Lummi Intertidal Baseline Inventory

Appendix C:
Intertidal Finfish Survey

Prepared by:

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Finfish sampling with a lampara net during high tide on May 21 2009.

A. LNR staff member Adam Pfundt (left), and NSEA volunteers Nate Lundgren and Ray Basonette process the catch from a set in Hale Passage.

B. A juvenile plainfin midshipman (*Porichthys notatus*) caught near Lummi Shore Road.

C. A juvenile salmon is identified and measured prior to release.

Executive Summary

The objective of the Intertidal Finfish Survey was to document the presence of fish across the Lummi Reservation tidelands over all seasons. Finfish monitoring was seen as a priority for data collection because of the lack of consistent information about finfish in eelgrass and tidal channel habitats. This appendix summarizes procedures and information that was collected as part of the Lummi Intertidal Baseline Inventory Intertidal Finfish Survey.

The LIBI collected monthly finfish samples from June 2008 to October 2009, using a lampara net. All fish in the catch were identified and enumerated, and with some high priority species the LIBI also collected length measurements, DNA samples, Coded Wire Tag (CWT) samples, and assessed gut contents.

In total, 34 finfish species were observed in the finfish survey. Catches and taxonomic richness were highest in the summer. Taxonomic richness was highest in eelgrass and channel habitats, and lowest on mudflats without vegetation or surface complexity.

The survey successfully documented that the Lummi Reservation tidelands play an important role in the early life history of many species that are important to the Lummi people, and also for other species that have ecological importance that contributes to the success of those species. The Reservation tidelands also provide an important migration corridor for returning adult salmonids. The dietary results suggest that these fishes are intimately connected with the tidelands and their populations would likely be negatively affected by adverse impacts to the tideland ecosystems.

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1.0 Introduction

Finfish such as salmon (family Salmonidae), forage fishes (families: Osmeridae, Ammodytidae, and Clupeidae), and ground fishes (families: Hexgrammidae, Gadidae, Batrachoididae) have been a part of Lummi subsistence, ceremonial, and commercial activities since time immemorial. Many of these fishes utilize intertidal waters for juvenile rearing (Hart 1980). The quality of food and refuge in intertidal areas are crucial in determining success of juveniles in future breeding (Pearcy 1992). Alterations to the Lummi Reservation tidelands and its habitats can thus have important implications for finfish populations that depend on them.

Salmon and forage fishes on the margins of the Reservation tidelands have been extensively assessed using a beach seine by Lummi Natural Resources (LNR) Fisheries Division staff (McKay 2004a; McKay 2004b; McKay 2005; McKay and Pfundt unpublished data). This work has identified the presence of out-migrating juvenile salmon smolts along intertidal areas and has been used to assess salmon residence patterns in intertidal habitats. In addition, LNR staff described the seasonal presence of forage fishes and performed low-intertidal and subtidal finfish surveys on, and adjacent to, the Nooksack Delta in Bellingham Bay to augment the existing beach seine survey data. This work provided a complete assessment of nearshore finfish presence on the Nooksack delta during the months sampled.

Washington Department of Fish and Wildlife (WDFW) has performed periodic trawls throughout the region to assess forage fish populations in Puget Sound and the Strait of Georgia (Lemberg *et al*. 1997; Bargman 1998; Stick 2005). The results of their work have indicated a dramatic decrease in adult herring abundance throughout the southern Strait of Georgia area. WDFW also conducts regional herring spawn surveys (Pentilla 1996; Stick 2005; Northwest Indian College, unpublished data) and has documented a decrease in spawn biomass over the last 20 years for Pacific herring (*Clupea pallasii*), sand lance (*Ammodytes hexapterus*), and surf smelt (*Hypomesus pretiosus*).

These previous finfish assessments adjacent to and across the Reservation tidelands provide an incomplete picture of finfish assemblages in intertidal areas. Beach seine activities of upper intertidal areas and results from trawls of pelagic waters usually exclude productive eelgrass meadows at low intertidal elevations in Portage Bay and Lummi Bay. Fishes other than salmon and forage fishes have not always been identified or enumerated, thus skewing assessments of past fish assemblages. Some fishes that may not be adequately represented in the data include: greenlings (Hexgrammidae), true cod (Gadidae), sand flounders (Paralichthyidae), righteyed flounders (Pleuronectidae), midshipmen (Batrachoididae), and surf perch (Embiotocidae), which are anecdotally known to be present in intertidal areas during high tide. Juveniles of these groups of fish are known to rear in intertidal areas (Hart 1980).

The LIBI Finfish Survey addressed these gaps in the available information. The LIBI efforts focused on deeper intertidal areas not reached by beach seine efforts and combined these results with past and present efforts to gain a complete picture of fish presence on the Reservation tidelands. Because previous data already provided some useful insight into finfish assemblages on the Reservation tidelands and many intertidal benthic species distributions were previously undocumented, the finfish work was given less priority in the allocation of the LIBI resources compared to the benthic surveys.

The objective of the finfish survey was to document the presence, timing, and size classes (age) of fishes within lower intertidal areas of the Reservation over the period of one year.

2.0 Methods

2.1 Field Methods

Fifteen sites were selected for monthly finfish collections, which were conducted from June 2008 to October 2009 by the LNR (Figure C.1). An additional site located in the Sandy Point Marina was included on October 2008 resulting in 16 sites in total. The sites were distributed across eelgrass meadows, pelagic waters, mudflats, channels, and rocky shores to represent the diversity of intertidal habitats on the Reservation. By sampling different types of habitats, catch richness was expected to increase and to provide the best representation of fish assemblages on the Reservation. Twice a month was the preferred sampling interval; however resource limitations meant that the sampling frequency was reduced to once a month only. Adverse weather conditions and mechanical difficulties sometimes precluded sampling (Table C.1).

Table C.1. LIBI Sampling Effort with Supplemental Beach Seine Effort Indicated (Grey boxes represent lampara sampling occurred, diamonds represents beach seine activities.)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008					♦	grey ♦	grey ♦	grey	grey	grey	grey	grey
2009	grey	grey	♦	grey ♦	grey ♦	grey	grey	grey	grey	grey		

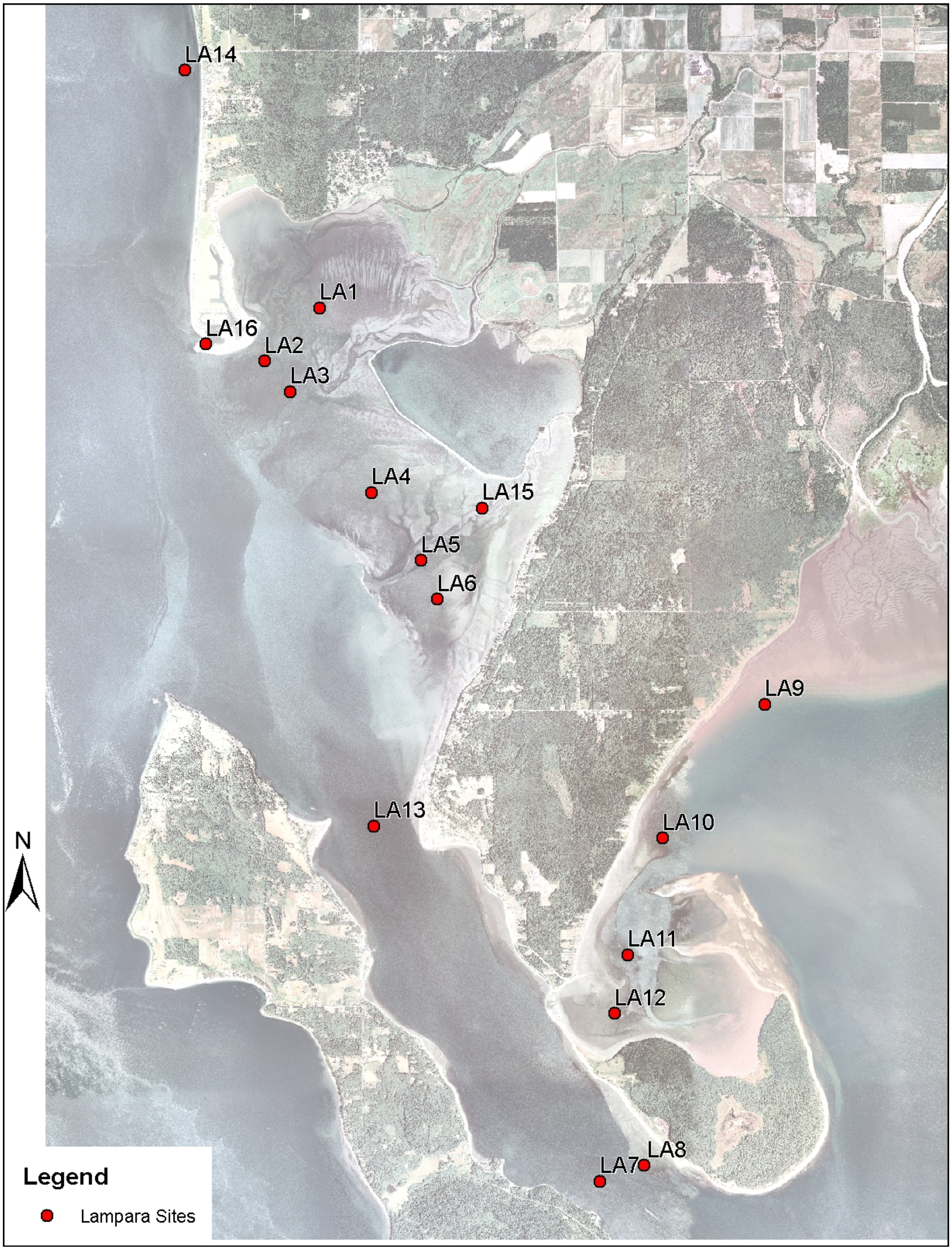


Figure C.1. LIBI Finfish Locations Sampled Using a Lampara Net

Fishes were collected at each site during flood tide using a boat to make round haul sets with a lampara net. A lampara net was deemed to be the most appropriate sampling gear for the LIBI finfish survey because the tidelands contain substrates ranging from rocky to sandy ground, and have extensive eelgrass meadows. Lampara nets are proven to be more effective than beach seines when operating from a boat over uneven ground (von Brandt 1984; Hayes *et al.* 1996). A lampara net is used similarly to a purse seine net by encircling fish both vertically and horizontally. The LNR lampara net dimensions used in the LIBI finfish survey were 12 feet (ft) by 300 ft with a terminal stretched mesh of 0.25 inches at the cod end.

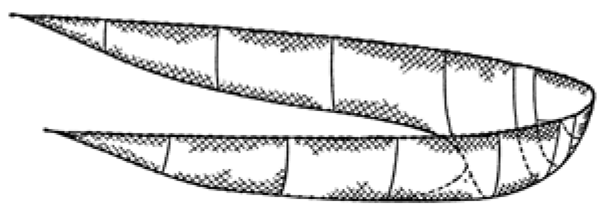


Figure C. 2. Diagram of a Lampara Net (FAO 2001-2009)

Once fish were collected, they were placed in a 5-gallon bucket with cool, well-oxygenated water. All fish were identified to species level and enumerated. Length measurements were taken for salmon, forage fishes, and ground fishes. Fish that required extra handling were anesthetized with MS-222 to limit harm to the fish. After the fish was anesthetized, it was allowed to recover within a bucket prior to release. Salmon have specific importance to tribal fishermen and hatchery-raised fish are uniquely marked to identify their origin. The LNR staff examined salmon species for external markings such as adipose fin clips, or internal markings such as coded wire tags. Fish with coded wire tags were removed for later analysis to determine the hatchery of origin. Caudal fin tissue samples were taken from Chinook salmon that had no apparent markings for later DNA microsatellite analysis to determine stock origin. Gastric lavage was also conducted on a subset of salmon individuals to determine dietary composition. Organisms within the stomachs were identified to the lowest possible taxonomic level.

Environmental conditions that have an effect on fishing quality, such as wind strength and wave height, were documented at each site. Water depth was measured with a Lowrance LMS-339 boat-mounted GPS (± 10 ft horizontal resolution) and sonar (± 0.5 ft vertical resolution). Salinity and temperature were measured with a calibrated YSI Model 85 hand-held meter at the surface and again at a depth of 6 feet. Water transparency was measured by secchi disc depth from the side of the boat. Where possible, LNR staff visited each location during low tide to document the intertidal habitats present at each site. These assessments were subjective classifications, and the categories used were: eelgrass, sand/mud flat, rock beach, tidal channel, and open water.

When appropriate, data collected during the LIBI finfish survey was combined with beach seine data from LNR's Stock Assessment Division. However, inconsistencies with the location and timing of beach seine samples limited the usefulness of the beach seine data within this analysis. Accordingly, beach seine information was only used to supplement the length-frequency plots, gut content analysis, fish presence, and the fish periodicity results for the Reservation tidelands.

2.2 Data Analysis

Changes in fish communities over time, and across the Reservation tidelands, were analyzed using the lampara catch information gathered as part of the LIBI project. The numbers of fish taxa present by month, by sub area, and by habitat type were visually assessed using box plots.

Beach seine information was included in the length frequency diagrams and the gut content analysis to increase the available sample size.

3.0 Results

3.1 Fish Communities

Over the course of the LIBI finfish survey, 34 species of finfish were observed on the Reservation tidelands (Table C.2). Species richness changed by season and varied across different intertidal habitats (Figure C.3). More species were present in catches from May to October than from November to April. For that reason, species richness was analyzed separately for the winter season (November to April) and the summer season (May to October) and then compared across geographic regions. Species richness tended to be higher in eelgrass habitats and channel habitats compared to mudflats, steep beaches, or open water. Therefore, geographic areas such as Lummi Bay and Portage Bay that contained habitats associated with higher species richness proved to show higher species richness (Figure C.4). Patterns in the absolute number of fish caught were similar to species richness. The number of fish caught increased during the summer months and were higher in eelgrass areas. Sites with eelgrass provided the highest catches during the finfish survey during the summer months.

Weather factors were analyzed for possible effects on the catch. Species richness was found to differ significantly ($\alpha = 0.05$) across wind speeds, and the number of fish caught differed significantly ($\alpha = 0.05$) with different wave heights (Table C.3). However, wind speed and wave heights are positively related to each other, and usually increase during the winter months. Because these weather factors are related to season, and both species richness and the number of fish caught were also related to season, observations were split into winter and summer seasons to assess whether wind speed and wave height really were significant factors. Within each season, the number of fish and the species richness in the catch were not found to significantly differ with wind speed and wave height. This suggests that season was the primary factor affecting the number of fish and species present, not weather conditions.

Table C.2. Finfish Species Observed During the LIBI Finfish Survey

Species	Mean	n	Standard error	% times present in set
Pacific Sanddab	0.03	4	0.11	2.0%
Speckled Sanddab	0.01	2	0.07	1.0%
Starry Flounder	0.56	47	0.20	23.6%
American Shad	0.01	1	0.07	0.5%
Anchovy	0.01	1	0.07	0.5%
Longfin Smelt	0.01	2	0.07	1.0%
Pacific Herring	32.70	102	9.22	51.3%
Sandlance	0.67	14	1.23	7.0%
Surf Smelt	4.59	72	1.66	36.2%
Pacific Cod	0.41	16	0.50	8.0%
Pacific Tomcod	0.01	2	0.07	1.0%
Kelp Greenling	0.01	2	0.07	1.0%
Lingcod	0.06	3	0.41	1.5%
Whitespotted Greenling	0.12	14	0.13	7.0%
Crescent Gunnel	0.08	8	0.20	4.0%
Penpoint Gunnel	0.09	8	0.26	4.0%
Saddleback Gunnel	0.28	17	0.41	8.5%
Snake Prickleback	6.93	23	15.97	11.6%
Chinook salmon	1.79	94	0.42	47.2%
Chum salmon	0.85	26	0.82	13.1%
Coho salmon	0.41	19	0.43	9.5%
Cutthroat	0.01	1	0.07	0.5%
Pink salmon	0.31	5	0.73	4.8%
Steelhead	0.02	3	0.07	1.5%
Buffalo sculpin	0.02	4	0.07	2.0%
Sailfin sculpin	0.02	1	0.21	0.5%
Staghorn sculpin	0.39	29	0.25	14.6%
Tidepool sculpin	0.01	2	0.07	1.0%
Pacific Spiny Dogfish	0.02	2	0.11	1.0%
Three-spine Stickleback	46.11	115	23.88	57.8%
Pile Perch	0.39	16	0.66	8.0%
Shiner Perch	35.34	94	10.80	47.2%
Bay Pipefish	0.27	33	0.12	16.6%
Plain Fin Midshipman	0.22	14	0.36	7.0%

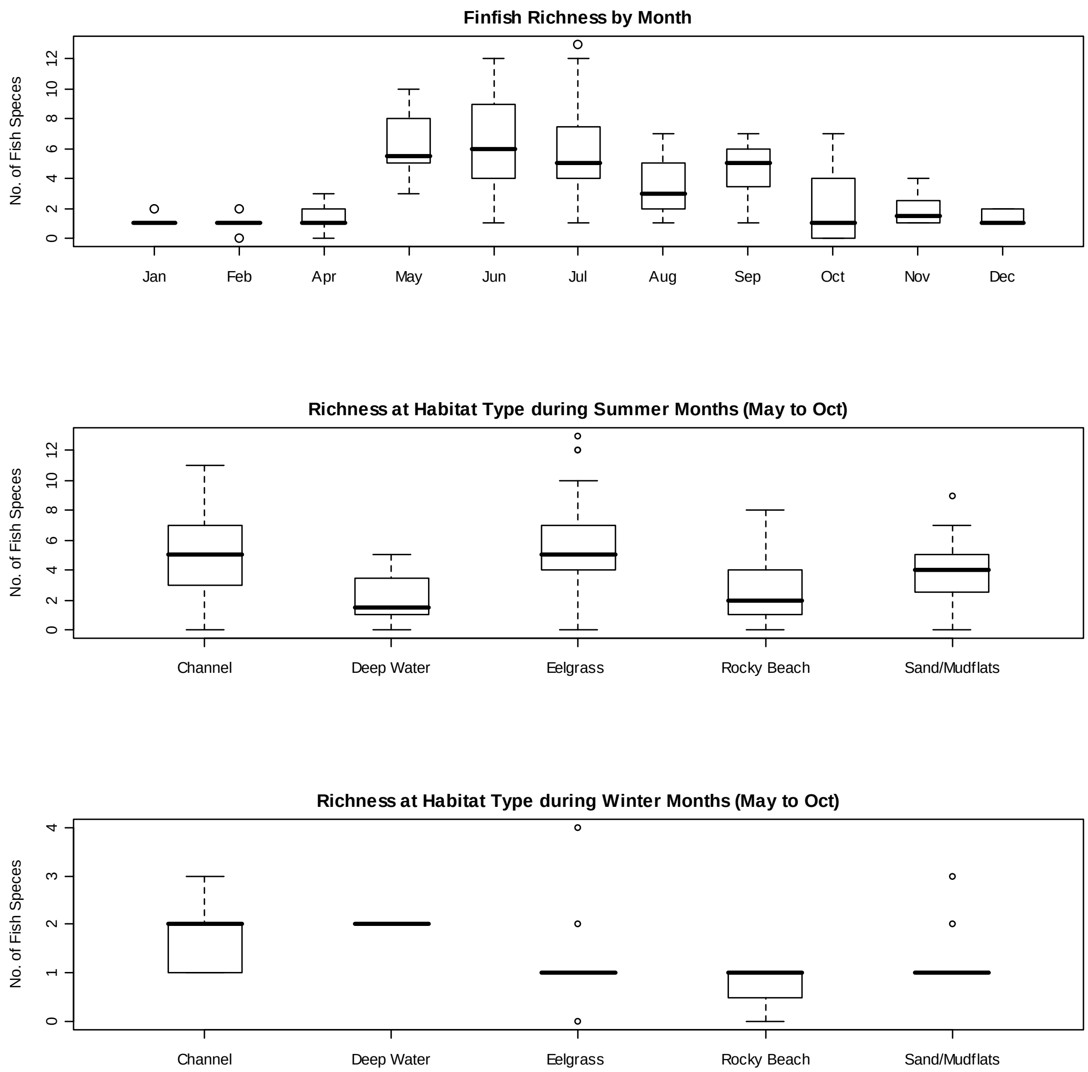
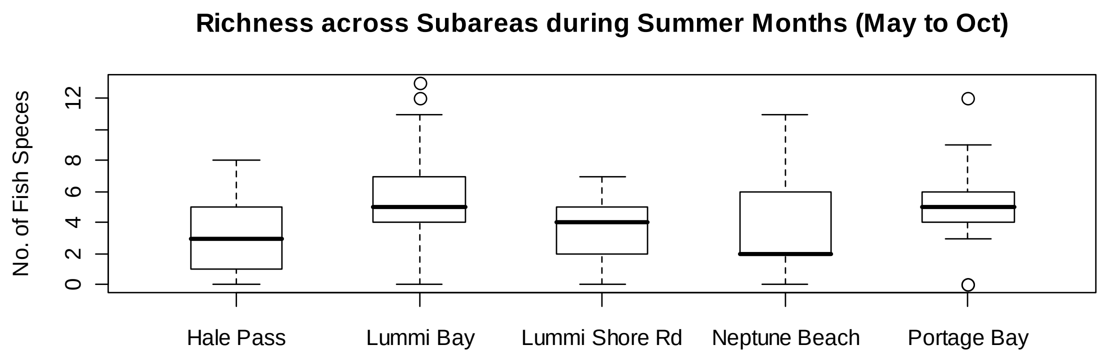


Figure C.3. Observed Species Richness by Month, Habitat Type from May to October, and Habitat Type from November to April at 16 Sites Across the Reservation Tidelands



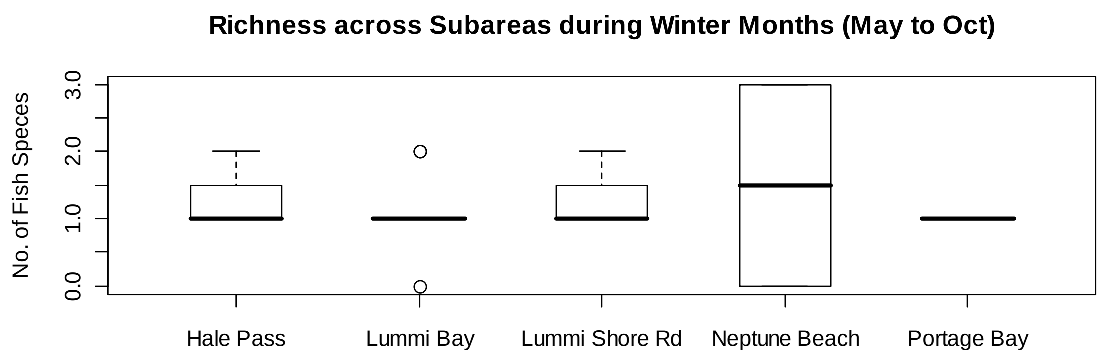


Figure C.4. Observed Species Richness by Geographic Area from May to October, and Geographic Area from November to April at 16 Sites Across the Reservation Tidelands

Table C.3. Total Catch and Species Richness Compared to Set Conditions Using a Kruskal-Wallis Comparison

	Total Catch		Species Richness	
	Chi-squared	p-value	Chi-squared	p-value
Set Quality Description	0.894	0.344	0.001	0.978
Secchi Depth (m)	90.27	0.300	83.40	0.498
Weather Description	6.239	0.101	5.842	0.120
Wind Speed (kts)	7.780	0.100	10.73	**0.030**
Wave Height (ft)	9.255	**0.026**	3.802	0.284

Bold values represent significant differences; p-value < 0.05

3.2 Fish Species of Interest

The LIBI Intertidal Finfish Survey identified some fish species that have specific interest to the Lummi people, and these were described independently. These fish by no means are a complete list of fishes harvested by the Lummi people, but were identified by Lummi Natural Resources Department staff as fish species of interest (Table C.4).

Table C.4. LIBI Finfish Survey Fish Species of Interest

Common Name	Genus	Species
Chinook Salmon	*Oncorhynchus*	*tshawytscha*
Coho Salmon	*Oncorhynchus*	*kisutch*
Chum Salmon	*Oncorhynchus*	*keta*
Pink Salmon	*Oncorhynchus*	*gorbuscha*
Pacific Herring	*Clupea*	*pallasii*
Surf Smelt	*Hypomesus*	*pretiosus*
Sand Lance	*Ammodytes*	*hexapterus*
Ling Cod	*Ophiodon*	*elongatus*
Whitespotted Greenling	*Hexagrammos*	*stelleri*

3.2.1 Chinook salmon

Marked and unmarked juvenile Chinook salmon were observed at all sites sampled in the LIBI study. Juvenile Chinook salmon were present in 47.2 % of the lampara sets. Catch per set was low and had an average of 1.79 juvenile Chinook salmon per set, with a standard error of 4.05.

Marked juvenile Chinook salmon were inconsistently observed in the catches over time, but compared to unmarked juvenile Chinook salmon, they were more abundant when they were present (Figure C.5). Unmarked juvenile Chinook salmon were more frequently observed than marked juvenile Chinook salmon at different sites, but they usually were less numerous (Figure C.6). Both marked and unmarked juvenile Chinook salmon catches were highest during the summer (May to October). Juvenile Chinook salmon were absent from all sites between November and April.

Since more than one age class (cohort) of Chinook salmon juveniles could potentially be present on the Reservation tidelands, we assessed the fork length of all Chinook salmon collected to determine the number of cohorts present (Figure C.7). Fork length varied by month across the Reservation tidelands. In spring and early summer, juvenile Chinook salmon generally exhibited one size class ranging from 50 mm to 100 mm. By mid summer, juvenile Chinook salmon fork lengths averaged 105 mm. In September and October, two size classes of juvenile Chinook salmon were observed: a small size class of approximately 125 mm fork length and a large size class of approximately 175 mm. This suggests either that juvenile Chinook salmon exhibit residency in intertidal areas, or alternatively, that there is an out-migration of two size classes from the Nooksack River. Results from the smolt trap operated by the LNR on the lower mainstem of the Nooksack

River (LNR, unpublished data) are more consistent with the former interpretation (i.e., juvenile Chinook exhibit residency in intertidal areas).

The diet composition of the juvenile Chinook salmon was diverse and tended to depend on fish size (Figure C.8, Figure C.9). Terrestrial insects and forage fish were the items observed most often in juvenile Chinook salmon gut lavages across months. Terrestrial insects provided a higher proportion of diet observed in smaller juvenile Chinook salmon, whereas forage fish provided a higher proportion of diet in larger juvenile Chinook salmon. Overall, organisms that inhabit intertidal areas were more common than organisms that inhabit other areas such as terrestrial or freshwater environments.

DNA and coded wire tag samples collected during the LIBI have been sent for analysis but the results of that analysis were not yet available at the time of writing this report.

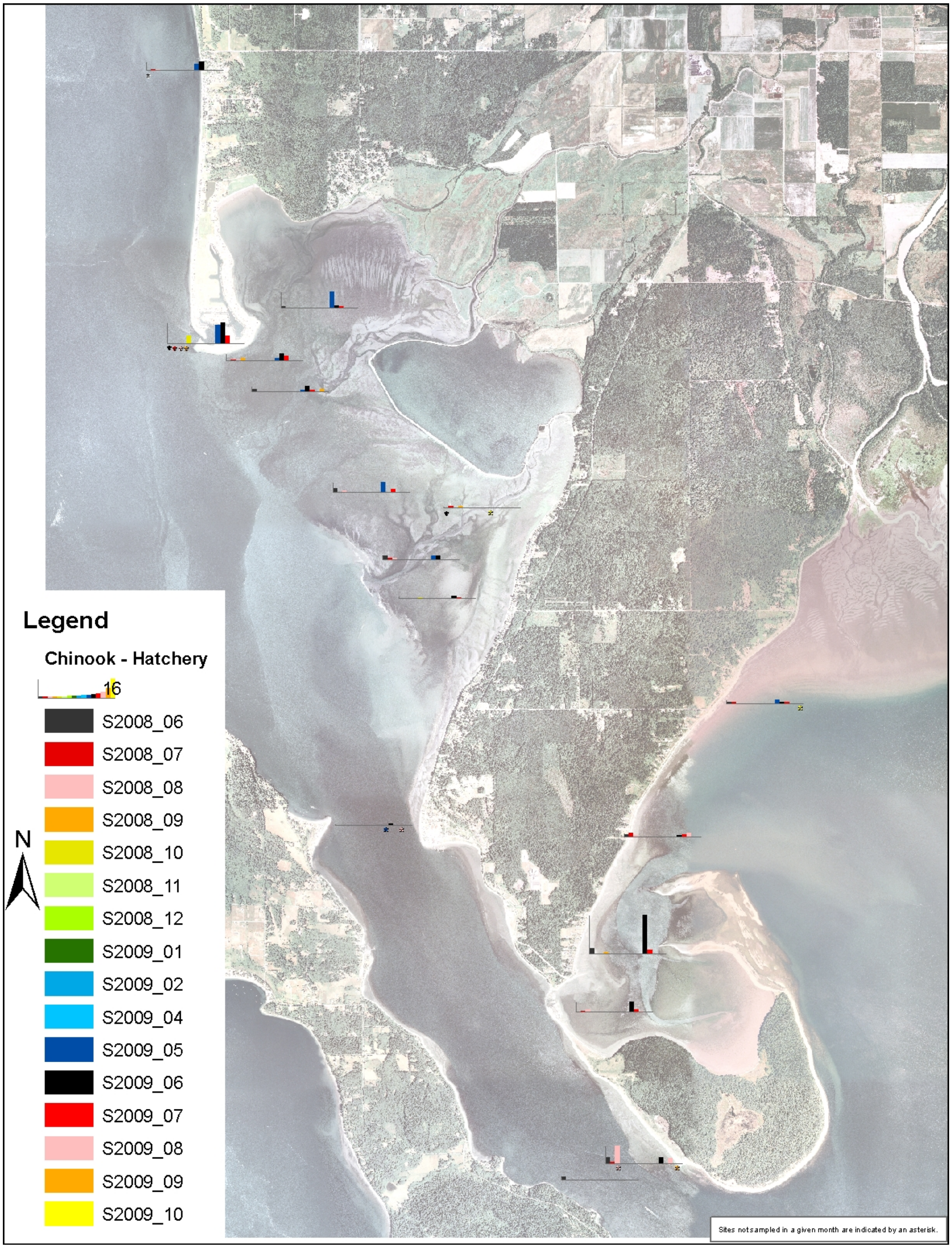


Figure C.5. Marked Juvenile Chinook Salmon Counts Across the Reservation from June 2008 to October 2009

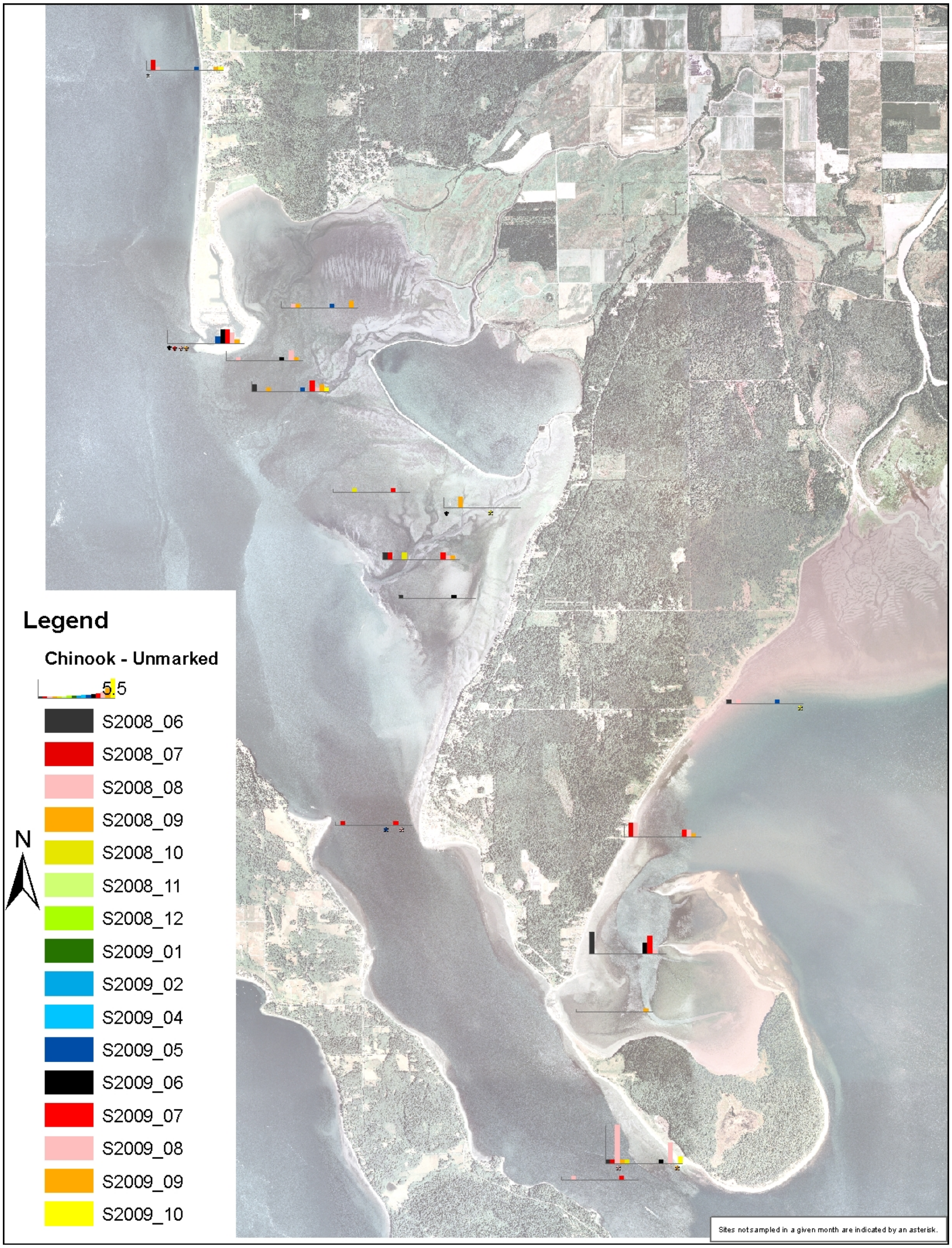


Figure C.6. Unmarked Juvenile Chinook Salmon Counts Across the Reservation from June 2008 to October 2009

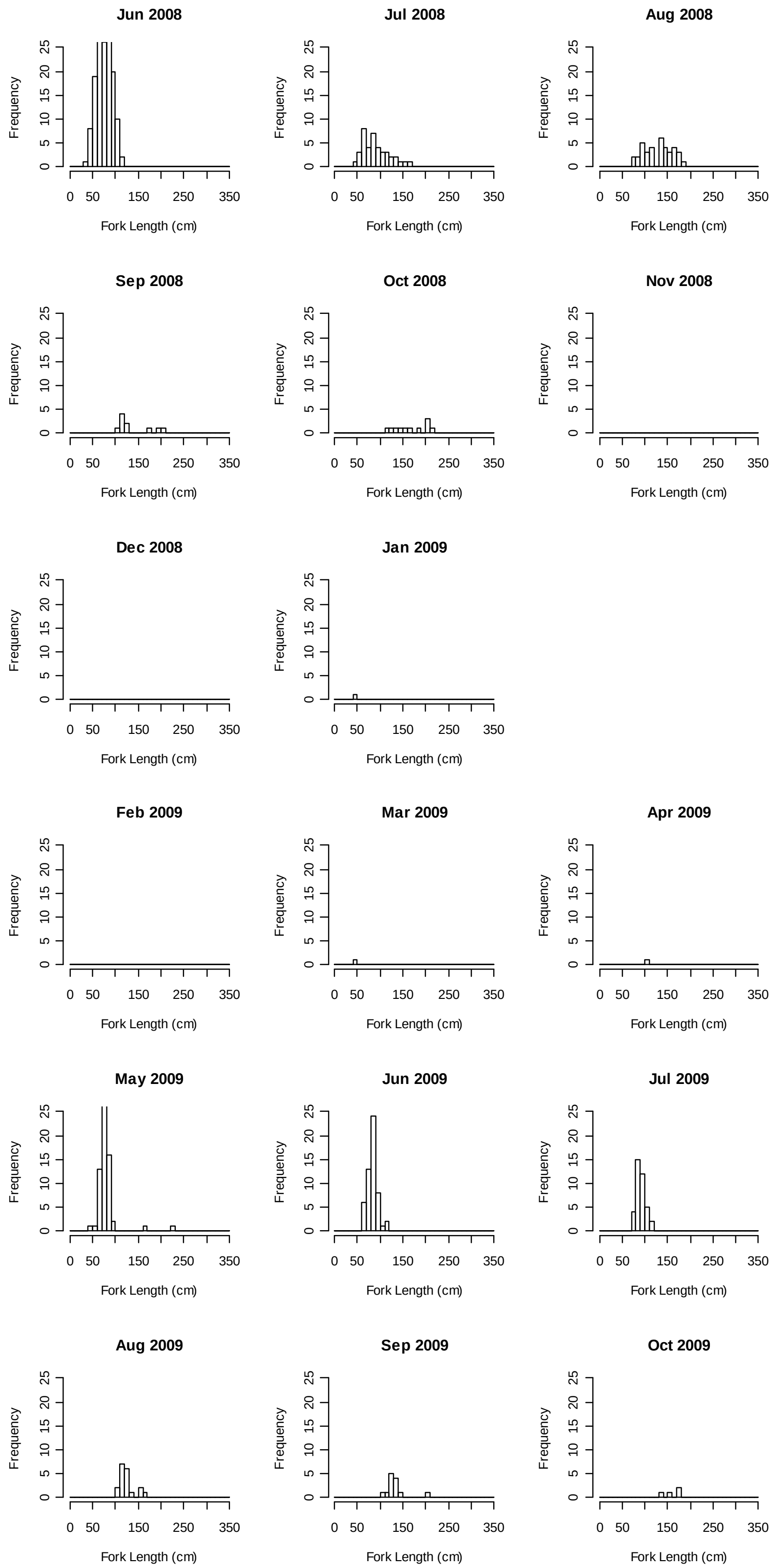


Figure C.7. Fork Length Frequencies of all Juvenile Chinook Salmon by Month

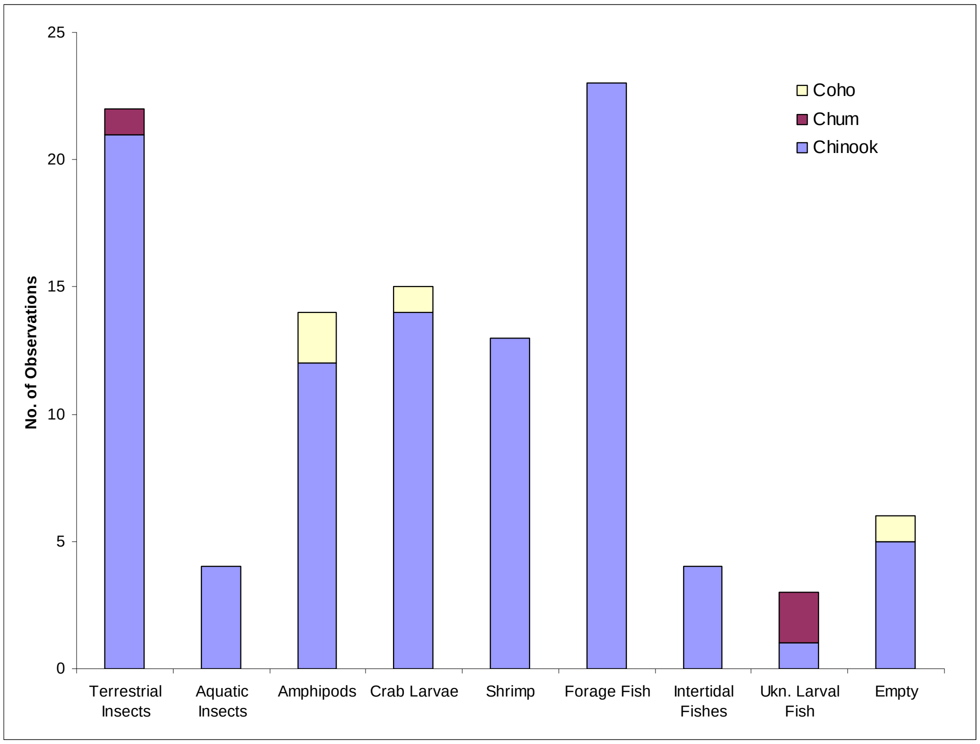


Figure C.8. Chinook, Coho, and Chum Diet Composition Frequency

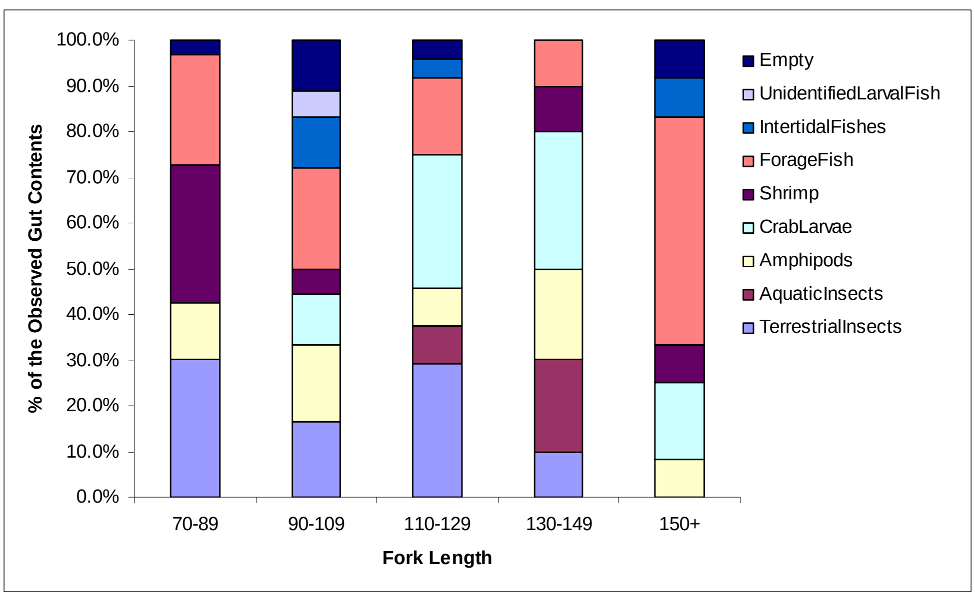


Figure C.9. Proportion of Diet Items Observed in Chinook Salmon by Fork Length Category

3.2.2 Coho Salmon

Coho salmon were present in 9.5% of the lampara sets. The average number of coho salmon per set was 0.41, with a standard error of 1.89. Coho salmon were observed to have a different pattern of distribution and abundance compared to juvenile Chinook salmon (Figure C.10 and Figure C.11). Unmarked and marked juvenile coho salmon were observed during May, June, September, and October within Hale Passage, Portage Bay, and at Sandy Point, and seldom observed in Lummi Bay.

Coho caught in May and June were typically out-migrating smolts of 100 to 150 mm fork length while coho salmon caught in September and October were larger than 200 mm (Figure C.12). The coho caught in the fall were possibly Salish Sea resident coho or returning jack salmon. Thus, coho utilization of Lummi Reservation tidelands may include both juvenile and non-juveniles life stages, unlike Chinook salmon, which only appear to utilize the tidelands as juveniles.

The diet composition of juvenile coho salmon was difficult to determine since coho were only sparsely observed in the catches (Figure C.8). When items were observed in juvenile coho guts, they were intertidal organisms.

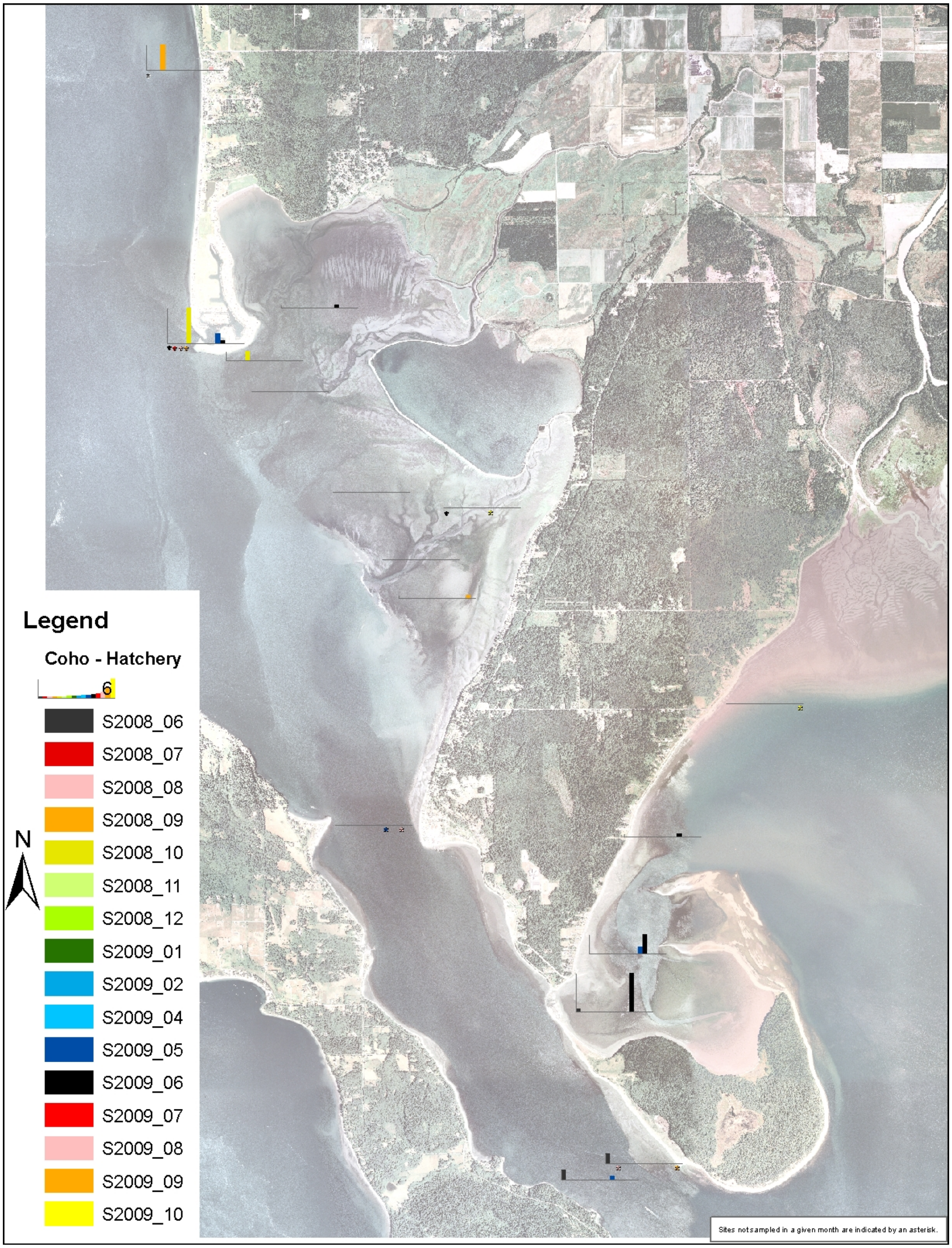


Figure C.10. Marked Coho Salmon Counts Across the Reservation from June 2008 to October 2009

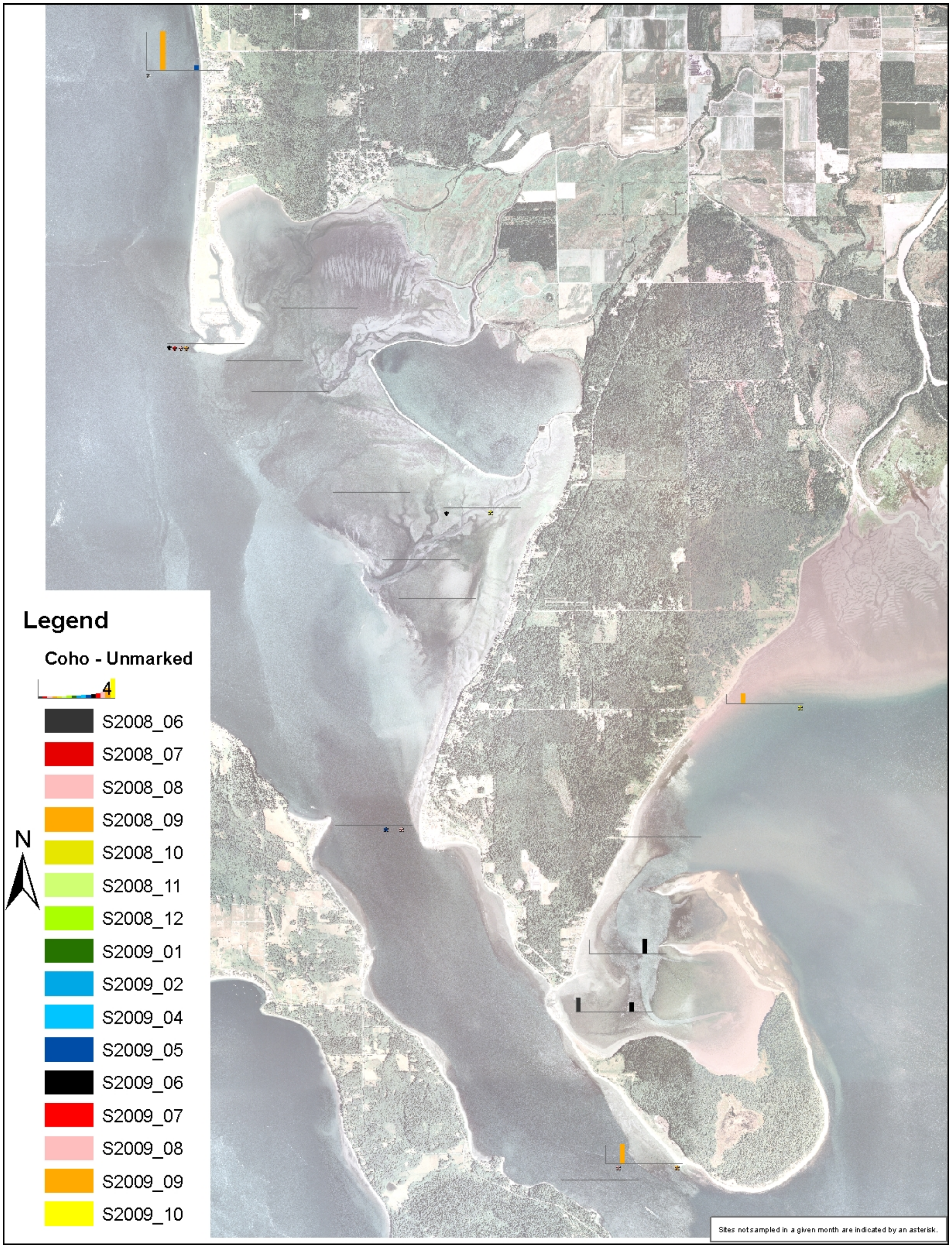


Figure C.11. Unmarked Coho Salmon Counts Across the Reservation from June 2008 to October 2009

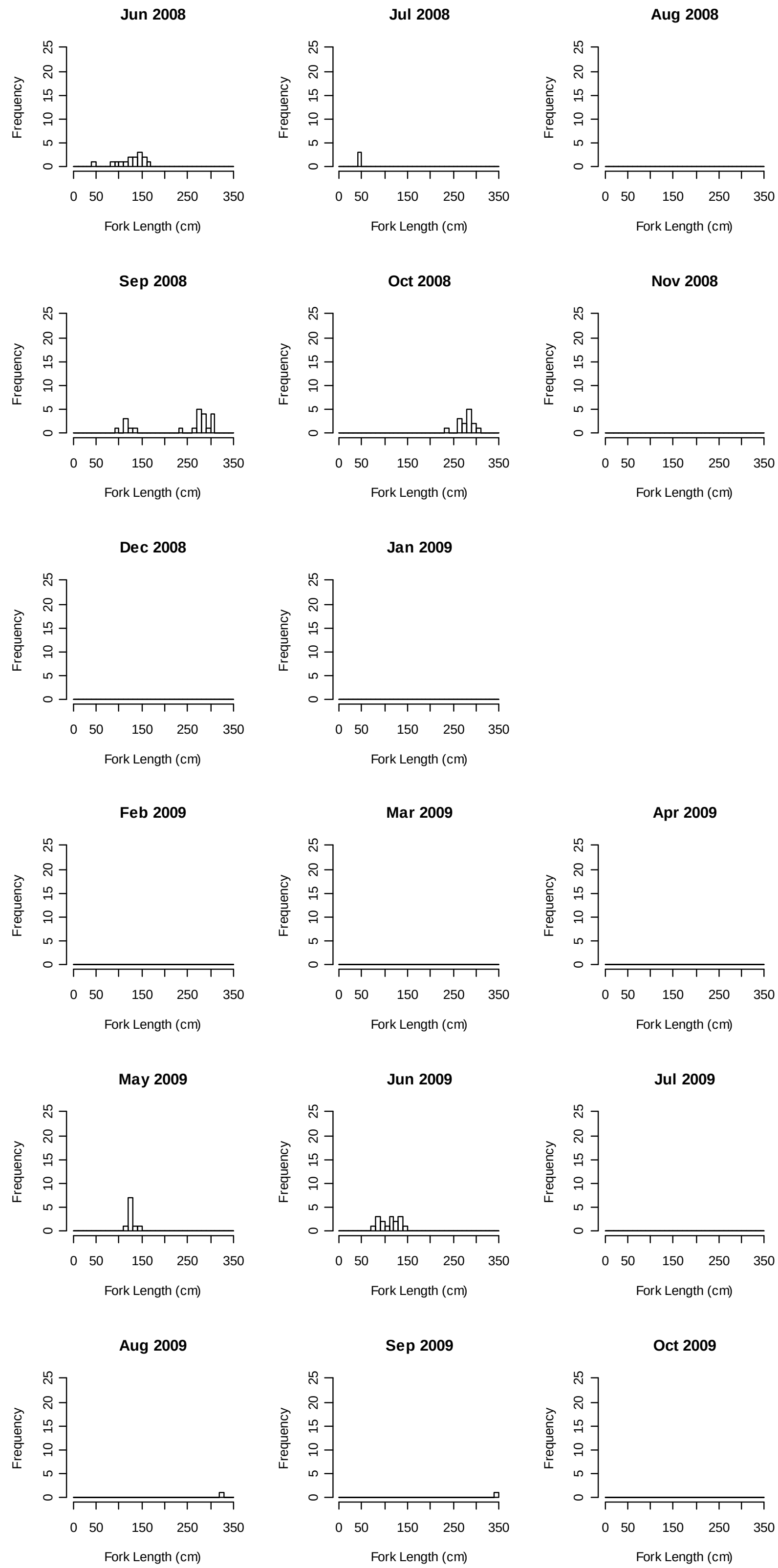


Figure C.12. Fork Length Frequencies of all Coho Salmon by Month.

3.2.3 Chum Salmon

Juvenile chum salmon were observed across most areas within the Reservation tidelands (Figure C.13). Juvenile chum salmon were present in 13.1% of the sets. The average number of juvenile chum salmon caught was 0.85 per set (standard error = 1.89). Juvenile chum salmon were observed during the months April, May, June, and July. The observed range of chum fork lengths was 40 mm to 135 mm, and comprised one size class (Figure C.14). As was observed for juvenile coho and Chinook salmon, the sizes of chum salmon increased through the summer period.

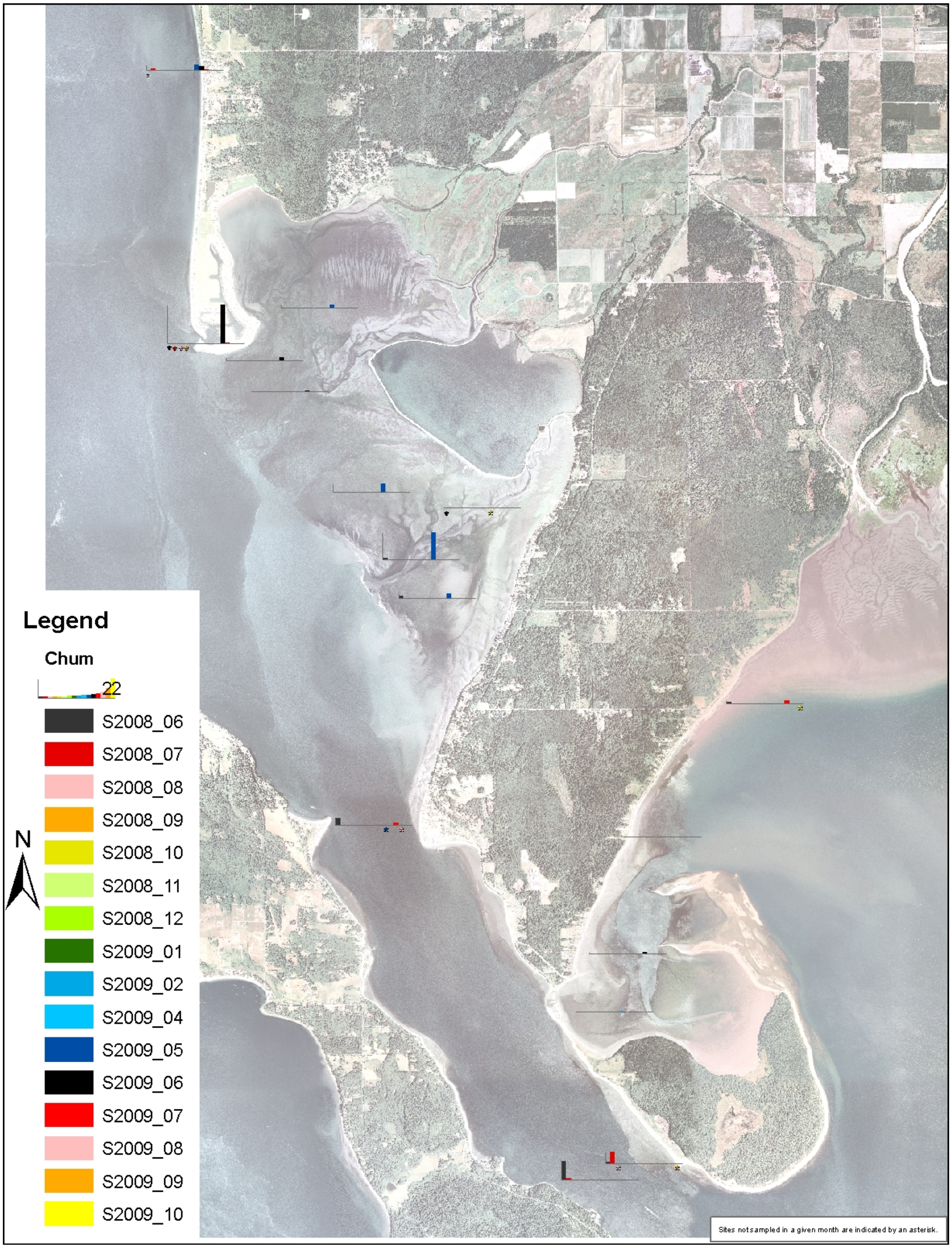


Figure C.13. Juvenile Chum Salmon Counts Across the Reservation from June 2008 to October 2009

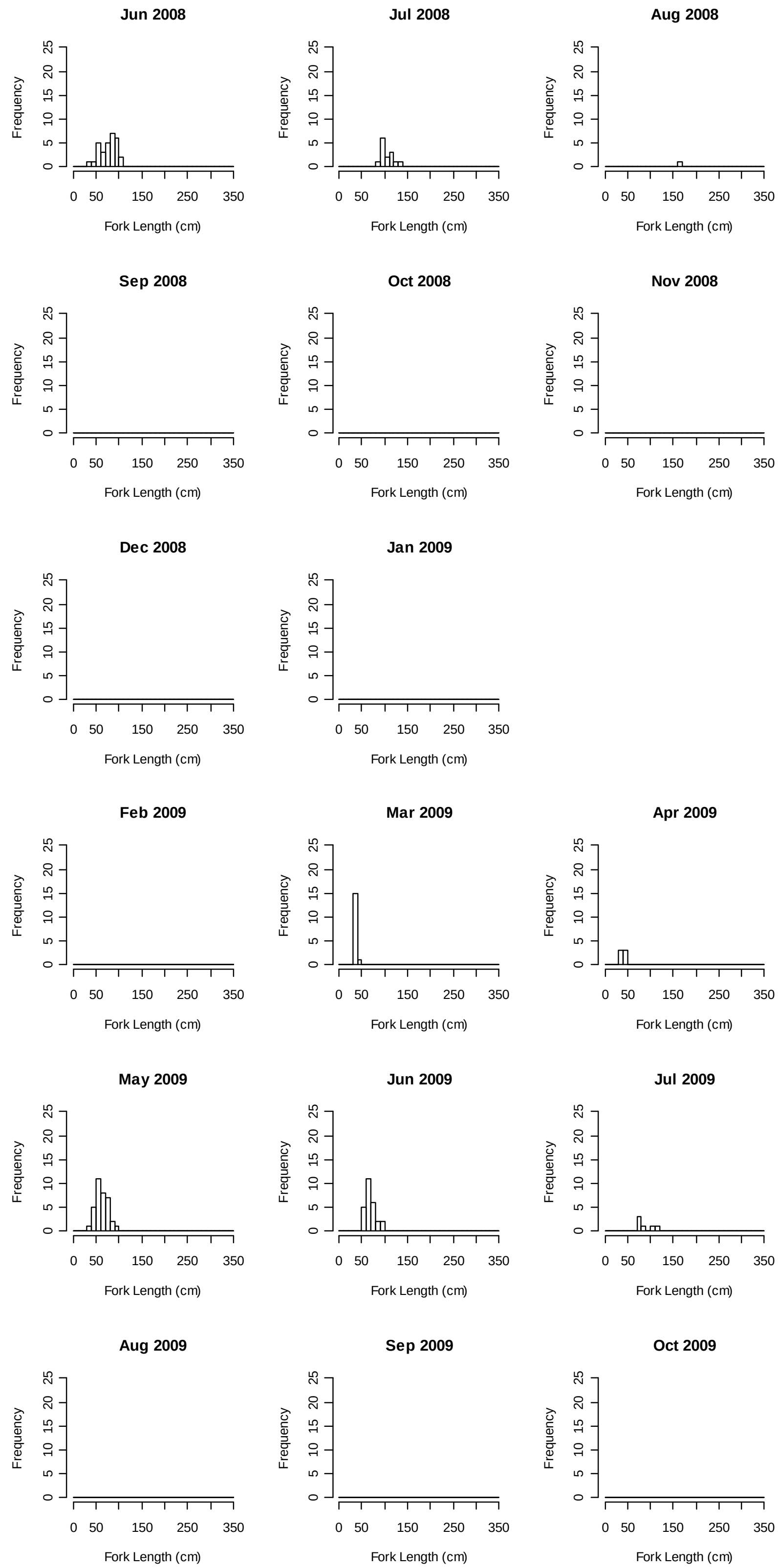


Figure C.14. Fork Length Frequencies of Juvenile Chum Salmon by Month

3.2.4 Pink Salmon

Juvenile pink salmon were only observed in 2008 because pink salmon in the Salish Sea spawn only every other year.

Juvenile pink salmon were present in 4.8% of the 2008 lampara sets, with catch averages of 0.31 juvenile pink salmon per set (standard error = 1.63). Juvenile pink salmon were observed in open water habitats in Hale Passage (Figure C.15) and were encountered at intertidal sites only near Portage Island. There was only one size class of pink salmon, which ranged from 50 mm to 125 mm fork length (Figure C.16).

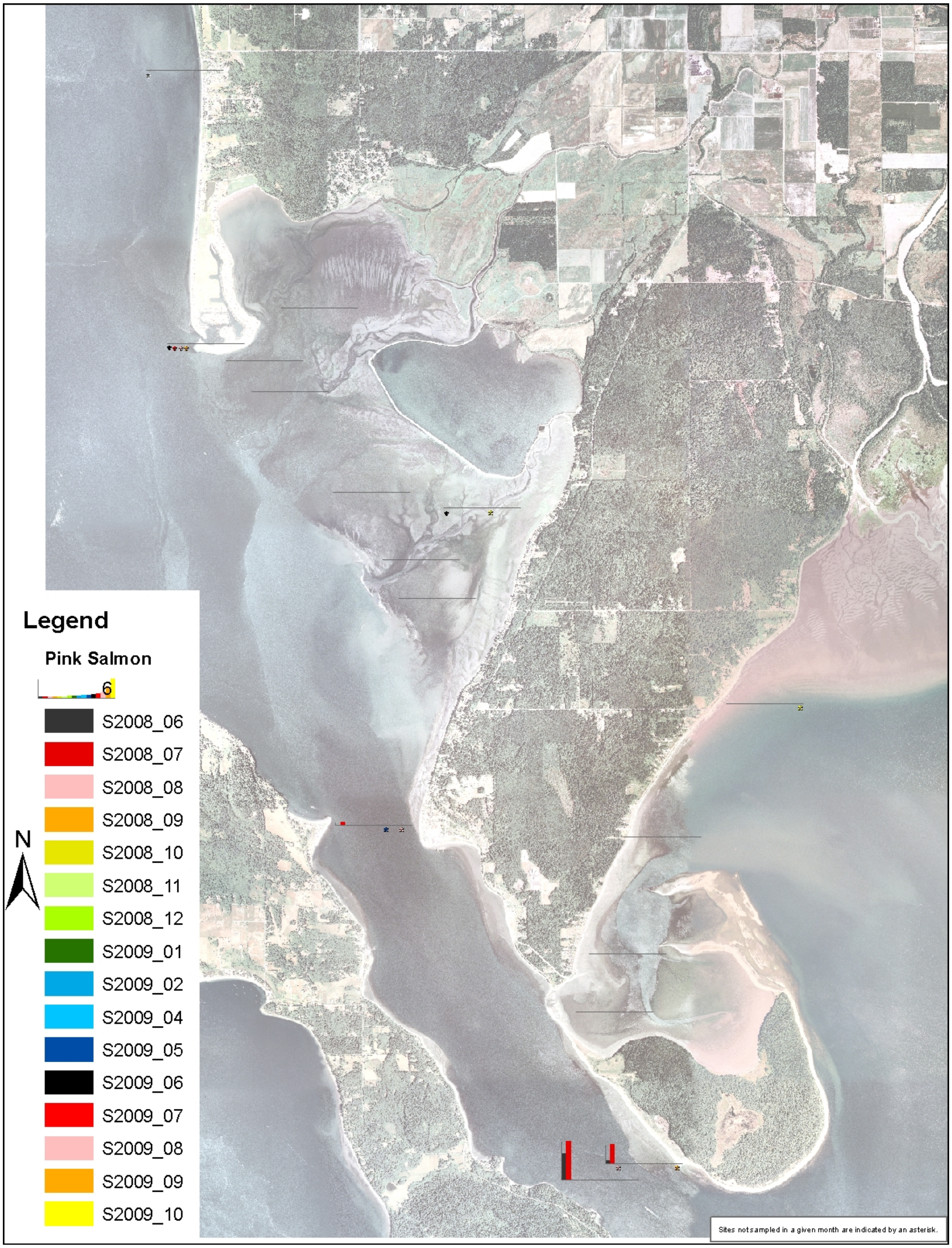


Figure C.15. Juvenile Pink Salmon Counts Across the Reservation from June 2008 to October 2009

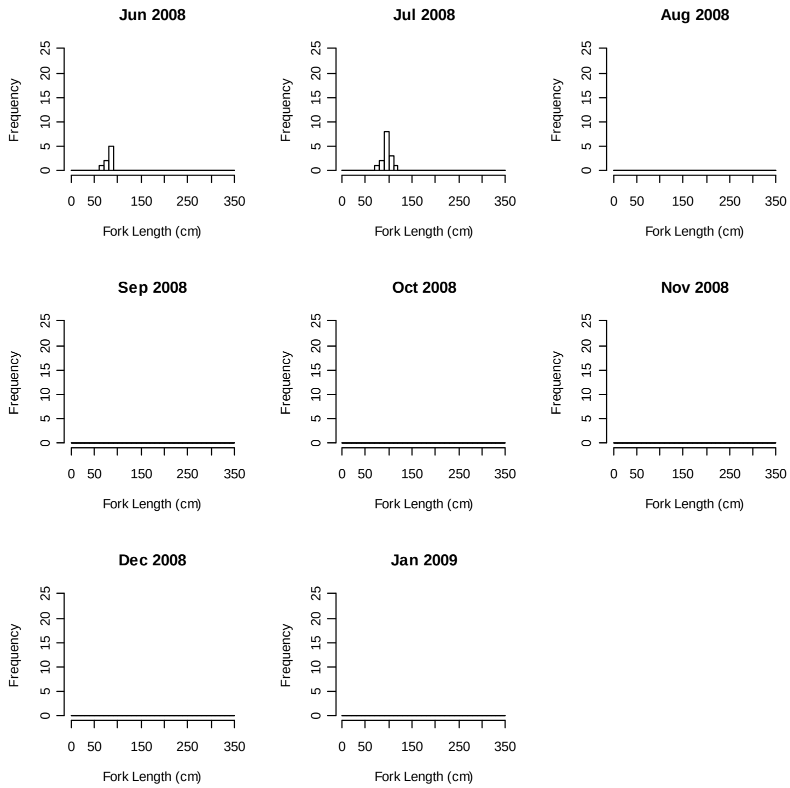


Figure C.16. Fork Length Frequencies of Juvenile Pink Salmon by Month

3.2.5 Pacific Herring

Pacific herring spawn, rear, and hold within and adjacent to the Reservation tidelands (Figure C.17). Pacific herring spawn on the beaches of Sandy Point, Gooseberry Point, Portage Island, and Portage Bay. At any time of the year, Pacific herring can be observed within the Reservation tidelands and was the most frequently observed fish in the LIBI finfish survey in general. Pacific herring were present in 51.3% of the lampara sets, with an average catch of 32.7 Pacific herring per set (standard error = 93.2). Pacific herring were distributed across all habitats and areas of the Reservation tidelands (Figure C.18) but were found most often in eelgrass and channel habitats.

In 2008, two size classes of Pacific herring were present in June, July, September, and December (Figure C.19), while in 2009 two size classes were present in May, June, and July. The presence of the smaller size class in the catch for most of the year suggests that juvenile Pacific herring are rearing in the Reservation intertidal environments. The inconsistency of presence for the larger size class could be the result of size-related catch inefficiencies, or an indication that larger herring may utilize intertidal areas only as transients when feeding opportunities or other benefits are sufficiently attractive.

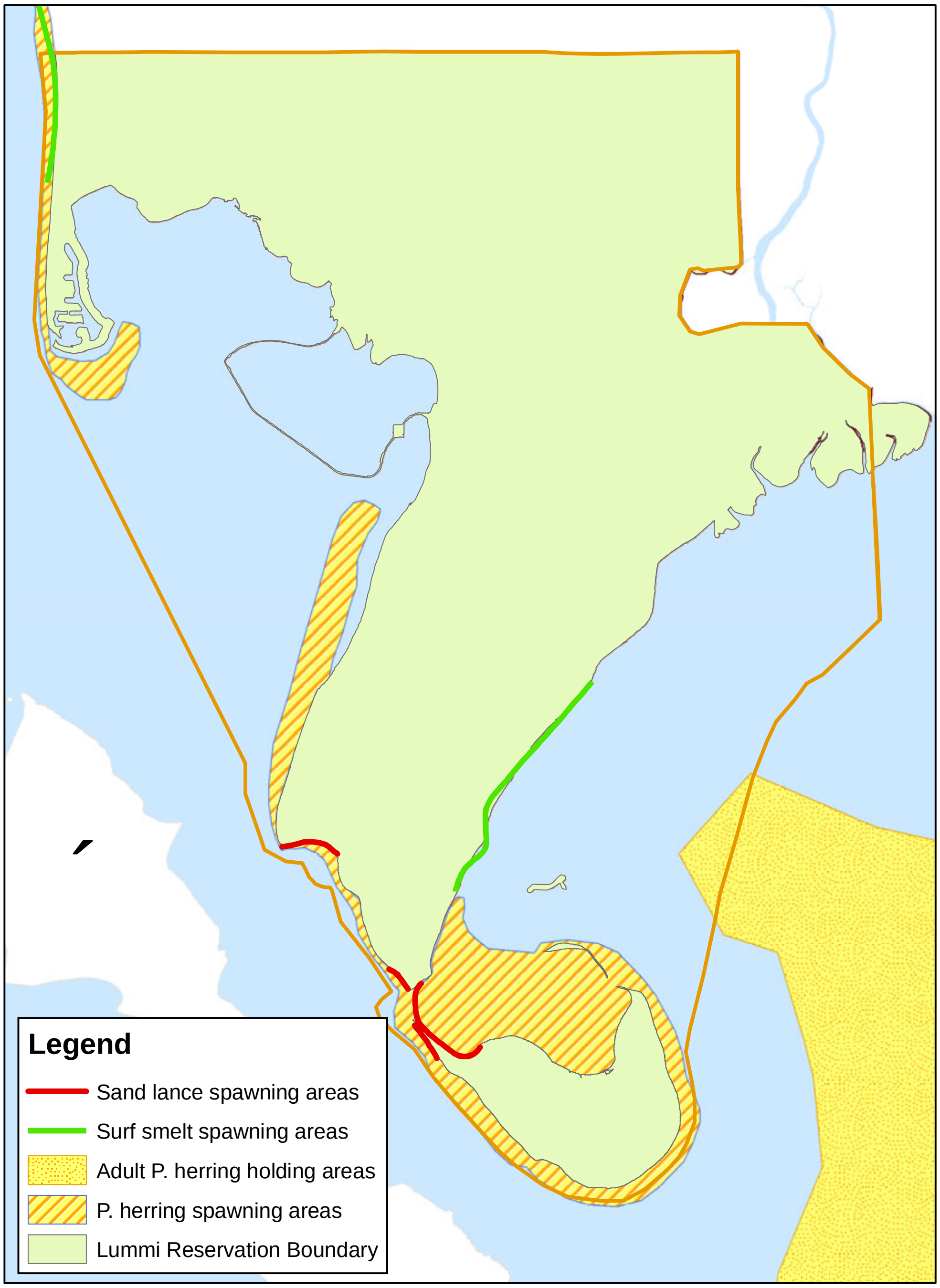


Figure C.17. Spawning and Holding Locations for Pacific Herring Within Puget Sound and Georgia Strait, Adapted from Information Gathered by the WDFW and the LNR

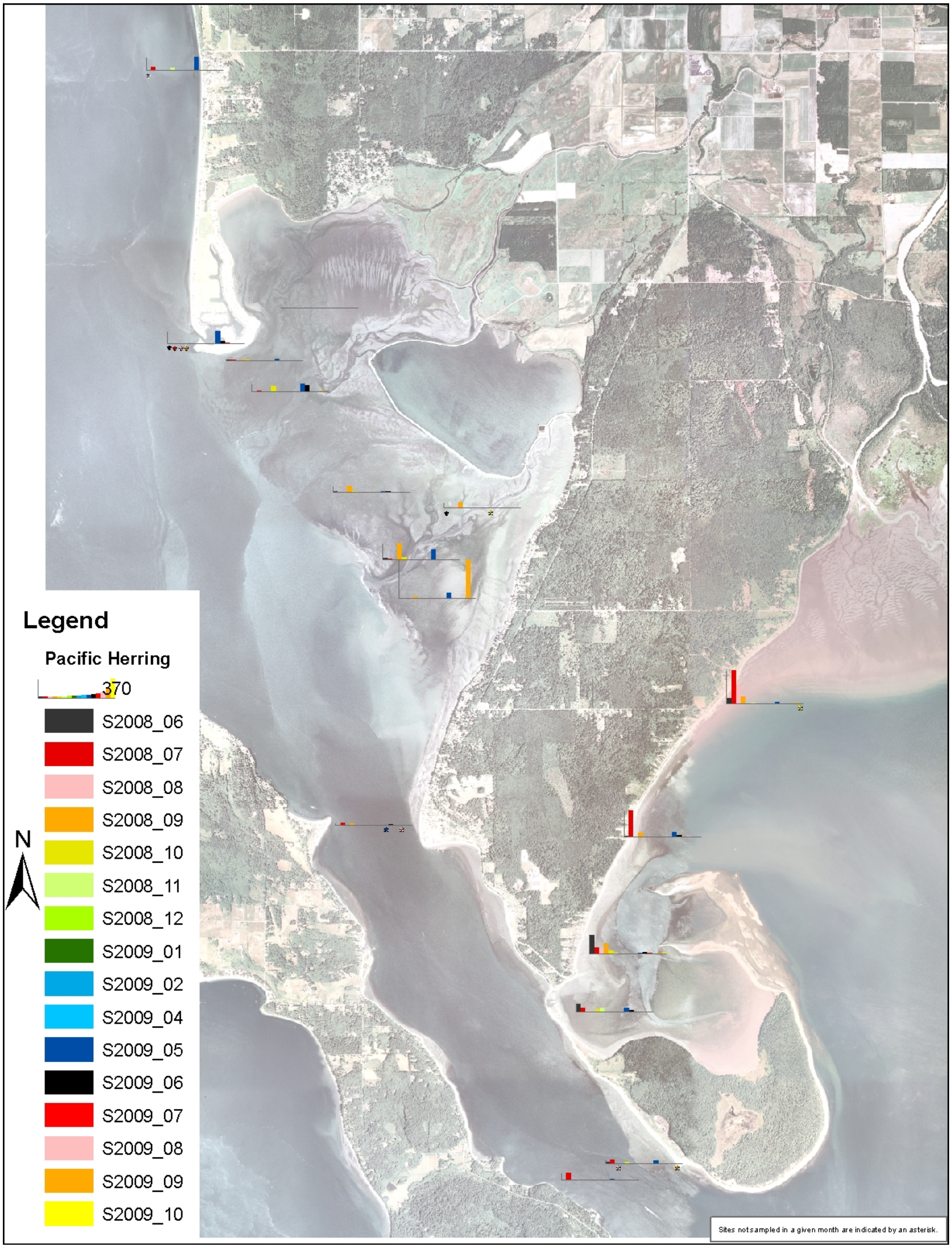


Figure C.18. Pacific Herring Counts Across the Reservation from June 2008 to October 2009

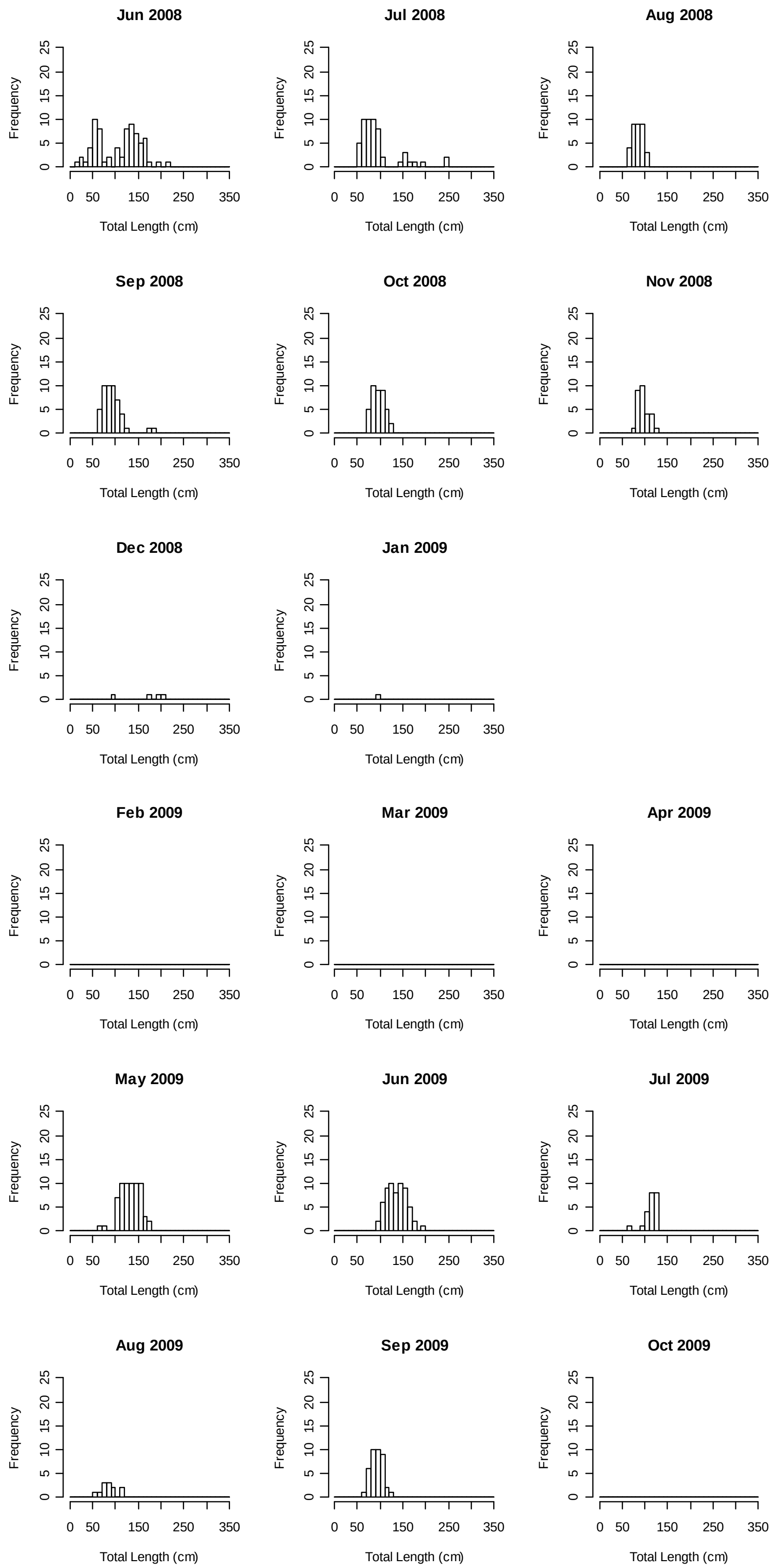


Figure C.19. Total Length Frequencies of Pacific Herring by Month

3.2.6 Surf Smelt

Surf smelt spawn, rear, and hold within and adjacent to the Reservation tidelands (Figure C.20). They are known to spawn on the beaches of Sandy Point and Lummi Shore Road. At any point of the year, surf smelt can be observed within the Reservation tidelands at high tide. Surf smelt were present in 36.2% of the lampara sets with an average of 4.59 surf smelt per set (standard error = 14.11). They were distributed across all habitats and all areas of the Reservation tidelands (Figure C.21) and were most often present in eelgrass and channel habitats.

Two size classes of surf smelt were present throughout the year except in February, March, and April, when no surf smelts were present (Figure C.22). As with other species, surf smelt sizes increased over the summer season.

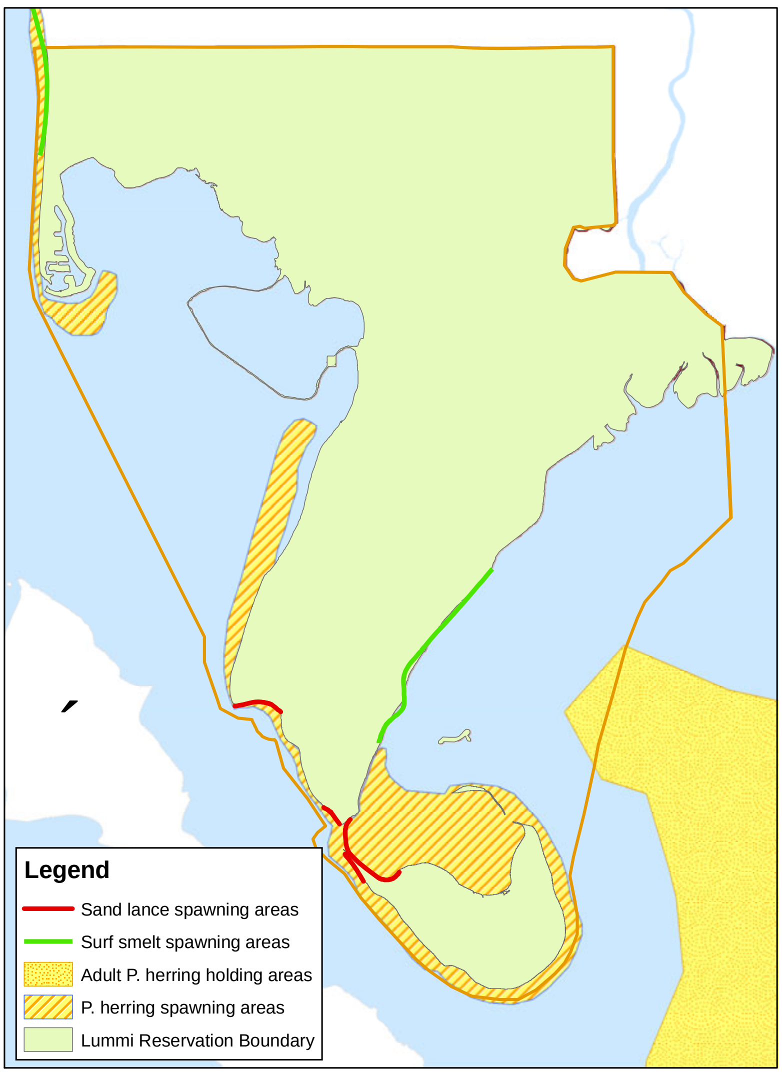


Figure C.20. Spawning Locations for Surf Smelt Within Puget Sound and Georgia Strait, Adapted from Information Gathered by the WDFW and the LNR

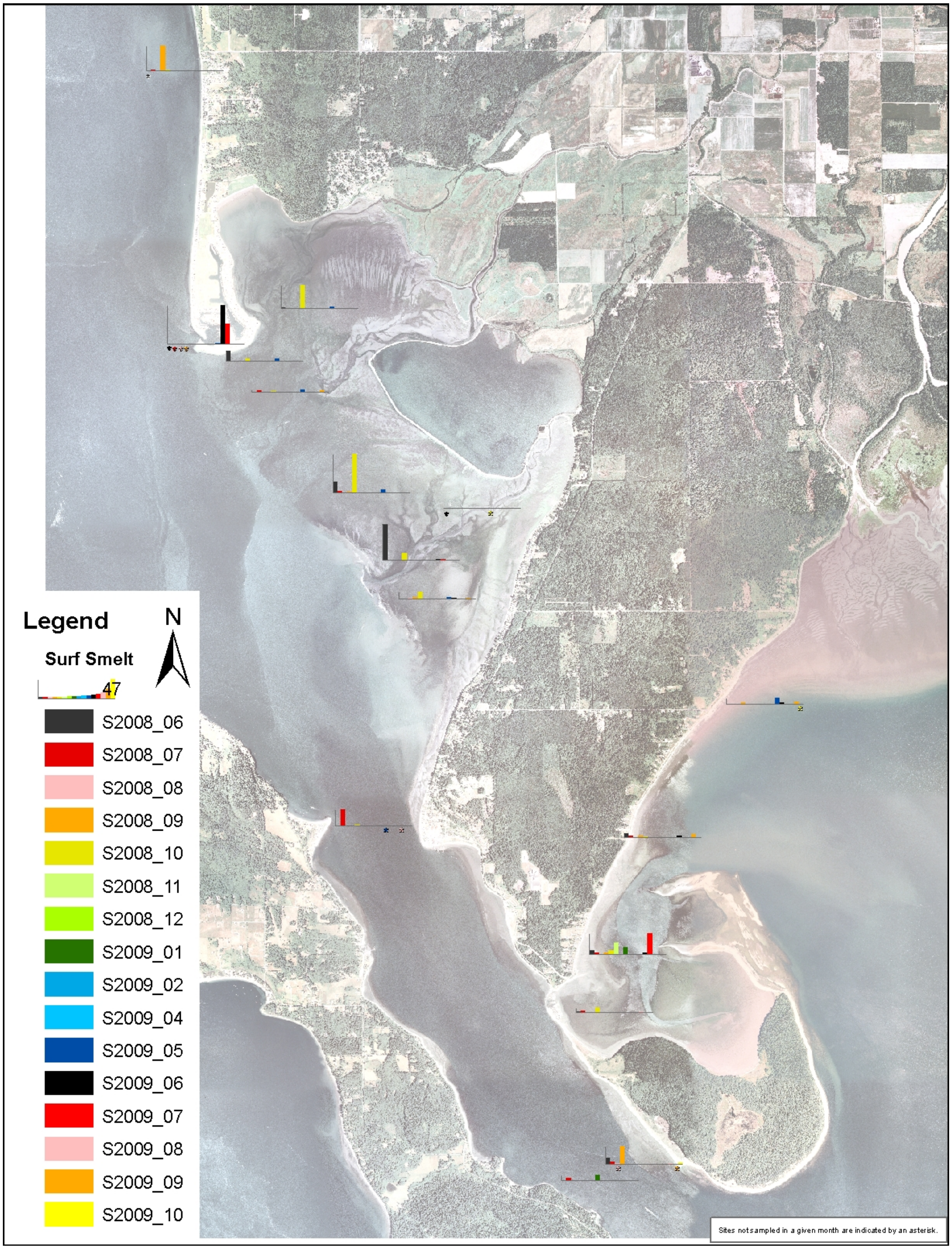


Figure C.21. Surf Smelt Counts Across the Reservation from June 2008 to October 2009

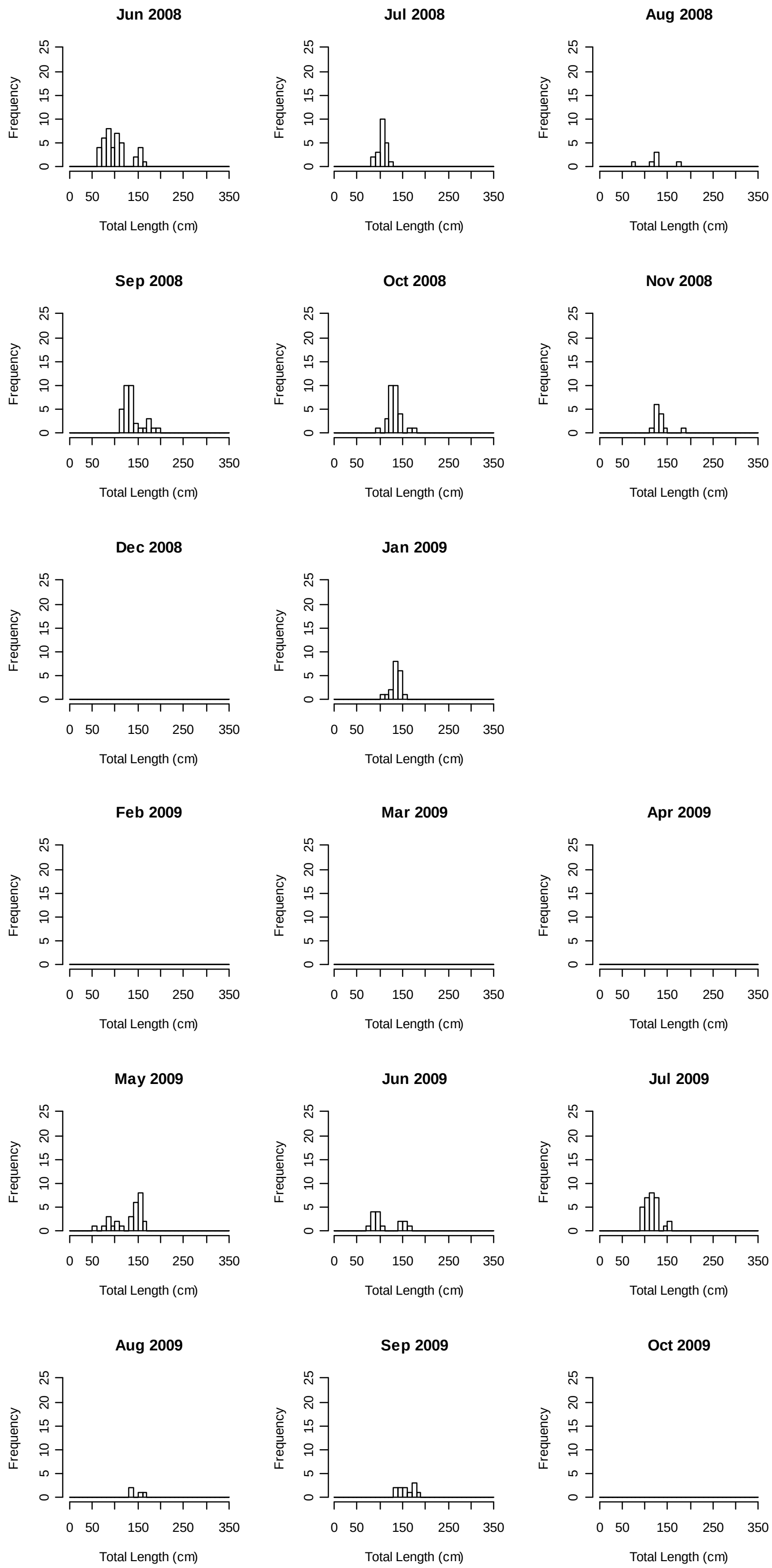


Figure C.22. Fork Length Frequencies of Surf Smelt by Month

3.2.7 Sand Lance

Pacific sand lance spawn, rear, and hold within and adjacent to the Reservation tidelands (Figure C.23). They spawn on the beaches of Lummi Shore Road, Gooseberry Point, Portage Island, and Portage Bay. Sand lance were observed within the Reservation tidelands during the months of May, June, July, and September (Figure C.24) and were present in 7.0% of the lampara sets with an average of 0.67 sand lance per set (standard error = 4.62). Sand lance were most commonly observed in Lummi Bay but were also present in small numbers in other areas.

Catches of sand lance were too low to determine the number of size classes present, however, sand lance did vary in size and the sizes observed increased over the summer season (Figure C.25). Sand lance were also periodically observed during low tide field work, when they emerged rapidly from loose sandy substrates in response to disturbance by nearby LIBI field teams. This was most commonly noted on low intertidal sand bars in Lummi Bay and Hale Passage (Dolphin, personal observation).

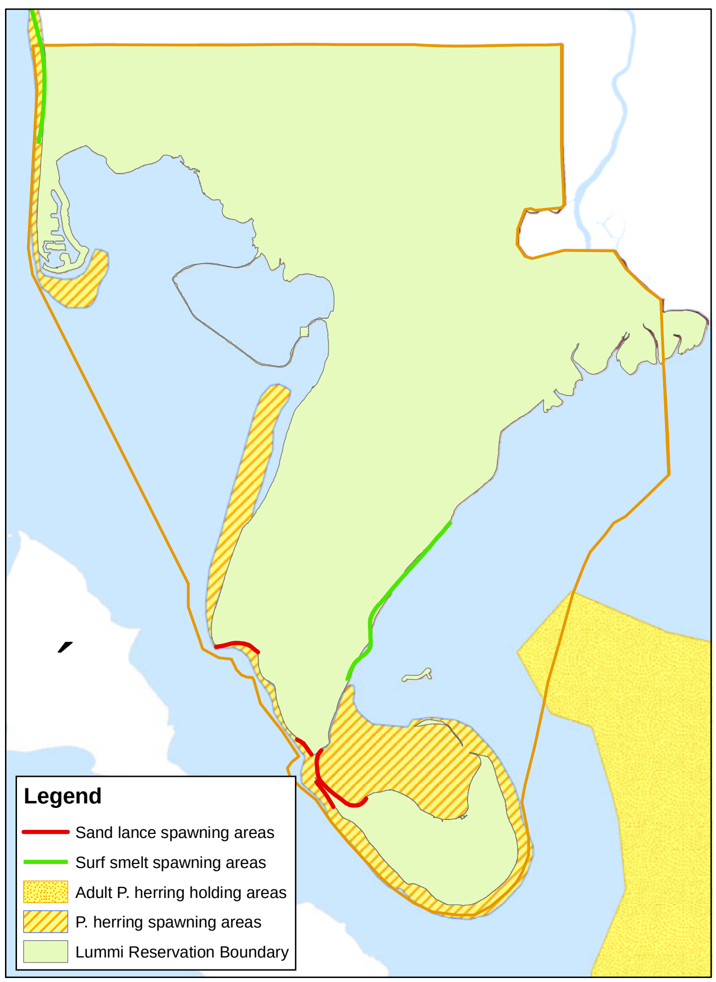


Figure C.23. Spawning Locations for Sand Lance Within Puget Sound and Georgia Strait, Adapted from Information Gathered by the WDFW and the LNR

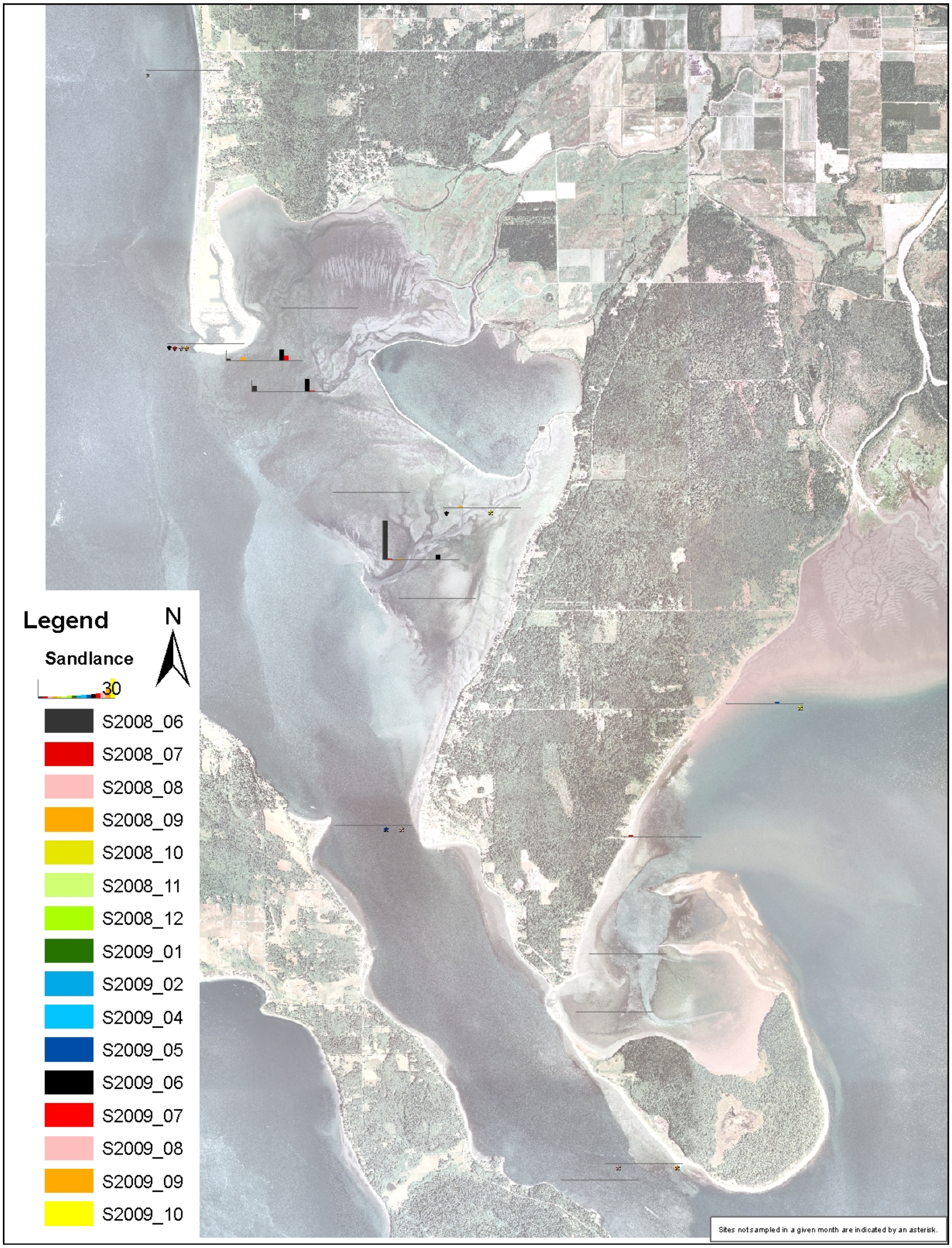


Figure C.24. Sand Lance Counts Across the Reservation from June 2008 to October 2009

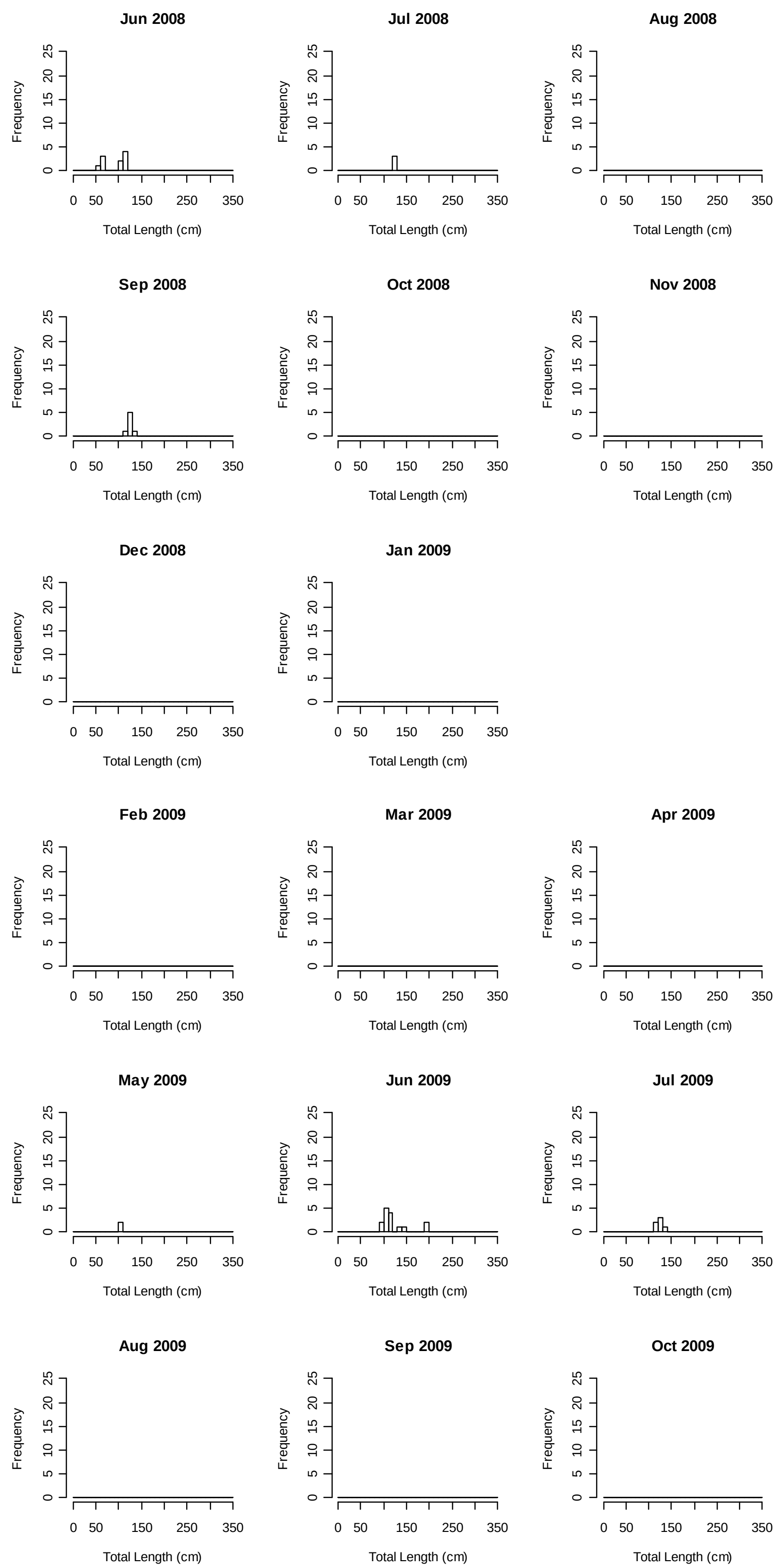


Figure C.25. Total Length Frequencies of Sand Lance by Month

3.2.8 Greenlings (Lingcod, Kelp Greenling, Whitespotted Greenling)

Greenlings provide an important subsistence resource for Lummi tribal members, and juveniles of species from this family were observed throughout the Reservation tidelands.

Juvenile lingcod were observed only in Portage Bay (Figure C.27) and only in eelgrass habitats, and had an average total length of 67 mm. These fish were observed during the month of July in 2008 and again in 2009, but overall they were only present in 1.5% of all the sets made.

Kelp greenling and whitespotted greenling were observed primarily in Lummi Bay during June, July, and August (Figure C.28) and were present in 8.0 % of the sets made overall. The average catch was 0.13 kelp/whitespotted greenling per set (standard error = 0.15). They were most common in eelgrass and channel habitats, and ranged in size from 56 to 182 mm fork length. The large size range and the limited number of months during which kelp greenling and whitespotted greenling were present suggest that more than one size class was present. However, too few fish were measured to determine how many size classes were present.

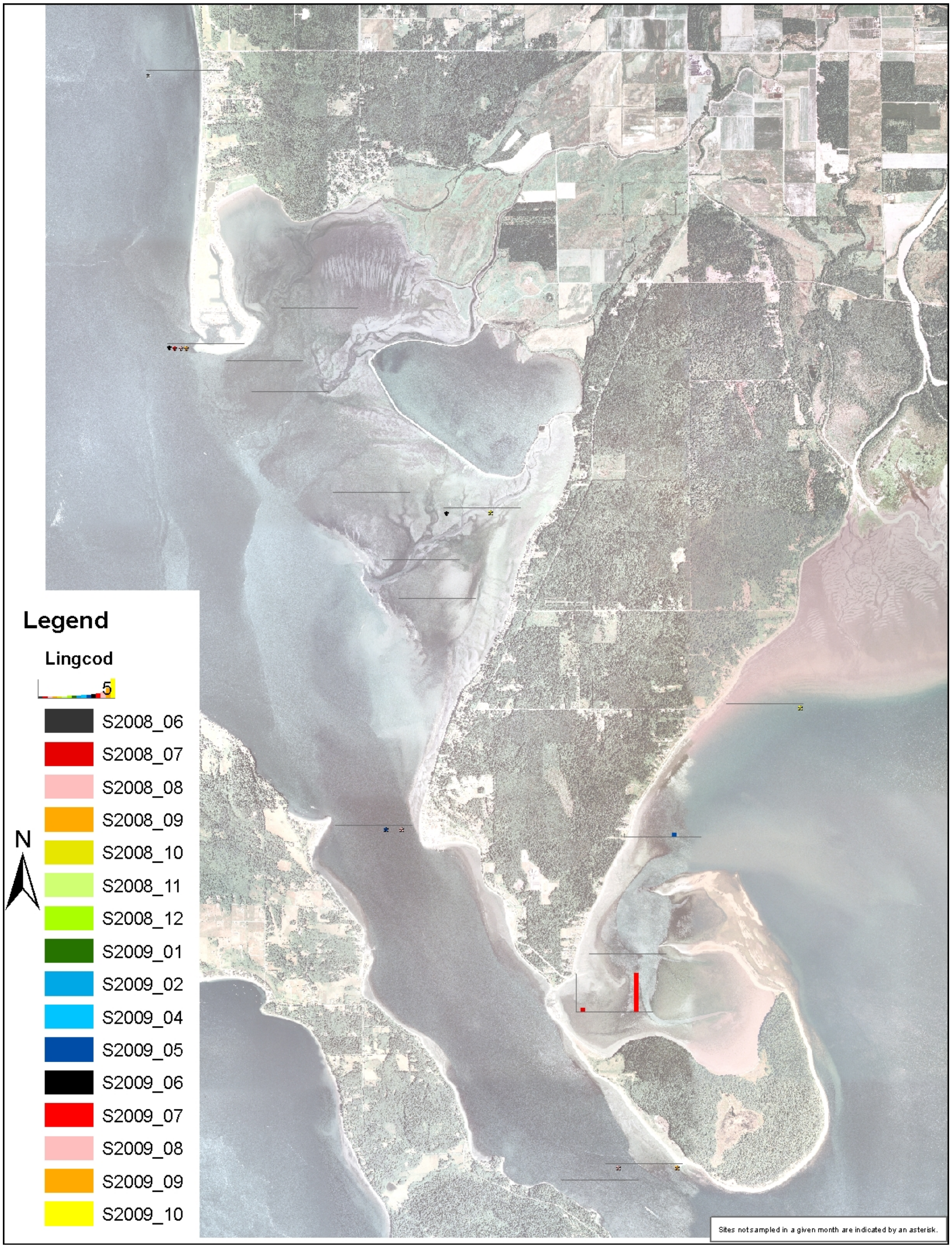


Figure C.27. Lingcod Counts Across the Reservation from June 2008 to October 2009

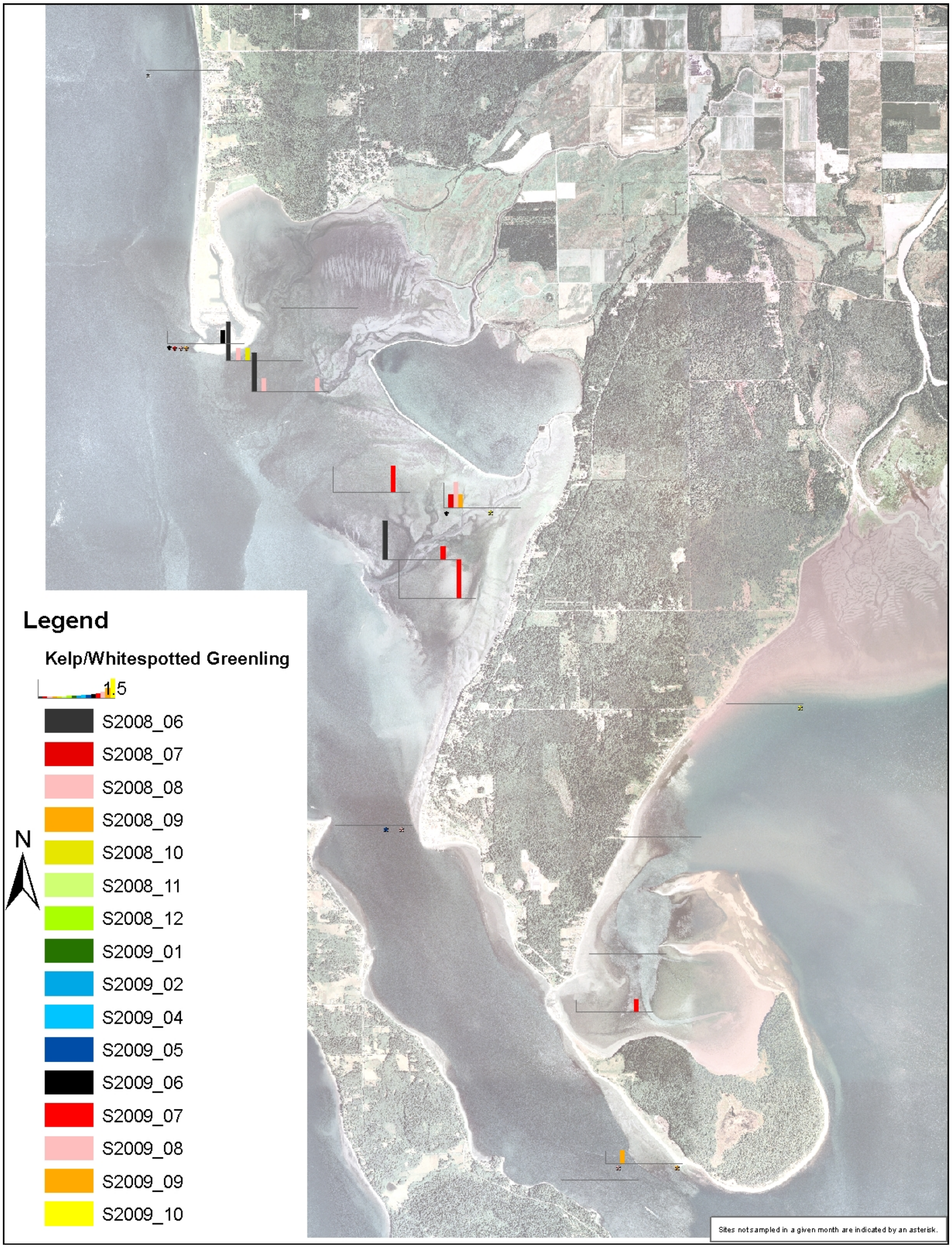


Figure C.28. Combined Kelp Greenling and Whitespotted Greenling Counts Across the Reservation from June 2008 to October 2009

4.0 Discussion

Nearshore areas in Puget Sound and Georgia Strait provide important rearing habitats for many juvenile fishes (Miller *et al.* 1980; Simenstad *et al*. 1979; Simenstad *et al*. 1981). Juvenile fishes can seek refuge from predators in the complex structure provided by macro-algae, eelgrass, and reef structures and may consume prey species that are common in nearshore areas.

The Lummi Reservation tidelands host a diverse community of juvenile fishes including salmon, forage fishes, true cods, flat fishes, and greenlings. Fishes were most abundant during the summer months, which is the time of peak primary production for eelgrasses and intertidal macroalgae. Conversely, areas with little or no intertidal flora such as mud flats, or areas during the winter season when eelgrass senescence had occurred had the lowest taxonomic richness observed and the lowest abundance of fish caught. These observations suggest the importance of eelgrass and macro-algae to the rearing of juvenile fishes within the Reservation tidelands.

Chinook salmon are of specific importance to the Lummi people. Juvenile Chinook salmon have been observed in the Nooksack River delta and throughout the Reservation tidelands (McKay 2004a; 2004b; 2005). As expected, juvenile Chinook salmon were also observed across the Reservation tidelands in the LIBI survey. Additionally, the LIBI was able to document changes in juvenile Chinook salmon stock composition over time because it surveyed fish assemblages continuously for a year. Unmarked juvenile Chinook salmon were present into October while marked juvenile Chinook salmon from fish hatcheries were not observed after August. This apparent residency of wild-origin juvenile Chinook salmon in nearshore areas is tied to increased growth rates compared to juvenile Chinook salmon that migrate directly to open water (Beamer and Larsen 2004). It may also partially explain the increased success of wild Chinook salmon compared to hatchery-reared Chinook salmon.

Pacific herring are considered an indicator of ecological health as well as a prey item for many marine organisms. Pacific herring was the most common fish observed during the LIBI Finfish Survey and was also the species that was most commonly associated with eelgrass and channel habitats. Pacific herring observed on the Reservation tidelands are likely to be from two different stocks. Herring spawning activities in Portage Bay occur earlier in the year compared to activities at Cherry Point suggesting that a distinctive Portage Bay herring stock exists. The presence of adult Pacific herring in Portage Bay prior to the presence and timing of individuals from the Cherry Point stock is consistent with that hypothesis. DNA samples were taken for Pacific Herring but were yet to be analyzed at the time of writing of this report.

If an oil spill were to occur on or adjacent to the Lummi tidelands, many species of finfish and their habitats would be affected. Many of these species are harvested directly by the Lummi people (Chinook salmon, coho salmon, chum salmon, pink salmon, steelhead, plain-fin midshipmen, long-fin smelt, Pacific herring) while other species that were observed in this survey were found to be present in the diet of these species (three spine stickleback, Pacific pipefish, sand lance, surf smelt).

The LIBI lampara effort, in addition to the beach seine survey data, proved to be beneficial for determining the presence of finfish across the Reservation tidelands during high tide. Lingcod, Pacific tomcod, and Pacific cod were all documented on Reservation tidelands for the first time. In addition, a direct connection was made between the Reservation tidelands and the diet of juvenile Chinook salmon as a result of the yearlong sampling effort and gut content observations.

The analysis of the information collected by the LIBI Finfish Survey has not been exhaustive. Budget limitations and project scope limited data analysis to a data summary report, however there are many further investigations that can be conducted with this data, such as defining stock composition of salmon and Pacific herring through analysis of DNA samples taken.

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