terrell Rd	7/1/2020	6/30/2025

GP: General permit
IP: Individual Permit
IU: Industrial user
POTW: Publicly owned treatment works
SW: Stormwater
SWDP: State water discharge permit

*List based on a query of Ecology's Water Quality Permitting and Reporting Information System (PARIS). Website accessed October 2020 and updated February 7, 2023. https://apps.ecology.wa.gov/paris/MapSearch.aspx

Effects of Water and Sediment Quality Stressors on Species and Habitats

Water and sediment quality can leave both short and long-term impacts on organisms and habitats within the reserve. Contaminants can not only accumulate and persist in the benthic sediments, but can also bioaccumulate in organisms and be transported up through the food web. Nutrient and sediment loading from anthropogenic (human-caused) inputs can also lead to seagrass decline which has many implications including impacts to Cherry Point herring and countless other species.

There have been several successes in and around the reserve resulting from water quality clean-up and impact minimization efforts. Local entities, industries, and the public are encouraged to continue keeping water and sediment quality as top priorities so stressors to ecosystem health remain minimal.

A major oil spill, while unlikely due to many safeguards now in place, could affect the habitats and organisms of the reserve in many ways, with recovery varying from days to years. If a spill were to occur, the potential impact on the remaining Cherry Point herring stock could be devastating. The declining marine bird population, which relies on Pacific herring and Pacific herring spawn, would also be heavily impacted. A major oil spill could also be detrimental to the endangered southern resident killer whale population, whose listing under the Endangered Species Act of 1973 was in part due to the risk of oil spills (Federal Register 2006).

The toxic effect of creosote on organisms has been well documented. Researchers from the Bodega Marine Lab at the University of California found that nearly all herring eggs collected from creosote pilings at their study site failed to develop properly and died (Vines et al. 2000). Furthermore, there was an effect observed on spawn deposited near the pilings as well. The continuation of creosote piling removal and treatment efforts by the industries is of high importance. Creosote pilings can be toxic to some life stages of marine organisms.

Vessel Traffic and Oil Spills

A common concern for ecosystem protection in the Salish Sea is the threat of increased vessel traffic and the inherent risk of an oil spill. The Cherry Point Aquatic Reserve envelops three industrial terminals which are frequented by tank ships, tank barge/ATBs, and tug vessels. According to Ecology's Vessel Entries and Transits (VEAT) data, the number of tank ships bound for Puget Sound via the Strait of Juan de Fuca, Strait of Georgia, and Haro Strait have fluctuated between 2011 and 2019, with all annual transits lower than the 2003 through 2008 values listed in the previous management plan. In contrast, the number of tank barges/ATBs transiting Puget Sound has gradually increased over the years (Figure A-11).

In 2015, Ecology sponsored an updated Vessel Traffic Risk Assessment (VTRA) to model current commercial vessel traffic in the Salish Sea and provide estimates for the likelihood of potential oil spills. The assessment concluded that large oil spills from commercial vessels are less likely to occur in the Salish Sea than smaller spills (Van Dorp and Merrick 2017). The VTRA model predicted that the likelihood of a catastrophic spill (~1.8 million gallons) occurring within the next 10 years was 0.5%. Smaller spills with an average size of ~12,000 gallons have a much higher likelihood with a 54% chance of occurring in the next 10 years (Table A-3). These probabilities were centered on the base case of 2015 commercial vessel traffic patterns, without the what-if case scenarios of added marine vessel traffic. Despite the low likelihood

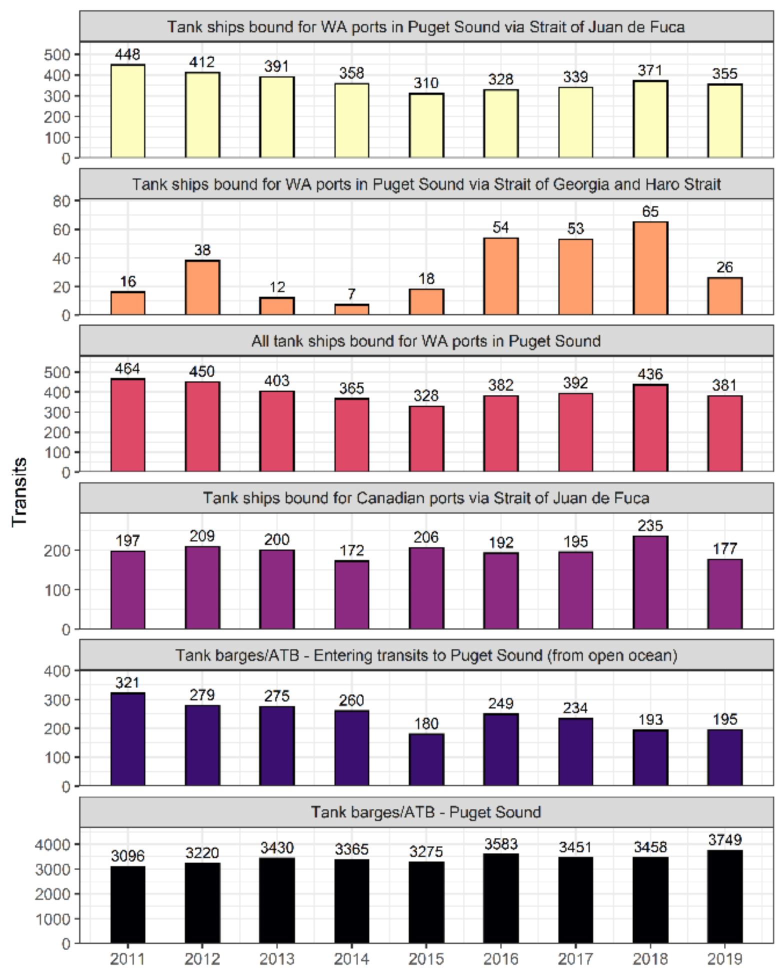

Figure A-11. Salish Sea vessel call data from Ecology's Vessel Entries and Transits system. Data were pulled from individual annual reports 2011 – 2019 on Ecology's publication page.

of large spills, oil spills from commercial vessels were deemed “low probability/high consequence events”. In the what-if case scenario of 1,600 additional cargo and tank vessels, the largest increase in potential oil loss by volume for the Salish Sea occurred in the Haro Strait/Boundary Pass waterway zone - southwest of the aquatic reserve. The addition of the 1,600 commercial vessels to the base case model increased potential accident frequency by 11% and potential oil loss by 85%. The results from the 2015 VTRA scenarios led to defined oil spill risk mitigation measures which included improvements to federal and international standards, the placement and utilization of tug escorts and rescue tugs and the effectiveness of oil tanker size restrictions.

Table A-3. Likelihood of future spill events based on historical spill data from 1990-2015. Results are from the “base case” scenario where no potential future vessel traffic were added to the model. Probabilities are rounded to the nearest percent. Data are from the 2015 Vessel Traffic Risk Assessment (Van Dorp and Merrick 2017).

Spill Volume (m^3)	Average Spill Size in Category (m^3)	Likelihood of at Least One Spill		
		In 1 year	In 10 years	In 25 years
> 2500	6798 (1,795,842 gal)	< 1 %	< 1 %	1 %
1000 - 2500	1619 (427,695 gal)	< 1 %	< 1 %	2 %
1 - 1000	46.9 (12,390 gal)	8 %	54 %	86 %
0 - 1	0.008 (2.3 gal)	99 %	100 %	100 %

Within the Cherry Point Aquatic Reserve boundaries, two oil spills have occurred since 2010 (for previous spills, see 2010 management plan). From these spills, 56 gallons of oil were released into the marine environment with only 0.5 gallons recovered (Table A-4). An additional two oil spills occurred just outside reserve boundaries: one west of the reserve and just south of Point Whitehorn from a recreational vessel, and one south of the reserve from a tug boat. These two events resulted in 30 gallons of gasoline and oil spilled into marine waters with only 4.5 gallons of known volume recovered.

Table A-4. Oil spills that have occurred in or very near to the Cherry Point Aquatic Reserve 2010-2020. Data was sourced from Ecology’s Spills Map and NOAA's Environmental Response Management Application (ERMA) Pacific Northwest which displays data from The Pacific States – British Columbia Oil Spill Task Force.

Date	Location	Amount Released (gallons)	Amount Recovered (gallons)	Description
February 11, 2014	Intalco	55	0	A cargo ship released lube oil/ motor oil due to an equipment failure.
August 18, 2016	West of CPAR	15	NA	A recreational vessel spilled gasoline due to external conditions.
October 22, 2016	South of CPAR	5	4.5	A tug boat spilled an oily water mixture while underway due to human error.
March 9, 2019	bp Cherry Point	1	0.5	A work boat was not operating or performing designed function and spilled diesel/ marine gas oil.

Vessel traffic from non-commercial vessels within the reserve is largely unknown. The number of recreational boat owners is increasing in Washington with 6,383 new vessels added to the recreational boating fleet in 2018 (Washington Sea Grant n.d.). According to Washington Sea Grant’s 2018 boat fleet characteristics dataset, recreational boat ownership in Whatcom County makes up 5.3 percent (6,568 vessels) of all registered recreational boats in Puget Sound. As of 2018, the most common registered vessel type in Whatcom County was the open motorboat with 52 percent of all vessels ranging from 15 to 22 feet in length. Increasing levels of recreational vessel use in the reserve has the potential to cause stress to the marine environment through the introduction of pollution and waste, increases in turbidity, and physical damage by anchoring.

Vessel Noise Impacts

One effect that vessel traffic has on marine organisms is that of increased anthropogenic (human caused) noise. Underwater noise has been shown to cause behavioral stress to marine mammals, resulting in reduced foraging efficiency, displacement, masked communication, increased production of sound, and increased stress (Tollit et al. 2017; Erbe 2012; Holt et al. 2008). Vessel traffic and noise has been identified as one of the three main threats to the endangered southern resident killer whale, in addition to toxic contaminants and availability of Chinook salmon. Vessel noise may also be a stressor to marine invertebrates, causing elevated rates of oxygen consumption (Wale et al. 2013), as well as to fish, increasing the mortality of some prey species (Simpson et al. 2016).

Vessel noise impacts to Pacific herring populations remain inconclusive (The Salish Sea Pacific Herring Assessment and Management Strategy Team 2018), however behavioral changes such as vessel avoidance including diving and lateral movements are well documented (De Robertis and Handegard 2013). Behavioral changes in schools of herring have been observed up to 1000 meters in front of the disturbance causing vessel (Misund et al. 1995).

Vessel traffic noise effects to marine life are dependent on vessel type, speed, and proximity. Commercial vessels transit the aquatic reserve frequently en route to and from the three industrial terminals, having close proximity to local aquatic life, however vessel speed is greatly reduced. A study which modelled 2015 AIS vessel traffic in the northern Salish Sea found that higher levels of vessel sound pressure were more concentrated to the main shipping lanes in July when the upper water column was less favorable for sound propagation, in comparison to opposite conditions in January (Matthews et al. 2017, see Figure A-12). These results suggest that noise levels within the reserve may have a greater impact from main passage vessel traffic during the winter months, in addition to the year-round local industrial vessel traffic.

A study conducted in Admiralty Inlet found that ship traffic increased ambient noise levels by 25 dB at low frequencies (<1 kHz) and broadband sound pressure levels regularly exceeded marine mammal harassment levels throughout the year-long study (Bassett et al. 2012). Another study on AIS-tracked vessels in the Strait of Georgia estimated that vessel passages increased the median noise level by 10-15 dB (Williams et al. 2015). The National Marine Fisheries Service (2018) has published thresholds of received sound levels at which marine mammal hearing sensitivity was predicted to change. For cetacean hearing ranges (7 Hz to 160 kHz), temporary threshold shifts for non-impulsive sounds ranged from 153-179 dB. Source noise levels for vessel types that frequent the reserve such as oil/chemical tankers and tug vessels have been estimated at 181 dB and 172 dB, respectively (Bassett et al. 2012).

The level of increase in anthropogenic noise from vessels entering and exiting the reserve remains unknown and is likely much different than reported in main shipping channel studies due to variations in bathymetry, substrate type, vessel speed, and duration of vessel presence. The regular and year-round transits of commercial vessels within the reserve suggest that vessel noise is a common stressor to the aquatic inhabitants of the reserve, and direct effects merit further study.

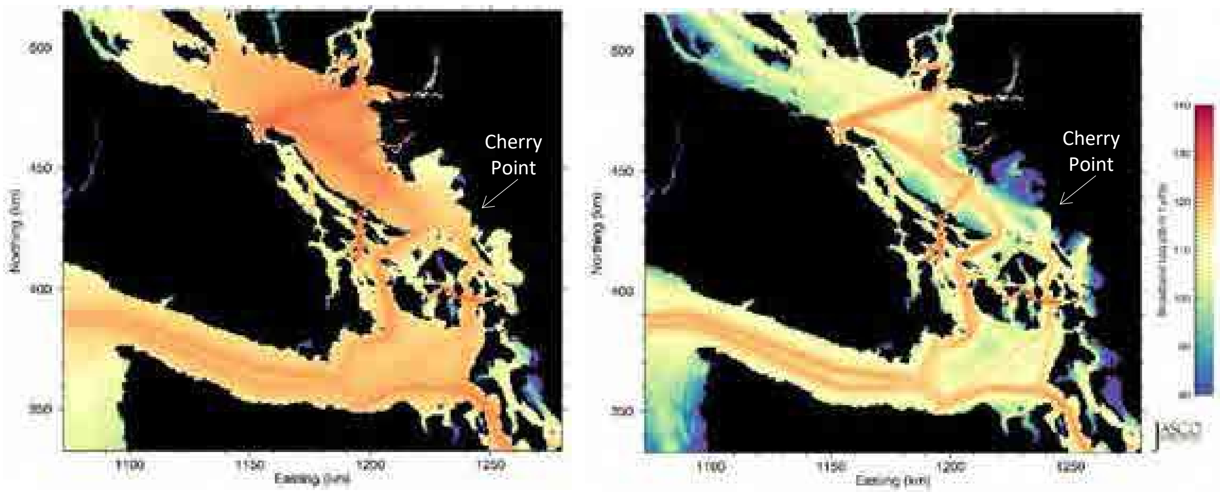

Figure A-12. Modelled vessel sound pressure levels (Leq) for January (left) and July (right) using AIS vessel traffic conditions in 2015 (Matthews et al. 2017). The location of Cherry Point has been added to these graphics.

Air Quality

Air pollution can have a negative impact on both ecosystem function as well as public enjoyment of using the reserve. Research has shown that air pollution may be harmful to aquatic life through surface deposition, can lead increases in stream acidification, and can accumulate in plants and animals (US Environmental Protection Agency n.d.). Under the federal Clean Air Act, the U.S. EPA has standards for six pollutants that are harmful to both the environment and to public health: carbon monoxide (CO), lead, nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM), and sulfur dioxide (SO_2). The Washington Department of Ecology has adopted more restrictive standards for these pollutants and other air toxics set forth in the Washington Ambient Air Quality Standards (WAAQS). According to Ecology, current levels of CO, lead, NO_2, O_3, and PM meet air quality standards across the state. In 2017, nearly all of Washington counties were designated as in attainment with the 2010 national EPA SO_2 standard. Whatcom was one of three counties under further investigation and Ecology was required to monitor SO_2 near facilities that emit more than 2,000 tons of SO_2 per year. Results from the 2017 to 2019 investigation indicated that most of Whatcom County met the federal standard, however SO_2 levels near the Intalco aluminum smelter were in exceedance (Caudill 2020). An air quality technical report was submitted to the EPA in 2020 and Whatcom County remains awaiting attainment designation for SO_2.

The Northwest Clean Air Agency (NWCAA) is responsible for monitoring air quality in Whatcom County. The nearest monitor to the aquatic reserve is in Ferndale and as of 6/26/2020, the air quality was "Good" with the dominant pollutant being particulate matter. Industries that have the potential to emit more than 10 tons per year of hazardous air pollutants are required to hold air operating permits (AOPs). Both the NWCAA and Ecology are the permitting authorities for the industries at Cherry Point. There are five AOP holders upland to the reserve: Intalco, bp, Phillips 66, PSE Ferndale Generating Station, and PSE Whitehorn. Annual emissions of criteria pollutants from these facilities are shown in Figure A-13. Petrogas is not an AOP source as they only burn natural gas and other low-sulfur fuels.

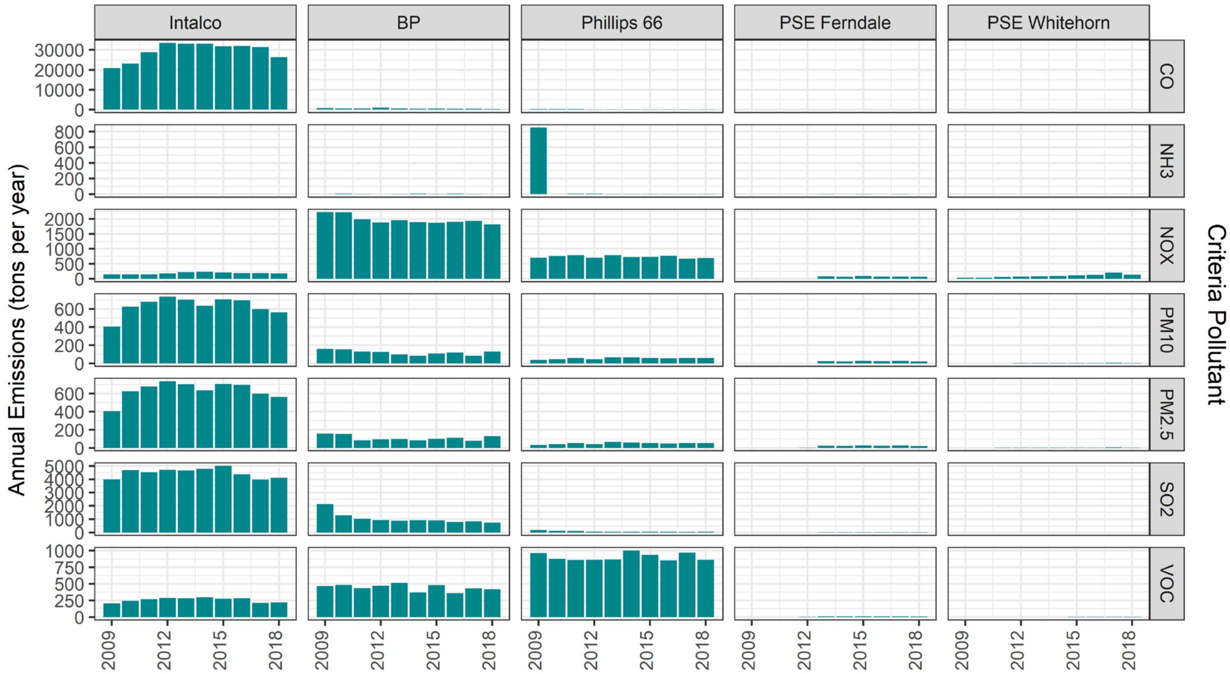

Figure A-13. Annual emissions of hazardous air pollutants from point sources near Cherry Point Aquatic Reserve. Criteria pollutants are carbon monoxide (CO), ammonia (NH3), nitrogen oxides (NOx), particulate matter (PM10 and PM2.5, by particle diameter), sulfur dioxide (SO_2), and volatile organic compounds (VOC). Data was sourced from Department of Ecology point source annual inventory, downloaded 7/7/2020 - https://ecology.wa.gov/Air-Climate/Air-quality/Air-quality-targets/Air-emissions-inventory.

In 2014, point sources (typically AOP holders) made up about 71 percent of SO_2 emissions in Whatcom County, with another 28 percent from commercial marine vessels. From 2014 to 2017, there was a 43 percent reduction in SO_2 emissions statewide, with a 16 percent reduction in Whatcom County (WA Ecology 2018a, 2020a). In 2017, SO_2 emissions from commercial marine vessels in Whatcom County dropped to 27 tons per year (<1% of SO_2 emissions), in response to new regulations requiring the use of fuel with lower sulfur content near the coast. With this reduction, the current majority of emissions come from point sources. Intalco emitted roughly 4,000 tons of SO_2 per year, and was the largest source statewide (Caudill 2020; WA Ecology 2018b). There are two monitors managed by Ecology near the Intalco smelter: one directly to the north along Kickerville Rd., and one directly to the east along Mountain View Rd. One of these stations has shown periodic SO_2 concentrations above the national ambient air quality standard (75 ppb over 1-hour), however Ecology and NWCAA found that SO_2 levels that violated the federal standard were only observed within 0.4 miles of the facility property (Caudill 2020). In August 2020, the Intalco facility curtailed its operations due to market conditions. As part of Agreed Order 18216, Intalco is required to install air pollution reduction measures before restarting its potlines.

Non-Native Species

The Cherry Point area and adjacent environs have been colonized by a variety of non-native species. The specific species, their abundance, and impacts to native populations have not been well-studied or described and in many circumstances are not fully known. While ecological functions and benefits can be prescribed to virtually all species, including non-native invasive species, the scope of habitat and biological community changes that result from the establishment and spread of invasive species can take a long time to ascertain. Invasive species are broadly recognized as the second leading cause of losses of Threatened and Endangered species, after habitat destruction (Pimentel et al. 2001). To date, no systematic survey has been attempted to assess which species are present within the reserve boundaries.

Some non-native species present in the reserve were deliberately introduced to the state and region through aquaculture, such as the Virginian (*Crassostrea virginica*) and Pacific oysters *(Magallana gigas*). The Pacific oyster is native to Japan and was first introduced on the Pacific Coast in Puget Sound in 1875. It is an economically important cultured shellfish in Washington State and has been found to reproduce successfully in a several areas in the Southern Salish Sea (Cohen 2004; Emmett et al. 1991). Several less conspicuous species were incidentally carried along with the Pacific oyster and accidentally introduced, in particular, Manila clams (*Venerupis philippinarum*). First recorded on the Pacific Coast in Puget Sound in 1924, where it is both widely cultivated and established in the wild (Cohen 2004; Emmett et al. 1991); Manila clams are relatively fast growing, easy to harvest and a popular recreational clam in CPAR. Similar ancillary introductions from oyster aquaculture that are classified as noxious or invasive species include Japanese wireweed (*Sargassum muticum*), Japanese eelgrass (*Nanozostera japonica*), the Pacific oyster drill (*Ocinebrellus inornatus*), and Asian mud snail (*Batillaria attramentaria*). The Asian mud snail was first recorded in Samish Bay in 1924 (or possibly 1918-19) (Cohen 2004). Today, the Asian mud snail is the most abundant macrofauna on many tidal flats throughout the southern Salish Sea and is widespread in most northern bays such as Samish, Padilla, (PSWQAT 2000) and Birch Bay. Exclusion experiments suggest that *Batillaria* may facilitate the invasions of other non-native species including another mud snail (*Nassarius faterculus*) (Wonham et al. 2003). A more recent introduction, the purple varnish clam (*Nuttallia obscurata*), are common on several beaches in Birch Bay and other areas in the reserve. Varnish clams tend to inhabit the upper one third of the intertidal zone, decreasing in middle and lower intertidal areas. These are becoming more popular for human consumption. The varnish clam was apparently introduced via ballast water from Asia (WDFW n.d.d).

Mentioned earlier in the macroalgae section, *Sargassum muticum* is an invasive seaweed that is pervasive throughout the Southern Salish Sea in areas with coarse gravel substrates in lower intertidal to shallow subtidal areas. *Sargassum* was first recorded in Puget Sound in 1948 and was found throughout the Sound by the early 1960s (Scagel 1956; Thom and Hallum 1991). In a study done in the San Juan Islands by Britton-Simons (2003), *Sargassum* was found to displace native understory kelp species. Additionally, in 1987, Michael Kyte carried out a quantitative ecological study along the Cherry Point reach assessing intertidal macroalgae percent cover, density, and distribution. In 1992, five years after the initial study, he resurveyed the same transect and quadrats and measured significant reductions in the native macroalgal diversity and abundance with dramatic increases of *Sargassum* in all quadrats (Kyte 2020a). *Sargassum* has displaced numerous native species, with the consequence of decreasing overall diversity and ecosystem resiliency in CPAR.

Before 2000, ballast water discharge went unmonitored in Washington State marine waters; as a result, it is unknown how many non-native species were introduced into the CPAR area from ballast water discharge at the CP terminals. As of 2000 ballast water discharge is managed by federal and

Washington State regulations that prohibit discharge of untreated ballast water into the waters of the State and the U.S., unless the ballast water has been subject to off-shore oceanic ballast water exchange. However, ballast and fouling communities on ships using the industrial piers and anchoring –out in the reserve area still pose a potential vector for the introduction of non-native species. A ballast water study of more than 500 ships entering Puget Sound between 2008-2011 by Cordell et al. (2015), revealed an Asian copepod likely arrived on ships visiting a Cherry Point terminal. Introductions of non-native species from biofouling on ship hulls has been found to be a significant vector as well, and needs further study. Of the 74 non-native species in Puget Sound, six species almost certainly arrived by attaching to the hull of a ship and as many as 37 could have arrived that way (Davidson et al. 2014). It is unknown which species or how many, have been introduced into the CPAR area from ballast water at the terminals.

The European green crab (*Carcinus maenus*) is one of the most successful and damaging invasive species in the world. Since 2016, European Green Crab (EGC) have been gaining a foot-hold in the Southern Salish Sea and have the potential for great habitat destruction, including severely injuring Washington State's oyster, clam, mussel, and Dungeness crab populations and industries. Although "EGC cannot crack the shell of a mature oyster, they will prey upon young oysters, and can dig down six inches to find clams to eat. One green crab can consume 40 half-inch clams a day, as well as other crabs its own size." (WDFW n.d.b). Other serious threats from this pestilent invader include competition or predation on juvenile or smaller native crabs and habitat destruction. EGC are aggressive burrowers leading to undermining estuarine shoreline areas, marsh banks and eelgrass beds.

Figure A-14. Locations of where EGC traps were set in October 2020, red dot is the EGC – inside Terrell Creek estuary (Chelsea Buffington, WDFW).

In the summer of 2019, EGC were found more locally in the southern Strait of Georgia in neighboring Lummi Bay and Drayton Harbor. Later in October 2019, a EGC was sighted near Birch Bay Resort in the eelgrass being "picked at by a gull". At the end of the trapping season, in October 2020, a young-of-the-year EGC was captured at the mouth of Terrell Creek in Birch Bay (Buffington, C. personal communication 2020). See Figure A-14 for trapping locations.

In Lummi Bay, Tribal biologists have vigorously trapped EGC, since the fall of 2019 and have the second largest invasion in Southern Salish Sea after the Wa'atch River Valley. As a result, WDFW and other local organizations agree that detections of EGC in Lummi Bay and the Drayton Harbor Action Area "meet an imminent danger threshold by virtue of the substantial likelihood of damage and high probability of establishment; emergency action is warranted to provide the resources necessary to adequately address this threat." There is an ongoing cooperative effort to work quickly to inventory, monitor, control, and prevent the spread of EGC across the Drayton Harbor Action Area and the broader Salish Sea." (Pleus, A. personal communication 2020). As an offshoot of this effort, assessing EGC populations in Birch Bay began in late 2020 near CPAR and will be more extensive in the 2021 season in this area. Additionally, the local Salish Sea EGC crew will be checking out at risk sites with suitable habitat. The Gulf Rd estuary and marsh will be included in this action area plan, once land access permission has been approved (Buffington, C. personal communication 2020). Slightly to the south of CPAR, Lummi Bay, tribal scientists have worked tirelessly through November 2020 to continue to trap large numbers of EGC in the diked impoundment in Lummi Bay.

A historical collaborative rapid assessment of non-indigenous species in the Southern Salish Sea occurred in 1998 - The Puget Sound Expedition (Cohen et al. 1998). The two sites surveyed nearest to the CP aquatic reserve were Squalicum Harbor Marina in Bellingham Bay and in Blaine, the assessment included Drayton Harbor Marina and a beach in Boundary Bay. Although these sites are not contiguous with the Cherry Point area, they are proximal localities that have had an invasive species assessment. A few of these species are known to degrade the quality of the habitat and/or compete with native species, particularly the tunicate, *Botrylloides violaceous*. Non-native species observed or present at Blaine or Squalicum Marina and vicinity include:

1. Japanese eelgrass *(Nanozostera japonica)*
2. Bryozoan (*Bugula* sp.)
3. Tunicate (*Botrylloides violaceus*)
4. Japanese littleneck (*Venerupis phillipenarum*)
5. Pacific Oyster (*Magallana gigas*)
6. Horn shell snails (*Batillaria attramentaria)*
7. Varnish Clam (*Nutallia obscurata)*

Potential Impacts

Some invasive, non-native species may cause ecological disruption by competing and potentially displacing native species changing ecosystem interactions and damaging physical structure and habitat. In the case of the aquaculture industry, these changes may cause significant economic losses as well. Monitoring and control of potentially harmful species is essential for maintaining the existing health status of the area. Several non-native invasive species pose a continual threat to physical and biological habitat areas and functions within different areas of the reserve. For example, *Sargassum muticum* which is ubiquitous along the outer coast of the reserve, has displaced native macroalgae species in the most productive area of the intertidal zone. Britton–Simmons (2004) found the negative effects of *Sargassum* on native algae are mostly the result of shading. He also saw a strongly negative indirect effect on native species, such as the green urchin (*Strongylocentrotus droebachiensis*), by reducing availability of the native kelp species on which it prefers to feed. His results indicate that *Sargassum* has a broad effect on the entire community including multiple trophic levels (Britton-Simmons 2004). For several of the other non-native species, the long-term detrimental effects are undetermined or controversial.

As discussed in Chapter 2, the recent expansion of European green crab (EGC) to northern Whatcom County "poses a threat to critically important estuarine ecosystems" including critical wildlife habitat and native species and shellfish resources (WDFW 2020a). In regions where the green crab has established reproducing populations, they have had devastating impacts to habitat and other species like smaller shore crab, snails, clams, and small oysters. As previously mentioned, green crabs can and do consume Dungeness crab up to their own size, according to laboratory studies (Grosholz and

Ruiz 1995, as cited by Cohen and Carlton 1995). Since Dungeness crabs spend part of their early life in the intertidal zone, they may be at risk of predation by EGC during that time (WDFW n.d.b). As nursery habitat for Dungeness crab a potentially expanding population of green crab in the region is of major concern and could have devastating effects to native crab species.

Green crab have also been found to be extremely destructive to several types of habitat from tidal sloughs, banks and marsh areas to large eelgrass beds. Borrowing causes sloughing, channel bank failure and in some areas have totally undermined the marsh platforms instigating a larger scale collapse of the habitat area. In Maine, EGC have caused the complete decimation of eelgrass beds leaving tidal flats devoid of any vegetation, vulnerable to sediment loss, and exposing shorelines to erosion. In addition, a cascade of biological consequences to a myriad of species is inevitable, along with impairing longterm ecosystem resilience. Additionally, a surge in the Pacific oyster population in Birch Bay could be accompanied by the invasive Asian and/or eastern oyster drills and *Battalaria* sp. Other non-native species that are in close proximity to the aquatic reserve, such as the tunicates found at marinas in Drayton Harbor and Bellingham Bay, can pose a threat by enveloping substrates used for settlement by oysters and other indigenous sessile species, therefore potentially stifling recruitment and survival of native species.

The non-native polychaete worm *Clymnella torquata* (bamboo worm) is a more recent invader of Samish Bay flats and poses a serious threat to the quality of substrate and the ecology of the existing epibenthic and infaunal communities in areas with extensive sand and mudflats.

Habitat Disturbance by Humans

Ecological stressors can include disturbance of habitat by humans. Physical disruption of foraging and resting habitat, noise and light levels can impact habitat use. Physical disruption may include activity from boaters or kayakers in the bay, or recreationists using the beach. Lights from refinery activities may affect portions of the reserve, in turn affecting nocturnal behaviors. As the future population of the area increases without mitigation measures, stressors from human disturbance could increase.

Although no detailed study of recreational use of the reserve itself has been undertaken, activities like boating, fishing, shellfish and seaweed harvesting, swimming, and beach walking are known to be popular throughout the reserve. As human populations in Whatcom County, Birch Bay and around Bellingham increase, the demand for recreation in and adjacent to the reserve will only continue to intensify.

Increased public access and recreation could affect the reserve in many ways. Physical disturbance as well as the recreational harvest or capture of organisms can negatively affect the ecosystems of the reserve. Extractive recreation like fishing, crabbing, clamming and waterfowl hunting can affect local populations of organisms – either through the removal of individuals or the physical stress of harvest on adjacent (non-harvested) individuals. For example, during clam harvest, trampling of intertidal vegetation and organisms, including leaving unfilled clam-digging holes undermines habitat integrity and species vulnerability and resilience. Also, increased boating and hunting activity can exacerbate the total stress on foraging and resting waterbirds, as well as marine mammals. Escalated use of beaches and tidelands may further disturb wildlife using the beaches, particularly if human recreation includes unleashed dogs. Additional physical degradation to habitat and water quality can occur from increased beach recreational boat traffic, especially from mooring and anchoring in eelgrass and seaweed beds. In order to reduce the risk of physical habitat degradation, DNR district staff have monitored unauthorized mooring in Birch Bay. (More details in chapter 4, Table x). Finally, derelict gear from recreational and commercial fishing activities continue to catch crabs, groundfish and other species and potentially snag or entangle marine mammals.

Both public and private property and habitat areas from Birch Bay State Park along the reserve shoreline south of Gulf Rd have been impacted by human uses. As public access increases, many of these issues will probably escalate. This highlights the need and opportunity for increased public education and outreach regarding the sensitive nature of many of the systems and resources in the reserve.

Appendix B – Observed Species List

Tables B–1 to B–6 identify the documented flora and fauna within the area of the Cherry Point Aquatic Reserve.

The species lists include birds, fish, reptiles, marine mammals, invertebrates, and intertidal and shallow subtidal marine vegetation. Various organizations and individuals who use the area in and around the Cherry Point Aquatic Reserve have identified the species listed below. Species are organized by Order with larger groups further broken down to Family. Species are listed alphabetically by scientific name within those categories.

These are preliminary species lists, not comprehensive lists. Only species observed and documented by a confirmed source were included.

State Species of Concern Status was obtained from Washington Department of Fish and Wildlife, 2019. Available at https://wdfw.wa.gov/sites/default/files/2019-06/threatened%20and%20endangered%20species%20list.pdf

Federal Species of Concern Status was obtained from the U.S. Fish and Wildlife Service. Available at https://ecos.fws.gov/ecp0/reports/ad-hoc-species-report?kingdom=V&kingdom=I&status=E&status=T&status=EmE&status=EmT&status=EXPE&status=EXPN&status=SAE&status=SAT&mapstatus=3&fcrithab=on&fstatus=on&fspecrule=on&finvpop=on&fgroup=on&header=Listed+Animals

Table B–1: Birds Observed in Cherry Point Aquatic Reserve

*Species protected by the Federal Migratory Bird Treaty Act (16 U.S.C. § 703-712 (1918))

Common Name	Scientific Name	State Status	Federal Status	Source
Waterfowl – Order Anseriformes				
Wood duck	*Aix sponsa*		*	2, 4
Northern pintail	*Anas acuta*		*	2, 4, 5
Green-winged teal	*Anas crecca*		*	4, 5
Mallard	*Anas platyrhynchos*		*	2, 4, 5, 6
Snow goose	*Anser caerulescens*		*	4, 5
Lesser scaup	*Aythya affinis*		*	4, 5
Ring-necked duck	*Aythya collaris*		*	4, 5
Greater scaup	*Aytha marila*		*	2, 4, 5, 6
Brant	*Branta bernicla*		*	4, 5, 6, 7, 8
Canada goose	*Branta canadensis*		*	2, 4, 5, 6
Bufflehead	*Bucephala albeola*		*	1, 2, 4, 5, 6, 9
Common goldeneye	*Bucephala clangula*		*	1, 2, 4, 5, 6, 7, 9
Barrow's goldeneye	*Bucephala islandica*		*	1, 2, 4, 5, 7
Long-tailed duck	*Clangula hyemalis*		*	2, 5, 6, 7, 8
Harlequin duck	*Histrionicus*		*	1, 2, 4, 5, 6, 7, 9
Hooded merganser	*Lophodytes cucullatus*		*	3, 5
American wigeon	*Mareca americana*		*	2, 4, 5
Gadwall	*Mareca strepera*		*	2, 4
Black scoter	*Melanitta americana*		*	2, 4, 5, 6, 8
White-winged scoter	*Melanitta delandi*		*	1, 2, 4, 5, 6
Surf scoter	*Melanitta perspicillata*		*	1, 2, 4, 5, 6, 7, 9
Common merganser	*Mergus merganser*		*	2, 4
Red-breasted merganser	*Mergus serrator*		*	1, 2, 4, 5, 6, 7
Loons – Order Gaviiformes				
Common loon	*Gavia immer*	Sensitive	*	1, 2, 4, 5, 6, 7, 9
Pacific loon	*Gavia pacifica*		*	2, 4, 6
Red-throated loon	*Gavia stellate*		*	4, 5, 6
Grebes – Order Podicipediformes				
Western grebe	*Aechmophorus occidentalis*	Candidate	*	1, 2, 4, 5, 6, 7, 9
Horned grebe	*Podiceps auritus*		*	1, 2, 4, 5, 6, 7
Red-necked grebe	*Podiceps grisegena*		*	2, 4, 5, 6
Eared grebe	*Podiceps nigricollis*		*	2, 4, 5

Common Name	Scientific Name	State Status	Federal Status	Source
Pied-billed grebe	*Podilymbus podiceps*		*	2, 4, 5
Pelicans, Cormorants and Allies – Order Pelicaniformes				
Double-crested cormorant	*Nannopterum auritus*		*	1, 2, 4, 6, 9
Pelagic cormorant	*Urile pelagicus*		*	1, 2, 4, 6, 7
Herons, Ibises and Allies – Order Ciconiformes				
Great blue heron	*Ardea herodias*		*	1, 2, 4, 5, 6, 7, 8
New World Vultures, Hawks, Eagles, Kites, and Allies – Order Accipitriformes				
Cooper's hawk	*Accipiter cooperii*		*	2, 4, 7
Red-tailed hawk	*Buteo jamaicensis*		*	6, 4, 5, 7, 8
Turkey vulture	*Cathartes aura*		*	1, 4
Northern harrier	*Circus hudsonius*		*	1, 4, 7
Bald eagle	*Haliaetus leucocephalus*		*Delisted	1, 2, 4, 5, 6, 7, 9
Osprey	*Pandion haliaetus*		*	1, 4, 9
Falcons, Kestrels, and Allies – Order Falconiformes				
Merlin	*Falco columbarius*		*	1, 4
Peregrine falcon	*Falco peregrinus*		*	1, 4, 9
Shorebirds, Gulls, Auks and Allies – Order Charadriiformes				
Marbled murrelet	*Brachyramphus marmoratus*	Endangered	*Threatened	2, 4, 9
Dunlin	*Calidris alpina*		*	1, 2, 4
Western sandpiper	*Calidris mauri*		*	2, 4
Least sandpiper	*Calidris minutilla*		*	2, 4
Pigeon guillemot	*Cepphys columba*		*	1, 2, 4, 5, 6
Rhinoceros auklet	*Cerorhinca monocerata*		*	2, 4, 6
Killdeer	*Charadrius vociferus*		*	1, 2, 4, 5, 8
Common snipe	*Gallinago*		*	1, 2, 4
Black oystercatcher	*Haematopus bachmani*		*	2, 4
Caspian tern	*Hydroprogne caspia*		*	2, 4, 6
Herring gull	*Larus argentatus*		*	1, 2, 4, 7
California gull	*Larus californicus*		*	2, 4
Mew gull	*Larus canus*		*	1, 4
Ring-billed gull	*Larus delawarensis*		*	3, 4
Glaucous-winged gull	*Larus glaucescens*		*	1, 2, 4
Thayer's gull	*Larus glaucoides thayeri*		*	2, 4
Western gull	*Larus occidentalis*		*	1, 2, 4, 7
Bonaparte's gull	*Larus philadelphia*		*	2, 4
Greater yellowlegs	*Tringa melanoleuca*		*	2, 4

Common Name	Scientific Name	State Status	Federal Status	Source
Common murre	*Uria aalge*		*	2, 4
Flycatchers, Songbirds and Allies – Order Passeriformes				
Red-winged blackbird	*Agelaius phoeniceus*		*	1, 4, 5, 7
Northern flicker	*Colaptes auratus*		*	1, 4, 7
Olive-sided flycatcher	*Contopus cooperi*		*	1, 4, 7
American crow	*Corvus brachyrhynchos*		*	4, 7
Northwest crow	*Corvus caurinus*		*	1, 4
Common raven	*Corvus corax*		*	1, 4
Pacific-slope flycatcher	*Empidonax difficilis*		*	1, 4, 7
Willow flycatcher	*Empidonax traillii*		*	1, 4, 7
Brewer's blackbird	*Euphagus cyanocephalus*		*	1, 4, 5
Barn swallow	*Hirundo rustica*		*	1, 4, 7
Dark eyed junco	*Junco Hyemalis*		*	1, 4, 7
Song sparrow	*Melospiza melodia*		*	1, 4, 5, 7
Brown-headed cowbird	*Molothrus ater*		*	1, 4, 7
Savannah sparrow	*Passerculus sandwichensis*		*	1, 4, 7
Black-capped chickadee	*Poecile atricapillus*		*	1, 4, 7
Yellow-rumped warbler	*Setophaga coronate*		*	1, 4, 7
Yellow warbler	*Setophaga petechia*		*	1, 4, 7
American goldfinch	*Spinus tristis*		*	1, 4, 7
[a]Common starling	*Sturnus vulgaris*			1, 4, 5
Tree swallow	*Tachycineta bicolor*		*	1, 4
Bewick's wren	*Thryomanes bewickii*		*	1, 4, 7
Mourning dove	*Zenaida macroura*		*	1, 4, 7
Kingfishers – Order Coraciiformes				
Belted kingfisher	*Megaceryle alcyon*		*	1, 4
Swifts – Order Caprimulgiformes				
Vaux's swift	*Chaetura vauxi*	Candidate	*	1, 4
Hummingbirds – Order Apodiformes				
Anna's hummingbird	*Calypte anna*		*	1, 4, 5, 7
Rufous hummingbird	*Selasphorus rufus*		*	1, 4, 7

[a] Non-native species

Table B-1 Sources:

1. AMEC Environment & Infrastructure, Inc. 2012. Avian baseline inventory report, Gateway Pacific Terminal, Whatcom County, Washington. Prepared for Pacific International Terminals, Inc., Seattle, WA.
2. AMEC Environment & Infrastructure, Inc. 2014. Wildlife baseline inventory report. Gateway Pacific Terminal, Whatcom County, Washington. Report No. 0-915-15338-C. Prepared for Pacific International Terminals, Inc., Seattle, WA.
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7. Pacific International Terminals, Inc. 2012. Major project permit and shoreline substantial development permit supplemental applications – supplemental information. Whatcom County, Washington. Permit no PL4-83-004B. Section 5.2. Available from https://whatcomcounty.us/DocumentCenter/View/2797/Original-Materials---MDP-VAR-and-SHR-Applications---March-19-2012-PDF?bidId.
8. Udea, K. 2020. iNaturalist research-grade observations. Available from https://www.inaturalist.org/. Occurrence dataset https://doi.org/10.15468/dl.gz1gyf accessed via GBIF.org on 4-Feb-20 and https://doi.org/10.15468/dl.eqca5j accessed via GBIF.org on 16-Jul-20.
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Table B–2: Fish Observed in Cherry Point Aquatic Reserve

Common Name	Scientific Name	State Status	Federal Status	Source
Toadfishes – Order Batrachoidiformes				
Plainfin midshipman	*Porichthys notatus*			4, 8
Ratfishes or Chimaeras – Order Chimaeriformes				
Spotted ratfish	*Hydrolagus colliei*			4, 8
Herrings – Order Clupeiformes				
American shad	*Alosa sapidissima*			4, 8
Pacific herring	*Clupea pallasii*	Candidate		2, 4, 6, 8
Northern anchovy	*Engraulis mordax*			4, 6, 8
Pacific sardine	*Sardinops sagax*			4, 8
Cods – Order Gadiformes				
Walleye pollock	*Gadus chalcogrammus*			3, 4, 8
Pacific cod	*Gadus macrocephalus*	Candidate		3, 4, 8
Pacific hake	*Merluccius productus*	Candidate		3, 4, 8
Pacific tomcod	*Microgadus proximus*	Candidate		4, 8
Sticklebacks – Order Gasterosteiformes				
Tubesnout	*Aulorhynchus flavidus*			4, 5
Three-spined stickleback	*Gasterosteus aculeatus*			4, 8
Bay pipefish	*Sygnathus leptorhynchus*			4, 5
Six-Gill Sharks – Order Hexanchiformes				
Bluntnose sixgill shark	*Hexanchus griseus*			4, 5
True Smelts – Order Osmeriformes				
Surf smelt	*Hypomesus pretiosus*			3, 4, 6, 8
Longfin smelt	*Spirinchus thaleichthys*			3, 4, 8
Eulachon	*Thaleichthys pacificus*	Candidate	Threatened	4, 8
Perches – Order Perciformes				
Pacific sand lance	*Ammodytes personatus*			3, 4, 5, 6, 7, 8
High cockscomb	*Anoplarchus purpurescens*			4, 8
Penpoint gunnel	*Apodichthys flavidus*			4, 5, 8
Arrow goby	*Clevelandia ios*			4, 8
Kelp perch	*Brachyistius frenatus*			4, 5
Shiner perch	*Cymatogaster aggregata*			4, 5, 8
Pile perch	*Damalichthys vacca*			4, 5, 8
Striped seaperch	*Embiotoca lateralis*			4, 5
Northern clingfish	*Gobiesox meandricus*			1, 4, 7, 8
Bay goby	*Lepidogobius lepidus*			4, 5

Common Name	Scientific Name	State Status	Federal Status	Source
Daubed shanny	*Leptoclinus maculatus*			4, 8
Snake prickleback	*Lumpenus sagitta*			4, 5, 7, 8
Shortfin eelpout	*Lycodes brevipes*			4, 8
Blackbelly eelpout	*Lycodes pacificus*			4, 8
Wattled eelpout	*Lycodes palearis*			4, 8
Crescent gunnel	*Pholis laeta*			4, 5, 7, 8
Saddleback gunnel	*Pholis ornata*			1, 4, 5, 7, 8
Whitebarred prickleback	*Poroclinus rothrocki*			4, 8
Blackeye goby	*Rhinogobiops nicholsii*			4, 5
Northern ronquil	*Ronquilus jordani*			4, 5
Lampreys – Order Petromyzontiformes				
Pacific lamprey	*Entosphenus tridentatus*			4, 8
Flatfishes – Order Pleuronectiformes				
Arrowtooth flounder	*Atheresthes stomias*			4, 8
Pacific sanddab	*Citharichthys sordidus*			3, 4, 6, 8
Speckled sanddab	*Citharichthys stigmaeus*			3, 4, 5, 6, 8
Petrale sole	*Eopsetta jordani*			4, 8
Rex sole	*Glyptocephalus zachirus*			4, 8
Flathead sole	*Hippoglossoides elassodon*			4, 8
Pacific halibut	*Hippoglossus stenolepis*			4, 8
Butter sole	*Isopsetta isolepis*			3, 4, 6
Rock sole	*Lepidopsetta bilineata*			3, 4, 5, 6, 8
Slender sole	*Lyopsetta exilis*			4, 8
Dover sole	*Microstomus pacificus*			3, 4, 6, 8
English sole	*Parophrys vetulus*			3, 4, 5, 6, 8
Starry flounder	*Platichthys stellatus*			4, 5, 6, 8
C-O sole	*Pleuronichthys coenosus*			2, 4
Sand sole	*Psettichthys melanostictus*			4, 8
Skates – Order Rajiformes				
Big skate	*Beringraja binoculata*			2, 4, 8
Longnose skate	*Raja rhina*			4, 8
Salmons and Trouts – Order Salmoniformes				
Cutthroat trout	*Oncorhynchus clarkii*			3, 4, 6
Pink salmon	*Oncorhynchus gorbuscha*			3, 4, 8
Chum salmon	*Oncorhynchus keta*	Candidate		3, 4, 8
Coho salmon	*Oncorhynchus kisutch*			3, 4, 8

Common Name	Scientific Name	State Status	Federal Status	Source
Steelhead trout	*Oncorhyncus mykiss*	Candidate	Threatened	3, 4, 6
Sockeye salmon	*Oncorhynchus nerka*	Candidate		3, 4, 8
Chinook salmon	*Oncorhynchus tshawytscha*	Candidate	Endangered	3, 4, 6, 8
Bull trout	*Salvelinus confluentus*	Candidate	Threatened	3, 4, 6
Dolly varden	*Salvelinus malma*			3, 4
Mail-Cheeked Fishes – Order Scorpaeniformes				
Poachers – Family Agonidae				
Northern spearnose poacher	*Agonopsis vulsa*			4, 8
Spinycheek starsnout	*Bathyagonus infraspinatus*			4, 8
Pygmy poacher	*Odontopyxis trispinosa*			4, 5
Tubenose poacher	*Pallasina barbata*			4, 8
Sturgeon poacher	*Podothecus accipenserinus*			4, 5, 8
Sablefishes – Family Anoplopomatidae				
Sablefish	*Anoplopoma fimbria*			4, 8
Sculpins – Family Cottidae				
Padded sculpin	*Artedius fenestralis*			4, 5, 8
Scalyhead sculpin	*Artedius harringtoni*			4, 5
Smoothhead sculpin	*Artedius lateralis*			4, 5
Buffalo sculpin	*Enophrys bison*			4, 5, 7, 8
Red Irish lord	*Hemilepidotus*			4
Northern sculpin	*Icelinus borealis*			4, 8
Longfin sculpin	*Jordania zonope*			4, 5
Pacific staghorn sculpin	*Leptocottus armatus*			4, 8
Great sculpin	*Myoxocephalus polyacanthocephalus*			4, 5, 8
Tidepool sculpin	*Oligocottus maculosus*			1, 4, 7, 8
Saddleback sculpin	*Oligocottus rimensis*			4
Slim sculpin	*Radulinus asprellus*			4, 8
Puget Sound sculpin	*Ruscarius meanyi*			4
Cabezon	*Scorpaenichthys marmoratus*			4, 8
Ribbed sculpin	*Triglops pingelii*			4, 8
Lumpfishes – Family Cyclopteridae				
Pacific spiny lumpsucker	*Eumicrotremus orbis*			2, 4
Spiny sculpins – Family Hemitripteridae				
Silverspotted sculpin	*Blepsias cirrhosus*			4, 8
Sailfin sculpin	*Nautichthys oculofasciatus*			4, 5, 8

Common Name	Scientific Name	State Status	Federal Status	Source
Greenlings – Family Hexagrammidae				
Kelp greenling	*Hexagrammos decagrammus*			4, 5
Rock greenling	*Hexagrammos lagocephalus*			5
Whitespotted greenling	*Hexagrammos stelleri*			4, 5
Lingcod	*Ophiodon elongatus*			3, 4, 5, 6, 8
Painted greenling	*Oxylebius pictus*			4, 5
Longspine combfish	*Zaniolepis latipinnis*			4
Snailfishes – Family Liparidae				
Showy snailfish	*Liparis pulchellus*			4, 8
Tadpole snailfish	*Nectoliparis pelagicus*			4, 8
Fathead sculpins – Family Psychrolutidae				
Spinyhead sculpin	*Dasycottus setiger*			4, 8
Tadpole sculpin	*Psychrolutes paradoxus*			4, 8
Grunt sculpins – Family Rhamphocottidae				
Grunt sculpin	*Rhamphocottus richardsonii*			4, 5, 8
Scorpionfishes – Family Scorpaenidae				
Copper rockfish	*Sebastes caurinus*	Candidate		3, 4, 5
Puget Sound rockfish	*Sebastes emphaeus*			5
Quillback rockfish	*Seabstes maliger*	Candidate		3, 4, 5
Dogfish Shark – Order Squaliformes				
Pacific spiny dogfish	*Squalus suckleyi*			4, 5, 8

Table B-2 Sources:

1. Hines, E. & Jaeren, L. 2018a. Intertidal biota monitoring in the Cherry Point and Fidalgo Bay Aquatic Reserves: 2013-2018 Monitoring Report. Prepared for Washington State Department of Natural Resources, Olympia, WA.
2. Kyte, M.A. 2020. Personal communication with Michael Kyte, semi-retired consulting marine biologist. Email and by phone, record on file—DNR Aquatic Reserves Program, Olympia, WA.
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8. Udea, K. 2020. iNaturalist research-grade observations. Available from https://www.inaturalist.org/. Occurrence dataset https://doi.org/10.15468/dl.gz1gyf accessed via GBIF.org on 4-Feb-20 and https://doi.org/10.15468/dl.eqca5j accessed via GBIF.org on 16-Jul-20.

Table B–3: Reptiles Observed in Cherry Point Aquatic Reserve

Common Name	Scientific Name	State Status	Federal Status	Source
Scaled Reptiles – Order Squamata				
Northern alligator lizard	*Elgaria coerulea*			1

Table B-3 Sources:

1. Lemon, B. 2020. Personal communication with Bob Lemon, Cherry Point intertidal monitoring lead naturalist. Email, record on file—DNR Aquatic Reserves Program, Olympia, WA.

Table B–4: Mammals Observed in Cherry Point Aquatic Reserve

*Species protected by the Federal Marine Mammal Protection Act (16 U.S.C. § 1361-1407 (1972))

Common Name	Scientific Name	State Status	Federal Status	Source
Marine Mammals				
Pinnipeds – Order Carnivora				
Steller sea lion	*Eumetopias jubatus*		*Delisted	7, 8, 9
North Pacific harbor seal	*Phoca vitulina richardii*		*	6, 7, 9
California sea lion	*Zalophus californianus*		*	9
Whales, Dolphins and Porpoises – Order Cetacea				
Pacific minke whale	*Balaenoptera acutorostrata*		*	9
Gray whale	*Eschrichtius robustus*	Sensitive	*Endangered	2, 7, 9
Humpback whale	*Megaptera novaeangliae*	Endangered	*Endangered	7, 9
Killer whale	*Orcinus orca*	Endangered	*Endangered (SRKW only)	7, 8, 9
Pacific harbor porpoise	*Phocoena*	Candidate	*	7, 9
Dall's porpoise	*Phocoenoides dalli*		*	7, 9
Terrestrial Mammals				
Deer – Order Artiodactyla				
Black-tailed deer	*Odocoileus hemionus columbianus*			1, 4, 5
Carnivores – Order Carnivora				
Coyote	*Canis latrans*			1, 4, 5
North American river otter	*Lutra canadensis*			3, 4
Striped skunk	*Mephitis*			1
American mink	*Neovison vison*			1
Cougar	*Puma concolor*			3
Northern raccoon	*Procyon lotor*			1, 4
Bats – Order Chiroptera				
Townsend's big-eared bat	*Corynorhinus townsendii*	Candidate		1
Big brown bat	*Eptesicus fuscus*			1
Silver-haired bat	*Lasionycteris noctivagans*			1
California bat	*Myotis californicus*			1
Keen's long-eared bat	*Myotis keenii*			1
Little brown bat	*Myotis lucifugus*			1
Yuma bat	*Myotis yumanensis*			1
Opossums – Order Didelphilmorphia				
Virginia opossum	*Didelphis virginiana*			1, 4

Table B-4 Sources:

1. AMEC Environment & Infrastructure, Inc. 2014. Wildlife baseline inventory report, Gateway Pacific Terminal, Whatcom County, Washington. Report No. 0-915-15338-C. Prepared for Pacific International Terminals, Inc., Seattle, WA.
2. Calambokidis, J., Klimek, A., & Schlender, L. 2009. Summary of collaborative photographic identification of gray whales from California to Alaska for 2007. Report No. AB133F-05-SE-5570. Available from https://www.cascadiaresearch.org/publications/summary-collaborative-photographic-identification-gray-whales-california-alaska-2007.
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4. Hann, R. 2020. Personal communication with Rick Hann of the Cherry Point Aquatic Reserve Citizen Stewardship Committee. Email, record on file—DNR Aquatic Reserves Program, Olympia, WA.
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Table B–5: Invertebrates Observed in Cherry Point Aquatic Reserve

NOTE: Invertebrate scientific names follow World Register of Marine Species (WoRMS) naming conventions.

Common name	Scientific Name	State Status	Federal Status	Source
Sponges – Phylum Porifera				
Red sponge	*Clathria* sp.			3, 7
Encrusting sponge	*Haliclona* sp.			3, 7
Yellow sun sponge	*Halichondria bowerbanki*			3
Anemones and Jellies – Phylum Cnidaria				
Moonglow anemone	*Anthopleura artemisia*			3, 7, 8
Aggregating anemone	*Anthopleura elegantissima*			3, 7, 8
Pacific lion's mane jelly	*Cyanea ferruginea*			7
Brooding anemone	*Epiactis prolifera*			7
Stalked jellyfish	*Haliclystus* sp.			3, 5, 6
Plumose anemone	*Metridium senile*			3, 7
Egg-yolk jelly	*Phacellophora camtschatica*			7, 8
Red-eye jellyfish	*Polyorchis penicillatus*			7
Pacific stubby rose anemone	*Urticina clandestina*			3, 7, 8
Painted anemone	*Urticina grebelnyi*			3, 7, 8
Lamp Shells – Phylum Brachiopoda				
Transverse lamp shell	*Terebratalia transversa*			7
Moss Animals – Phylum Bryozoa				
Branching bryozoan	Bugulidae family			3, 7
Encrusting bryozoan	Membraniporidae family			3, 7
Flatworms – Phylum Platyhelminthes				
Giant flatworm	*Kaburakia excelsa*			3
Ribbon Worms – Phylum Nemertea				
White ribbon worm	*Carinoma mutabilis*			3, 7
Big ribbon worm	*Cerebratulus* sp.			9
Green ribbon worm	*Emplectonema gracile*			3, 7
Dark ribbon worm	*Micrura verrilli*			3, 7
Ribbon worm	*Oerstedia* sp.			9
Neesid worm	*Paranemertes californica*			9
Purple ribbon worm	*Paranemertes peregrina*			3, 7
Orange ribbon worm	*Tubulanus polymorphus*			3, 9
Segmented Worms – Phylum Annelida				
Ampharetid worm	*Ampharete acutifrons*			9

Common name	Scientific Name	State Status	Federal Status	Source
Hair worm	*Aphelochaeta glandaria*			9
Hair worm	*Aphelochaeta* sp.			9
Thread worm	*Barantolla Americana*			9
Catworm	*Bipalponephtys cornuta*			9
Red-and-white banded sea-nymph	*Cheilonereis cyclurus*			7
Paraonid worm	*Cirrophorus branchiatus*			9
Hair worm	*Cossura pygodactylata*			9
Mud worm	*Dipolydora cardalia*			9
Oenonid worm	*Drilonereis longa*			9
Bloodworm	*Glyceridae* sp.			7
Goniadidae	*Glycinde picta*			9
Bristle worm	*Hesionidae* sp.			7
Thread worm	*Heteromastus filobranchus*			9
Orbiniid worm	*Leitoscoloplos pugettensis*			9
Paraonid worm	*Levinsenia gracilis*			9
Iridescent worm	*Lumbrineris luti*			9
Magelonid worm	*Magelona longicornis*			9
Thread worm	*Microclymene caudata*			9
Catworm	*Nephtys caeca*			9
Ragworm	*Nereidae* sp.			7
Earthworm	*Oligochaete* sp.			7
Mud worm	*Paraprionospio alata*			9
Pilargid worm	*Pilargis maculata*			9
Hesionid worm	*Podarkeopsis glabrus*			9
Tube worm	Polychaeta class			7
Scale worm	*Polynoidae* sp.			7
Bamboo worm	*Praxillella affinis pacifica*			9
Mud worm	*Prionospio lighti*			9
Mud worm	*Prionospio steenstrupi*			9
Serpulid tubeworm	*Serpulidae* sp.			7
Glassy tubeworm	*Spiochaetopterus costarum*			9
Mud worm	*Spiophanes berkeleyorum*			9
Dumbbell worm	*Sternaspis affinis*			9
Syllid worm	*Syllidae* sp.			7
Terebellid worm	*Terebellidae* sp.			7

Common name	Scientific Name	State Status	Federal Status	Source
Peanut Worms – Phylum Sipuncula				
Peanut worm	*Thysanocardia nigra*			9
Spiny–skinned Animals – Phylum Echinodermata				
Long-armed brittle star	*Amphiodia occidentalis*			6, 7
Dwarf brittle star	*Amphipholis squamata*			6
Brittle star	*Amphodia* sp.			9
Orange sea cucumber	*Cucumaria miniata*			6, 7, 8
Excentric sanddollar	*Dendraster excentricus*			7
Stiff-footed sea cucumber	*Eupentacta quinquesemita*			6, 7
Mottled sea star	*Evasterias troschelii*			6, 7
Pacific blood star	*Henricia leviuscula*			6, 7, 8
Dwarf mottled henricia	*Henricia pumila*			6, 7
Six-rayed sea star	*Leptasterias hexactis*			6, 7, 8
Sand star	*Luidia foliata*			5
Sunflower star	*Pycnopodia helianthoides*			6, 7
Pink star	*Pisaster brevispinus*			7
Ochre sea star	*Pisaster ochraceous*			6, 7, 8
Green sea urchin	*Strongylocentrotus droebachiensis*			6, 7
Chitons – Phylum Mollusca				
Gumboot chiton	*Cryptochiton stelleri*			6, 7
Gould's baby chiton	*Cyanoplax dentiens*			6, 7
Painted dendrochiton	*Dendrochiton flectens*			7
Black Katy chiton	*Katharina tunicata*			7
Merton's chiton	*Lepidozona mertensii*			7
Long-haired mopalia	*Mopalia cirrata*			7
Hind's chiton	*Mopalia hindsii*			6, 7
Northern hairy chiton	*Mopalia kennerleyi*			6, 7
Woody chiton	*Mopalia lignosa*			6, 7
Mossy chiton	*Mopalia muscosa*			6, 7, 8
Red-flecked mopalia	*Mopalia spectabilis*			7
Swan's mopalia	*Mopalia swanii*			7
Smooth chiton	*Mopalia vespertina*			6, 7
Lined chiton	*Tonicella lineata*			6, 7, 8
Blue-lined chiton	*Tonicella undocaerulea*			6, 7
Snails and Nudibrachs – Phylum Mollusca				
Nanaimo horned dorid	*Acanthodoris nanaimoensis*			7

Common name	Scientific Name	State Status	Federal Status	Source
Whitecap limpet	*Acmaea mitra*			7
Shag-rug nudibranch	*Aeolidia loui*			6, 7
Spotted aglaja	*Aglaja ocelligera*			7
Carinate dove shell	*Alia carinata*			6, 7
Compact alvania	*Alvania compacta*			7
Blue topsnail	*Calliostoma ligatum*			6, 7
Chinese hat snail	*Calyptraea fastigiata*			7
Spiny pink scallop	*Chlamys hastata*			7
Giant nudibranch	*Dendronotus iris*			1, 7, 8
Spotted leopard dorid	*Diaulula odonoghuei*			7
White-lined dirona	*Dirona albolineata*			7
Monterey dorid	*Doris montereyensis*			7, 8
Pacific stomach wing	*Gastropteron pacificum*			7
White bubble shell	*Haminoea vesicula*			6, 7
Opalescent nudibranch	*Hermissenda crassicornis*			6, 7
Variegated lacuna	*Lacuna variegata*			6, 7
Northern lacuna	*Lacuna vincta*			6, 7
Dire whelk	*Lirabuccinum dirum*			6, 7, 8
Sea snail	*Lirobittum* sp.			9
Pearly topsnail	*Lirularia lirulata*			7
Checkered periwinkle	*Littorina scutulata*			6, 7
Sitka periwinkle	*Littorina sitkana*			6, 7, 8
Finger limpet	*Lottia digitalis*			6, 7
Shield limpet	*Lottia pelta*			6, 7
Mask limpet	*Lottia persona*			6, 7
Plate limpet	*Lottia scutum*			6, 7, 8
Puppet margarite	*Margarites pupillus*			6, 7
Shining balcis	*Melanella micans*			7
Hooded nudibranch	*Melibe leonina*			6, 7, 8
Western lean nassa	*Nassarius mendicus*			7
Lewis' moonsnail	*Neverita lewisii*			5, 6, 7
Frilled dogwinkle	*Nucella lamellosa*			6, 7, 8
Northern striped dogwinkle	*Nucella ostrina*			6, 7
Sea snail	*Odostomia satura*			7
Sea snail	*Odostomia* sp.			9
Sea snail	*Odostomia tenuisculpta*			7

Common name	Scientific Name	State Status	Federal Status	Source
Sea snail	*Oenopota* sp.			7
Leather limpet	*Onchidella borealis*			7
Barnacle-eating nudibranch	*Onchidoris bilamellata*			6, 7
Gray snakeskin-snail	*Ophiodermella inermis*			7
Lurid rocksnail	*Paciocinebrina lurida*			7
Sea snail	*Turbonilla* sp.			7, 9
Clams, Oysters and Allies – Phylum Mollusca				
Divaricate nutclam	*Acila castrensis*			9
Plain tellin	*Ameritella modesta*			7, 9
Lenticular axinopsid	*Axinopsida serricata*			9
Thin-shell littleneck	*Callithaca tenerrima*			7
Heart cockle	*Clinocardium nuttalii*			6, 7, 8
Giant rock scallop	*Crassadoma gigantea*			8
Smooth nutclam	*Ennucula tenuis*			9
Northwest ugly clam	*Entodesma navicula*			7
Wrinkled rock-borer	*Hiatella arctica*			6, 7
Robust mysella	*Kurtiella tumida*			9
Pacific littleneck clam	*Leukoma staminea*			3, 7, 8, 9
Baltic macoma	*Macoma balthica*			6, 7
Charlotte’s macoma	*Macoma carlottensis*			9
Pointed macoma	*Macoma inquinata*			6, 7
Bent-nose macoma	*Macoma nasuta*			6, 7
White sand macoma	*Macoma secta*			7
Pacific oyster	*Magallana gigas*			7
Straight horsemussel	*Modiolus rectus*			7
Eastern soft shell clam	*Mya arenaria*			6, 7
Pacific blue mussel	*Mytilus trossulus*			6, 7, 8
Minute nutclam	*Nuculana minuta*			9
Lord dwarf-venus	*Nutricola lordi*			9
Purple mahogany clam	*Nuttallia obscurata*			2
Pacifc geoduck	*Panopea generosa*			1, 7
Clam	*Leukoma restorationensis*			7
Fine-line lucine	*Parvilucina tenuisculpta*			9
Green false jingle	*Pododesmus macrochisma*			6, 7
Washington butter clam	*Saxidomus gigantea*			6, 7, 9
Blunt jacknife clam	*Solen sicarius*			7, 9

Common name	Scientific Name	State Status	Federal Status	Source
Fat gaper clam	*Tresus capax*			6, 7
Pacific gaper clam	*Tresus nuttallii*			7
Manila clam	*Venerupis philippinarum*			6, 7
Rough piddock	*Zirfaea pilsbryi*			5, 6, 7, 8
Scaphopods – Phylum Mollusca				
Salish toothshell	*Pulsellum salishorum*			9
Isopods and Amphipods – Phylum Arthropoda				
Amphipod	*Ampithoe* sp.			7
Skeleton shrimp	*Caprella* sp.			3, 7
Dulichiid amphipod	*Dyopedos* sp.			9
Cumacean	*Eudorella pacifica*			9
Ostracod	*Euphilomedes carcharodonta*			9
Ostracod	*Euphilomedes product*			9
Isopod	*Exosphaeroma russellhansoni*			7
Pill bug isopod	*Gnorimosphaeroma oregonense*			3, 7
Phoxocephalid amphipod	*Heterophoxus oculatus*			9
Rock louse	*Ligia pallasi*			7
Eelgrass isopod	*Pentidotea resecata*			3, 7
Rockweed isopod	*Pentidotea wosnesenskii*			3, 7
Corophiid amphipod	*Protomedeia grandimana*			9
Corophiid amphipod	*Protomedeia prudens*			9
Beach hopper	Talitridae family			7
Tryphosid amphipod	*Orchomenella pinguis*			9
Phoxocephalid amphipod	*Rhepoxynius boreovariatus*			9
Crustaceans (Barnacles, Crabs and Allies) – Phylum Arthropoda				
Crenate barnacle	*Balanus crenatus*			3, 7
Acorn barnacle	*Balanus glandula*			3, 7, 8
Red rock crab	*Cancer productus*			3, 7, 8
Leptocheilos anthropod	*Chondrochelia savignyi*			9
Small brown barnacle	*Chthamalus dalli*			3, 5, 7
Blacktail shrimp	*Crangon nigricauda*			7
Purple shore crab	*Hemigrapsus nudus*			3, 7, 8
Hairy shore crab	*Hemigrapsus oregonensis*			3, 7, 8
Stour shrimp	*Hepticarpus brevirostris*			7
Broken-back shrimp	*Heptacarpus* spp.			3, 7
Black-clawed mud crab	*Lophopanopeus bellus*			3

Common name	Scientific Name	State Status	Federal Status	Source
Graceful rock crab	*Metacarcinus gracilis*			3, 7, 8
Dungeness crab	*Metacarcinus magister*			3, 7, 8
Red velvet mite	*Neomolgus littoralis*			3
Bay ghost shrimp	*Neotrypaea californiensis*			4
Graceful decorator crab	*Oregonia gracilis*			3, 7
Bering hermit crab	*Pagurus beringanus*			3
Grainyhand hermit crab	*Pagurus granosimanus*			3, 7, 8
Hairy hermit crab	*Pagurus hirsutiusculus*			3, 7, 8
Dock shrimp	*Pandalus danae*			4, 7
Northern pink shrimp	*Pandalus eous*			4
Coonstripe shrimp	*Pandalus hypsinotus*			4
Spot shrimp	*Pandalus platyceros*			4
Flattop porcelain crab	*Petrolisthes eriomerus*			3, 7, 8
Gaper pea crab	*Pinnixa littoralis*			7
Pea crab	*Pinnixa* sp.			9
Graceful kelp crab	*Pugettia gracilis*			3, 7, 8
Northern kelp crab	*Pugettia producta*			3, 7, 8
Schmitt's pea crab	*Scleroplax schmitti*			9
Thatched barnacle	*Semibalanus cariosus*			3, 7, 8
Helmet crab	*Telmessus cheiragonus*			3, 7, 8
Sea Squirts – Phylum Chordata				
Broad base sea squirt	*Cnemidocarpa finmarkiensis*			7
Colonial tunicates	Unidentified sp.			7
Insects – Phylum Arthropoda				
Maritime earwig	*Anisolabis maritima*			3, 7
Fly	*Diptera* sp.			7
Devil's coach horse beetle	*Ocypus olens*			3, 6
Aracnids – Phylum Arthropoda				
Red velvet mite	*Neomolgus littoralis*			3, 7

Table B-5 Sources:

1. AMEC Environment & Infrastructure, Inc. 2012. 2012 Marine biology baseline inventory, Gateway Pacific Terminal, Whatcom County, Washington. Prepared for Pacific International Terminals, Inc., Seattle, WA.
2. Bookheim, B. 2020. Personal communication with Betty Bookheim, marine ecologist, DNR Aquatic Reserves Program. In person and by phone, record on file—DNR Aquatic Reserves Program, Olympia, WA.
3. Hines, E. & Jaeren, L. 2018a. Intertidal biota monitoring in the Cherry Point and Fidalgo Bay Aquatic Reserves: 2013-2018 Monitoring Report. Prepared for Washington State Department of Natural Resources, Olympia, WA.
4. Jefferson, N. 2020. Personal communication with Nick Jefferson, Lummi Nation biologist. In person with written notes, record on file—DNR Aquatic Reserves Program, Olympia, WA.
5. Kyte, M.A. 2020. Personal communication with Michael Kyte, semi-retired consulting marine biologist. Email and by phone, record on file—DNR Aquatic Reserves Program, Olympia, WA.
6. Lemon, B. 2020. Personal communication with Bob Lemon, Cherry Point intertidal monitoring lead naturalist. Email, record on file—DNR Aquatic Reserves Program, Olympia, WA.
7. Schroeder, L. 2020. Personal communication with Linda Schroeder, Cherry Point intertidal monitoring lead naturalist. Email and by phone, record on file—DNR Aquatic Reserves Program, Olympia, WA.
8. Udea, K. 2020. iNaturalist research-grade observations. Available from https://www.inaturalist.org/. Occurrence dataset https://doi.org/10.15468/dl.gz1gyf accessed via GBIF.org on 4-Feb-20 and https://doi.org/10.15468/dl.eqca5j accessed via GBIF.org on 16-Jul-20.
9. Washington Department of Ecology. n.d. Marine sediment sampling at site PSAMP/NOAA-19 (1997) and PSAMP_SP_19 (2006). Online accessed on 8/14/20. Available from https://ecology.wa.gov/Research-Data/Data-resources/Environmental-Information-Management-database.

Table B–6: Aquatic Vegetation Observed in Cherry Point Aquatic Reserve

Common Name	Scientific Name	State Status	Federal Status	Source
Brown Algae – Phylum Ochrophyta				
Diatoms	Unidentified spp.			4
Order Desmarestiales				
Witch's hair	*Desmarestia aculeata*			2, 4, 6, 7, 10
Flattened acid weed	*Desmarestia herbacea*			1, 2, 6, 7, 10
Stringy acid kelp	*Desmarestia viridis*			6, 7, 10
Order Ectocarpales				
Bulb seaweed	*Colpomenia* sp.			4
Sea cauliflower	*Leathesia marina*			7
Whip tube	*Scytosiphon lomentaria*			7, 10
Soda straws	*Scytosiphon* sp.			4
Studded sea balloons	*Soranthera ulvoidea*			4
Sea balloons	*Soranthera* sp.			7
Order Fucales				
Rockweed, "two-headed wrack"	*Fucus distichus*			1, 4, 8
Rockweed	*Fucus* sp.			1, 2, 4, 7, 10
[a]Japanese weed, sargassum	*Sargassum muticum*			3, 4, 7, 8
Order Laminariales				
Seive kelp	*Agarum/Neoagarum* sp.			1, 6
Winged/ribbon kelp	*Alaria marginata*			2, 4, 10
Seersucker	*Costaria costata*			1, 2
Tangle Kelps, others	*Laminaria* sp.			2, 10
Bull kelp	*Nereocystis luetkeana*			1, 2, 4, 7, 10
Sugar wrack kelp	*Saccharina latissima*			1, 2, 4, 7, 8, 10
Sea cabbage	*Saccharina sessilis*			2, 4, 6
Order Ralfsales				
Sea fungus	*Ralfsia* sp.			4, 6, 7
Green Algae – Phylum Chlorophyta				
Order Bryopsidales				
Sea bottle	*Derbesia marina*			4, 6
Order Ulotrichales				
Green rope	*Acrosiphonia* sp.			4, 7
Order Ulvales				
Gut weed	*Ulva intestinalis*			2, 4

Common Name	Scientific Name	State Status	Federal Status	Source
Sea lettuce	*Ulva lactuca*			2, 4
Bright grass kelp	*Ulva linza*			4
Sea lettuces (unknown)	*Ulva* spp.			1, 2, 4, 7, 9, 10
Red Algae – Phylum Rhodophyta				
Order Bangiales				
Nori	*Pyropia/Porphyra* complex			1, 2, 4
Coldwater seaweed	*Wildemania amplissima*			2, 6
Order Ceramiales				
Red algae	*Ceramium* sp.			7
Red algae	*Cryptopleura/Hymenena* complex			4
Winged rib	*Cumathamnion decipiens*			2
Sea fern fringe	*Hymenena* sp.			2, 4
Coarse sea lace	*Microcladia* sp.			4, 7, 10
Black pine	*Neorhodomela larix*			4, 7
Fine thallus red algaes	*Odonthalia* spp.			1, 2
Sea brush	*Odonthalia floccosa*			4, 7, 9
Sea laurel	*Osmundea spectabilis*			7
Red algae	*Polyneura latissima*			7
Filamentous red algae	*Polysiphonia* sp. complex			2, 4
Order Corallinales				
Calcareous red algae	*Bossiella* sp.			4
Articulated red algae	*Corallinales* sp.			7
Encrusting red algae	*Corallinales* sp.			7
Order Erythropeltales				
Red fringe	*Smithora naiadum*			7
Order Gigartinales				
Beautiful leaf seaweed, red fan	*Callophyllis* spp.			4, 7, 9
Turkish towel	*Chondracanthus exasperatus*			2, 4, 8
Red algae	*Chondracanthus* sp.			7
Cracked saucer seaweed	*Constantinea subulifera*			4, 6, 7, 9
Bleached brunette	*Cryptosiphonia woodii*			4, 7
Farlow's seaweed	*Farlowia mollis*			1, 6
Turkish towel/washcloth	*Mastocarpus* sp.			1, 2, 3, 4, 7, 9
Iridescent seaweed	*Mazzaella splendens*			1, 2, 3, 4, 7, 9
Sea noodles	*Sarcodiotheca gaudichaudii*			2, 3, 4, 9

Common Name	Scientific Name	State Status	Federal Status	Source
	Order Gracilariales			
Red spaghetti algae	*Gracilaria/Gracilariopsis* spp.			1, 4, 6, 9, 10
	Order Halymeniales			
Bleach weed	*Prionitis* sp.			2, 4, 7, 9
	Order Hildenbrandiales			
Rusty rock	*Hildenbrandia* sp.			4, 7
	Order Palmariales			
Pacific dulse	*Devaleraea mollis*			2
Red ribbon	*Palmaria/Devaleraea* sp.			4
	Order Plocamiales			
Thalloid red algae	*Plocamium* sp.			2, 7, 9
	Order Rhodymeniales			
Red eyelet silk	*Sparlingia pertusa*			2
	Vascular Plants – Phylum Tracheophyta			
	Order Alismatales			
Marine Flowering Plants – Family Zosteraceae				
Dwarf/Japanese eelgrass	*Nanozostera japonica*			2, 4, 7, 10
Common eelgrass	*Zostera marina*			2, 4, 7, 8, 9, 10
	Salt Marsh and Spit/Berm Plants*			
	Daisy – Order Asterales			
Composit – Family Asteraceae				
Common yarrow	*Achillea millefolium*			3, 8
Silver burr ragweed	*Ambrosia chamissonis*			3, 4, 7
Absinth wormwood	*Artemisia* sp.			3, 4
Coastal mugwort	*Artemesia suksdorfii*			7, 8
Douglas aster	*Aster subspicatus*			3
Gumweed	*Grindelia integrifolia*			3, 5, 8
Goldenrod	*Solidago* sp.			7
	Mustards and Allies – Order Brassicales			
American sea-rocket	*Cakile edentula*			3, 4
European sea-rocket	*Cakile maritima*			3, 4
Sea-rocket	*Cakile* sp.			7
	Order Caryophyllales			
Fat-hen, Saltbush	*Atriplex patula*			3, 4, 6
Dock	*Rumex* sp.			3, 7
Pickleweed	*Salicornia virginica*			3, 5

Common Name	Scientific Name	State Status	Federal Status	Source
		Order Cyperales		
Chairmaker's bulrush	*Schoenoplectus americanus*			3
		Order Equisetales		
Horsetail	*Equisetum* spp.			3, 4
		Order Fabales		
Beach pea	*Lathyrus japonicus*			3, 8
Bird's-foot trefoil	*Lotus cornicatus*			3, 8
		Order Lamiales		
Ribwort plantain	*Plantago lanceolata*			3, 8
		Order Najadales		
Seaside arrowgrass	*Triglochin maritima*			3
		Order Poales		
Lyngbye's sedge	*Carex lyngbyei*			3
Tufted hairgrass	*Deschampsia cespitosa*			3
American dunegrass	*Leymus mollis*			3, 4, 7, 8
Common cattail	*Typha* spp.			3, 5
Seashore salt grass	*Distichilis spicata*			3, 5, 7
		Order Rosales		
Pacific silverweed	*Potentilla anserina*			3
		Fungi – Phylum Ascomycota		
		Lichens – Order Teloschistales		
Seaside fire dot	*Caloplaca* sp.			7
Lichen	*Physcia* sp.			7
Sunburst lichen	*Xanthoria* sp.			7
		Lichens – Order Verrucariales		
Sea tar lichen	*Verrucaria* sp.			7

[a] Invasive
* Species in the salt marsh and spit berm are upland of the reserve
NOTE: aquatic vegetation scientific names follow AlgaeBase naming conventions

Table B-6 Sources:

1. AMEC Environment & Infrastructure, Inc. 2012. 2012 Marine biology baseline inventory, Gateway Pacific Terminal, Whatcom County, Washington. Prepared for Pacific International Terminals, Inc., Seattle, WA.
2. AMEC Environment & Infrastructure, Inc. 2014. 2014 Marine biology baseline inventory, Gateway Pacific Terminal, Whatcom County, Washington. Prepared for Pacific International Terminals, Inc.

3. Bookheim, B. 2020. Personal communication with Betty Bookheim, marine ecologist, DNR Aquatic Reserves Program. In person and by phone, record on file—DNR Aquatic Reserves Program, Olympia, WA.
4. Hines, E. & Jaeren, L. 2018a. Intertidal biota monitoring in the Cherry Point and Fidalgo Bay Aquatic Reserves: 2013-2018 Monitoring Report. Prepared for Washington State Department of Natural Resources, Olympia, WA.
5. Hitchman, M. 2020. Personal communication with Marie Hitchman of the Cherry Point Aquatic Reserve Citizen Stewardship Committee. Phone and written notes, record on file—DNR Aquatic Reserves Program, Olympia, WA.
6. Lemon, B. 2020. Personal communication with Bob Lemon, Cherry Point intertidal monitoring lead naturalist. Email, record on file—DNR Aquatic Reserves Program, Olympia, WA.
7. Schroeder, L. 2020. Personal communication with Linda Schroeder, Cherry Point intertidal monitoring lead naturalist. Email and phone, record on file—DNR Aquatic Reserves Program, Olympia, WA.
8. Udea, K. 2020. iNaturalist research-grade observations. Available from https://www.inaturalist.org/. Occurrence dataset https://doi.org/10.15468/dl.gz1gyf accessed via GBIF.org on 4-Feb-20 and https://doi.org/10.15468/dl.eqca5j accessed via GBIF.org on 16-Jul-20.
9. Washington Department of Fish and Wildlife. n.d. Herring spawn survey database 2012-2018. Database on file—DNR Aquatic Reserves Program, Olympia, WA.
10. Washington Department of Natural Resources. 2014. Washington marine vegetation atlas. Online accessed on 11/24/20. Availalble from http://mva-test.apphb.com/index.html.

Appendix C – Maps

State-owned aquatic land is derived from DNR ownership index plates and does not represent actual spatial extent of tidelands and shorelands. Bedlands are not separately represented on this map, however are included within the areas represented by the tideland and shoreland classifications.

Extreme care was used during the compilation of this map to ensure accuracy. However, due to changes in data and the need to rely on outside sources of information, the Department of Natural Resources cannot accept responsibility for errors or omissions, and, therefore, there are no warranties which accompany this material.

List of Maps

Map coordinate system: North American Datum of 1983 (NAD83 HARN), Washington State Plane South, feet

Map Data Sources

BASE LAYERS

Imagery: 2017 Washington Orthophoto 1 foot 4 band, Northwest Geomatics, LTD (DNR)
International Border: US-Canada border, Canada/United States of America Boundary Dataset, Homeland Infrastructure Foundation-Level Data, 2017 (https://hifld-geoplatform.opendata.arcgis.com/datasets/canada-and-us-border)
Lakes: DNR Hydrography – water bodies (https://geo.wa.gov/)
Marine Waters: Northwest Marine Waters (DNR, Nearshore Habitat Program)
Rivers and Streams: DNR Hydrography – water courses (https://geo.wa.gov/)
Roads: County Routes, Washington State Department of Transportation (https://www.wsdot.wa.gov/mapsdata/geodatacatalog/)

MARINE

Bathymetry: 30 ft depth contours, WDFW (DNR); Bathymetry shading, Finlayson D.P., Haugerud, R.A., Greenberg, H., and Logsdon, M.G. 2000. Puget Sound Digital Elevation Model. University of Washington (https://www.ocean.washington.edu/data/pugetsound/psdem2000.html)
Overwater Structures: Over water structures, Marine Waters (DNR, Aquatic Resources Division)
Vessel Traffic: Automatic Identification System (AIS) vessel transit counts, Office for Coastal Management, 2020: 2015-2019 AIS Vessel Transit Counts (https://marinecadastre.gov/)

UPLAND

Elevation: Bare Earth LiDAR Elevation (DNR)
Imperviousness: Percent imperviousness, U.S. Geological Survey, National Land Cover Database 2016 v2016 (https://www.mrlc.gov/)
Watershed: Water Resource Inventory Area 1 boundary, Ecology, 2000 (https://geo.wa.gov/); Stream order, National Hydrography Dataset for Washington, Puget Sound Subregion 1711, Ecology, 2019 (https://geo.wa.gov/)

LAND USE/OWNERSHIP

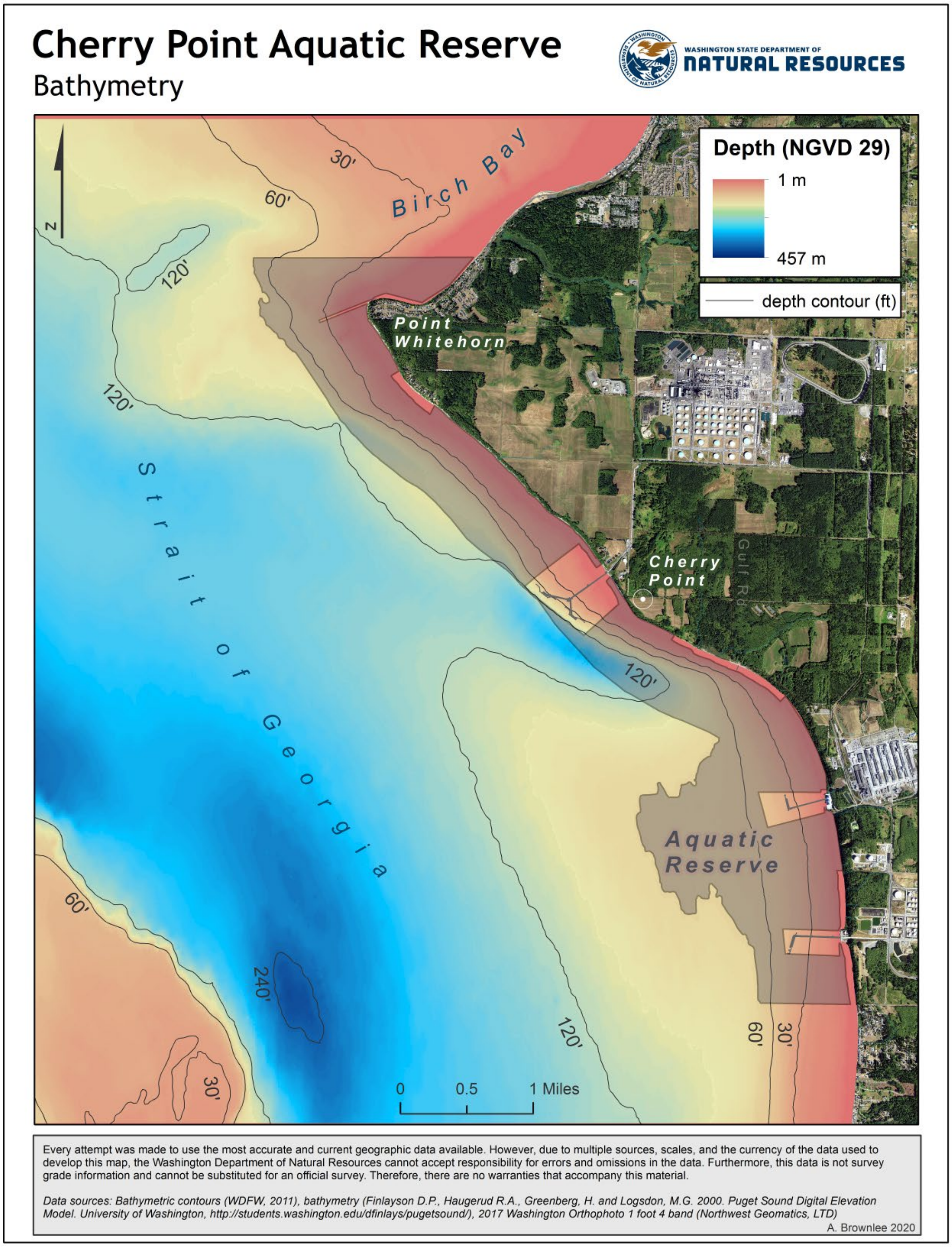
Active Encumbrances: Active encumbrance footprints, Encumbrances (DNR)
Aquatic Lands Ownership: Assumed Aquatic Lands Ownership (DNR)
Aquatic Reserve Boundary: Aquatic Reserves (DNR)
Public Lands: Washington State Non-DNR Major Public Lands (DNR)
Shoreline Environment Designations: Whatcom County (obtained from Whatcom County, April 2020)
Tribal Lands and Reservations: Washington State Non-DNR Major Public Lands (DNR)
Zoning: Current Whatcom County zoning designations, Whatcom County, downloaded January 30, 2020 (https://www.whatcomcounty.us/716/Data)

HABITAT AND SPECIES

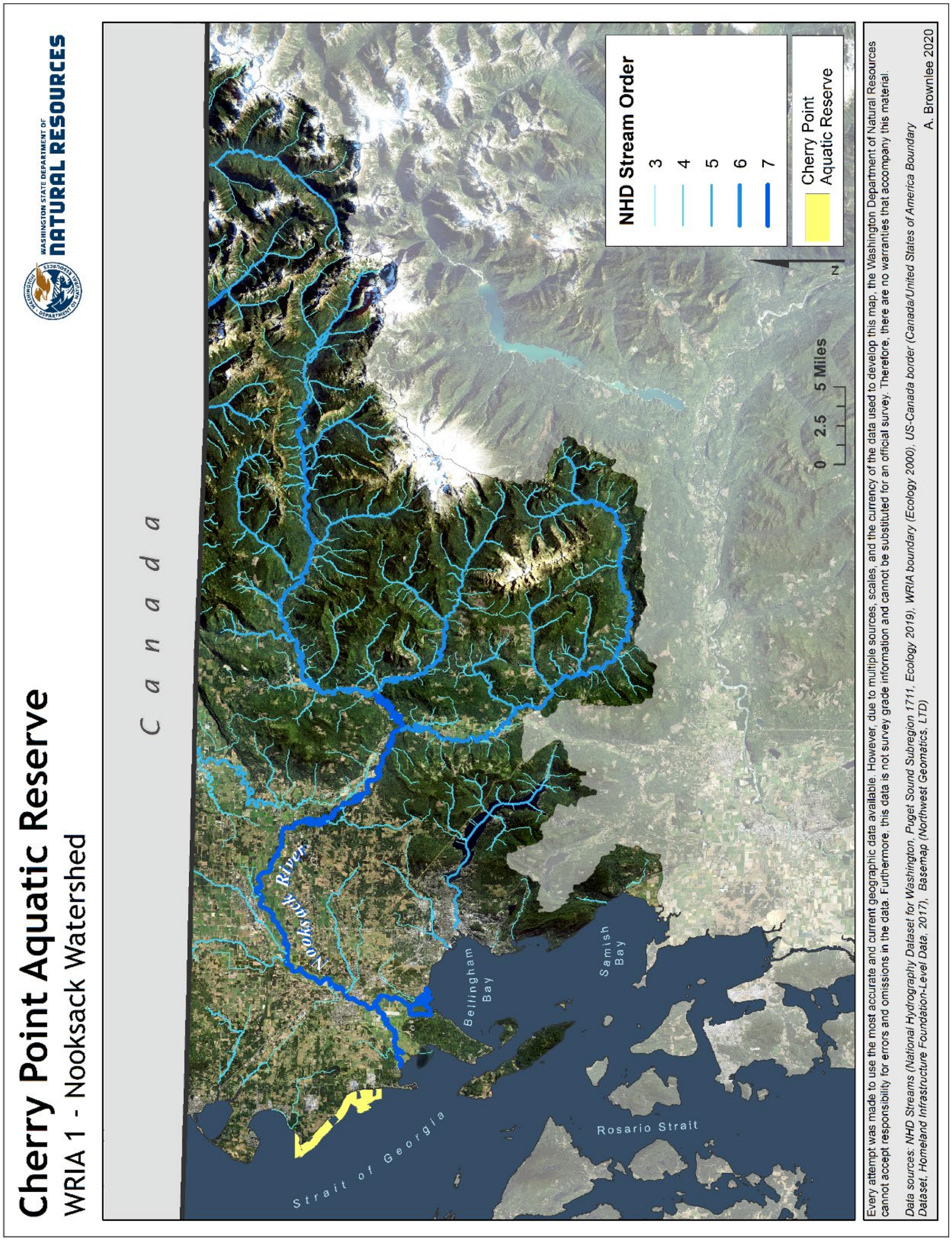
Benthic Substrate: Intertidal Habitat Inventory 1995, Whatcom County, WA, (DNR Nearshore Habitat Program)
Citizen Stewardship Committee Monitoring Sites: Intertidal and Avian sample sites (DNR, Aquatic Reserves Program)
Forage Fish: Sand lance and surf smelt egg abundance (DNR Aquatic Reserves Program)

Herring Spawn: Herring spawn data (database obtained from WDFW); Historic herring areas, WDFW (https://geo.wa.gov/)
Mussel Watch: Transplant locations, WDFW Mussel Watch Program (DNR, Aquatic Reserves Program)
Seagrass Distribution: Intertidal Habitat Inventory 1995, Whatcom County, WA (DNR, Nearshore Habitat Program); ShoreZone Inventory (DNR, Nearshore Habitat Program); Submerged Vegetation Monitoring Program (SVMP) eelgrass transects, 2000-2017 geospatial database (DNR, Nearshore Habitat Program)
Sediment Sampling Sites: DNR sediment sites (DNR Aquatic Reserves Program); Ecology Marine Sediment sites, Ecology's Environmental Information Management database (https://ecology.wa.gov/Research-Data/Data-resources/Environmental-Information-Management-database)
Sediment Transport: Drift cell direction and shore type, Beach Strategies 2017 geodatabase, Coastal Geologic Services, Western Washington University Spatial Institute, Puget Sound Partnership, map services published by WDFW (https:/fortress.wa.gov/dfw/public/PublicDownload/Habitat)
Shoreline Modifications: Shoreline armoring and nearshore fill, Puget Sound Nearshore Ecosystem Restoration Project database, Washington State Geospatial Data Archive (https://wagda.lib.washington.edu/data/geography/wa_state/)
Water Quality: DNR stormwater sample locations (DNR Aquatic Reserves Program)

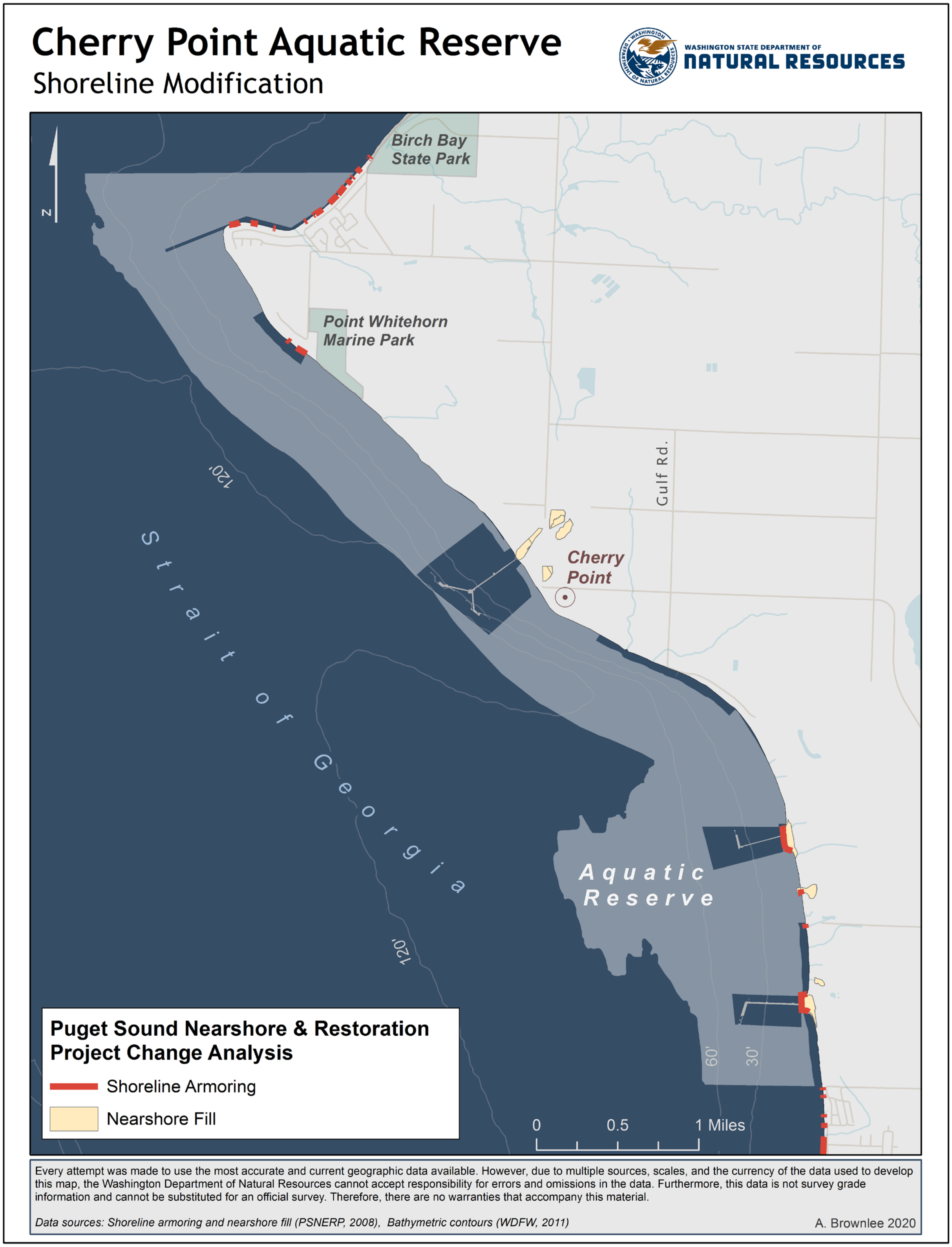
Map C-1. Bathymetry



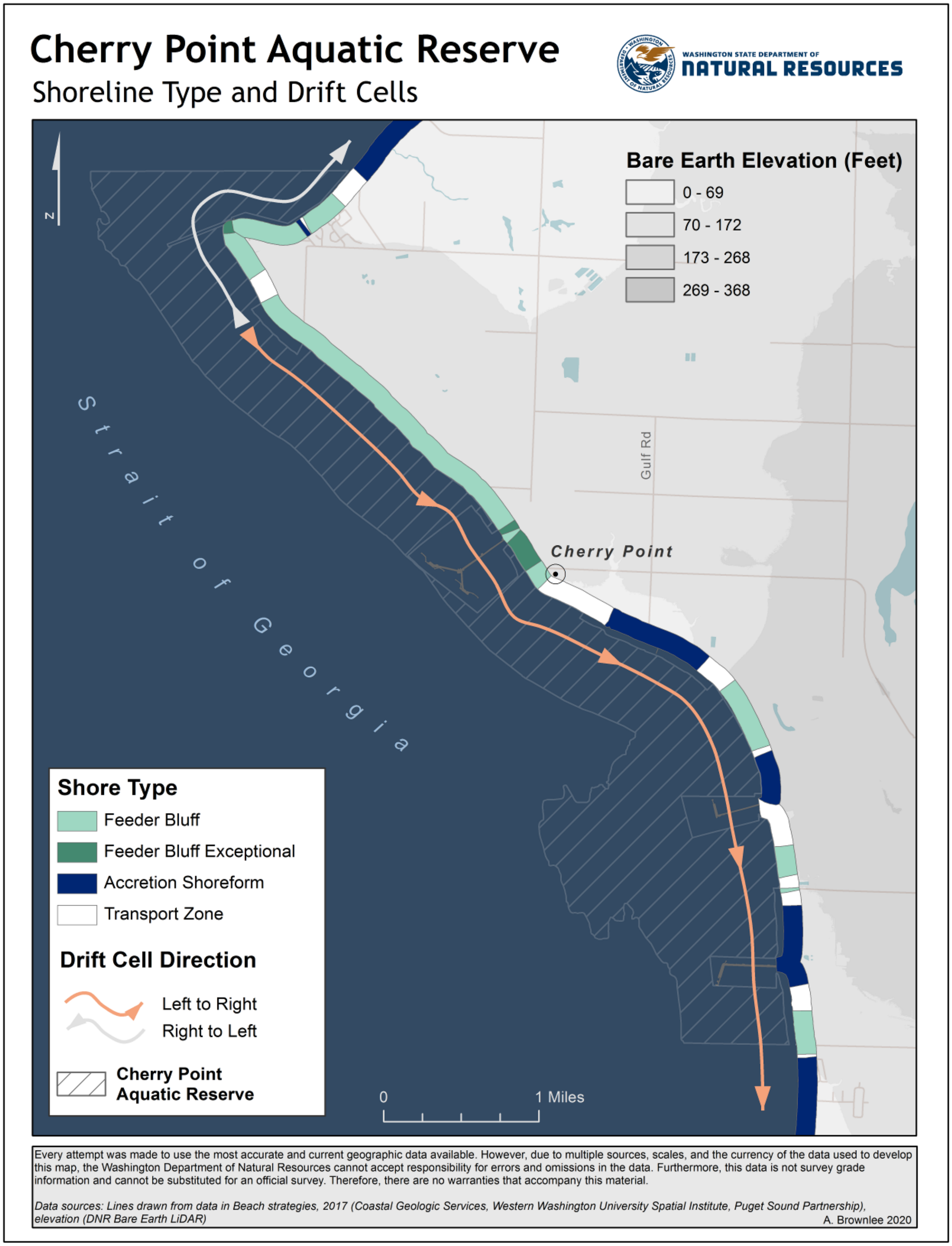
Map C-2. WRIA 1 – Nooksack Watershed



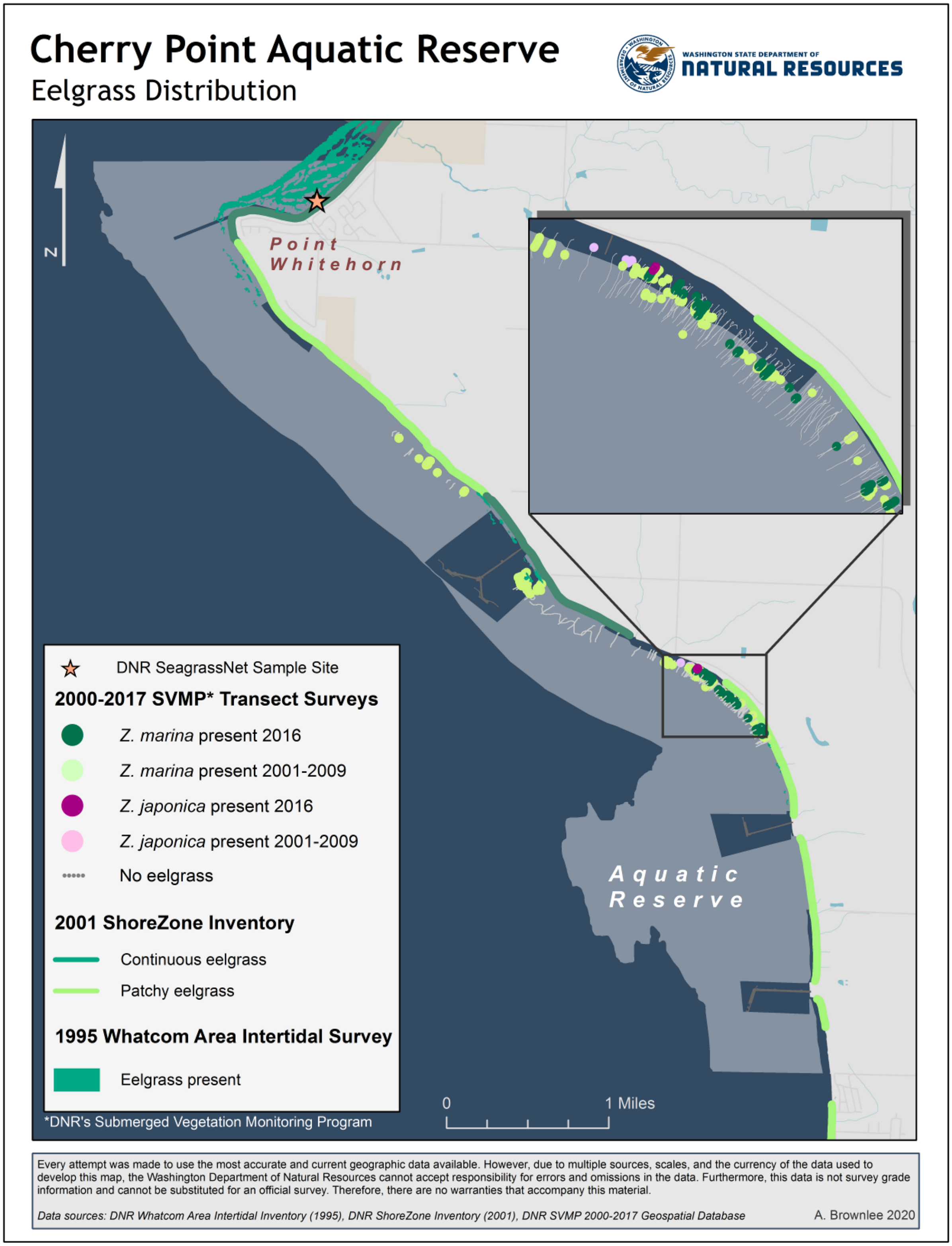
Map C-3. Shoreline Modification



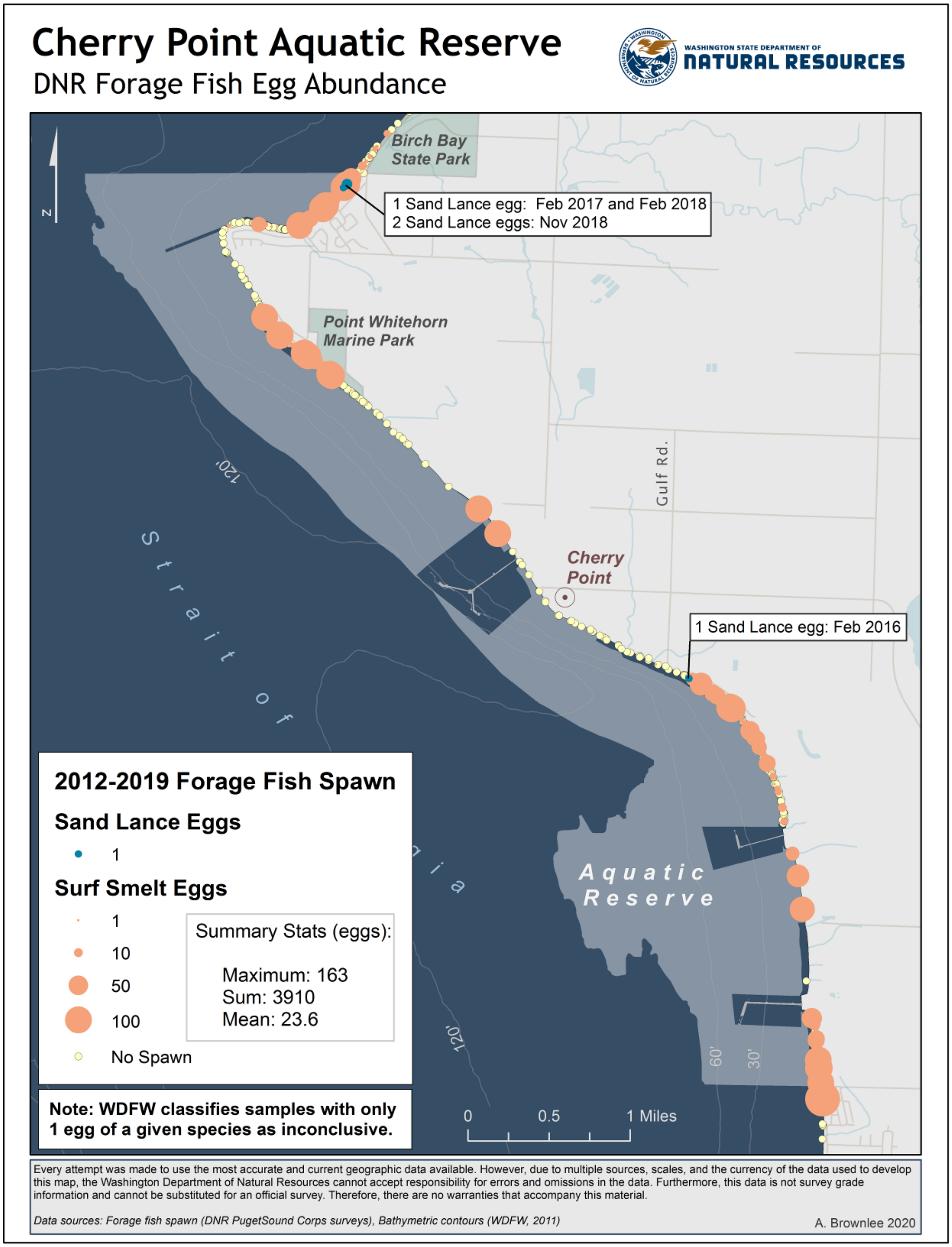
Map C-4. Shoreline Type and Drift Cells



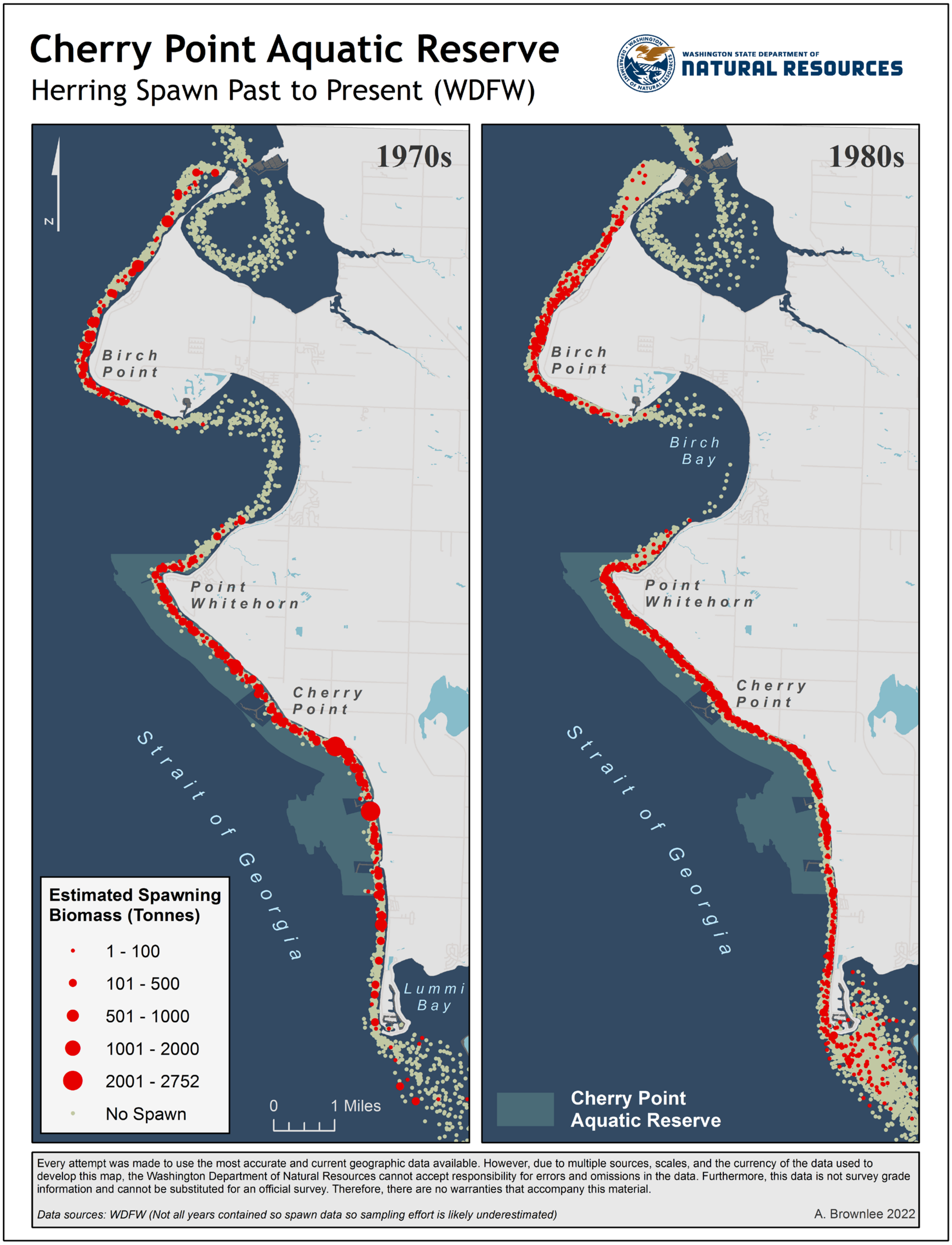
Map C-5. Eelgrass Distribution



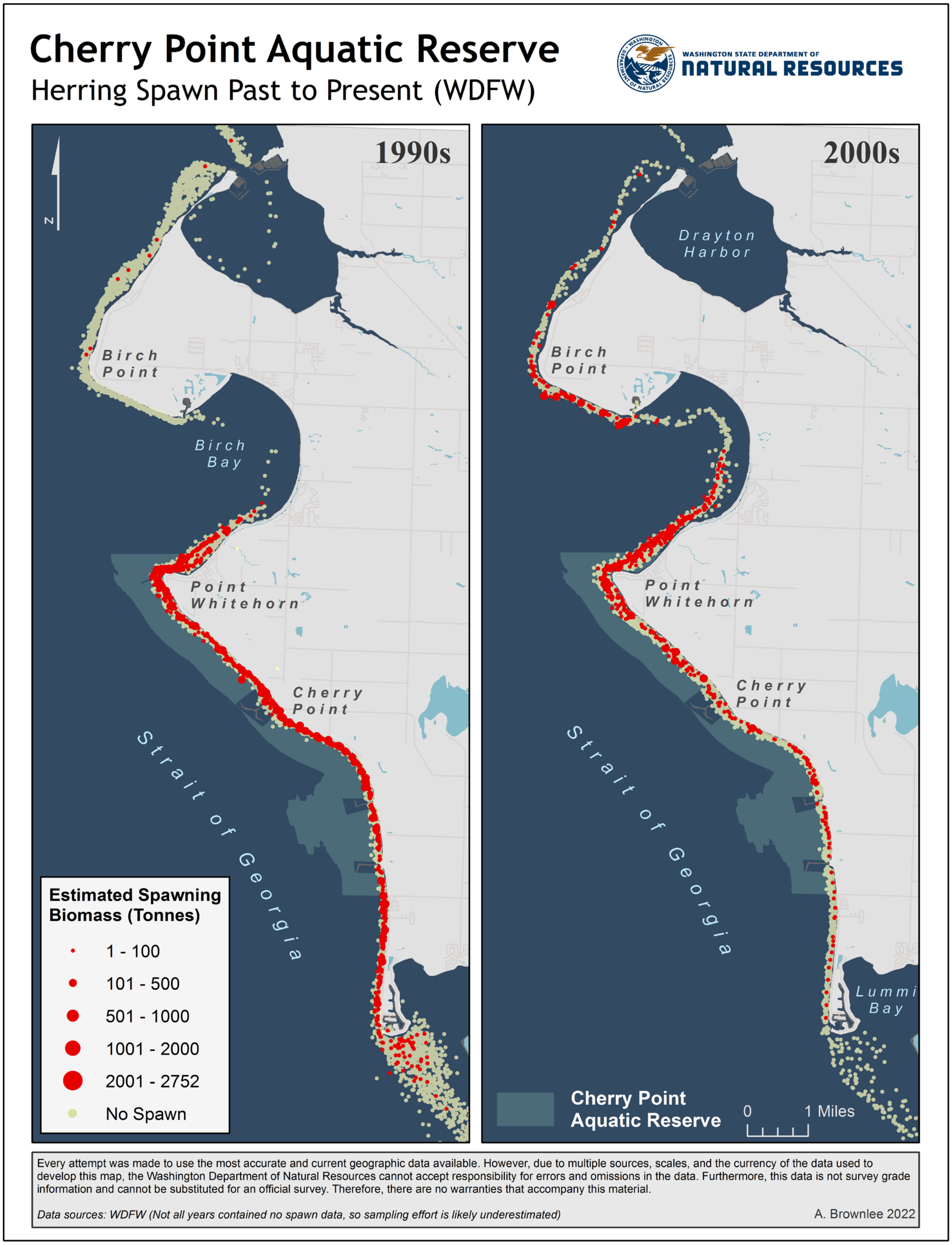
Map C-6. DNR Forage Fish Egg Abundance



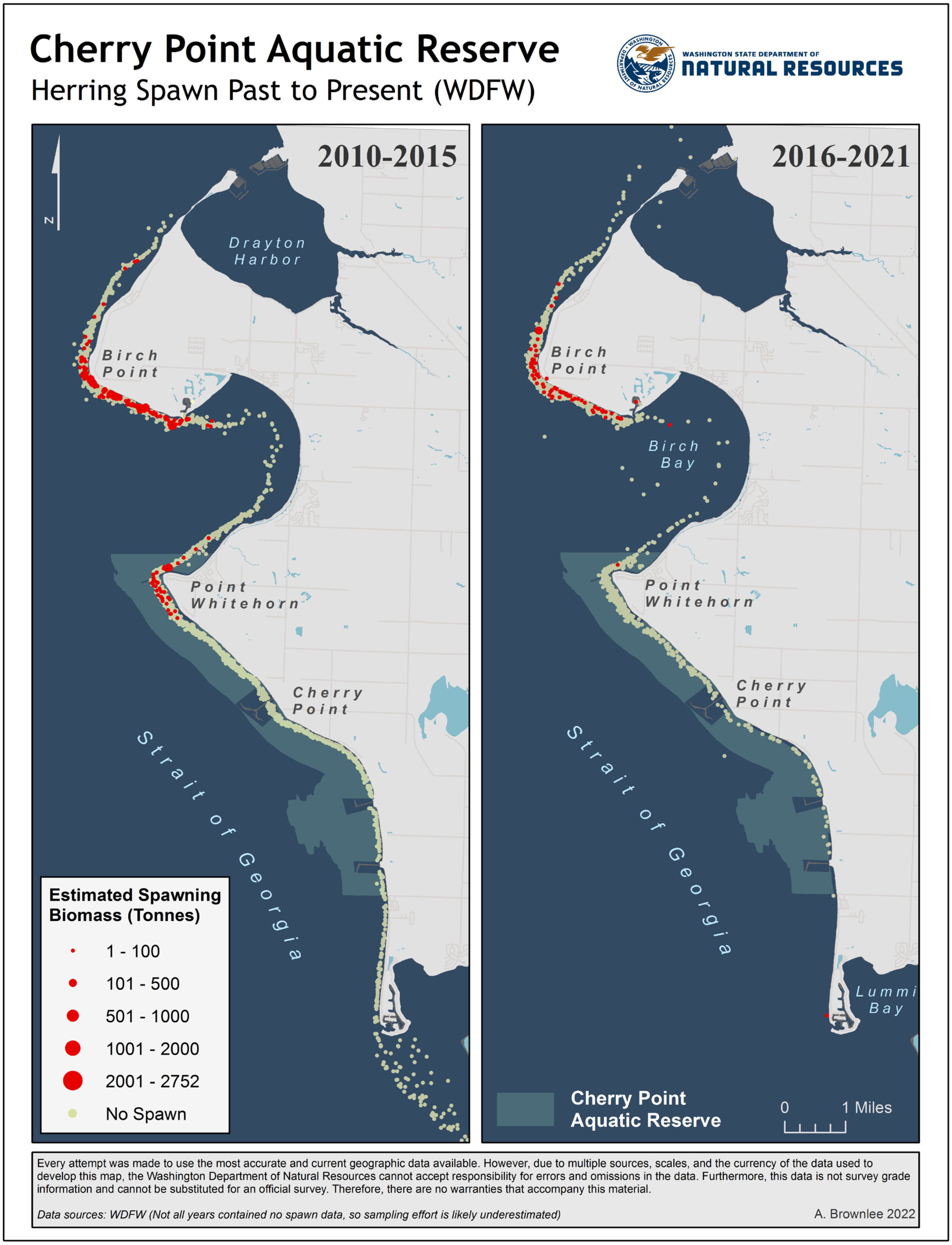
Map C-7. Herring Spawn Past to Present 1970s to 1980s



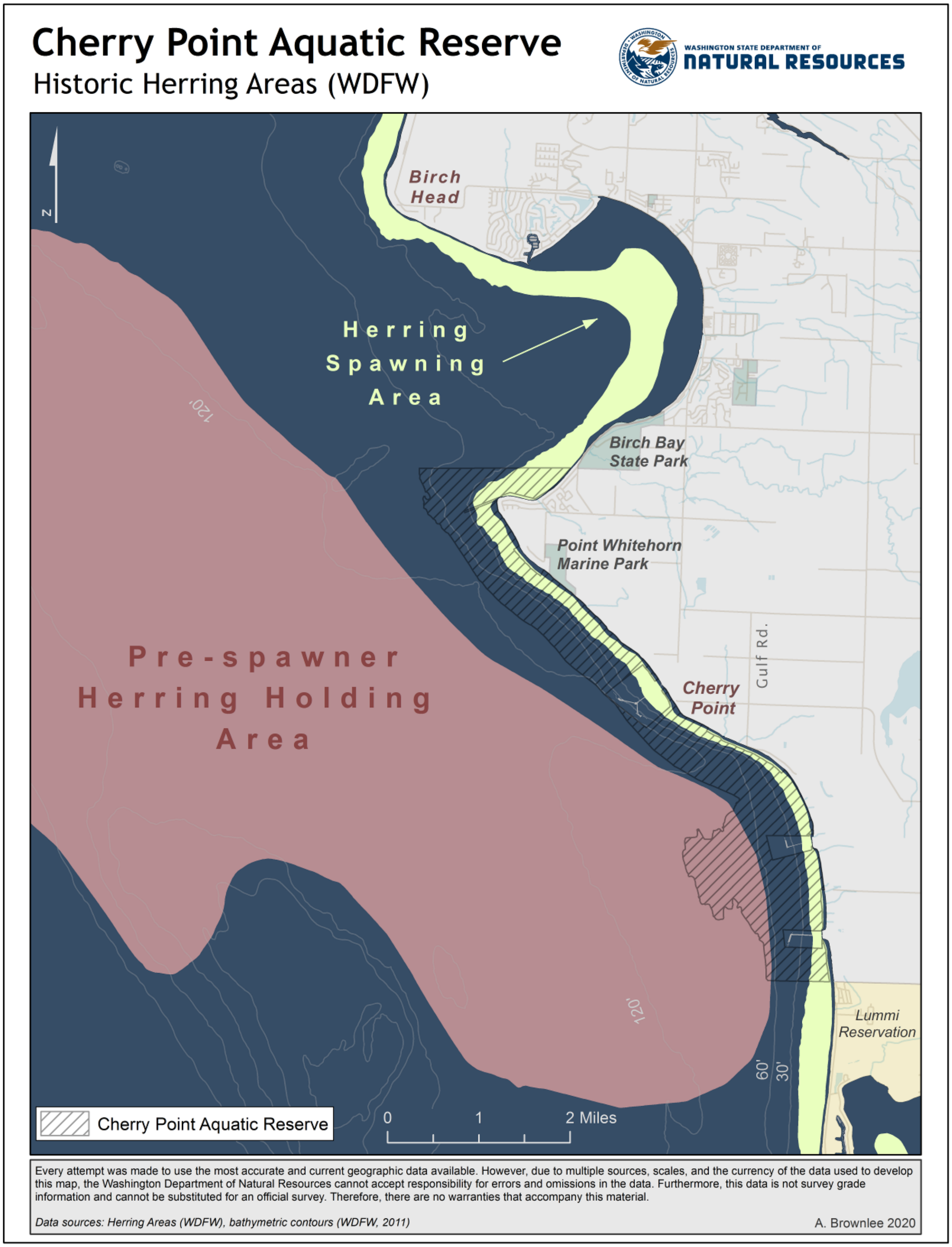
Map C-8. Herring Spawn Past to Present 1990s to 2000s



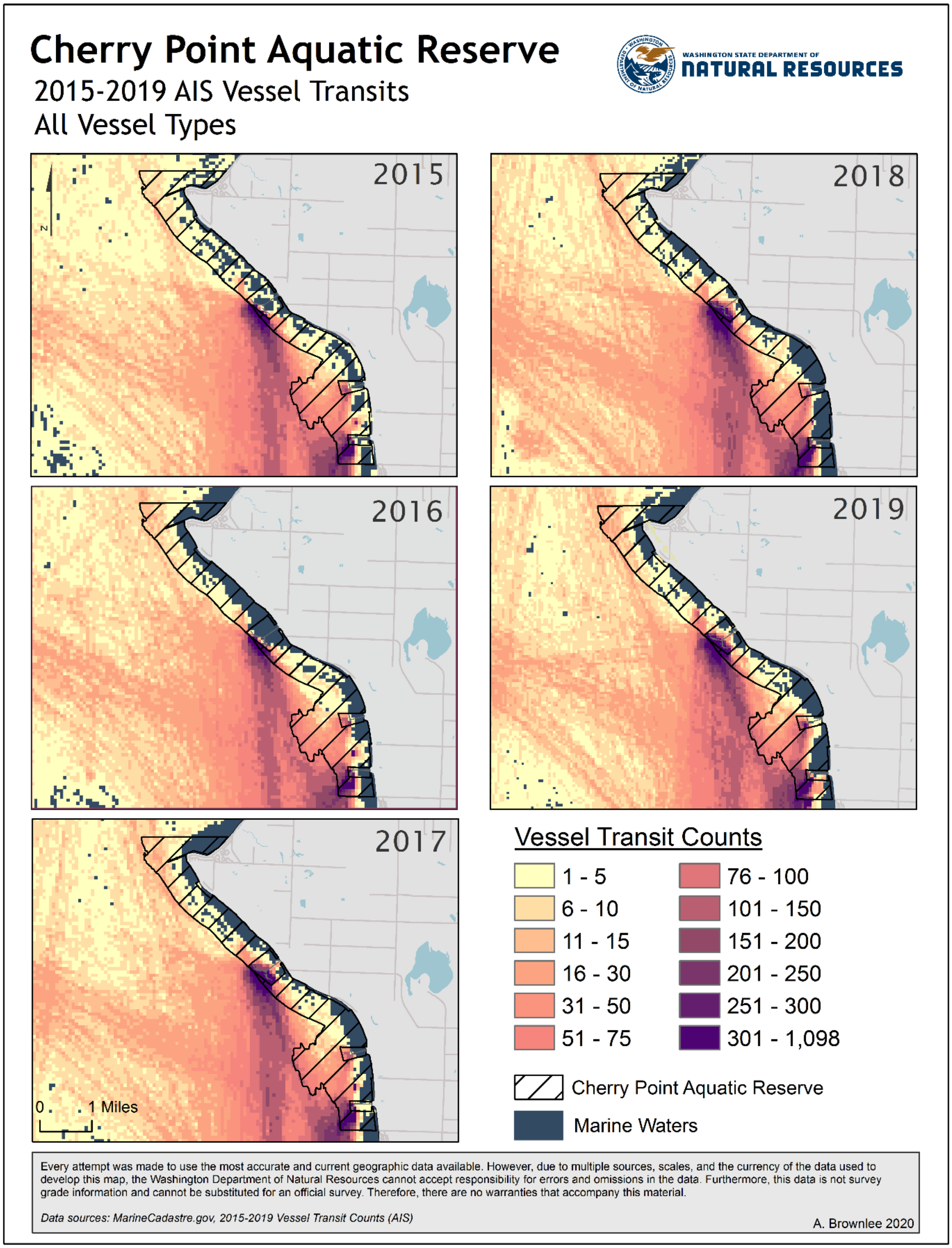
Map C-9. Herring Spawn Past to Present 2010 to 2018



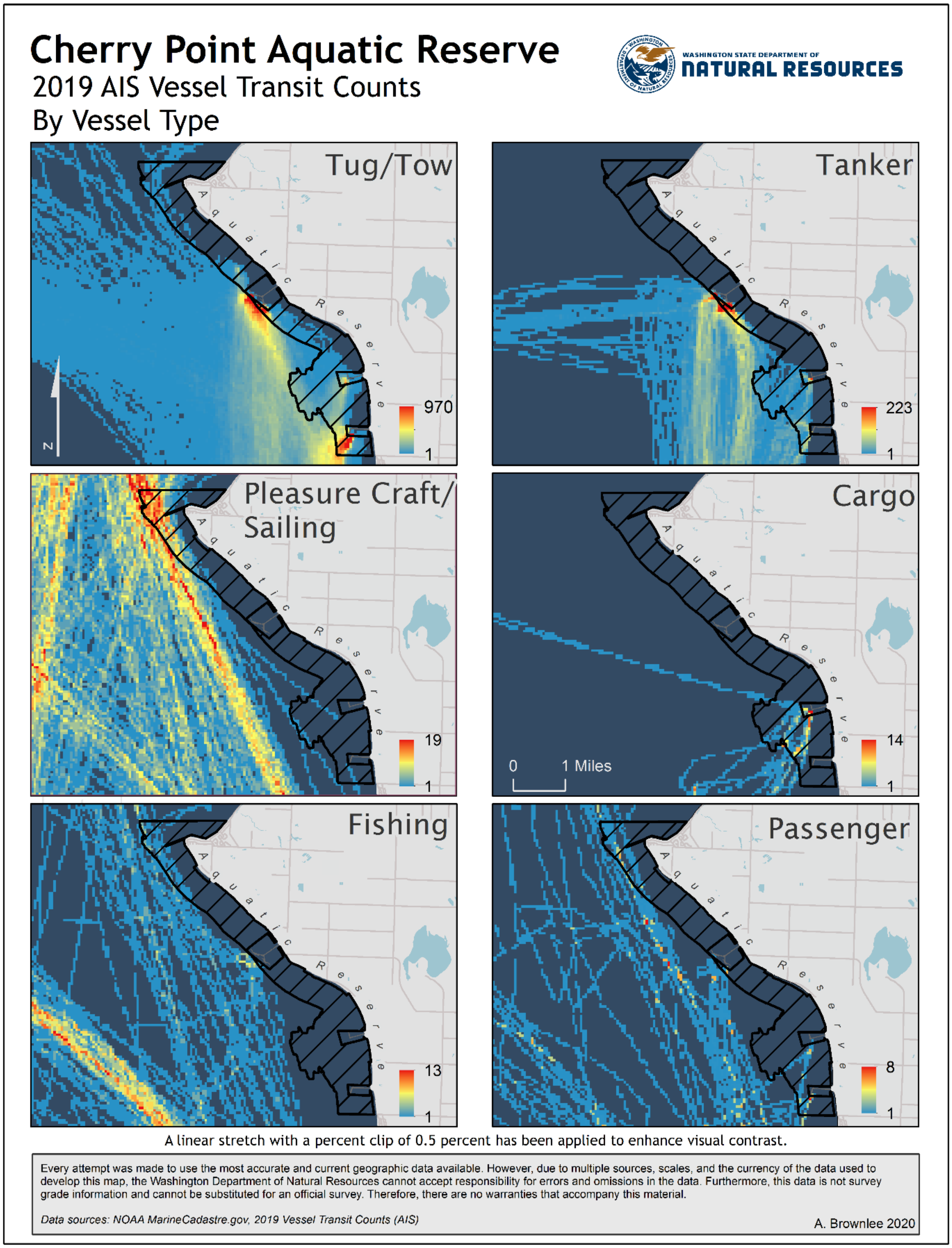
Map C-10. Historic Herring Areas



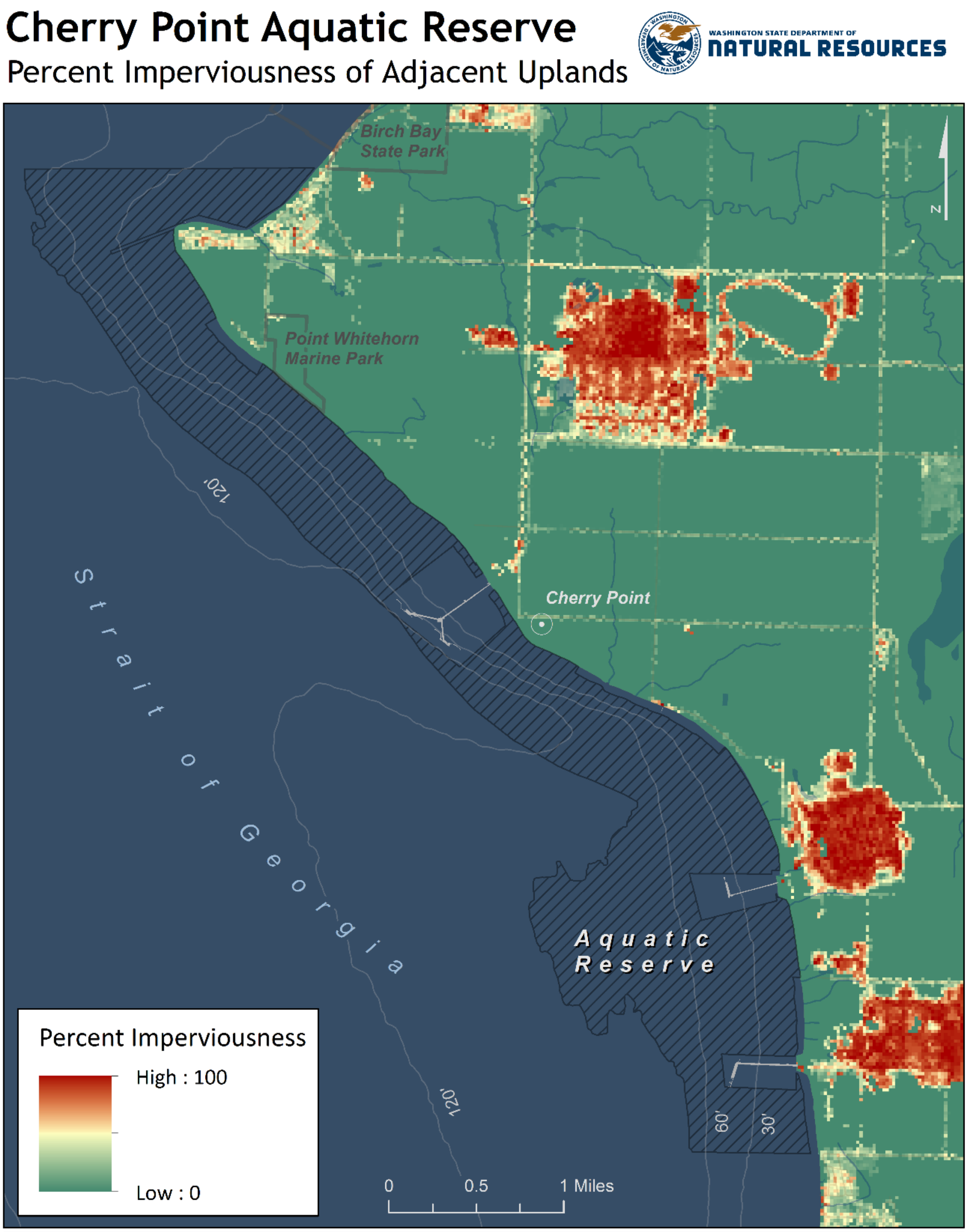
Map C-11. 2015-2019 AIS Vessel Transits (All Vessel Types)



Map C-12. 2019 AIS Vessel Transit Counts (By Vessel Type)



Map C-13. Percent Imperviousness of Adjacent Uplands

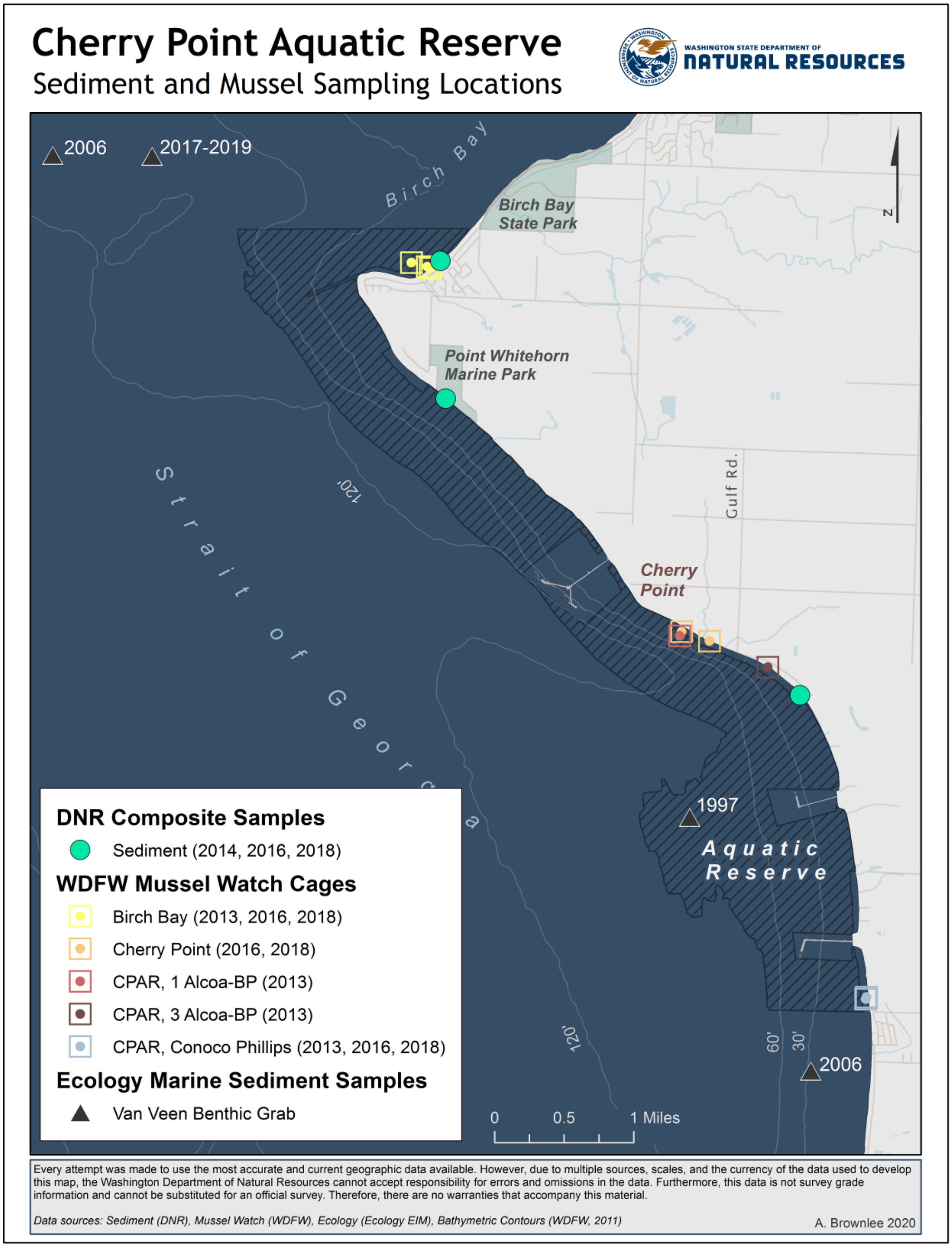


Every attempt was made to use the most accurate and current geographic data available. However, due to multiple sources, scales, and the currency of the data used to develop this map, the Washington Department of Natural Resources cannot accept responsibility for errors and omissions in the data. Furthermore, this data is not survey grade information and cannot be substituted for an official survey. Therefore, there are no warranties that accompany this material.

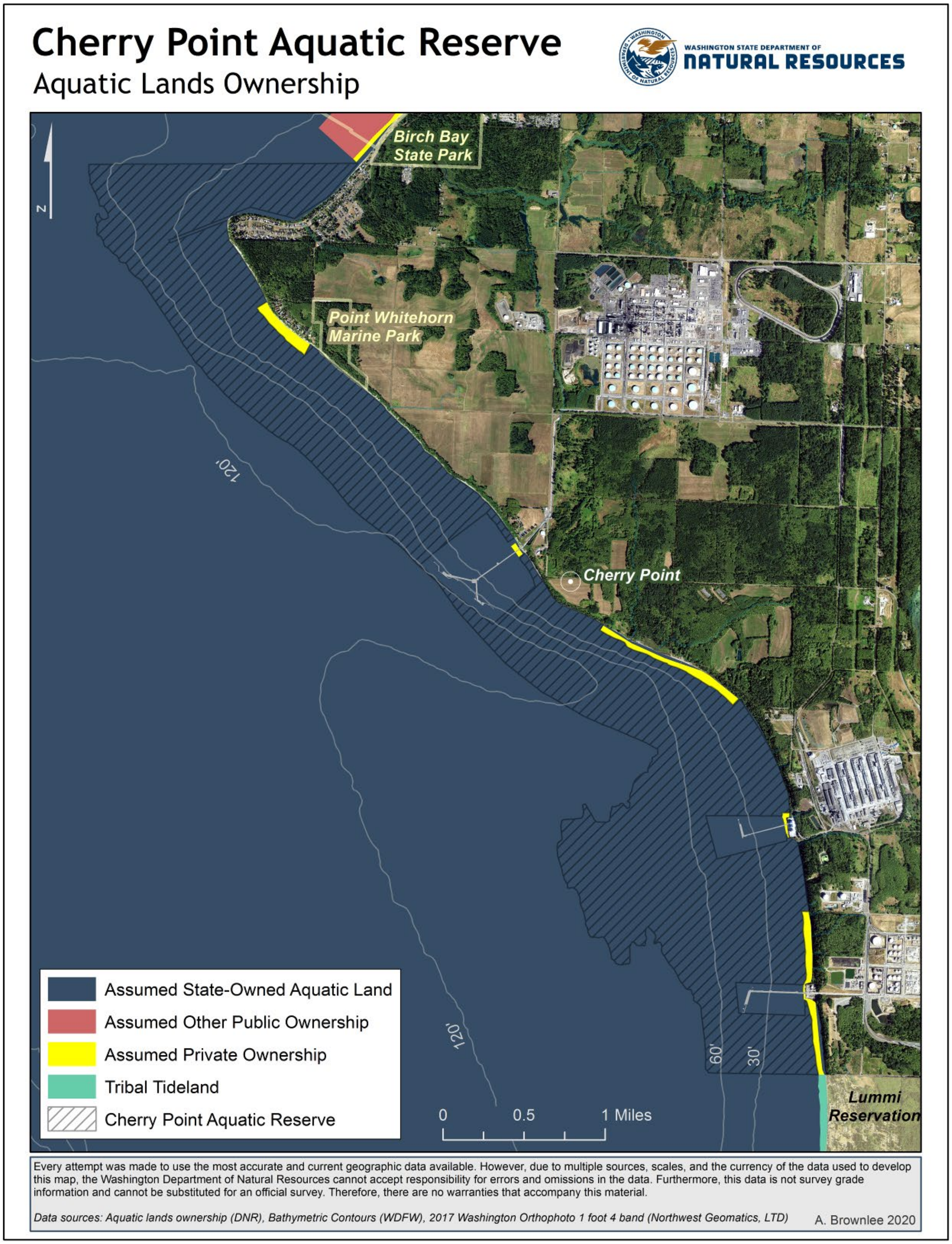
Data sources: Percent imperviousness (USGS NLCD 2016, v2016), Bathymetric contours (WDFW, 2011)

A. Brownlee 2020

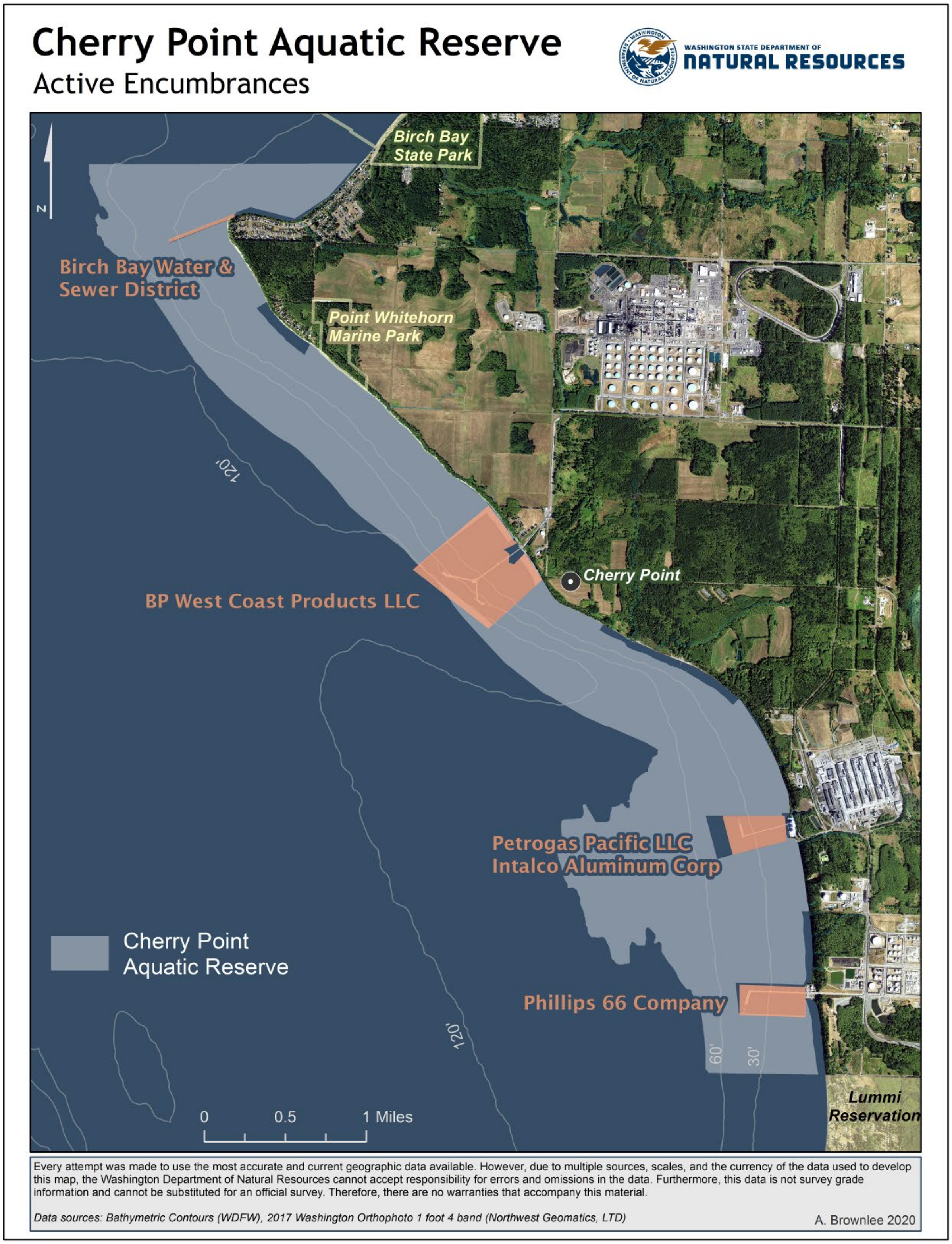
Map C-14. Sediment and Mussel Sampling Locations



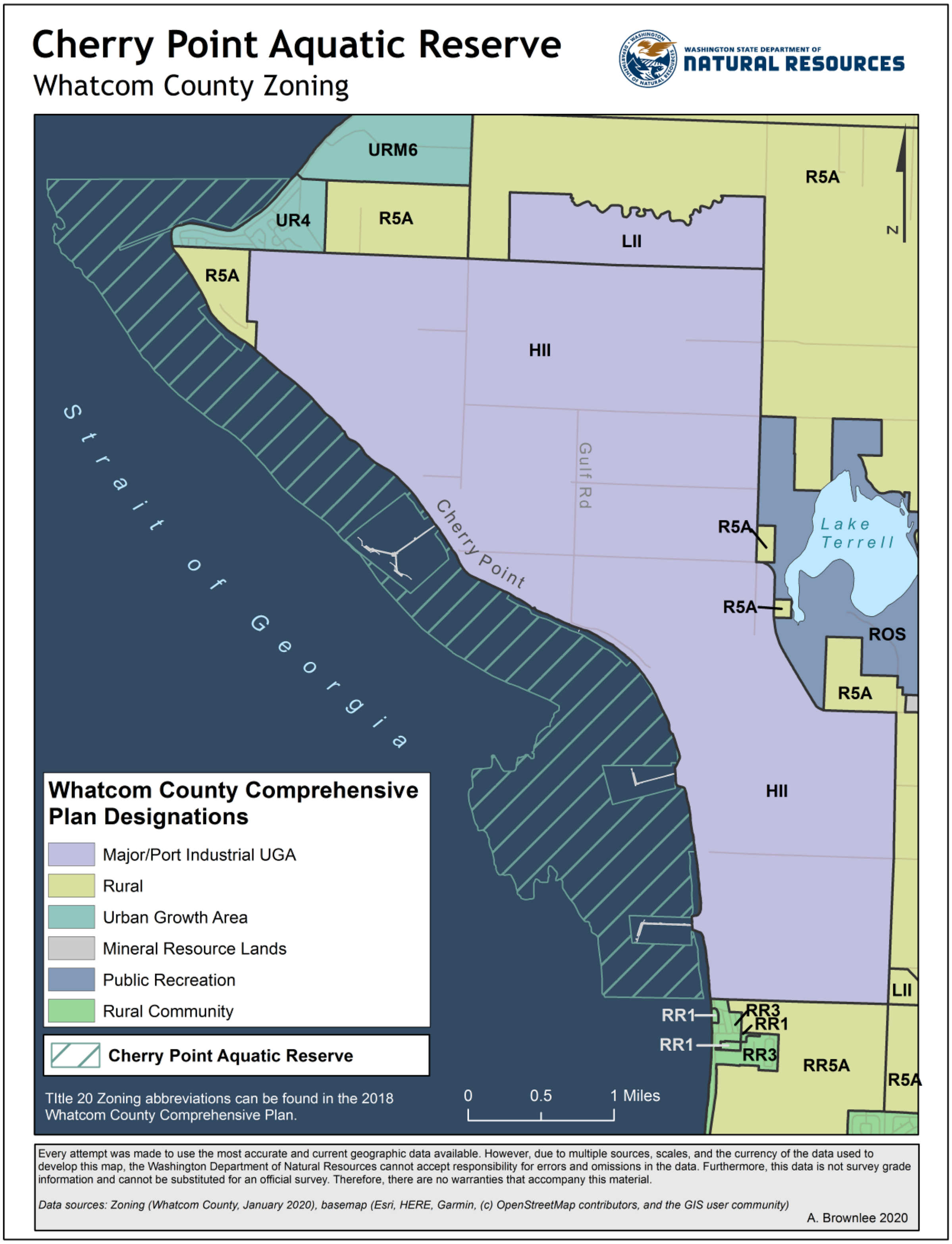
Map C-15. Aquatic Lands Ownership



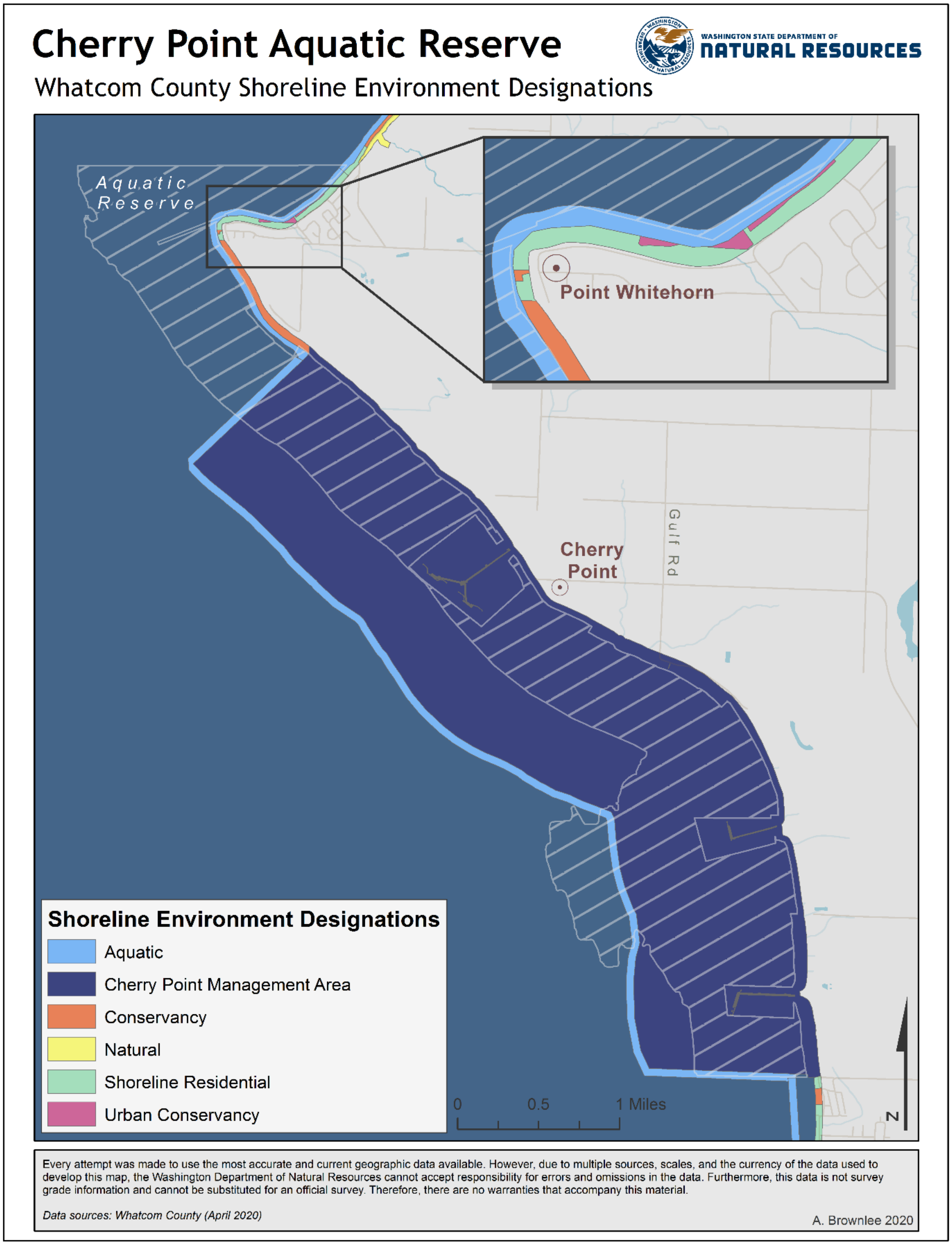
Map C-16. Active Encumbrances



Map C-17. Whatcom County Zoning

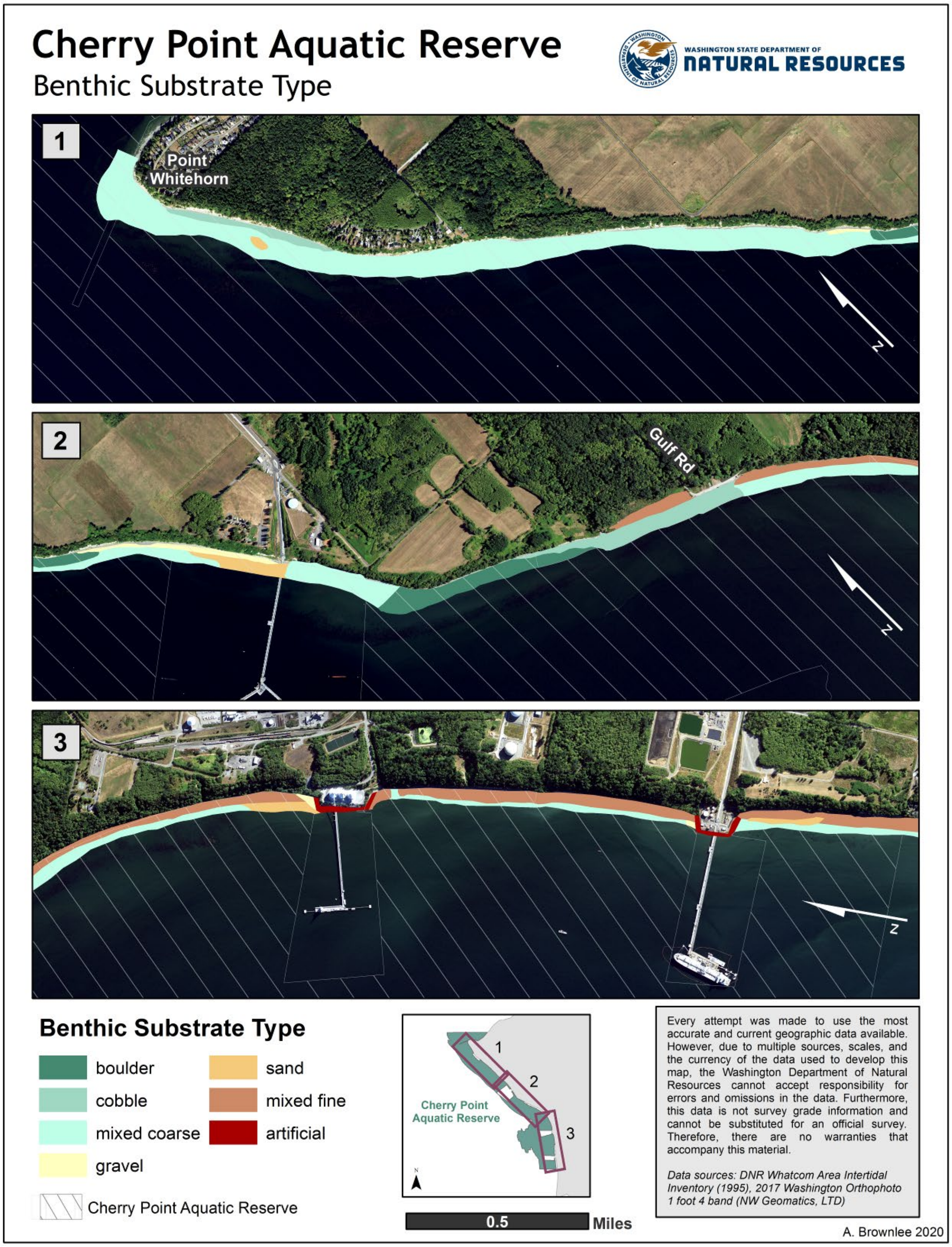


Map C-18. Whatcom County Shoreline Environment Designations

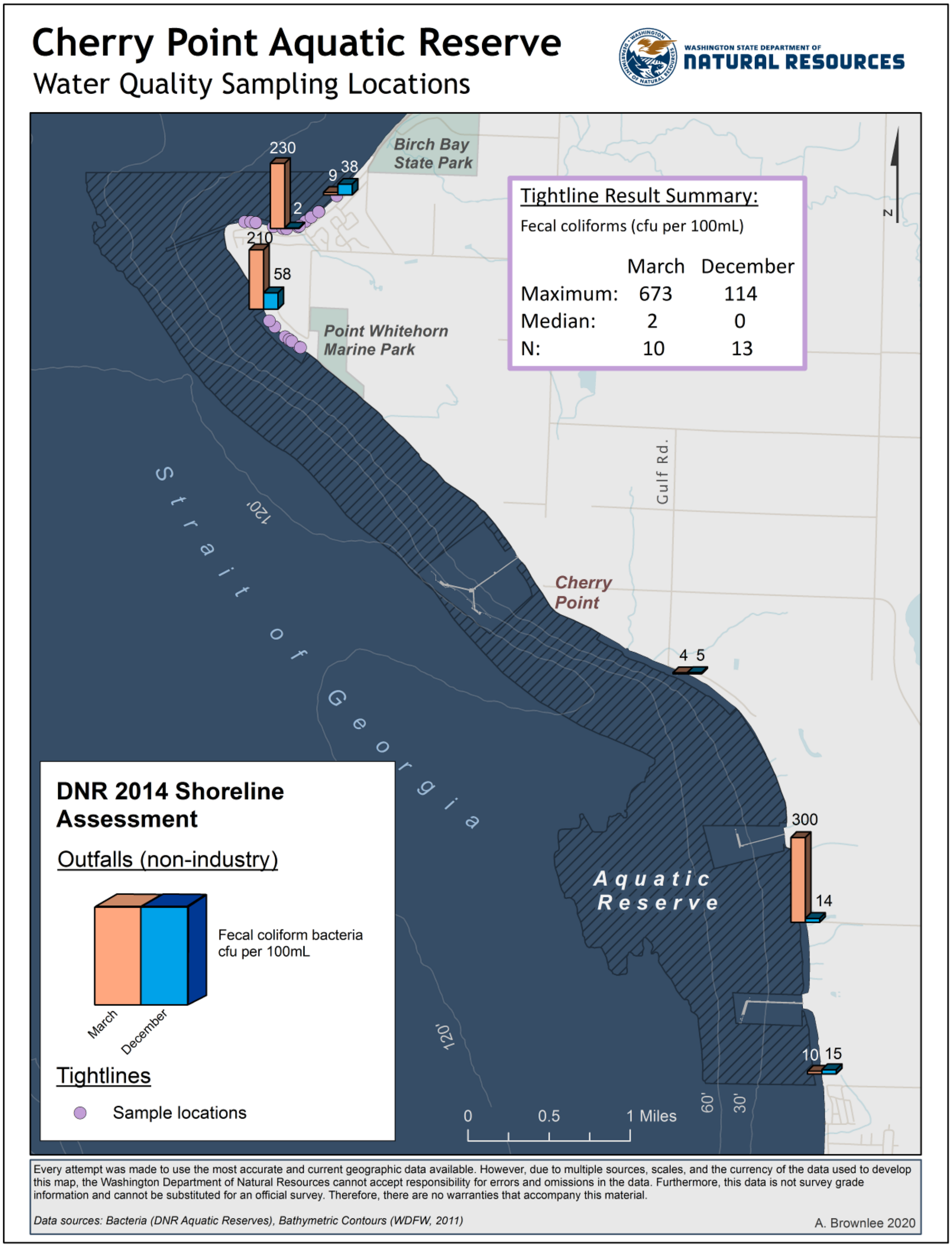


Map C-19. Citizen Stewardship Committee Intertidal and Avian Monitoring Sites

Map C-20. Benthic Substrate Type



Map C-21. Water Quality Sampling Locations



Appendix D – Existing Encumbrances Abutting the Aquatic Reserve

The following encumbrances have specific exceptions from the aquatic reserve in the original Commissioner of Public Lands withdrawal order. All of the leases and easements below abut, are adjacent to, or are in the the Cherry Point Aquatic Reserve.

Birch Bay Water and Sewer District: DNR Aquatic Land Easement 51-082214 authorizing wastewater pipeline and diffuser

This easement grants use of right of way measuring 2,300 feet in length and 100 feet in width comprising a total area of 5.28 acres of tidelands and bedlands. The Birch Bay Water and Sewer District continuously discharges treated municipal wastewater under terms of a National Pollutant Discharge Elimination System permit. The use was first established on March 23, 1975 as a Lease 20-010521 and renewed as an easement on January 13, 2009.

The term for the BBWSD easement, # 51-083314, is March 23, 2009 – March 22, 2039

bp Cherry Point Refinery: DNR Aquatic Land Lease 20-A09122 authorizing pier and outfall

The bp Cherry Point Refinery is located at 4519 Grandview Road. The refinery proper is situated on 849 acres of developed land. An additional approximately 2,000 acres of undeveloped land owned by bp exists around the refinery, including approximately 1,000 acres of marine riparian land between the Cherry Point Refinery Dock and Point Whitehorn. The refinery has been in operation since 1971.

The refinery processes crude oil received by tanker at the marine terminal, pipeline from Canada, and rail. Refinery throughput averages approximately 250,000 barrels of crude oil per day, making it the largest refinery in Washington State. The refinery produces multiple grades of gasoline, jet fuel, low-sulfur and ultra-low sulfur diesel, calcined coke, butane, propane and sulfur. The Cherry Point Refinery operates 24 hours a day, 365 days a year, except during turnaround periods that occur about once every two to three years. The refinery has approximately 800 full-time bp employees; an additional approximately 1000 contractors also work on-site.

The Cherry Point Refinery marine terminal is located approximately 1.5 miles south of the refinery, extending 2,100 feet offshore into the Southeast Strait of Georgia in a “Y” configuration and terminating in two vessel berths - the North and South Dock Wings. The Cherry Point dock is constructed of concrete on steel pilings and there is a minimum of 65 feet of water alongside each dock wing at Mean Lower Low Water. The Cherry Point Dock can accommodate only one tanker or barge at a time on the seaward side of each dock wing (2 vessels maximum at the terminal at any time). The maximum vessel length that can be accommodated is 1,100 feet.

The refinery has the capability to receive 100% of its crude oil needs via tanker deliveries and often relies on this capability to supply its operations; ultimately, however, global market conditions and other factors dictate the amount of crude oil Cherry Point receives by tanker. Similarly, the refinery has the capability to ship 100% of its refined petroleum products (other than butane, coke, and liquified petroleum gas) by tanker or barge from the marine terminal, as market conditions dictate. Due to global market conditions, the total crude plus product vessel traffic calling on the bp Cherry Point dock varies from year to year, with a current annual high of 416 vessel calls in calendar year 2007. Both crude oil and refined products are loaded/unloaded using fixed “marine loading arms.”

Dock operations at the bp Cherry Point refinery are conducted in accordance with the refinery's US Coast Guard- and Washington Department of Ecology-approved Oil Handling Facility Operations Manual, which describes personnel responsibilities, dock operating procedures, and safe operating envelopes (for example, maximum wind conditions and sea state during which transfers can occur). The bp Cherry Point refinery has a dock inspection and maintenance program designed to ensure the long-term operational integrity of the pier.

The Cherry Point Refinery processes industrial wastewater and stormwater through its on-site wastewater treatment plant and discharges an average 3.5 million gallons per day of combined treated process wastewater and stormwater under NPDES Permit No. WA 002290-0 to the Strait of Georgia through a diffuser located below the North Dock. The NPDES permit requires daily effluent quality monitoring, effluent mixing and fish toxicity studies, groundwater studies, sediment quality studies, and the development and implementation of Pollution Prevention Plans. In contrast to the outfalls at the Petrogas/Intalco and Phillips 66 piers, which are authorized by DNR under separate easements, the wastewater outfall at bp is authorized under the Aquatic Lands Lease.

The term for the bp lease, # 20-A09122, is April 1, 1999 – March 31, 2029.

Petrogas Pacific – DNR Lease 20-A08488 – Aquatic Land Lease authorizing Petrogas Pacific pier only

Petrogas Pacific purchased Intalco Aluminum Corporation's deepwater wharf, causeway, and a portion of Intalco's lands in 2016. DNR consented to the assignment of the Intalco lease to Petrogas Pacific at that time.

Petrogas Pacific uses the pier to load liquefied petroleum gas (LPG) onto tankers for export. Liquefied petroleum gas products were shipped from the Intalco marine terminal for years under a "fee-for-use" agreement between Intalco and the shipper. Until 2014, the shipper was Chevron; in that year, Petrogas purchased the former Chevron LPG Ferndale Terminal, which is located south of Intalco next to the Phillips 66 refinery.

Liquefied petroleum gas products, also known as LPGs, are primarily butane and propane. LPGs are readily shipped, stored, and used in liquid form at normal temperatures. LPGs are produced through both the crude oil refining process and natural gas processing.

The wharf and causeway have a pipeline attached to it that is connected to the LPG shipping facility. When a LPG tanker arrives, a mobile "marine loading arm" is wheeled to the end of the pier, hooked up to the pipeline, and connected to the vessel. When not in use, the marine loading arm is stored on land. During 2016-2020, LPGs were only loaded onto to vessels for export, with no LPGs unloaded.

Under agreement with Petrogas Pacific following the 2016 sale, Intalco continued to receive alumina ore at the wharf to smelt aluminum at its nearby smelter. The aluminum smelter occupies approximately 300 acres of a 1,500 acre tract fronting on the Strait of Georgia between Cherry Point and Sandy Point. Intalco began operations in 1966 as a primary aluminum smelter. Alumina ore arrived in "bulker" cargo vessels. A shiploader on the wharf unloaded the alumina ore using a clamshell bucket. A conveyor belt attached to the wharf transported the ore to storage bins on land. During 2016-2020, 8-10 bulkers per year delivered alumina ore to Intalco. In April 2020, Intalco announced the curtailment of smelter operations in August of 2020.

The Petrogas Pacific lease is the only lease adjacent to the Cherry Point Aquatic Reserve that limits the number of vessels allowed on the leasehold. No more than 48 vessels (combined LPG tanker or alumina ore bulker) may call at the facility per year. Actual vessel calls during the 2016-2019 period were considerably below the 48 vessel limit as shown in Table D-1 below (the "lease year" for the Petrogas lease is February 1 – January 31):

Table D-1. Vessel calls by type between 2016 and 2019 to the Petrogas facility.

Vessel Type	2016-17	2017-18	2018-19	2019-20
Alumina ore bulker	10	8	7	8
LPG tanker	17	18	20	25
Total both types	**27**	**26**	**27**	**33**

The term for the Petrogas Pacific lease, # 20-A08488, is February 1, 2003 – January 31, 2033.

Intalco Aluminum Corporation (Intalco) has a separate easement, #51-073039 (term February 1, 2003 – January 31, 2033), for the discharge of treated wastewater effluent. When Intalco sold the wharf and causeway to Petrogas Pacific in 2016 and assigned its DNR lease, it retained this easement. The easement authorizes use of a 22-foot wide strip of land located in the footprint of the causeway that extends to the wharf (and thus it does not abut the aquatic reserve and is merely adjacent to it). The smelter operates a National Pollutant Discharge Elimination System-permitted wastewater treatment plant. The outfall discharges into the Strait of Georgia approximately 1,200 feet from the shoreline. The outfall pipe is fixed to the wooden causeway. The smelter NPDES permit requires monitoring, effluent mixing and toxicity studies, sediment sampling, and Stormwater Pollution Prevention Plan updates and implementation.

Intalco also holds a second easement, #51-034983 (February 10, 1971 – perpetual), for the discharge of stormwater. The 400-foot long easement is for an outfall pipe on tidelands and bedlands and a diffuser on bedlands. It is located 250 feet south of the southeast corner of the Petrogas leasehold. This is the only DNR use authorization located within the aquatic reserve (there was no "cutout" as in the case of the Birch Bay Water and Sewer District outfall easement or the other three current leases). This easement was granted in perpetuity provided, however, that if Intalco abandons the use of the easement for the purposes for which it was granted (stormwater outfall), the right of way reverts back to the state.

Phillips 66 Ferndale Refinery: DNR Aquatic Land Lease 20-B11714 authorizing pier

The Phillips 66 Ferndale refinery is located on an 850-acre site, fronting on the Strait of Georgia between Cherry Point and Sandy Point. Originally built in 1954, the refinery has completed several upgrades and expansions since then.

The main source of crude oil is from tankers delivering various water borne crudes and various crude oils via pipeline. The crude oil is processed to produce a range of fuels and products including gasoline, diesel (low sulfur and ultra-low sulfur), liquid petroleum gas, residual fuel oil, marine bunker fuel oil, and sulfur. The refinery currently employs about 280 people with an additional 150 contract employees. The indirect employment associated with the refinery is about 900 people. The refinery operates 24 hours per day and 365 days per year, except during turnaround periods which occur approximately once every five years.

A transportation study prepared in 2019 by ERM on behalf of Phillips 66 (Sussman 2019) summarized the 2018 Ferndale Refinery vessel traffic shipment data. Overall the refinery received 59 shipments of crude oil and generated 349 outbound shipments of multiple refined products.

Both crude oil and refined products are loaded/unloaded using fixed “marine loading arms” in the seaward berth; hoses are used on the landward berth.

Dock operations at the Phillips 66 refinery are conducted in accordance with the refinery’s Marine Terminal Safety & Operations Manual, which describes personnel responsibilities, operating procedures, and related data concerning the refinery dock and transfer operations, including the pre-booming of oil transfers in accordance with state and federal requirements. In compliance with federal and state regulations, the refinery also maintains and updates plans and programs, such as the Oil Spill Prevention Plan, the Oil Spill Response Plan, the Spill Prevention, Control, and Countermeasure Plan, the Integrated Contingency Plan, and Oil Handling Personnel Training. Phillips 66 has an ongoing program for periodic inspection, maintenance, repair, and replacement activities required to ensure the longevity and reliability of operations at the dock and associated facilities.

The existing wharf was originally constructed in 1953 and updated with an all-concrete structure in the early 1990s. In 2020, Phillips 66 commenced a five year project to re-construct the causeway. The re-construction will replace the current causeway with concrete-surface and with fewer and more widely spaced steel pilings.

The term for the Phillips 66 lease, # 20-A09122, is June 15, 2006 – May 31, 2036.

Phillips 66 has a separate easement, #51-076895 (term June 1, 2006 – May 31, 2036), for the discharge of treated wastewater effluent. The refinery operates a National Pollutant Discharge Elimination System-permitted wastewater treatment plant. The outfall discharges into the Strait of Georgia approximately 1,200 feet from the shoreline, and is fixed to the causeway that extends to the wharf. The outfall line is also permitted to periodically (not continuous) convey treated wastewater from Puget Sound Energy’s cogeneration facility located adjacent to the refinery. The refinery NPDES permit requires monitoring, effluent mixing and toxicity studies, sediment sampling, and Stormwater Pollution Prevention Plan updates and implementation.

Appendix E – History of Land Use at Cherry Point

The following timeline provides a chronological summary of major construction events, land use decisions and proposals, fisheries management decisions, and selected dates of laws and rules with specific importance at Cherry Point.

Date	Event	Type
Time Immemorial	Ceremonial, subsistence, and commercial harvest of finfish and shellfish and other commerce by Native American Indians	Tribal Law
1855	Treaty of Point Elliot signed	Federal/Tribal Law
1889	Washington Statehood	Federal/State Law
1954	The General Petroleum Corporation begins operation of the Ferndale refinery, pier, and outfall.	Major construction
1966	The Intalco Aluminum Corporation builds a second pier and outfall at Cherry Point.	Major construction
1971	The ARCO refinery constructs a third pier and outfall at Cherry Point now owned by British Petroleum.	Major construction
1971	Washington's Shoreline Management Act was enacted.	State law
1972	Federal Water Pollution Control Act is enacted.	Federal law
1974	State herring sac roe fishery is opened.	Fishery management
1975	Whatcom County Water District Number Eight constructs a secondary wastewater effluent outfall at Point Whitehorn.[3]	Major construction
1976	First Shoreline Management Program adopted designating Cherry Point uplands as a "conservancy," shoreline allowing water-dependent industrial use of the shoreline as an outright permitted use and recognizing the state and local importance of such uses at Cherry Point.	Land use
1976	Final Decision of *United States v. Washington* (384 F. Supp. 312, 377 [W.D. Wash. 1974], aff'd, 520 F.2d 676 [9th Cir. 1975], cert. Denied, 423 U.S. 1086 [1976])	Federal/State/Tribal Law
1976	Chicago Bridge and Iron (CBI) proposes to build offshore oil drilling rigs at Cherry Point.	Land use
1977	Whatcom County "Interim Zoning" adopted identifying Cherry Point as an industrial area.	Land use
1977	Federal Clean Water Act is enacted, by amending the 1972 Water Pollution Control Act.	Federal law
1979	Cherry Point-Ferndale Subarea Plan adopted by Whatcom County designating Cherry Point for industrial use.	Land use
1981	Whatcom County updates the "Official Zoning Map" re-affirming Cherry Point as an industrial area. Ordinance No. 81-99	Land use
1982	State herring sac roe fishery permanently closed.	Fishery management
1982	CBI's proposal to build oil drilling rigs is ended by governor's veto of legislation that would have exempted CBI from provisions of the Shoreline Management Act.	Land use
1983	Kiewit proposes to build offshore oil drilling rigs on the Cherry Point uplands	Land use

[3] The operator of this outfall is now the Birch Bay Water and Sewer District.

Date	Event	Type
1984	Kiewit's permits denied by Ecology and DFW	Land use
1987	State herring spawn-on-kelp fishery are opened.	Fishery management
1992	Joseph Schecter proposes to build the Cherry Point Industrial Park (CPIP), including a shipping pier.	Land use
1992	SSA proposes to build the Gateway Pacific Terminal (GPT) pier at Cherry Point.	Land use
1995	Letter from Commissioner of Public Lands states that DNR will consider at most one additional pier at Cherry Point.[4]	Land use
1996	State herring spawn-on-kelp fishery is closed.	Fishery management
1996	State sediment management standards become effective.[5]	State rule
1996	Northwest Sea Farms v. U.S. Army Corps of Engineers, 931 F.Supp. 1515 (WD WA 1996)	Federal Law
1998	The 1992 CPIP proposal is abandoned; legally they have a shoreline permit until the county rescinds the permit.	Land use
1998	Executive Order 13084 issued by the White House, Consultation and Coordination with Indian Tribal Governments	Federal Law
1998	Whatcom County and Washington State adopt the 1998 Shoreline Program Update designating the Cherry Point Management Area – re-affirming the use of the reach for water-dependent industrial uses.	Land use
1999	NMFS accepts petition to list 18 species of marine fish under ESA, including all Puget Sound Herring.	Legal
2000	Second wing is added to the ARCO (now bp) pier.	Major construction
2000	National Marine Fisheries Service (NMFS) decides Cherry Point herring do not merit listing under the federal Endangered Species Act.[6]	Fishery management, federal law
2000	Ocean Advocates et al sues Corps for granting ARCO/bp permit for refinery dock expansion w/o EIS or consideration of Magnuson restrictions	Legal
2000	Commissioner's Order establishes Cherry Point as an aquatic reserve	Land Use/Order
2001	Washington Department of Health re-opens 1.5 miles of beaches around Pt. Whitehorn previously closed to recreational shellfishing, reducing the closure zone from 2,640 feet to 1,380 feet.	Land Use
2001	DNR applies Interim Guidance to Cherry Point Aquatic Reserve	Land Use
2002	New leases are issued for Intalco/Alcoa pier and wastewater outfall.	Land use
2002	Birch Bay Water and Sewer District withdraws its proposal for wholesale service to Blaine, choosing to construct reclaimed water plant instead.	Land use

[4] The letter, dated October 5, 1995, was written by then-commissioner Jennifer Belcher to Tim Winn, District Engineer, US Army Corps of Engineers. Copies filed in CPIP Negotiations with DNR file.

[5] State sediment management standards are codified at WAC 173-204. They are administered by Ecology.

[6] The notice, Endangered and Threatened Species: Puget Sound Populations of Copper Rockfish, Quillback Rockfish, Brown Rockfish, and Pacific Herring, Notice of determination of status review was published in the Federal Register, Volume 66, Number 64, April 3, 2001, pp. 17659 – 17668.

Date	Event	Type
2003	Williams Pipeline (also known as Georgia Strait Crossing) proposes placement of a natural gas pipeline across the Cherry Point Withdrawn Area. Proposal later withdrawn.	Land use
2003	The Cherry Point Withdrawn Area scheduled for review, determining whether the area will remain an aquatic reserve.	Land use
2005	The authorization for the Birch Bay Water and Sewer District outfall expires. DNR postpones the application.	Land use
2006	ConocoPhillips lease is renewed with DNR	Land use
2007	bp Cherry Point lease is modified by DNR to accommodate required spill control structures	Land use
2007	Whatcom County adopts updated Shoreline Master Program including protection of shoreline critical areas	Land use
2008	Trillium sells large parcel west of bp facility to bp	Land use
2008	Whatcom County Parks purchase of Trust lands	Land use
2009	Birch Bay Water and Sewer District receives a 30-year easement for the Point Whitehorn outfall	Land Use
2015	DNR begins education/compliance regarding illegal buoys on state-owned tidelands east of Point Whitehorn	Land Use
2016	U.S. Army Corps of Engineers denies permit to SSA Marine to construct the Gateway Pacific Terminal; DNR subsequently denies 1992 lease application.	Land Use
2016	Intalco/Alcoa sells pier to Petrogas Pacific and lease assigned to Petrogas.	Land Use
2017	DNR expands the reserve to add the 45-acre cutout previously considered for the Gateway Pacific Terminal project.	Land Use
2017	County's Comprehensive Plan amended to include the following: • Management plans consistent with the Aquatic Reserve Management Plan; • To limit the number of industrial piers at Cherry Point to the existing three piers • Support and remain consistent with the state Department of Natural Resources' withdrawal of Cherry Point tidelands and bedlands from the general leasing program and the species recovery goals of the Cherry Point Aquatic Reserve designation and Management Plan	Land Use

Appendix F – Two Year Work Plan (Implementation Priorities)

Plan Goal Supported	Recommended Strategy or Action	Lead(s)	Partners	Time Frame	Notes
Goal 1: Protect enhance and restore natural functions and processes	1.2 b) Identify and remove creosote soaked wood from reserve beaches	DNR	Volunteers, neighbors, landowners	As needed	Use MyCoast app to report
	1.2 d) Support annual marine debris cleanups	DNR - ARP, CSC, industries	Whatcom MRC	Annual	
	1.3 c) Support research and monitoring to identify actions to increase resilience in the face of climate change	DNR aquatic research team	Volunteers, ARP PSC	Quarterly	ANeMoNe project
Goal 2: Improve and protect water quality	2.1 a) Monitor nearshore water quality including pH, temperature and other parameters	DNR ARP research team, ARP staff	Volunteers	Quarterly	ANeMoNe, and new "TidbiT" sensor deployment in nearshore waters on all reserves
	2.2 b) Collaborate with WDFW on Mussel Watch Program	WDFW, DNR ARP	CSC Volunteers	Biennial monitor	Update plan with analyzed heavy metal and organics data
	2.3 b) and c) Spill response planning, contingency plans, and Geographic Response Plan	DNR ARP and sediment quality unit	Industries, Ecology, affected Tribes		Need to research time frame

Plan Goal Supported	Recommended Strategy or Action	Lead(s)	Partners	Time Frame	Notes
Goal 3: Species protection and marine habitats	3.1 b) and 3.6 b) Support efforts to increase the Cherry Point herring population to a sustainable population	DNR ARP	WDFW, Lummi Nation	Annual	Herring spawn and acoustic trawl surveys, larval herring research, genetic research
	3.4 c) Continue to assist invasive European green crab control efforts to the north of Cherry Point in Drayton Harbor	WDFW, Sea Grant	DNR ARP, volunteers	Annual, spring – early fall	Monitor Birch Bay for European green crab
	3.5 a) and b) In conjunction with CSC continue annual surveys to determine abundance, distribution, and population trends of marine birds and duck. The CSC also monitors the intertidal community structure and condition seasonally, at regular intervals	CSC, ReSources	DNR ARP, other volunteers	Seasonal: Fall and winter for avian, summer for intertidal	Avian studies conducted seasonally when populations are at maximum levels for a complete understanding of the use and trends
	3.5 d) Continue mapping of submerged aquatic vegetation, specifically eelgrass, bull kelp, and macroalgae communities	DNR Aquatics Nearshore group, DNR ARP	Whatcom MRC, other volunteers	Annual or biennial	
	3.7 a) Use a standardized metadata collection method; address QA/QC needs, standardize data collection and protocols and make results available	DNR ARP	CSC, WDFW, Lummi Nation, others that collect data		(Brownlee) (Data quality model)

Plan Goal Supported	Recommended Strategy or Action	Lead(s)	Partners	Time Frame	Notes
	3.7 c) Coordinate monitoring and research efforts	DNR ARP	Tribes, agencies, nonprofits, universities, CSC, community science groups	Winter planning period	(Bleke lead with support from DNR staff)
Goal 4: Stewardship, partnerships and environmental education	4.1 a) Aquatic reserves manager will periodically join land manager site inspection visits to pier facilities for updates on facility management and build relationships with industry neighbors	DNR	Industry neighbors	Biennial	
	4.3 b) Support annual public events such as “What’s the Point?”	Whatcom MRC, CSC	DNR ARP, Many others	Annual	Family focused low tide educational event at Point Whitehorn
	4.4 a), 4.5 a) and b) Promote education programs and signs that engage the public in reserve stewardship	DNR ARP	Lummi Nation, CSC, Whatcom MRC		Emphasize ecological, geologic, cultural and historic components
	4.4 c) Provide outreach to the public regarding issues and progress on the reserve. Improve webpage, data viewer, and online resources. Upgrade reserve brochure and outreach card	DNR ARP	CSC	Annual	Development of storymap collective and data dashboards

Plan Goal Supported	Recommended Strategy or Action	Lead(s)	Partners	Time Frame	Notes
Goal 5: Archeological and cultural resources: Identify, respect, and protect archaeological, cultural, and historical resources on the reserve. DNR recognizes Northwest Tribes as sovereign nations.	5.3 a) DNR will ensure plan implementation is consistent with protection of tribal culture, values and treaty rights	DNR ARP	Lummi Nation, Nooksack, Swinomish Suquamish, and Tulalip Tribes (tribes with adjudicated usual and accustomed treaty rights)		**5.3 Support cultural uses at the site** – Responsible management of natural resources that are part of tribal traditions and that sustain the quality of life of the Tribes. Ensure these resources are protected and preserved for sustainable use.
	5.3 b) Protect cultural resources, traditional uses and partner with Tribes to promote public awareness of cultural values	DNR ARP	Same as above		
	5.3 c) Work with Tribes to develop educational and interpretive materials that incorporate cultural and historical topics and current environmental stewardship	DNR ARP	Same as above		

Plan Goal Supported	Recommended Strategy or Action	Lead(s)	Partners	Time Frame	Notes
Goal 6: Authorized uses: Ensure that any authorized uses of state-owned aquatic lands must be consistent with the aquatic reserve long term vision and management goals	Goal 6 does not outline pro-active actions for the work plan; it primarily details allowable uses, and reviews of applications and proposals that DNR will complete as needed	DNR Orca Straits staff, DNR ARP	USACE, USFWS, Ecology, WDFW, Whatcom County		

Appendix G – Commissioner's Withdrawal Order

201701

COMMISSIONER'S ORDER

STATE OF WASHINGTON
DEPARTMENT OF NATURAL RESOURCES
Peter Goldmark
Commissioner of Public Lands

AMENDED WITHDRAWAL AND DESIGNATION ORDER
FOR THE CHERRY POINT AQUATIC RESERVE

The State of Washington is owner of aquatic lands known as the Cherry Point Aquatic Reserve, consisting of tidelands and bedlands at Cherry Point in Whatcom County. Under statutory mandates, the Washington State Department of Natural Resources is responsible for managing state-owned aquatic lands in a manner that includes:

> Ensuring environmental protection as a management objective for state-owned aquatic lands (RCW 79.105.030(3)), and
>
> Considering natural values of state-owned aquatic lands as wildlife habitat, natural area preserves, representative ecosystems or spawning areas prior to the Department issuing any lease or authorizing any changes in use (RCW 79.105.210(3)), and
>
> Withholding from leasing lands which the Department finds to have significant natural values (RCW 79.105.210(3)).

In accordance with such powers and obligations, certain state-owned aquatic lands possessing significant natural values near the Cherry Point Reach were withdrawn from general leasing on August 1, 2000 and identified as the Cherry Point State Aquatic Reserve.

Following creation of the Reserve, the Department worked with others to develop a plan to manage the Reserve in a manner that protects its unique resources. In November 2010, this effort resulted in completion of the Cherry Point Environmental Aquatic Reserve Management Plan. The Plan identifies the natural resources and addresses the proposed uses, future threats, and management actions that will be employed by DNR to protect the resources. Consistent with the objectives of the Plan, on November 18, 2010, the Commissioner of Public Lands rededicated the Cherry Point State Aquatic Reserve as the Cherry Point Environmental Reserve.

In 2016, the Department evaluated a request to change the Reserve boundary to add lands previously excluded under the August 1, 2000 and November 18, 2010 Orders. As supported by the November 2, 2016 Determination of Nonsignificance, and the November 20, 2016 recommendations of the technical advisory committee, as well as public comments received by the Department, the amendment of the Reserve boundary will further accomplish the purposes of the Reserve, is compatible with existing and projected uses of the area, and best serves the public interest.

Therefore, according to the powers vested in the office of Commissioner of Public Lands (RCW 79.105.030(3), RCW 79.10.210, and WAC 332-30-151), I, Peter Goldmark, hereby ORDER and DIRECT amendment of the Cherry Point Environmental Aquatic Reserve to include additional lands. Henceforth the Washington State tidelands and bedlands described below are withdrawn from the general leasing program and shall be managed according to the Final Cherry Point Aquatic Reserve Management Plan for 90 years from November 18, 2010.

> That portion of the tidelands and bedlands of navigable waters owned by the state of Washington, fronting and abutting Sections 2, 11, 13, 14, and 24, Township 39 North, Range 1 West, Willamette Meridian and fronting and abutting Sections 19, 20, 29 and 32, Township 39 North, Range 1 East, Willamette Meridan described as follows:
>
> Lying south of the south line of government lot 1, of said Section 2, Township 39 North, Range 1 West, W.M. being the south line of Birch Bay State Park; lying north of the south line of Township 39, Range 1 East; and extending waterward to a line which is 70 feet below mean lower low water OR 0.5 mile beyond extreme low tide, whichever line is further waterward;

EXCEPTING THEREFROM, the following Use Authorizations issued by the Department of Natural Resources; lease application numbers 20-A09122, 20-A11714, 20-A08488 and 20-010521;

ALSO EXCEPTING THEREFROM, any second class tidelands previously sold by the State of Washington.

Situated in Whatcom County, Washington

Dated this 3rd day of January, 2017.

STATE OF WASHINGTON
DEPARTMENT OF NATURAL RESOURCES

Peter Goldmark
Commissioner of Public Lands
Olympia, Washington