Final Assessment of Threatened and Endangered Marine and Anadromous Fish Presence Adjacent to the NAVSTA Everett: 2015-16 Beach Seine Survey Results

Prepared for:

Naval Facilities Engineering Command Northwest (NAVFAC NW)

Submitted by:

The WDFW Marine Fish Science Unit

Taylor Frierson, William Dezan, Dayv Lowry, Larry LeClair, Lisa Hillier, Robert Pacunski, Jennifer Blaine, Andrea Hennings, Amanda Phillips, Philip Campbell

FINAL REPORT

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Executive Summary

Puget Sound is home to a variety of marine and anadromous fish species that are afforded legal protection under the Endangered Species Act (ESA). The ESA-listed fish species within Puget Sound most relevant to this study include three species of rockfish (Yelloweye, Canary, and Bocaccio), four species of salmonid (Chinook, Hood Canal summer-run Chum, steelhead, and Bull Trout), and one species of forage fish (Eulachon). In an effort to determine whether occurrence of these ESA-listed species has the potential to affect operations in the waters adjacent to the Naval Station (NAVSTA) at Everett, the Naval Facilities Engineering Command Northwest (NAVFAC NW) and the Washington Department of Fish and Wildlife (WDFW) entered into a cooperative agreement whereby the WDFW agreed to survey these waters to evaluate both the seasonal and resident presence of ESA-listed fish.

The NAVSTA Everett, specifically the areas within the Port Gardner Naval Restricted Area (PGNRA), was surveyed by the WDFW in 2015 and 2016 using various techniques and technologies. After reviewing the geographic scope, depth profile, water quality, and security restrictions associated with the survey area, it was determined that a combination of sampling methods including a remotely-operated vehicle (ROV), split-beam echosounder (hydroacoustics), and beach seine would be used to survey the entire PGNRA outside the floating security barrier (FSB). Beach seining surveys targeted forage fish and juvenile salmonids in the nearshore, while all other sampling techniques were appropriate to surveying rockfish and critical habitat for all species. Surveys for rockfish were conducted at six month intervals in 2015, while surveys for forage fish and juvenile salmonids occurred monthly in 2015 and 2016 in order to detect temporal changes in fish abundance or distribution. This report is only intended to outline the 2016 beach seine results and follow up one full year of sampling that began in 2015. See Appendix A for a comprehensive list of fish species recorded for beach seining in 2015-16. For results on rockfish, their critical habitat, and a description of sampling methods other than beach seine see the 2014-15 final report.

The only confirmed ESA-listed species captured with the beach seine at the NAVSTA Everett was Chinook Salmon, present at all of the sampling sites with peak catch rates of juveniles occurring in May and June for both survey years. However, based on the results from 2015 and 2016 we preliminarily conclude that in order to reduce impact on juvenile salmon, the work window (July 15 to February 15) for any NAVSTA Everett facility's in-water maintenance, military construction (MILCON), mitigation projects, future Fleet training and testing should not include March through July, as is consistent with the measures outlined in WAC 220-660-330.

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Background

The inland marine waters of Washington State, which include all waters east of Cape Flattery and south of the Canadian border (i.e., Puget Sound), are inhabited by a variety of species that have been afforded legal protection under the Endangered Species Act (ESA) due to a reduction in their range, average biomass, a combination of these population-level parameters, and/or their inherent "value" to humankind. This value may stem from fisheries or other exploitative uses, ecotourism, other non-exploitative uses, or recognition of the integral ecological role a species plays in the local or regional food web (NMFS online). Several fishes protected under the ESA within Puget Sound include Eulachon (*Thaleichthys pacificus*) (NMFS 2010a), Chinook Salmon (*Oncorhynchus tshawytscha*) (NMFS 1999a), Hood Canal summer-run Chum Salmon (*O. keta*) (NMFS 1999b), steelhead (*O. mykiss*) (NMFS 2007), and Bull Trout (*Salvelinus confluentus*) (USFWS 1999). Each of these species is listed as Threatened, being significantly reduced in abundance and experiencing ongoing pressure from several threats, but not under imminent threat of extirpation or extinction. In 2010, ESA protection was extended to three species of rockfish within a geographic area that includes the vast majority of Puget Sound (NMFS 2010b). Yelloweye Rockfish (*Sebastes ruberrimus*) and Canary Rockfish (*S. pinniger*) were afforded Threatened status, while Bocaccio (*S. paucispinis*) received an Endangered designation.

These ESA-listings have the capacity to influence nearshore construction activities and at-sea operations of private and government sector vessels. As a result, the United States Department of the Navy (DON) desired to understand the species composition, timing, and migration of ESA-listed Threatened and Endangered (T&E) fish, and additionally ensure compliance with the Fish and Wildlife Conservation Act, Magnuson-Stevens Fishery Conservation and Management Act, and the Sikes Act Improvement Act at the following nine Naval installations: Naval Air Station (NAS) Whidbey Island Crescent Harbor, NAS Whidbey Island Lake Hancock, Naval Magazine (NAVMAG) Indian Island, Naval Base (NAVBASE) Kitsap Keyport, NAVBASE Kitsap Bremerton, NAVBASE Kitsap Bangor, Naval Station (NAVSTA) Everett, Manchester Fuel Department (MFD), and Zelatched Point. A Cooperative Agreement (CA) was established between the DON and the Washington Department of Fish and Wildlife (WDFW) to design and implement studies to assess shoreline and adjacent marine water use by ESA-listed fish species. It was further agreed that the WDFW, based on known ESA-listed fish habitat preferences and trophic relationships, would also assess the suitability of the habitat and prey for supporting ESA-listed fish at each of the nine installations.

The four primary project tasks identified in the CA are: 1) a kick-off meeting to formalize the monitoring project planning and management; 2) develop survey protocols and a study plan; 3) conduct field surveys and collect field data; and 4) provide a final report documenting results of surveys at Navy installations. In accordance with Tasks 1 and 3, a kick-off meeting between principle participants from the WDFW and NAVFAC NW personnel was held in November 2015. The meeting included discussions on security, access, survey methods, scheduling, logistics, and installation-specific survey priorities. Monthly progress reports were prepared by the WDFW, and meetings were held periodically to discuss headway and to identify and resolve any impediments to the project. The WDFW coordinated and communicated extensively with installation security and other personnel to arrange for access at prescribed times and locations. Task 2 is detailed under headings below, and this report meets the deliverables requirement for the final task by detailing all research conducted as part of this cooperative agreement at the NAVSTA Everett installation.

Methods

Study Area

The NAVSTA Everett is located along the eastern shore of Possession Sound (Figure 1a) within the Port Gardner Naval Restricted Area (PGNRA), which encompasses an area of approximately 0.5km^2 around the carrier pier, marina, and service piers. Due to security restrictions, the study area was limited to the area within the PGNRA boundary, but outside of the floating security barrier (FSB) (Figure 1b). The majority of bottom habitat within the study area is considered featureless mud and sand (NOAA nautical chart 18444), with complex anthropogenic structures including the carrier pier, breakwater, FSB, marina, and service piers (Figure 2).

Figure 1. Orthophoto of the NAVSTA Everett location in Puget Sound (a) showing the Port Gardner Naval Restricted Area (PGNRA) boundary line in yellow (b). Image from Esri DigitalGlobe.

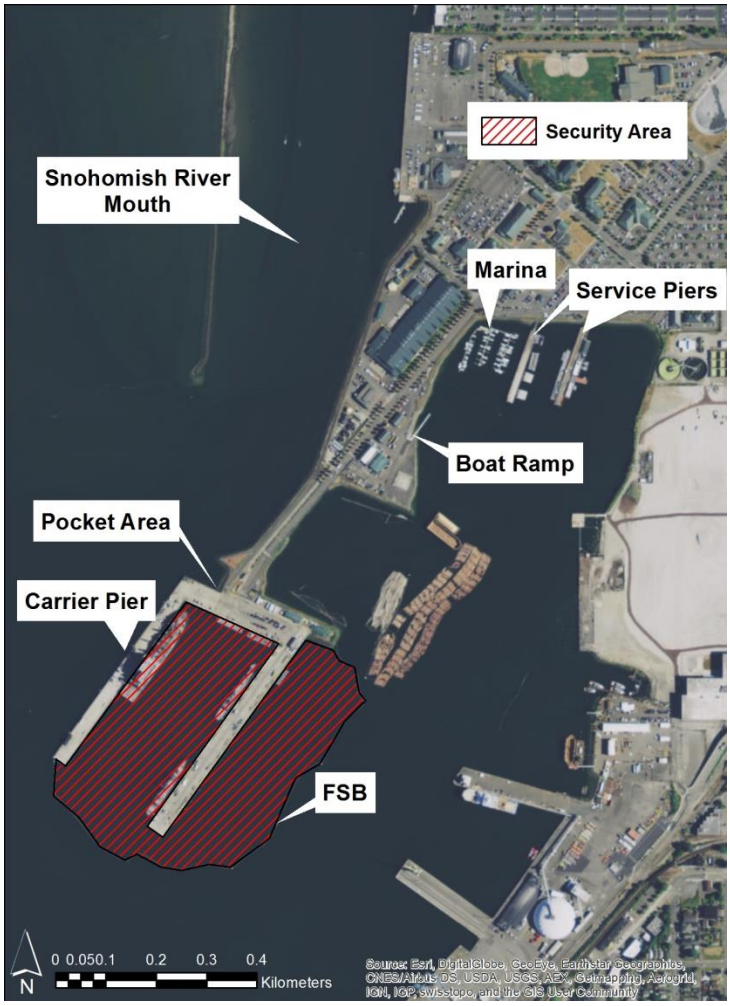

Figure 2. Orthophoto of the NAVSTA Everett identifying the survey sites: pocket area, carrier pier, floating security barrier (FSB), boat ramp, marina, and service piers. Image from Esri DigitalGlobe.

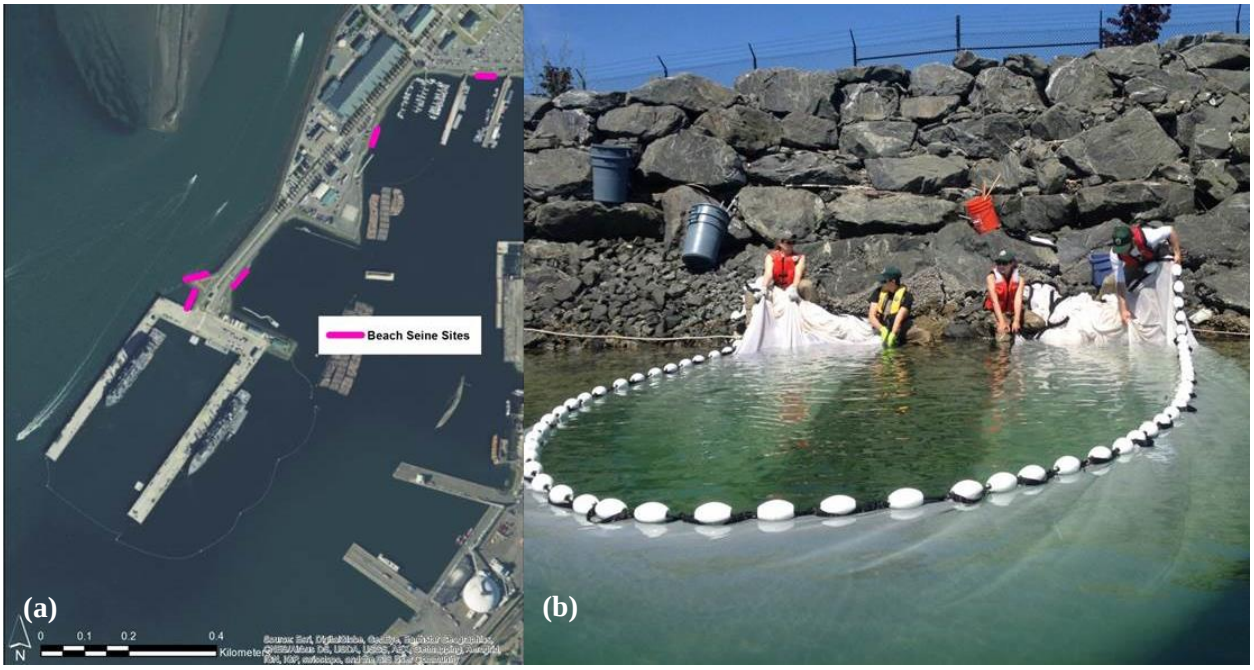

Figure 3. Orthophoto of the NAVSTA Everett identifying the beach seining survey sites: west and east of the carrier pier (a). Image from Esri DigitalGlobe. Photo of the WDFW crew landing the beach seine on steep rip-rap walls at the NAVSTA Everett (b).

Within the study area, survey sites were sampled with a beach seine along the shoreline armoring adjacent to the west and east sides of the carrier pier (Figure 3a). Each of the sites was classified as modified, no appreciable drift-artificial shoreform types (WA DOE Coastal Atlas Map). Sampling of the western sites occurred at the mouth of the Snohomish River, and included a sheltered pocket area designed to promote fish passage around the carrier pier. The eastern sampling sites occurred adjacent to the carrier pier entrance, boat ramp, marina, and service piers where many artifacts of past structures remained at the water line, including cut-off pilings, concrete slabs, rebar, and other metal debris. The only intertidal substrate within the survey area consisted of steeply sloping angular rip-rap walls with bio-cover comprised mainly of barnacles and brown algae (*Fucus* spp.) below the approximate mean high water level (Figure 3b). Due to the large rip-rap boulders used for shoreline armoring at all the sampling sites, the beach seine frequently snagged during retrieval and occasionally allowed fish to escape. Therefore, catch rates may not accurately represent densities of each fish species.

Survey Design

Beach seining allows fish to be collected in the intertidal and shallow subtidal zone (<5m deep) where few other techniques are capable of sampling. This is critically important for assessing forage fish and juvenile salmonids because they rely heavily on this nearshore zone for spawning, feeding, refuge, and/or migration. From the possible array of shorelines controlled by the DoN in need of assessment, sampling sites were selected based on priorities identified by Navy personnel to determine fish presence and occupancy timing adjacent to the carrier pier and marina. One priority was to assess juvenile salmonid passage as they migrated from the Snohomish River through the sheltered pocket area. A coded wire tag (CWT) wand was used to detect the presence of CWTs in all captured Coho Salmon in order to determine hatchery origin. These sites were sampled monthly at high-slack tides from May to September in 2015 and March to September in 2016, which are known to be preferred by beach-spawning forage fish and migrating juvenile salmonids. A single beach seine "set" was performed at each of the sites on a single date each month. All fish captured during sampling were identified, counted, and released.

Beach Seining Survey Protocols

Beach seine surveys were conducted during daylight hours within two hours of high-slack tide using a 5.5m WDFW research vessel (aluminum hull, 115hp outboard motor) equipped with a bowpicker. The beach seine was 36.6m long x 3.7m deep with 3.2mm knotless nylon mesh (Cristensen Net Works - Everson, WA). The net was cut to taper from 1.8m to 3.7m deep in the leading 18.3m of net, followed by 18.3m of netting 3.7m deep (Figure 4). This "Skagit" net design is widely used by the WDFW, Wild Fish Conservancy (WFC), Skagit River System Cooperative (SRSC), and many other organizations to assess nearshore fish assemblages throughout the Puget Sound region.

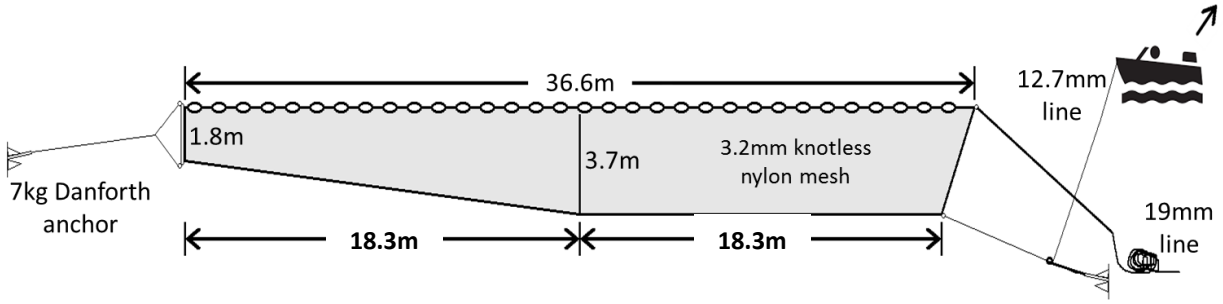

Figure 4. Diagram of the beach seine with dimensions used for sampling.

During sampling the shallow end of the net was anchored to the beach with a 7kg Danforth anchor and deployed perpendicular to the beach. A haul line of 19mm braided nylon attached to the deep end of the net was secured to the bow with approximately 10m of line between the boat and end of the net. The net was towed by the boat in reverse against the current in a "round haul" fashion and returned towards shore at a point approximately 75% of the net's length (Figure 5). As the boat approached shore, a second line of 12.7mm, three-strand nylon attached at the net's lead line was tossed to a crew member on shore, passed through a stainless steel snatch block attached to a second anchor, and returned to the boat where it was secured to a post on the bow. The boat then carefully reversed away from shore pulling the line through the anchored snatch block, and landing the net on the beach (Figure 6a). Set durations ranged from three to five minutes from net deployment to landing on the beach, and each sampling trip typically included six to eight total sets on a given date.

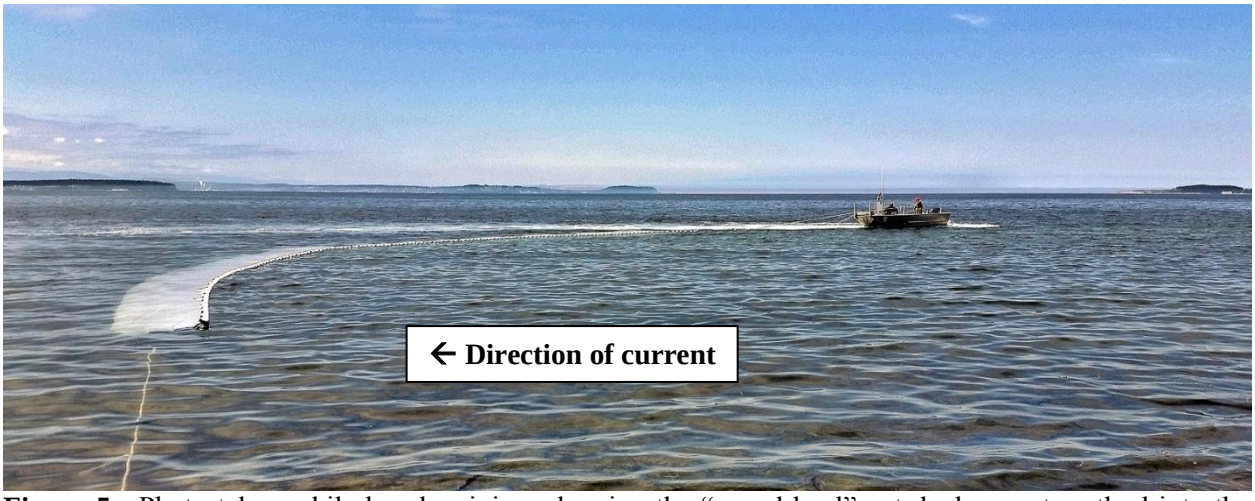

Figure 5. Photo taken while beach seining, showing the "round haul" net deployment method into the current.

Figure 6. Photo taken during a beach seine set showing the use of a snatch block anchored to shore and research vessel to land the net (a). The WDFW beach seine staff sorting fish species in the landed net enclosure (b).

Upon landing the net, smaller catches were transferred to 113L containers that were aerated by bubblers and regularly irrigated with fresh seawater. Larger catches were retained in the net enclosure to minimize heat and oxygen stress during handling. Each set's catch was sorted and identified to the lowest possible taxonomic level and enumerated before release (Figure 6b). Holding time was often less than 5 minutes and not longer than 15 minutes. A subsample of each species of forage fish (n=40) and juvenile salmonid (n=20) was measured (fork length) to the nearest millimeter for each sampling trip. Salmonids were checked for adipose fin presence/absence to determine hatchery or natural-origin, if applicable to the species. In addition to collecting biological data specific to catch, information describing weather, water surface conditions, depth, tide stage and elevation, primary and secondary substrate characteristics, and amount of algae in each set was recorded.

Results

Beach Seine Surveys in 2015

Beach seine sampling occurred at sites west and east of the carrier pier adjacent to the NAVSTA Everett once a month from May to September 2015 (eastern sites were not sampled in May) (see Figure 3). A total of 22 sets were completed in 2015, with one or two sets occurring at each site on each date. Sampling always began at the western sites, and subsequent sets were deployed at the eastern sites. Maximum nearshore water depth recorded while sampling the western sites averaged 9.9m. Maximum nearshore water depth recorded while sampling the eastern sites averaged 11.8m.

A total of 19 fish species (including unidentified taxa) were captured and identified during the five months of sampling from all sites. Overall catch composition consisted primarily of Pacific Herring (*Clupea palasii*), Shiner Perch (*Cymatogaster aggregata*), and Chum Salmon (Table 1). Species richness ranged from 7 to 13 species captured during each month of sampling, with peak species richness recorded in June (Figure 7). Fork lengths were recorded for a total of 132 forage fish and 245 salmonids during the five months of sampling at all sites (Table 2).

Table 1. Total number of beach seine sets completed and counts of all marine fish captured by sampling month in 2015.

Species	26-May	23-Jun	23-Jul	7-Aug	3-Sep	Total	% of Total
# of Sets Completed	4	4	5	5	4	22	-
Bay Pipefish		1	1	1		3	0.06%
Chinook Salmon	33	29	8		1	71	1.39%
Chum Salmon	564	53	2	1		620	12.10%
Coho Salmon	134	11	1	4		150	2.93%
Crescent Gunnel	1			1		2	0.04%
Cutthroat Trout		1				1	0.02%
Greenling (unidentified)		1				1	0.02%
Kelp Perch	1					1	0.02%
Pacific Herring	1	868	307	1155	4	2335	45.59%
Pacific Sand Lance		2		116	1	119	2.32%
Pacific Sanddab				1		1	0.02%
Padded Sculpin				1	1	2	0.04%
Pile Perch		1				1	0.02%
Salmonid (unidentified)					2	2	0.04%
Shiner Perch	39	2	890	97	7	1035	20.21%
Striped Seaperch	1		1			2	0.04%
Surf Smelt		283	57		3	343	6.70%
Threespine Stickleback	29	5	361	27	9	431	8.41%
Tidepool Sculpin		1	1			2	0.04%

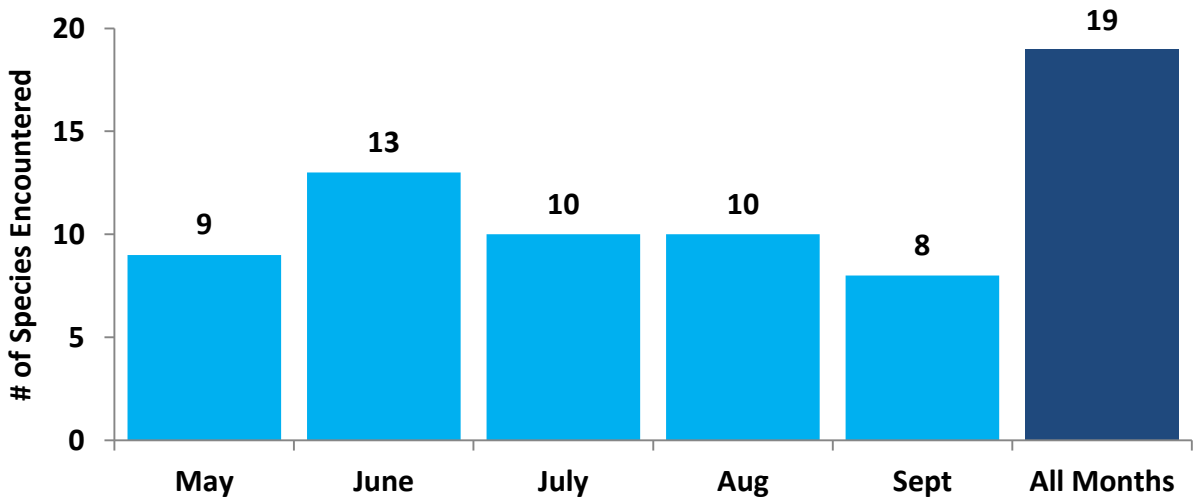

Figure 7. Species richness (including unidentified taxa) of all fish captured during beach seining, by month and all months combined in 2015.

Table 2. Fork length (mm) data summaries for juvenile salmonid (left) and all forage fish (right) species in 2015.

Species	Mean ± SD	CV	n
Chinook natural	96 ± 14.52	0.15	14
Chinook hatchery	92.85 ± 16.66	0.18	52
Coho natural	99.45 ± 11.33	0.11	38
Coho hatchery	93.81 ± 16.01	0.17	37
Chum Salmon	87.57 ± 11.91	0.14	103
Cutthroat Trout	183.00	-	1

Species	Mean ± SD	CV	n
Pacific Herring	78.15 ± 9.94	0.13	67
Surf Smelt	117.40 ± 15.88	0.14	43
Pacific Sand Lance	109.91 ± 21.99	0.20	22

Forage fish species captured in 2015 included Pacific Herring, Surf Smelt (*Hypomesus pretiosus*), and Pacific Sand Lance (*Ammodytes hexapterus*), with peak catch rates for all species occurring in June and August (Figure 8). Pacific Herring was the predominant forage fish species captured with peak catch rates in June (217 fish/set) and August (231 fish/set) primarily from the western sites. Pacific Herring fork length data for all months combined resulted in little variation (CV=0.13), and a unimodal distribution of fish up to age-1 (Buchanan 1985) (Figure 9). Surf Smelt were primarily captured at the western sites with a peak catch rate in June (70.8 fish/set) and declined in July (11.4 fish/set). Surf Smelt fork length data for all months combined resulted in little variation (CV=0.14), and a predominantly unimodal distribution of age-1+ fish (Penttila 1978) with variation in length between sexes (Figure 10). Pacific Sand Lance were primarily captured at the eastern sites with a peak catch rate in August (23.2 fish/set) from a single set between the service piers. Pacific Sand Lance fork length for all months combined resulted in high variation (CV=0.20), and a multimodal distribution of age-1 through age-3+ fish (Emmett et al. 1991, Greene at al. 2011) (Figure 11).

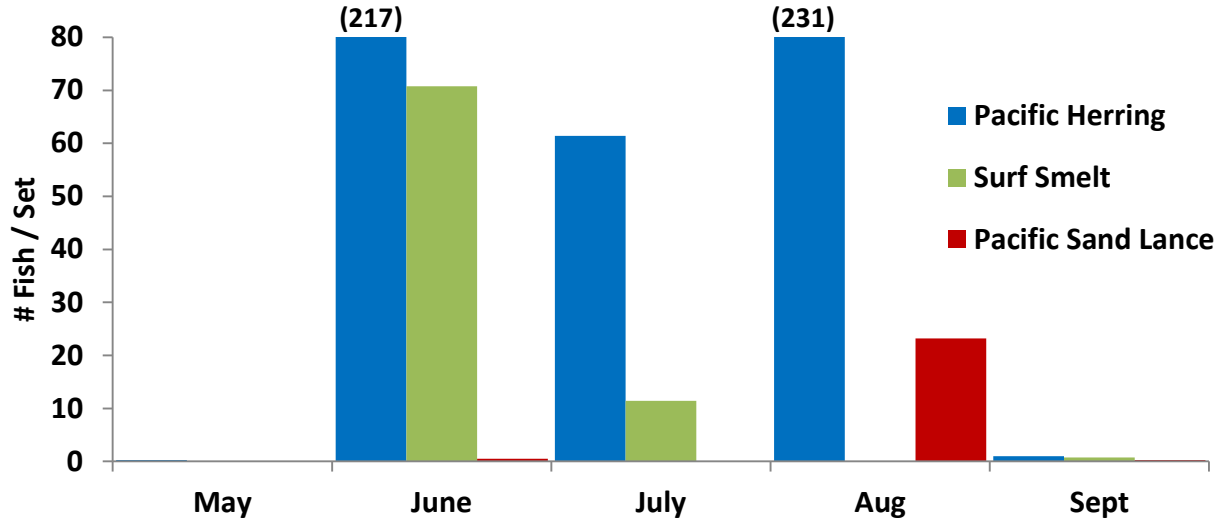

Figure 8. Catch rates for forage fish species captured during beach seining, by month for all sites combined in 2015. Values are labeled for catch rates exceeding the vertical axis.

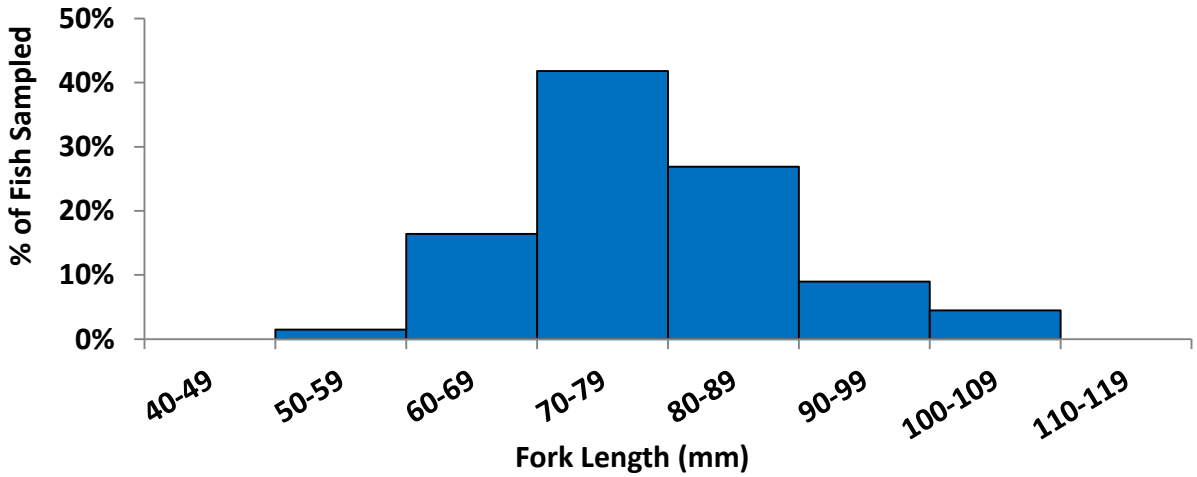

Figure 9. Histogram of Pacific Herring fork length data for all sites and months combined in 2015.

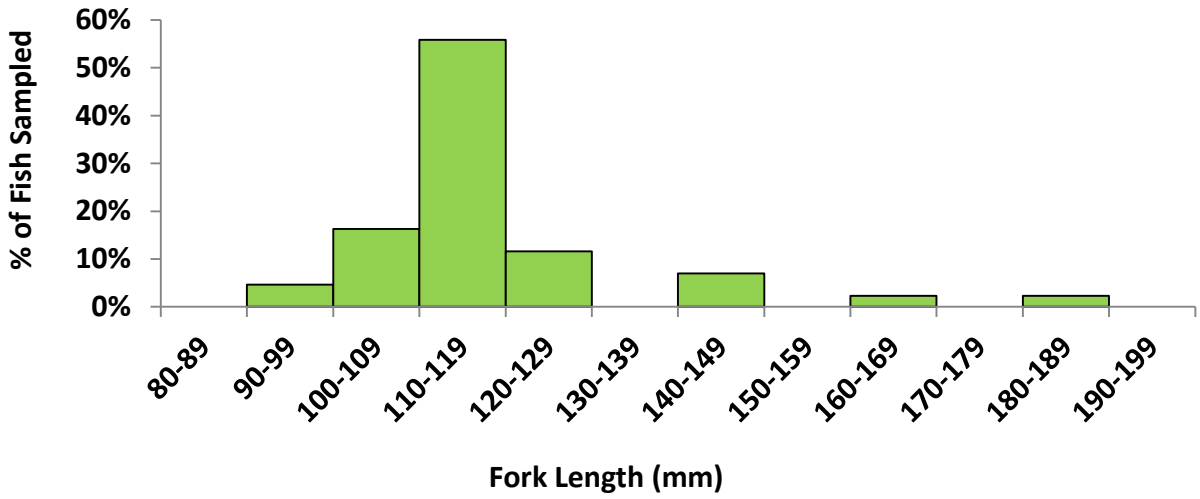

Figure 10. Histogram of Surf Smelt fork length data for all sites and months combined in 2015.

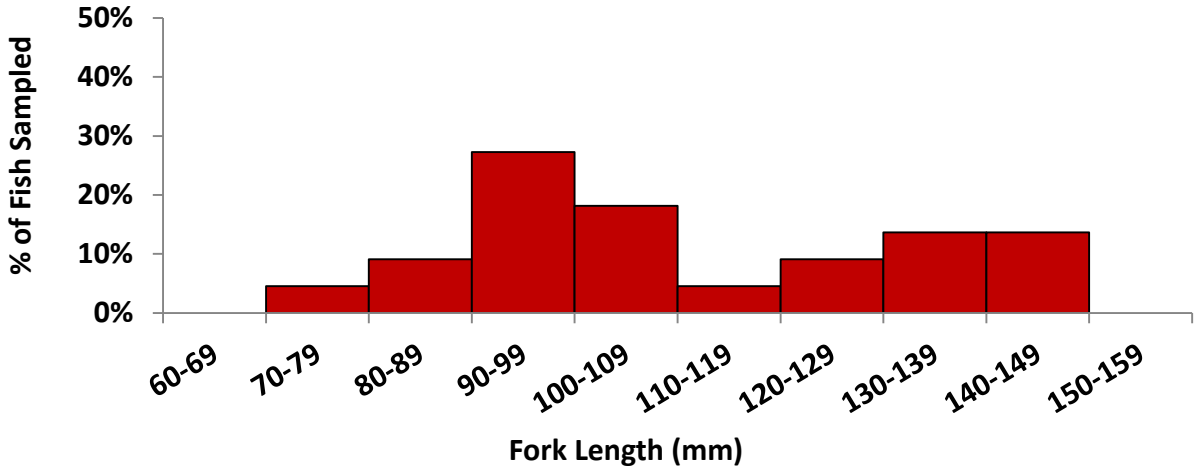

Figure 11. Histogram of Pacific Sand Lance fork length data for all sites and months combined in 2015.

Salmonid species captured in 2015 included Chinook Salmon, Chum Salmon, Coho Salmon (*O. kisutch*), and Cutthroat Trout (*O. clarkii*), with peak catch rates for all species observed in May (Figure 12). Salmonid fork lengths generally increased for each species' cohort, as a consequence of seasonal growth after outmigration from local watersheds, from May through September (Figure 13). Chinook Salmon catch rates were highest in May (8.3 fish/set) and June (7.3 fish/set), which consisted of 56 hatchery and 15 natural-origin fish for all 2015 sampling. Chum Salmon were captured primarily at the western site with a peak catch rate occurring in May (141 fish/set), then declined during June sampling (13.3 fish/set). Coho Salmon were primarily captured from the western site, with the peak catch rate occurring in May (34 fish/set) and declining in June (2.8 fish/set). Of the Coho Salmon captured, 71 were hatchery and 79 were natural-origin. A single Cutthroat Trout was captured at the western site in June.

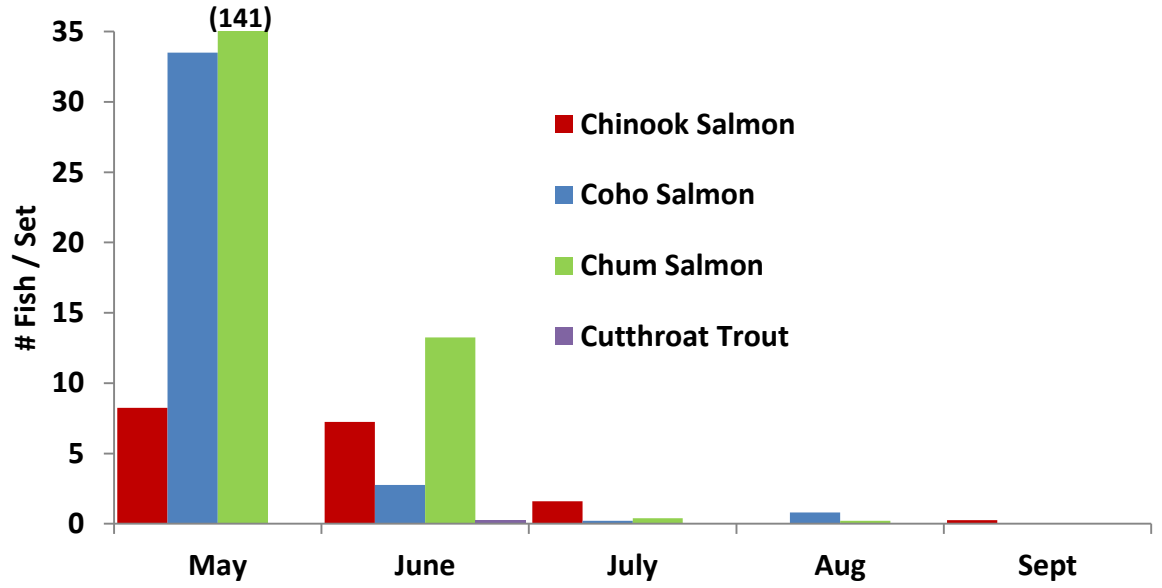

Figure 12. Catch rates by month for salmonid species captured during beach seining, by month for all sites combined in 2015. Values are labeled for catch rates exceeding the vertical axis.

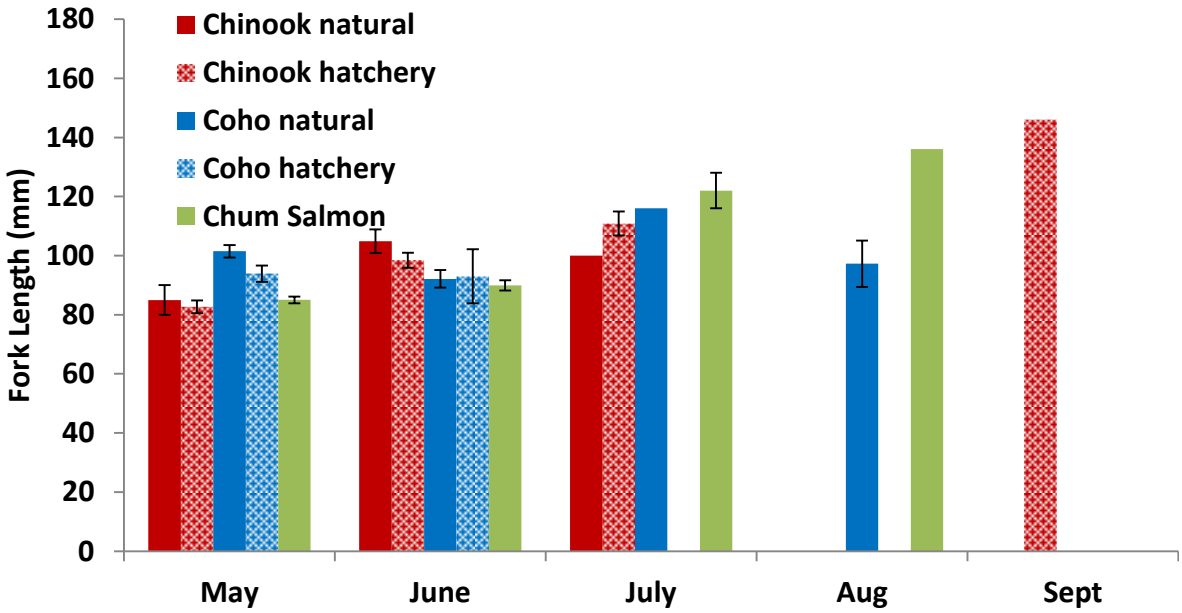

Figure 13. Mean fork length (± 1SE) for juvenile salmonid species, by month for all sites combined in 2015.

Beach Seine Surveys in 2016

Beach seine sampling occurred at sites west and east of the carrier pier adjacent to the NAVSTA Everett once a month from March to September 2016 (see Figure 3). The eastern site adjacent to the carrier pier entrance was added in 2016. A total of 41 sets were completed in 2016, with one or two sets occurring at each site on each date. For the month of May, sampling effort was duplicated with an extra trip in an attempt to collect any Coho Salmon with CWTs. Sampling typically began at the western sites, and subsequent sets were deployed at the eastern sites. Maximum nearshore water depth recorded while sampling the western sites averaged 9.0m. Maximum nearshore water depth recorded while sampling the eastern sites averaged 9.9m.

A total of 16 fish species (including unidentified taxa) were captured and identified during the five months of sampling from all sites. Overall catch composition consisted primarily of Pink Salmon (*O. gorbuscha*), Pacific Herring, Pacific Sand Lance, and Chum Salmon (Table 4). Species richness ranged from 6 to 10 species captured during each month of sampling, with peak species richness recorded from May through July (Figure 14). Fork lengths were recorded for a total of 514 forage fish and 329 salmonids during the seven months of sampling at all sites (Table 4).

Table 3. Total number of beach seine sets completed and counts of all marine fish captured by sampling month in 2016.

Species	15-Mar	13-Apr	16-May	31-May	27-Jun	13-Jul	9-Aug	8-Sep	Total	% of Total
# of Sets Completed	**6**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**41**	-
Bay Pipefish			3	2	1	3	1		10	0.10%
Chinook Salmon			182	91	31	15	4		323	3.11%
Chum Salmon	21	1185	359	154	23				1742	16.79%
Coho Salmon			83	27	3	1	1		115	1.11%
Kelp Perch								1	1	0.01%
Larval Forage Fish		8							8	0.08%
Northern Anchovy				14		11		63	88	0.85%
Pacific Herring	6		1	962	4	1076	83	6	2138	20.61%
Pacific Sand Lance		3	24	1821	40	3	56		1947	18.77%
Pink Salmon	226	2025	240	11					2502	24.12%
Salmonid (unidentified)							1		1	0.01%
Sculpin (unidentified)					1			1	2	0.02%
Shiner Perch			2	1	2	20	377	1	403	3.88%
Striped Seaperch						2		1	3	0.03%
Surf Smelt	41	1	1		73	2	25		143	1.38%
Threespine Stickleback	3	3	39	52	11	15	341	484	948	9.14%

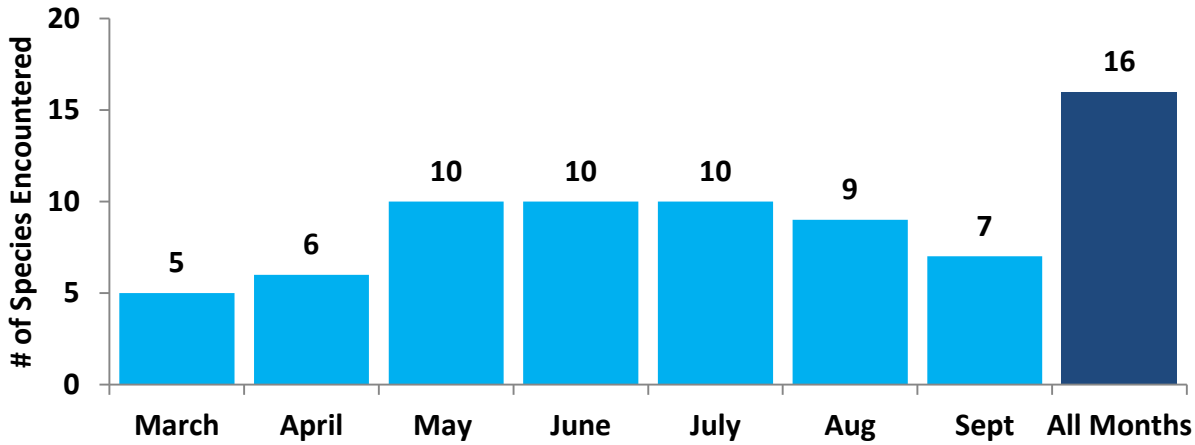

Figure 14. Species richness (including unidentified taxa) of all fish captured during beach seining, by month and all months combined in 2016.

Table 4. Fork length (mm) data summaries for juvenile salmonid (left) and all forage fish (right) species in 2016.

Species	Mean ±SD	CV	n
Chinook hatchery	92.35 ±13.73	0.15	68
Chinook natural	99.20 ±16.15	0.16	25
Coho hatchery	118.60 ±39.14	0.33	5
Coho natural	104.24 ±9.80	0.09	55
Chum Salmon	68.23 ±22.58	0.33	106
Pink Salmon	53.40 ±19.87	0.37	70

Species	Mean ±SD	CV	n
Pacific Herring	70.18 ±15.26	0.22	160
Pacific Sand Lance	77.19 ±13.27	0.17	149
Surf Smelt	130.36 ±38.28	0.29	117
Northern Anchovy	49.14 ±21.22	0.43	88

Forage fish species captured in 2016 included Pacific Herring, Surf Smelt, Pacific Sand Lance, and Northern Anchovy (*Engraulis mordax*) with variable peak catch rates for all species occurring between May and September (Figure 15). Pacific Herring was the predominant forage fish species captured at both the western and eastern sites with peak catch rates in May (96.3 fish/set) and July (215.2 fish/set). Pacific Herring fork length data for all months combined resulted in high variation (CV=0.22), and a multimodal distribution of fish up to age-1 (Buchanan 1985) (Figure 16). Pacific Sand Lance were primarily captured at the both western sites with a peak catch rate in May (184.5 fish/set) from a single set in the pocket area. Pacific Sand Lance mean fork length for all months combined resulted in little variation (CV=0.17), and a unimodal distribution of fish up to age-1+ (Emmett et al. 1991, Greene at al. 2011) (Figure 17). Surf Smelt were primarily captured at the western sites with a peak catch rate in June (14.6 fish/set). Surf Smelt fork length data for all months combined resulted in high variation (CV=0.29), and a multimodal distribution of fish up to age-1+ (Penttila 1978) with variation in length between sexes (Figure 18). Northern Anchovy were primarily captured from the pocket area with a peak catch rate in September (12.6 fish/set). Northern Anchovy fork length data for all months combined resulted in high variation (CV=0.43), and a multimodal distribution of age-0 and age-1 fish (Emmett et al. 1991) (Figure 19).

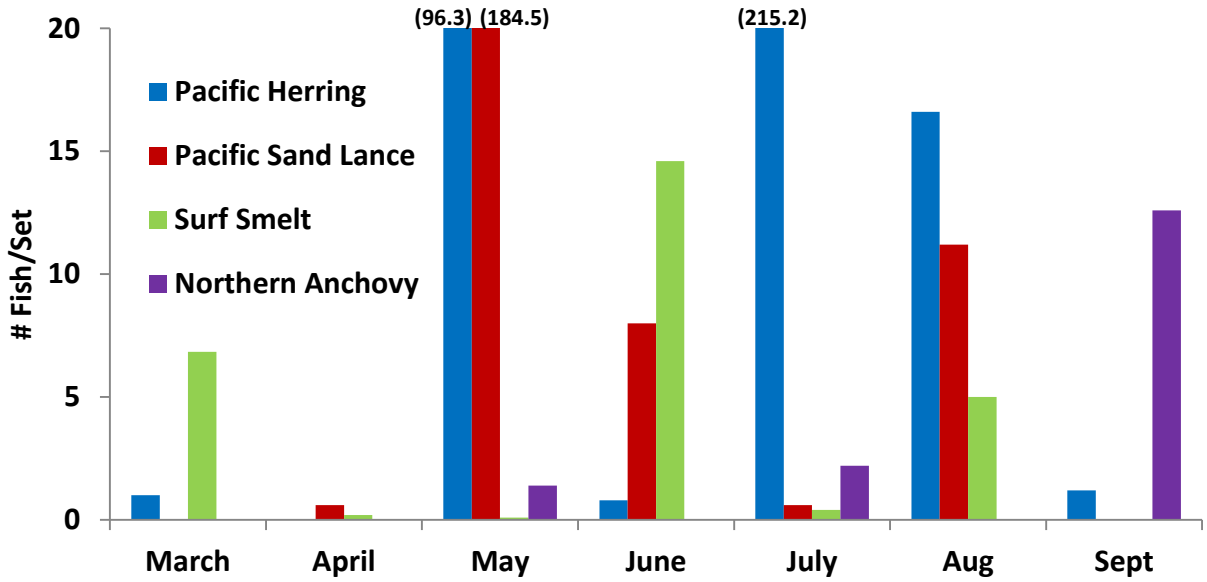

Figure 15. Catch rates for forage fish species captured during beach seining, by month for all sites combined in 2016. Values are labeled for catch rates exceeding the vertical axis.

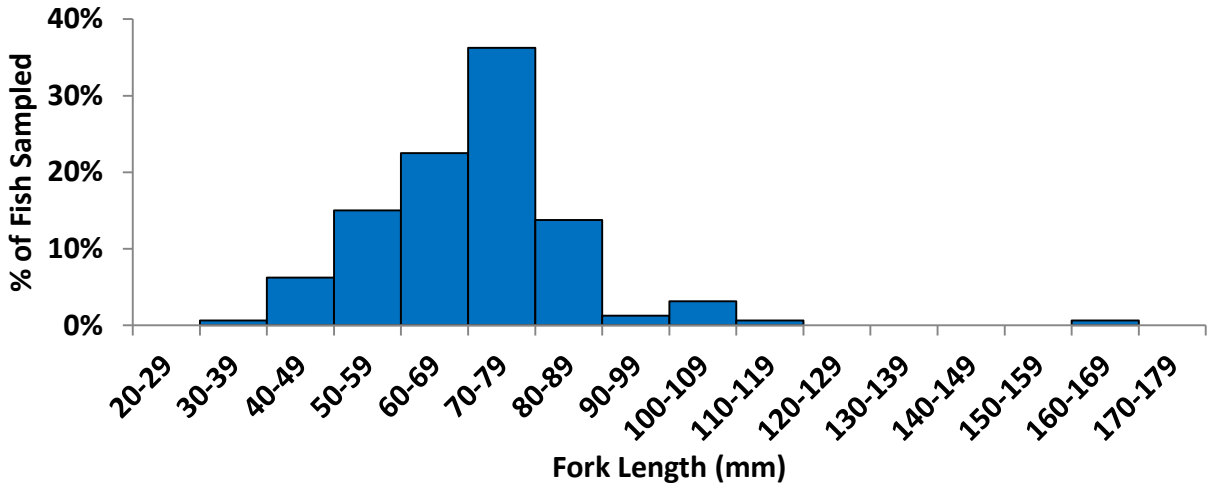

Figure 16. Histogram of Pacific Herring fork length data for all sites and months combined in 2016.

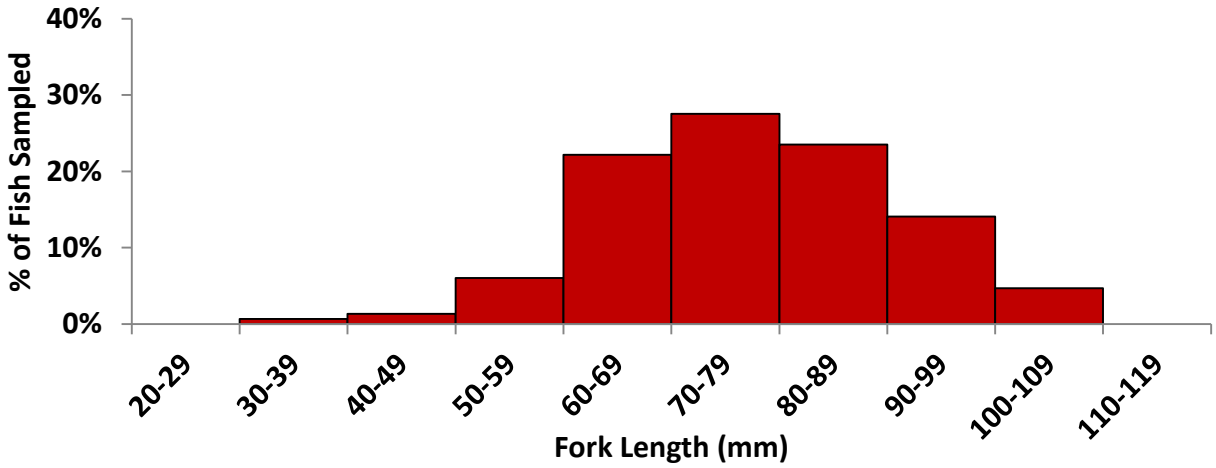

Figure 17. Histogram of Pacific Sand Lance fork length data for all sites and months combined in 2016.

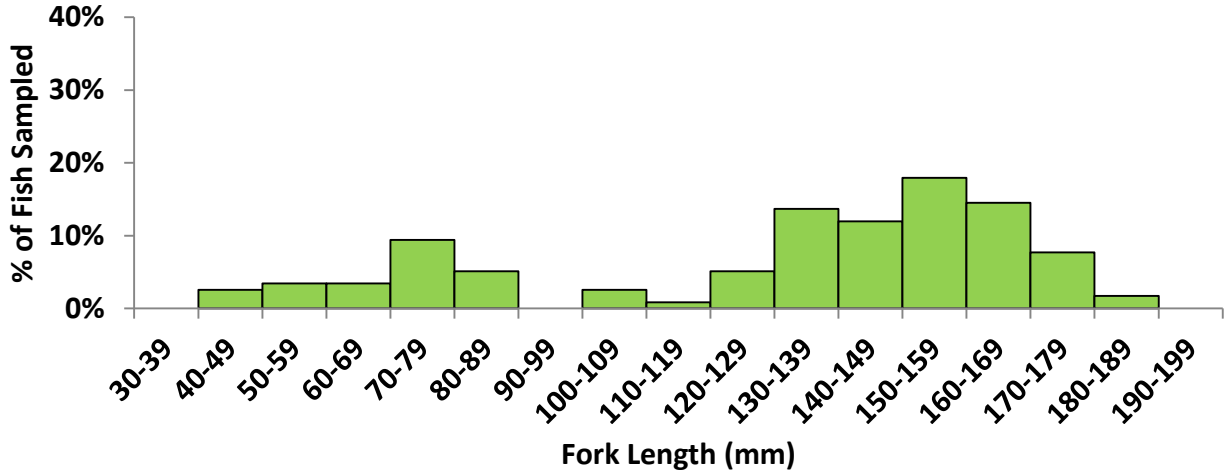

Figure 18. Histogram of Surf Smelt fork length data for all sites and months combined in 2016.

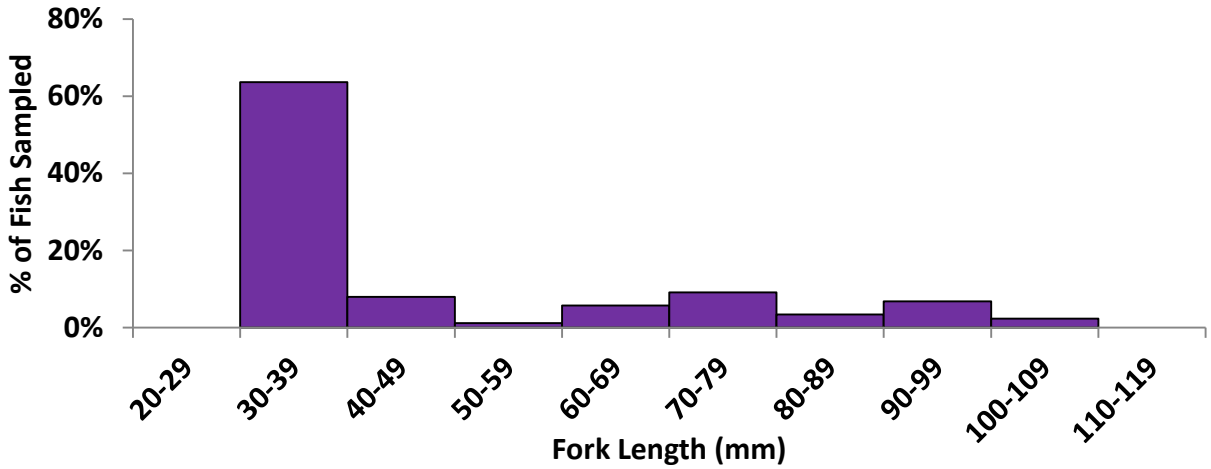

Figure 19. Histogram of Northern Anchovy fork length data for all sites and months combined in 2016.

Salmonid species captured in 2016 included Chinook Salmon, Chum Salmon, Pink Salmon, and Coho Salmon with peak catch rates observed in April and May (Figure 20). Salmonid fork lengths generally increased for each species' cohort, as a consequence of seasonal growth after outmigration from local watersheds, from May through September (Figure 21). Chinook Salmon catch rates were highest in May (27.3 fish/set) and declined through August (<1 fish/set), which consisted of 268 hatchery and 55 natural-origin Chinook during all 2016 sampling. Chum Salmon were captured at all sites with a peak catch rate occurring in April (237 fish/set), then declined during June sampling (4.6 fish/set). Pink Salmon were captured in very high densities during April (405 fish/set), but absent after May sampling. Coho Salmon were primarily captured from both western and eastern sites, with the peak catch rate occurring in May (11 fish/set) and declining in June (<1 fish/set). Of the Coho Salmon captured, 9 were hatchery and 106 were of natural-origin. No CWTs were detected in any Coho Salmon from the 2016 surveys.

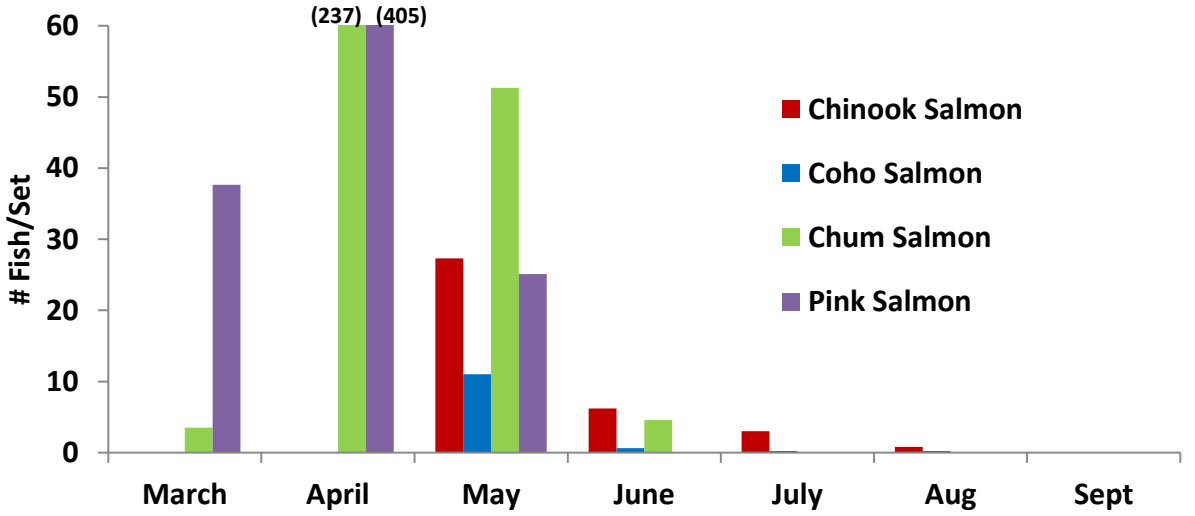

Figure 20. Catch rates by month for salmonid species captured during beach seining by month for all sites combined in 2016. Values are labeled for catch rates exceeding the vertical axis.

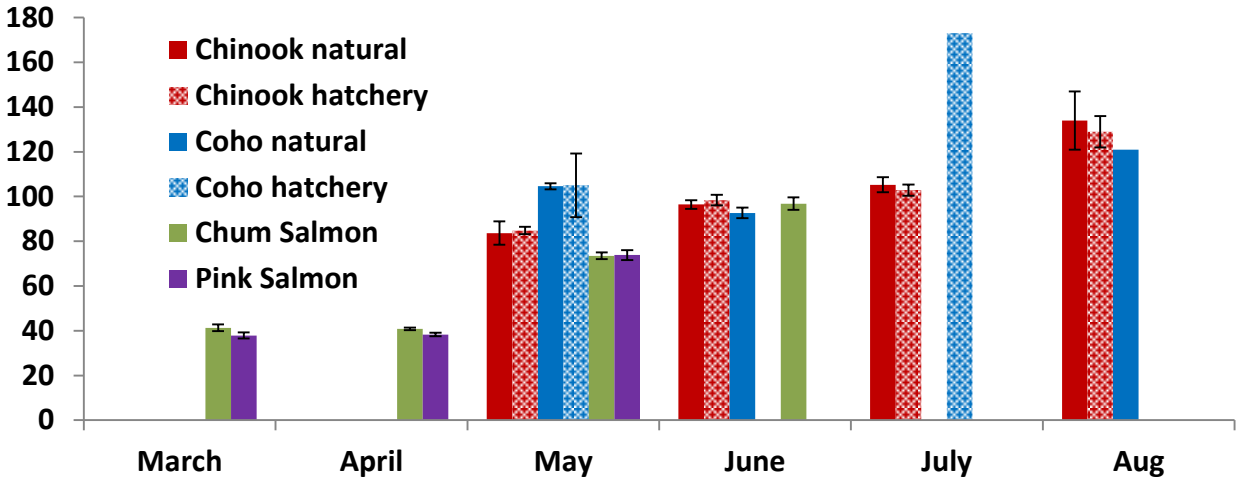

Figure 21. Mean fork length (± 1SE) for juvenile salmonid species by month for all sites combined in 2016.

Discussion

Forage Fish and Salmonids in 2015-16

Beach seine surveys were completed to assess ESA-listed forage fish and salmonid species' use of marine nearshore habitats, specifically with regard to their timing, distribution, and relative abundance adjacent to the NAVSTA Everett facilities and the PGNRA. This report combines both 2015 and 2016 survey years with the intent to update and compare recent surveys of forage fish and salmonids, conducted with a similar design, using a beach seine within the Snohomish River estuary (see Rowse and Fresh 2003, Rice at al. 2014). These studies also focused their sampling efforts from January through early and late summer to assess the different outmigration patterns of each salmonid species; however, they did not report detailed catches of forage fish species.

In Puget Sound, forage fish species occupy every marine and estuarine nearshore habitat, and their spawning habitats all commonly occur within the nearshore zone of Pacific Northwest beaches (Penttila 2007). However, little is known about any forage fish species away from their spawning grounds (Penttila 2007). Due to their critical role as prey species for salmon and marine mammals, conservation efforts regarding their abundance trends and spawning habitats have been considerably emphasized. Overwater structures (e.g., docks, piers, floats, boathouses) have potential negative impacts on these spawning habitats, but they vary depending on the species and the size and configuration of the structure (Nightingale and Simenstad 2001, Penttila 2007). There are neither historically documented spawning grounds for forage fish in Port Gardner (WDFW online), including the PGNRA, nor suitable habitat for spawning (i.e., intertidal beach, eelgrass). Due to the heavily modified shoreline within the PGNRA and absence of suitable spawning habitat, the extent of which the many overwater structures at the NAVSTA Everett that may impact forage fish spawning grounds remains irrelevant.

Forage fish were primarily captured with the beach seine during May through August sampling in both 2015 and 2016, though no ESA-listed forage fish were encountered. Pacific Herring were encountered in high densities while sampling the pocket area during both survey years, capturing >1000 fish in a single set. Surf Smelt peak catch rates occurred during June sampling in both survey years, but the rate in 2016 was only 21% of the rate recorded in 2015. Pacific Sand Lance were encountered more frequently and in greater numbers during 2016 sampling, with the highest densities captured simultaneously with many Pacific Herring in the pocket area. Northern Anchovy were only captured in 2016, exclusively from the

pocket area and service pier sites. Fork length data collected for all species of forage fish indicate presence of juveniles, age-1 sub-adults, and age-1+ adults utilizing nearshore habitat within sampling areas. While there are no documented forage fish spawning areas at Port Gardner or the NAVSTA Everett (WDFW online), the abundance of anthropogenic structures (i.e., pocket area, service piers) may offer refuge to juvenile forage fish species as a temporary holding area during late spring and summer. The Snohomish River estuary monitoring survey reported catches of Surf Smelt and Pacific Sand Lance, up to approximately 30% composition at their marine sites, but no Pacific Herring or Northern Anchovy (Rice et al. 2014). Regarding abundance, catches of forage fish in 2015-16 showed high variation and inconsistency which could be indicative of natural interannual variation driven by sea surface temperature, prey abundance, or other factors affecting both broad-scale population demographics and localized habitat usage.

Pacific Salmon (*Oncorhynchus* spp.) depend upon a wide range of habitats throughout their life cycle (Groot and Margolis 1991, Nightingale and Simenstad 2001). The nearshore zone along the mouth the Snohomish River, including the NAVSTA Everett shoreline, serves as an essential migration route for nearly all juvenile salmonids (natural and hatchery) produced in the Snohomish basin. When these juveniles enter the marine environment from their natal streams, they depend upon nearshore vegetated habitats for prey resources and shelter from predation. In this way, shallow nearshore habitats are critical to the survival of such species (Naiman and Seibert 1979; Simenstad 1979, 1980, 1982; Healey 1982; Johnson et al. 1997, Nightingale and Simenstad 2001). Overwater structures have been well documented to impact fish migration behavior and increase mortality by creating sharp underwater light contrasts in ambient daylight conditions as well as artificial lights cast during nighttime conditions (Nightingale and Simenstad 2001). A study specific to the Everett Harbor reported observations of fewer and smaller Chum Salmon schools at piers, while the greatest number and largest schools along the rip-rap shorelines (Pentec 1997). They further concluded that when the juvenile salmon encountered piers, they split up and moved around the piers. The overwater structures at the NAVSTA Everett occur directly at the mouth of the Snohomish River, and have the potential to negatively impact outmigrating juvenile salmonids.

Past surveys have documented the presence and timing of outmigrating juvenile salmonids within the Snohomish Estuary to begin in January and continue through the summer (Rowse and Fresh 2003, Rice et al. 2014). Both of these studies primarily focused on juvenile Chinook and Coho Salmon, with little to no mention of other salmonids. Overall, the relative abundance and timing of juvenile Chinook and Coho reported in these past studies appears to have remained stable, coinciding with the 2015-16 survey results. Hatchery releases also corresponded to abundance and timing of salmonids captured in past studies and the 2015-16 surveys. Millions of hatchery produced juvenile salmonids are released in the Snohomish River Basin every year to provide increased recreational and commercial harvest opportunities, as well as supplement the recovery and conservation of naturally-spawning salmon populations. Snohomish River basin hatchery releases were composed of approximately 55% unmarked fish in 2015 and 21% unmarked fish in 2016, meaning they could not be visually distinguished from naturally produced fish (see Appendix B and C).

Chinook Salmon was the only confirmed ESA-listed species captured at the NAVSTA Everett during 2015 and 2016 sampling. Chinook catch rates were highest in May and June for both survey years, but the rate in 2015 was only 30% of the rate recorded in 2016. Timing of Chinook catches closely corresponded to the hatchery release of over 3.5 million Chinook in the Snohomish River basin in May and June of both survey years, consisting of 91% adipose clipped fish. During both survey years, the majority (82%) of captured Chinook were hatchery produced (adipose clipped) rather than naturally produced (non-clipped) fish, which is consistent with the hatchery release marked fish rate. This 2015-16 data for Chinook is consistent with the timing and moderate catch rates reported from past studies in the Snohomish River estuary (Rowse and Fresh 2003, Rice et al. 2014).

Coho Salmon were captured at peak rates in May and sharply declined after June of both survey years. This trend corresponded with the hatchery releases of approximately 1.4 million total Coho in May of 2015-16, consisting of approximately 96% adipose clipped fish. However, only 41% of captured Coho in 2015-16 were hatchery produced (adipose clipped). Surveys at other Navy installations in 2015-16 also observed this disproportionately low catch rate of hatchery produced Coho. This 2015-16 data for Coho is consistent with the timing and moderate catch rates reported from past studies in the Snohomish River estuary (Rowse and Fresh 2003, Rice et al. 2014).

Chum and Pink Salmon dominated the catch during March and April in 2016, which was missed in 2015 due to the later sampling start date in May. Chum Salmon were encountered at very high densities in May 2015 and April 2016, which corresponded with the hatchery releases in April of both years. The high densities of Pink Salmon juveniles encountered in 2016 sampling correspond with the species' biennial spawning in Puget Sound rivers, and likely from hatchery releases throughout other Puget Sound regions.

In regards to fish passage around the carrier pier from the western to eastern sites, it appears that outmigrating juvenile salmonids potentially originating from the Snohomish River are distributed throughout all sampling sites. In an attempt to make definitive conclusions about Snohomish River-origin juvenile salmonid passage under or around the carrier pier, every captured Coho Salmon was scanned for CWTs in 2016, but none were detected. To test the accuracy of the CWT reader, many adipose-clipped Chinook Salmon were also scanned and confirmed to contain CWTs. However, Chinook were not permitted to sacrifice in this study and could not be processed for hatchery origin. Only 11% of all hatchery released Coho in 2016 were marked with a CWT, so the odds of detection were not in our favor. Further recommendations to reveal successful fish passage around the carrier pier may include another attempt to collect CWTs from Coho and Chinook Salmon with more frequent sampling that begins earlier in May. Additional sampling with a purse seine along the carrier pier and FSB may supplement any results that indicate the level of fish passage success from the Snohomish River to the eastern waterway. Another consideration would be to include beach seine sampling along the shoreline of Jetty Island, which may indicate the extent of juvenile salmonid outmigrants using the western shoreline of the Snohomish River mouth.

Conclusions

Overall, the relative timing and abundance of forage fish and salmonids sampled with a beach seine in 2015 and 2016 were consistent with past surveys conducted within the Snohomish River basin. Collectively, these studies indicate that whatever impacts to the nearshore habitat, as used by juvenile salmonids and forage fish, due to the NAVSTA Everett facilities remain uncertain. Since the many complex overwater structures along the PGNRA shoreline occur over 'saltwater habitats of special concern' (WAC 220-660-320), mitigation including periodic monitoring of fish and habitat is recommended to ensure optimal health.

Rockfish surveys conducted by the WDFW in 2015 found that neither the habitats nor depths recorded were consistent with known associations of ESA-listed rockfish species elsewhere in Puget Sound. We further concluded that the PGNRA is unlikely to support ESA-listed rockfish species at any life history stage or their preferred habitats (see Frierson et al. 2016).

The only confirmed ESA-listed species captured while beach seining at the NAVSTA Everett was juvenile Chinook Salmon, with peak catch rates occurring in May and June during both 2015 and 2016 surveys. Based on results from 2015-16, we preliminarily conclude that in order to reduce impact on juvenile salmon, the work window (July 15 to February 15) for the NAVSTA Everett facility's in-water

maintenance, military construction (MILCON), mitigation projects, future Fleet training and testing should not include March through July, as is consistent with the measures outlined in WAC 220-660-330.

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Appendix A: Comprehensive list of all fish species recorded at the NAVSTA Everett in 2015 and 2016 with the beach seine. Taxonomic nomenclature and phylogenetic organization follows arrangement from Pietsch and Orr (2015) unless otherwise noted.

TAXON	COMMON NAME
CLUPEIFORMES	**HERRINGS**
Engraulidae	**Anchovies**
Engraulis mordax	Northern Anchovy
Clupeidae	**Herrings and Sardines**
Clupea pallasii	Pacific Herring
OSMERIFORMES	**FRESHWATER SMELTS**
Osmeridae	**Smelts**
Hypomesus pretiosus	Surf Smelt
SALMONIFORMES	**TROUTS**
Salmonidae	**Trouts and Salmon**
Oncorhynchus clarkii	Cutthroat Trout (coastal)
Oncorhynchus gorbuscha	Pink Salmon
Oncorhynchus keta	Chum Salmon
Oncorhynchus kisutch	Coho Salmon
Oncorhynchus tshawytscha	Chinook Salmon
GASTEROSTEIFORMES	**STICKLEBACKS**
Gasterosteidae	**Sticklebacks**
Gasterosteus aculeatus	Threespine Stickleback
Syngnathidae	**Pipefishes**
Syngnathus leptorynchus	Bay Pipefish
SCORPAENIFORMES	**MAIL-CHEEKED FISHES**
Hexagrammidae	**Greenlings**
	Greenling unidentified
Cottidae	**Sculpins**
Artedius fenestralis	Padded Sculpin
Oligocottus maculosus	Tidepool Sculpin
PERCIFORMES	**PERCHES**
Embiotocidae	**Surfperches**
Brachyistius frenatus	Kelp Perch
Cymatogaster aggregata	Shiner Perch
Embiotoca lateralis	Striped Seaperch
Rhacochilus vacca	Pile Perch
Pholidae	**Gunnels**
Pholis laeta	Crescent Gunnel
Ammodytidae	**Sand Lances**
Ammodytes personatus	Pacific Sand Lance
PLEURONECTIFORMES	**FLATFISHES**
Paralichthyidae	**Sand Flounders**
Citharichthys sordidus	Pacific Sanddab
Pleuronectidae	**Righteye Flounders**
Parophrys vetulus	English Sole

Appendix B: Hatchery releases in the Snohomish River (SNOH) basin during 2015. Data summarized from the Regional Mark Information System (RMIS).

Species	Release Basin	Release Year	Release Month	CWT only	CWT + Ad Clip	Unmarked	Ad Clip only	Mean Length (mm)
Chinook	SNOH	2015	April		69,515	5,341	348,752	166
Chinook	SNOH	2015	May	109,178	112,812		2,259,814	
Chinook	SNOH	2015	June	200,277	198,443	8,832	658,763	90
TOTAL				**309,455**	**380,770**	**14,173**	**3,267,329**	
Chum	SNOH	2015	April			6,500,000		
TOTAL						**6,500,000**		
Coho	SNOH	2015	February			300		
Coho	SNOH	2015	March				60,000	
Coho	SNOH	2015	April			5,106		
Coho	SNOH	2015	May	44,835	106,570	16,936	1,453,717	128
Coho	SNOH	2015	July				250	
Coho	SNOH	2015	September			12	120	
TOTAL				**44,835**	**106,570**	**22,354**	**1,514,087**	
Cutthroat	SNOH	2015	June			51,391		
Cutthroat	SNOH	2015	July			710		
Cutthroat	SNOH	2015	September			230		
Cutthroat	SNOH	2015	October			8,162		
Cutthroat	SNOH	2015	November			18,040		
TOTAL						**78,533**		
Steelhead	SNOH	2015	February			103	3,986	
Steelhead	SNOH	2015	April			7,638	361,993	201
Steelhead	SNOH	2015	October			34	3,966	
TOTAL						**7,775**	**369,945**	

Appendix C: Hatchery releases in the Snohomish River (SNOH) basin during 2016. Data summarized from the Regional Mark Information System (RMIS).

Species	Release Basin	Release Year	Release Month	CWT only	CWT + Ad Clip	Unmarked	Ad Clip only	Mean Length (mm)
Chinook	SNOH	2016	April	1,615	78,753	7,779	379,240	151
Chinook	SNOH	2016	May	110,200	109,829	18,470	2,150,196	
Chinook	SNOH	2016	June	205,864	203,964	3,422	687,157	84
TOTAL				**317,679**	**392,546**	**29,671**	**3,216,593**	
Chum	SNOH	2016	March			947,968		
TOTAL						**947,968**		
Coho	SNOH	2016	February			249		
Coho	SNOH	2016	March			327	60,000	
Coho	SNOH	2016	April			14,308		
Coho	SNOH	2016	May	45,213	108,988	3,030	1,191,699	132
Coho	SNOH	2016	June			250		
TOTAL				**45,213**	**108,988**	**18,164**	**1,251,699**	
Cutthroat	SNOH	2016	May			5,000		
Cutthroat	SNOH	2016	June			43,060		
Cutthroat	SNOH	2016	July			60		
Cutthroat	SNOH	2016	August			700		
Cutthroat	SNOH	2016	September			260		
Cutthroat	SNOH	2016	October			5,672		
Cutthroat	SNOH	2016	November			19,241		
TOTAL						**73,993**		
Steelhead	SNOH	2016	April			2,615	419,762	205
Steelhead	SNOH	2016	May			68	18,257	197
TOTAL						**2,683**	**438,019**	