Cypress Island Aquatic Reserve
Pilot Nearshore Fish Use Assessment

A 2009 joint nearshore research effort conducted in Skagit County, Washington by:

Wild Fish Conservancy
NORTHWEST
SCIENCE EDUCATION ADVOCACY

and

WASHINGTON STATE DEPARTMENT OF
Natural Resources

Cypress Island Aquatic Reserve

Pilot Nearshore Fish Use Assessment

March – October 2009

Technical Report prepared June 2011
by Wild Fish Conservancy Northwest

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Aquatic Reserves Program

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A preliminary description of the marine fish resources utilizing select nearshore habitats of Cypress Island

Wild Fish Conservancy Northwest

June 2011

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Executive Summary

Wild Fish Conservancy Northwest conducted beach seine sampling of migratory and resident nearshore fish communities at eleven study sites from late February through October of 2009 for the Cypress Island Pilot Nearshore Fish Use Assessment. Results from the pilot project are intended to inform managers of the current status of marine fish resources utilizing specific sites and habitats within the Cypress Island Aquatic Reserve, and to serve as baseline data for future monitoring of status trends for marine fish species, particularly targeting native salmonids, forage fish and groundfish stocks, and federal and state listed threatened species and species of concern. Final reporting provided June 2011 to Washington State Department of Natural Resources Aquatic Reserve Program managers. The pilot project provided a template for future nearshore fish use monitoring throughout the Washington State marine Aquatic Reserve network, with specific recommendations included for sampling design, field logistics, data management and analysis, and resource and cost-sharing among other agencies and entities. The pilot project was a collaborative effort, engaging natural resource scientists from NOAA – Northwest Fisheries Science Center, Skagit River Systems Cooperative, and Kwiaht (Center for the Historical Ecology of the Salish Sea), as well as volunteers from the Washington State University Beach Watcher programs of both Skagit and Island County.

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Section 1: Introduction

1.1 Introduction – *Purpose and Objectives*

The purpose of this project was to conduct a pilot investigation of the marine fish communities utilizing select nearshore sites within the Cypress Island Aquatic Reserve. Specifically, this project would fill a recognized data gap in knowledge about nearshore juvenile salmon use in north Puget Sound and the San Juan Islands (Fig. 1.2), and also contribute to information about the geographic distribution of other migratory, sessile, and demersal marine fish species in local nearshore habitats in the vicinity of Skagit County's Cypress Island, in northwest Washington State. Objectives were two-fold:

1. To provide Washington Department of Natural Resources Aquatic Reserve managers with initial (baseline) information on marine fish species composition, relative seasonal abundance, timing, and patterns of site occupancy within the mostly undisturbed nearshore habitats of the Cypress Island Aquatic Reserve, with particular emphasis on species (and life history stages) of concern such as juvenile salmonids, forage fish, ESA-listed stocks, and unique occurrences.

2. Based on what was learned during this pilot project, to recommend adaptive project management and logistic considerations, and to refine a repeatable sampling, data analysis, and reporting schema for long-term population trend monitoring of nearshore fish resources throughout the Reserve network (Fig. 1.1).

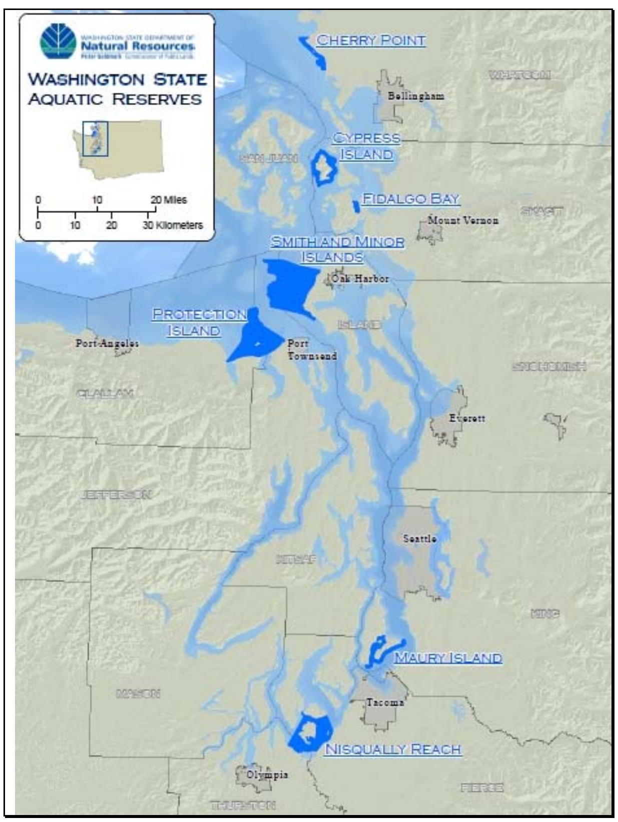


Figure 1.1 – Cypress Island Aquatic Reserve within the context of greater Puget Sound (WDNR map).

1.2 Introduction – *Justification for the Pilot Study*

To date, much information has been amassed by an active marine research consortium consisting of scientists from Skagit River Systems Cooperative (SRSC – the research arm of the Swinomish Tribe), Northwest Fisheries Science Center (a division of NOAA), Friday Harbor Laboratories (University of Washington), Kwiaht Center for the Historical Ecology of the Salish Sea, regional fisheries enhancement groups and county Marine Resource Committees, Wild Fish Conservancy (WFC), and others elucidating the seasonal timing, distribution, and composition of salmon and other marine fish utilizing nearshore and estuarine habitats throughout north Puget Sound (WRIA 2). However, apart from a pair of temporally limited surveys of the geographic extent and short-term population variability of demersal fish species in deep water habitats of western Skagit County (Weipsfenning 2006; Valz and Dinnel 2007), very little information was previously available with regard to nearshore fish species assemblages, and intertidal habitat utilization of the marine waters surrounding the Cypress Island Aquatic Reserve.

Figure 1.2 – North Puget Sound nearshore sample sites prior to February 2009 inception of the Cypress Island Aquatic Reserve Pilot Nearshore Fish Use Assessment (Map courtesy SRSC).

Designated in 2007, the Cypress Island Aquatic Reserve withdraws approximately 5910 surface acres of state-owned tidelands and subtidal bedlands adjoining Cypress Island, and the adjacent Strawberry, Towhead, and Cone Islands, from leasing and development.

Details about the Washington State Aquatic Reserve Program, and the Cypress Island unit specifics can be found at the Department of Natural Resources official website:

http://www.dnr.wa.gov/ResearchScience/Topics/AquaticHabitats/Pages/aqr_rsve_aquatic_reserves_program.aspx

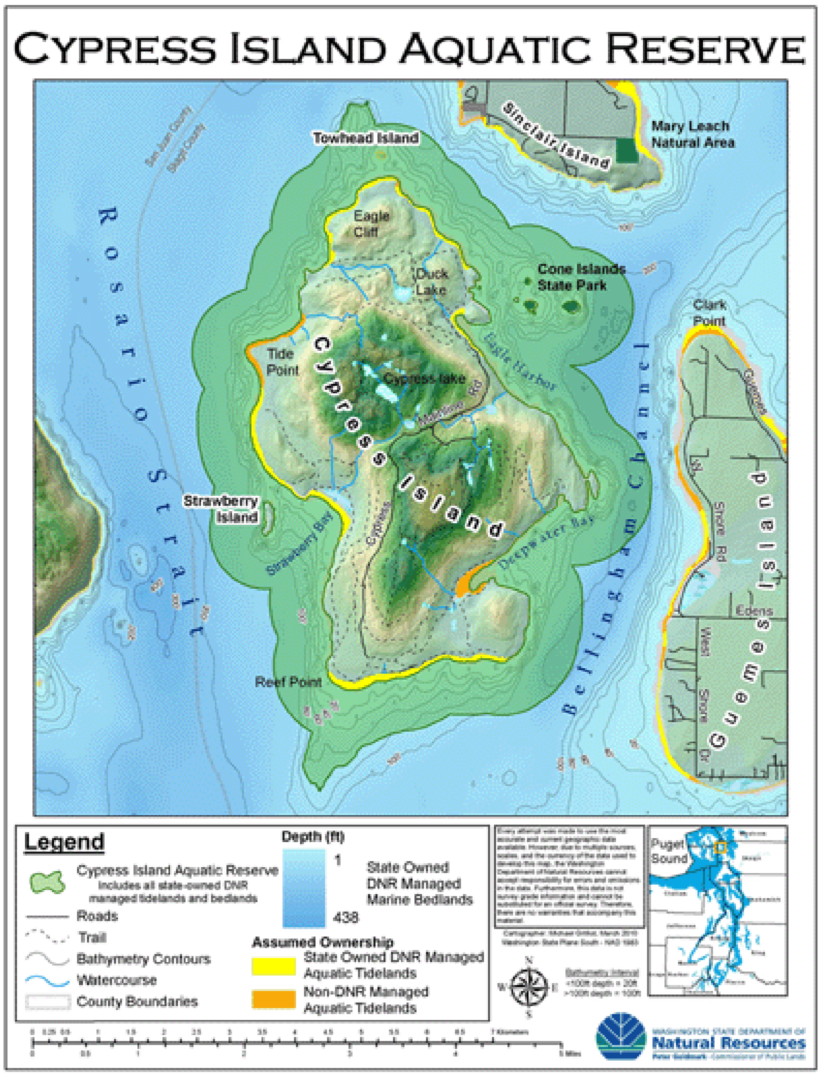


Figure 1.3 – Cypress Island Aquatic Reserve boundary (map courtesy WDNR).

Impetus for this project was provided by Washington Department of Natural Resources' Conservation Areas Program. The "Cypress Island Comprehensive Management Plan", adopted by the State of Washington in 2007, provides coordinated guidance for the management and oversight of the combined Cypress Island Natural Area Preserve and Cypress Island Aquatic Reserve. The plan stipulates the maintenance and restoration of natural systems and processes, with particular emphasis on preserving and promoting biological diversity and a functional habitat mosaic necessary for sustaining native species that are reduced or rare at regional scales.

Goal 7 of the several stated management objectives requires WDNR Aquatic Reserve managers to "Identify aquatic habitats and associated...wildlife species, with special emphasis on rocky reef habitat, pocket beaches, and kelp and eelgrass beds" (pg. 17). Specifically, the document provides direction for the development of "...an initial baseline inventory...of aquatic habitats and species that utilize the Reserve" and "...ongoing monitoring plans to evaluate the condition of aquatic resources identified for conservation" (***Objectives 7.1 & 7.2*** respectively, pp. 17-18).

Goal 3, ***Objective 3.1*** directs Reserve Managers to "Give high priority to the inventory, enhancement, and protection of sensitive, threatened and endangered species' habitats, as dictated by federal law, state legislation, and DNR policy goals".

- ***Objective 3.3*** mandates "routine surveys for sensitive, threatened, and endangered species and associated habitats, and following any new listings".

and

- ***Objective 3.4*** invites "other agencies, tribes and organizations with appropriate expertise to work cooperatively with the inventory, monitoring, and management of native species."

It is with the above-named management goals and objectives in mind that WDNR Aquatic Reserve personnel contracted with Wild Fish Conservancy in early 2009 to design and implement an initial inventory and assessment of marine fish usage of nearshore habitats within the Cypress Island Aquatic Reserve. Wild Fish Conservancy Northwest (WFC) is a regionally active not-for-profit, non-governmental organization that has extensive experience monitoring marine fish populations using a variety of standard methods, and covering the entire suite of nearshore habitats typically found in north Puget Sound waters including (but not limited to) barrier spits and lagoons, cuspate forelands, pocket beaches and estuaries, and blind tidal channels. In 2005 and 2006, WFC researchers investigated the western coastline of Whidbey Island to quantitatively describe nearshore fish use, addressing what had been a significant regional data gap. Wild Fish Conservancy also currently conducts nearshore fisheries research in Clayoquot and Barkely Sounds on the west coast of Vancouver Island, as well as the extensive coastal estuary of Grays Harbor in southwest Washington State.

Wild Fish Conservancy staff biologists conducted field work from late February through October of 2009 for the Cypress Island Pilot Nearshore Fish Use Assessment, with data analysis and final report delivered to Washington State Department of Natural Resources Aquatic Reserve Program managers in June of 2011. Results from the pilot project are intended to serve as baseline data for future monitoring of status trends for marine fish species, particularly targeting native salmonids, forage fish and groundfish stocks, and federal and state listed threatened species and species of concern including Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), Bull trout (*Salvelinus confluentes*) and steelhead trout (*Oncorhynchus mykiss*).

1.3 Introduction – *Study Area*

As the least developed of the large islands of the San Juan archipelago, Cypress Island is somewhat isolated at the far northwest corner of Skagit County, separated from the better-known "outer group" of islands (Orcas, San Juan, Shaw, Lopez, Blakely, Waldron) by the 3-4 mile width of Rosario Strait, and from Fidalgo Island (and its urban mainland connections to the southeast) by Guemes Channel. The nearest landmass in this region of the Salish Sea is rural Guemes Island, directly across the narrow Bellingham Channel to the east, with smaller Sinclair Island located off the rugged northeast prow of Cypress. Its strategic location at the convergence of the broad marine waterways of Rosario Strait and Bellingham Channel that connect the ecologically similar, but geographically distinct southern Georgia Basin and Strait of Juan de Fuca / northern Puget Sound eco-provinces, creates a natural focus for tidal currents and localized upwelling around Cypress Island.

The Cypress Island uplands largely consist of mountainous bedrock terrain that was overridden and smoothed by the Puget Lobe of the continental glaciers associated with the most recent stade of the Wisconsin glaciation (ca. 17,000 – 12,000 years b.p.). Soil development has progressed to the point that Cypress is currently heavily vegetated with second-growth coniferous forests regenerated from extensive clearcut logging during the first half of the 20^{th} century. Small lakes, ponds and marshy wetlands occupy the swales and saddles between the island's hilltops, and these drain to surrounding tidelands via several small creeks with relatively steep gradients. Many of these streams are seasonal, and the few that are perennial often lack enough volume and energy to force a permanent channel through the barrier beaches across their mouths; for most of the year sinking into the beach substrates before reaching a tidewater confluence. Hence, there are no known anadromous fish populations currently extant to Cypress Island.

A possible historic source for diadromous salmon and other freshwater spawning fish species may have been the small stream that drains the wetland marsh just inland from narrow Secret Harbor, at the shallow, far western end of Deepwater Bay (Fig. 2.2, pg 13). Available spawning and rearing habitat at this location was rendered inaccessible to salmon, trout and other anadromous species by construction of a tidewater dike spanning the salt marsh with an undersized culvert that created a barrier to upstream fish migration. Washington Department of Natural Resources recently procured funding to replace the blocking culvert, remove old land fill, and implement a restoration of the important pocket estuary at the mouth of this stream. Another location for freshwater fish spawning and rearing may have been the lower reaches of the Cypress Lake outlet stream, draining the west side of the island with an outlet to Strawberry Bay. Historic T-sheets dated from the 19^{th} century map this wetland, but provide no details about hydrology or vegetation communities (Collins and Sheik, 2005). The wetland may have been a tidal lagoon and salt marsh as recently as the 1950's, with an open channel connection directly to Strawberry Bay, but this channel was subsequently filled by local community residents (N. Fahey, pers. comm. 2009), rendering the stream inaccessible to migrating salmon.

For the most part, nearshore waters, beaches and bluffs surrounding Cypress Island are not subject to the significant wave action and tidal current energetics that are present for example, further south in the Admiralty Inlet and along the west coasts of Whidbey and Fidalgo Islands. These locales are exposed to storms and wind waves sweeping east along the Strait of Juan de Fuca from the open ocean, but Cypress is largely protected by local geography. However, the Island's several projecting points that extend seaward into bracketing marine waterways do experience high velocity currents associated with daily tide fluctuations. These include aptly-named Tide Point, as well as the offshore Strawberry Island, Reef Point, Broughton Point, Cypress Head, and Cypress Island's northern tip, where tiny Towhead Island just offshore compresses the intervening channel waters, dramatically increasing the current velocity. Standing current waves are often observed at these locations during the peak of the daily tide swings. Winter storms buffet the Rosario Strait (northwest to southwest) coastline of Cypress Island, generating wind wave energy along pocket beaches from Eagle Cliff to Tide Point (photo 1.1).

Photo 1.1 – View from Tide Point on Cypress Island across Rosario Strait to Orcas Island on a calm day. Long fetches of open channel such as this have the potential to generate wind wave activity, and complicate nearshore sampling efforts.

Typical afternoon westerly breezes associated with summer high pressure cells also produce significant wind-waves along the west and south coast of the island, particularly at South Beach and within the shallow waters and lengthy fetch of Strawberry Bay.
If their timing and teamwork are thoroughly in sync, experienced seining crews can successfully set and haul a nearshore net full of fish in wind-generated waves up to 1.5 ft. (crest to trough), but waves more serious than this can result in mortality or severe mechanical damage to fish in the net. Changing weather conditions must be taken into account on a daily and hourly basis to ensure successful sampling during future nearshore fish monitoring at Cypress Island, as well as the other Aquatic Reserve sites where long fetches of open water are prone to wind-generated waves during storm cycles, or face west into afternoon sea breezes under periods of other-wise calm weather.

Section 2: Methods

2.1 Methods – *Site Selection*

Nearshore fish habitats of Cypress Island are a diverse sub-set of those found throughout northern Puget Sound, the San Juan Islands, and the southern Strait of Georgia. Beaches and point bars at Cypress are maintained by intervening feeder bluffs and associated nearshore drift cells (Fig. 2.1). Sample sites for the Pilot Nearshore Fish Use Assessment were selected to emphasize barrier point bars, pocket beaches, and freshwater stream mouths as outlined for specific consideration in sub-sections of the Cypress Island Comprehensive Management Plan (see Goal 7, pg. 17 and Appendix C, pg. 64), while adhering to limited available resources and the need for sample replication, as well as the restrictions of boating hazards and consideration for the abilities and safety of the field crews. With respect to the latter, steep, rocky projections with poor footing were avoided, though several of these around the perimeter of the island may have yielded important information about the distribution of juvenile rock fish that were recently listed as threatened under the federal Endangered Species Act (ESA). Bluff-backed beaches are typically rife with underwater boulders creating hazardous boating conditions and minimizing the effectiveness of the preferred sampling technique (beach seine netting).

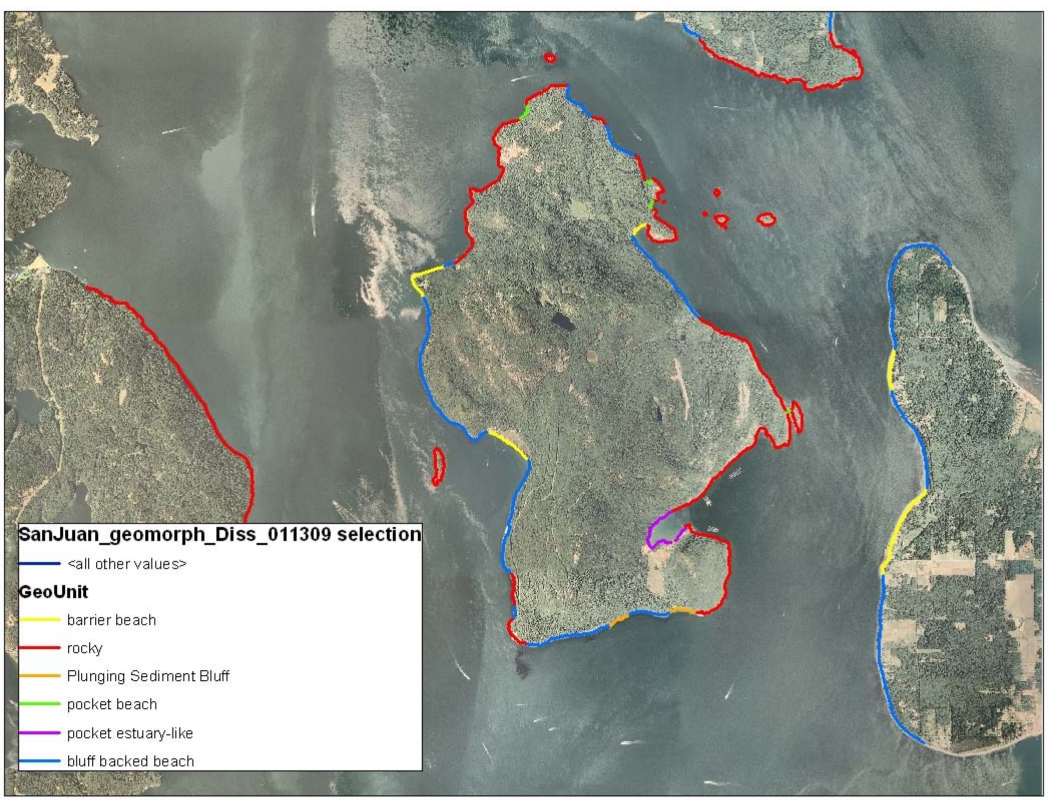


Figure 2.1 – Geomorphic classifications for the Cypress Island shoreline and adjacent land masses. (Map courtesy Skagit River Systems Cooperative).

Ten primary sites were chosen for intensive data collection during 18 consecutive sample sessions spaced at intervals of approximately 12-14 days throughout the sample season. This season (late February to late October) was selected to bracket the known timing for outmigration of juvenile salmon from mainland natal rivers to nearshore habitats in north Puget Sound, enabling researchers to pinpoint the dates of site occupancy for juvenile salmon of all species within the Cypress Aquatic Reserve. Three study sites were located at the three identified barrier beaches on Cypress Island (Tide Point, Strawberry Bay, Eagle Harbor); three were pocket beaches (Cypress Head South Cove and North Cove, and Bridge Rock Cove), and the remaining four sites were located along the few boat-accessible bluff-backed beaches that are widely scattered around the Island's perimeter including: Pelican Beach, Smuggler's Cove, Fahey's Beach, and South Beach.

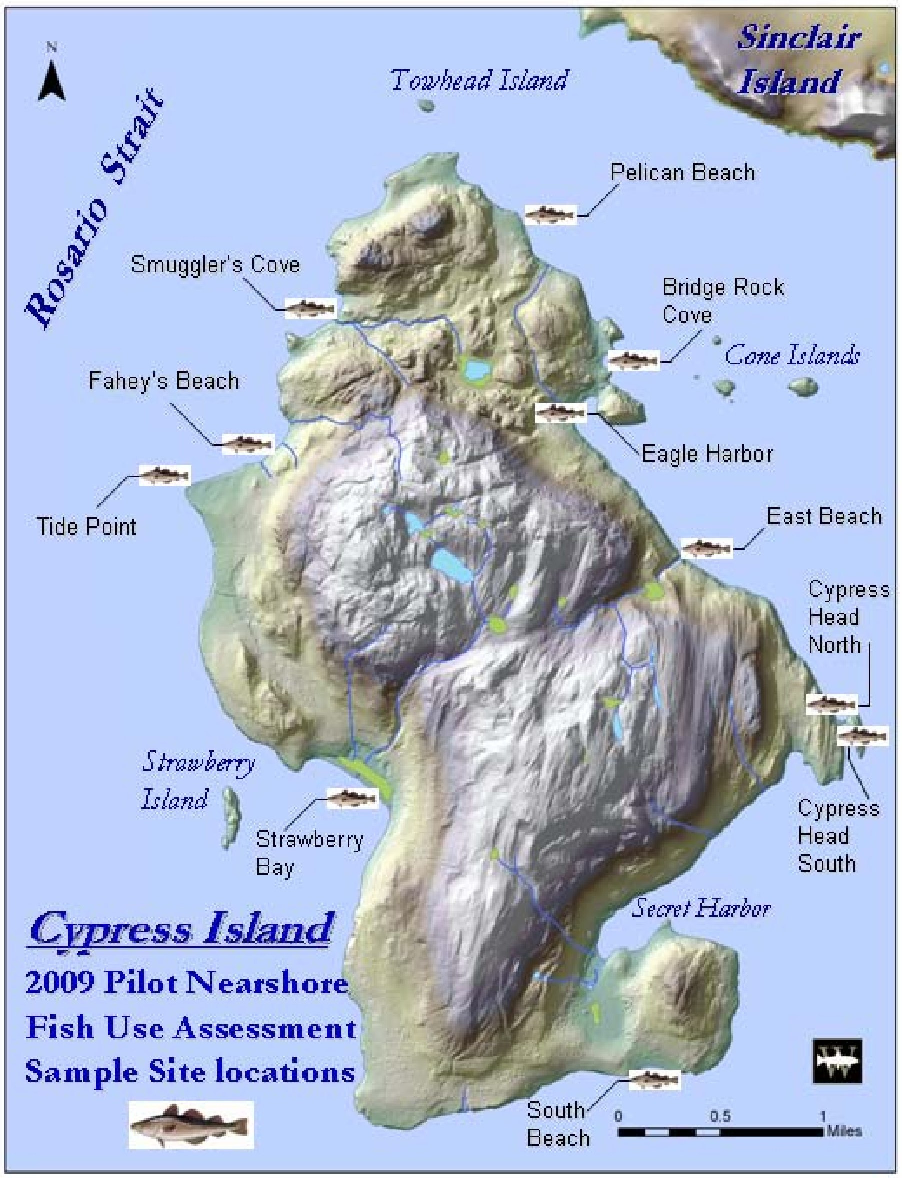


Figure 2.2 – Sample Sites for 2009 Cypress Island Pilot Nearshore Fish Use Assessment (WFC).

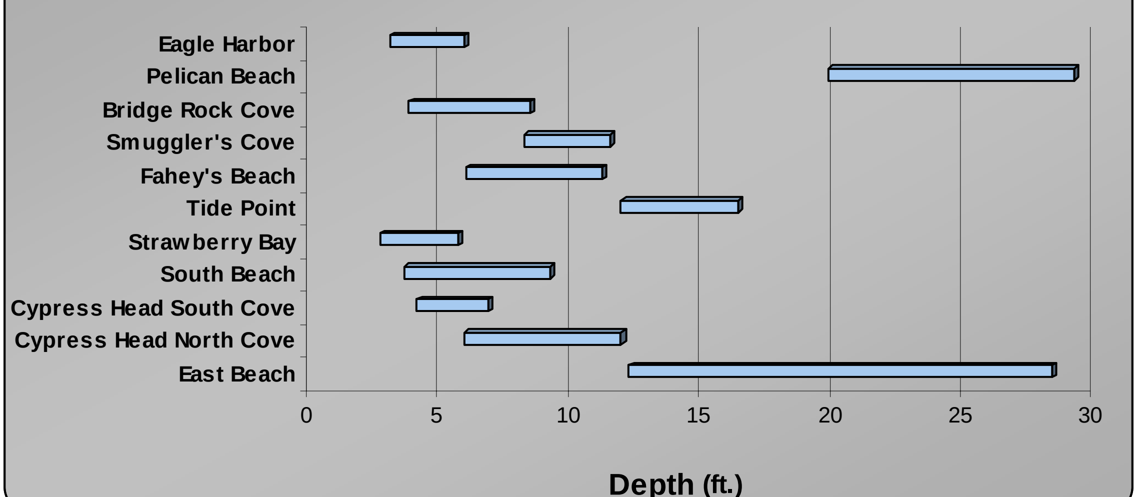
Field teams attempted on several occasions early in the season to sample at Reef Point on the southwest corner of Cypress Island, but were thwarted by underwater rocks and boulders that repeatedly caused the net to hang up, damaging the net and creating unacceptable boating hazards. An eleventh site (East Beach, at the tidewater confluence of the Reed Lake outlet stream) was added later in the season in order to sample the rocky shoreline habitat type similar to Reef Point that was not represented at other sites. Finally, legal complications prevented Wild Fish Conservancy from sampling within Deepwater Bay and the vicinity of the Secret Harbor pocket estuary, though the latter is likely a hotspot for use by juvenile salmon (Beamer et al. 2003 and 2006), and possibly forage fish and juvenile groundfish as well. Baseline fish use data was not collected from the shorelines of Deepwater or Mexican Bays in 2009. Samish Tribe Natural Resources will be conducting pre-and-post monitoring of fish use at the Secret Harbor restoration project site starting in 2011, and future monitoring should focus effort at these potentially important sites. Coordinate location data in the following table refers to the latitude and longitude on the beach at waterline directly adjacent to the standard net anchor point for each site. This will vary slightly depending on tide height if these coordinates are used to determine net set locations for future nearshore fish sampling. *Note*: Longitude -*122° W*.

Table 2.1: Latitude / Longitude for 2009 Cypress Island Pilot Fish Use Assessment Sample Sites

	Eagle Harbor	Bridge Rock Cove	Pelican Beach	Smuggler's Cove	Fahey's Beach	Tide Point	Straw-berry Bay	South Beach	Cypress Head South	Cypress Head North	East Beach
Lat.	48° 35.44	48° 35.62	48° 36.19	48° 35.84	48° 35.39	48° 35.14	48° 33.82	48° 32.64	48° 34.05	48° 34.12	48° 34.81
Long.	122°41.92	122°41.76	122°42.22	122°43.46	122°43.76	122°44.35	122°43.25	122°41.47	122°40.05	122°40.25	122°41.25

Nearshore bathymetry was highly variable across the 11 sites. Descriptions in Section 2.2 reference Fig. 2.3 (below) for information on the range of maximum depths measured within the area of the net for each site and sample session. To summarize: sample sites at the heads of bays were shallow, coves were moderately deep, and exposed point bars and bluff-backed beaches (particularly on the northeast coast fronting Bellingham Channel) were deepest. The one exception to this generalization was the South Beach site which was quite shallow and flat for some distance out from shore into the channel.

Figure 2.3: Range of Nearshore Depths at 2009 Cypress Island Sample Sites



2.2 Methods – *Study Sites*

The following section briefly describes landform type, predominant substrate and vegetation, tidal function, and general bathymetry for each of the Cypress Island pilot nearshore fish use assessment sample sites. *Note:* The arrows in Photos 2.01 - 2.16 show the typical direction of the net set at each of the eleven sites. Tidal current direction sometimes necessitated switching the set direction so that the open end of the net was always facing into the prevailing current, but generally speaking, measurable current was absent or had very low surface velocity at most sites during most sample sessions (exceptions to this are detailed in the site descriptions). The arrows also approximate the area covered by the beach seine net, but this is not meant to be an exact replica of the actual sample area; merely a visual representation. Sites are presented here counter-clockwise from the northeast to the southeast around the perimeter of Cypress Island.

Eagle Harbor

Photo 2.01 – The barrier beach study site at the nearshore head of Eagle Harbor.

Eagle Harbor is a long, protected embayment on the northeast coast of Cypress Island. The mouth opens toward the southeast onto the marine waterway of Bellingham Channel, and the width decreases approaching the head of the "harbor", where a barrier sand beach backed by forested bluffs encloses the narrow bay. This beach (officially the northern-most section of WDNR Beach #212A) is popular for outdoor recreation; many parties land by skiff or kayak from deep water boat moorage sites near the mouth of the bay, and hike inland on nearby trails. An obscure seasonal stream seeps into the northwest corner of the beach, but contributes very little freshwater input except during heavy rains. Wave action is minimal (prevailing winds are blocked by the steep enclosing hills), and no tidal current was recorded along the beach during the 18 site visits. Depths at this site shared with Strawberry Bay the distinction of being the shallowest of the 11 2009 Cypress Island sample sites, ranging from 3.1 to 5.9 ft. at the leading edge of the net, depending on tide height (Fig. 2.3).

The sample site was located at approximately the mid-point of the sandy barrier beach, and all nets were deployed in the direction indicated in photo 2.01. Substrate to the east of the arrow (to the right in the figure) was composed of mixed fines (mud and silty muck), and tended to be too soft for safe walking by the 2009 survey crew. Substrates at the actual sample site had a much larger sand and small gravel component, allowing field crews to walk without sinking. Nearshore vegetation at Eagle Harbor was limited to relatively small quantities of green sea lettuce *(Ulva spp.)* extant at the site only during the height-of-summer sampling sessions (May through August). The Eagle Harbor site was successfully seined during all 18 sample sessions (Fig. 3.01, page 35).

Eagle Harbor (background)
and Bridge Rock Cove (foreground, right)

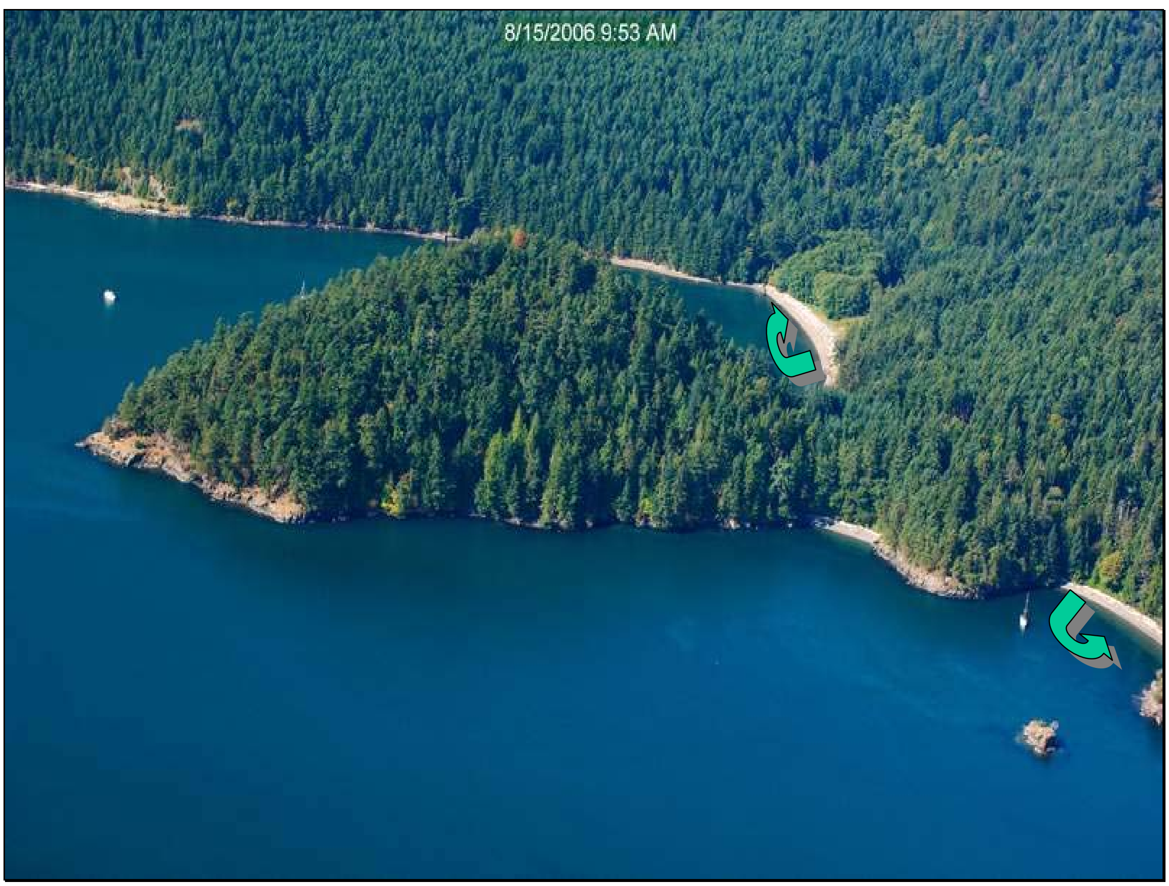


Photo 2.02 – Overview showing the proximity of the Eagle Harbor and Bridge Rock Cove study sites.

Bridge Rock Cove

The Bridge Rock Cove sample site is the northern of two adjacent but isolated pocket beaches located along the northeast shore of Cypress Island, just across the narrow-necked isthmus from Eagle Harbor, and directly west from the several nearby Cone Islands (photo 2.04). The cove (located at the southern end of WDNR Beach #212) is named for the small islet located just off-shore that resembles a northward-marching elephant (Elephant Rock). It is sometimes referred to by locals as "Hanson's Cove" (for a former landowner who sold the majority of the Cypress Island uplands to WDNR in 1987), but that unofficial moniker was replaced by the current name for this study.

Photo 2.03 – Bridge Rock Cove study site; Bridge Rock (or "Elephant Rock") is in the right foreground.

The net was anchored at the southern end of the beach, with all nets deployed in the direction indicated by the arrow (photo 2.03) to take advantage of the deepest area of the cove. Sample sessions at this relatively shallow site (Fig. 2.3) ranged in depth from 3.8 ft. at low tides, up to 10.1 ft. when the tide was high. Substrate along the higher elevations of the beach consisted of a coarse mix of gravels and some sand (ideal spawn substrate for some forage fish species), while lower tides revealed a cobble expanse on the floor of the cove. No measurable tidal current was recorded at Bridge Rock Cove during any of the sample sessions, and the site has generally quiet waters, well protected by local geography from prevailing westerly winds and offshore currents of Bellingham Channel. Bridge Rock Cove was seined during all but one of the 18 sample sessions.

Nets set at the lower tide ranges at this site encountered the highest concentrations of nearshore vegetation at any of the 2009 Cypress Island sample sites. A dense floating mix of brown, red, and green algae, including various low kelps, required significant time expenditure to sift through for netted fish (photo 2.05). Photos below also signify how entirely different nearshore habitat types (and fish communities) are sampled at each of the study sites depending on whether netting occurs at high tide (top) or lower sea levels (bottom). This should be accounted for when designing a robust future monitoring plan.

Photo 2.04 – Bridge Rock Cove study site at high tide; Cone Islands State Park in background.

Photo 2.05 – Bridge Rock Cove study site at low tide; Beachwatcher volunteers sift vegetation for fish.

Pelican Beach

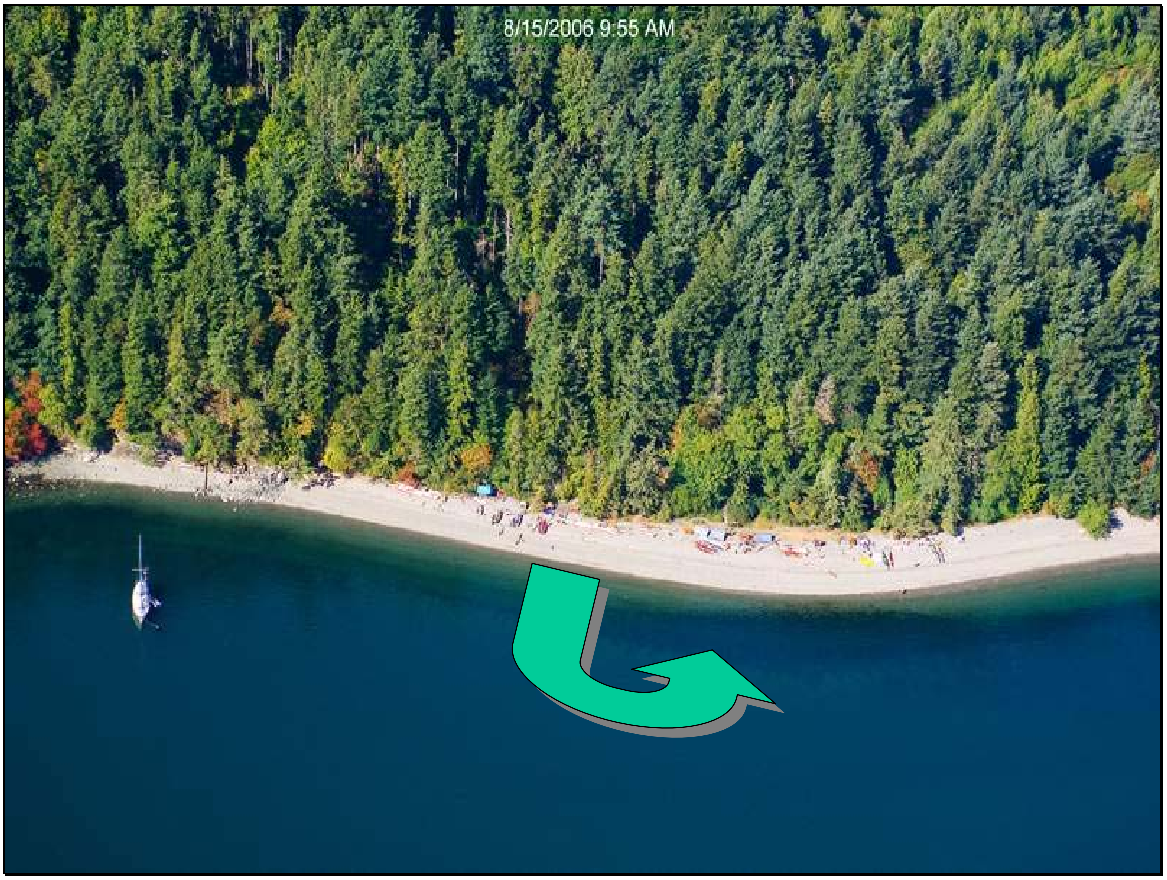


Photo 2.06 – Pelican Beach study site; note the extensive recreational use during the summer months.

Pelican Beach (located at the northern end of WDNR Beach #212) extends a lengthy sand spit along the exposed northeast shore of Cypress Island, with a steep beach profile that drops quickly into deeper offshore waters. This site had the greatest average depth of the 2009 sample sites, ranging from 19.8 ft. to 29.2 ft. deep during site visits (Fig. 2.3). Measured current velocities were also highest at the Pelican Beach site for most sample sessions, with researchers encountering significant daily tidal currents (up to 0.2 ft. / sec.) along the Cypress nearshore at this narrowest point of the Bellingham Channel. Depending on the current, nets were set in either direction from an anchor point located just south of the visually apparent point of the spit (photo 2.06).

The beach is a very popular recreation spot (see photo), and the location of one of only two official shoreline campsites within the Aquatic Reserve (the other is Cypress Head). Field crews often had a public audience during sample sessions at this site, providing an excellent opportunity to educate recreational users about the nearshore fish inhabitants of the Aquatic Reserve. WDNR management personnel familiar with long-term changes at the site reported that the exposed area of the higher beach and back berm have become steeper and shorter over time, possibly due to heavy foot traffic breaking down vegetation at the upper limits, and exposing the spit to increased wave erosion (S. Hewitt personal communication, 2009). Substrates within the area of the net set were a coarse mix of gravel and sand, with some large cobble encountered at lower tides near the point.

Seaweed vegetation at the site was minimal, with <25% of the coverage area of a typical net set consisting of a variety of brown, red, and green algae. Pelican Beach and Eagle Harbor were the only sites that were successfully seined during all 18 sample sessions (Fig. 3.01, pg. 35).

Smuggler's Cove

Photo 2.07 – Smuggler's Cove site; a portion of Eagle Cliff is visible as the plunging bedrock mass at left.

Nearshore habitat at the Smuggler's Cove site consists of a small, isolated pocket beach nestled at the western base of Eagle Cliff, on the northwest coast of Cypress Island. The cove is infamous as the location for Mrs. Hardy's homestead, a pioneer figure in the annals of Cypress Island history. This locale is also referred to as "Foss Cove" by some sources, and is located at the mouth of the Duck Lake outlet stream, a freshwater source with a tidewater channel cutting through the beach berm for much of the season, finally going subsurface in late August of a typical water year. It is very unlikely that salmonids utilize the relatively high gradient segment upstream from the beach for spawning or juvenile rearing, though this remains unverified.

To avoid rock outcrops on either side of the cove, all net sets at the site were anchored at the southern end of the beach, and the net was deployed in the direction indicated by the arrow in photo 2.07, encompassing the mouth of the Duck Lake outlet stream. Substrates on the upper beach consisted of a coarse mix of gravel and sand, with a cobble and boulder component prominent further out from shore (boulders occasionally caused hung nets at this site, requiring the boat operator to free the net and re-deploy to ensure a valid sample). Depths at Smuggler's Cove were moderate, ranging from 8.2 ft. to 11.5 ft. deep (Fig. 2.3). The offshore two-thirds of each net set swept a vegetated area of low kelp species, green algae (*Ulva*), rockweed *(Fucus spp.)*, and eelgrass *(Zostera)* – one of five nearshore sample sites to have significant eelgrass beds (the others are nearby Fahey's Beach, distant South Beach, Strawberry Bay, and the Cypress Head North Cove). Protected by projecting bedrock points on either side, tidal velocities were relatively benign at Smuggler's Cove, with only 2 of 13 sample sessions recording a measurable surface current. Smuggler's Cove was seined during thirteen of the eighteen sessions (Fig. 3.01, pg. 35), and was the only site to support all Pholids and Stichaeids at Cypress.

Photo 2.08 – Adult saddleback gunnel at Smuggler's Cove *(Pholis ornate)*; a common nearshore inhabitant

Fahey's Beach

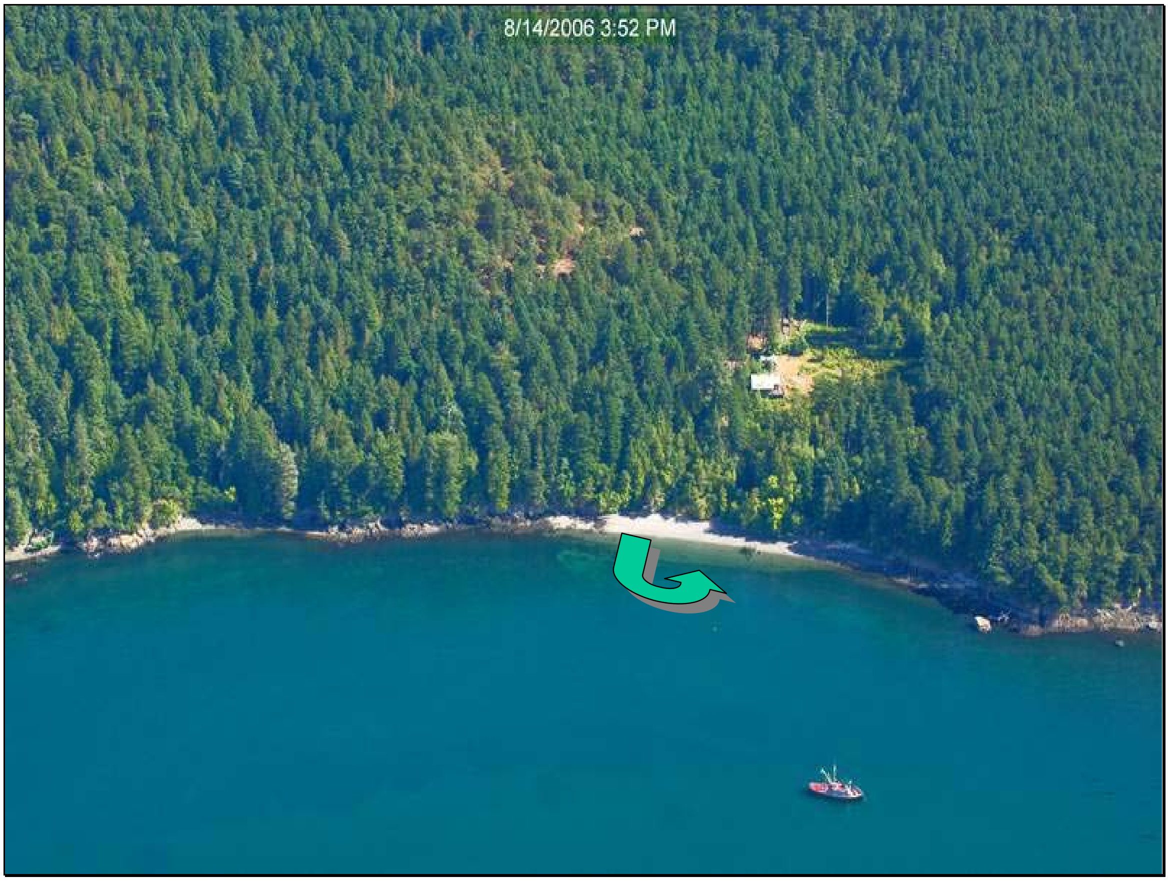


Photo 2.09 – Fahey's Beach site; part of the Fahey family homesite is visible in the background clearing.

Fronting on Rosario Strait along the northwest coast of Cypress Island, Fahey's Beach is the family name of third-generation property owners on a portion of the island extending from this location to (and including) Tide Point proper. The shallow coastal indentation here was historically referred to as "Goon Bay" (N. Fahey, pers. comm. 2009). The moderately shallow beach had depths ranging from 6 ft. to 11.2 ft. (Fig. 2.3), and is wholly exposed to significant wave action from the northwest across Rosario Strait. Current velocities were below the measurable threshold during most sample sessions (slack water), but ranged from 0.02 – 0.05 ft/sec on four occasions. However, surface current velocities were observed to be much higher slightly further offshore, just outside the reach of a low tide beach seine. The bluff-backed beach consists of mixed fines (sand and small gravels) throughout, with a sluggish, intermittent stream seeping across the beach at the net anchor location. At typical tide heights, the seaward one-third of the net area encountered subtidal eelgrass beds, low kelp, and mid-summer *Ulva*. Fahey's Beach was successfully seined during 14 of the 18 sample sessions (Fig. 3.01, page 35).

Tide Point

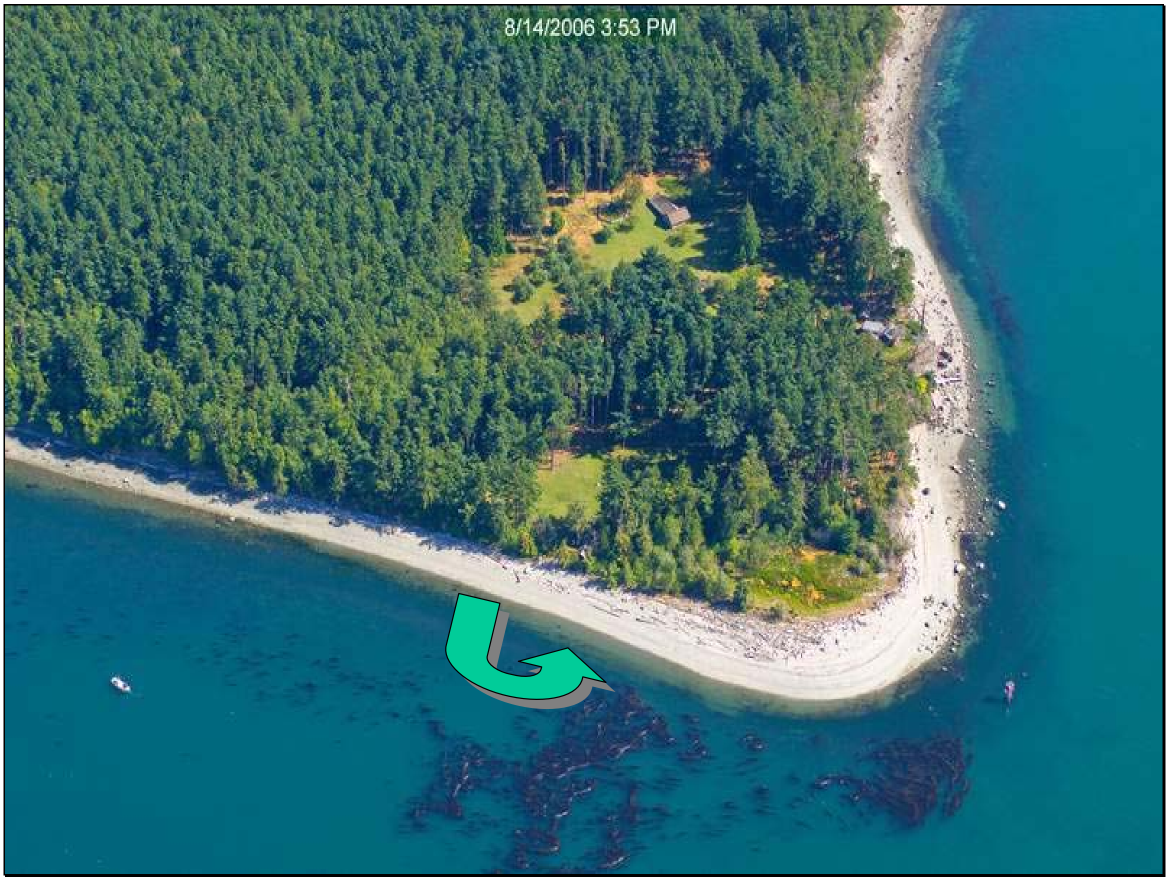


Photo 2.10 – Tide Point study site; note the brown strands of bull kelp; the beach seine net just reached the inshore edge of the kelp beds at lower tide sets.

Tide Point is a prominent barrier beach / cuspate foreland jutting westward into the tidal currents of Rosario Strait from the northwestern shore of Cypress Island. It is aptly named; the daily tidal flux produces a powerful current rip along this point that is one of the swiftest anywhere along the Cypress Island coastline. Due to unfamiliarity with the vagaries of this strong tide rip, researchers were unable to seine at the Tide Point site during the early season sample sessions. Later discussions with the local landowner provided the necessary information regarding slack tide stages and the only safe beach landing spot (Table 2.1) to begin fishing this site during the first week of May (sample session #6). This is a good example of the need for adequate resources to fund pre-season scouting. Despite the late start, the site was successfully seined during 11 of 18 sample sessions (Fig. 3.01, page 35).

The beach on the north side of Tide Point drops steeply into relatively deeper offshore water (sample depths ranged from 11.9 ft. to 16.4 ft. – Fig. 2.3), harboring a subsurface boulder field that provides holdfast anchorages for an extensive bull kelp forest *(Neroecystis luetkeana)*. Tide Point was the only site where bull kelp was available for sampling, although the leading edge of the beach seine barely reached the inshore edge of the kelp during typical net sweeps (photo 2.10). Similar to Smuggler's Cove, boulders cause the net to hang up at the Tide Point sample site, but an experienced and careful pilot can negotiate the net set to avoid the rocks (they are visible below the surface at most tide heights that are safe to sample). Exposed higher elevations of the beach are a coarse mix of unsorted gravels at this high-energy nearshore site, where surface velocity measurements of up to 0.23 ft. per second were recorded during samples.

Strawberry Bay

Photo 2.11 – Strawberry Bay; the southernmost structures of the beach community are visible at far left.

Strawberry Bay vied with Eagle Harbor as the shallowest of the eleven nearshore sites selected for sampling in 2009. Depths at this site ranged from only 2.7 ft. during a low tide, mid-season sample session, up to 5.7 ft. during higher tides (Fig. 2.3). Strawberry Bay is a broad, though relatively shallow indentation along the southwestern coastline of Cypress Island that is exposed to significant wind wave action generated by storms and typical high-pressure afternoon westerlies across the long, open fetch of Rosario Strait. Longer-period ground swell was also noted here on several occasions as well. As with most of the 2009 Cypress sites, nearshore current velocities were essentially slack during all sample sessions (16 of 18 successful seine sets – Fig. 3.01, pg. 35).

A small community of vacation homes with few year-round residents is located at the north end of Strawberry Bay, and these likely contribute untreated septic waste to the otherwise nearly-pristine nearshore environment of the Cypress Island Aquatic Reserve. The seine site was located along the gravel beach several hundred meters to the south of the Strawberry Bay community (Table 2.1). Within the subtidal zone, substrate at this site was almost entirely sand, grading into a short segment of small cobbles at the intertidal / subtidal fringe. A coarse mix of sand and gravel comprised the upper beach. Sampling at lower tide levels provided access to subtidal eelgrass beds covering the sandy bottom of the bay, with a varying mix of *Ulva* and brown algae making up the remainder of the vegetation covering the narrow cobble zone. A large brackish wetland complex just inland of the beach berm (photo 2.11) collects surface flow from several upland tributary streams (including the Cypress Lake outlet stream), and contributes freshwater seepage into nearshore areas of Strawberry Bay for most of the season.

South Beach

Photo 2.12 – South Beach study site; note Bull Kelp beds at lower right of photo (outside of sample area). Extensive meadows at upper end of the Secret Harbor watershed are visible in the background, upper left.

The South Beach site is located at the deepest indentation of a lengthy bluff-backed beach extending westward from an old olivine mine that scars the bedrock outcropping of Broughton Point, along the south coast of Cypress Island. South Beach was historically referred to as “Nedrow Beach” by locals from the city of Anacortes (southeast across the Guemes Channel from the point) though its official designation is the western end of WDNR Beach #210. A well-established trail leads inland from the beach near the seine site (Table 2.1), north over a shallow saddle through the adjacent hills to Secret Harbor. The beach is exposed to wind waves from the south, and nearshore tidal currents were measurably higher than at most other Cypress study sites during sample visits (0.03 to 0.1 feet per second surface velocities during 4 of the 17 successful seines at this site).

Observed nearshore currents result from multiple marine waterways converging just offshore in this vicinity (Bellingham Channel, Rosario Strait, Guemes Channel).

Sample depths at South Beach ranged from a minimum of 3.6 ft. at very low tide, up to a maximum high tide depth of 9.2 ft. (Fig. 2.3). These depths describe a beach profile that is relatively steep and short at the higher elevations where a coarse mix of large cobble and gravel predominates, but tapers quickly onto a nearly flat seafloor comprised mostly of sand that is partly exposed at the intertidal / subtidal fringe during low tides. The sand provides ideal substrate for a healthy, extensive eelgrass bed at this site. Depending on tide height, 25% to 60% of the net area consisted of eelgrass, with relatively minor amounts of rockweed *(Fucus spp.)* and green sea lettuce *(Ulva)* making up the remainder of the vegetation over submerged, rockier substrates. Apart from nearshore fish communities documented in the Results section of this report, WFC's project manager noted that the eelgrass beds of South Beach appeared to be a significant juvenile Dungeness crab nursery (*Metacarcinus magister*), as catches similar to that depicted in photo 2.13 were common during the height of the sample season.

Photo 2.13 – Juvenile Dungeness crab were observed in numbers throughout the season at South Beach.

Cypress Head South Cove and Cypress Head North Cove

Photo 2.14 – Cypress Head overview showing the configuration of the South (left) and North Cove sites.

Although located within just a dozen meters of each other on opposite sides of the narrow sand spit (or tombolo) connecting the Cypress Head satellite to Cypress Island, nearshore habitats at the adjacent coves of Cypress Head South and Cypress Head North couldn't be more unalike. The long, narrow, and shallow South Cove had a small range of sample depths that only differed by 2.7 ft. over the course of the 8 successful site visits (from the minimum measured depth of 4.1 ft. to the maximum of 6.8 ft. – Fig. 2.3). These depths indicated a lengthy area of nearly flat seafloor after an initial short drop off the higher elevation pocket beach. This long, flat, sandy substrate typically encompassed two thirds or more of the set area and late in the season provided ideal conditions for a proliferation and concentration of green sea lettuce (species of the genus *Ulva*). Surface current was non-existent at the Cypress Head South Cove during sample sessions, and the site is largely shielded from wind wave action on the beach. However, field crews were prevented from sampling the South Cove on several occasions due to arrival on site at low or minus tides, when the site cannot be safely accessed with propeller-driven boats.

In contrast, the wider, shorter Cypress Head North Cove site often experiences significant wind wave action from the north. Current bleed from the violent rip current that sets up during daily changing tides off the north end of Cypress Head was observed to infiltrate offshore limits of the North Cove, though actual measurements recorded little or no surface current at the nearshore net site during the 11 separate successful beach seines over the course of the sample season (Fig. 3.01, pg. 35). Due to a lack of detectable surface current, nets were always set in the direction indicated by the arrows in photos 2.14 and 2.15 at both the Cypress Head South Cove and North Cove sites. Sample depths ranged over 6 ft. of seawater surface elevation (from 5.9 to 11.9 ft. – Fig. 2.3, pg. 14), indicating a steep beach profile dropping northward into the North Cove from the pocket beach at its head. The higher, steeper portion of this beach consisted largely of a coarse mix of gravel and sand, with a significant component of medium-to-large sized cobble exposed during lower tides at the intertidal / subtidal fringe. This cobble also generated net drag (at lower tides when less of the net was actually floating in the water column), causing difficulty for field crews attempting to bring the seine to shore in a timely manner, and possibly allowing a few netted fish to escape through cobble interstices under the lead lines of the net. However, fish loss was closely monitored by the project manager from the leading and trailing edges of the closed net, and is believed minimal.

A moderate-sized eelgrass bed *(Zostera spp.)* develops over the course of the season in the deeper portions of the North Cove, and this important habitat was available for sampling at lower tide levels. A variety of low kelp species, significant amounts of *Ulva*, and various other brown and green algae made up the bulk of the subsurface vegetation surrounding the eelgrass zone. Nearshore vegetation at this site was quite variable depending on the coverage area of the net, and rivaled the Bridge Rock Cove site for sheer volume, resulting in extensive expenditures of crew time and effort sorting fish from a net filled with floating algae.

Photo 2.15 – Near view of the Cypress Head sites showing the South Cove (left) and North Cove (right).

East Beach

Photo 2.16 – East Beach study site; the steep, shadowed ravine of the Reed Lake outlet stream is visible just beyond the sample area (green arrow).

The East Beach site was included for sampling on an ad-hoc basis throughout the season, after it was determined that effective sampling at Reef Point was impossible to achieve. East Beach (WDNR Beach #211) is located along the northeast coastline of Cypress Island (Fig. 2.2, pg. 13) at the tidewater confluence of the Reed Lake outlet stream. This high gradient freshwater source disappeared subsurface in early summer of 2009, but maintained a steady surface flow and defined channel across the beach prior to July.

East Beach is bracketed to the north and south by rocky bluffs that fall steeply to sea level. The site was successfully seined on 8 of the 18 sample sessions (Fig. 3.01, pg. 35), but not visited during the peak of the juvenile salmon outmigration period. East Beach consists of a steep, narrow exposed coarse gravel and sand beach that drops quickly into deeper water with a cobble rock substrate. Depths at the site ranged from 12.2 ft. deep at lower tide sampling, up to 28.4 ft. at the higher tides (only Pelican Beach was deeper on average – Fig. 2.3, pg. 14). The beach is exposed to current and wind waves from the northeast across Bellingham Channel, with measured surface current velocities up to 0.07 feet per second during seine sessions. Depending on the tide height, various intertidal red, green and brown algae species encompass as much as 50% of the area of the net set, and provided cover for a variety of fish species, particularly Pholids and Stichaeids.

2.3 Methods – *Sampling Protocol*

Sampling for the Cypress Island Pilot Fish Use Assessment was conducted using a seining protocol adapted and modified from similar methods that were developed and implemented by Skagit River Systems Cooperative throughout Skagit Bay and other nearshore waters of north Puget Sound (Beamer et al. 2006). A large, fine-meshed beach seine is deployed via motorized skiff at each sample site, and hauled to shore by hand (with a crew of strong-backed volunteers). The physical demands of this work, both net-hauling and fish processing in inclement weather, should not be underestimated when selecting field personnel and planning for future long-term nearshore fish monitoring.

Intertidal / subtidal habitats at Cypress Island were sampled using a 120 ft.-long beach seine constructed of one-eighth inch mesh material. A series of plastic-coated styrofoam corks along the surface edge of the net maintain its flotation, and a double length of lead lines encased in a cloth material designed to withstand repeated abrasion are sewn into the bottom net edge (this material allows the net to be easily pulled across under water obstructions – naked lead lines tend to hang up on rocks or become buried in soft sands). The beach seine is 12 ft. deep at the middle of the net (the purse), and tapers to 6 ft. at the shore end of the net. The net is tied to a solid onshore anchor with enough lead on the tie-off line to ensure that the shore end of the seine falls precisely at the current waterline. An outboard propeller-driven aluminum skiff was employed to pull the net off the beach, forming a semi-circle loop with the open end of the net facing into the prevailing current. At sites and instances where there is significant surface current, the net is held in place for 3 minutes before returning to shore. At Cypress Island, where surface current was minimal or non-existent at nearly all of the sites and sample sessions, the boat-end of the seine was simply returned to shore without holding in place. Thus, the “set time” for the net (from the time it leaves the beach to the time that the leading end of the net is finally closed by the hand crews) averaged approximately 1.5 min. (photos 2.17 – 2.20).

The following data were recorded for each site / sample session (single net deployment):

- Time and date of the net set
- Weather conditions, and maximum and avg. daily air temperature (obtained from weather records)
- Tide stage - four categories: <u>E</u>bb, <u>F</u>lood, <u>H</u>igh Tide slack water, <u>L</u>ow Tide slack water
- Haul time - typically 1.5 minutes for Cypress Island nearshore sets with no measurable current
- Temperature and salinity at the water surface and at a 1-meter depth – measurements were conducted using a YSI Model 30 handheld temperature / conductivity / salinity meter
- Maximum depth of area seined – measured by standard boat-mounted sonar / depth finder
- Surface water velocity – measured using a Swoffer Instruments propeller-driven current meter
- Predominant beach and subsurface substrate and vegetation types, and a visual estimate of vegetative cover – i.e. the percent of area under net that was vegetated
- Complete fish catch records by species; for juvenile salmon this included fork length (FL) measurements of the first <u>20</u> individuals of each species randomly selected from holding tanks, with the exception that fork length was measured for the first <u>40</u> juvenile Chinook salmon

Photo 2.17 – Towing the 120' beach seine against the nearshore current.

Photo 2.18 – Hand-hauling the beach seine back to shore; tough work if there is a strong current!

Note: Cypress Island Aquatic Reserve study sites showed very little tidal current during most sample sessions (see Methods section 2.2 site descriptions for specifics). Nearshore waters usually had little or no current, even when a significant surface current was noted just offshore (and outside of the seine area) at the time of the net set.

Photo 2.19 – Closing the net to trap any potential catch, and prevent fish from escaping.

Photo 2.20 – Moving fish from the net into temporary holding tanks for processing. Inexpensive commercial aerators are available from most pet supply stores to maintain an adequate supply of dissolved oxygen to fish in the tanks; mandatory to ensure the safety of captured fish, particularly so on warm days. Holding bins should also be shaded using drop-cloths whenever possible to minimize solar heating and fish stress from repeated predator-avoidance response.

2.3 Methods - *Sampling protocol (cont'd.)*

Juvenile Chinook salmon with no visible external markings indicating that they were artificially propagated at a hatchery facility (i.e. missing adipose fin), had a small clip of the anal fin removed for subsequent genetic analysis. Tissue samples from these 81 unmarked Chinook smolts were preserved in small vials filled with de-natured alcohol, and later provided to Northwest Fisheries Science Center and Skagit River Systems Cooperative researchers conducting an investigation of the stock origins of juvenile Chinook in mixed rearing environments of north Puget Sound and the San Juan Islands.

A sub-sample of juvenile salmon (83 Chinook, 10 coho, and 4 chum) were hand-lavaged for gut-content analysis by researchers from Kwiaht, for an analysis of the diets of juvenile salmon from nearshore rearing environments of the outer San Juan Islands. The window for capture of outmigrating salmon smolts was nearly closed at Cypress Island by the time Kwiaht was able to free up personnel to assist with stomach lavage training and gut content collection. Few samples were obtained, but analysis is ongoing at the time of writing, and results for Cypress Island nearshore will available at a later date.

Lastly, all juvenile Chinook and coho salmon determined by non-lethal means (via magnetic scanner) to have an embedded Coded Wire Tag (CWT) were euthanized, and the snout of these fish was retained for subsequent tag extraction and processing by SRSC laboratory staff. Results from reading these tags provided important information regarding hatchery-of-origin and river release dates for the tagged smolts.

2.4 Methods – *Data management and statistical analyses*

Post-sampling, data was transferred from the field forms into an electronic database spreadsheet format for analysis. Quality control was maintained throughout. Fish capture data for all species were summarized by sample site, and fish density per sample session was calculated and reported for juvenile salmon, as well as forage fish species. For this project, fish density was defined as:

Density = catch-per-unit-effort of target species / area of habitat sampled (in Hectares)

Mean catch-per-unit-effort ($CPUE_{Avg}$) for each site / sample session is also reported for juvenile salmon to provide comparisons with other north Puget Sound nearshore catch records where density was not calculated. For all other marine fish species, the metric used for chart comparison of nearshore community aggregations at each site is the instantaneous Maximum catch/effort ($CPUE_{Max}$). This was selected over the more often reported Mean catch/effort ($CPUE_{Avg}$) due to the highly variable sample effort, and typically small sample sizes for most nearshore species. Lack of adequate replication across sample sites and sample sessions precludes a robust statistical analysis of between-site and time-scale comparisons of the majority of the fish capture data. However, in order to preserve the initial goal of providing a baseline metric for comparison to future monitoring, standard Mean catch/effort ($CPUE_{Avg}$) per site is reported for each species in the quick-reference tables of Appendix 4.

For clarity of analysis, juvenile salmon catch records were stratified into geographic bins, and hypotheses were tested regarding salmon abundance and length by species for the two sample bins – the Bellingham Channel coastline of Cypress (East and South sites) and the Rosario Strait coast (northwest to southwest sites). Combining juvenile salmon capture data across the sample sites within each bin enabled tests of differences in average catches by sample session for juvenile Chinook, coho, and chum salmon between east and west for the Cypress Island nearshore. Paired T-tests were employed to test for differences in mean fork lengths both within and across the geographic sample bins for externally-marked (i.e. known hatchery) and unmarked (or probable wild) juvenile Chinook and coho (however, see pg. 54 for a discussion about origins of the latter group). Regression coefficients were calculated for growth rates of those juvenile salmon groups exhibiting linear growth over the course of the sample season.

Shannon Diversity Indices were calculated for all fish species and fish families by site.

Seawater temperature and salinity data for the 2009 Cypress Island nearshore sample sites are reported, and briefly compared to available daily air temperature averages and maxima from the nearest official reporting weather station for each sample session. No attempt was made to calculate the statistical correlations of these data with seasonal discharge from nearby large rivers (e.g. Skagit, Samish, Nooksack, Fraser River).

Information obtained from coded wire tags recovered from artificially propagated coho and Chinook are summarized by site (photo 2.20), and patterns of site occupancy by hatchery fish are displayed and discussed relative to recently-returned genetic data on “wild” Chinook concurrently utilizing Cypress nearshores (Beamer and Teel, et al 2011).

Photo 2.21 – Placing fish in a plexiglass viewing “photarium” is also the safest method for Coded Wire Tag scanning; the enclosure eliminates the need for extensive handling of the fish out-of-water. Note that this subadult coho already experienced some scale loss while attempting to free itself from the net during initial seining operations.

Section 3: Results

3.1 Results – *Sampling and site considerations*

In 2009, 151 total single-set beach seine hauls were conducted at the eleven nearshore sample sites within the Cypress Island Aquatic Reserve. Seining took place every 12-14 days through the full sample period (from the last week in February through the third week of October) at each site, with a total of 198 possible net sets if all sites received equal sample effort as outlined in the original study plan. Thus, field crews had a 76% success rate for planned beach seines across all sites in 2009. For the ten primary sites, 90 of the net sets were at sites located along the Bellingham Channel coastline (63%; includes South Beach; excludes the eight site visits at East Beach) while the remaining 53 seine hauls (or 37%) were spread across the season at the four Rosario Strait sample sites (Smuggler's Cove, Fahey's Beach, Tide Point, Strawberry Bay). Figure 3.01 details actual site visitation across the 18 separate (2-day) sample sessions for this pilot study, and Table 3.1 lists the specific dates associated with each sample session.

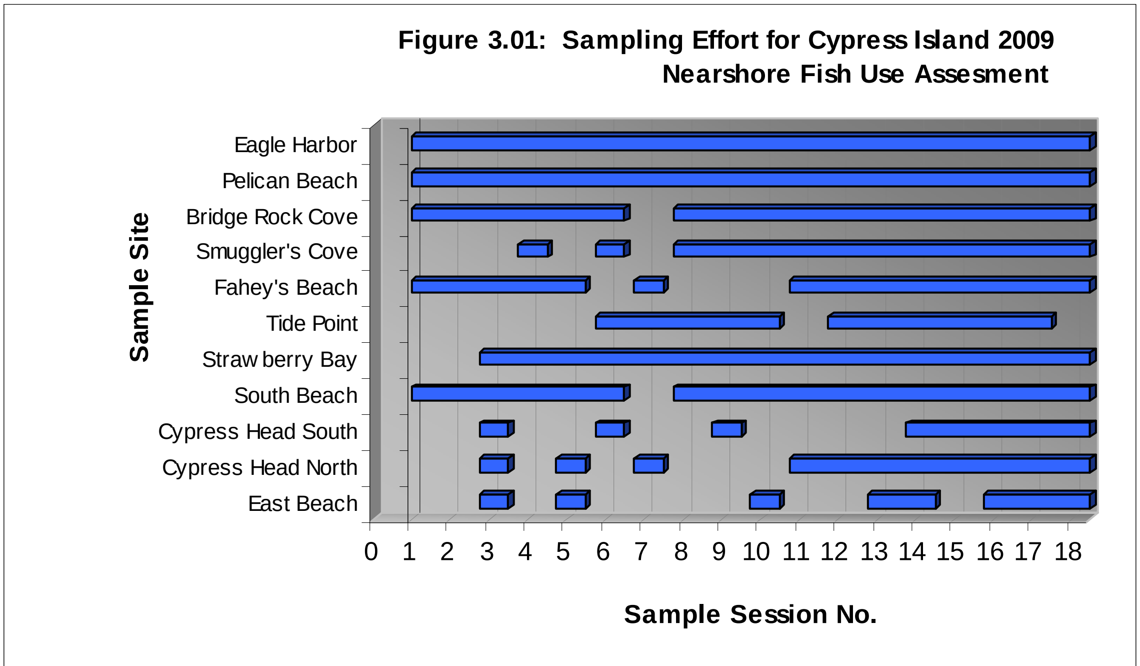


Figure 3.01 – Site visits by sample session for 2009 Cypress Island Pilot Nearshore Fish Use Assessment.

Table 3.1: Sample dates for 2009 Cypress Island Pilot Nearshore Fish Use Assessment

SAMPLE SESSION No. (from Fig. 3.01)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Feb.	March	March	Apr.	Apr.	May	May	June	June	June / July	July	July	Aug.	Aug	Sept.	Sept.	Oct.	Oct.
26,27	11,12	25,26	7,9	23,24	4,8	18,20	1,2	15,16	30/1	13,14	28,29	10,11	25,26	8,9	22,24	6,8	19,20

Eagle Harbor and Pelican Beach were the only sites visited during every sample session. Crews were periodically prevented from reaching some sites, particularly Tide Point and Cypress Head South Cove, by tide stage and conditions at the time of arrival on-site. The latter could only be sampled at or near high tides as it was otherwise too shallow for safe boating and effective net setting with available equipment (prop-driven outboard skiff).

Tide Point was not sampled during early-season sessions due to unfamiliarity of the field crew with the very strong rip current that develops along the point bar during daily tide swings. Scouting of the site during a range of tide conditions, and pre-season discussions with the landowner (N. Fahey) would have provided the information needed to safely sample this site earlier in the season. Smuggler's Cove and Fahey's Beach have similar northwest exposures and very similar habitat types so, in part, these sites were mutually compensatory during missed visits at each. Differences in fish use were clearly identified at these two sites, but enough similarities exist that WFC researchers were confident in the likelihood that any pertinent information about migrating fish that may have been missed at one site was readily captured at the adjacent site for a given session (compare visits overlap in Fig. 3.01). Fahey's Beach and Tide Point, though in close proximity, were dissimilar in habitat. The same is true for Cypress Head South and North Coves.

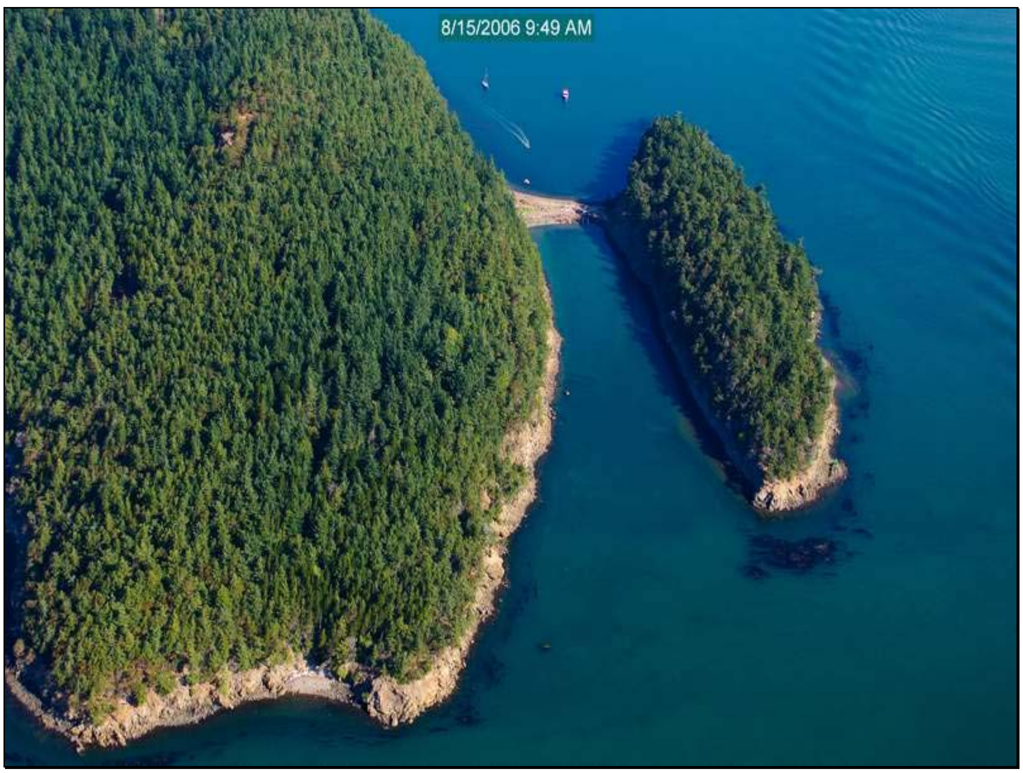


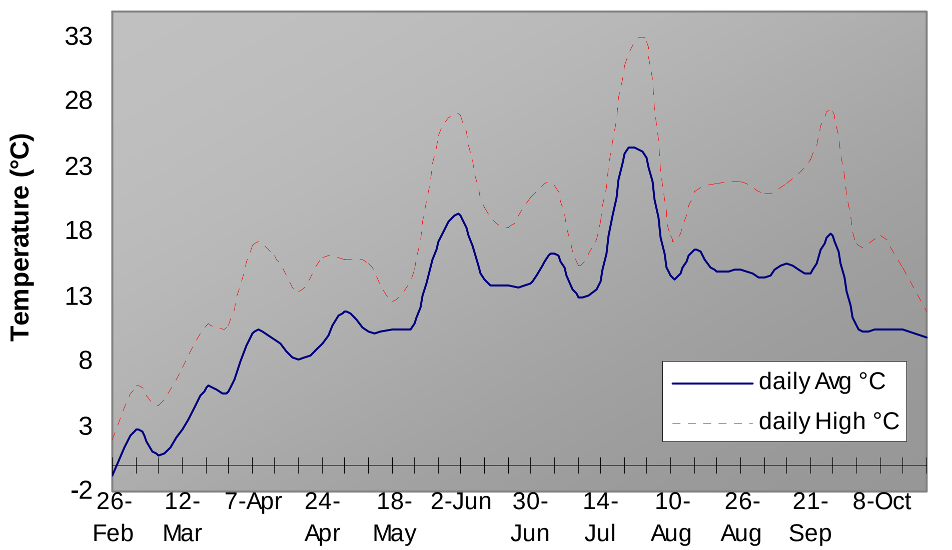
Photo 3.01 – Overview of Cypress Head looking northeast across the South Cove site. Bull kelp beds surround the outer margins of Cypress Head, but are not present at the North and South Cove sites.

As discussed in the site descriptions (Section 2.2), the East Beach site was only sampled on an ad-hoc basis; i.e. whenever field crews had completed sampling at the ten primary sites for a given sample session. Extended time spent processing large catches prevented sampling at all sites during the peak of juvenile salmon outmigration (May and June).

3.2 Results – *Environmental monitoring*

Seawater salinity and temperature point data were collected at the surface and at a depth of 1-meter just prior to net deployment for each sample session. Trends in surface seawater temperature for 2009 Cypress Island Nearshore sample sites are presented here.

Figure 3.02: 2009 seasonal air temperature average and maxima as recorded at the Ship Harbor weather station in Anacortes, WA



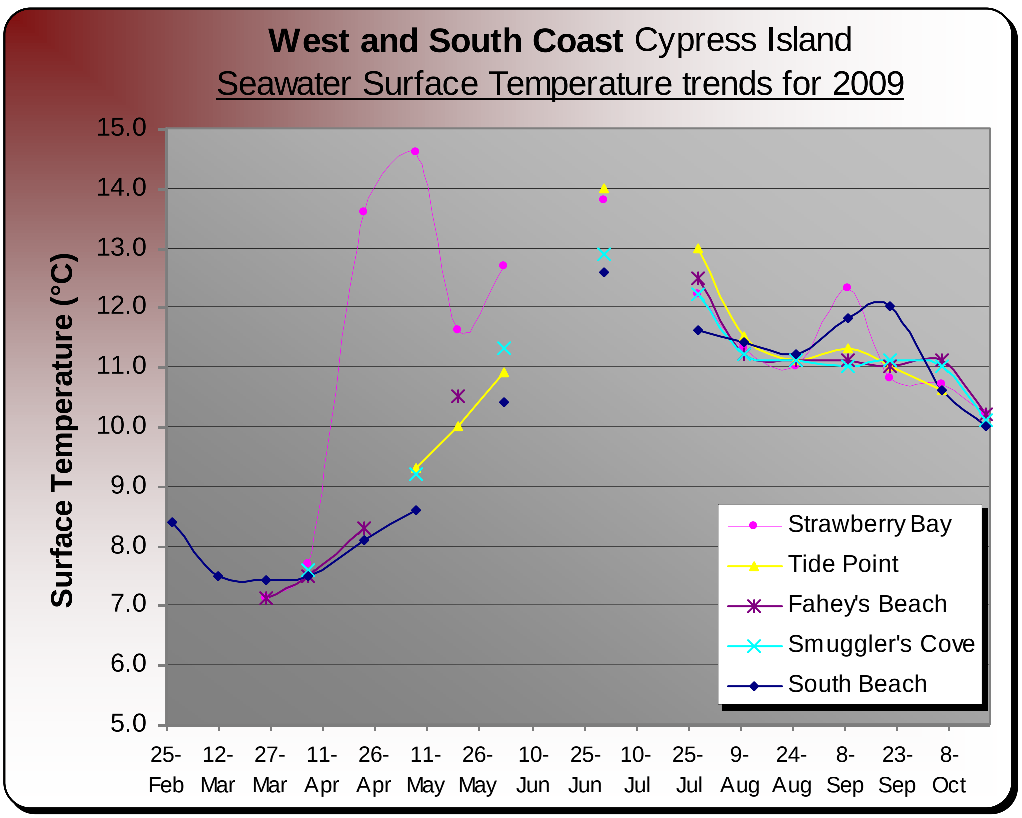


Figure 3.03 – Surface temperature data and trends for Cypress Island *South and West Coast* sample sites.

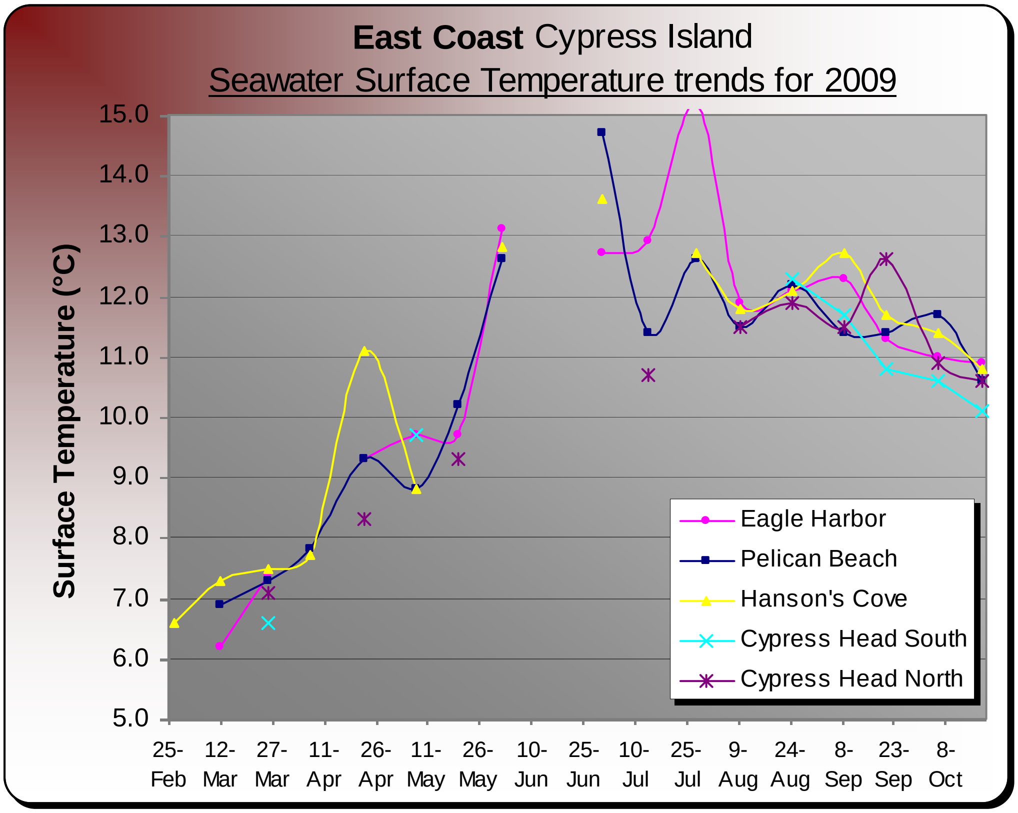
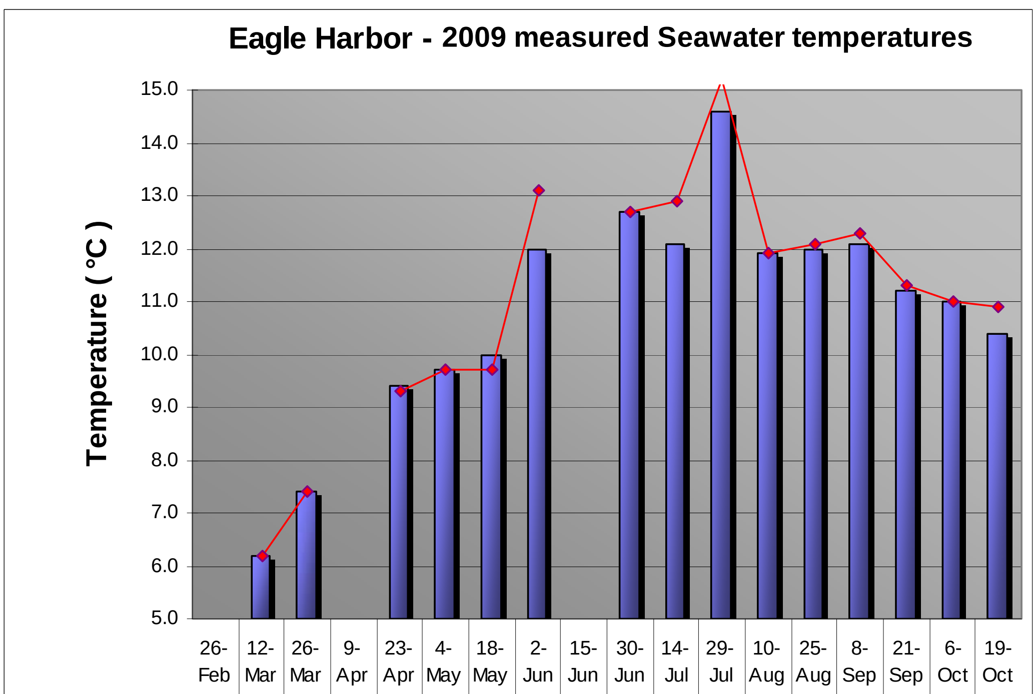


Figure 3.04 – Surface temperature data and trends for Cypress Island 2009 *East Coast* sample sites.



	26-Feb	12-Mar	26-Mar	9-Apr	23-Apr	4-May	18-May	2-Jun	15-Jun	30-Jun	14-Jul	29-Jul	10-Aug	25-Aug	8-Sep	21-Sep	6-Oct	19-Oct
1 meter depth		6.2	7.4		9.4	9.7	10.0	12.0		12.7	12.1	14.6	11.9	12.0	12.1	11.2	11.0	10.4
Surface		6.2	7.4		9.3	9.7	9.7	13.1		12.7	12.9	15.2	11.9	12.1	12.3	11.3	11.0	10.9

Figure 3.05 – Measured seawater temperatures for the Eagle Harbor 2009 sample sessions. See Appendix 3 for all other Cypress Island Pilot Nearshore Fish Use Assessment sites.

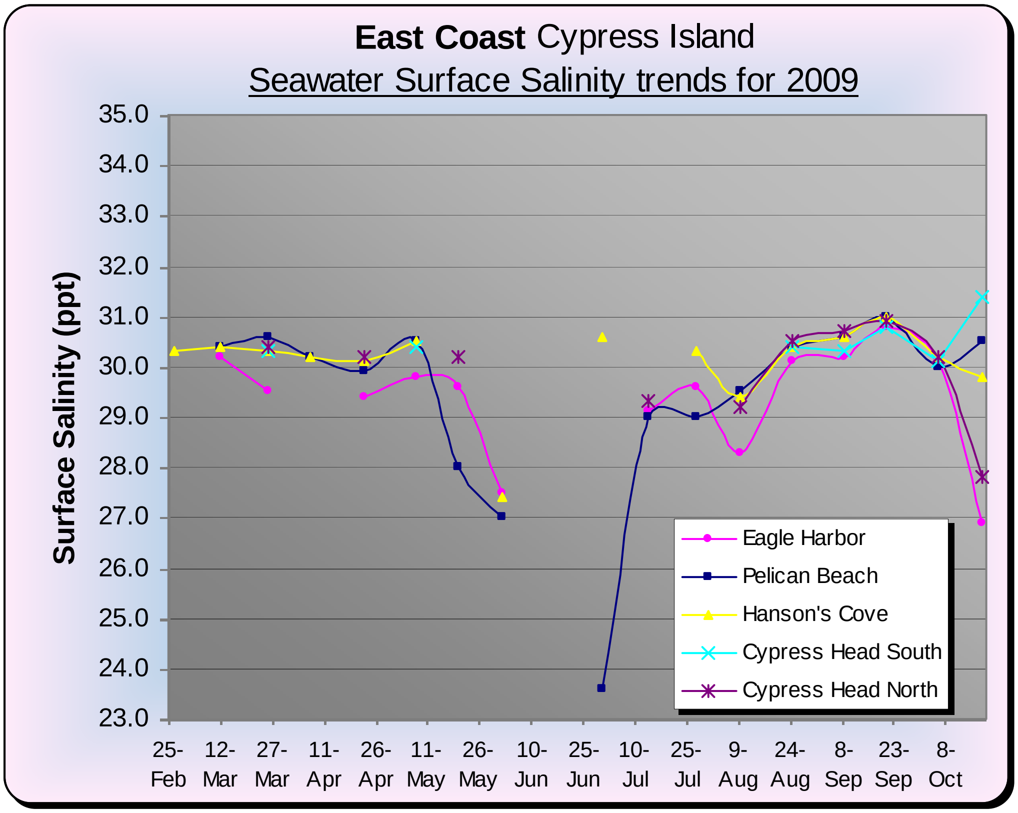
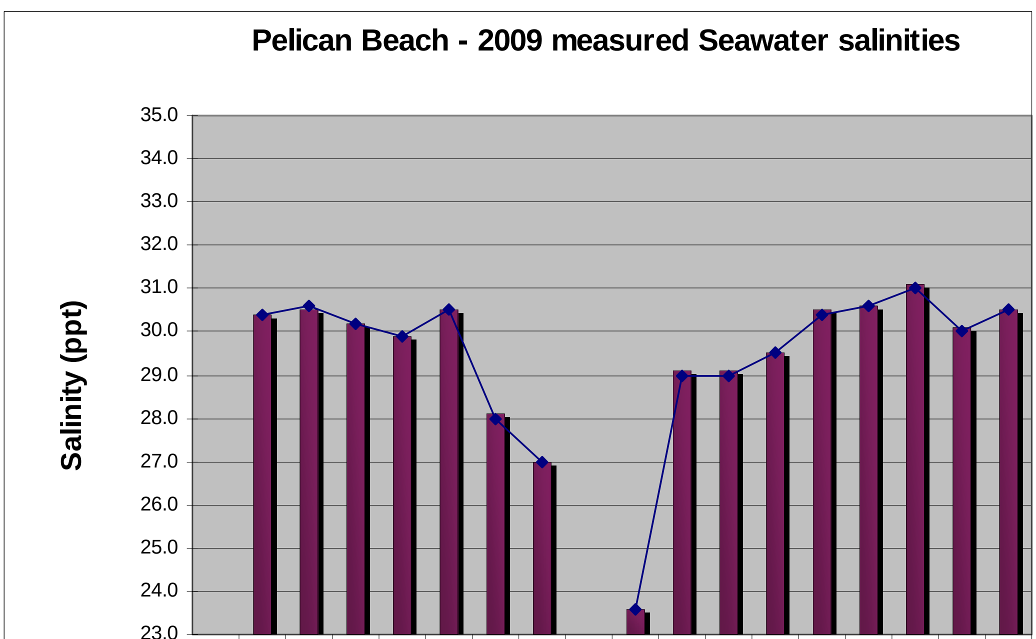


Figure 3.06 – Surface salinity data and trends for Cypress Island 2009 East Coast sample sites.



	27-Feb	12-Mar	26-Mar	7-Apr	23-Apr	8-May	20-May	2-Jun	16-Jun	1-Jul	14-Jul	28-Jul	10-Aug	25-Aug	9-Sep	21-Sep	6-Oct	19-Oct
1 meter depth		30.4	30.5	30.2	29.9	30.5	28.1	27.0		23.6	29.1	29.1	29.5	30.5	30.6	31.1	30.1	30.5
Surface		30.4	30.6	30.2	29.9	30.5	28.0	27.0		23.6	29.0	29.0	29.5	30.4	30.6	31.0	30.0	30.5

Figure 3.07 – Measured seawater temperatures for the Pelican Beach 2009 sample sessions.
See Appendix 3 for all other Cypress Island Pilot Nearshore Fish Use Assessment sites.

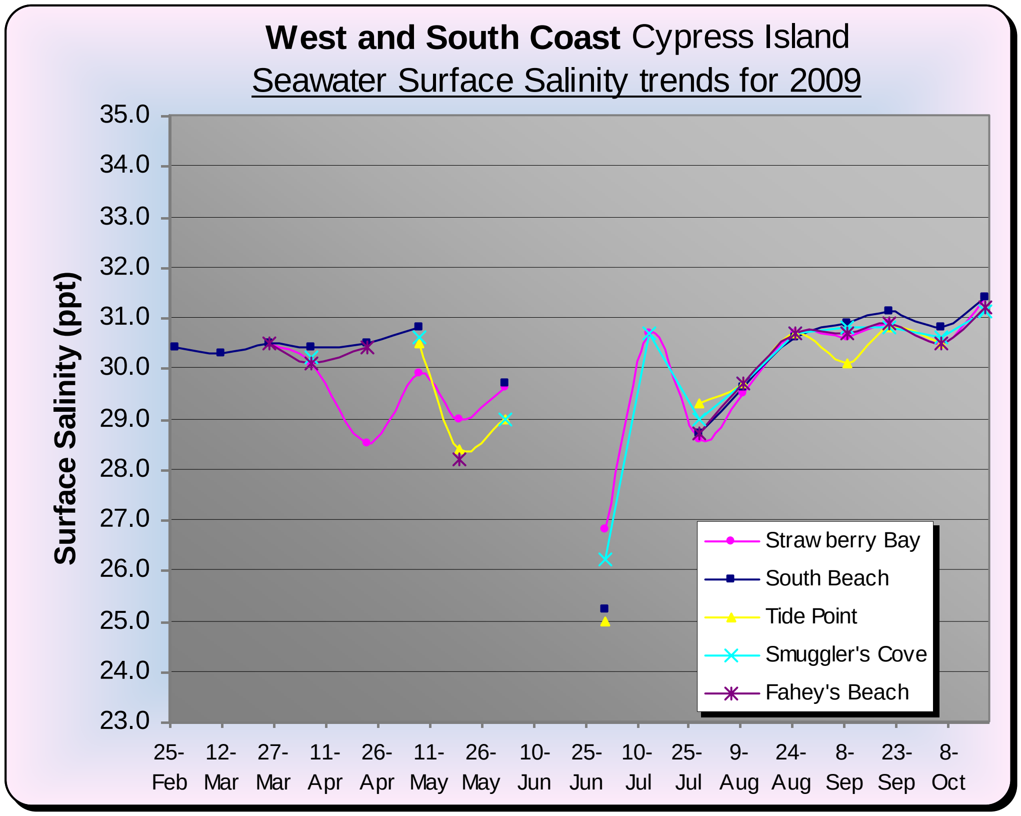


Figure 3.08 – Surface salinity data and trends for Cypress Island 2009 South and West Coast sample sites.

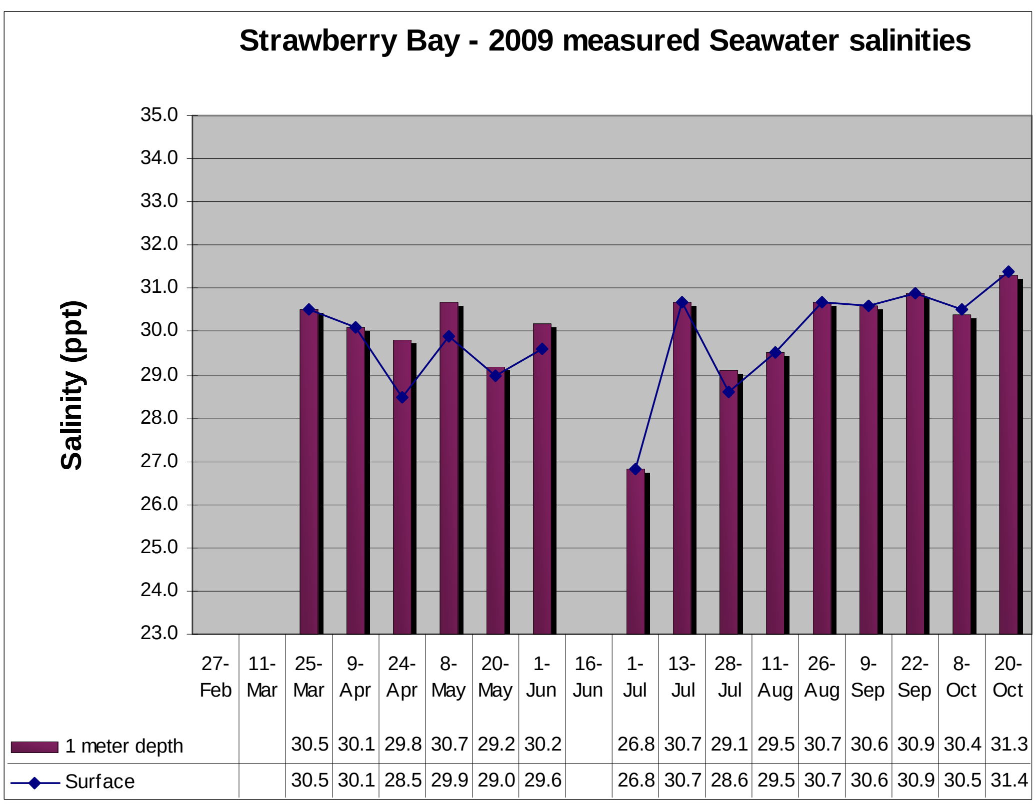


Figure 3.09 – Measured seawater salinities for the Strawberry Bay 2009 sample sessions.
See Appendix 3 for all other Cypress Island Pilot Nearshore Fish Use Assessment sites.

Sites are arranged in Figures 3.03 and 3.04 from the warmest average water temperature across the sampling season to the coolest (top to bottom). *Note that the smoothed lines are for ease of viewing temperature trends only, and are not intended to represent continuous data collection. Surface water temperatures may have fluctuated significantly from these idealized trend lines during the approximately two week intervals between sample sessions.* Also, temperatures are displayed as recorded at a single date and time only; i.e. there was no attempt to standardize the data by weather conditions (clear and warm vs. cloudy and cool), or for time of day (e.g. early morning cooler than afternoon).

Figure 3.02 (page 37, top) displays seasonal average and maximum air temperatures for all of the 2009 Cypress Island Pilot Nearshore Fish Use Assessment sample session dates. This graphic is provided as a general weather reference for the seawater temperature data displayed in Figures 3.03 and 3.04. Temperatures generally tracked warming air across the spring / summer season, falling off with cooling in the autumn. Shallow Strawberry Bay had the highest peak temperature across the time series for West and South coast sites combined (during the late July 2009 heat wave), with the other sites fluctuating less dramatically (usually differing from each other by 1° to 2° C at most). The South Beach site appears to warm earlier in the season and remain warmer later in autumn, presumably due to shallow waters and a southern exposure allowing for longer periods of direct solar heating on sunny days. This may indicate primary productivity ramping up earlier in the season at this site, providing early feeding opportunities for fish and aquatic organisms.

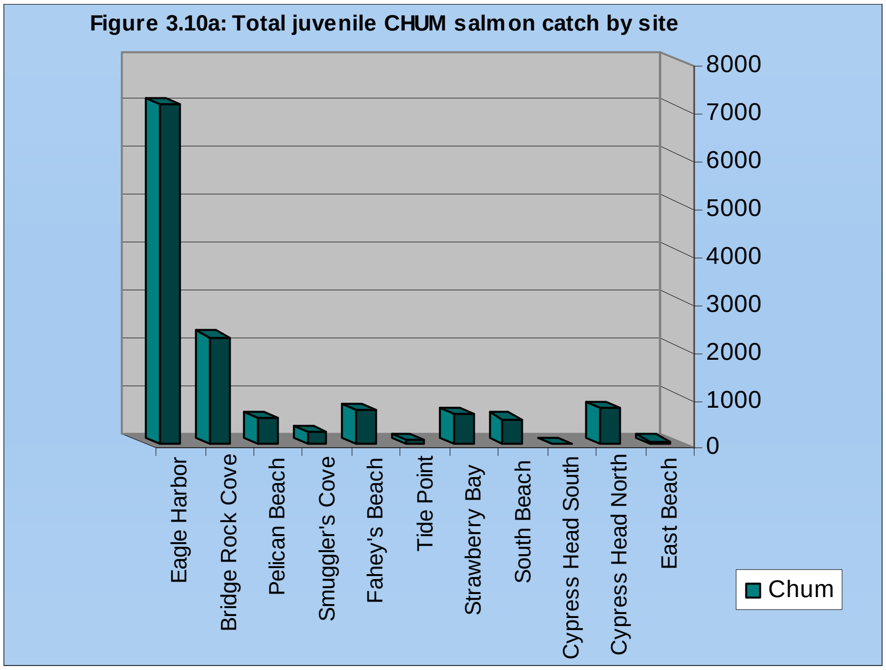
Data for East Coast sites appears in Fig. 3.04 (page 38, top - note that the East Beach site was not included in this graphic). As with Strawberry Bay and South Beach, the shallow sand flats of Eagle Harbor recorded the highest surface water temperatures on the east coast of the island. Fig. 3.05 shows the seawater surface temperature and temperature at 1 meter depth for the Eagle Harbor study site. Eagle Harbor also recorded the highest surface temperature of any Cypress Island nearshore site during the late July 2009 heat wave. Although data are incomplete, the other sites had summer surface temperatures that appeared to remain below the lower tolerance thresholds for juvenile salmonids and other marine fish species. The deep cove of Cypress Head North stayed cooler longer into the season than other sites. Depending on their temperature tolerances and preferences, marine species move into and out of nearshore sites as the water heats and cools throughout the day and across seasons. Data for surface and 1 meter sub-surface seawater temperatures at all other 2009 sample sites are available in Appendix 3, near the end of this report. For the most part, very little temperature stratification was observed; sites were generally well mixed at all sample sites on most of the seining dates.

Seawater salinity trends for the West and South Coast vs. the East Coast sample sites are displayed in Figures 3.06 and 3.08. Units are parts-per-thousand, with 35.0 ppt as the accepted value for the salinity of the open ocean off the Washington coast. Most sites clustered around the 30.0 ppt mark for most of the season; common for nearshore regions of north Puget Sound away from direct river-mouth influence. The onset of mountain snowmelt and peak river discharge in mid-to-late May and continuing through June is quite apparent as seawater salinity plunges at all sample sites with the rapid influx of freshwater into northern regions of Puget Sound (missing data for sample session #8 in mid-June was a result of equipment malfunction).

With few exceptions, temperature and salinity at most sites were well mixed from the surface down to a measured depth of 1 meter, but note the sites and sample dates where temperature inversion occurred (e.g. Strawberry Bay on April 24 and July 28, Fig. 3.09). These dates reveal the effect of high ambient air temperatures on both elevating seawater temperature and depressing surface salinity for sites with shallow, flat bathymetry and sandy bottom substrates. Both Strawberry Bay and Eagle Harbor were sampled in mid-afternoon on flooding tides during the heat waves of late April and late July (sample sessions #5 and 12 respectively). Both sites clearly show elevated seawater temperatures relative to other sample sites, with concurrent dips in surface seawater salinity. As cool offshore water enters these embayments, its temperature quickly rises as it floods shallow waters that are insolated throughout the ebb and low tide period. There is a time lag before nearshore seawater temperatures equilibrate with ambient offshore temperatures, and this lag likely affects nearshore fish sampling as it may be several hours after the onset of flood-tide before species (such as juvenile salmonids) that are less tolerant of high water temperatures re-enter shallow bays to feed. Sampling during low tide or just after the tide shift would likely miss these mobile, temperature-sensitive species entirely, and this also indicates that some nearshore habitat types (shallow bays, specifically) are probably less available for foraging over the course of a day during spells of sunny / hot weather relative to cooler, more temperate weather conditions. Dissolved oxygen was not measured for the Cypress Island Pilot Nearshore Fish Use Assessment, as “DO” is not typically considered to be a limiting factor for fish distribution in north Puget Sound and the southern Georgia Basin. However, given the recurring “dead zones” of fish die-off documented in southern Hood Canal in recent years, it would be prudent to monitor dissolved oxygen levels and any associated faunal effects at Strawberry Bay and similar shallow, warmwater sites with adjacent septic input (e.g. Secret Harbor at Cypress Island, Quartermaster Harbor in the Maury Island Aquatic Reserve) during future nearshore monitoring for the statewide Aquatic Reserve network.

3.3 Results – *Juvenile salmon*

Three species of native juvenile salmon were commonly observed from the last week of February through the third week of September at study sites along the East and South Coast of Cypress Island (Bellingham Channel). The period of nearshore occupancy was truncated for West Coast (Rosario Strait) sample sites, with juvenile smolts appearing in net hauls from mid-March through late-July only. The contribution of each juvenile group to the total catch for the 2009 Cypress nearshore by site appears in Figs. 3.10a – b (note scale difference on right side of graphs). Dominance of chum among early season catches is even more apparent by comparing density charts for each site (Appendix 1).



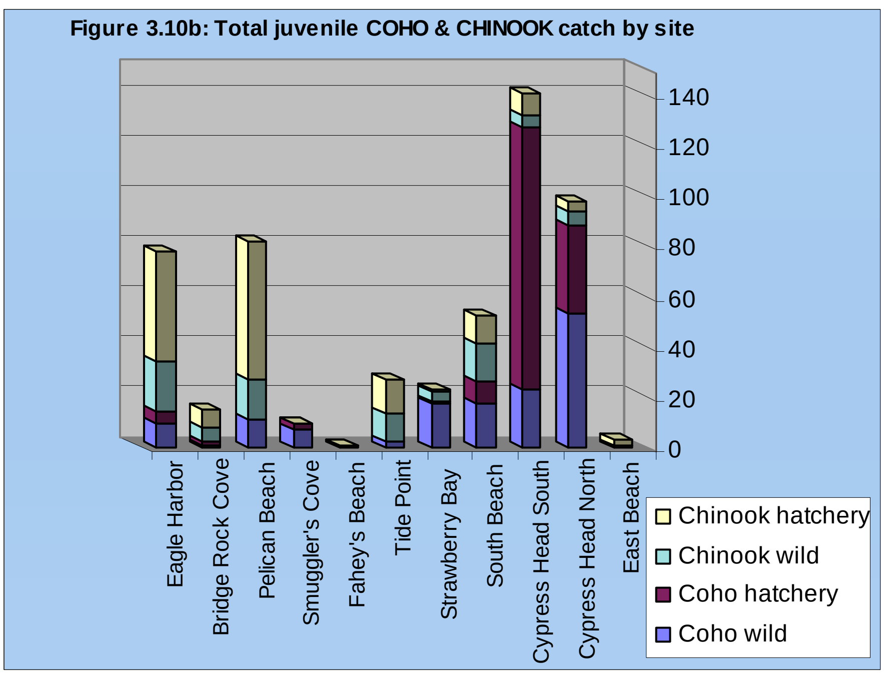


Figure 3.10a & 3.10b – Total juvenile salmon catch by site (for chum & Chinook vs. coho study groups).

Eagle Harbor had the highest observed juvenile salmon densities among all Cypress sites, as well as the greatest density of chum for all sites. Fig. 3.11 shows maximum observed density (single-session $CPUE_{Max}$) for juvenile salmon species combined as well as the date of maximum catch. This graphic primarily represents chum density for each site with the exception of Cypress Head South Cove, where an unusually large school of hatchery coho netted in session #6 was the predominant juvenile salmon catch in 2009. Chum were 95% or more of the total 2009 salmon catch at 6 of the eleven sample sites, at or near 90% at 3 additional sites, and represented >70% of juvenile catch at Tide Point. The South Cove at Cypress Head was anomalous in having <10% chum vs. other salmon (hatchery coho in particular Fig. 3.10b). Keep in mind once again the inconsistent sampling effort when studying these figures – more frequent sample replication may have resulted in greater catch of schooling chum and other juvenile salmon at many sites.

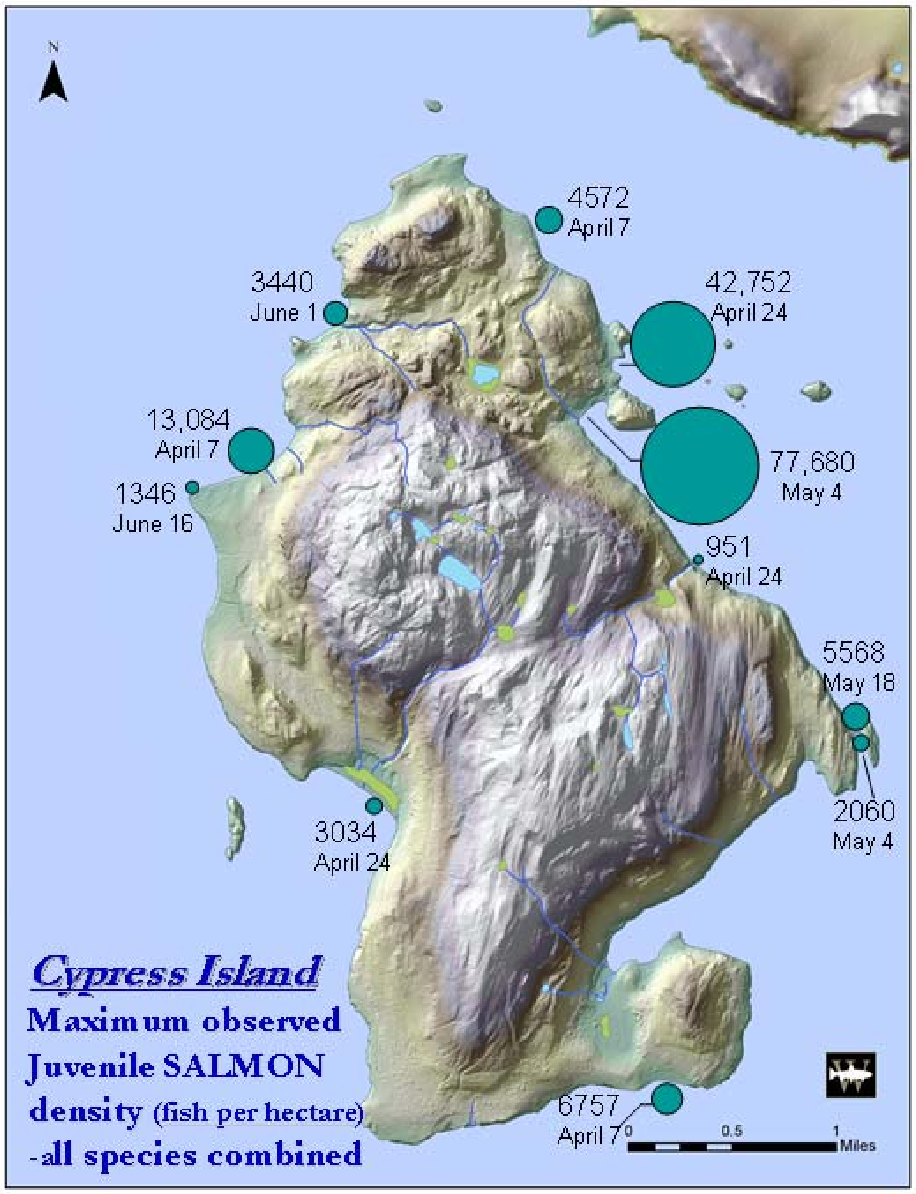


Figure 3.11 – Combined maximum juvenile salmon density at 2009 nearshore sites & date of observation.

Juvenile chum *(Oncorhynchus keta* – photo 3.2*)* are typically the first river outmigrants of the season in odd-numbered years (see pink salmon discussion on page 54), and were the first to arrive at Cypress Island sites. 2009 was a somewhat colder spring relative to the climatological average for western Washington, and fry hatching and juvenile outmigration may have been delayed. Other north sound researchers have reported higher abundance and more widespread site occupancy of juvenile chum in nearshore waters earlier in the season in previous years (WFC 2007), but this may be a result of sampling a geographic nearshore (the west coast of Whidbey Island and Admiralty Inlet) that has a potentially much higher contributing population from south Puget Sound rivers than is available to western Skagit County and the San Juan Islands archipelago.

Photo 3.2 – Two separate size classes of juvenile Chum salmon netted concurrently in the Cypress Island nearshore – note: parr marks on the 2 older fish (background) have disappeared while the younger fish retain their parr. During peak site occupancy for chum, at least 3 separate size/age classes were apparent

Chum were the most numerous salmonid in the Cypress nearshore in 2009, with orders of magnitude more juvenile chum salmon than coho and Chinook combined at all sites (compare total catch effort data for Fig. 3.12a – 3.12c, pp. 47-48). This is a common abundance pattern for juvenile chum and pink salmon vis-à-vis coho, Chinook, and sockeye salmon in north Puget Sound – [*note*: no sockeye were netted at Cypress in 2009. Sockeye smolts are typically larger and feeding further offshore at this distance from the mouths of natal streams in north Puget Sound and the Georgia Basin.] Chum also had the longest period of nearshore habitat occupancy, appearing in nets from session 1 through session 13 on the Bellingham Channel coastline, and from session 2 to session 10 on the Rosario Strait side of the island.

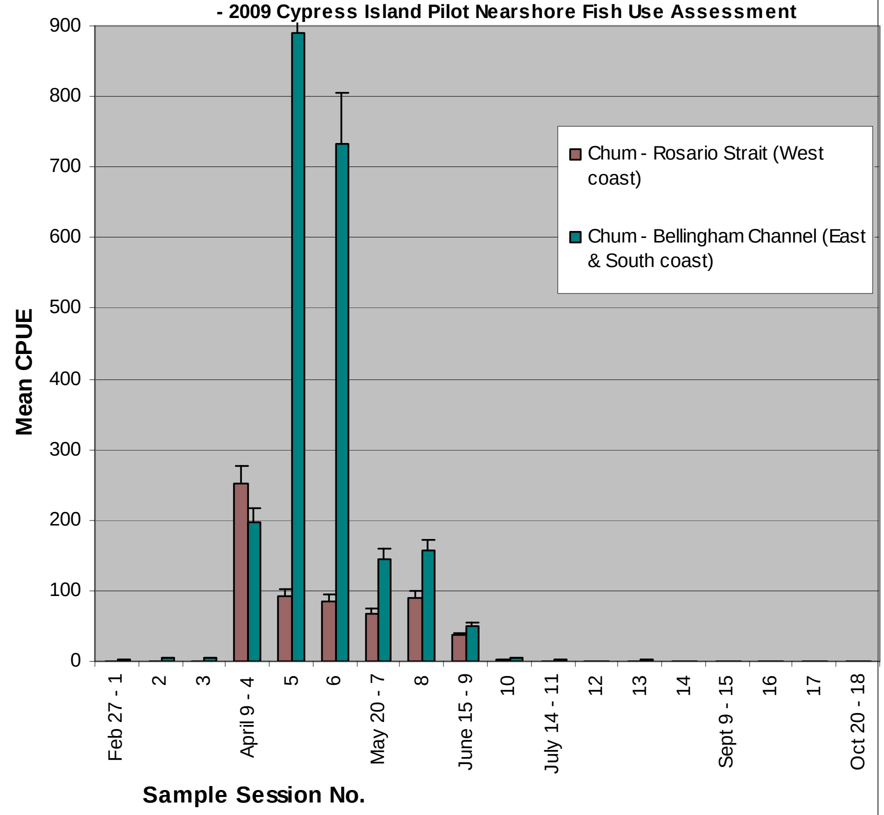
Conclusions about specific peak site occupancy dates are problematic due to inconsistent sampling effort across sites, but certainly the general trend for most sites was for chum to occupy sites earlier than coho and Chinook, with Chinook the last juvenile group to persist in the Cypress nearshore. Relative abundance (as density) of hatchery vs. wild coho and Chinook by sample session appear in the graphics in Appendix 1. Chinook captures also revealed a bimodal site occupancy at most study sites with an early pulse of Chinook arriving in nearshore rearing habitats in June, a dramatic decline in Chinook abundance during the height of summer (mid-July through early August), followed by a resurgence in late August and September. This pattern has often been reported for Chinook smolts in the north Puget Sound nearshore (E. Beamer 2008, pers. comm.), though at some Cypress sites (Eagle Harbor in particular) juveniles were consistently observed leaping from the surface in close-by offshore waters during the mid-summer sample sessions when no salmon were netted at the nearshore beach site. Juvenile coho (both wild and hatchery) were present in the Cypress nearshore beginning as early as the first week of April (sample session #4) and persisting through mid-July. Interestingly, a single coho captured at Strawberry Bay on June 1 had yet to smolt, still retaining its stream coloration despite being the same size (~140 mm) as other coho from the school, all of which displayed the silvery sheen and faded parr marks of full ocean-going smolts. Lacking a coded wire tag, it was impossible to determine the origin of this unusual fish.

Photos 3.3a and 3.3b – Typical hatchery coho *(O. kisutch)* from the Cypress Island nearshore (left), and a very atypical hatchery coho captured in Strawberry Bay that still retained its pre-smolt morphology (right). Notice that a portion of the adipose remains on the silver smolt on the left, indicating that the fin was only partially-clipped. Although uncommon, clipping errors do occur during pre-release marking operations.

Photo 3.4 – A wild juvenile Chinook *(O. tshawytscha)* netted at Bridge Rock Cove on Cypress Island.

Mean catch / effort ($CPUE_{Avg}$) for juvenile chum, coho, and Chinook (hatchery and wild combined for the latter two groups) in the East Coast and West Coast sample bins appear in Figures 3.12a – 3.12c. Paired T-tests for differences in average catch between the Rosario Strait (West coast) and Bellingham Channel (East and South coast) sample bins for the peak periods of site occupancy revealed that there was no statistical difference in catch / effort for Chinook at sample sites located on the Bellingham Channel coastline of Cypress Island compared to Rosario Strait (p=0.14 for Chinook). Mean catch / effort was marginally greater for both coho and chum on the Bellingham Channel side of the island vs. Rosario ($p \leq 0.05$ for coho from May to mid-July; p=0.04 for chum from March through June). *Note*: the East Beach site was not included in these analyses as it was not sampled consistently enough during the April – July peak nearshore occupancy period.

Figure 3.12a: Average catch / effort for juvenile CHUM salmon by bin - 2009 Cypress Island Pilot Nearshore Fish Use Assessment



Within bin comparisons of Mean CPUE for Chinook and coho indicate that there was no statistically discernible difference in catch / effort for unmarked vs. hatchery Chinook in either sample bin (p>0.3 for East & Southside sites, and p>0.8 for Westside sites), and no difference for juvenile hatchery vs. wild coho on the Bellingham Channel side of the island (p=0.87). Combined average catch / effort for wild coho was *marginally* higher for sites along Rosario Strait if the less rigorous test level of 0.1 is applied (p=0.09 for wild vs. hatchery juvenile coho for sites on the Rosario side of Cypress Island). It has often been suggested that biological data should be tested at the 0.1 alpha level (rather than the standard 0.05) due to the variability inherent in natural systems (Skalski 1994). However, paucity of data clouds these results; e.g. only 3 hatchery coho were netted at the four sites on the West side of the island. Also, see pg. 54 for information about distinctions between marked and unmarked Chinook in the north Puget Sound nearshore.

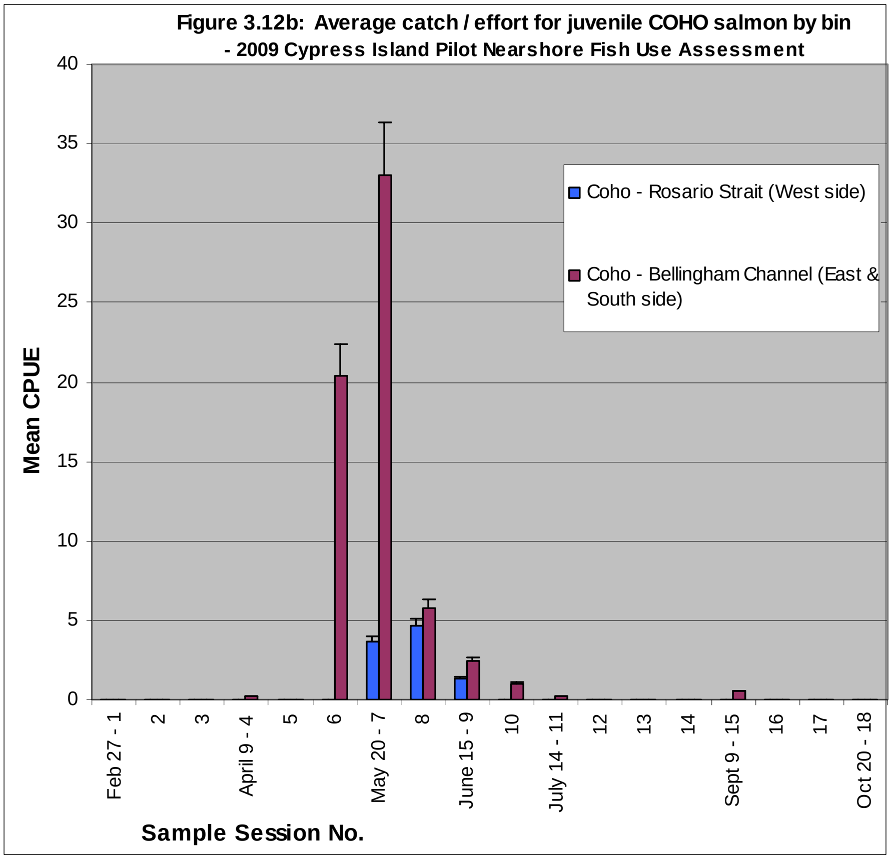


Figure 3.12b: Average catch / effort for juvenile COHO salmon by bin
- 2009 Cypress Island Pilot Nearshore Fish Use Assessment
Mean CPUE
0
5
10
15
20
25
30
35
40
Coho - Rosario Strait (West side)
Coho - Bellingham Channel (East & South side)
Feb 27 - 1
2
3
April 9 - 4
5
6
May 20 - 7
8
June 15 - 9
10
July 14 - 11
12
13
14
Sept 9 - 15
16
17
Oct 20 - 18
Sample Session No.

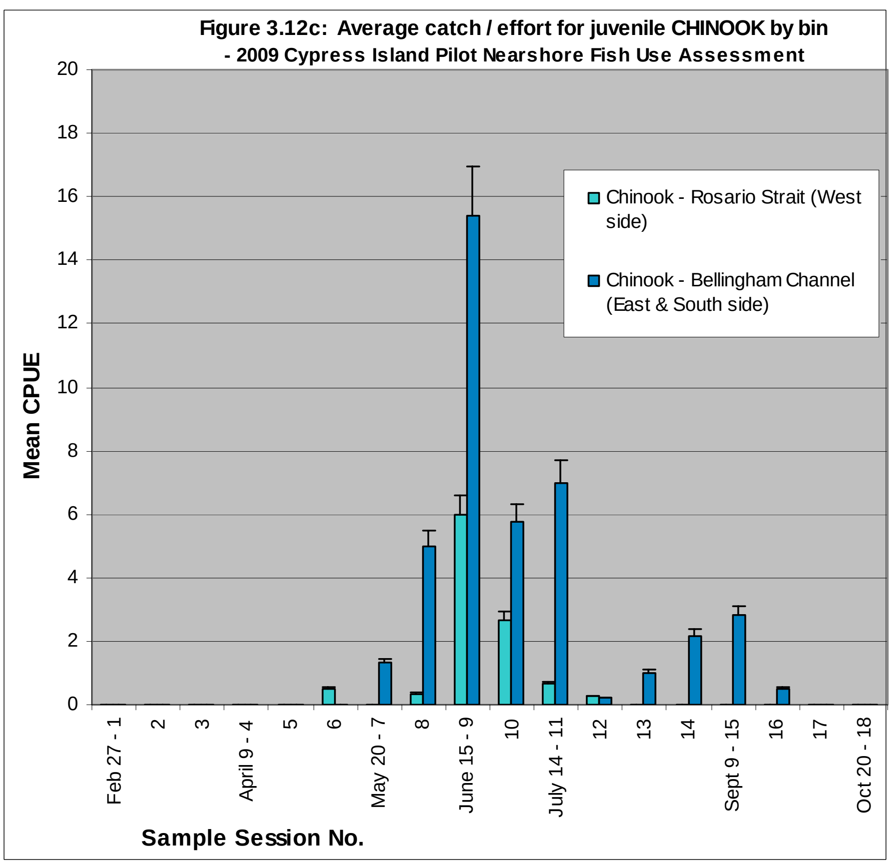


Figure 3.12c: Average catch / effort for juvenile CHINOOK by bin
- 2009 Cypress Island Pilot Nearshore Fish Use Assessment
Mean CPUE
0
2
4
6
8
10
12
14
16
18
20
Chinook - Rosario Strait (West side)
Chinook - Bellingham Channel (East & South side)
Feb 27 - 1
2
3
April 9 - 4
5
6
May 20 - 7
8
June 15 - 9
10
July 14 - 11
12
13
14
Sept 9 - 15
16
17
Oct 20 - 18
Sample Session No.

Average fork lengths (FL) for a sub-sample of juvenile chum, and for a similar sample of wild and hatchery coho and Chinook appear in Fig. 3.13, along with the frequency distributions (Figures 3.14a – 3.14e) for measured fish from each contributing group (field crews measured 6% of netted juvenile chum, 58% of coho, and 100% of Chinook).

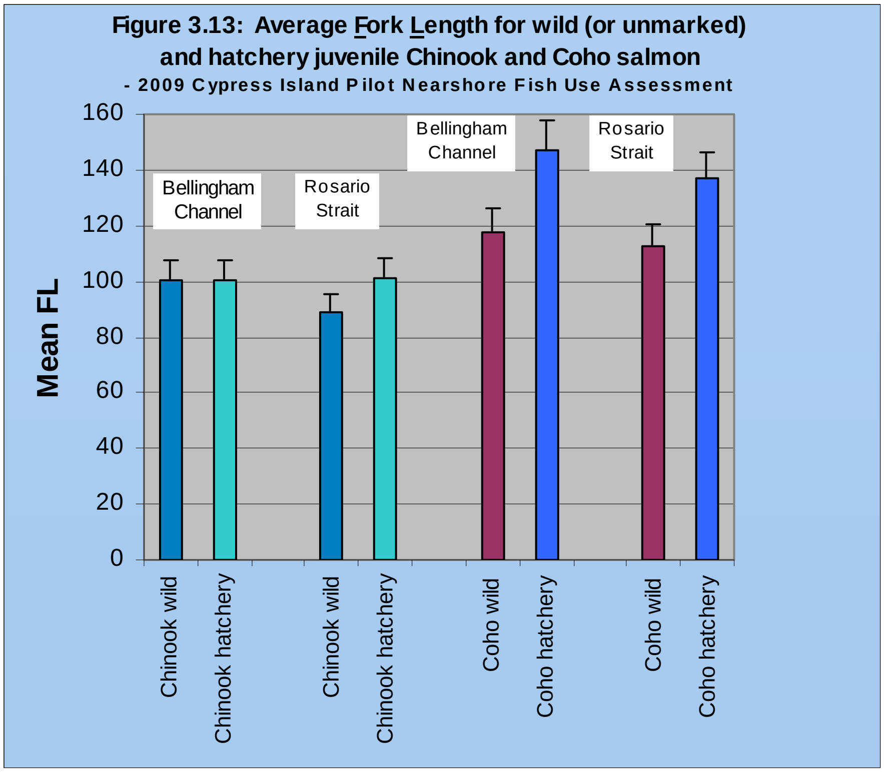
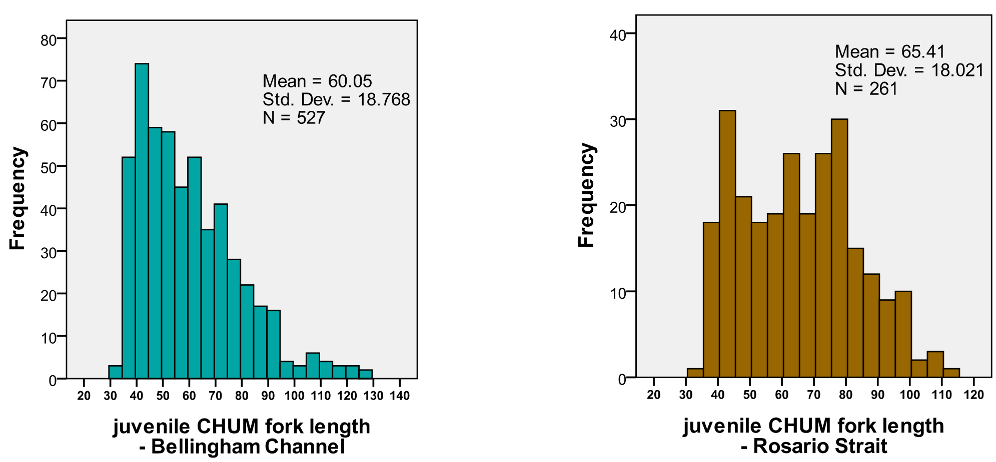
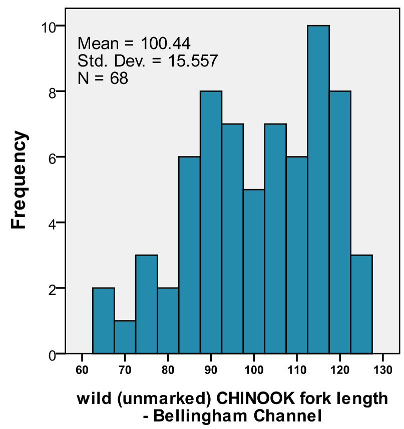


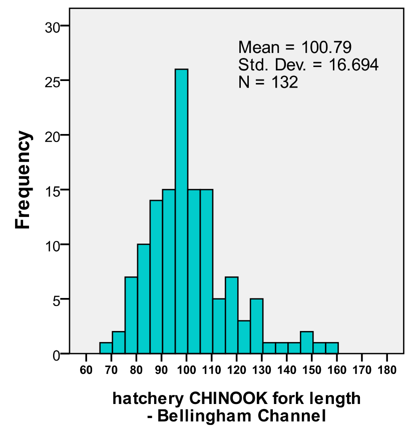
Figure 3.13 – Average fork length for juvenile Coho and Chinook (hatchery vs. wild / unmarked).

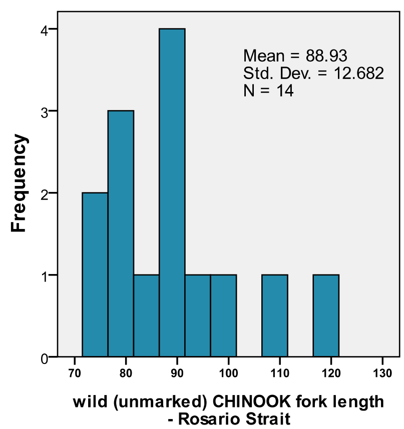


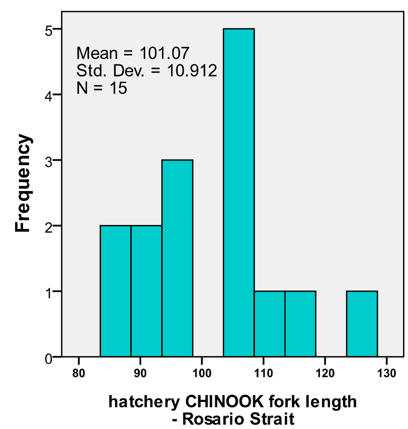
Figures 3.14a - 3.14e. – frequency distributions for juvenile salmon Fork Lengths compared across geographic sample bins. Refer to chart titles for salmon groups and sample bin for each graphic.

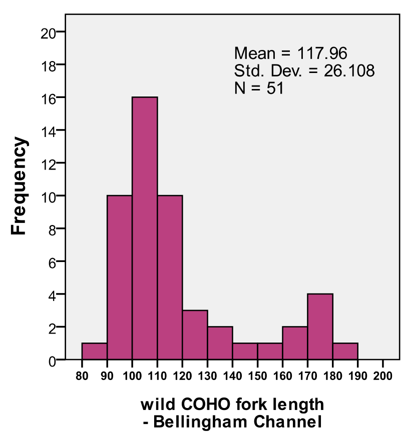
Note: A few large individual chum lengths were recorded during May and June sample sessions at most sites. Summer chum emerge earlier than falls, and have longer nearshore growth period. Most ESA-listed Hood Canal summer chum are thought to exit the Strait of Juan de Fuca to the west, but these may be summer chum utilizing the Cypress Island shoreline. Future juvenile salmon monitoring should include genetic testing of select chum smolts to determine stock origin.

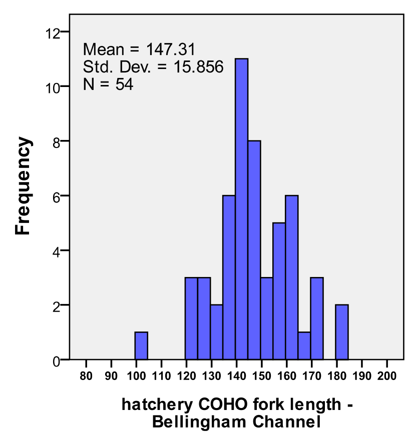

Mean = 100.44
Std. Dev. = 15.557
N = 68
Frequency
wild (unmarked) CHINOOK fork length - Bellingham Channel

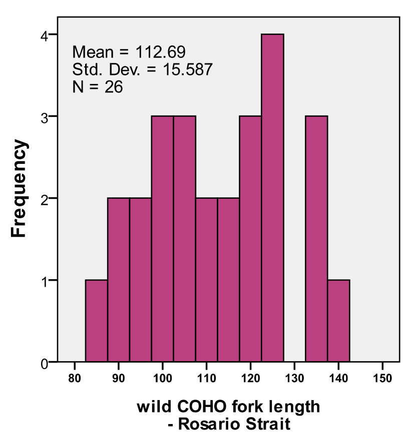

Mean = 100.79
Std. Dev. = 16.694
N = 132
Frequency
hatchery CHINOOK fork length - Bellingham Channel

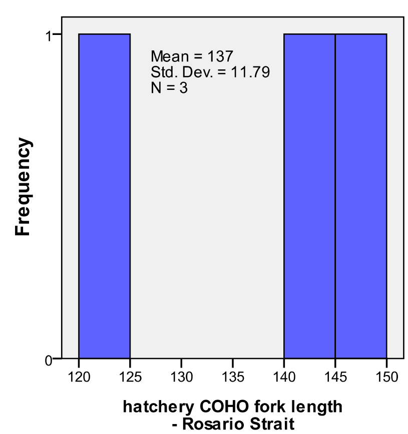

Mean = 88.93
Std. Dev. = 12.682
N = 14
Frequency
wild (unmarked) CHINOOK fork length - Rosario Strait


Mean = 101.07
Std. Dev. = 10.912
N = 15
Frequency
hatchery CHINOOK fork length - Rosario Strait


Mean = 117.96
Std. Dev. = 26.108
N = 51
Frequency
wild COHO fork length - Bellingham Channel


Mean = 147.31
Std. Dev. = 15.856
N = 54
Frequency
hatchery COHO fork length - Bellingham Channel


Mean = 112.69
Std. Dev. = 15.587
N = 26
Frequency
wild COHO fork length - Rosario Strait


Mean = 137
Std. Dev. = 11.79
N = 3
Frequency
hatchery COHO fork length - Rosario Strait

Paired-sample T-tests for differences in average fork length for hatchery and wild coho, and hatchery vs. wild (or unmarked) Chinook for sample sessions within sample bins where both juvenile groups were captured in the same net set (Figs. 3.14a – 3.14e) suggested that hatchery Chinook were significantly longer for combined sample sites on the Rosario Strait coast of Cypress Island (p=0.04 for Chinook) and hatchery coho were significantly longer at sites along Bellingham Channel (p=0.02 for coho); differences are apparent in Figs. 3.15a & 3.15b, however there were only 3 sample periods when both marked and unmarked Chinook were captured at westside (Rosario) sample sites so results remain inconclusive (see page 54 for discussion about independent populations). Hatchery Chinook did not show a strong statistical difference relative to unmarked Chinook at the 0.05 alpha level (p=.064) for sites located along Bellingham Channel. (*Note*: data was insufficient to test differences in fork length for wild vs. hatchery coho at Rosario Strait sites; both groups were netted during one session only at westside sites).

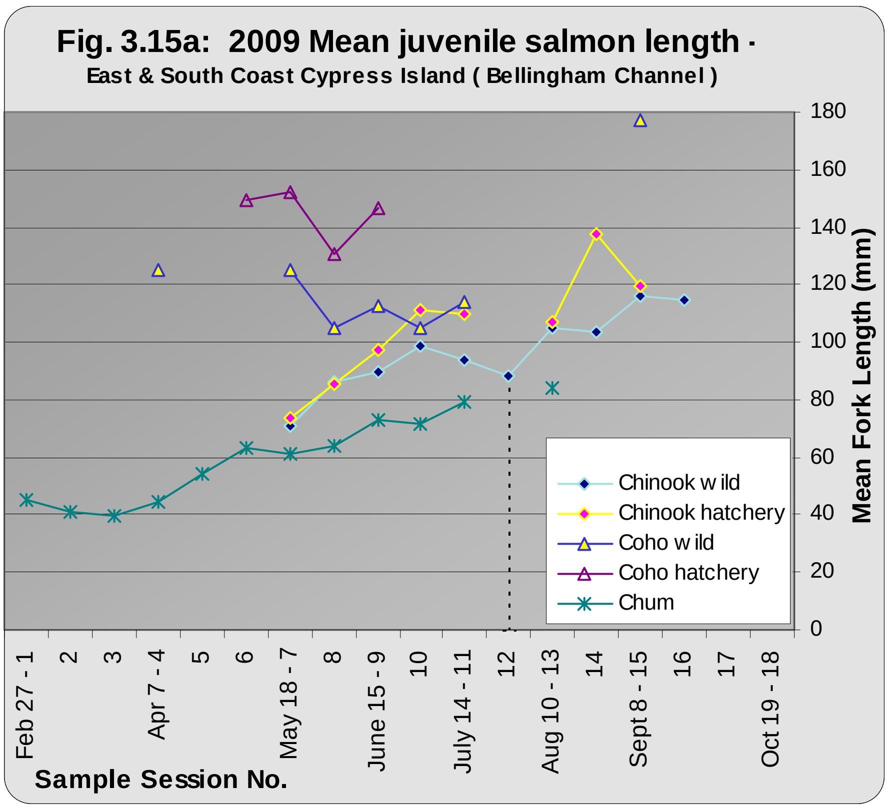


Fig. 3.15a – Time series length data for juvenile chum, coho and Chinook salmon at sample sites along the Bellingham Channel coastline of Cypress Island. Note that the wild (unmarked) Chinook data point for sample session #12 (dotted line) was only a single fish capture; i.e. this individual may not be representative of Mean fork length for wild Chinook during late July and early August.

Assuming that sampling was sufficient to account for differences in population fork length with different juvenile salmon outmigrant stocks encountered after each 2-week interval between sample sessions, juvenile chum and Chinook salmon both displayed strong linear growth trends (measured by Fork Length) over the course of the sample season for sites located along the Bellingham Channel coastline (Fig. 3.15a). Sampled chum increased 86.6% in Mean fork length from late February to late August at East and Southside sample sites combined (r^2=0.93), and showed a length increase of 70.5% at westside sites from March through June (r^2=0.76). Hatchery Chinook increased 62% and unmarked Chinook showed an overall fork length increase of 64% over the capture period for these two groups (May through September) along Bellingham Channel sites (r^2=0.83 and 0.91 respectively). However, neither hatchery nor wild coho appeared to have an appreciable growth trend during the nearshore occupancy period for east and south coast sites, possibly indicating that juvenile coho in the Cypress nearshore have reached a temporary plateau in length addition, but are rapidly accumulating body mass during this period. Due to time constraints, field crews did not weigh juvenile salmon (combined length-to-weight ratios are a better metric for juvenile growth) during the 2009 season. Future nearshore fish-use monitoring should incorporate length *and* weight measures for juvenile salmon. If significant decreases in growth rates are detected over time at various sites throughout the state Aquatic Reserve network, it could be an early indication of decrease in quantity and/or nutritive content of available forage with changes in nearshore conditions concomitant with predicted climate change.

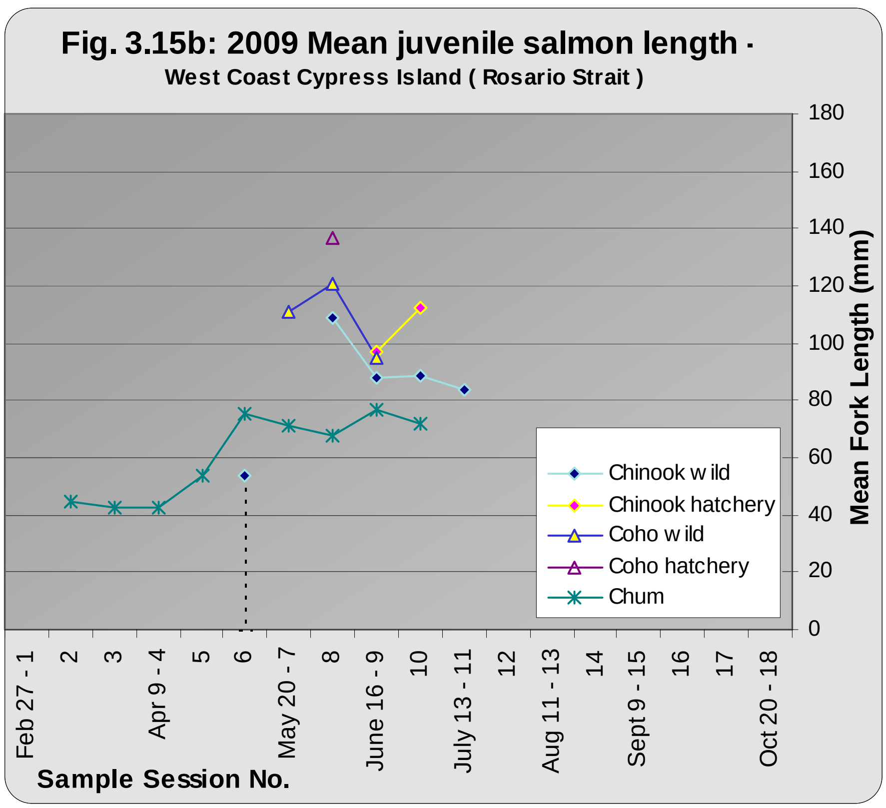


Fig. 3.15b – Time series length data for juvenile chum, coho, and Chinook salmon at sample sites along the Rosario Strait coastline of Cypress Island. Note that the wild (unmarked) Chinook data point for sample session #6 (dotted line) was only a single 54 mm fish capture; this was certainly the youngest and smallest 0+ year juvenile Chinook captured during the 2009 sample season.

An ongoing diet study of juvenile salmon utilizing pocket nearshore habitats of the outer San Juan Islands conducted by Kwiaht (R. Barsh et al. 2011) indicates that terrestrial invertebrates are a significant diet component of juvenile salmonids at island sites. This reiterates the importance of maintaining marine shoreline vegetation as a source for insects deposited into nearshore waters for juvenile salmon to forage. Data collection for this research is ongoing (summer 2011), with final reporting expected in early 2012.

Coded Wire Tags were recovered from 16 hatchery-reared Chinook (all aged 0+) and 6 hatchery coho smolts (1+ year juveniles) during beach seine sampling at the Cypress Island Aquatic Reserve in 2009, with CWT extraction (photos 3.5a – 3.5c) provided by technicians from Skagit River Systems Cooperative. Table 3.2 lists the results with a general discussion on pg. 54.

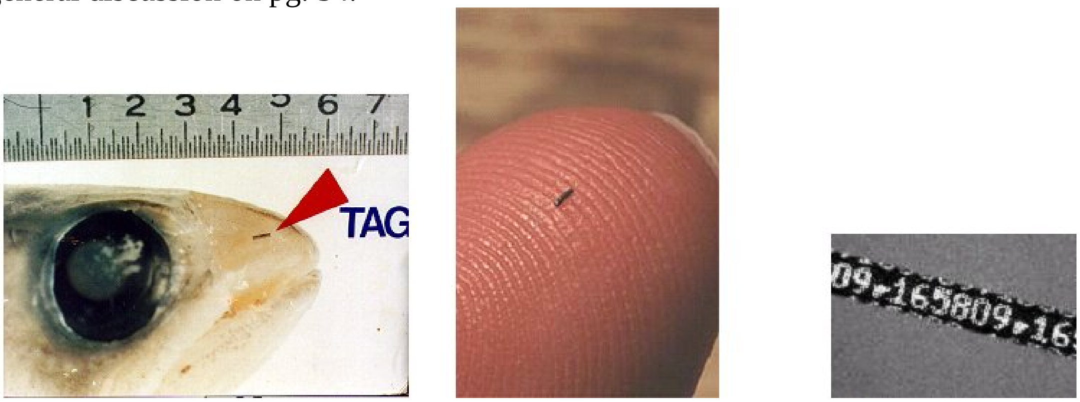


Photo 3.5a, 3.5b, and 3.5c – Embed location, relative size, and microscopic view of coded wire tag.

TABLE 3.2: Hatchery and Stock Origin for juvenile Chinook and Coho salmon fitted with Coded Wire Tag – 2009 Cypress Island Pilot Nearshore Fish Use Assessment

Cypress Island Aquatic Reserve 2009 Nearshore sample site	Sample session No. (date)	SPECIES / stock	External mark	originating Hatchery
EAGLE HARBOR	(May 18)	Coho / falls	Ad-clipped	Nooksack
CYPRESS HEAD NORTH COVE	(May 18)	Coho / falls	Ad-clipped	Nooksack
CYPRESS HEAD NORTH COVE	(May 18)	Coho / falls	NONE	Nooksack
CYPRESS HEAD NORTH COVE	(May 18)	Coho / falls	Ad-clipped	Nooksack
CYPRESS HEAD NORTH COVE	(May 18)	Coho / falls	NONE	Nooksack
CYPRESS HEAD NORTH COVE	(May 18)	Coho / falls	Ad-clipped	Nooksack
EAGLE HARBOR	(June 2)	Chinook/falls	Ad-clipped	East Sound (Orcas Island)
CYPRESS HEAD SOUTH COVE	(June 15)	Chinook / falls	Ad-clipped	Samish
CYPRESS HEAD SOUTH COVE	(June 15)	Chinook / falls	Ad-clipped	Samish
EAGLE HARBOR	(June 15)	Chinook / falls	NONE	Samish
TIDE POINT	(June 16)	Chinook / falls	Ad-clipped	Samish
PELICAN BEACH	(June 16)	Chinook / falls	NONE	Samish
PELICAN BEACH	(June 16)	Chinook / falls	NONE	Samish
PELICAN BEACH	(June 16)	Chinook / falls	Ad-clipped	Samish
PELICAN BEACH	(July 1)	Chinook / falls	NONE	Samish
PELICAN BEACH	(July 1)	Chinook / falls	NONE	Samish
PELICAN BEACH	(July 14)	Chinook / spring	Ad-clipped	Skagit
EAGLE HARBOR	(August 10)	Chinook / falls	Ad-clipped	Skagit
EAGLE HARBOR	(August 25)	Chinook / falls	Ad-clipped	Skagit
BRIDGE ROCK COVE	(August 25)	Chinook / falls	Ad-clipped	Chilliwack (Fraser River)
EAGLE HARBOR	(Sept. 8)	Chinook / falls	Ad-clipped	Skagit
EAGLE HARBOR	(Sept. 8)	Chinook / spring	Ad-clipped	Skagit

All coded wire tag recoveries from juvenile Chinook and coho at Cypress Island in 2009 came from eastside sites so, not unexpectedly, the three nearest major river basins to the east contributed all but 2 (or 91%) of the coded wire tagged smolts to nearshore sites along the Bellingham Channel coast of the island. All 6 CWT coho smolts arrived in the Cypress nearshore from the Nooksack River via Bellingham Bay and Bellingham Channel, and all were captured on northeast coast sample sites (nearest to the Nooksack mouth). The Samish River Chinook program was well-represented, with 9 of the 16 CWT Chinook smolts originating at the Samish hatchery and arriving via Samish Bay and Bellingham Channel. These fish remained to forage in the Cypress nearshore at several east and south coast sites for a period of at least 2 weeks (June 15 – to July 1). Skagit basin hatchery smolts (both spring and fall stock) had the furthest to travel, and made up the bulk of the second wave of juvenile Chinook (see pg. 46 for discussion), arriving either by way of the Swinomish Channel to Padilla Bay and Guemes Channel, or via Deception Pass-to-Fidalgo Island shoreline to-Bellingham Channel. There was one CWT recovery from an East Sound Orcas Island hatchery Chinook, indicating that some East Sound releases exit toward the east through Obstruction, Peavine, or Thatcher Passes to arrive at Eagle Harbor on the opposite side of Cypress Island. Finally, a single marked Chinook from the Fraser River system (Chilliwack River hatchery) was netted at Bridge Rock Cove in late August, likely arriving on the enormous outfall plume from the Fraser River that extends southward through Rosario Strait past the Orcas Island shoreline.

Although sample size is relatively small, coded wire tag recoveries essentially confirm findings of the juvenile Chinook origin patterns from the 67 fin clip samples provided for microsattelite DNA analysis (Beamer and Teel et al. 2011), where early results indicate that 79.5% of unmarked Chinook smolts netted at Cypress sites originated from Whidbey Basin genetic stock (primarily Skagit), and the remaining 20.5% were Lower Fraser River stock. No South Puget Sound Chinook stocks were identified from the Cypress shoreline in 2009, and Cypress Island nearshore and offshore samples had a much higher proportion of Whidbey Basin stocks in general than the other sampled marine areas of the outer San Juan Islands, where British Columbia stocks were much more prevalent.

It is important to be aware that overwhelming majorities of hatchery-release Chinook from British Columbia are not marked; 91.9% of Chinook smolts originating from hatcheries in southern BC in 2009 were not identifiable from an external mark or internal coded wire tag. The proportion is much less for Puget Sound-origin Chinook, but not insignificant (11.8% in 2009). This clearly adds a degree of uncertainty to the analysis and discussion of "wild" vs. hatchery Chinook in the Cypress nearshore, particularly in light of the genetic stock information provided by Beamer & Teel and others indicating that up to 20% or more of unmarked juvenile Chinook netted in the Cypress nearshore in 2009 likely originated from the lower Fraser River (at least one Chilliwack hatchery Chinook was confirmed via coded wire tag in the Cypress nearshore). Hence, any analysis that separates unmarked vs. hatchery Chinook was likely combining samples of wild and unmarked hatchery fish within the sample populations to an unknown degree. At present, there is no opportunity to rectify this potential source of analytical error. Future nearshore sampling at Cypress Island and other Aquatic Reserves could better inform their analysis by providing for a sub-sample of Chinook fin clips to be analyzed and a correction factor applied to the total unmarked Chinook group to arrive at a better estimate of wild vs. hatchery-origin juveniles. This may apply to juvenile coho as well.

3.4 Results – *Other salmonid observations*

Pink salmon *(Oncorhynchus gorbuscha)* were nearly absent from Cypress Island nearshore samples in 2009. Pinks typically spawn in odd-numbered years in most Puget Sound rivers, with juveniles usually present in significant numbers in north Puget Sound nearshore environs in even years only. The one exception to this is the Snohomish River system which has a very productive even-year run of pinks, although other systems such as the Skagit have recently been reporting the natural establishment of small even-year runs (B. McMillan and D. Pflug, 2008 pers. comm.). Future Aquatic Reserve nearshore fish use monitoring should consist of a minimum of 2 consecutive years of sampling at each site to ensure adequate seasonal coverage for sampling of outmigrating pink salmon.

Only 2 pink salmon smolts were positively identified during nearshore sampling at Cypress Island in 2009 (both during sample session #4; at Pelican Beach and Fahey's Beach on the same date in early April, and both during quality-assurance checks by the project manager). Given the early-season inexperience of the volunteer field crew with juvenile salmon identification, there may have been a few more that were mistaken for chum. The learning curve for identifying juvenile salmonids is relatively steep due to the similarity of appearance of the several species. 2009 Cypress volunteers showed great commitment in learning their ID skills as quickly as possible, but would certainly have benefited from pre-season training in fish identification, though this was not within the purview of the pilot project. Utilizing this large and extremely dedicated pool of volunteers is a very economically efficient model for nearshore fish use assessments (which tend to be very labor and budget intensive), but quality assurance and quality control of the data collection inevitably suffers somewhat for lack of experienced staff.

No ESA-listed Bull trout *(Salvelinus confluentes)* were observed during beach seining within the Cypress Island Aquatic Reserve in 2009. Threatened Puget Sound ESU Steelhead trout *(Oncorhynchus mykiss)* were represented by a lone juvenile fish netted at Smuggler's Cove in mid-June. This individual (~190mm) displayed the "half-salt" coloration of a rainbow trout with the life-history penchant for spending only part of its juvenile maturation as an ocean-going fish.

A small school of sub-adult coho (10 total; mean fork length of ~350mm) were netted just off the barrier beach at the Eagle Harbor study site during the first sample session (last week of February; photo 2.21, pg. 34), indicating that the Cypress nearshore is utilized year-round by schools of resident sub-adult salmon (these fish do not migrate to pelagic waters, but remain resident in north Puget Sound throughout their growth and maturation period). Beach seining also netted a single sub-adult hatchery Chinook (~290mm) at Eagle Harbor during the last sample session (October 18). Finally, an adult female coho was captured passing along the Strawberry Bay nearshore during its homeward spawning migration in late August (sample session #14).

Individual adult anadromous coastal cutthroat trout *(Oncorhynchus clarki)* were netted during two consecutive sample sessions at South Beach in August.

3.5 Results – *Community Diversity, Rare species captures, and ESA- listed or species of concern*

An even total of 52,100 individual fish from 57 unique species representing 21 marine fish families were captured over the course of the 18 sample sessions at the ten primary sites plus the East Beach impromptu site (where only 267 fish were caught in 8 sessions) in 2009. This total is somewhat inflated as sample crews were aware that sessile species such as sculpins, gunnels and pricklebacks, and flounders were repeat captures – sculpins in particular are known to have remarkable homing instincts and site fidelity, and individual fish (photos 3.6a – 3.6c) were recognizable over multiple sample sessions.

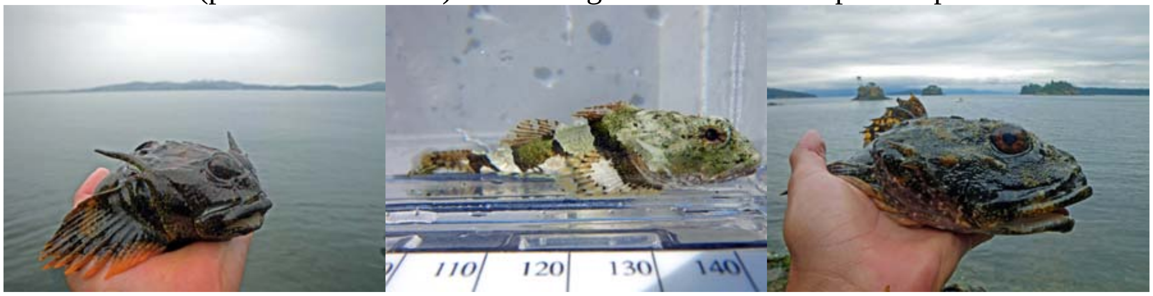
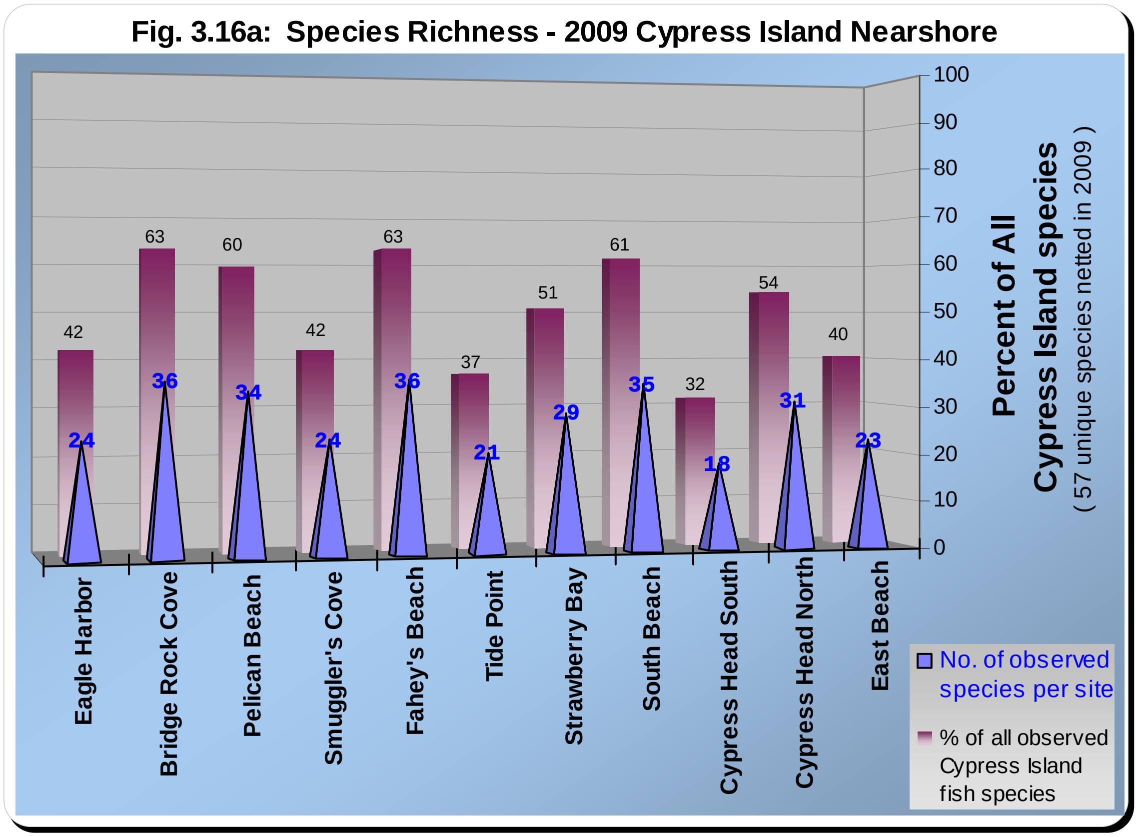


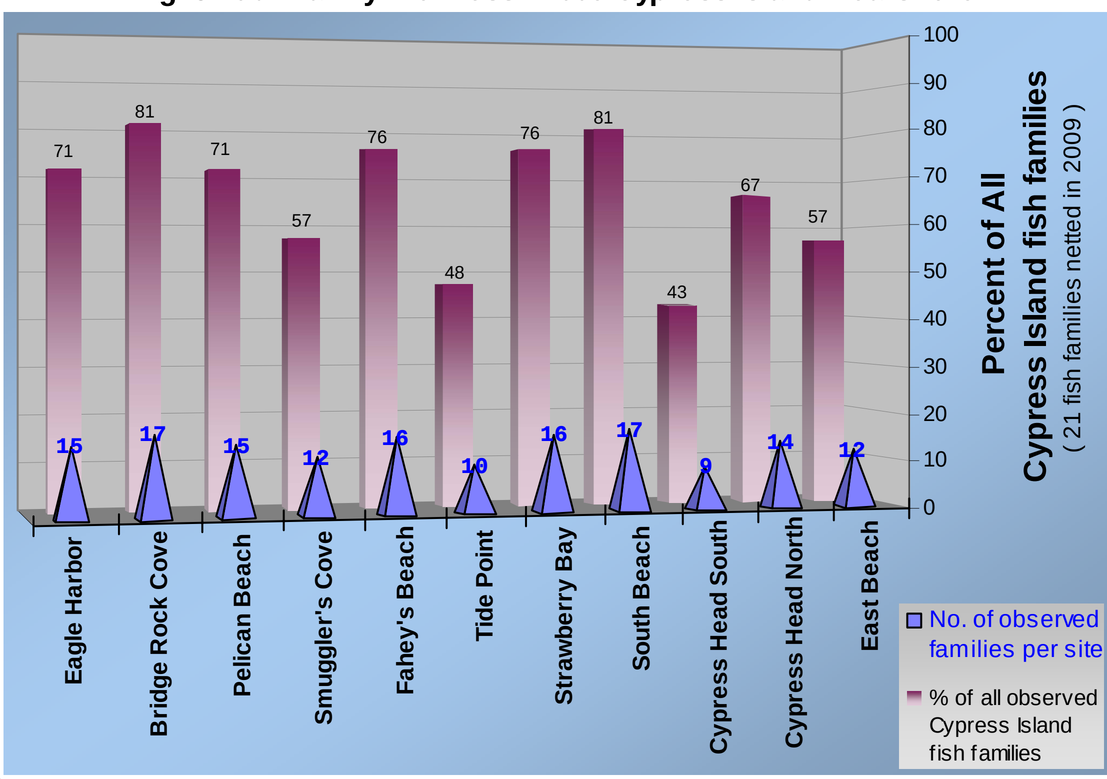
Photo 3.6a, 3.6b, and 3.6c – Large/old Buffalo sculpin (left), Great sculpin (far right), and Great sculpin with unusual color patterning (center) that were repeat captures at Cypress Island nearshore sites in 2009.

Figure 3.16a details the total number of species encountered at each sample site, as well as the per-site percentage of all species netted from the Cypress nearshore. No single locale had greater than 65% of all species present across the 11 widely dispersed sites.



The quick reference tables of Appendix 4 provide detailed capture information and cross-season catch / effort data for species encountered at each site, including unique species that were only encountered at a single study site in 2009 (highlighted cells in the tables). It should be noted that the species richness values (from Figure 3.16a) under-represent the actual number of species identified at Cypress nearshore sites. Due to the difficulty involved with the field identification of hundreds of small, nearly-translucent juvenile left-eyed and right-eyed flatfish, no attempt was made to identify these to species; only to family (Bothidae and Pleuronectidae respectively). However, individual adults were keyed to species at several sites including Pacific sanddab *(Citharichthys sordidus)*, English sole *(Parophrys vetulus)*, Butter sole *(Isopsetta isolepsis)*, Rock sole *(Lepidopsetta bilineata)*, and the Starry flounders *(Platichthys stellatus* – photo 3.8). Cursory examination indicated that the majority of Cypress Island flatfish netted in 2009 belonged to these five species. More thorough sampling of all habitat types would likely reveal others. Figure 3.16b details nearshore richness at each study site by fish family.

Fig. 3.16b: Family Richness - 2009 Cypress Island Nearshore



Nearshore fish community sampling typically results in large captures of the relatively abundant species (e.g salmon, forage fish, etc.) or the habitat generalists at most sites. The separation in species and family richness and diversity scores between sites occurs as a result of the incremental addition of small captures of the relatively rare species over the course of a season. These species may specialize on specific habitat types such as eelgrass beds or bull kelp, or have other habitat or foraging requirements at different life stages that are only available at a few of the sample sites. Some species also move into the nearshore (and are thus available for capture) for short periods of time only. These would easily be missed at many sites without regular, repeated sampling. For example, the Myctophids (lampfishes) are typically a sub-tidal deepwater family that occasionally move into the shallower intertidal / subtidal nearshore habitats during the juvenile life history phase. The only 2 captures of juvenile northern lampfish *(Stenobrachius leucopsarus)* were both at Pelican Beach, easily the deepest of the 2009 study sites. Other species that presented very small catches in the Cypress Island nearshore included a single juvenile Puget Sound Rockfish *(S. emphaeus)*, one of the few species of *Sebastes* that are *not* currently a state candidate for listing. Adult rockfish inhabit submerged, rocky reef habitats and are not typically netted at nearshore sites in Puget Sound. The poachers (Agonidae) were represented by 4 individuals at 2 sites: a pygmy poacher and a sturgeon poacher were netted at Bridge Rock Cove, and at least 2 tubenose poachers *(Pallasina barbata)* inhabited the South Beach site. Gobiids were absent from sites except the warm, shallow mud and sand flats of Eagle Harbor that provided arrow gobies *(Clevelandia ios)* with their preferred habitat; though only two individuals were captured.

Also important to keep in mind is the influx and fall-off of fish species utilizing nearshore habitats. As productivity increases with the warming of nearshore waters in spring and summer, many species change behavior patterns and move from offshore / subtidal habits to the intertidal nearshore to take advantage of seasonal foraging opportunities and resources, and to spawn. Figure 3.16c provides an example of the seasonal timing of peak nearshore species occupancy for the Eagle Harbor study site, where species richness and fish abundance (latter data not shown) are tied to seasonal cycles. Nearshore sites in the Cypress Island Aquatic Reserve displayed a similar trend.

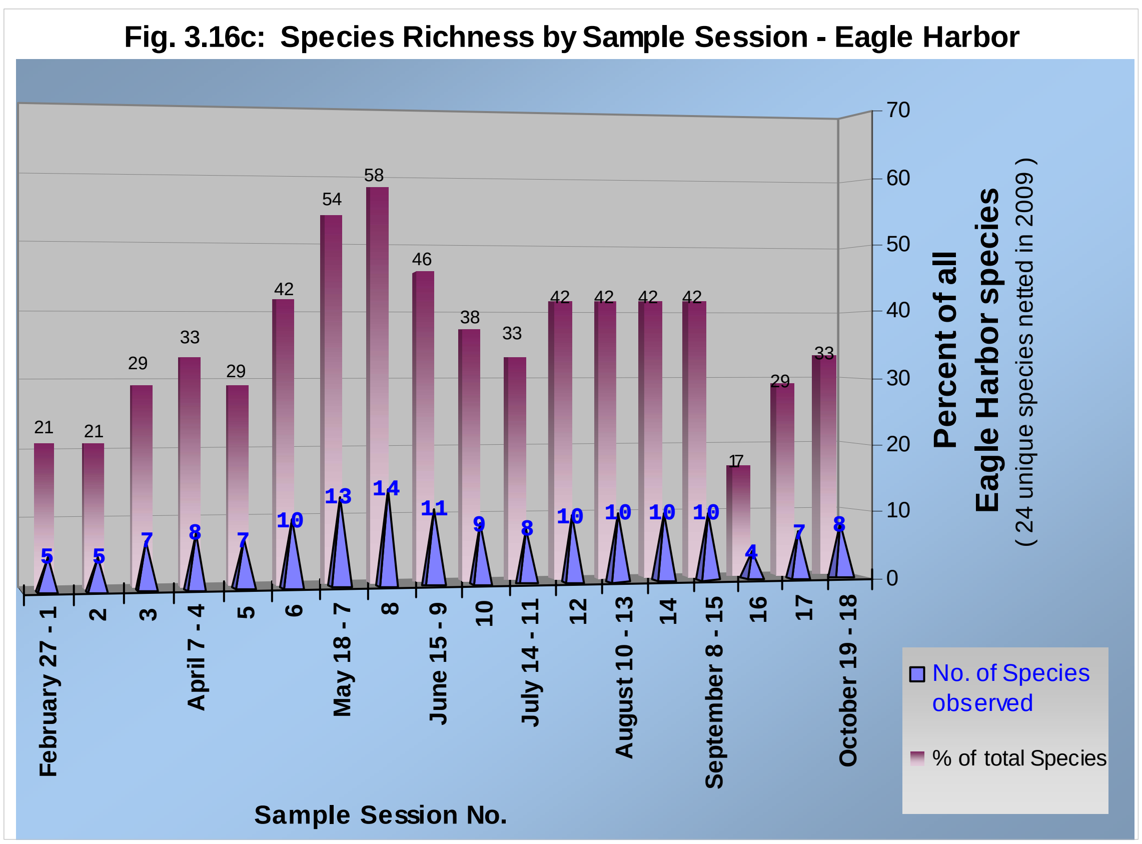


Figure 3.16c – Eagle Harbor fish species richness by sample date, showing rise and fall over sample season

Fig. 3.17 (page 59) compares nearshore fish diversity index scores across sample sites.

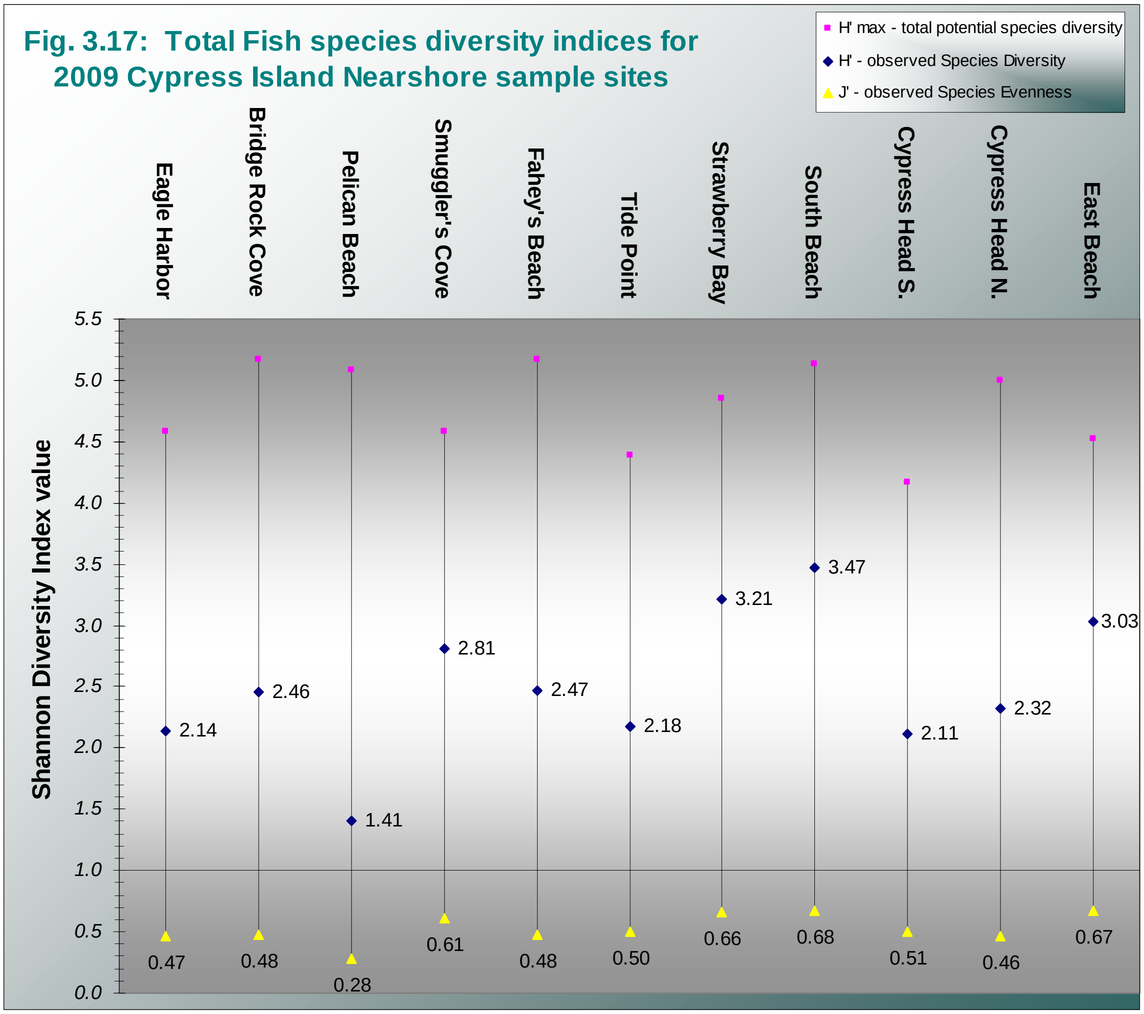


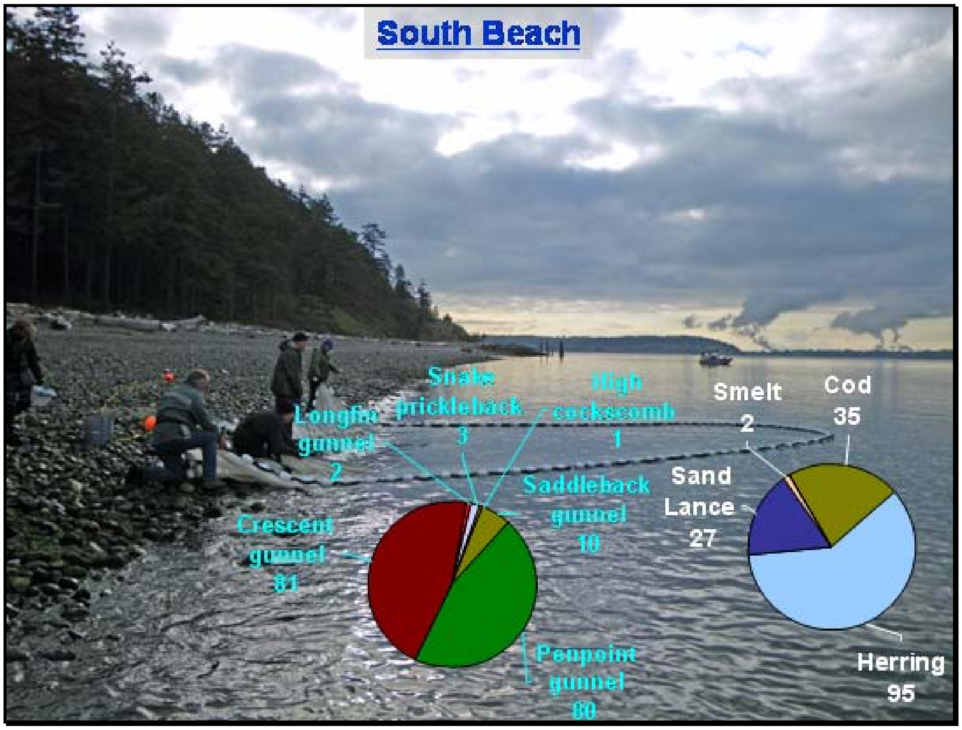
Figure 3.17 – Shannon-Weiner diversity index scores for 2009 Cypress Island nearshore fish use data.

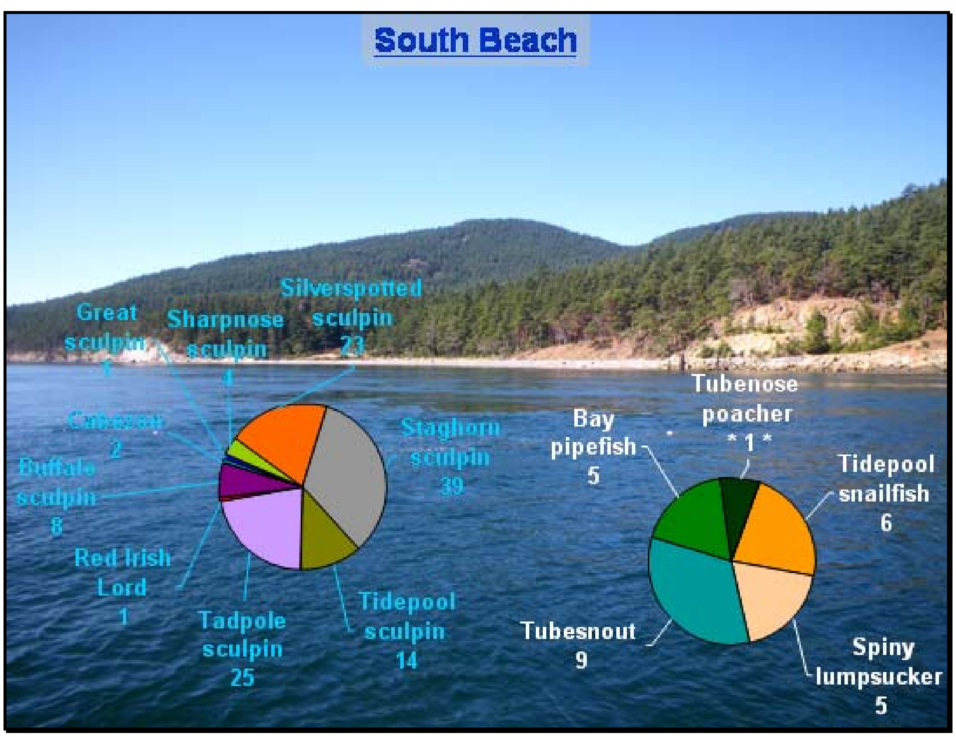
The Shannon-Weiner index allots equal weight to both species richness and evenness (e.g. total relative catch count) when calculating the diversity score. An evenness score of 1.0 indicates that captures of all species at a given site were equivalent, while a very low evenness score describes a site where a large number of individuals of just a few species were captured vs. a small catch of all other species (Pelican Beach for example, where herring, sand lance, and juvenile salmon – species typically comprised of numerous schooling individuals – dominated the catch). Despite the general lack of distinct separation in diversity scores among sites (a common criticism of the Shannon index), some patterns do emerge. Not surprisingly, species richness and diversity largely tracked apparent habitat complexity (sites with relatively diverse habitat types in the small area encompassed by the beach seine showed the highest richness), and also reiterated the importance of eelgrass in promoting nearshore marine fish diversity (Strawberry Bay, South Beach, Cypress Head North, Fahey's Beach, Smuggler's Cove). Tide Point and Pelican Beach, at the low end of the diversity scale, had average depths greater than the width of the net, so samples of schooling fish in the upper 12 ft. of the water column dominated catches, and likely skew toward a lower score. The lower scoring sites, Eagle Harbor and Cypress Head South Cove, have relatively simplified nearshore habitats and recorded the largest catches of a few species – juvenile salmon, smelt, herring, shiner perch, tidepool sculpins, and snake pricklebacks (photo 3.7).

Photo 3.7 – Pacific snake pricklebacks *(Lumpenus sagitta)* were easily the most numerous of the Stichaeids at most Cypress Island nearshore sites; they were observed lying motionless by the hundreds over sandy substrates in the shallow reaches of Eagle Harbor during warmer summer months in 2009.

Hundreds of tiny (<10mm) unidentified juvenile sculpins were captured at several sculpin nursery sites (esp. Cypress Head South Cove and Eagle Harbor). These were observed to grow with subsequent captures over the course of several sample sessions, and were later identified as largely consisting of Pacific Staghorn Sculpin (~75-80%) and a combination of Tidepool (est. 10-15%) and Sharpnose sculpin (~5%) for the remainder of the catch. Because they were too small to accurately identify, these early-season counts were not included in the diversity analysis by species (i.e. only identifiable sculpin were included). At the other end of the spectrum for the Cypress Island nearshore sites, Strawberry Bay and South Beach had a high overall species richness component (due to eelgrass beds), but did not record the very large catches of forage fish and some sculpin species that skew the diversity score at other sites. It is important to keep in mind that the index is only a relative score vis-à-vis all other sample sites within the Cypress Aquatic Reserve, and can be misleading. A site with a low relative diversity score may still have a specific suite of habitat characteristics that make it invaluable for the few species that call it home for all or part of their life history, and occurrences of single or a few individuals of rare species increases the richness component, and underscores the importance of conserving and maintaining an assortment of unaltered nearshore habitats types if the long-term goal is to promote fish species abundance and diversity.

Additional features of the marine fish community diversity at each site are displayed in the charts of Appendix 2. Figures express the single-session maximum observed catch / effort for species representing four separate ecological guilds: forage fish, Cottids (the sculpins), Pholids + Stichaeids (gunnels, pricklebacks, warbonnets etc.), and all other incidental nearshore marine species that were represented by relatively small or single individual captures during the 2009 sample season at Cypress Island. These charts, showing maximum CPUE for each species combined across all sample sessions per site, are analogous to what an idealized single net set would yield at any given site throughout the 2009 sample season, and, given the very real data limitations (see Section 4.1), likely provide a more accurate representation of intra-and inter-guild relative abundance for each species at each site than the Mean catch / effort data reported for Appendix 4. Examples for the South Beach site appear in Figure 3.18 (refer to Appendix 2, pg. 76).





A comparative study of the figures of Appendix 2 and the quick-reference tables of Appendix 4 will provide a sitable sense of the similarities and differences in marine fish communities across all Cypress Island study sites. Data for several important fish groups do not fit neatly into the four guild categories shown in Fig. 3.18 (and Appendix 2), though, primarily due to high variability in capture rates associated with the large captures of recently-emerged larvals that were netted in large numbers prior to their growth and subsequent dispersal. These groups – the Hexagrammids, Embiotocids, Gasterosteids (sticklebacks) and the flatfishes - flounders, halibut, soles etc. – contribute distinct ecological roles to fish aggregates within the Cypress Island Aquatic Reserve.

Flatfish typically appeared in small numbers per session at sites with appropriate habitat (usually prefer sandy substrates), but larval Pleuronectids were relatively abundant during individual sample sessions at both South Beach and Eagle Harbor (Fig. 3.19). Mentioned previously (pg. 57), field personnel did not attempt to identify flatfish to species. Bothids (the true left-eyed flounders; e.g Sanddabs) were very rare among 2009 samples / sites.

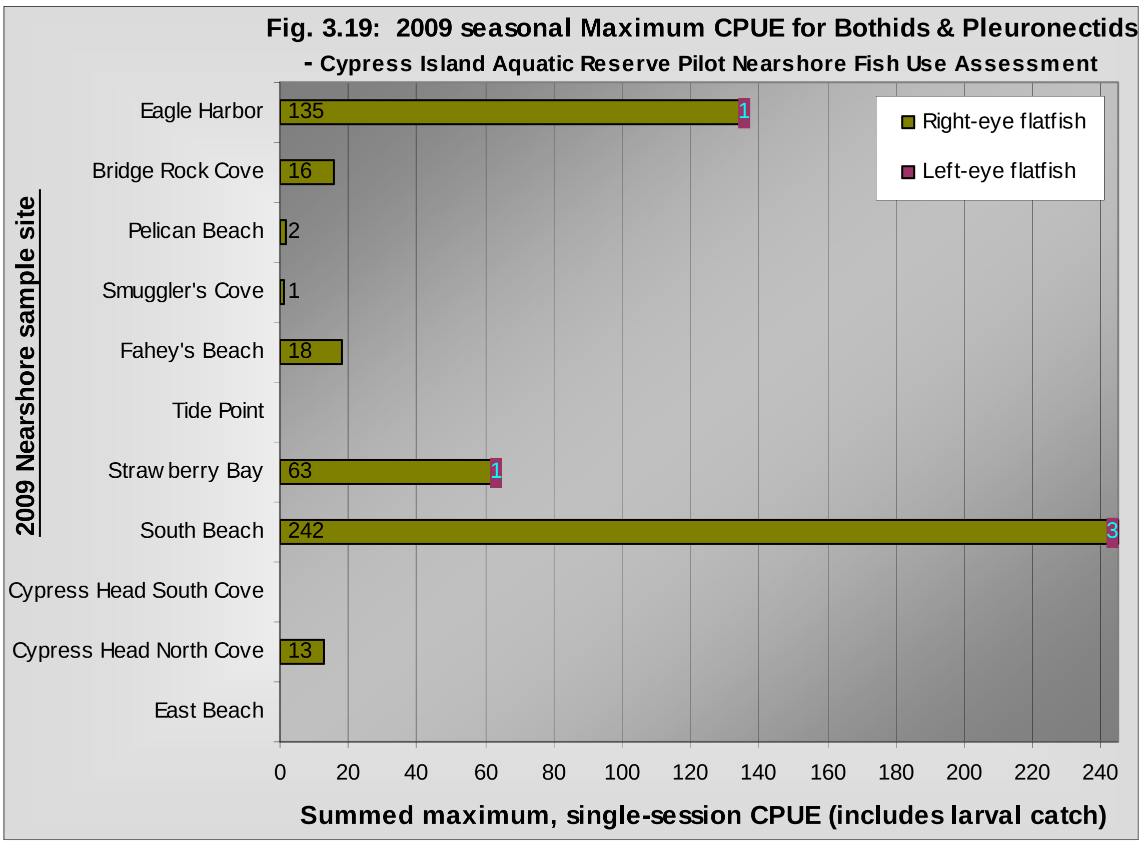


Figure 3.19 – Single-session maximum catch-per-unit-effort for left-eyed and right-eyed flatfish species.

Photo 3.8 – Starry flounder *(Platichthys stellatus)*.

Beach seine crews netted small schools of adult Shiner perch *(Cymatogaster aggregata)* as well as pairs or single individuals at most Cypress Island sites; with the largest captures (Eagle Harbor, Strawberry Bay, Cypress Head South Cove) enumerating hundreds of recently-birthed juveniles (viviparity is unusual among marine fish but common among surf perches). Only two surf perch species were observed in the Cypress nearshore in 2009. Three-spine stickleback *(Gasterosteus aculeatus)* was one of the few species present at every sample site. This fish is very tolerant of a wide range of habitat conditions, temperatures, salinities etc. Recently-emerged juvenile stickleback were netted in numbers at South Beach, Pelican Beach, and the Cypress Head North Cove (Fig. 3.20 - *note*: log scale).

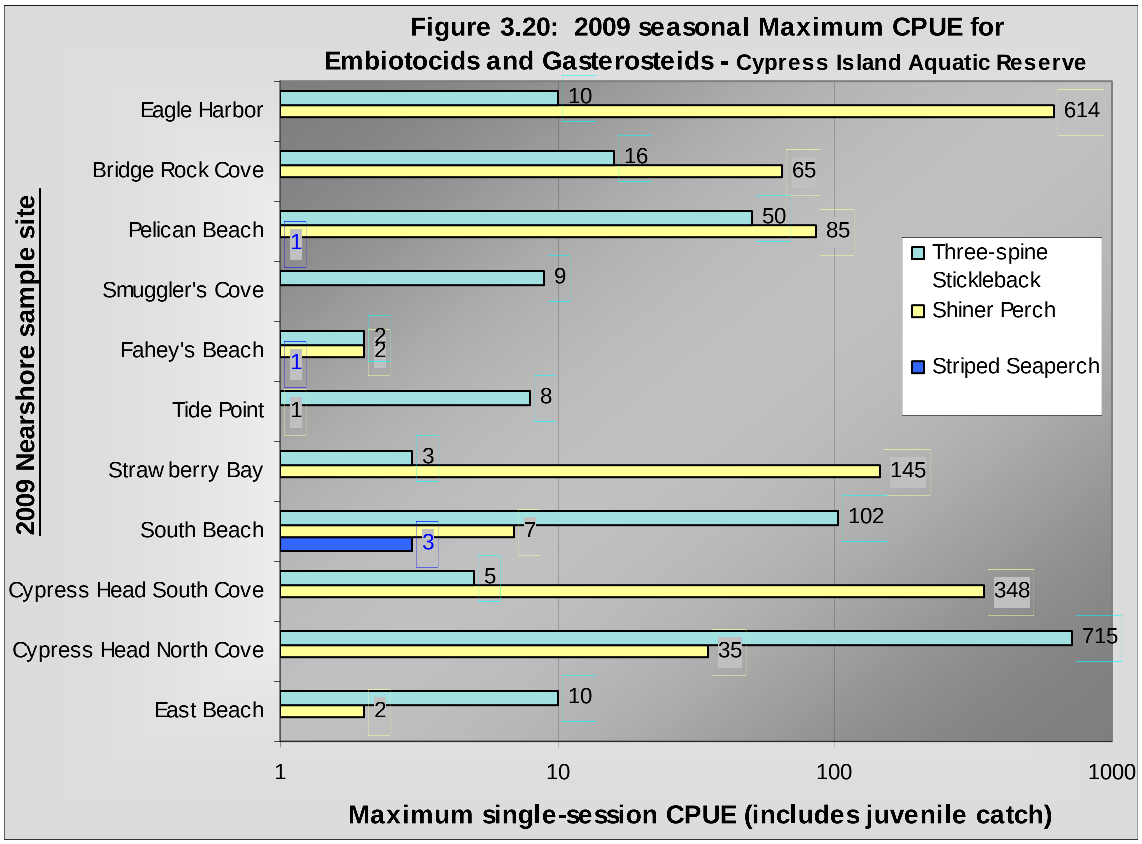


Figure 3.20 – Single-session maximum catch-per-unit-effort for stickleback and surf perch species.

Photo 3.9a & 3.9b – Shiner perch (left) and the relatively much less abundant Striped seaperch (right).

Hexagrammids (Greenlings and Lingcod) were represented by just three species at Cypress Island sample sites in 2009, though the White-spotted greenling *(Hexagrammos stelleri*) was widely distributed in the Cypress Island nearshore (captured at 10 of 11 sites). A lone juvenile Lingcod was netted at low tide in heavy intertidal vegetation at the Bridge Rock Cove site. Adult greenling were relatively common at heavily vegetated sites (Fahey's Beach, Smuggler's Cove, South Beach) where prey species are abundant. Figure 3.21 displays the single-session maximum catch / effort contribution for each species to the total Hexagrammid catch at Cypress nearshore sites. Juvenile greenling are common at all sites but Eagle Harbor; they are very difficult to distinguish to species.

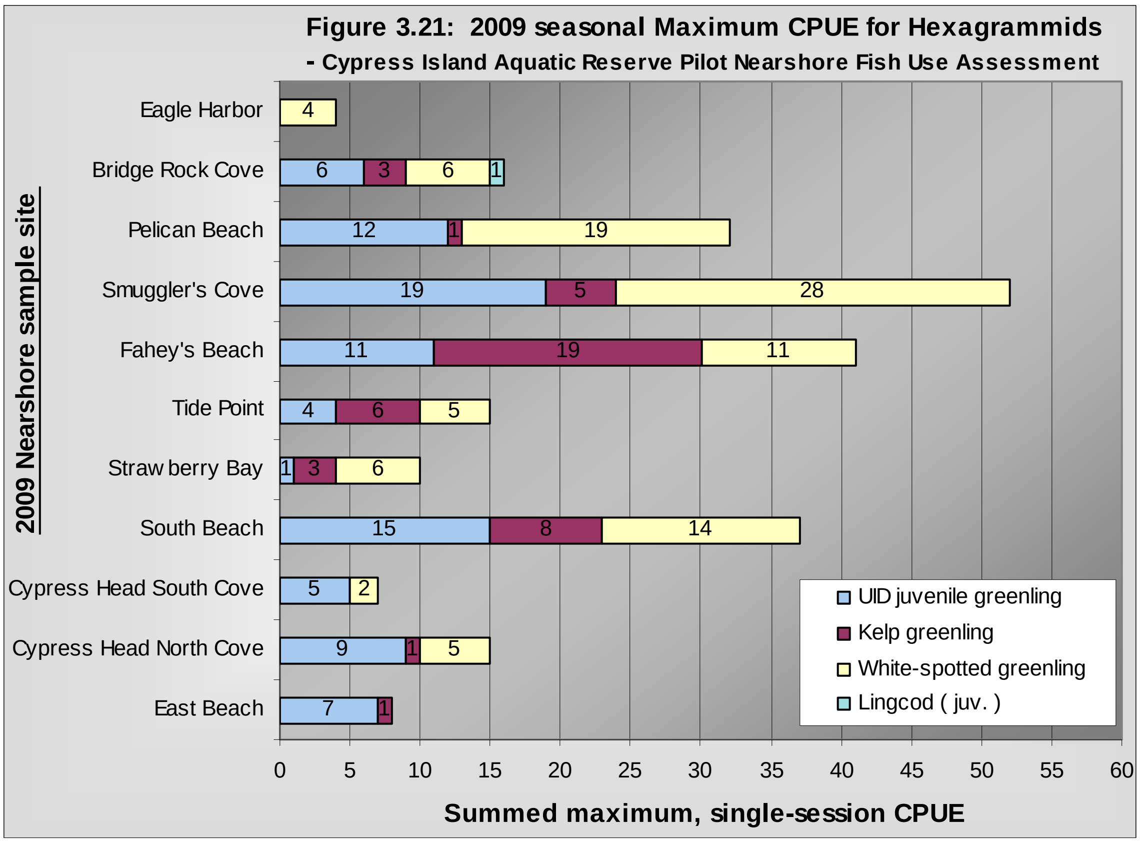


Figure 3.21 – Single-session maximum catch-per-unit-effort for Greenling and Lingcod species.

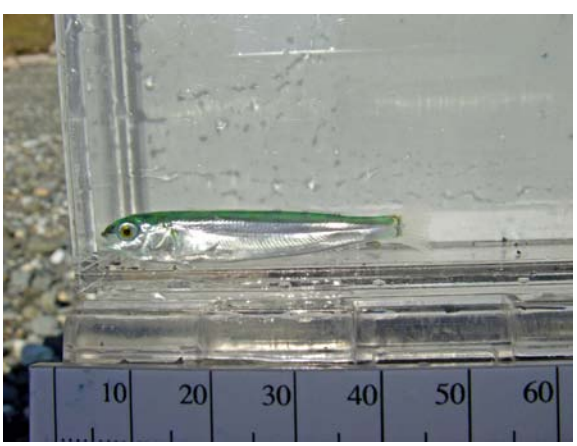


Photo 3.10a & 3.10b – Juvenile greenling are difficult to identify until they differentiate as sub-adults

3.6 Results – *Forage Fish*

Region-wide interest in the conservation and recovery of wild salmon has also rekindled an interest in studies of the distribution and population abundance trends of marine forage fish species; primarily in light of their value as a vital prey resource to foraging juvenile and sub-adult salmon (hence the collective term), but also as an ecosystem energetics driver amidst the complex Puget Sound food web that ranges in size from microscopic zooplankton to vertebrate mammals (Orca, harbor seal, sea lion). Fig. 3.22 shows single-session maximum density (combined for all forage fish), the principle species per site, and the date of observation for maximum forage fish captures. Typically this represented a single schooling species observation, with nominal captures of other species, but includes both herring and sand lance at Bridge Rock Cove for sample session #17.

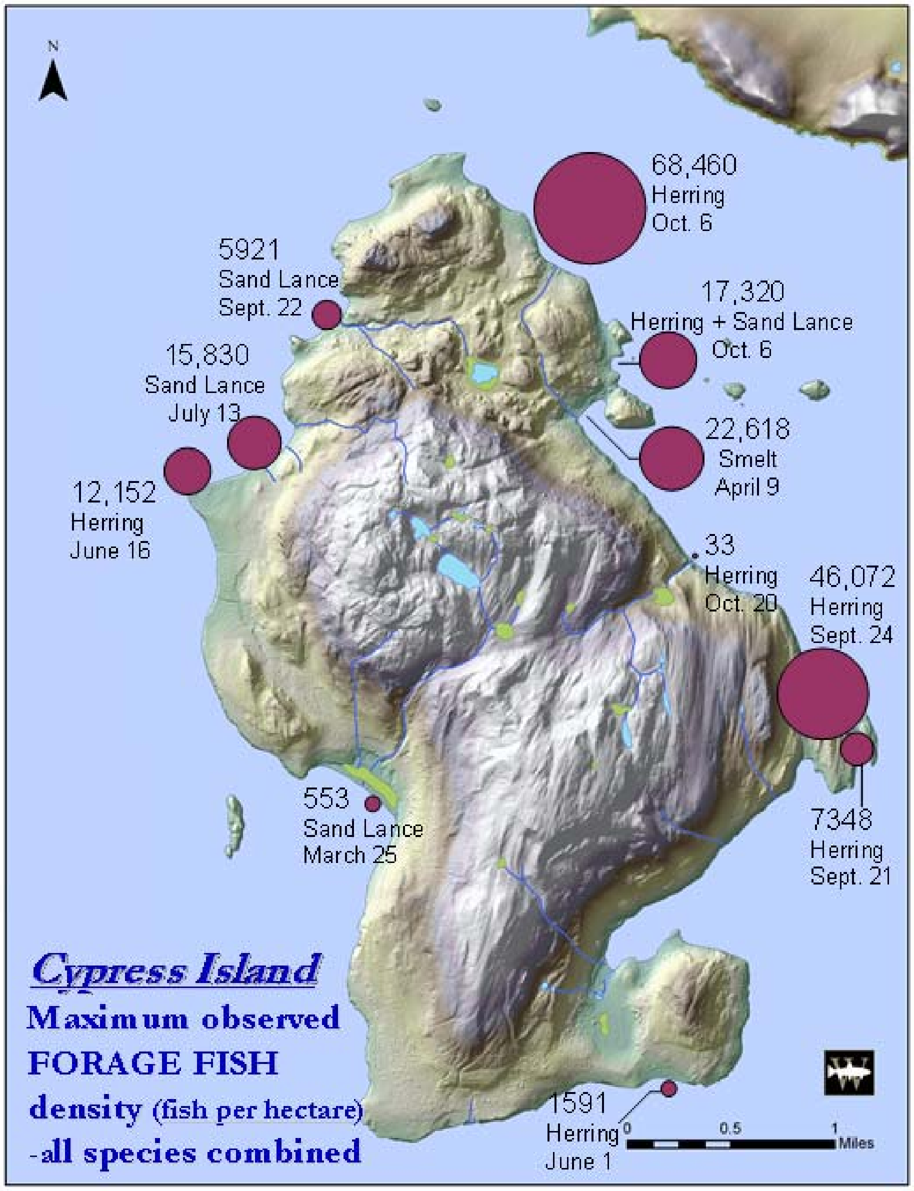


Figure 3.22 - Combined maximum forage fish density at 2009 nearshore sites & date of observation.

Forage fish samples at nearshore sites were irregular with respect to seasonal timing and relative abundance. The pattern for forage fish captures at Cypress Island sites in 2009 were large, mostly single-species schools netted during widely-separated sample sessions (see dates referenced on Fig. 3.22), although it was apparent from the earliest sample sessions that Pacific sand lance *(Ammodytes hexapterus)* dominated catches at sites located along the northwest / Rosario Strait coastline of the island (Fahey's Beach, Smuggler's Cove, and Tide Point – see Appendix 4 for relative Mean catch / effort data for forage fish). Post-larval sand lance were noted on several occasions as the single prey item in stomach samples of juvenile Chinook, reminding field crews of the importance of juvenile forage fish to foraging salmon smolts. A single large school of surf smelt *(Hypomesus pretiosus)* was netted at Eagle Harbor in early April, and a few tens of individuals were typically encountered mixed with larger schools of Pacific herring *(Clupea harengus p.)*, but abundant schools of smelt were surprising by their absence from seine hauls in 2009. This result may have been an artifact of the infrequent sampling at many sites. No Eulachon, Capelin, or Longfin smelt were identified in 2009.

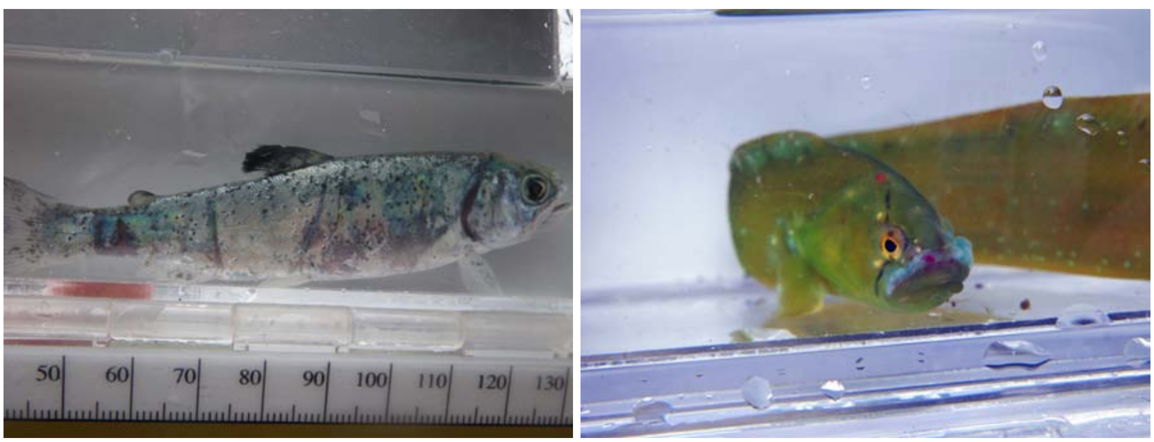
A single juvenile northern anchovy netted at Eagle Harbor in early June (session #8) represented the entire anchovy capture for the Cypress Island nearshore. No hake were present in 2009 catches. Only 5 juvenile Walleye Pollock were netted with a larger school of larval cod at Fahey's Beach in late April (session #5). Pollock are a state candidate species for threatened listing in the South Puget Sound Distinct Population Segment (DPS). Cod were netted as schools of both recently-hatched larval fish and the 1-2 year juvenile age classes at 9 of 11 sites. Although the north Puget Sound / Georgia Basin DPS for Pacific cod is not currently of specific concern, the Central and South Puget Sound DPS is a candidate for state listing. The codfishes are typically considered offshore groundfish stock for fisheries management purposes (as adults), but larval and juvenile cod are an important prey species for foraging juvenile and sub-adult salmon in the San Juan Islands' nearshore (R. Barsh et al. 2011, unpub. data), and juvenile Gadids were considered within the forage fish guild for this project (charts of Appendix 2).

Forage fish spawn site data was compiled for the Northwest Straits Commission by researchers from Padilla Bay National Marine Estuary (S. Shull, 2008). Washington Department of Fish and Wildlife survey data was available from 1972 to 2003 throughout Skagit County, and included 41 sites around the perimeter of Cypress Island, with only 14 of those sites receiving multiple sample visits during the reporting period, and no forage fish spawn (eggs) were found at any Cypress Island site. A habitat suitability model developed concurrently with the Skagit County forage fish spawn data summary concluded that more than 90% of Cypress Island beaches rated high or moderately high, though no potential Cypress forage fish spawn sites rated in the "very high" category. Eagle Harbor, Secret Harbor, and the pocket beach at Mexican Bay all rated at the low end of the scale index for potential forage fish spawn suitability. Assuming a general lack of mobility for larval forage fish (they are typically netted at or near their point of emergence until they are large enough and strong enough to navigate nearshore currents), of the eleven 2009 nearshore fish use assessment sites, only Pelican Beach had significant captures of post-larval forage fish – a school of post-larval smelt was netted in early June. Other sites including Strawberry Bay, Smuggler's Cove, Fahey's Beach, East Beach, Eagle Harbor, and Bridge Rock Cove had insignificant captures of post-larval sand-lance and smelt (<10) during the 2009 sample season.

3.7 Results – *Incidental observations: fish parasites and disease*

Parasitic adult copepods (or sea lice – primarily *Lepophtheirus salmonis* and species of the genus *Caligus*) were noted at all sample sites at various times throughout the season. Field crews did not enumerate sea lice on salmonids or other marine fish, but observed the adults on herring and smelt as well as juvenile and sub-adult salmon, and noted that large benthic sculpins and flounders appeared to have very high rates of infestation.

Early-season beach seine sets at Smuggler's Cove netted several penpoint gunnels *(Apodichthys flavidus)* with oddly-discolored lesions and swollen tissues, particularly around the mouth and head. Without expertise in gunnel physiology, this was initially assumed to be a secondary sexual characteristic of the breeding season, though it had not been observed prior to this over the course of thousands of penpoint gunnel captures. Photos of these several fish (photo 3.11b) were distributed to other north Puget Sound marine fish experts, none of whom had observed this apparent affliction either (only noted at the Smuggler's Cove site, with other penpoint gunnels and all other gunnel species netted in the same samples appearing normal). Sample sessions later in the season (after April) netted no further affected penpoints. Two of the gunnels were collected in 2009 and remain in a freezer at Wild Fish Conservancy's main office awaiting assay, though the length of time since initial capture may have rendered the specimens inert and not suitable for further toxicological analysis.



Photos 3.11a and 3.11b – Juvenile wild coho with black spot infestation netted at South Beach; an adult Penpoint gunnel with unusual lesions; several were sampled during the early-season at Smuggler's Cove.

A single juvenile coho smolt captured at the South Beach sample site in mid-June was heavily infested with parasitic larval trematodes of the family Diplostomidae, causing a condition that is referred to as "black spot disease" for the intramuscular cysts that form around the areas of infestation (photo 3.11a). This is the only occurrence of this parasite that WFC's project manager has observed in four complete seasons of beach seining for juvenile salmon in north Puget Sound nearshore habitats.

Two parasitic marine leeches were also photographed on a moderately-sized great sculpin *(Myoxocephalus polyacanthocephalus)* netted in the Eagle Harbor nearshore. While apparently not uncommon, again, this is the only occurrence of such parasites that the project manager has noted over four seasons of nearshore beach seining for marine fish.

4.1 DISCUSSION

From March through October of 2009, Wild Fish Conservancy staff successfully tested, applied, and (as needed) modified nearshore sampling protocols at study sites within the Cypress Island Aquatic Reserve, including an exploration of the value and limitations of volunteer field personnel contributions to future nearshore fish use assessment projects. Data and conclusions made available through this report provide new information about marine fish species occurrence and relative abundance at study sites within the Reserve, and provides a baseline for future trends in nearshore fish use. Certainly, applying this sampling scheme consistently over a long enough period of time would identify macro-scale effects such as localized species extirpations, species distribution expansions and / or contractions over local geographic scales, and long-term changes in relative abundance within and among sample sites. Caution should be exercised with short-term (i.e. year-to-year) comparisons and the like however, as observed changes may fall well within the natural variability of nearshore fish populations. Within the limited scope of this pilot project, several recommendations were brought to light for future nearshore fish use assessments and site monitoring. Many of these appear throughout the body text of this report, but others not previously mentioned include:

- Expand study sites in the Cypress Island Aquatic Reserve to include other habitat types than those sampled for the pilot project. Several pocket beaches remain unsampled that may provide an entirely different set of nearshore habitat conditions. However, the narrow, rocky coastal strip beneath plunging shoreline bluffs around the island perimeter would be very problematic to sample, though a thorough exploration would likely turn up areas that are amenable to beach seines.

- Review and re-negotiate the legal constraints to sampling within Deepwater Bay and Secret Harbor. These are important sites within the greater context of the Cypress Island nearshore, and should not be left out of future monitoring plans.

- Fish activity varies temporally, by time of day, by tide stage, by season etc. Nearshore monitoring should attempt (to the degree possible given the constraints of time, volunteer labor etc.) to purposely vary sample times across sites, so that all sites are visited over a variety of time, tide, current, and seasonal conditions (including early morning, late evening etc.) in order to obtain a more accurate assessment of nearshore habitat use by marine fish species at selected sites.

Accepted sampling theory maintains that every site should be visited during each of the scheduled sessions in order to maintain continuity and equability throughout the entire research period, and to make meaningful comparisons of fish capture data across all sample sites and time. Despite the modest sampling effort for this pilot project, a variety of tide stages were adequately sampled at each site over the course of the season. However, the highly variable fish catches common with nearshore seining (i.e. more fish netted equates to longer time spent processing and recording data), and the vagaries of weather, crew fatigue, and limited resources (providing for only 2 days of sampling during each session) precluded crews from visiting all ten primary sites during every sample session. Also due to time constraints, only a single net was set during each site visit throughout the duration of the study. Adequate sample replication would call for a minimum of 2, and ideally 3 net sets per site visit. During the peak of the juvenile salmon outmigration, when it was impossible to reach all sites during each sample session, WFC's project manager adaptively compensated by preferentially selecting sites on a session-by-session basis that attempted to strike a compromise between likelihood of encountering important target species based on previous site catch data (juvenile salmon, forage fish etc.), and the most recent visit to a given site. Although ideal sample replication was not achieved for this study, every attempt was made to include any site in a subsequent sample session that was missed during the previous session.

It's been stated several times throughout this report, but it is important to reiterate the data limitations imposed by the infrequency of site visitation. Although this was considered a pilot investment, available resources were simply not adequate to provide for statistically robust replication of sampling at each site throughout this initial season. At best, sites were visited once approximately every two weeks, and occasionally only a few times during the entire season (see the Sampling & Site Consideration discussion in Section 3.1 for details). Regular and repeated sampling would not likely have resulted in a significant increase in the number of local resident species netted per site (or the number of individuals of each resident species), but this issue does become particularly relevant when discussing presence / absence and relative abundance of (in particular) migratory schooling species. The current data may show that, for example, chum salmon or smelt were not encountered at a particular site on a certain date, but this is much more likely to be an artifact of the timing of the most recent site visitation, rather than a definitive statement about the presence (or lack thereof) of salmon or forage fish species at a given site during that time period.

Succinctly put, assume that the data presented herein is only a snapshot during a small sampling window of the actual information to be obtained at any given site on species presence / absence or relative abundance, rather than a complete time record of nearshore fish use at the Cypress Island nearshore sites. It is likely that entire pulses of migratory fish species were missed with this limited effort. Early-season sampling was somewhat sporadic when field crews were familiarizing themselves with the specific sites and general sampling protocols, though coverage was still adequate to establish the onset of juvenile salmon occupancy (for chum) at most nearshore sites. This was a stated goal for the pilot project from the outset, and the information will inform schedule planning for future fish use monitoring at the Cypress Island Aquatic Reserve.

Reporting Mean CPUE ($CPUE_{Avg}$) for very small sample sizes (as with the data for the Appendix 4) risks critically over-inflating or devaluing actual abundance estimates. Calculation of catch / effort easily becomes skewed by very large catches (e.g. schools of forage) or very small catches of a given species relative to the few other sample sessions where that species was represented in the nearshore catch. Notice how many species in Appendix 4 have a calculated (and rounded) Mean catch / effort of 0.1 fish. Rarefaction could be applied to the data set to account for the inequality and inconsistency in sample effort, but this is quite a time-consuming process, and outside the scope of the pilot project. The solution, of course, is two solid seasons of sampling, replicated weekly, at every sample site throughout the entire season. Nearshore fish use data (average CPUE) is much more robust with repeated, long-term monitoring, when the value of baseline data as a long-term comparative for changes to site diversity, and species assemblages and relative abundances over time becomes apparent. Changes in fish use at any site may eventually be attributable to identifiable altered habitat conditions (e.g. decline in eelgrass coverage, a shift in substrate, warming or cooling seawater temperatures etc.)

Finally, a cautionary word. To date, no known studies have been conducted to determine the potential long-term detriments to fish habitat of repeatedly dragging heavy beach seines over delicate nearshore vegetated substrates. At least one eelgrass site appeared to be negatively impacted at Cypress Island in 2009. Researchers should be aware of (and attempt to mitigate for) this effect during fish sampling. It is important that we not do more harm than good when trying to elucidate the trends in fish use throughout the nearshore marine network protected under the umbrella of state Aquatic Reserve status.

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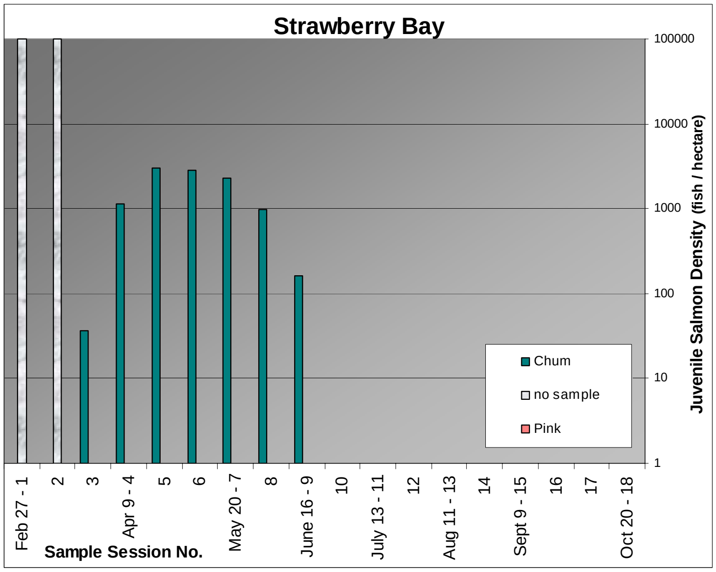
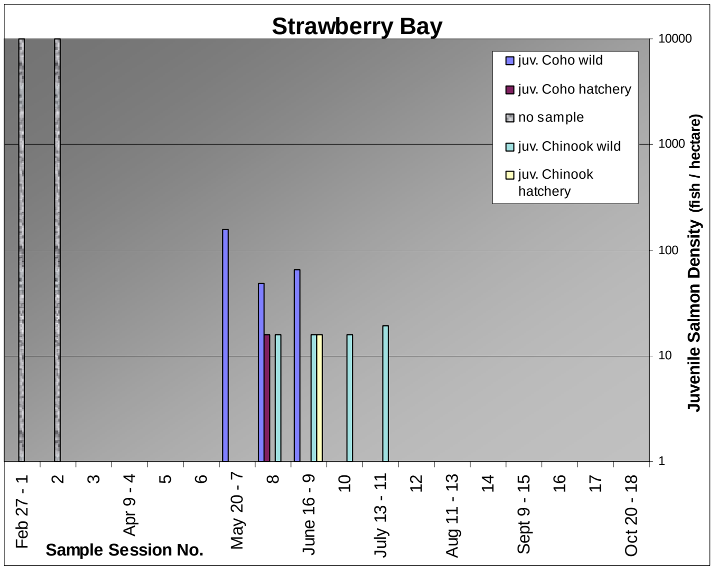
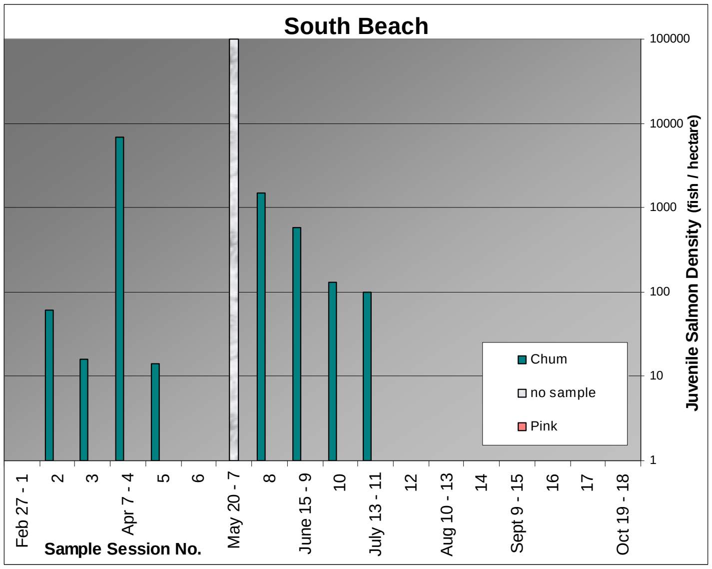
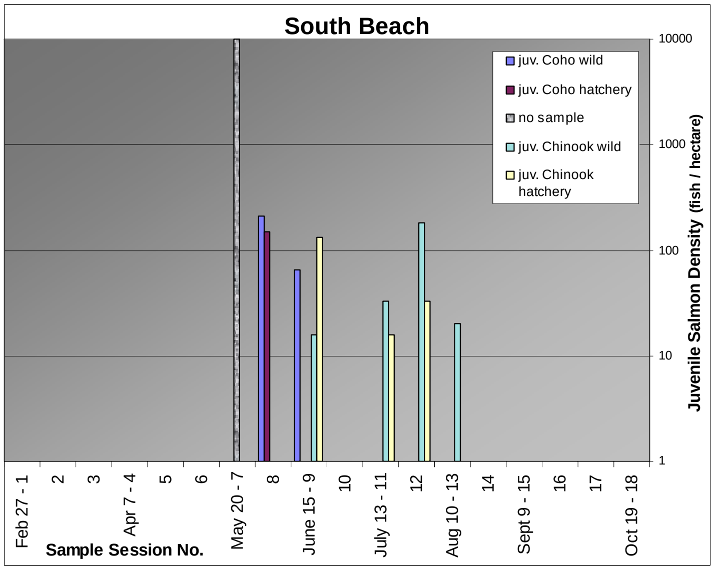
Appendix 1: Per-session juvenile salmon densities for 2009 Cypress Island Pilot Nearshore Fish Use Assessment sites

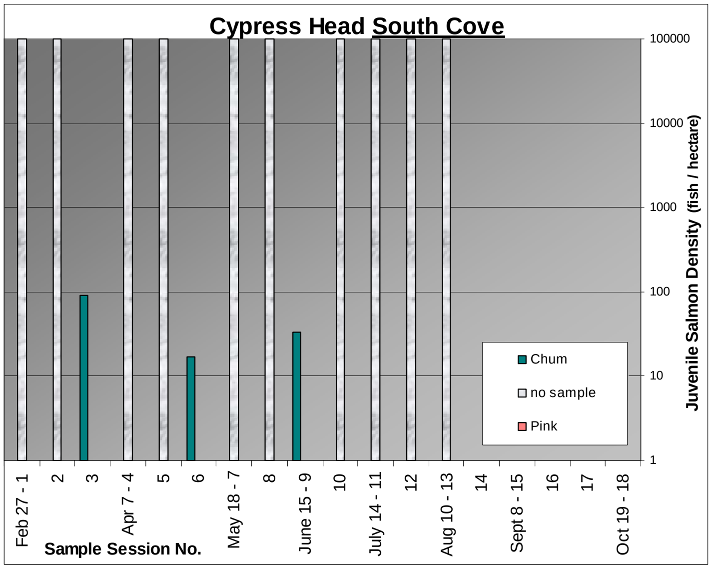
** Note: logarithmic axis scales up to 100,000 fish for Chum salmon (left), and up to 10,000 fish for Coho and Chinook (right).

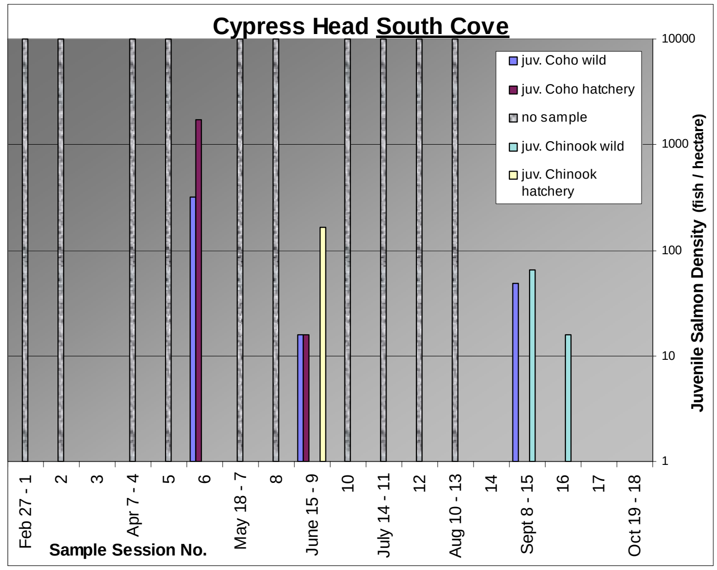


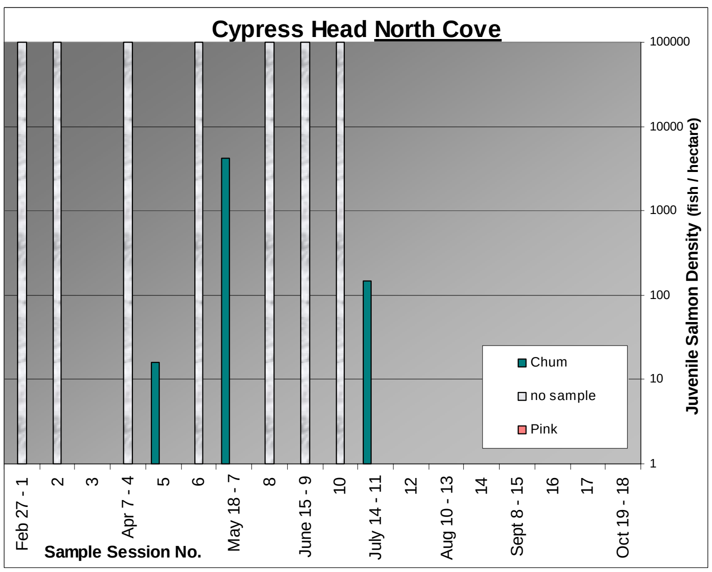


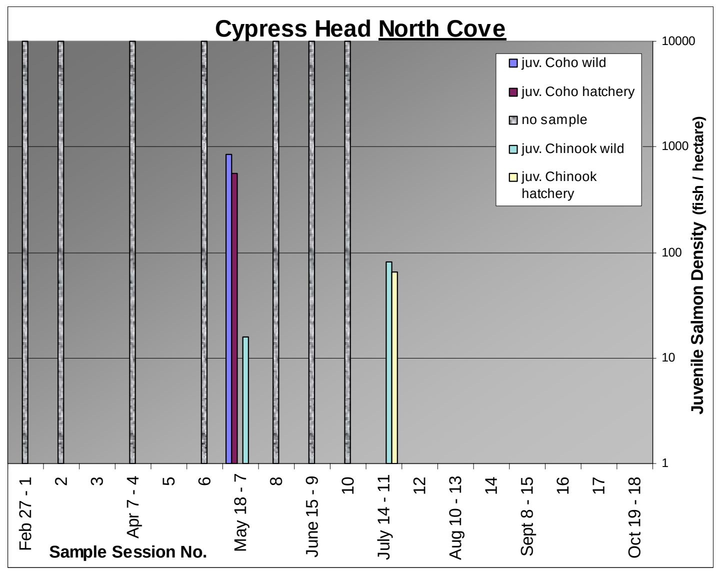


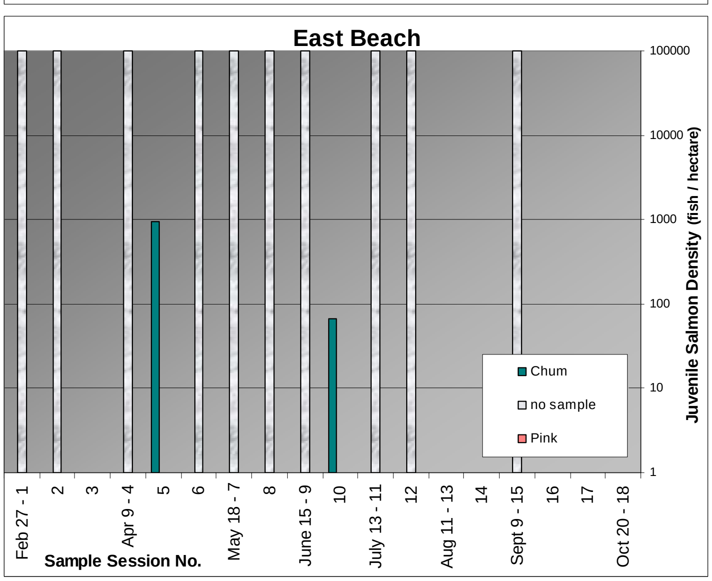


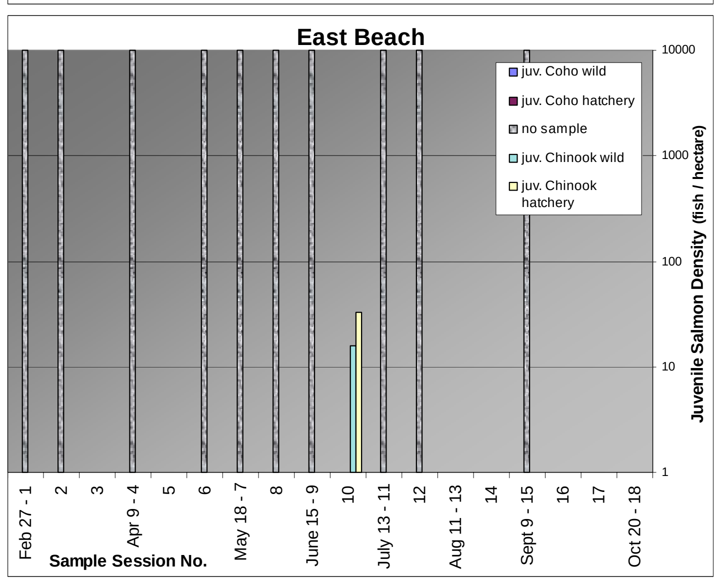

Cypress Head South Cove
Juvenile Salmon Density (fish / hectare)
100000
10000
1000
100
10
1
Chum
no sample
Pink
Feb 27 - 1
2
3
Apr 7 - 4
5
6
May 18 - 7
8
June 15 - 9
10
July 14 - 11
12
Aug 10 - 13
14
Sept 8 - 15
16
17
Oct 19 - 18
Sample Session No.

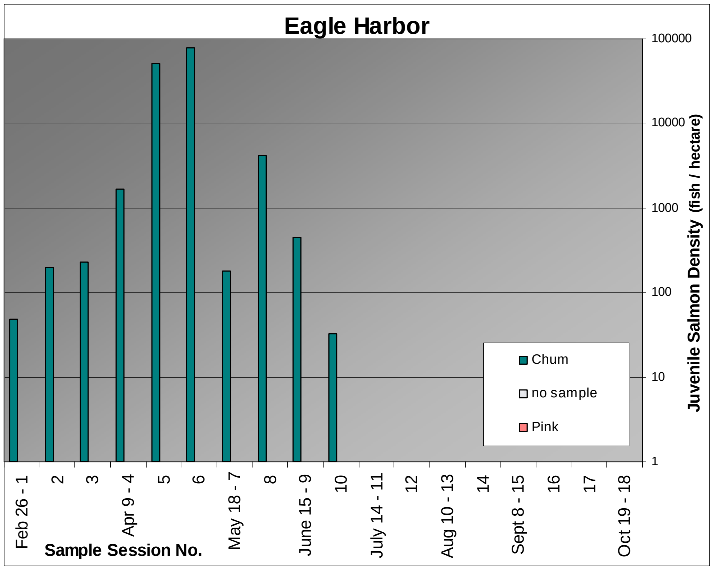

Cypress Head South Cove
Juvenile Salmon Density (fish / hectare)
10000
1000
100
10
1
juv. Coho wild
juv. Coho hatchery
no sample
juv. Chinook wild
juv. Chinook hatchery
Feb 27 - 1
2
3
Apr 7 - 4
5
6
May 18 - 7
8
June 15 - 9
10
July 14 - 11
12
Aug 10 - 13
14
Sept 8 - 15
16
17
Oct 19 - 18
Sample Session No.

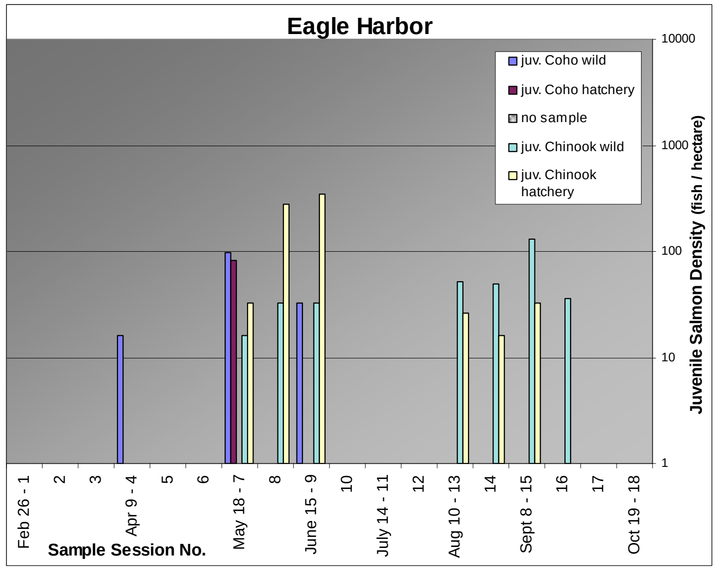

Cypress Head North Cove
Juvenile Salmon Density (fish / hectare)
100000
10000
1000
100
10
1
Chum
no sample
Pink
Feb 27 - 1
2
3
Apr 7 - 4
5
6
May 18 - 7
8
June 15 - 9
10
July 14 - 11
12
Aug 10 - 13
14
Sept 8 - 15
16
17
Oct 19 - 18
Sample Session No.

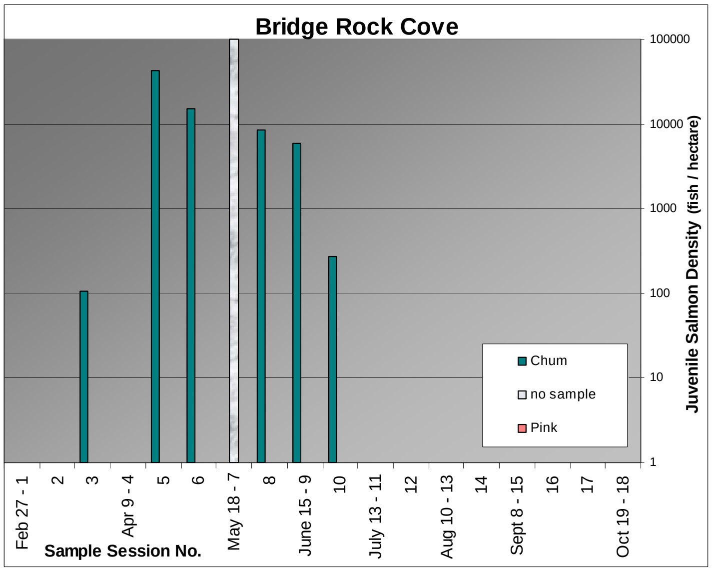

Cypress Head North Cove
Juvenile Salmon Density (fish / hectare)
10000
1000
100
10
1
juv. Coho wild
juv. Coho hatchery
no sample
juv. Chinook wild
juv. Chinook hatchery
Feb 27 - 1
2
3
Apr 7 - 4
5
6
May 18 - 7
8
June 15 - 9
10
July 14 - 11
12
Aug 10 - 13
14
Sept 8 - 15
16
17
Oct 19 - 18
Sample Session No.

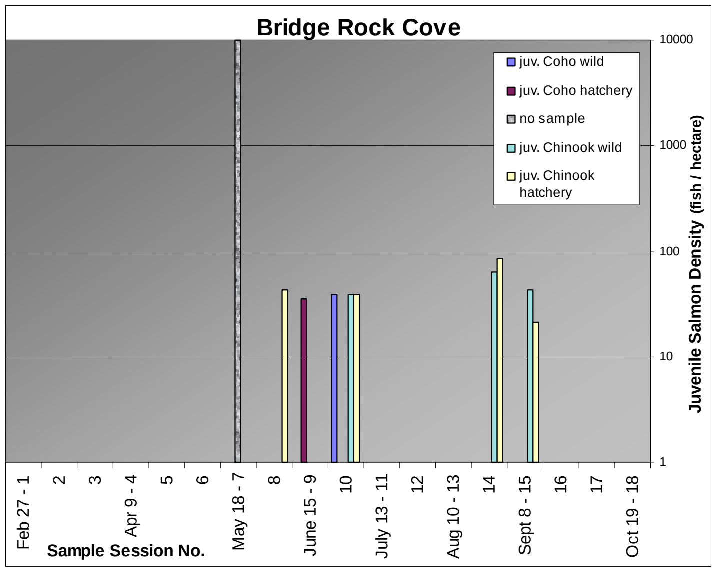

East Beach
Juvenile Salmon Density (fish / hectare)
100000
10000
1000
100
10
1
Chum
no sample
Pink
Feb 27 - 1
2
3
Apr 9 - 4
5
6
May 18 - 7
8
June 15 - 9
10
July 13 - 11
12
Aug 11 - 13
14
Sept 9 - 15
16
17
Oct 20 - 18
Sample Session No.

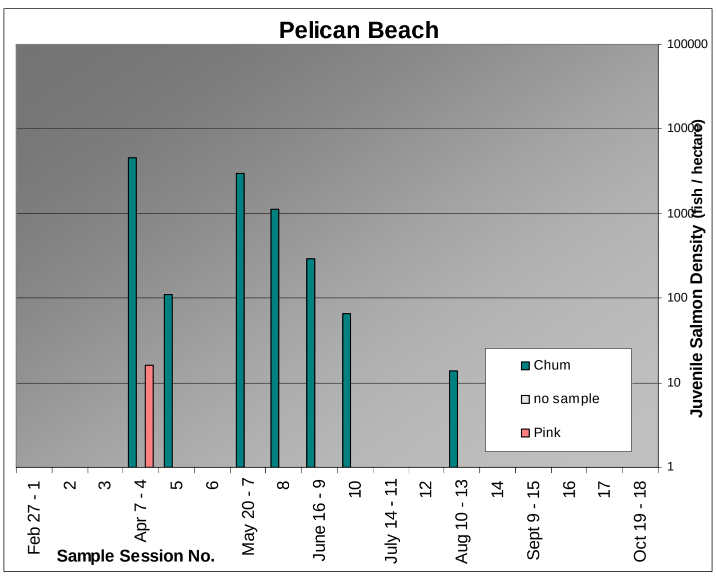

East Beach
Juvenile Salmon Density (fish / hectare)
10000
1000
100
10
1
juv. Coho wild
juv. Coho hatchery
no sample
juv. Chinook wild
juv. Chinook hatchery
Feb 27 - 1
2
3
Apr 9 - 4
5
6
May 18 - 7
8
June 15 - 9
10
July 13 - 11
12
Aug 11 - 13
14
Sept 9 - 15
16
17
Oct 20 - 18
Sample Session No.

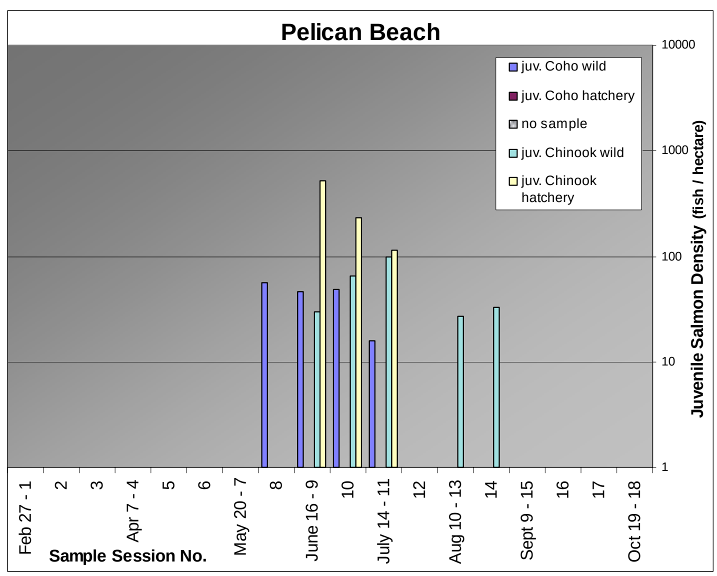

Eagle Harbor
Chum
no sample
Pink
Juvenile Salmon Density (fish / hectare)
Sample Session No.

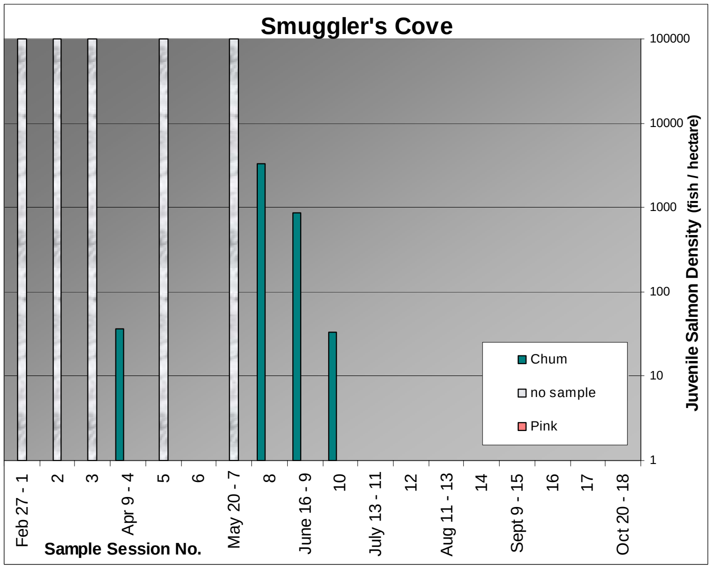

Eagle Harbor
juv. Coho wild
juv. Coho hatchery
no sample
juv. Chinook wild
juv. Chinook hatchery
Juvenile Salmon Density (fish / hectare)
Sample Session No.

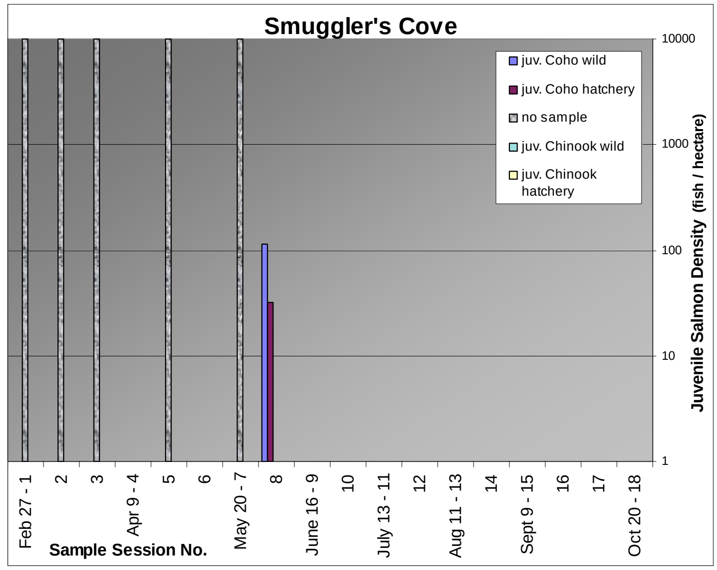

Bridge Rock Cove
Chum
no sample
Pink
Juvenile Salmon Density (fish / hectare)
Sample Session No.

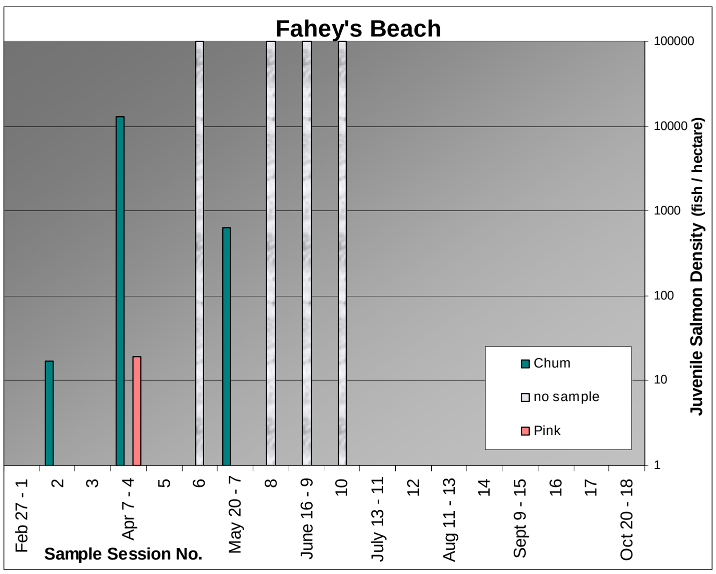

Bridge Rock Cove
juv. Coho wild
juv. Coho hatchery
no sample
juv. Chinook wild
juv. Chinook hatchery
Juvenile Salmon Density (fish / hectare)
Sample Session No.

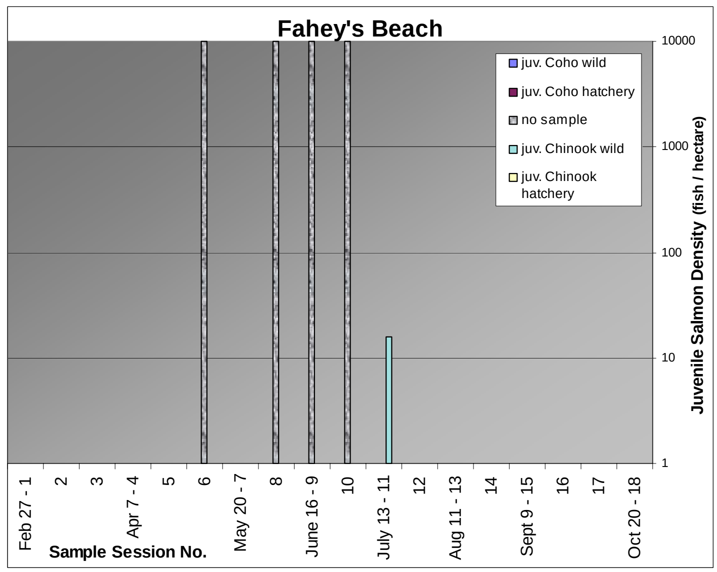

Pelican Beach
Chum
no sample
Pink
Juvenile Salmon Density (fish / hectare)
Sample Session No.

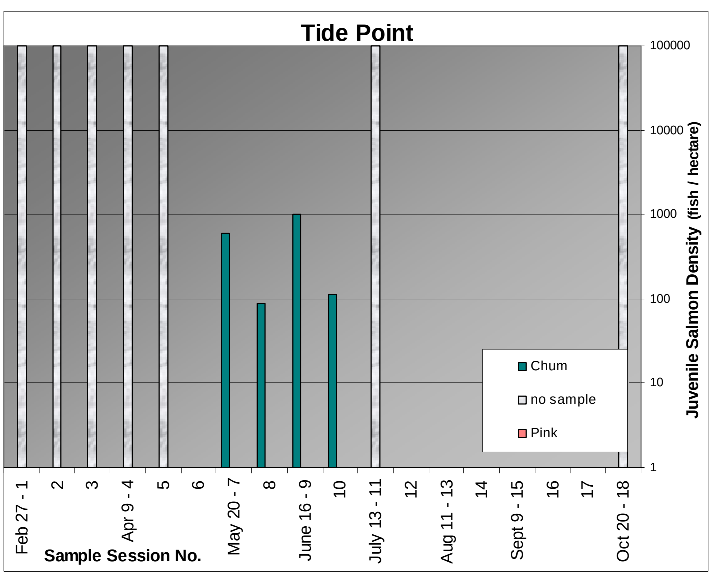

Pelican Beach
juv. Coho wild
juv. Coho hatchery
no sample
juv. Chinook wild
juv. Chinook hatchery
Juvenile Salmon Density (fish / hectare)
Sample Session No.

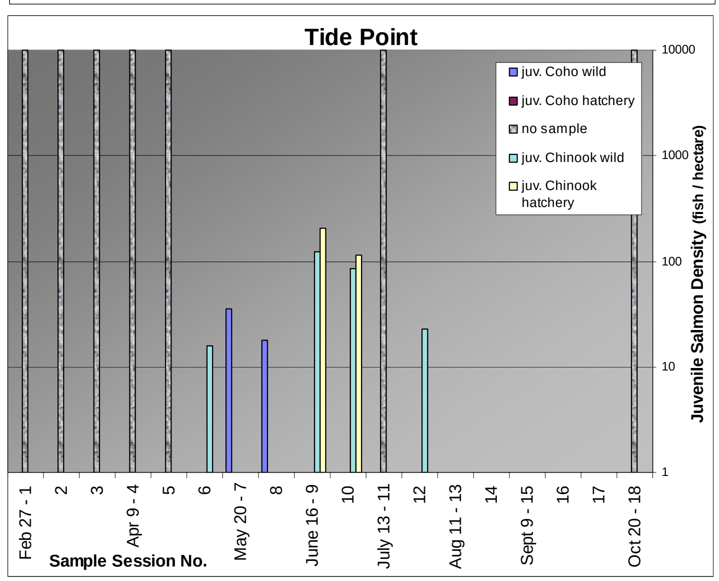

Smuggler's Cove
Chum
no sample
Pink
Juvenile Salmon Density (fish / hectare)
100000
10000
1000
100
10
1
Feb 27 - 1
2
3
Apr 9 - 4
5
6
May 20 - 7
8
June 16 - 9
10
July 13 - 11
12
Aug 11 - 13
14
Sept 9 - 15
16
17
Oct 20 - 18
Sample Session No.


Smuggler's Cove
juv. Coho wild
juv. Coho hatchery
no sample
juv. Chinook wild
juv. Chinook hatchery
Juvenile Salmon Density (fish / hectare)
10000
1000
100
10
1
Feb 27 - 1
2
3
Apr 9 - 4
5
6
May 20 - 7
8
June 16 - 9
10
July 13 - 11
12
Aug 11 - 13
14
Sept 9 - 15
16
17
Oct 20 - 18
Sample Session No.

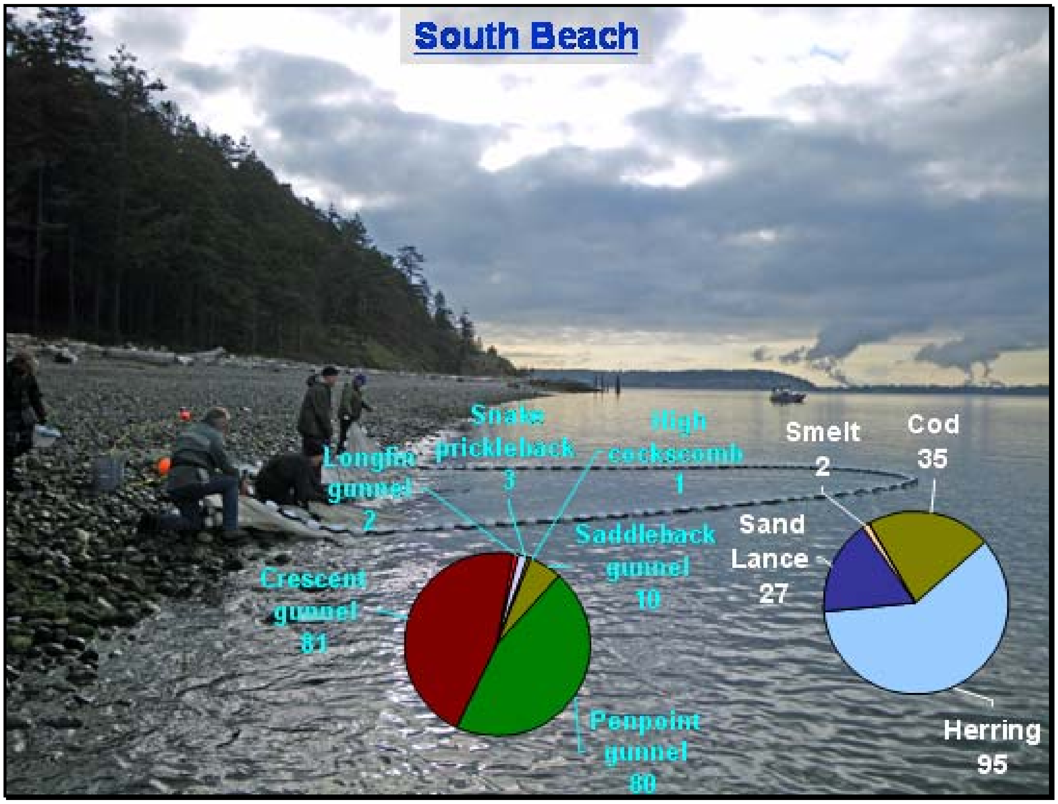

Fahey's Beach
Chum
no sample
Pink
Juvenile Salmon Density (fish / hectare)
100000
10000
1000
100
10
1
Feb 27 - 1
2
3
Apr 7 - 4
5
6
May 20 - 7
8
June 16 - 9
10
July 13 - 11
12
Aug 11 - 13
14
Sept 9 - 15
16
17
Oct 20 - 18
Sample Session No.

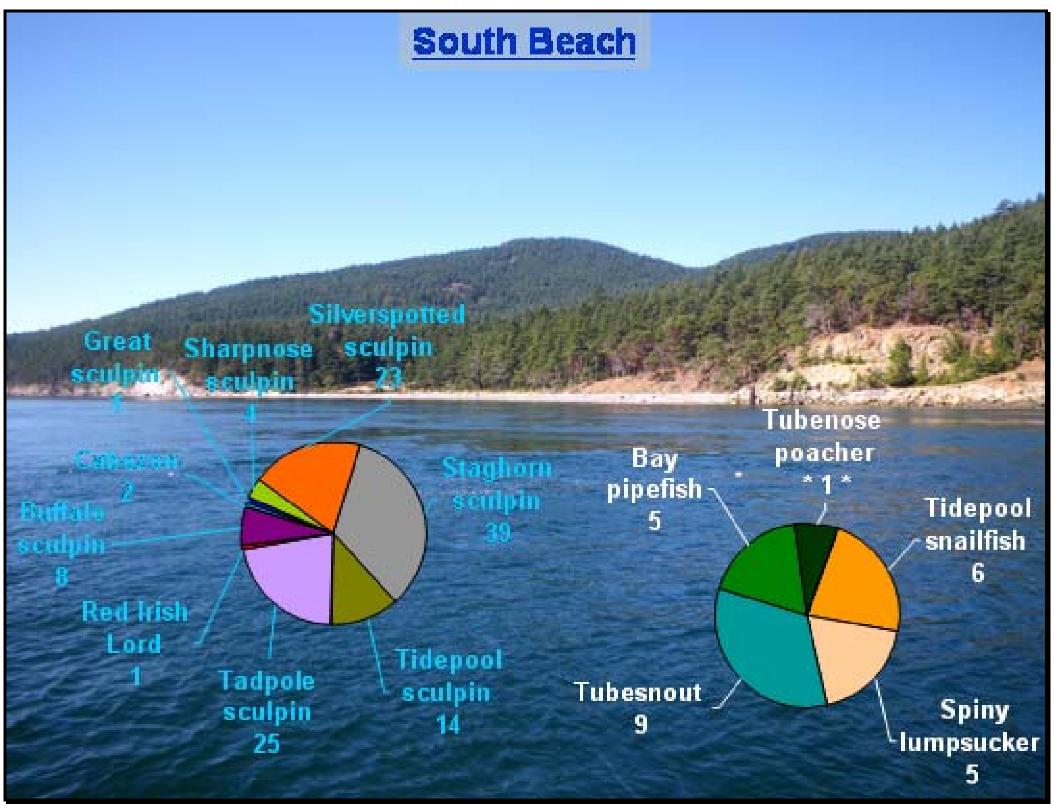

Fahey's Beach
juv. Coho wild
juv. Coho hatchery
no sample
juv. Chinook wild
juv. Chinook hatchery
Juvenile Salmon Density (fish / hectare)
10000
1000
100
10
1
Feb 27 - 1
2
3
Apr 7 - 4
5
6
May 20 - 7
8
June 16 - 9
10
July 13 - 11
12
Aug 11 - 13
14
Sept 9 - 15
16
17
Oct 20 - 18
Sample Session No.

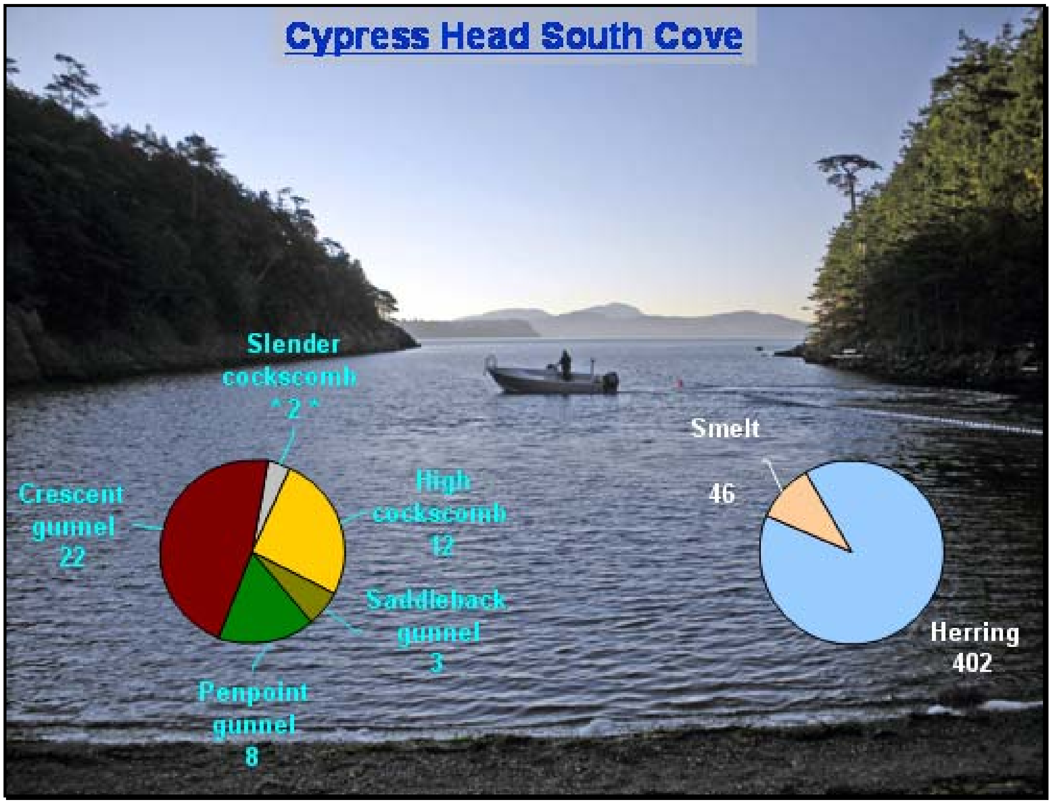

Tide Point
Chum
no sample
Pink
Juvenile Salmon Density (fish / hectare)
100000
10000
1000
100
10
1
Feb 27 - 1
2
3
Apr 9 - 4
5
6
May 20 - 7
8
June 16 - 9
10
July 13 - 11
12
Aug 11 - 13
14
Sept 9 - 15
16
17
Oct 20 - 18
Sample Session No.

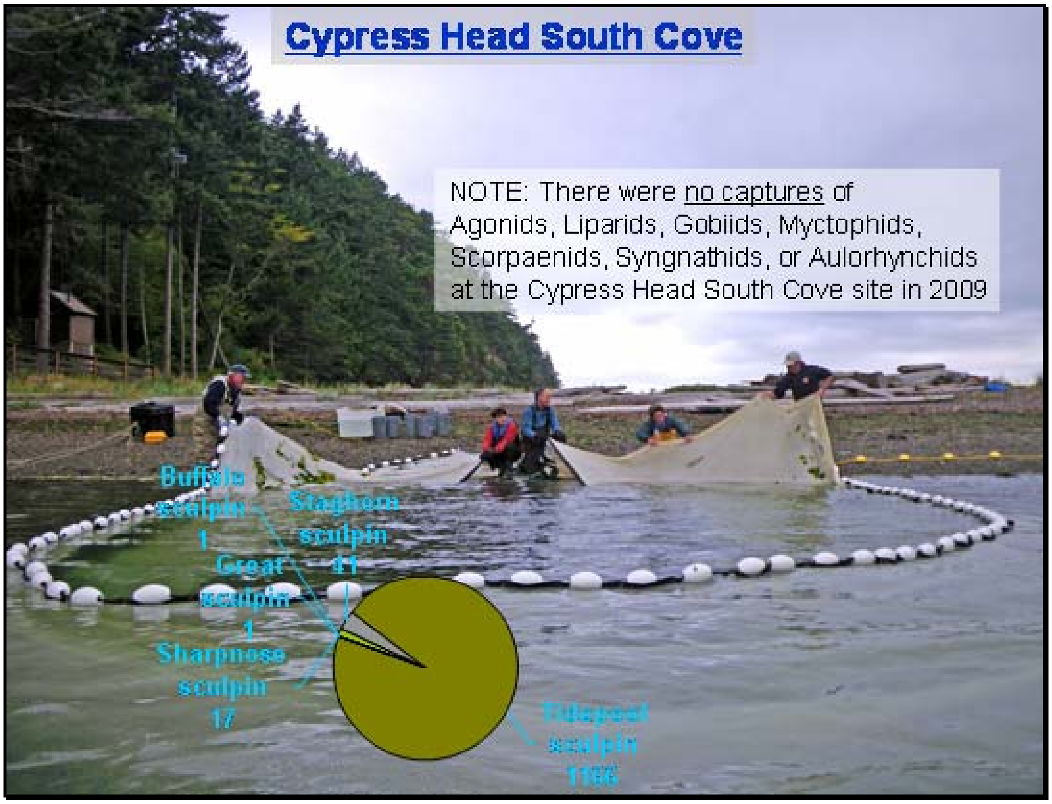

Tide Point
juv. Coho wild
juv. Coho hatchery
no sample
juv. Chinook wild
juv. Chinook hatchery
Juvenile Salmon Density (fish / hectare)
10000
1000
100
10
1
Feb 27 - 1
2
3
Apr 9 - 4
5
6
May 20 - 7
8
June 16 - 9
10
July 13 - 11
12
Aug 11 - 13
14
Sept 9 - 15
16
17
Oct 20 - 18
Sample Session No.

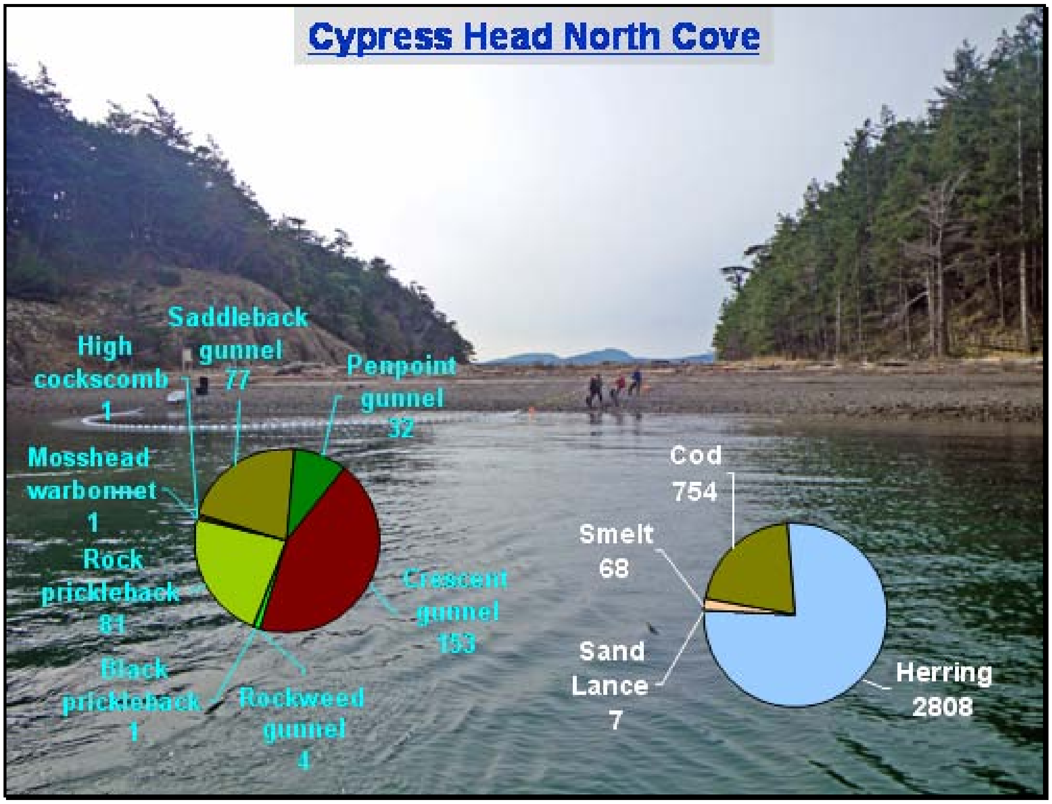
Appendix 2: Maximum single session catch-per-unit-effort for four marine fish guilds - 2009 Cypress Island Pilot Nearshore Fish Use Assessment sites

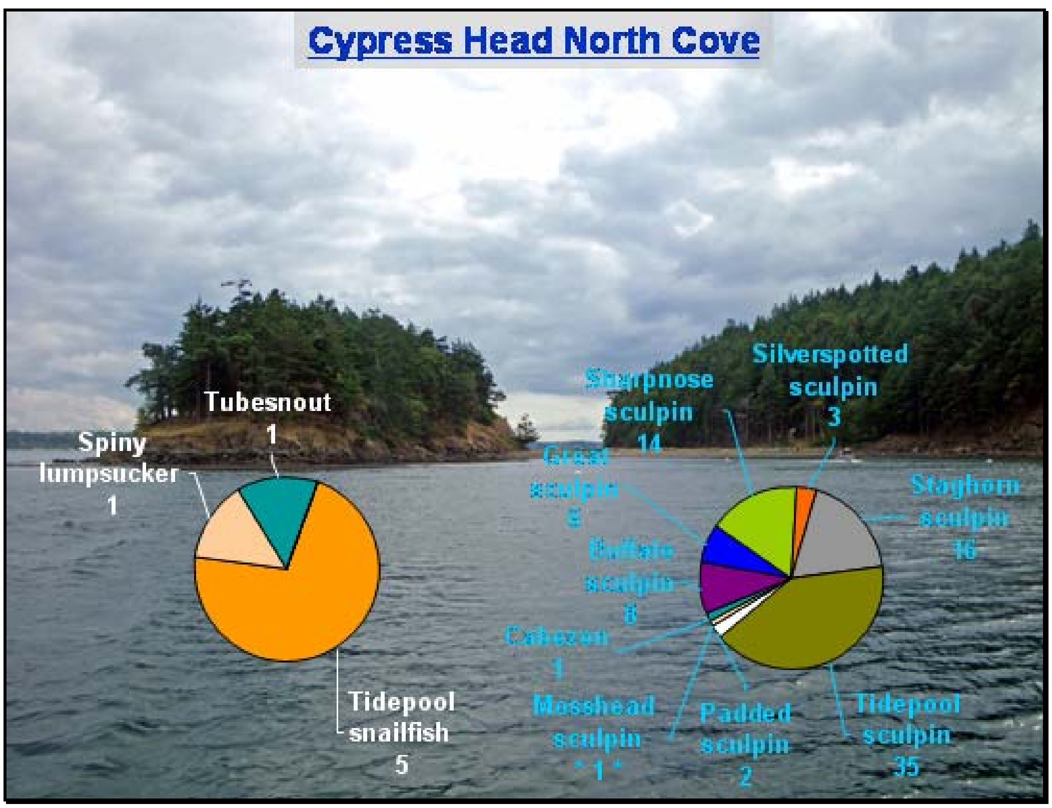


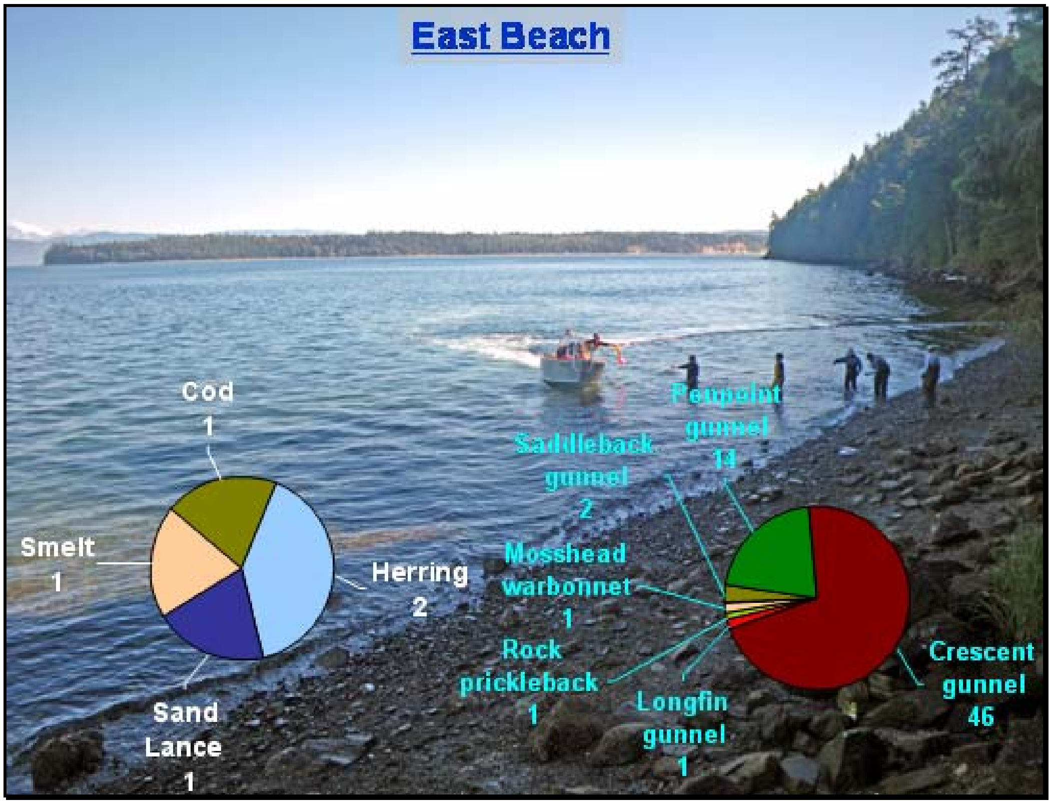


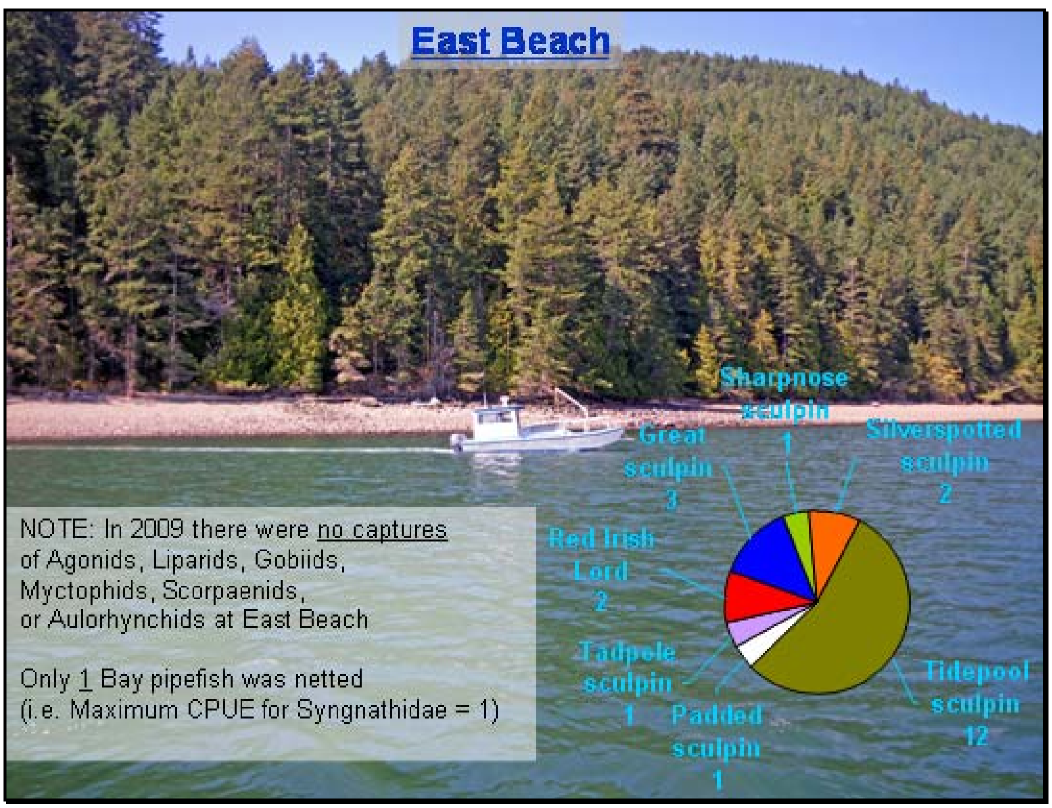

Cypress Head South Cove
Slender cockscomb
* 2 *
High cockscomb
12
Saddleback gunnel
3
Penpoint gunnel
8
Crescent gunnel
22
Smelt
46
Herring
402

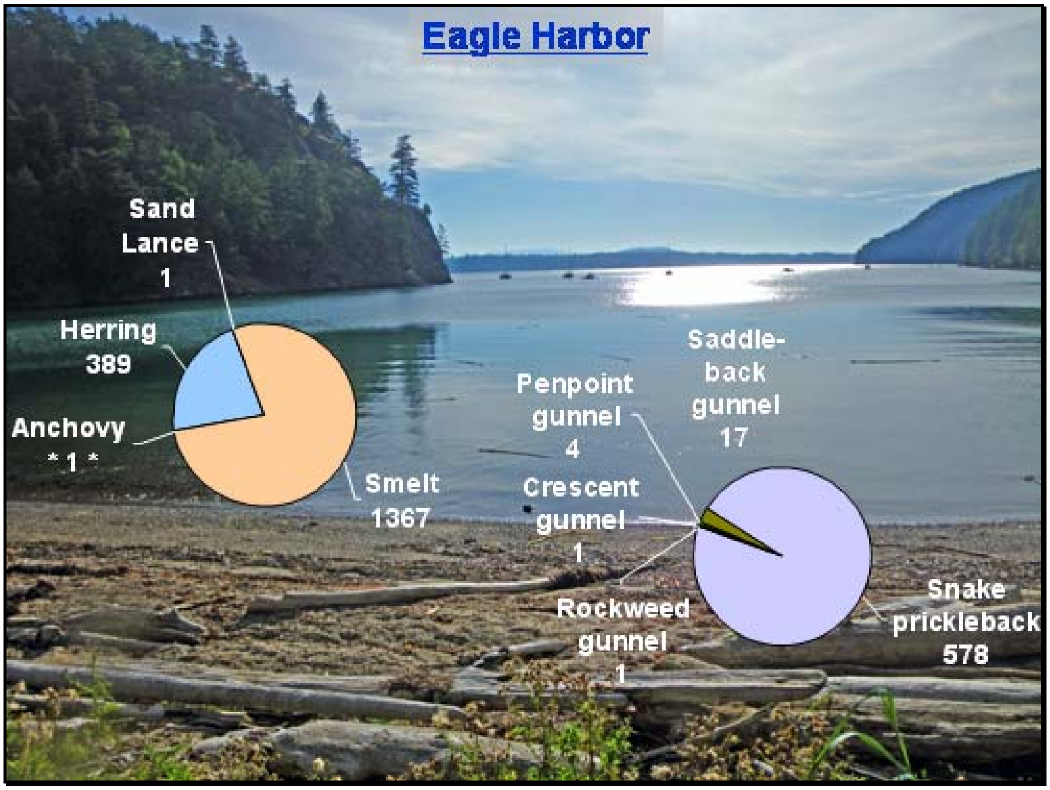

Cypress Head South Cove
NOTE: There were no captures of Agonids, Liparids, Gobiids, Myctophids, Scorpaenids, Syngnathids, or Aulorhynchids at the Cypress Head South Cove site in 2009
Buffalo sculpin
1
Staghorn sculpin
41
Great sculpin
1
Sharpnose sculpin
17
Tidepool sculpin
1166

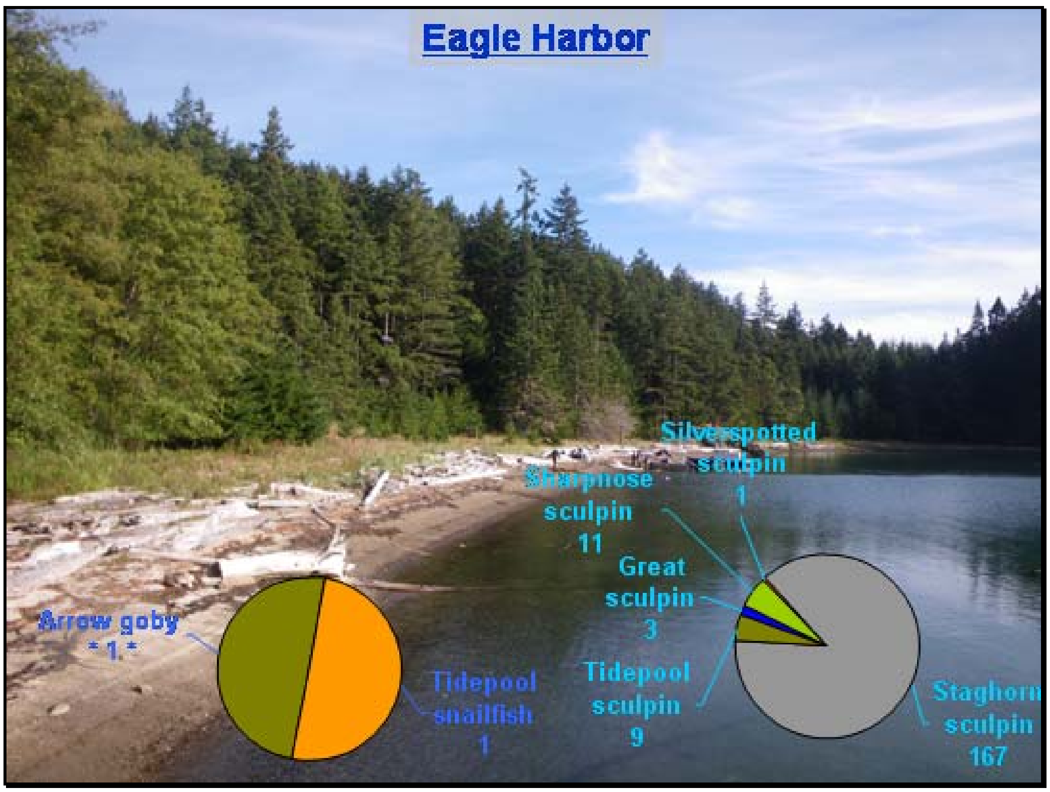

Cypress Head North Cove
Saddleback gunnel 77
High cockscomb 1
Penpoint gunnel 32
Mosshead warbonnet 1
Rock prickleback 81
Crescent gunnel 153
Black prickleback 1
Rockweed gunnel 4
Cod 754
Smelt 68
Sand Lance 7
Herring 2808

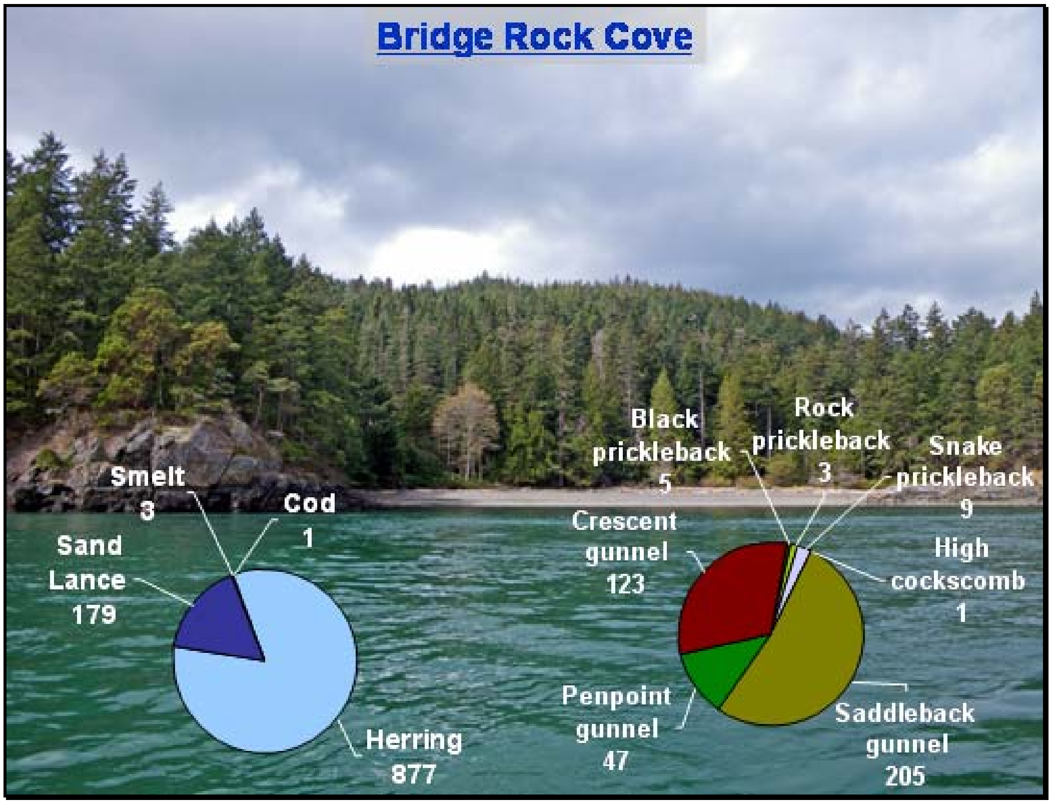

Cypress Head North Cove
Tubesnout 1
Spiny lumpsucker 1
Tidepool snailfish 5
Silverspotted sculpin 3
Sharpnose sculpin 14
Great sculpin
Staghorn sculpin 16
Buffalo sculpin 8
Cabezon 1
Mosshead sculpin * 1 *
Padded sculpin 2
Tidepool sculpin 35

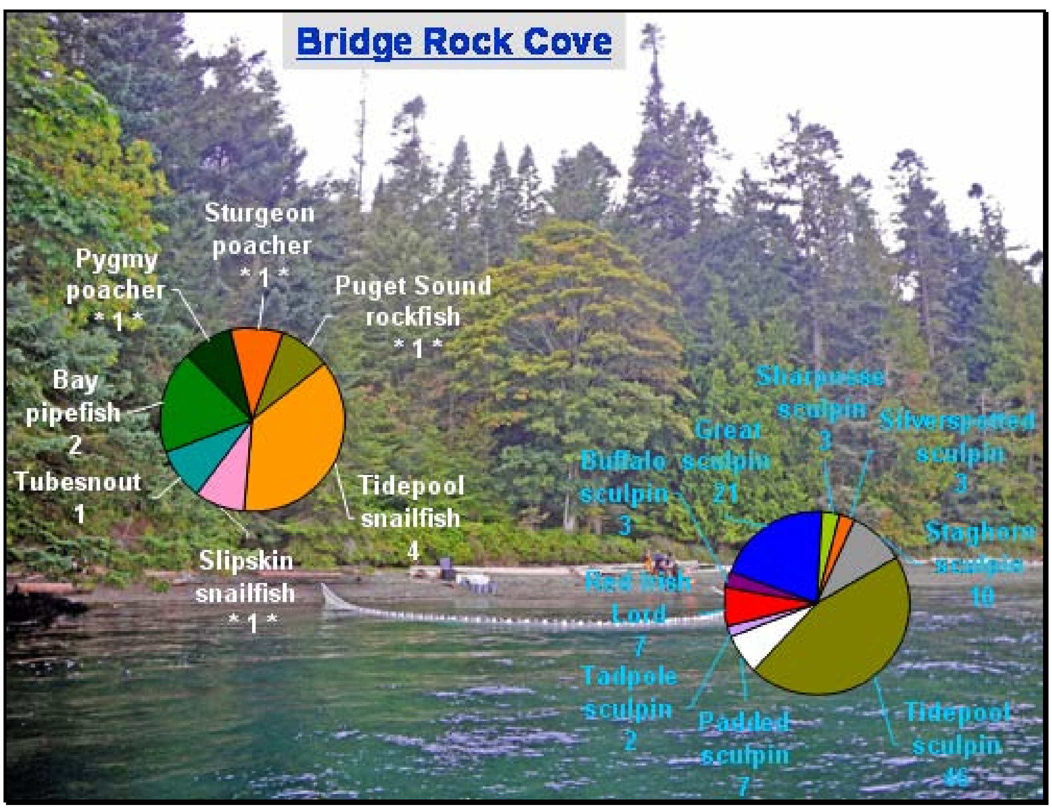

East Beach
Cod
1
Smelt
1
Herring
2
Sand
Lance
1
Penpoint
gunnel
14
Saddleback
gunnel
2
Mosshead
warbonnet
1
Rock
prickleback
1
Longfin
gunnel
1
Crescent
gunnel
46

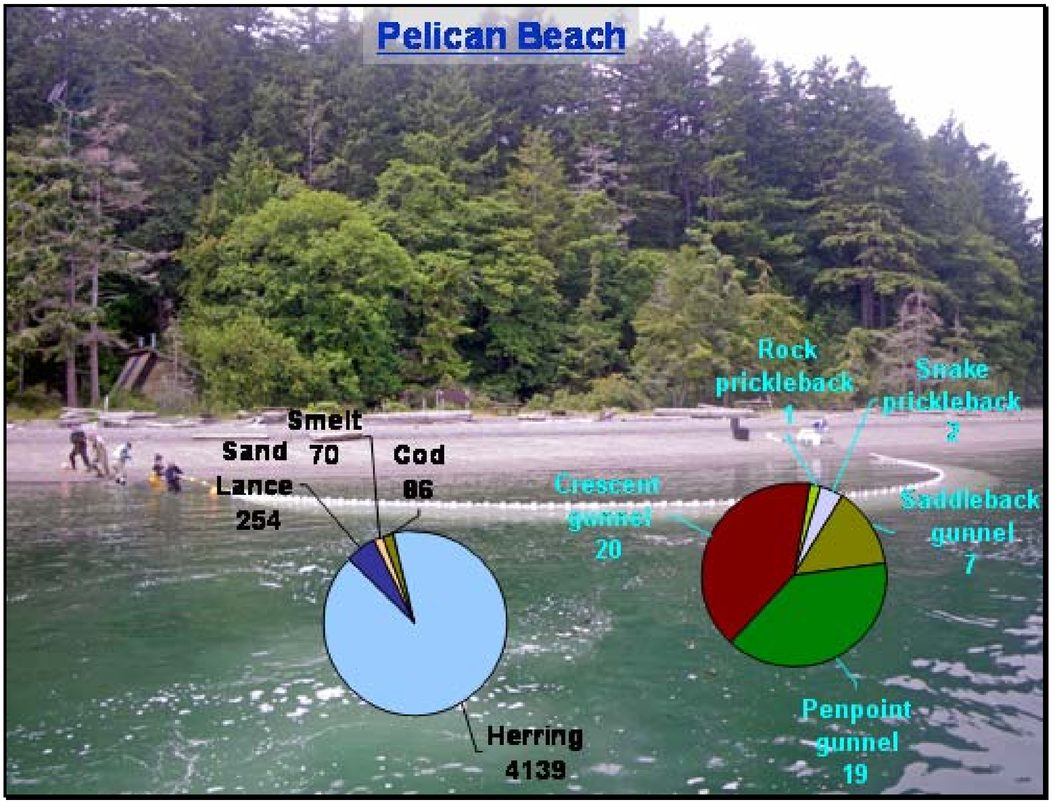

East Beach
Sharpnose
sculpin
1
Great
sculpin
3
Silverspotted
sculpin
2
Red Irish
Lord
2
Tadpole
sculpin
1
Padded
sculpin
1
Tidepool
sculpin
12
NOTE: In 2009 there were no captures
of Agonids, Liparids, Gobiids,
Myctophids, Scorpaenids,
or Aulorhynchids at East Beach
Only 1 Bay pipefish was netted
(i.e. Maximum CPUE for Syngnathidae = 1)

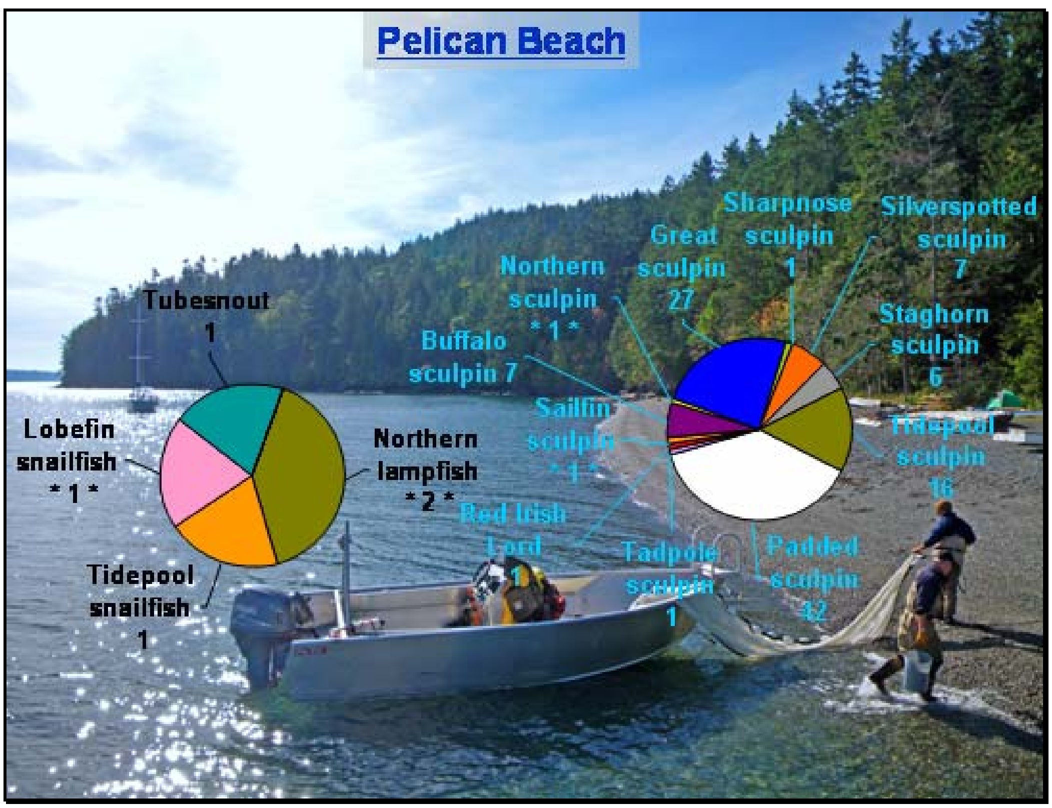

Eagle Harbor
Sand Lance 1
Herring 389
Anchovy * 1 *
Smelt 1367
Penpoint gunnel 4
Saddle-back gunnel 17
Crescent gunnel 1
Rockweed gunnel 1
Snake prickleback 578

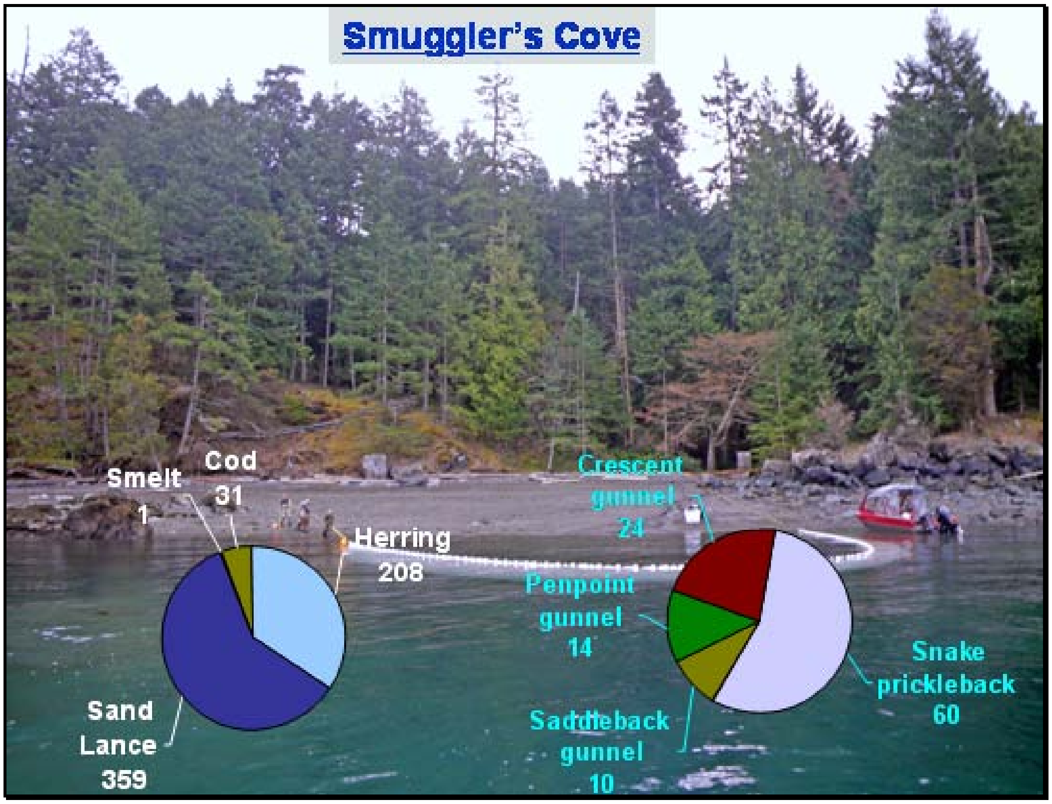

Eagle Harbor
Silverspotted sculpin 1
Sharpnose sculpin 11
Great sculpin 3
Arrow goby * 1 *
Tidepool snailfish 1
Tidepool sculpin 9
Staghorn sculpin 167

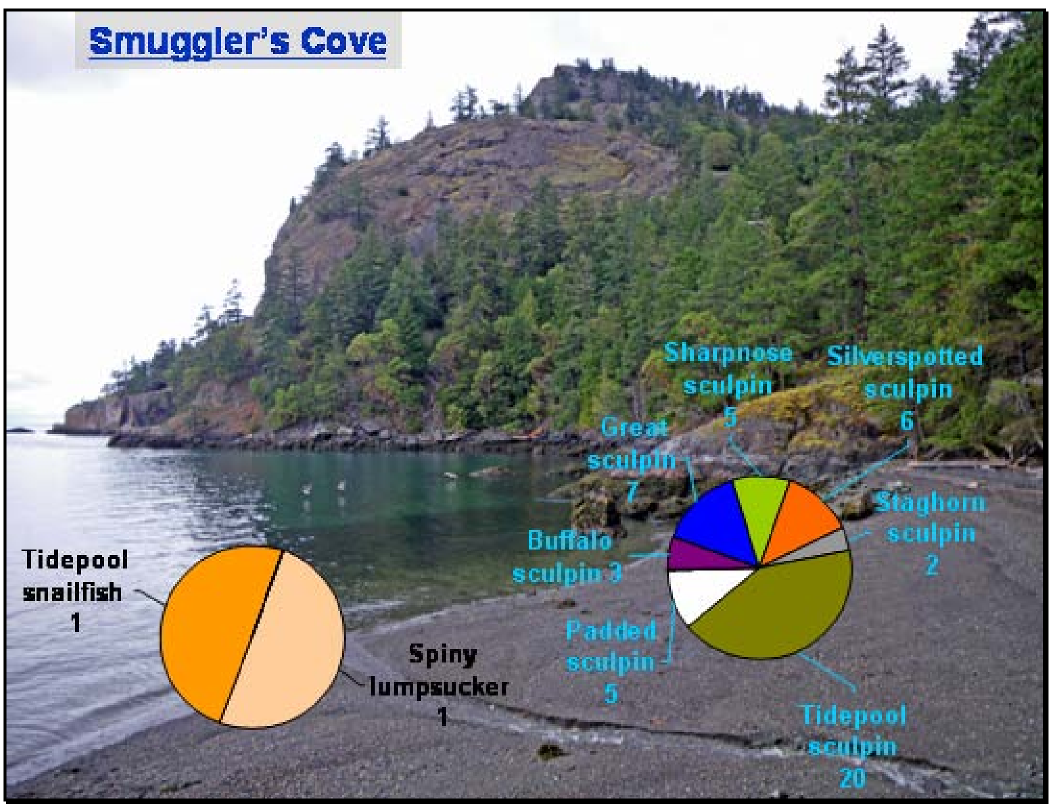

Bridge Rock Cove
Smelt 3
Cod 1
Sand Lance 179
Herring 877
Black prickleback 5
Rock prickleback 3
Snake prickleback 9
Crescent gunnel 123
High cockscomb 1
Penpoint gunnel 47
Saddleback gunnel 205

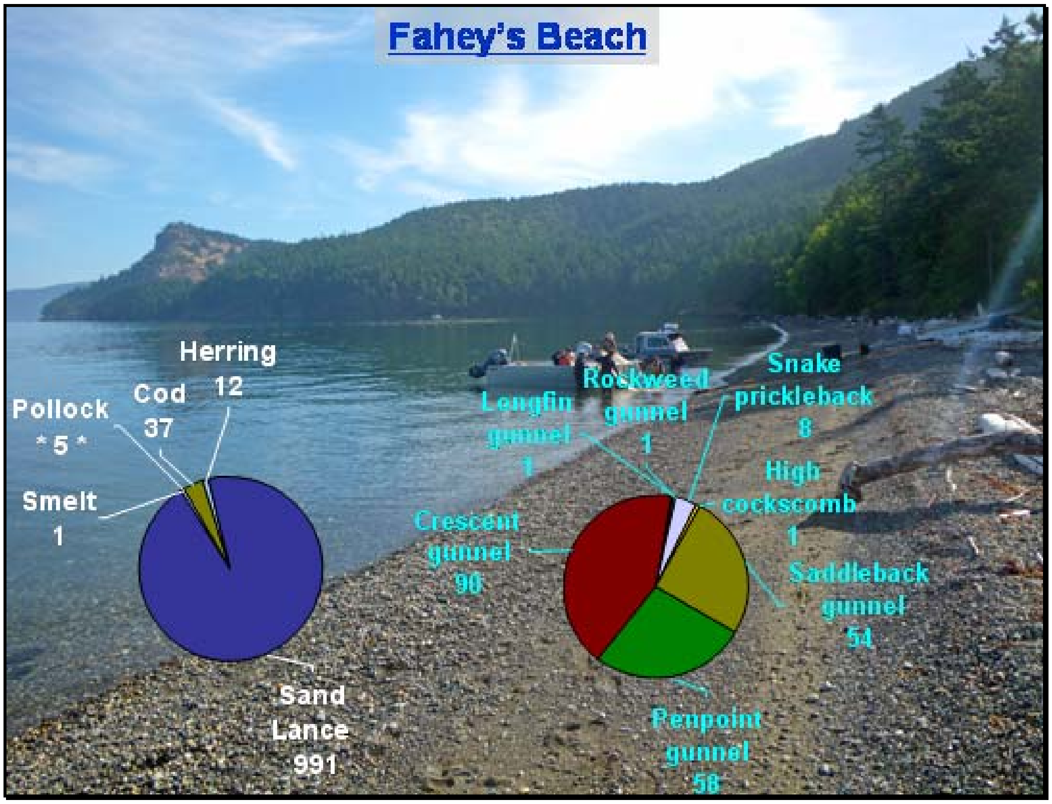

Bridge Rock Cove
Sturgeon poacher * 1 *
Pygmy poacher * 1 *
Puget Sound rockfish * 1 *
Bay pipefish 2
Tubesnout 1
Tidepool snailfish 4
Slipskin snailfish * 1 *
Sharpnose sculpin 3
Silverspotted sculpin 3
Great sculpin 21
Buffalo sculpin 3
Staghorn sculpin 10
Red Irish Lord 7
Tadpole sculpin 2
Padded sculpin 7
Tidepool sculpin 46

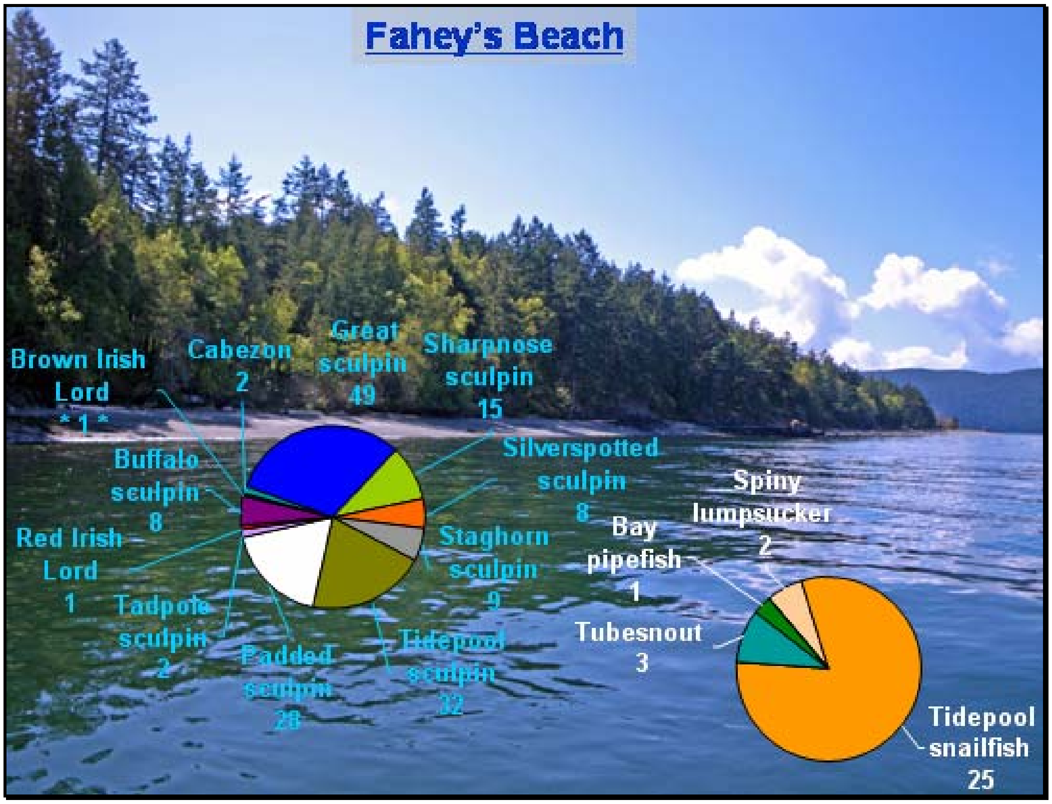

Pelican Beach
Smelt 70
Sand Lance 254
Cod 86
Herring 4139
Rock prickleback 1
Snake prickleback 2
Crescent gunnel 20
Saddleback gunnel 7
Penpoint gunnel 19

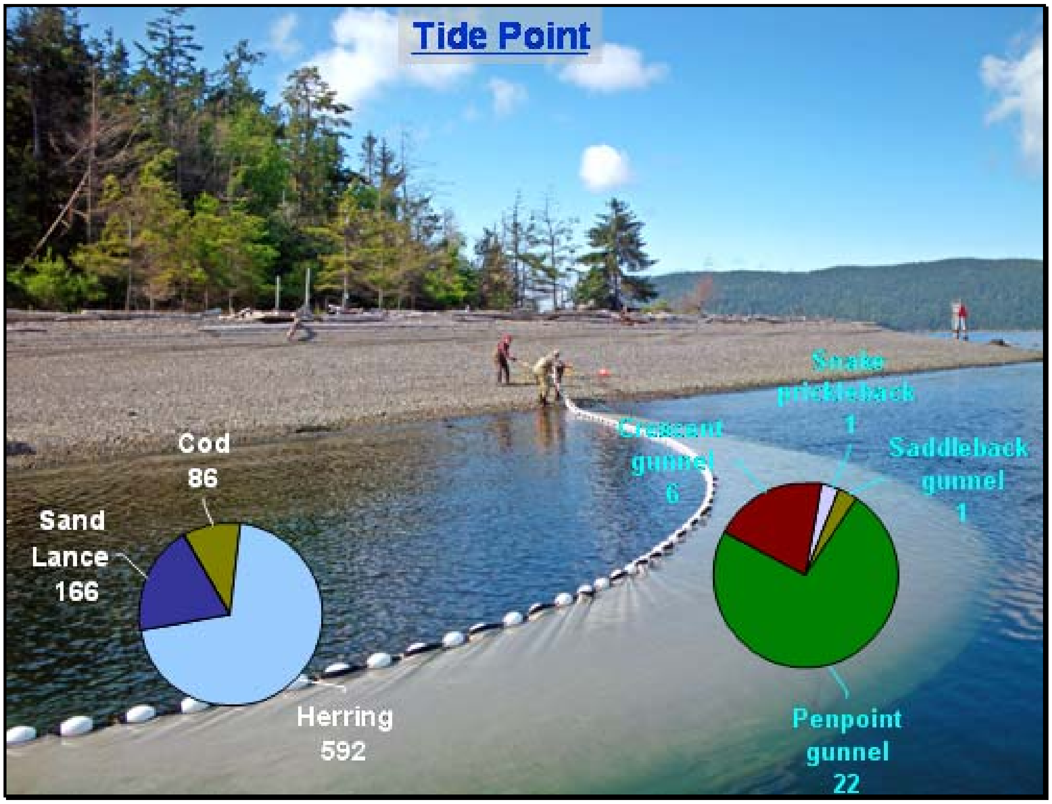

Pelican Beach
Tubesnout 1
Lobefin snailfish * 1 *
Northern lampfish * 2 *
Tidepool snailfish 1
Northern sculpin * 1 *
Buffalo sculpin 7
Great sculpin 27
Sharpnose sculpin 1
Silverspotted sculpin 7
Staghorn sculpin 6
Tidepool sculpin 16
Sailfin sculpin * 1 *
Red Irish Lord 1
Tadpole sculpin 1
Padded sculpin 42

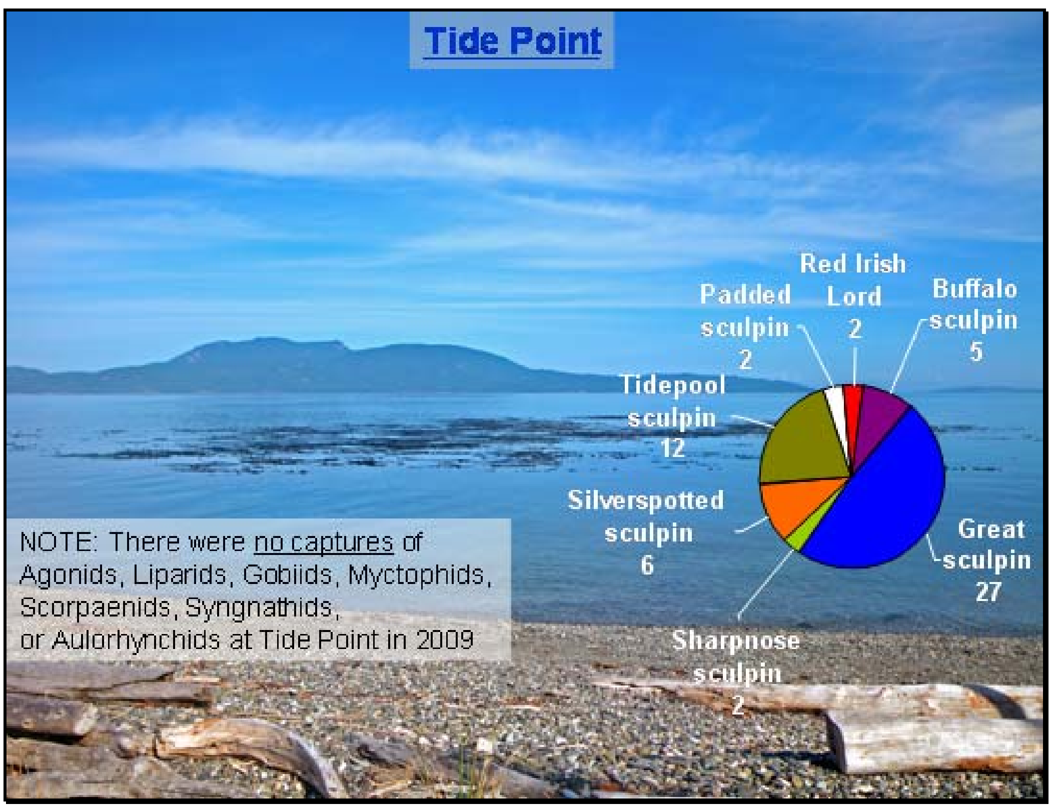

Smuggler's Cove
Smelt 1
Cod 31
Herring 208
Sand Lance 359
Crescent gunnel 24
Penpoint gunnel 14
Saddleback gunnel 10
Snake prickleback 60

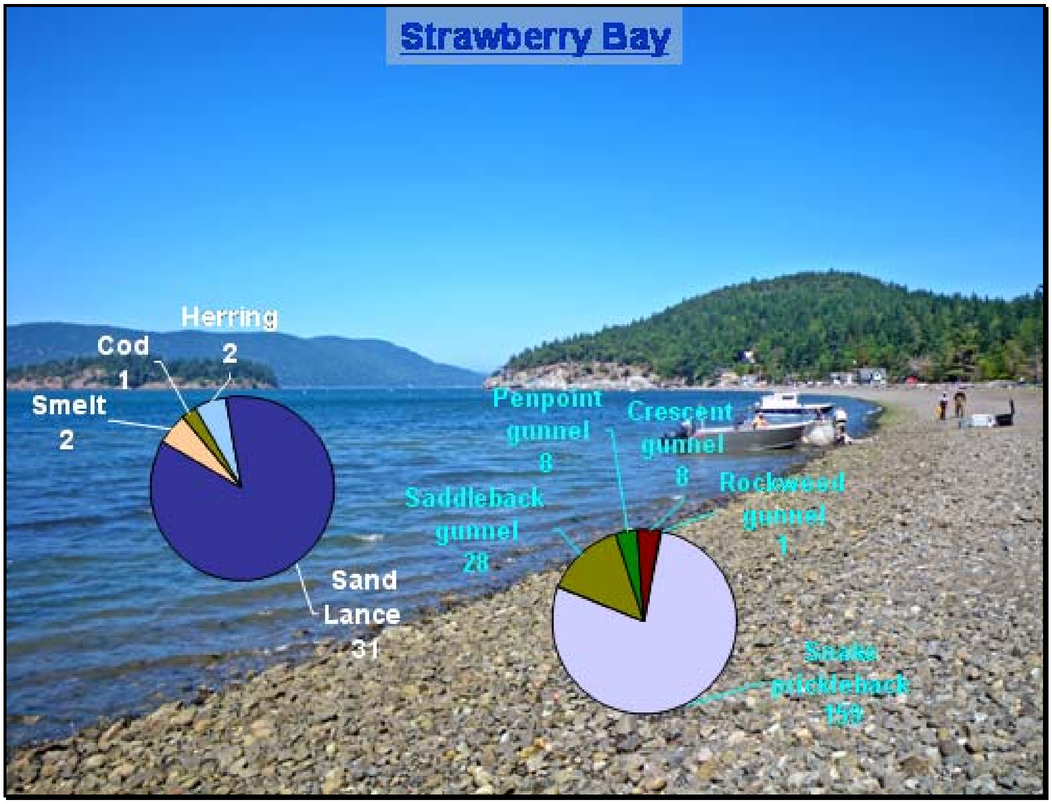

Smuggler's Cove
Tidepool snailfish 1
Spiny lumpsucker 1
Sharpnose sculpin 5
Silverspotted sculpin 6
Great sculpin 7
Staghorn sculpin 2
Buffalo sculpin 3
Padded sculpin 5
Tidepool sculpin 20

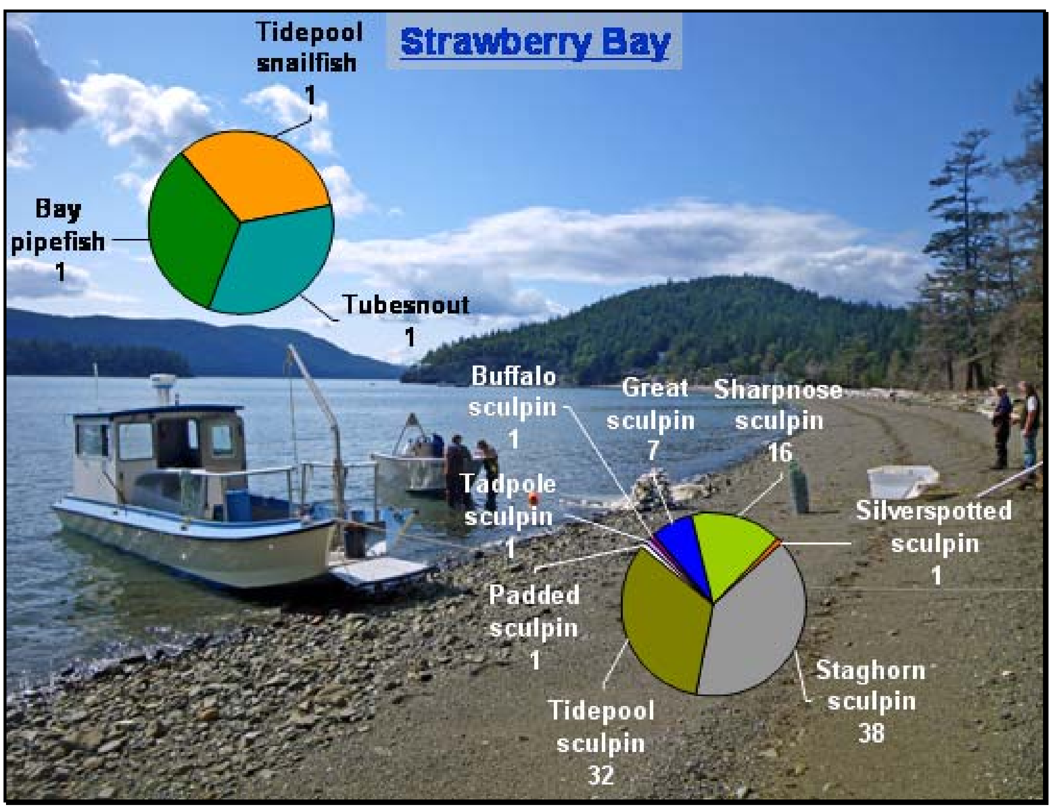

Fahey's Beach
Herring 12
Cod 37
Pollock * 5 *
Smelt 1
Sand Lance 991
Longfin gunnel 1
Rockweed gunnel 1
Snake prickleback 8
High cockscomb 1
Crescent gunnel 90
Saddleback gunnel 54
Penpoint gunnel 58


Fahey's Beach
Brown Irish Lord * 1 *
Cabezon 2
Great sculpin 49
Sharpnose sculpin 15
Silverspotted sculpin 8
Buffalo sculpin 8
Red Irish Lord 1
Staghorn sculpin 9
Tadpole sculpin 2
Padded sculpin 28
Tidepool sculpin 32
Spiny lumpsucker 2
Bay pipefish 1
Tubesnout 3
Tidepool snailfish 25


Tide Point
Cod
86
Sand
Lance
166
Herring
592
Snake
prickleback
1
Crescent
gunnel
6
Saddleback
gunnel
1
Penpoint
gunnel
22


Tide Point
Red Irish
Lord
2
Padded
sculpin
2
Buffalo
sculpin
5
Tidepool
sculpin
12
Silverspotted
sculpin
6
Great
sculpin
27
Sharpnose
sculpin
2
NOTE: There were no captures of Agonids, Liparids, Gobiids, Myctophids, Scorpaenids, Syngnathids, or Aulorhynchids at Tide Point in 2009

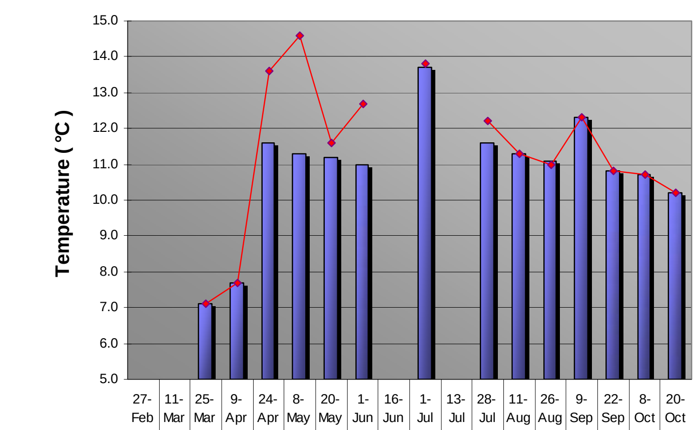

Strawberry Bay
Herring 2
Cod 1
Smelt 2
Sand Lance 31
Penpoint gunnel 8
Crescent gunnel 8
Rockweed gunnel 1
Saddleback gunnel 28
Snake prickleback 159


Strawberry Bay
Tidepool snailfish 1
Bay pipefish 1
Tubesnout 1
Buffalo sculpin 1
Great sculpin 7
Sharpnose sculpin 16
Tadpole sculpin 1
Silverspotted sculpin 1
Padded sculpin 1
Staghorn sculpin 38
Tidepool sculpin 32

Appendix 3: Measured Seawater Temperatures and Salinities - 2009 Cypress Island Pilot Nearshore Fish Use Assessment sites

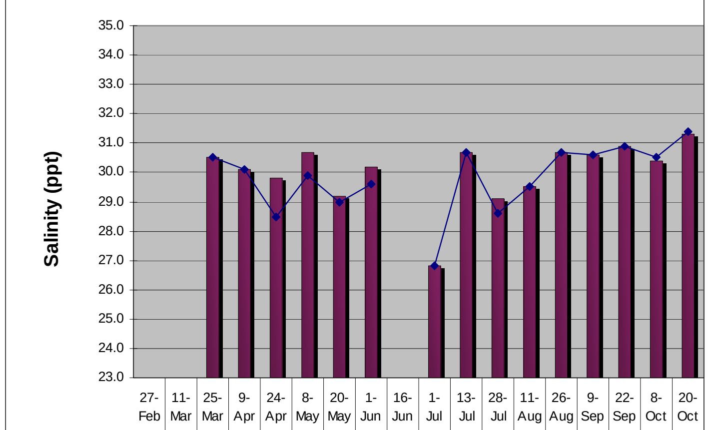
**Note: 35.0 ppt is the accepted value for average seawater salinity of the open ocean.

Strawberry Bay - 2009 measured Seawater temperatures



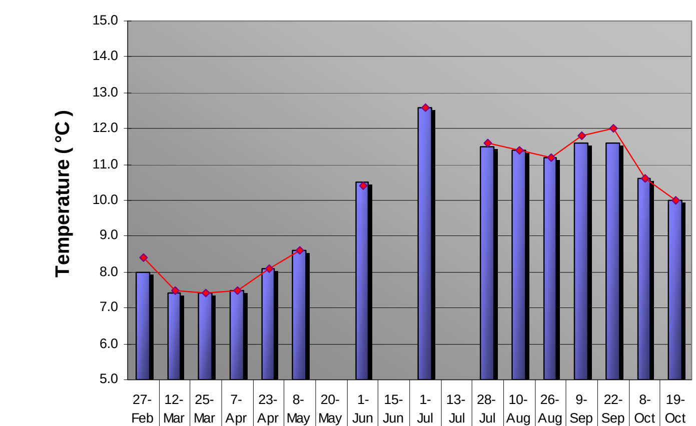
	27-Feb	11-Mar	25-Mar	9-Apr	24-Apr	8-May	20-May	1-Jun	16-Jun	1-Jul	13-Jul	28-Jul	11-Aug	26-Aug	9-Sep	22-Sep	8-Oct	20-Oct
1 meter depth			7.1	7.7	11.6	11.3	11.2	11.0		13.7		11.6	11.3	11.1	12.3	10.8	10.7	10.2
Surface			7.1	7.7	13.6	14.6	11.6	12.7		13.8		12.2	11.3	11.0	12.3	10.8	10.7	10.2

Strawberry Bay - 2009 measured Seawater salinities



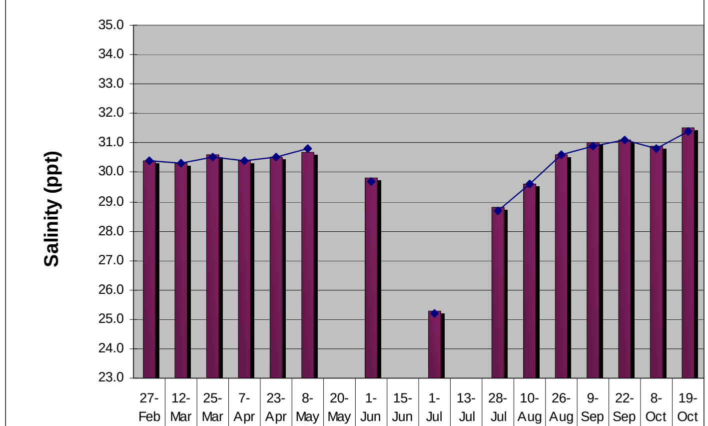
	27-Feb	11-Mar	25-Mar	9-Apr	24-Apr	8-May	20-May	1-Jun	16-Jun	1-Jul	13-Jul	28-Jul	11-Aug	26-Aug	9-Sep	22-Sep	8-Oct	20-Oct
1 meter depth			30.5	30.1	29.8	30.7	29.2	30.2		26.8	30.7	29.1	29.5	30.7	30.6	30.9	30.4	31.3
Surface			30.5	30.1	28.5	29.9	29.0	29.6		26.8	30.7	28.6	29.5	30.7	30.6	30.9	30.5	31.4

South Beach - 2009 measured Seawater temperatures



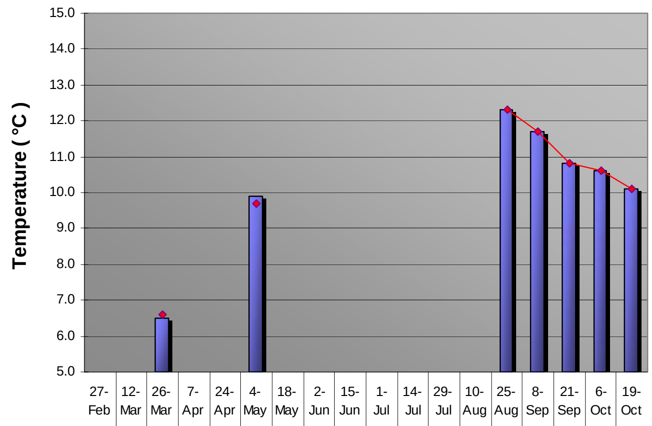
	27-Feb	12-Mar	25-Mar	7-Apr	23-Apr	8-May	20-May	1-Jun	15-Jun	1-Jul	13-Jul	28-Jul	10-Aug	26-Aug	9-Sep	22-Sep	8-Oct	19-Oct
1 meter depth	8.0	7.4	7.4	7.5	8.1	8.6		10.5		12.6		11.5	11.4	11.2	11.6	11.6	10.6	10.0
Surface	8.4	7.5	7.4	7.5	8.1	8.6		10.4		12.6		11.6	11.4	11.2	11.8	12.0	10.6	10.0

South Beach - 2009 measured Seawater salinities



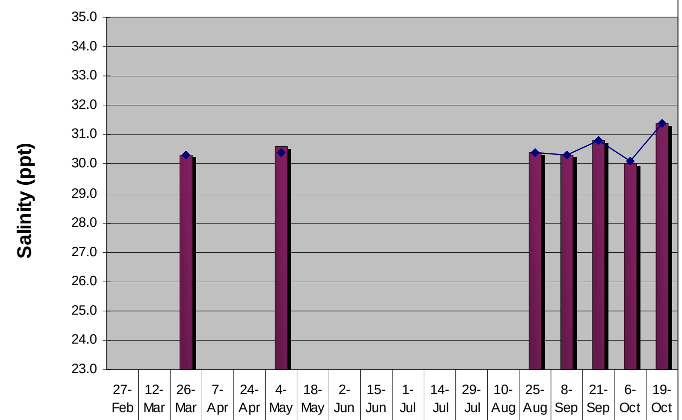
	27-Feb	12-Mar	25-Mar	7-Apr	23-Apr	8-May	20-May	1-Jun	15-Jun	1-Jul	13-Jul	28-Jul	10-Aug	26-Aug	9-Sep	22-Sep	8-Oct	19-Oct
1 meter depth	30.4	30.3	30.6	30.4	30.5	30.7		29.8		25.3		28.8	29.6	30.6	31.0	31.1	30.9	31.5
Surface	30.4	30.3	30.5	30.4	30.5	30.8		29.7		25.2		28.7	29.6	30.6	30.9	31.1	30.8	31.4

Cypress Head South - 2009 measured Seawater temperatures



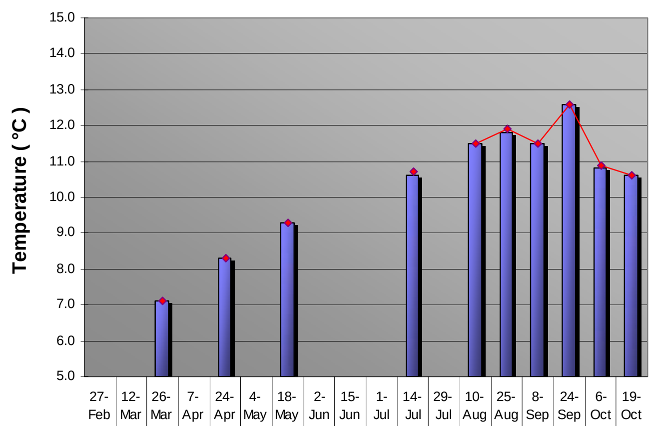
	27-Feb	12-Mar	26-Mar	7-Apr	24-Apr	4-May	18-May	2-Jun	15-Jun	1-Jul	14-Jul	29-Jul	10-Aug	25-Aug	8-Sep	21-Sep	6-Oct	19-Oct
1 meter depth			6.5			9.9								12.3	11.7	10.8	10.6	10.1
Surface			6.6			9.7								12.3	11.7	10.8	10.6	10.1

Cypress Head South - 2009 measured Seawater salinities



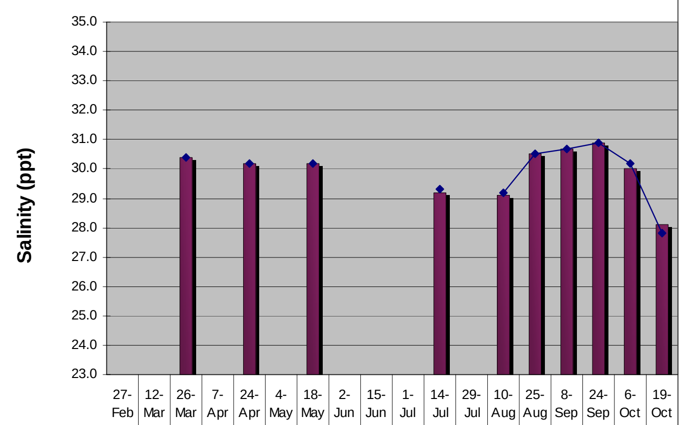
	27-Feb	12-Mar	26-Mar	7-Apr	24-Apr	4-May	18-May	2-Jun	15-Jun	1-Jul	14-Jul	29-Jul	10-Aug	25-Aug	8-Sep	21-Sep	6-Oct	19-Oct
1 meter depth			30.3			30.6								30.4	30.3	30.8	30.0	31.4
Surface			30.3			30.4								30.4	30.3	30.8	30.1	31.4

Cypress Head North - 2009 measured Seawater temperatures



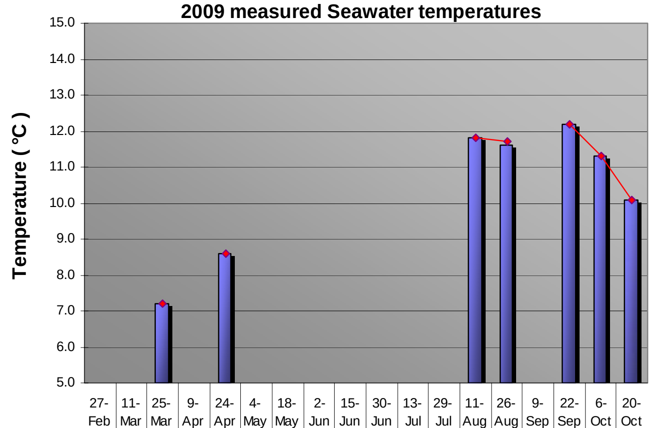
	27-Feb	12-Mar	26-Mar	7-Apr	24-Apr	4-May	18-May	2-Jun	15-Jun	1-Jul	14-Jul	29-Jul	10-Aug	25-Aug	8-Sep	24-Sep	6-Oct	19-Oct
1 meter depth			7.1		8.3		9.3				10.6		11.5	11.8	11.5	12.6	10.8	10.6
Surface			7.1		8.3		9.3				10.7		11.5	11.9	11.5	12.6	10.9	10.6

Cypress Head North - 2009 measured Seawater salinities



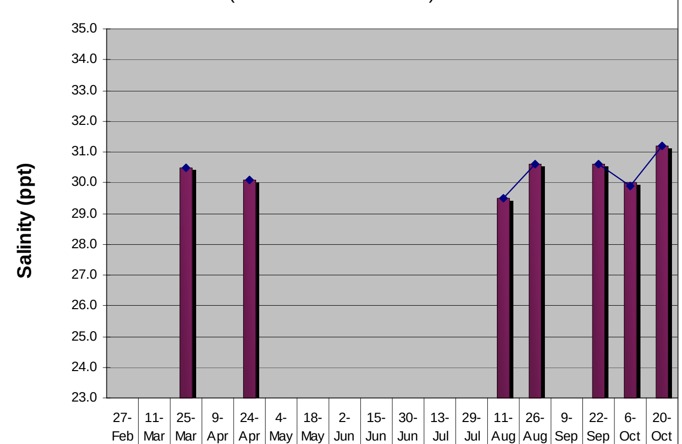
	27-Feb	12-Mar	26-Mar	7-Apr	24-Apr	4-May	18-May	2-Jun	15-Jun	1-Jul	14-Jul	29-Jul	10-Aug	25-Aug	8-Sep	24-Sep	6-Oct	19-Oct
1 meter depth			30.4		30.2		30.2				29.2		29.1	30.5	30.7	30.9	30.0	28.1
Surface			30.4		30.2		30.2				29.3		29.2	30.5	30.7	30.9	30.2	27.8

East Beach (Reed Lake outlet stream) -
2009 measured Seawater temperatures

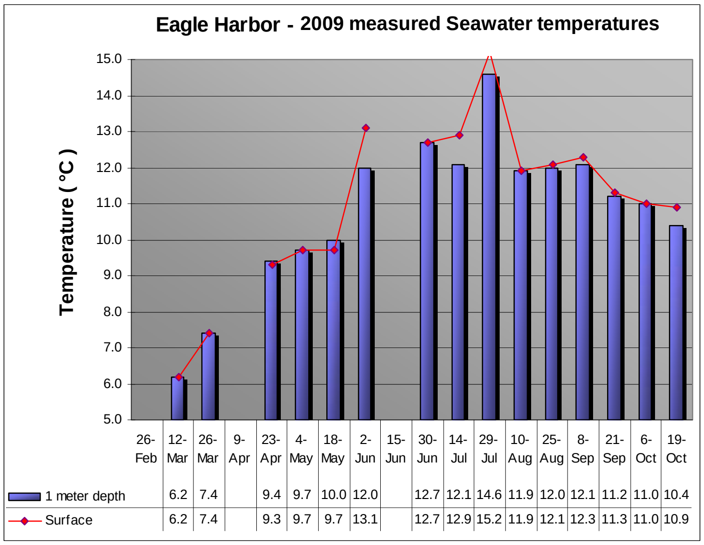


	27-Feb	11-Mar	25-Mar	9-Apr	24-Apr	4-May	18-May	2-Jun	15-Jun	30-Jun	13-Jul	29-Jul	11-Aug	26-Aug	9-Sep	22-Sep	6-Oct	20-Oct
1 meter depth			7.2		8.6								11.8	11.6		12.2	11.3	10.1
Surface			7.2		8.6								11.8	11.7		12.2	11.3	10.1

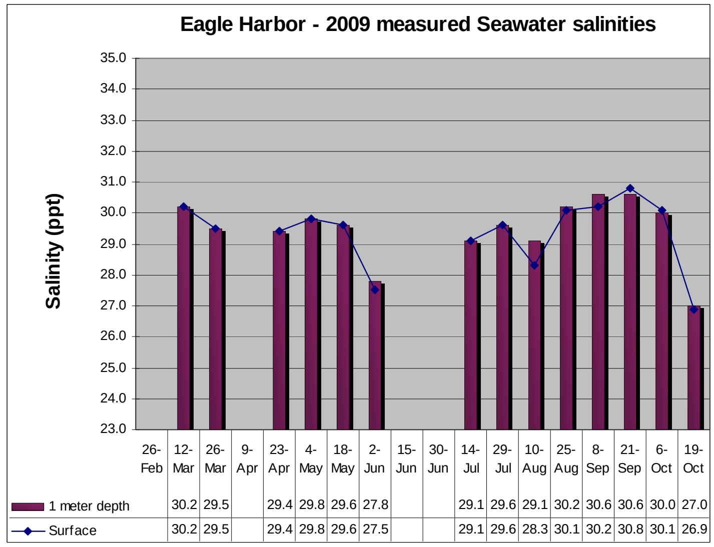
East Beach (Reed Lake outlet stream) **- 2009 Seawater salinities**



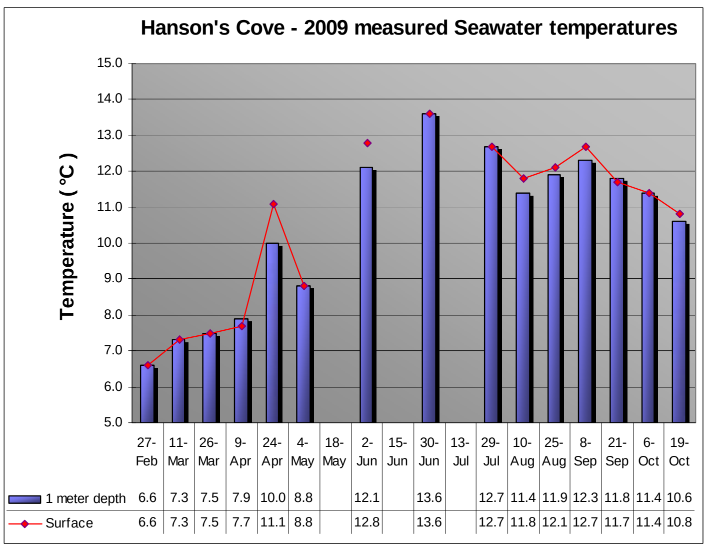
	27-Feb	11-Mar	25-Mar	9-Apr	24-Apr	4-May	18-May	2-Jun	15-Jun	30-Jun	13-Jul	29-Jul	11-Aug	26-Aug	9-Sep	22-Sep	6-Oct	20-Oct
1 meter depth			30.5		30.1								29.5	30.6		30.6	30.0	31.2
Surface			30.5		30.1								29.5	30.6		30.6	29.9	31.2



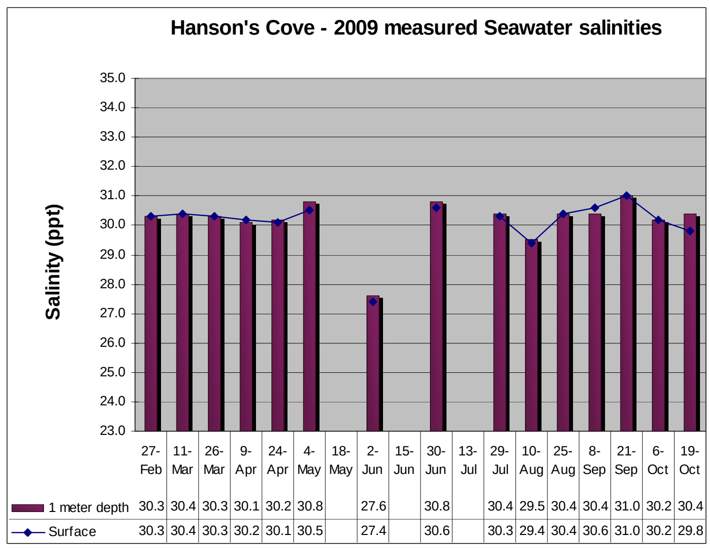
	26-Feb	12-Mar	26-Mar	9-Apr	23-Apr	4-May	18-May	2-Jun	15-Jun	30-Jun	14-Jul	29-Jul	10-Aug	25-Aug	8-Sep	21-Sep	6-Oct	19-Oct
1 meter depth		6.2	7.4		9.4	9.7	10.0	12.0		12.7	12.1	14.6	11.9	12.0	12.1	11.2	11.0	10.4
Surface		6.2	7.4		9.3	9.7	9.7	13.1		12.7	12.9	15.2	11.9	12.1	12.3	11.3	11.0	10.9



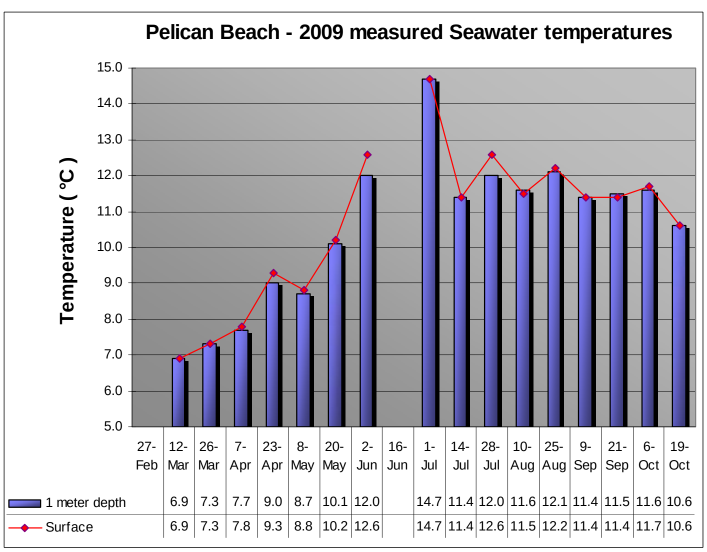
	26-Feb	12-Mar	26-Mar	9-Apr	23-Apr	4-May	18-May	2-Jun	15-Jun	30-Jun	14-Jul	29-Jul	10-Aug	25-Aug	8-Sep	21-Sep	6-Oct	19-Oct
1 meter depth		30.2	29.5		29.4	29.8	29.6	27.8			29.1	29.6	29.1	30.2	30.6	30.6	30.0	27.0
Surface		30.2	29.5		29.4	29.8	29.6	27.5			29.1	29.6	28.3	30.1	30.2	30.8	30.1	26.9



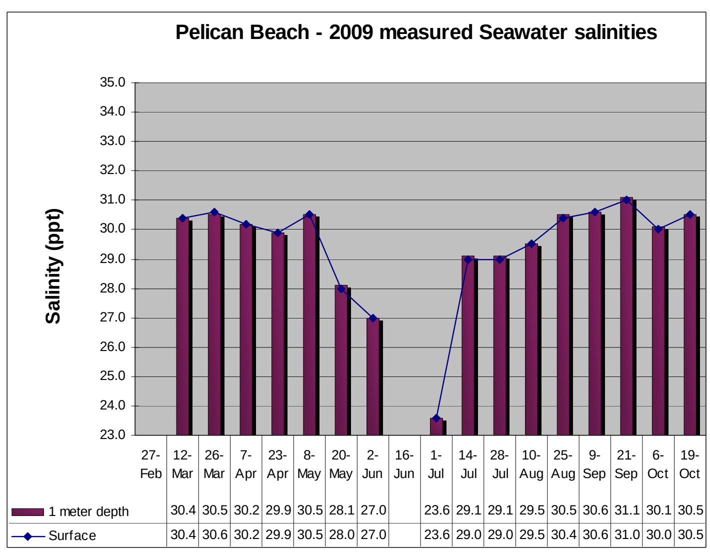
	27-Feb	11-Mar	26-Mar	9-Apr	24-Apr	4-May	18-May	2-Jun	15-Jun	30-Jun	13-Jul	29-Jul	10-Aug	25-Aug	8-Sep	21-Sep	6-Oct	19-Oct
1 meter depth	6.6	7.3	7.5	7.9	10.0	8.8		12.1		13.6		12.7	11.4	11.9	12.3	11.8	11.4	10.6
Surface	6.6	7.3	7.5	7.7	11.1	8.8		12.8		13.6		12.7	11.8	12.1	12.7	11.7	11.4	10.8



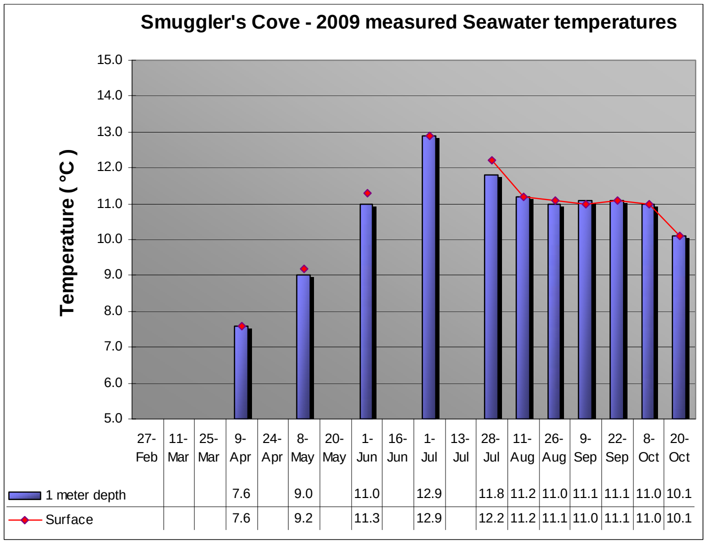
	27-Feb	11-Mar	26-Mar	9-Apr	24-Apr	4-May	18-May	2-Jun	15-Jun	30-Jun	13-Jul	29-Jul	10-Aug	25-Aug	8-Sep	21-Sep	6-Oct	19-Oct
1 meter depth	30.3	30.4	30.3	30.1	30.2	30.8		27.6		30.8		30.4	29.5	30.4	30.4	31.0	30.2	30.4
Surface	30.3	30.4	30.3	30.2	30.1	30.5		27.4		30.6		30.3	29.4	30.4	30.6	31.0	30.2	29.8



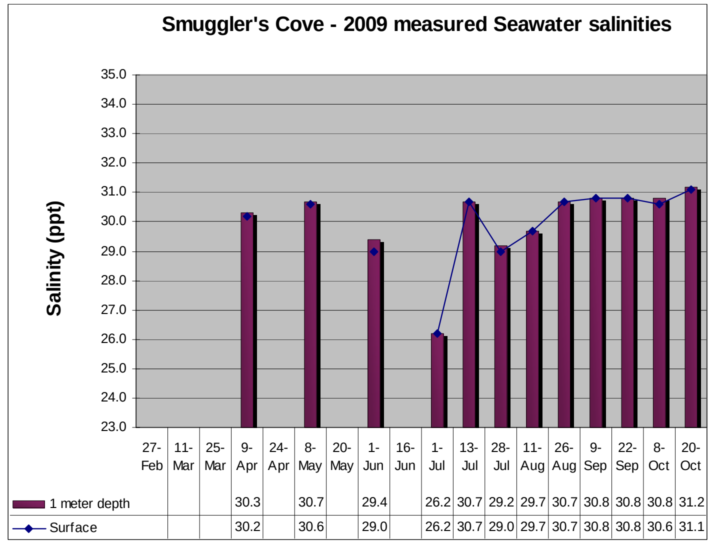
	27-Feb	12-Mar	26-Mar	7-Apr	23-Apr	8-May	20-May	2-Jun	16-Jun	1-Jul	14-Jul	28-Jul	10-Aug	25-Aug	9-Sep	21-Sep	6-Oct	19-Oct
1 meter depth		6.9	7.3	7.7	9.0	8.7	10.1	12.0		14.7	11.4	12.0	11.6	12.1	11.4	11.5	11.6	10.6
Surface		6.9	7.3	7.8	9.3	8.8	10.2	12.6		14.7	11.4	12.6	11.5	12.2	11.4	11.4	11.7	10.6



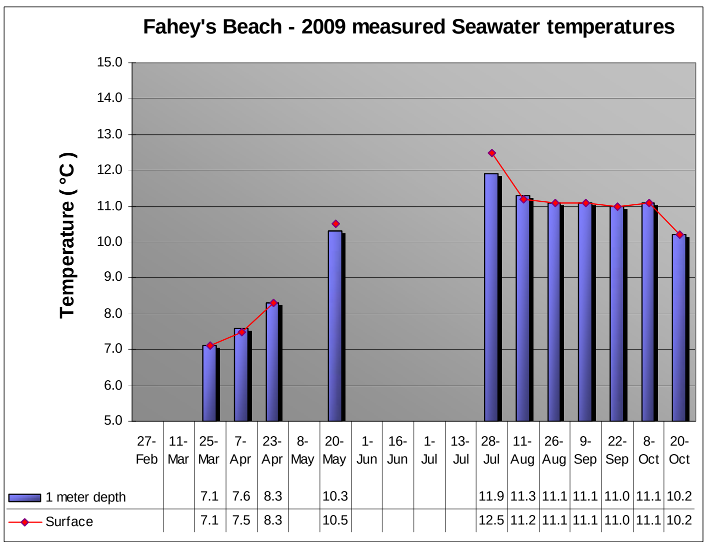
	27-Feb	12-Mar	26-Mar	7-Apr	23-Apr	8-May	20-May	2-Jun	16-Jun	1-Jul	14-Jul	28-Jul	10-Aug	25-Aug	9-Sep	21-Sep	6-Oct	19-Oct
1 meter depth		30.4	30.5	30.2	29.9	30.5	28.1	27.0		23.6	29.1	29.1	29.5	30.5	30.6	31.1	30.1	30.5
Surface		30.4	30.6	30.2	29.9	30.5	28.0	27.0		23.6	29.0	29.0	29.5	30.4	30.6	31.0	30.0	30.5



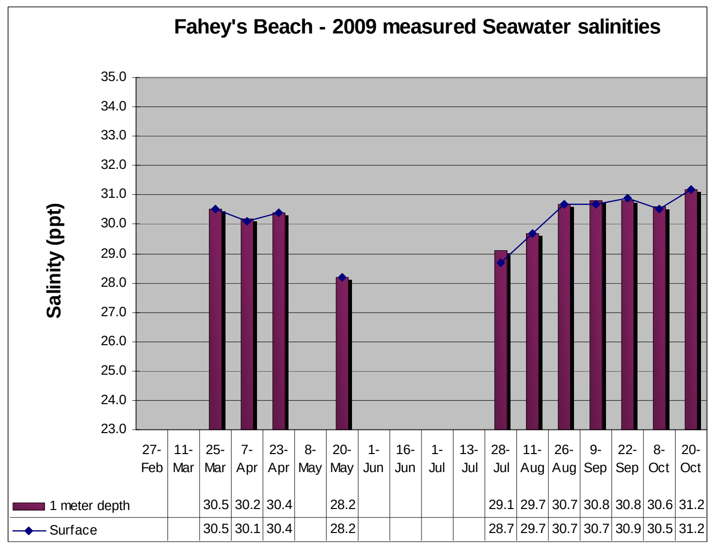
	27-Feb	11-Mar	25-Mar	9-Apr	24-Apr	8-May	20-May	1-Jun	16-Jun	1-Jul	13-Jul	28-Jul	11-Aug	26-Aug	9-Sep	22-Sep	8-Oct	20-Oct
1 meter depth				7.6		9.0		11.0		12.9		11.8	11.2	11.0	11.1	11.1	11.0	10.1
Surface				7.6		9.2		11.3		12.9		12.2	11.2	11.1	11.0	11.1	11.0	10.1



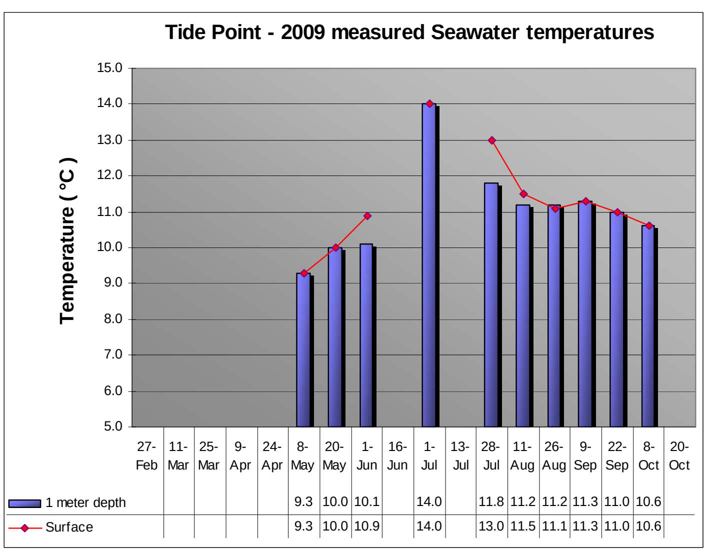
	27-Feb	11-Mar	25-Mar	9-Apr	24-Apr	8-May	20-May	1-Jun	16-Jun	1-Jul	13-Jul	28-Jul	11-Aug	26-Aug	9-Sep	22-Sep	8-Oct	20-Oct
1 meter depth				30.3		30.7		29.4		26.2	30.7	29.2	29.7	30.7	30.8	30.8	30.8	31.2
Surface				30.2		30.6		29.0		26.2	30.7	29.0	29.7	30.7	30.8	30.8	30.6	31.1



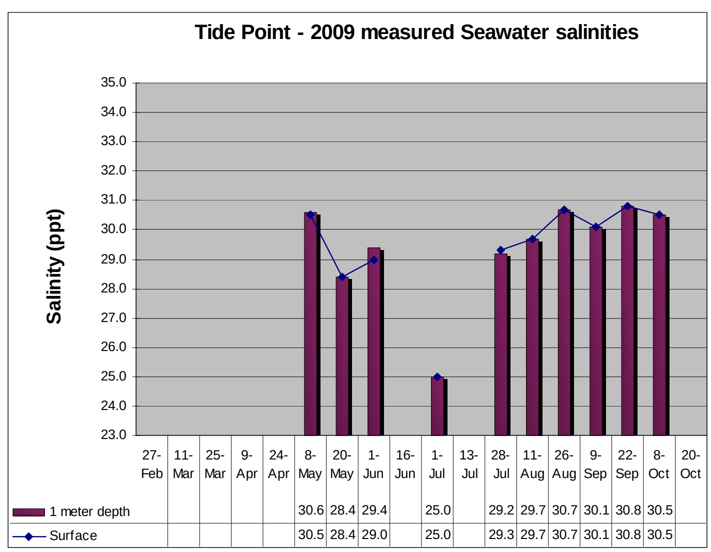
	27-Feb	11-Mar	25-Mar	7-Apr	23-Apr	8-May	20-May	1-Jun	16-Jun	1-Jul	13-Jul	28-Jul	11-Aug	26-Aug	9-Sep	22-Sep	8-Oct	20-Oct
1 meter depth			7.1	7.6	8.3		10.3					11.9	11.3	11.1	11.1	11.0	11.1	10.2
Surface			7.1	7.5	8.3		10.5					12.5	11.2	11.1	11.1	11.0	11.1	10.2



	27-Feb	11-Mar	25-Mar	7-Apr	23-Apr	8-May	20-May	1-Jun	16-Jun	1-Jul	13-Jul	28-Jul	11-Aug	26-Aug	9-Sep	22-Sep	8-Oct	20-Oct
1 meter depth			30.5	30.2	30.4		28.2					29.1	29.7	30.7	30.8	30.8	30.6	31.2
Surface			30.5	30.1	30.4		28.2					28.7	29.7	30.7	30.7	30.9	30.5	31.2



	27-Feb	11-Mar	25-Mar	9-Apr	24-Apr	8-May	20-May	1-Jun	16-Jun	1-Jul	13-Jul	28-Jul	11-Aug	26-Aug	9-Sep	22-Sep	8-Oct	20-Oct
1 meter depth						9.3	10.0	10.1		14.0		11.8	11.2	11.2	11.3	11.0	10.6	
Surface						9.3	10.0	10.9		14.0		13.0	11.5	11.1	11.3	11.0	10.6	



	27-Feb	11-Mar	25-Mar	9-Apr	24-Apr	8-May	20-May	1-Jun	16-Jun	1-Jul	13-Jul	28-Jul	11-Aug	26-Aug	9-Sep	22-Sep	8-Oct	20-Oct
1 meter depth						30.6	28.4	29.4		25.0		29.2	29.7	30.7	30.1	30.8	30.5	
Surface						30.5	28.4	29.0		25.0		29.3	29.7	30.7	30.1	30.8	30.5	

Appendix 4: CPUE for marine fish species observed at the 2009 Cypress Island Nearshore Fish Use Assessment sites

SITE ASPECT: East →→→ Northeast→Northwest→→→West→Southwest→South→Southeast → East

Catch / effort for species by site across the sample season (March – Oct.) appears in the individual cells	Eagle Harbor	Bridge Rock Cove	Pelican Beach	Smuggler's Cove	Fahey's Beach	Tide Point	Strawberry Bay	South Beach	Cypress Head South	Cypress Head North	East Beach
Total No. of Species observed	24	36	34	24	36	21	29	35	18	31	23
SALMONIDS											
CHINOOK TOTAL	3.6	0.8	3.9	0	0.1	2.3	0.3	0.6	1.8	0.9	0.4
Chin. wild (adipose intact & no CWT)	1.1	0.4	0.9	0	0.1	1.0	0.3	0.6	0.6	0.5	0.1
Chin. Hatchery (no adipose; or CWT)	2.5	0.4	3.1	0	0	1.3	0.1	0	1.1	0.4	0.3
COHO TOTAL	0.8	0.1	0.6	0.7	0	0.2	1.1	0.8	15.9	8.0	0
Coho wild (adipose intact & no CWT)	0.5	0.1	0.6	0.5	0	0.2	1.1	0.8	2.9	4.8	0
Coho hatchery (no adipose; or CWT)	0.3	0.1	0	0.2	0	0	0.1	0	13	3.2	0
CHUM Salmon	125.4	132.8	125.4	173.6	161.2	205.2	141.1	132.8	282.1	205.2	282.1
PINK Salmon	0	0	0.1	0	0.1	0	0	0	0	0	0
SOCKEYE Salmon	0	0	0	0	0	0	0	0	0	0	0
Coastal Cutthroat trout (2 adults)	0	0	0	0	0	0	0	0.1	0	0	0
Steelhead / Rainbow trout	0	0	0	0.1	0	0	0	0	0	0	0
Bull Trout / Dolly Varden	0	0	0	0	0	0	0	0	0	0	0
FORAGE FISH (5 families)											
Pacific Sand Lance	0.1	12.3	34.1	34.6	108.1	17.1	3.4	1.6	0	1.0	0.3
Pacific Herring	36.6	57.4	256.8	17.2	1.5	54.9	0.3	5.6	53.3	549.0	0.3
Northern Anchovy	0.1	0	0	0	0	0	0	0	0	0	0
Surf Smelt	87.7	0.4	5.7	0.2	0.3	0	0.1	0.1	6.0	6.2	0.1
Pacific Cod	0	0.2	5.3	8.0	3.9	7.8	0.1	2.1	0	68.5	0.1
Walleye Pollock	0	0	0	0	0.4	0	0	0	0	0	0
HEXAGRAMMIDS (Greenlings & Lingcod)											
Lingcod	0	0.1	0	0	0	0	0	0	0	0	0
Kelp Greenling	0	0.3	0.1	0.8	1.4	0.9	0.2	0.5	0	0.1	0
White-spotted Greenling	0.8	0.9	2.1	3.1	2.2	1.9	1.4	0.8	0.4	1.5	1.8
Unidentified juvenile Greenling	0	0.6	2.8	1.9	1.3	0.6	0.1	0.9	0.6	1.8	5.6

Catch / effort for species by site across the sample season (March – Oct.) appears in the individual cells	Eagle Harbor	Bridge Rock Cove	Pelican Beach	Smuggler's Cove	Fahey's Beach	Tide Point	Strawberry Bay	South Beach	Cypress Head South	Cypress Head North	East Beach
PHOLIDS & STICHAEIDS (gunnels & pricklebacks, cockscombs, warbonnets etc.)											
Crescent Gunnel	0.2	27.9	2.3	2.5	8.4	1.0	1.2	4.8	4.6	24.3	5.9
Longfin Gunnel	0	0	0	0	0.1	0	0	0.1	0	0	0.1
Penpoint Gunnel	0.6	11.9	3.7	1.8	6.3	4.1	1.4	4.7	1.1	6.8	1.9
Rockweed Gunnel	0.1	0	0	0	0.1	0	0.1	0	0	0.4	0
Saddleback Gunnel	2.4	27.4	1.3	1.0	6.6	0.4	5.1	0.6	0.6	7.8	0.4
Black Prickleback	0	0.2	0	0	0	0	0	0	0	0.1	0
Rock Prickleback	0	0.5	0.1	0	0	0	0	0	0	8.1	0.1
Pacific Snake Prickleback	96.7	0.6	0.1	7.8	1.1	0.2	17.3	0.2	0	0	0
High Cockscomb	0	0.1	0	0	0.1	0	0	0.1	0	0.1	0
Slender Cockscomb	0	0	0	0	0	0	0	0	0.3	0	0
Mosshead Warbonnet	0	0	0	0	0	0	0	0	1.6	0.1	0
									0.3		0.1
COTTIDS (the Sculpins)											
Buffalo Sculpin	0	0.7	1.2	0.5	3.2	1.4	0.2	0.5	0.1	1.3	0
Great Sculpin	0.9	9.2	6.7	3.6	13.2	12.4	1.3	0.1	0.4	2.7	1.5
Cabezon	0	0	0	0	0.1	0	0	0.1	0	.1	0
Brown Irish Lord	0	0	0	0	0.1	0	0	0	0	0	0
Red Irish Lord	0	0.5	0.1	0	0.1	0.3	0	0.1	0	0	0.3
Mosshead Sculpin	0	0	0	0	0	0	0	0	0	0.1	0
Pacific Staghorn Sculpin	54.4	3.3	1.3	0.6	3.2	0	9.9	0	10.0	2.1	0
Padded Sculpin*	0	0.6	2.6	0.5	3.8	0.4	0.1	2.3	0	0.2	0.1
Sailfin Sculpin	0	0	0.1	0	0	0	0	0	0	0	0
Silver-spotted Sculpin	0.1	0.6	1.3	0.5	1.6	0.6	0.1	0	0	0.3	0.3
Sharpnose Sculpin	2.0	0.3	0.1	1.2	2.4	0.4	3.4	0.2	2.1	2.1	0.1
Northern Sculpin	0	0	0.1	0	0	0	0	0	0	0	0
Tadpole Sculpin	0	0.1	0.1	0	0.2	0	0.1	1.5	0	0	0.1
Tidepool Sculpin	0.7	8.4	3.9	6.5	7.2	3.7	7.1	0.8	346.5	6.3	3.4
Unidentified juvenile sculpin	11.3	4.0	0.8	0.7	2.4	0.1	4.8	0.7	39.9	0.1	0

* Padded sculpin may actually be a complex of three species of the genus *Artedius* that are very difficult to distinguish from each other in the field: the Padded sculpin *(Artedius fenestralis)*; the Scalyhead sculpin *(Artedius harringtoni)*; and the Smoothhead sculpin *(Artedius lateralis)*. Many specimens did in fact appear to be *A. fenestralis*, but as a time-saving measure the project manager did not attempt to identify each individual sculpin of this genus to species, instead lumping them all as "Padded sculpins".

Catch / effort for species by site across the sample season (March – Oct.) appears in the individual cells	Eagle Harbor	Bridge Rock Cove	Pelican Beach	Smuggler's Cove	Fahey's Beach	Tide Point	Strawberry Bay	South Beach	Cypress Head South	Cypress Head North	East Beach
EMBIOTOCIDS (Surfperches)											
Shiner perch	95.8	6.1	5.9	0	0.5	.01	14.8	0.4	60.0	3.3	0.5
Striped Seaperch	0	0	0.1	0	0.1	0	0	0.2	0	0	0
AGONIDS (Poachers)											
Pygmy Poacher	0	0.1	0	0	0	0	0	0	0	0	0
Sturgeon Poacher	0	0.1	0	0	0	0	0	0	0	0	0
Tubenose Poacher	0	0	0	0	0	0	0	0.1	0	0	0
LIPARIDS (Snailfishes)											
Lobefin Snailfish	0	0	0.1	0	0	0	0	0	0	0	0
Slipskin Snailfish	0	0.1	0	0	0	0	0	0	0	0	0
Tidepool Snailfish	0.1	0.5	0.1	0.1	1.8	0	0.1	0.4	0	0.7	0
Pacific Spiny Lumpsucker	0	0	0	0.1	0.1	0	0	0.3	0	0.1	0
GASTEROSTEIDS (Sticklebacks)											
Three-spine Stickleback	2.1	1.2	4.4	2.0	0.1	1.0	0.5	6.0	1	157.4	2.3
GOBIIDS (Gobies)											
Arrow Goby	0.1	0	0	0	0	0	0	0	0	0	0
AULORHYNCHIDS (Tubesnouts)											
Tube-snout	0	0.1	0.1	0	0.4	0	0.1	0.5	0	0.1	0
SYNGNATHIDS (Pipefishes)											
Bay Pipefish	0	0.4	0	0	0.3	0	0.1	0.3	0	0	0.1
MYCTOPHIDS (Lanternfishes)											
Northern Lampfish	0	0	0.1	0	0	0	0	0	0	0	0
SCORPAENIDS (Rockfishes)											
Puget Sound Rockfish	0	0.1	0	0	0	0	0	0	0	0	0
Bothids (Lefteyed flounders)	0.1	0	0	0	0	0	0.1	0.2	0	0	0
Pleuronectids (Righteyed flounders)	39.1	1.9	0.2	0.2	5.1	0	19.7	14.2	0	1.4	0

***Note:* Highlighted cells (beige) represent a unique species capture for that site in 2009.