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

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Naval Facilities Engineering Command Northwest (NAVFAC NW)

Submitted by:

The WDFW Marine Fish Science Unit

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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 Manchester Fuel Department (MFD), 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 MFD, specifically the areas adjacent to the Manchester Fuel Department Naval Restricted Area (MFDNRA), was surveyed by the WDFW in 2015 and 2016. 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 beach seine and scuba divers would be used to survey the MFDNRA and immediate adjacent areas. Beach seine surveys targeted forage fish and juvenile salmonids in the nearshore, while scuba survey techniques were specific to rockfish and critical habitat evaluation. Surveys for rockfish were conducted once in October 2015, while beach seining surveys occurred monthly in 2015 and 2016 in order to detect any temporal changes in fish abundance or distribution. 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 recorded at the MFD was juvenile Chinook Salmon, with peak catch rates occurring in June 2015 and March 2016. Based on results from the 2015-16 surveys, we preliminarily conclude that the work window (August 1 to February 15) for the MFD facilities' 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 MFD installation.

Methods

Study Area

The MFD is located along the western shore of central Puget Sound at Orchard Point (Figure 1a). It includes the MFD Naval Restricted Area (MFDNRA), which encompasses an area of approximately 0.2km^2 around the fuel pier (Figure 1b). Environmental monitoring has occurred to assess conditions before, during, and after the fuel pier replacement which concluded in 1993 (see Weitkamp 1994). The majority of bottom habitat within the study area is considered featureless mud and sand (NOAA nautical chart 18449), with vegetative habitat features including nearshore eelgrass (*Zostera* spp.), macroalgal beds (e.g., Ulvales, Laminariales), and rocky substrates (WA DOE Coastal Atlas Map).

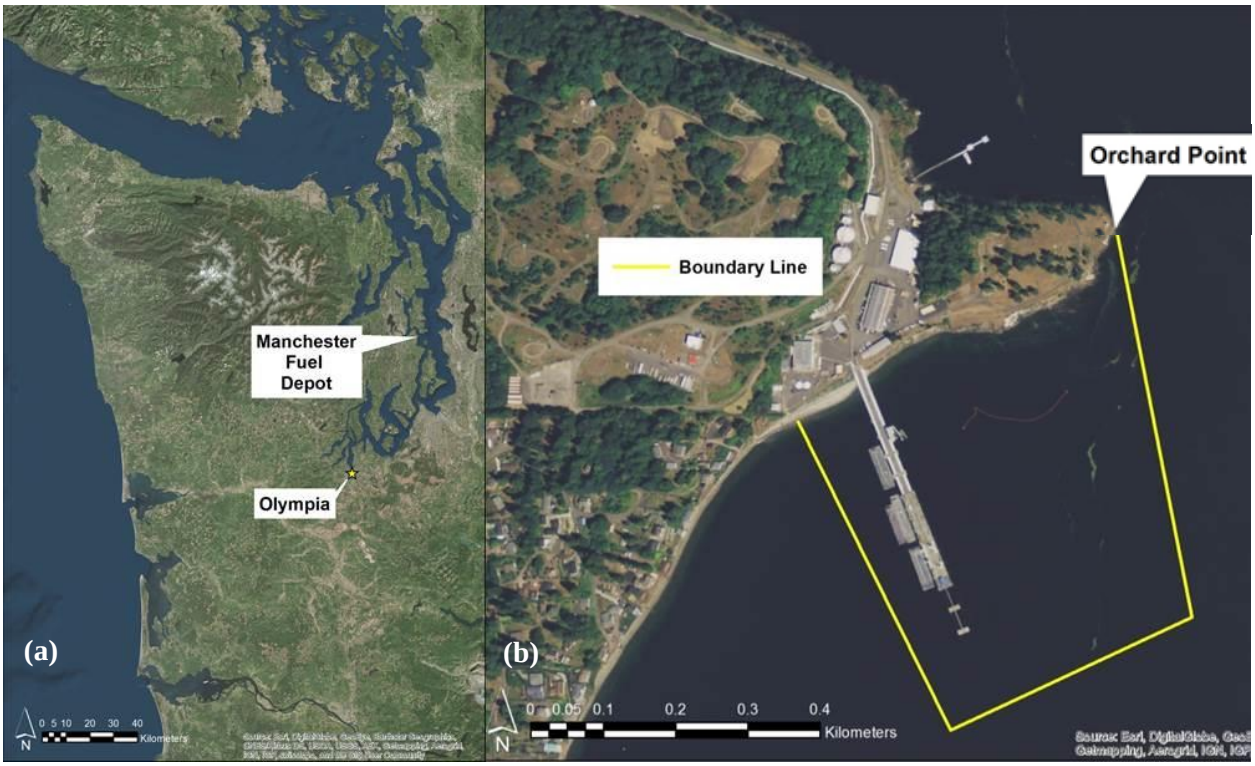

Figure 1. Orthophoto of the Manchester Fuel Department (MFD) location in Puget Sound (a) and the MFD Naval Restricted Area (MFDNRA) boundary line in yellow (b). Image from Esri DigitalGlobe.

Within the study area, survey sites were sampled with a beach seine at the shorelines west and east of the fuel pier, a pocket beach north of Orchard Point, the southeast shoreline of Clam Bay including the entrance to Little Clam Bay, and mouth of Beaver Creek (Figure 2). Each sampling site is classified as a distinct shoreform type, and exhibits various substrate and other habitat characteristics (WA DOE Coastal Atlas Map). The western shoreline of the fuel pier is classified as an accretion shoreform, with substrate consisting of deep sand. The eastern shoreline of the fuel pier is classified as a modified shoreform due to the rip rap shoreline armoring, with substrate consisting of coarse gravel and pebble with a sand base. There is historical documentation of Pacific Sand Lance (*Ammodytes personatus*) spawning on the beaches to the west and east of the fuel pier; and Orchard Point has been identified as a pre-spawner holding area for Pacific Herring (*Clupea pallasii*) (WDFW online). The pocket beach site is located at the entrance to a pier within a bedrock-dominated section of shoreline classified as no appreciable-drift bedrock, with substrate consisting of deep sand. The other three sites adjacent to Clam Bay are classified as either modified or transport zones, with substrate consisting of gravel and pebble.

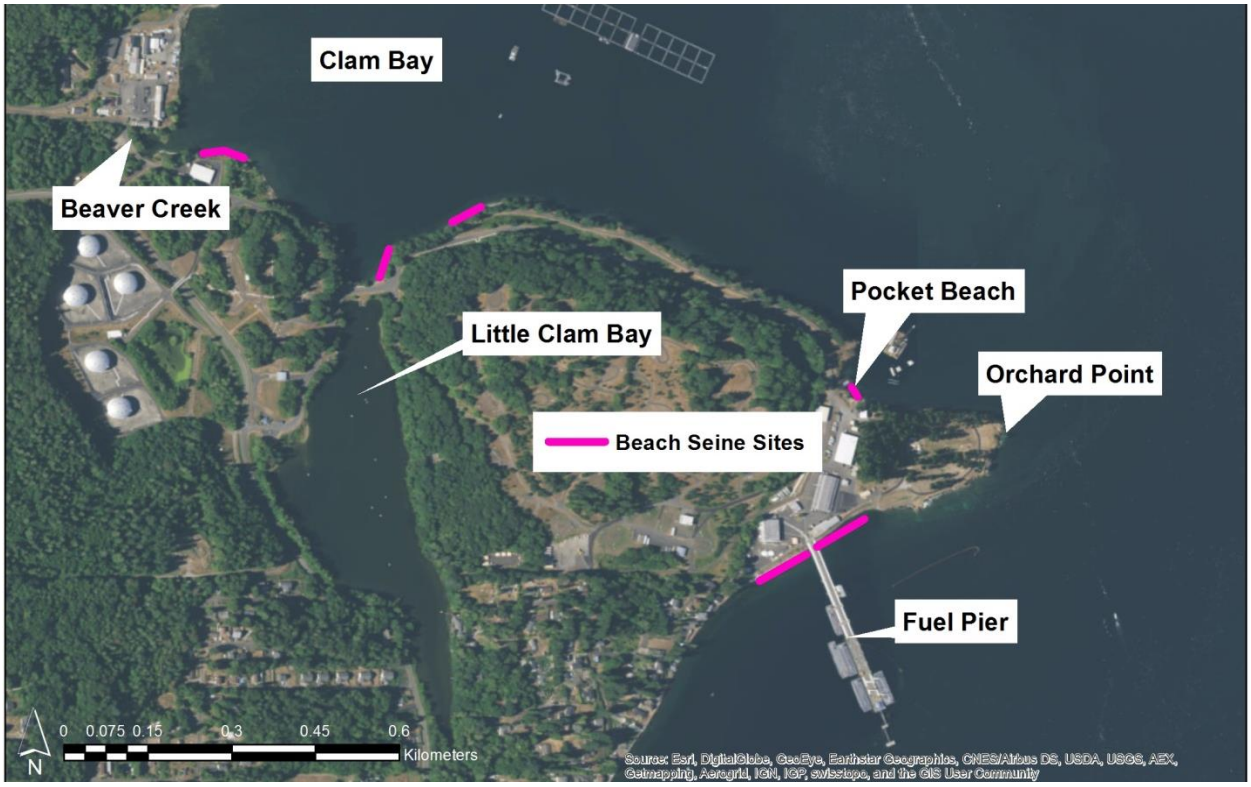

Figure 2. Orthophoto of the MFD identifying the beach seine survey sites and other key geographical features. Image from Esri DigitalGlobe.

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 the priorities of Navy personnel to determine fish presence and occupancy timing adjacent to the fuel pier and Clam Bay. These sites were sampled monthly from May to September in 2015 and March to September in 2016 at high-slack tides, which are known to be preferred by beach-spawning forage fish and migrating juvenile salmonids. A minimum of one to three beach seine "sets" were performed at each of the sites on a single date each month. Sampling typically began at the fuel pier, and subsequent sets were deployed along the southwestern shoreline of Clam Bay. 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 3). 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.

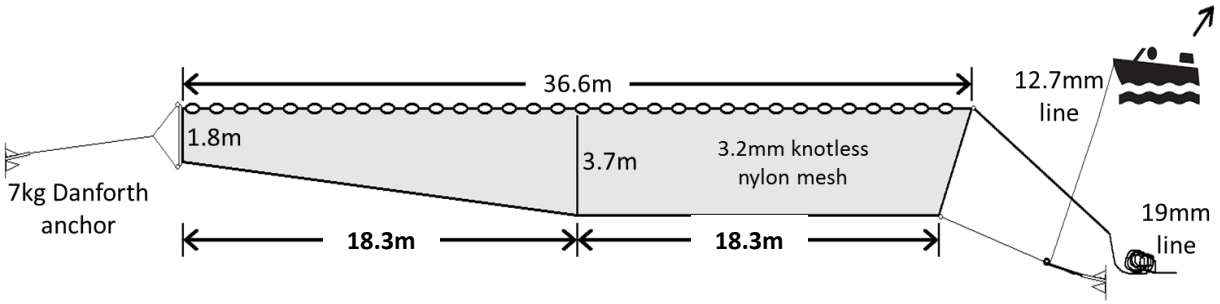

Figure 3. Diagram of the beach seine with dimensions used for sampling.

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 4). 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 5a). 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.

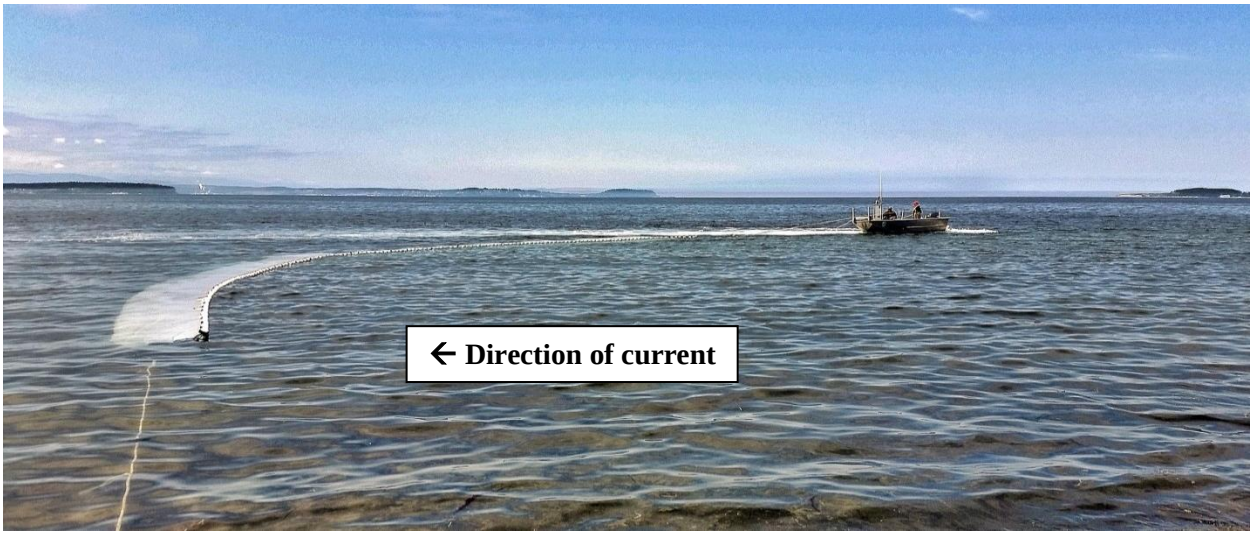

Figure 4. Photo taken while beach seining showing the "round haul" net deployment method into the current.

Figure 5. 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 5b). 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. 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 fuel pier within the MFDNRA once a month from May to September 2015 (see Figure 2). The pocket beach site to the north was only successfully sampled in June, July, and September. The pocket beach was not conducive for typical beach seine deployments, and over-water pier construction that occurred in August impeded the 2015 sampling rotation. A total of 29 sets were deployed in 2015, with one to three sets completed at each site on each day. Maximum nearshore water depths averaged 3.6m for the west fuel pier site, 2.9m for the east fuel pier site, and 3.7m for the pocket beach site.

A total of 29 fish species (including unidentified taxa) were captured over the five months of sampling at all sites. Overall catch composition consisted primarily of Threespine Stickleback (*Gasterosteus aculeatus*), Shiner Perch (*Cymatogaster aggregata*), Saddleback Gunnel (*Pholis ornata*), and Pacific Staghorn Sculpin (*Leptocottus armatus*) (Table 1). Species richness varied monthly from 12 to 22 species captured during each sampling event, with peak species richness observed in June (Figure 6). Fork lengths were recorded for a total of 8 forage fish and 116 salmonids during the five months of sampling at all sites combined (Table 2).

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

Species	11-May	8-Jun	7-Jul	6-Aug	22-Sep	Total	% of Total
# of Sets Completed	**12**	**22**	**20**	**16**	**18**	**29**	**-**
Bay Pipefish		8	4	7	3	22	1.10%
Buffalo Sculpin				1	5	6	0.30%
Chinook Salmon		17	11	5		33	1.64%
Chum Salmon	21	1				22	1.10%
Coho Salmon		7	17	1		25	1.25%
Crescent Gunnel	1	18	1			20	1.00%
Cutthroat Trout	2	5	11	7	12	37	1.84%
English Sole		18	40	62	1	121	6.03%
Flatfish (unidentified)	6	17	10			33	1.64%
Fluffy Sculpin			3		1	4	0.20%
Gunnel (unidentified)	75		2	8	46	131	6.52%
Pacific Sand Lance		1	1			2	0.10%
Pacific Staghorn Sculpin		41	41	35	19	136	6.77%
Padded Sculpin					6	6	0.30%
Penpoint Gunnel		24		4	4	32	1.59%
Pile Perch	31		6	1	2	40	1.99%
Pink Salmon		1				1	0.05%
Rock Sole	1				1	2	0.10%
Rockweed Gunnel		1	43	1		45	2.24%
Saddleback Gunnel		57	70	11	2	140	6.97%
Sculpin (unidentified)	4		2		1	7	0.35%
Shiner Perch		49	9	77	65	200	9.96%
Snake Prickleback		1				1	0.05%
Starry Flounder	2	4	16	22	18	62	3.09%
Surf Smelt	3	1	5			9	0.45%
Threespine Stickleback	1	44	*150169	3	566	*783	*38.99%
Tidepool Sculpin		25	6		23	54	2.69%
Tubesnout		27			2	29	1.44%
Whitespotted Greenling	3	1		1		5	0.25%

***** Total excludes an estimated 150,000 Threespine Stickleback captured in a single set in July.

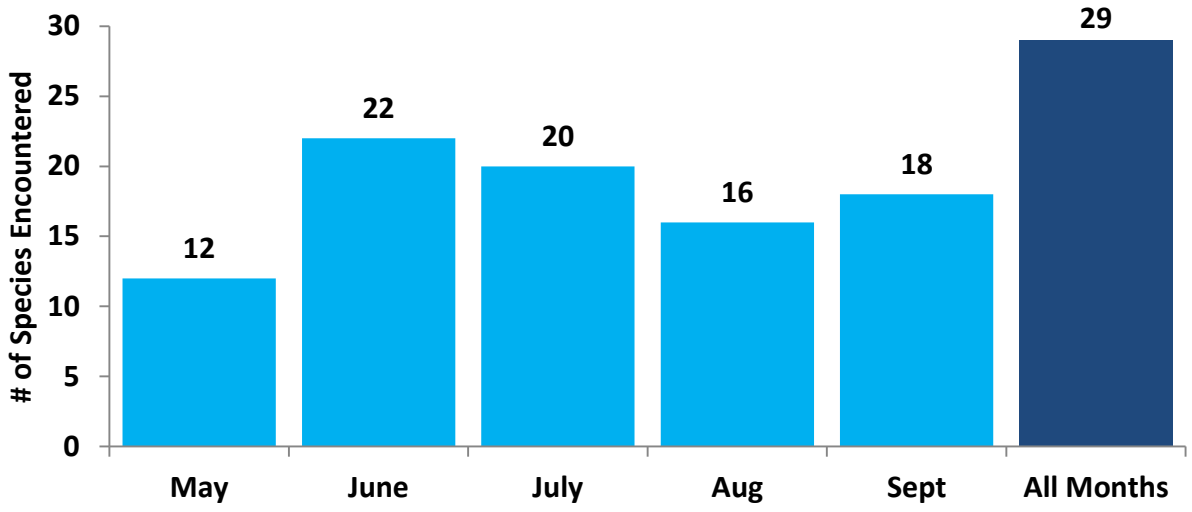

Figure 6. Species richness (including unidentified taxa) of all fish captured during beach seining, by month and all months combined in 2015.

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

Species	Mean ±SD	CV	n
Chinook natural	100.20 ±24.43	0.24	10
Chinook hatchery	92.00 ±19.16	0.21	23
Coho natural	117.67 ±31.31	0.27	9
Coho hatchery	117.00 ±29.89	0.26	16
Chum Salmon	53.27 ±9.69	0.18	22
Pink Salmon	96.00	-	1
Cutthroat Trout	242.17 ±70.18	0.29	35

Species	Mean ±SD	CV	n
Surf Smelt	63 ±25.00	0.40	6
Pacific Sand Lance	80 ±5.66	0.07	2

Very few forage fish were captured in 2015, which included Surf Smelt (*Hypomesus pretiosus*) (n=6) and Pacific Sand Lance (n=2), both occurring in June and July. Surf Smelt fork length data for all months combined showed high variation (CV=0.40), and a multimodal distribution of age-0 to age-1+ fish (Figure 7) with variation in length between sexes (Penttila 1978). Pacific Sand Lance fork length data indicated a single class of age-0 fish (Emmett et al. 1991, Greene et al. 2011).

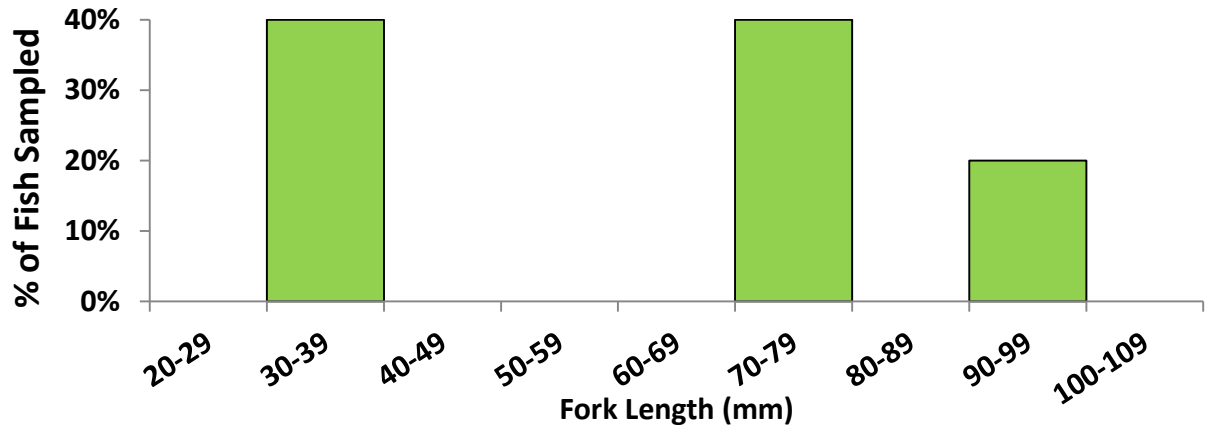

Figure 7. Surf Smelt fork length histogram for all months and sites combined in 2015.

Salmonid species captured in 2015 included Chinook Salmon, Chum Salmon, Coho Salmon (*O. kisutch*), Pink Salmon (*O. gorbuscha*), and Cutthroat Trout (*O. clarkii*) with variable catch rates occurring in May, June, and July (Figure 8). 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 9). Chinook Salmon catch rates were highest in June (2.4 fish/set) and July (1.6 fish/set), and declined in August (<1 fish/set). Chinook Salmon were further identified as 23 hatchery and 10 natural-origin fish for all 2015 sampling. Coho Salmon were captured at all sites with the peak catch rate occurring in July (2.4 fish/set), then declining in August (<1 fish/set). Coho Salmon included 16 hatchery and 9 natural-origin fish for all 2015 sampling events. Chum Salmon were mostly captured at the eastern fuel pier site with a peak catch rate in May (10.5 fish/set), and declined in June (<1 fish/set). A combined total of 35 Cutthroat Trout were captured at sites west and east of the fuel pier, with consistent catches occurring for each month of sampling. Cutthroat Trout fork length data for all months combined showed high variation (CV=0.29), and multiple age classes from juvenile to adult (Emmett et al 1991).

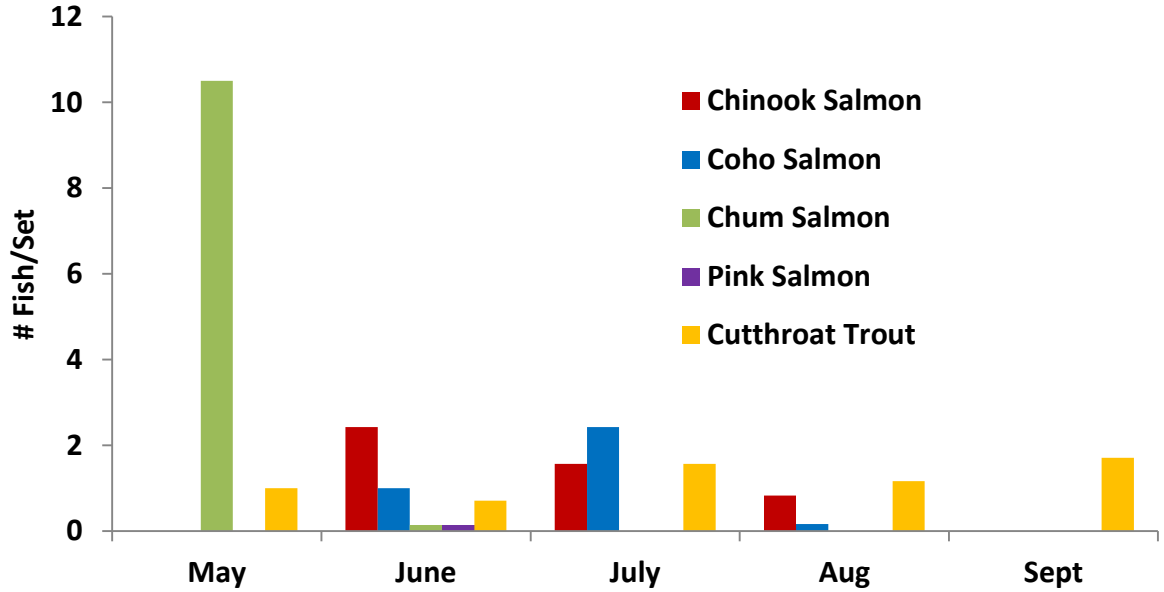

Figure 8. Catch rates for juvenile salmonid species captured during beach seining, by month for all sites combined in 2015.

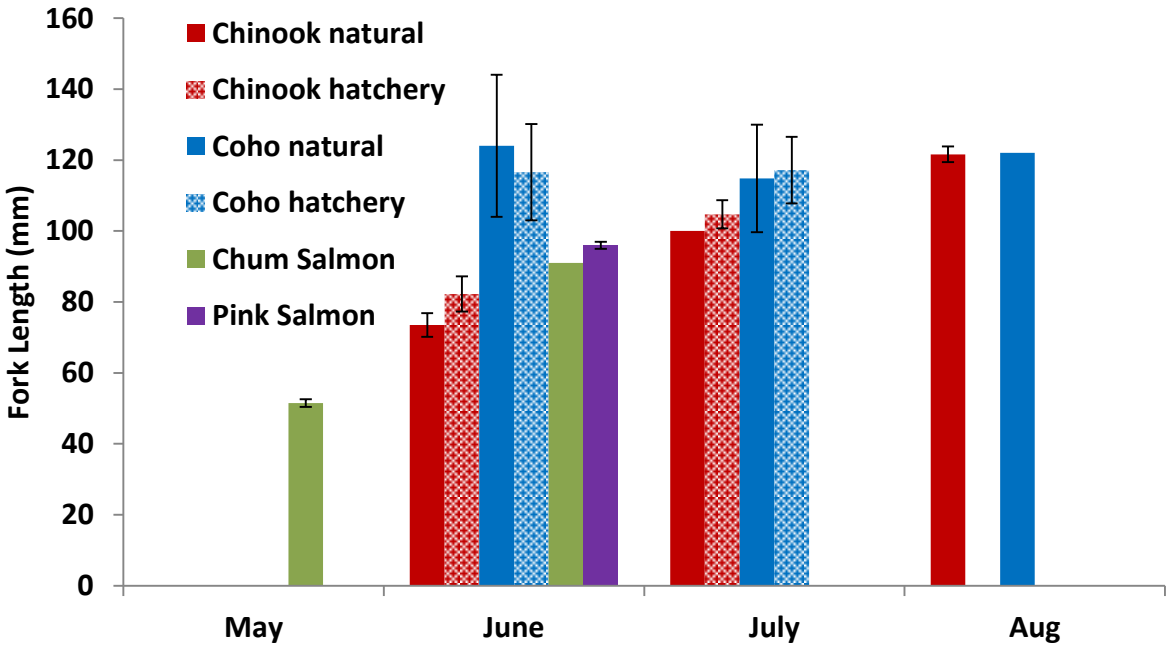

Figure 9. Mean fork length (± 1SE) for juvenile salmonid species by month for all sites in 2015.

Beach Seine Surveys in 2016

Beach seine sampling occurred at the shorelines west and east of the fuel pier, southeast shoreline of Clam Bay including the entrance to Little Clam Bay, and mouth of Beaver Creek once a month from March to September 2016 (see Figure 2). The sampling trip which occurred on March 31st will be referred to as the April dataset. A total of 64 sets were deployed in 2016, with one to three sets completed at each site on each day. Maximum nearshore water depths averaged 3.3m for the west fuel pier site, 2.6m for the east fuel pier site, 1.2m for the Beaver Creek site, and 3.3m for the Clam Bay sites.

A total of 28 fish species (including unidentified taxa) were captured over the seven months of sampling at all sites. Overall catch composition consisted primarily of Threespine Stickleback, Shiner Perch, and Surf Smelt (Table 3). Species richness varied monthly from 12 to 20 total species captured during each sampling event, with peak species richness observed in June (Figure 10). Fork lengths were recorded for a total of 182 forage fish and 291 salmonids during the seven months of sampling at all sites combined (Table 4).

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

Species	3-Mar	31-Mar	2-May	13-Jun	11-Jul	8-Aug	6-Sep	Total	% of Total
# of Sets Completed	**10**	**10**	**10**	**8**	**10**	**8**	**8**	**64**	-
Arrow Goby	1			2				3	0.01%
Bay Pipefish	2		8	19	3	2		34	0.09%
Buffalo Sculpin		1						1	<0.01%
Chinook Salmon	14		3	1		1		19	0.05%
Chum Salmon	349	202	9	1	3	5		569	1.51%
Coho Salmon	10	3		5				18	0.05%
Crescent Gunnel							2	2	0.01%
Cutthroat Trout	49	10	16	19	21	17	41	173	0.46%
English Sole	4	3		1	35	22	3	68	0.18%
Flatfish (unidentified)		2	12	26	31			71	0.19%
Fluffy Sculpin				1				1	<0.01%
Pacific Herring			2		1	1		4	0.01%
Pacific Sand Lance			37	1	3	1	2	44	0.12%
Pacific Staghorn Sculpin	5	3	27	236	404	141	71	887	2.35%
Padded Sculpin				1		2		3	0.01%
Penpoint Gunnel			1	6	9	7	2	25	0.07%
Pile Perch			4	4	8	19	8	43	0.11%
Pink Salmon	1	584	2					587	1.56%
Rock Sole	2							2	0.01%
Saddleback Gunnel				45	33	32	36	146	0.39%
Sculpin (unidentified)	7	152	39	3				201	0.53%
Shiner Perch			5302	854	1647	930	254	8987	23.84%
Sockeye Salmon					2			2	0.01%
Starry Flounder	7	3	6	34	71	51	79	251	0.67%
Surf Smelt		50	873	19	1085	3477		5504	14.60%
Threespine Stickleback	3	5	991	236	487	15294	3026	20042	53.17%
Tidepool Sculpin					2		1	3	0.01%
Tubesnout	1							1	<0.01%

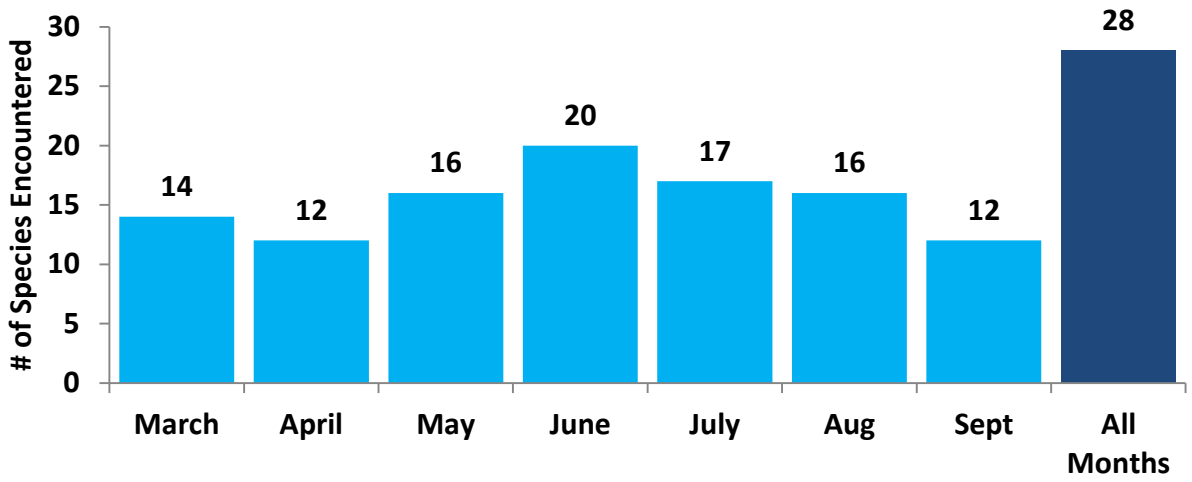

Figure 10. Species richness (including unidentified taxa) of all fish captured during beach seining, by month and all months combined in 2016.

Table 4. Fork length (mm) data summaries for juvenile salmonid (left) and all forage fish (right) species sampled in 2016. *Indicates adult salmonids (>300mm). Cutthroat Trout includes juveniles and adults.

Species	Mean ±SD	CV	n
Chinook natural	200.18 ±80.21	0.40	11
Chinook hatchery	234.75 ±51.60	0.22	8
Coho natural	230.00 ±83.16	0.36	3
Coho hatchery	220.14 ±65.88	0.30	7
Coho natural*	321 ±15.59	0.05	3
Coho hatchery*	357.8 ±32.87	0.09	5
Chum Salmon	65.48 ±45.54	0.70	58
Pink Salmon	40.57 ±5.12	0.13	23
Sockeye Salmon*	571	0.04	2
Cutthroat Trout	285.19 ±71.49	0.25	171

Species	Mean ±SD	CV	n
Surf Smelt	54.23 ±23.18	0.43	145
Pacific Sand Lance	58.67 ±14.44	0.25	33
Pacific Herring	92.75 ±47.67	0.51	4

Forage fish catch rates were remarkably higher for all the Clam Bay sites combined, while salmonid species catch rates were more evenly dispersed between the fuel pier and Clam Bay sites (Figure 11). Forage fish species captured in 2016 included Surf Smelt, Pacific Sand Lance, and Pacific Herring with variable peak catch rates that occurred from May through August sampling (Figure 12). Surf Smelt were captured at high densities from the Clam Bay sites during May (87.3 fish/set), July (108.5 fish/set), and August (434.3 fish/set). Surf Smelt fork length data for all months combined showed high variation (CV=0.43), and a primarily unimodal distribution of age-0 fish comprised of mixed broods (Figure 13) with variation in length between sexes (Penttila 1978). Pacific Sand Lance were encountered at peak catch rates in May (3.7 fish/set) and declined through September (<1 fish/set). Pacific Sand Lance fork length data indicated a bimodal distribution of age-0 to age-1+ fish (Emmett et al. 1991, Greene et al. 2011) (Figure 14). Pacific Herring were only captured at low rates (<1 fish/set) during May, July, and August. Fork length data for Pacific Herring indicated age-0 (n=2) and age-1 (n=2) fish.

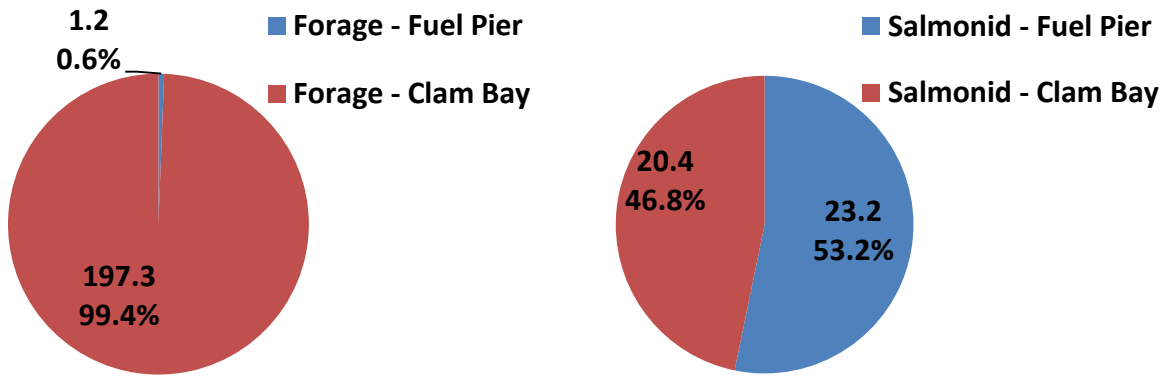

Figure 11. Catch rates (fish/set) and percentages within forage fish and salmonid species groups, separated by north and south sampling sites for all months combined in 2016.

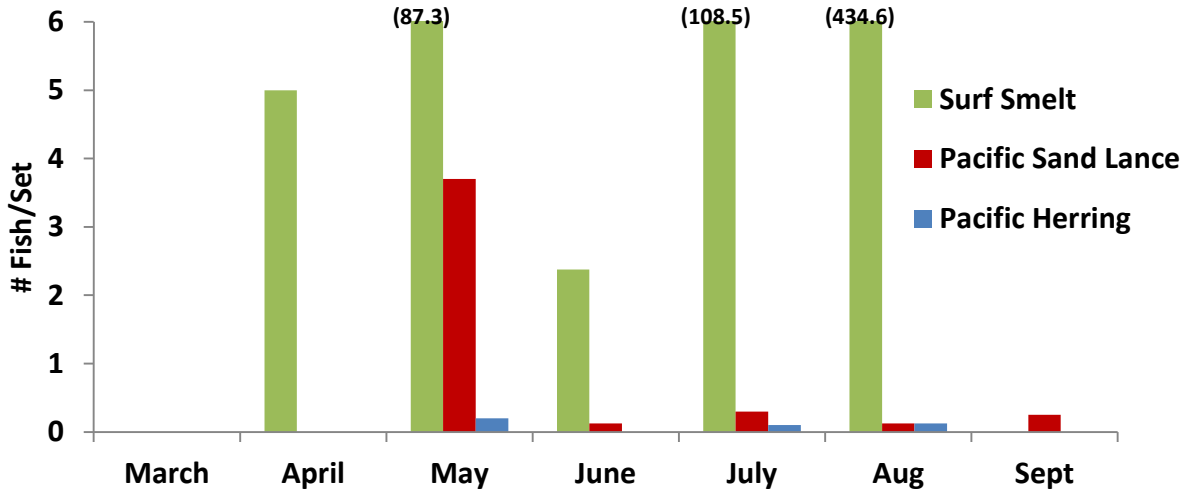

Figure 12. Catch rates for forage fish species captured during beach seining for all sites combined in 2016. Values are labeled for catch rates exceeding the vertical axis.

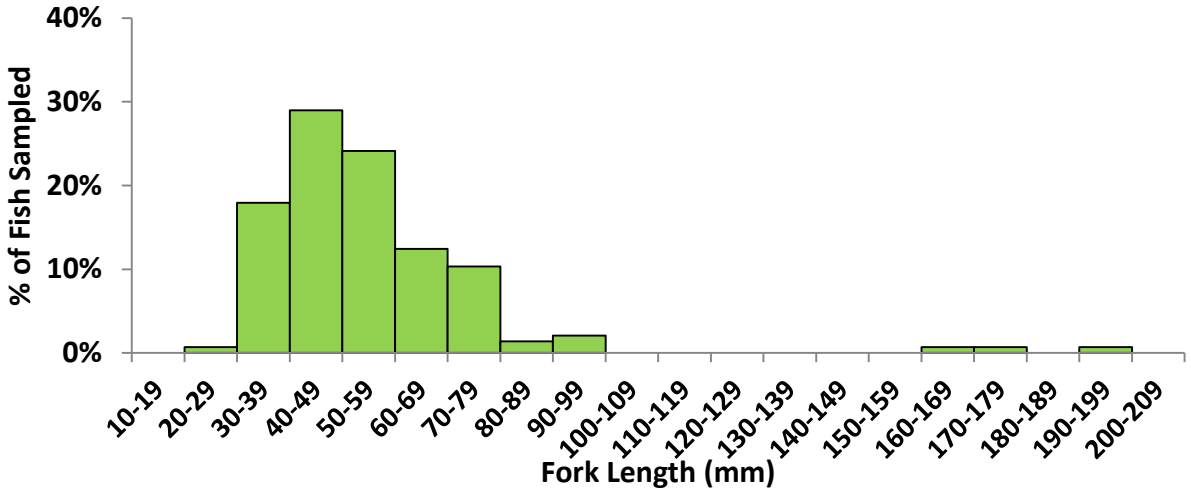

Figure 13. Surf Smelt fork length histogram for all months and sites combined in 2016.

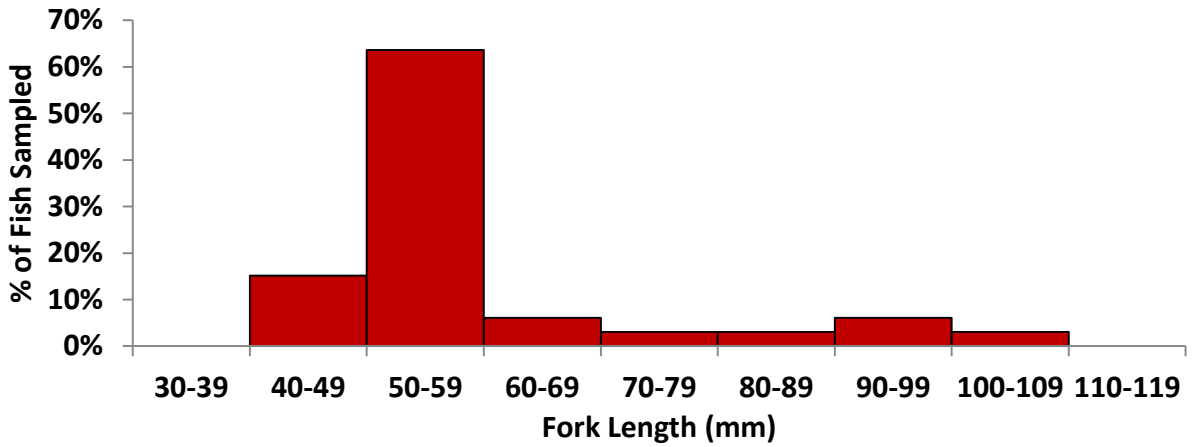

Figure 14. Pacific Sand Lance fork length histogram for all months and sites combined in 2016.

Salmonid species captured in 2016 included Chinook Salmon, Coho Salmon, Chum Salmon, Pink Salmon, Sockeye Salmon (*O. nerka*), and Cutthroat Trout with variable catch rates occurring throughout the entire sampling period (Figure 15). Outmigrating juvenile salmonid fork lengths increased for each species as expected from March through September, with the exception of larger resident Chinook and Coho Salmon captured only in March (Figure 16). Chinook Salmon captured in March at the fuel pier sites were all sub-adult fish too large to be outmigrating juveniles, and too small to be jack salmon. Chinook catch rates were highest in March (1.4 fish/set) and declined after May (<1 fish/set). Chinook Salmon were further identified as 8 hatchery and 11 natural-origin fish for all 2016 sampling. All the Coho Salmon captured in March and April at the fuel pier sites were either sub-adult fish (n=4) or resident fish (n=8); the peak catch rate occurred in March (1 fish/set) and declined through June (<1 fish/set). Coho Salmon included 12 hatchery and 6 natural-origin fish for all 2016 sampling events. Chum Salmon were mostly captured at the fuel pier sites with a peak catch rate in March (34.9 fish/set), and declined in May (<1 fish/set). A pair of adult Sockeye Salmon were captured west of the fuel pier in July. Cutthroat Trout were primarily captured at the sites east of Little Clam Bay, with peak catches occurring in March (4.9 fish/set) and September (5.1 fish/set). Cutthroat Trout fork length data for all months combined showed high variation (CV=0.29), and multiple age classes from juvenile to adult fish (Emmett et al. 1991).

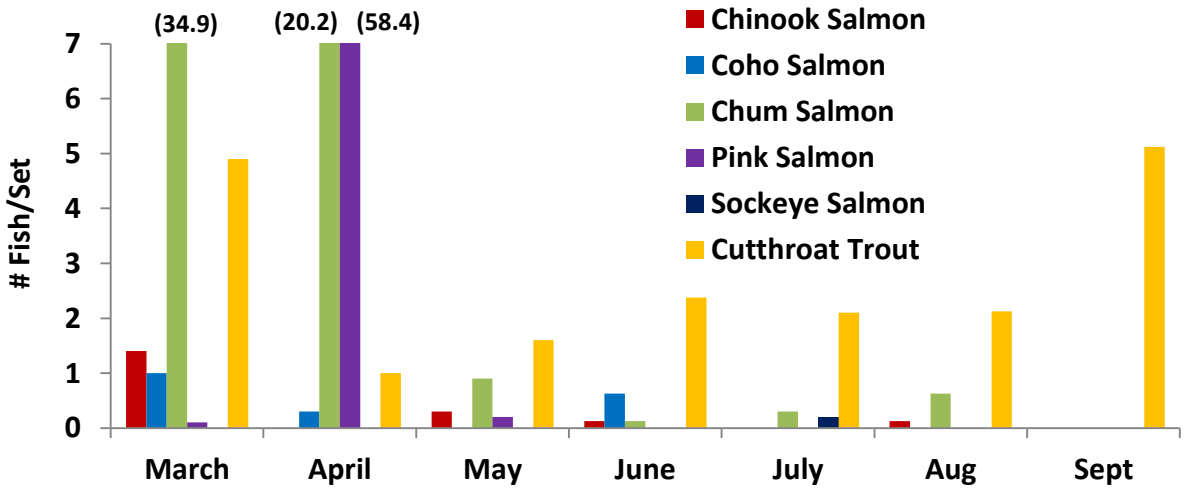

Figure 15. Catch rates for salmonid species captured at all sites combined in 2016. Values are labeled for catch rates exceeding the vertical axis.

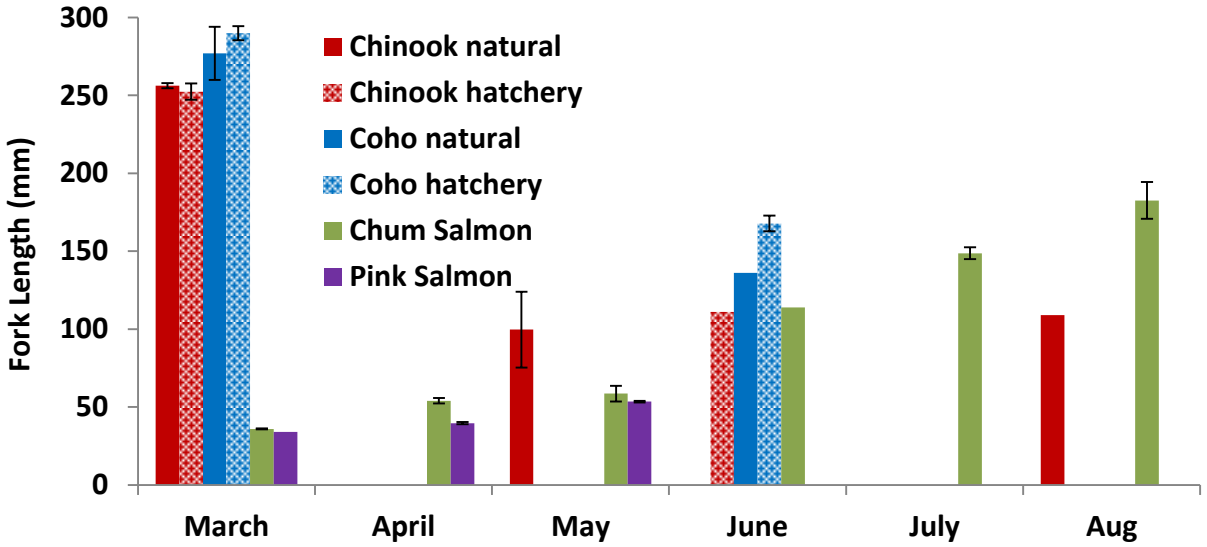

Figure 16. Mean fork length (± 1SE) for juvenile salmonid species by month for all sites in 2016.

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 within the MFD facilities and the MFDNRA. This report combines both 2015 and 2016 survey years with the intent to update and compare past surveys of forage fish and salmonids, conducted with a similar design, using a beach seine along the MFD shoreline. Past studies have also focused their sampling efforts from spring through summer to assess the different outmigration patterns of each salmonid species (see Dey 1991, Weitkamp and Dey 1993, Weitkamp 1994).

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). The extent of which the many overwater structures at the MFD that may impact forage fish spawning grounds remains uncertain. There is historical documentation of Pacific Sand Lance spawning on the beaches to the west and east of the fuel pier; and Orchard Point has been identified as a pre-spawner holding area for Pacific Herring (WDFW online). Spawning events for Surf Smelt, Pacific Sand Lance, and Pacific Herring are known to occur in the vicinity of the MFD from August to March (Penttila 1978). The maximum utilization of habitat for spawning within the survey area potentially occurred outside of our 2015-16 sampling window.

Forage fish were rarely encountered in 2015 when sampling only occurred at the fuel pier and pocket beach. However in 2016, Surf Smelt were captured in high densities at the sites within Clam Bay from May through August. Past studies with a beach seine encountered high densities of Surf Smelt and Pacific Sand Lance at the fuel pier in 1993, but very few of either species in 1991 or 1992 (Dey 1991,

Weitkamp and Dey 1993, Weitkamp 1994). However, these studies did not sample in Clam Bay. The disparities among these five different survey years (1991-1993 and 2015-16) 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 Fork length data taken for all species of forage fish indicate presence of age-0 and age-1 sub-adults utilizing nearshore habitat within the sampling areas. No ESA-listed species of forage fish (i.e., Eulachon) were captured during 2015 sampling.

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 throughout central and northern Puget Sound, including the MFD shoreline, serves as an essential migration route for millions of juvenile salmonids (natural and hatchery) produced in Puget Sound. 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). Salo et al. (1980) studied the effects of construction of Naval facilities on the outmigration of juvenile salmonids from Hood Canal; they concluded that the long-term effects of construction and operation upon the prey communities of outmigrating Chum and Pink Salmon fry were expected to be minimal as long as extensive areas of shallow eelgrass habitat were not destroyed. They also speculated that the illumination of the nearshore environment during nighttime was likely to alter the composition and standing stock of prey communities available to the salmon fry during their normal crepuscular feeding periods. Past studies at the MFD reported that their catch data suggested that juvenile salmonids were successfully migrating underneath the fuel pier, with few fish travelling around the pier (Weitkamp 1994).

The interannual timing and relative abundance of outmigrating juvenile salmonid species observed during corresponding sampling months in 2015 and 2016 showed similar trends to the past studies along the MFD shoreline (Dey 1991, Weitkamp and Dey 1993, Weitkamp 1994). Each of these studies reported that juvenile Chum Salmon were the predominant salmonid species captured with a beach seine, followed by Coho, Chinook, and Cutthroat Trout. They also reported that juvenile steelhead were very rarely captured. Overall, the relative abundance and timing of each juvenile salmonid species 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 throughout Puget Sound every year to provide increased recreational and commercial harvest opportunities, as well as supplement the recovery and conservation of naturally-spawning salmon populations. In 2015 and 2016, over 55% of all the hatchery releases in mid Puget Sound were composed of unmarked fish, meaning they could not be visually distinguished from naturally produced fish (see Appendix B and C).

Chum Salmon were captured at high densities during March 2016 sampling and quickly declined in May, which corresponded to the hatchery release of 7-8 million Chum in March and April 2015-16. However in 2015, high densities of Chum persisted through May, and the peak catch rate was likely missed due to the later sampling start date. Previous beach seine studies at the fuel pier have documented similar interannual variation for Chum Salmon peak abundance (Weitkamp 1994).

Very few Coho Salmon juveniles were captured in 2016, and the peak catch rate in June 2016 was only 26% of the peak rate recorded in July 2015. Larger resident Coho Salmon were captured in March and April 2016. This timing may have corresponded with the hatchery release of approximately 3 million

total Coho in April and May of 2015-16, consisting of approximately 90% adipose clipped fish. During both survey years, the majority (65%) of captured Coho 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 Coho is consistent with the timing and moderate catch rates reported from past studies at the MFD (Dey 1991, Weitkamp and Dey 1993, Weitkamp 1994).

Chinook Salmon was the only confirmed ESA-listed species captured at the MFD, with outmigrating juveniles occurring from May through August. However, the peak catch rate in May 2016 was only 11% of the peak rate recorded in June 2015. Larger sub-adults, presumably resident Chinook were only captured in March 2016. This timing corresponded to the hatchery releases of over ten million fish in April through June of 2015-16, consisting of approximately 77% adipose clipped fish. During both survey years, the majority (60%) 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 along the MFD shoreline (Dey 1991, Weitkamp and Dey 1993, Weitkamp 1994).

High densities of Pink Salmon juveniles were only captured during 2016 sampling from March through May, which corresponded with the species' biennial spawning in Puget Sound rivers. Past studies along the MFD shoreline did not report any Pink Salmon in their catches during 1992 (Weitkamp and Dey 1993).

The two adult Sockeye Salmon captured in July 2016 were most likely stray fish that intended to enter Lake Washington through the Ballard Locks, almost directly across Puget Sound from the MFD. The WDFW counts Sockeye every year as they pass the Ballard Locks' fishway, and the peak counts typically occur in June and July.

The highest densities of Cutthroat Trout captured with the beach seine occurred at the MFD, as compared to the other Naval properties during the 2015-16 sampling. Hybridization between Cutthroat Trout and steelhead (Rainbow Trout) has been documented in several streams along the North American west coast, and confirmed specifically from Puget Sound (Campton and Utter 1985, Moore et al. 2010). Tissue samples collected from captured Cutthroat Trout during 2016 sampling detected second generation hybridization with steelhead in one sampled fish at Clam Bay (east) in March. The genetic analysis results are detailed in a separate report funded by another cooperative agreement (Small et al. 2017). These data can provide some evidence to confirm our visual identification of Cutthroat Trout versus steelhead based on occasionally equivocal phenotypic traits observed in juveniles. Further recommendations for these data may include a contribution to the WDFW fishery managers to better understand their stock status and genetic stock structure.

Conclusions

Overall, the relative timing and abundance of forage fish and salmonids sampled with a beach seine in 2015 and 2016 were consistent with historical surveys conducted along the MFD shoreline. Collectively, these studies indicate that whatever impacts to the nearshore habitat, as used by juvenile salmonids and forage fish, due to the MFD facilities have remained consistent over time. Since the many complex overwater structures along the MFD 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.

In 2015, very few rockfish were observed directly associated with the rocky nearshore areas within the MFDNRA. None of the rockfish species recorded at the MFD facility in 2015 were ESA-listed. The

rocky nearshore areas found at Orchard Point overlap with essential features for juvenile rockfish. Based on the results from the 2015 scuba survey, we concluded that the MFDNRA has the potential to support juvenile ESA-listed rockfish species and their preferred habitats (see Frierson et al. 2016). Ongoing monitoring of these essential features is recommended to further assess rockfish recovery in Puget Sound.

The only confirmed ESA-listed species captured with the beach seine at the MFD facility was juvenile Chinook Salmon, as early as March and as late as August. Based on the results from 2015-16, we preliminarily conclude that in order to reduce impact on juvenile salmon, the work window (August 1 to January 15) for the MFD facilities' in-water maintenance, military construction (MILCON), mitigation projects, future Fleet training and testing should not include March through July, which 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 MFD 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**
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 nerka	Sockeye Salmon
Oncorhynchus tshawytscha	Chinook Salmon
GASTEROSTEIFORMES	**STICKLEBACKS**
Aulorhynchidae	**Tubesnouts**
Aulorhynchus flavidus	Tubesnout
Gasterosteidae	**Sticklebacks**
Gasterosteus aculeatus	Threespine Stickleback
Syngnathidae	**Pipefishes**
Syngnathus leptorynchus	Bay Pipefish
SCORPAENIFORMES	**MAIL-CHEEKED FISHES**
Hexagrammidae	**Greenlings**
Hexagrammos stelleri	Whitespotted Greenling
Cottidae	**Sculpins**
Artedius fenestralis	Padded Sculpin
Enophrys bison	Buffalo Sculpin
Leptocottus armatus	Pacific staghorn Sculpin
Oligocottus maculosus	Tidepool Sculpin
Oligocottus snyderi	Fluffy Sculpin
	Sculpin unidentified
PERCIFORMES	**PERCHES**
Embiotocidae	**Surfperches**
Cymatogaster aggregata	Shiner Perch
Rhacochilus vacca	Pile Perch
Stichaeidae	**Pricklebacks**
Lumpenus sagitta	Snake Prickleback
Pholidae	**Gunnels**
Apodichthys flavidus	Penpoint Gunnel
Apodichthys fucorum	Rockweed Gunnel
Pholis laeta	Crescent Gunnel
Pholis ornata	Saddleback Gunnel

Ammodytidae	**Sand Lances**
Ammodytes personatus	Pacific Sand Lance
Gobiidae	**Gobies**
Clevelandia ios	Arrow Goby
PLEURONECTIFORMES	**FLATFISHES**
Pleuronectidae	**Righteye Flounders**
Lepidopsetta spp.	Rock Sole
Parophrys vetulus	English Sole
Platichthys stellatus	Starry Flounder
	Flatfish unidentified

Appendix B: Hatchery releases in the Mid Puget Sound (MPS) region during 2015. Data summarized from the Regional Mark Information System (RMIS).

Species	Release Region	Release Year	Release Month	CWT only	CWT + Ad Clip	Unmarked	Ad Clip only	Mean Length (mm)
Chinook	MPS	2015	February			317		
Chinook	MPS	2015	March	32,705		397		
Chinook	MPS	2015	April		101,945		186,088	143
Chinook	MPS	2015	May	767,795	415,741	429,227	4,700,591	81
Chinook	MPS	2015	June	648	150,042	1,121,248	1,927,763	84
Chinook	MPS	2015	July		100,694	287	71,384	124
Chinook	MPS	2015	September			119	34,881	95
TOTAL				**801,148**	**768,422**	**1,551,595**	**6,920,707**	
Chum	MPS	2015	February			959,388		
Chum	MPS	2015	March			4,347,162		45
Chum	MPS	2015	April			3,231,016		52
Chum	MPS	2015	May			10,501		49
TOTAL						**8,548,067**		
Coho	MPS	2015	January			50,235		
Coho	MPS	2015	February	1,456	106,062	45,215	1,248	123
Coho	MPS	2015	March			161,467		
Coho	MPS	2015	April	76,713	144,270	96,492	1,795,938	129
Coho	MPS	2015	May	1,032	224,344	97,414	894,979	134
Coho	MPS	2015	June			12,830		
Coho	MPS	2015	December			72,000		
TOTAL				**79,201**	**474,676**	**535,653**	**2,692,165**	
Cutthroat	MPS	2015	January			154		
Cutthroat	MPS	2015	May			1,728		
Cutthroat	MPS	2015	June			8,930		
Cutthroat	MPS	2015	July			100		
Cutthroat	MPS	2015	September			100		
Cutthroat	MPS	2015	October			1,340		
TOTAL						**12,352**		
Sockeye	MPS	2015	February			2,032,034		32
Sockeye	MPS	2015	March			3,176,557		33
Sockeye	MPS	2015	April			85,892		32
TOTAL						**5,294,483**		
Steelhead	MPS	2015	April			37,935	113,522	174
Steelhead	MPS	2015	May			9,922		
Steelhead	MPS	2015	June			17	11,503	176
Steelhead	MPS	2015	October			172	19,828	
Steelhead	MPS	2015	November			59	6,861	
TOTAL						**48,105**	**151,714**	

Appendix C: Hatchery releases in the Mid Puget Sound (MPS) region during 2016. Data summarized from the Regional Mark Information System (RMIS).

Species	Release Region	Release Year	Release Month	CWT only	CWT + Ad Clip	Unmarked	Ad Clip only	Mean Length (mm)
Chinook	MPS	2016	April	45,016		7,213	639,957	105
Chinook	MPS	2016	May	759,431	869,783	529,346	7,562,693	78
Chinook	MPS	2016	June			1,210,000		105
TOTAL				**804,447**	**869,783**	**1,746,559**	**8,202,650**	
Chum	MPS	2016	February			80,000		
Chum	MPS	2016	March			3,336,156		49
Chum	MPS	2016	April			3,952,392		53
Chum	MPS	2016	May			368,159		61
Chum	MPS	2016	June			200		
TOTAL						**7,736,907**		
Coho	MPS	2016	February			123,330		
Coho	MPS	2016	March			62,733		
Coho	MPS	2016	April	96,831	316,527	94,775	1,317,674	122
Coho	MPS	2016	May	4,053	200,875	109,294	551,233	134
Coho	MPS	2016	June			10,142		
TOTAL				**100,884**	**517,402**	**400,274**	**1,868,907**	
Cutthroat	MPS	2016	January			350		
Cutthroat	MPS	2016	May			5,955		
Cutthroat	MPS	2016	June			10,202		
Cutthroat	MPS	2016	October			500		
Cutthroat	MPS	2016	November			350		
TOTAL						**17,357**		
Sockeye	MPS	2016	February			322,353		34
Sockeye	MPS	2016	March			2,661,870		32
TOTAL						**2,984,223**		
Steelhead	MPS	2016	January			40,000		
Steelhead	MPS	2016	April			30,748	11,800	147
Steelhead	MPS	2016	May			42,557	520	147
TOTAL						**113,305**	**12,320**	