SEA LICE MONITORING STUDY IN GOLETAS CHANNEL AND QUEEN CHARLOTTE STRAIT, BC YEAR 4

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Marine Harvest Canada Inc
2015

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YEAR 4 - 2015

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Table of Contents

Introduction

Pacificus Biological Services (Pacificus) supplemented the existing base-line studies (Pacificus 2011, 2013a and 2013b, 2014) of ambient sea lice levels present in Goletas Channel and Queen Charlotte Strait, British Columbia (Figure 1) by continuing the study during this years' salmonid outmigration period (April and May, 2015). The study was conducted on behalf of Marine Harvest Canada, the Tlatlasikwala First Nation, and Gwa'sala Nakwaxda'xw First Nation.

A total of 20 beach seine sites were sampled during the 2015 sample year. All 20 sites were the same sites sampled during the 2014 sample year. Six sites were located within the Shelter Bay Area, Queen Charlotte Strait in DFO's Management Areas 11-2[1] and 12-13[2]. The remaining 14 sites were located in Goletas Channel in DFO's Management Areas 12-11, 12-12, 12-15, 12-16. Two species of sea louse commonly found on salmonids in BC waters, *Lepeophtheirus salmonis* and *Caligus clemensi*, were the focus of this study. All smolt samples were caught with a beach seine and processed for lab analysis at the BC Center for Aquatic Health Sciences in Campbell River, BC.

The target species for this study were pink salmon smolts (*Oncorhynchus gorbuscha*) although samples of chum (*O. keta*), coho (*O. kisutch*), Chinook (*O. tshawytshcha*), and sockeye (*O. nerka*) salmon juveniles as well as cutthroat trout (*O. clarki*), Dolly Varden (*Salvelinas malma*) and Pacific herring (*Clupea pallasi*) juveniles were also retained for analysis if encountered. Samples were analysed for sea lice prevalence (percentage of fish that are infected), intensity (average number of sea lice on infected fish) and abundance (average number of sea lice on all fish sampled).

A total of ten fish farms were located within the study area (Figures 2, 3, 4, 5 and 6). Two active fish farm sites and two inactive sites were located in the Shelter Bay Area (Zone 6). Two active fish farm sites and two inactive sites were located within in the Gordon Islands area (Zone 5). Two sites are in the development phase but have not seen any farm activity within Zone 3. Previous studies in the Broughton Archipelago have indicated that such farms may or may not be a source of sea lice infection in wild populations as reported by studies published by Beamish et al. (2006), Butterworth et al. (2008), Jones et al. (2007) and Saksida et al. (2007). However, high

[1] http://www.pac.dfo-mpo.gc.ca/fm-gp/maps-cartes/areas-secteurs/12-eng.html (Accessed June 16, 2014)
[2] http://www.pac.dfo-mpo.gc.ca/fm-gp/maps-cartes/areas-secteurs/11-eng.html (Accessed June 16, 2014)

natural levels of sea lice have also been observed in areas with no active fish farms nearby as observed by Beamish et al. in the 2009 paper *A large infection of sea lice on juvenile Pacific salmon in the Gulf Islands area of British Columbia, Canada*. Although a large amount of data exists regarding sea lice and salmon interactions on the BC coast, due to the highly charged and ongoing debate in the public realm, no scientific consensus regarding these interactions has been achieved as a result of the complex nature of these relationships.

As no historical data existed for Goletas Channel and Queen Charlotte Strait prior to 2011, the primary objective of this project was to create a baseline of data. This is the fourth study year in Goletas channel (Pacificus 2011, 2013a, 2014) and the third study year in the Shelter Bay area (Pacificus 2013b, 2014). Secondary objectives included determining life history characteristics of sea lice in this area in terms of abundance, life stage, and distribution of the two species analysed. Additionally, observations regarding smolt outmigration timing, abundance and distribution patterns were to be determined.

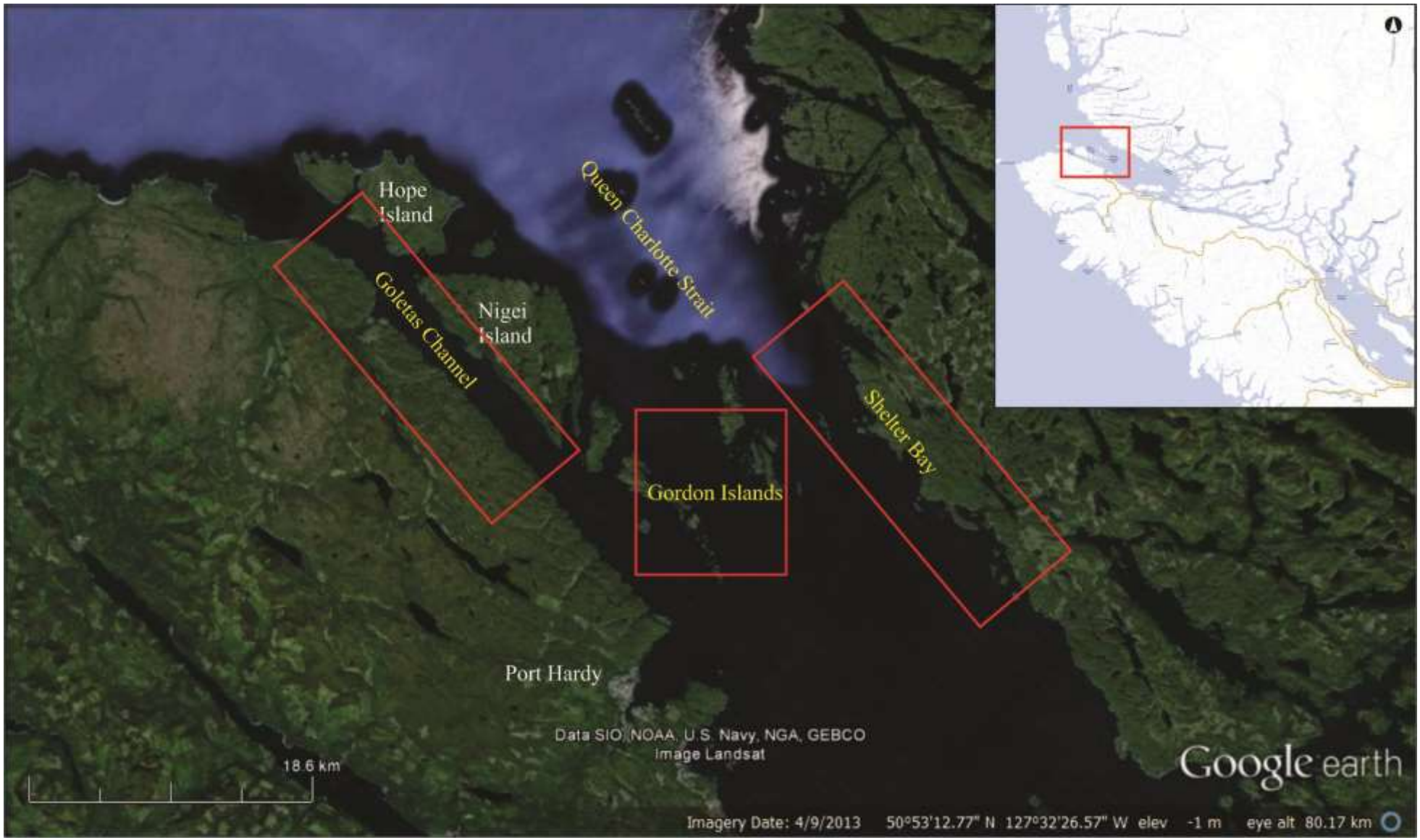

Figure 1: Overview map showing study locations (red boxes) for the 2015 sample year in relation to Port Hardy, Vancouver Island, BC.

Figure 2: Location map of the fish farms located on the BC coast by company for 2014[3] with area of study location outlined in red.

[3] http://www.salmonfarmers.org/sites/default/files/all_companies_2014-07_out_migration_sites.pdf (Accessed June 16, 2014)

Methodology

The survey area consisted of 20 beach seine sampling locations within Queen Charlotte Strait. The 20 sites are separated into six zones based on relative geographic locations. Sample locations within Goletas Channel (Zones 1-5) were determined in the first year of the study (2011), and identified during the pre-sampling field reconnaissance (Pacificus 2011). Shelter Bay (Zone 6, Queen Charlotte Strait) sampling sites were determined in 2013 (Pacificus 2013b) and altered slightly in 2014 (Pacificus 2014). Sample locations were chosen based on targeting areas with appropriate habitat characteristics and likelihood of juvenile salmonids holding in these locations during the project time frame. Efforts were made to evenly distribute sites throughout the survey.

Zones 1 - 5

This is the fourth year of sea lice monitoring in Zones 1 to 5, all located within Goletas Channel (previous years; 2011, 2013). Originally, all zones contained 3 to 4 samples sites, however in 2014, Site 1 in Zone 1, Site 3 in Zone 2, and Site 1 in Zone 4 were eliminated due to a combination of lack of fish being captured, redistributing effort, and allowing new sites to be added. In addition, Site 4 was added to Zone 5 in 2014 and located within the Deserters Group of islands. Sample sites selected for the 2015 sample year were the same as those selected in 2014. Zones 1 and 2 were located on the west side of Goletas channel, on Vancouver Island (Figure 3 and 4) and consisted of two sampling sites per zone. Zones 3 and 4 consisted of three sampling sites per zone. Zone 3 was located on Hope Island (Figure 4), Zone 4 on Nigei Island (Figure 3) and Zone 5 around the Gordon and Deserter Group of Islands (Figure 5). Zone 5 consisted of four sampling sites.

Zone 6

This is the third year of sea lice monitoring in Zone 6, located northeast of Port Hardy, in the Shelter Bay area of Queen Charlotte Strait (Figure 6). Five sampling locations were originally established (Pacificus 2013b). In 2014, Site 2 was eliminated and Site 4 and 5 were merged into one site in a new location (now known as Site 4) due to lack of suitable areas for beach seining. Two new sites were added in April of 2014. Site 6 was located near Marsh Bay, and Site 7, was located by Robinson Island. In May of 2014, an additional sampling location (Site 5) was added and located near Browning Island, in between Site 6 and 7. All Zone 6 sites sampled in 2014 were repeated for the 2015 sample year.

Similar to the 2014 sampling season, seining occurred on a monthly cycle in April and May in 2015. This differed from the 2013 study year where sampling occurred in April, May and June. In 2011, the sampling occurred from March until June.

Crew size was four people with one person operating the boat and collecting environmental data and three people hauling the net and processing fish samples. The sampling crew was composed of personnel from Pacificus. Murray Humchitt; a representative from the Tlaltlasikwala First Nation, joined the crew on a portion of the sampling dates.

Fish were sampled using a beach seine net deployed in a simple arc set pattern by boat and pulled into the beach area by the crew as outlined in the beach seining section of *The Salmonid Field Protocols Handbook* (2008). The seine net was built by Redden Nets in Campbell River with dimensions as follows: 150 ft length with ½" wings and ¼" bunt mesh, 2 fathom depth and #2 lead line.

Prior to setting the net a preliminary search of the shoreline at each location was performed for 5 minutes from the boat at a distance of 10-20m from the shore in order to assess the presence of salmonids. If fish were observed then a set encompassed this area, if no fish were observed during this search then the set was performed at the most likely area for fish presence as determined by the crew during the search.

If no salmonids were caught on the first set in a sample site, a subsequent set was made within the defined sample area to a maximum of two sets per sampling location (Pacificus 2013a). During the 2011 study, subsequent sets were made to a maximum of three sets per sampling location, however the results indicated that only on one occasion did a third set within a sampling location result in a captured salmonid (Pacificus 2011). Therefore, the maximum number of sets per sampling location was modified to two for the 2013 study year and has remained this way for each sample year since.

If salmonids were caught, specimens were randomly selected for lab analysis and a count of the remaining numbers of fish to be released in the set was made based on field identification to the species level. A maximum of 30 fish/species for each target species were retained from each site for the lice analysis in each monthly cycle. Target species for the survey were pink (maximum 1440 specimens retained for entire project), chum, sockeye (maximum 1140 specimens per

species retained), coho, Chinook, Dolly Varden, cutthroat, stickleback and herring (maximum 1140 specimens per species retained).

Retained sample specimens were placed in sample bags and euthanized with a Tricaine methanesulfonate (TMS) overdose immediately. Samples in 2 ounce bags were given 1.0 ml of a 240 mg/L TMS solution while samples in 4 ounce bags were given 5 ml of the TMS solution. Each sample bag, having been pricked with a tack prior to usage, was then placed in a bucket where the solution was allowed to drain out and then poured to ground in the upland area. Sample bags for each site were placed in a larger bag together with relevant data for the set included on waterproof paper. Once samples were processed they were placed on ice in a cooler while in the field and frozen once they were transported back to Port Hardy. When the monthly cycle was complete the samples were transported in a frozen state to the BC Centre for Aquatic Health (CAHS) for laboratory analysis which included species identification and microscopic lice counts. Specimens were classified and analysed for wet weight, fork length and sea lice were identified to species and sexed with life stage determined and enumerated for each sample. For the purpose of analysis, louse prevalence was defined as the number of fish infected out of the total number sampled, abundance as the total average number of lice per fish and intensity as the total number of lice per infected fish.

In sets where large numbers of fish (over 100) were encountered in a single set or where sea conditions did not permit identification and/or processing of fish in the bunt of the net, caught fish were placed in a sea-water filled tote with airstones to maintain dissolved oxygen levels before being processed. Those fish that were not retained were released in a timely manner when identification and quantification had been completed.

Environmental data was collected at every seine location and consisted of temperature (^{0}C), dissolved oxygen (D_0) and salinity in parts per thousand (ppt) at the surface (0m), 1m depth and 4m depth. These measurements were taken using a 556 YSI meter at the same time and location as the set proximal to the mid-point of the net. Weather conditions at the time of each set were noted as well as any additional comments pertaining to the set. Locational data was collected from the sampling vessel's navigation system, a Ray-Marine multi-function GPS unit.

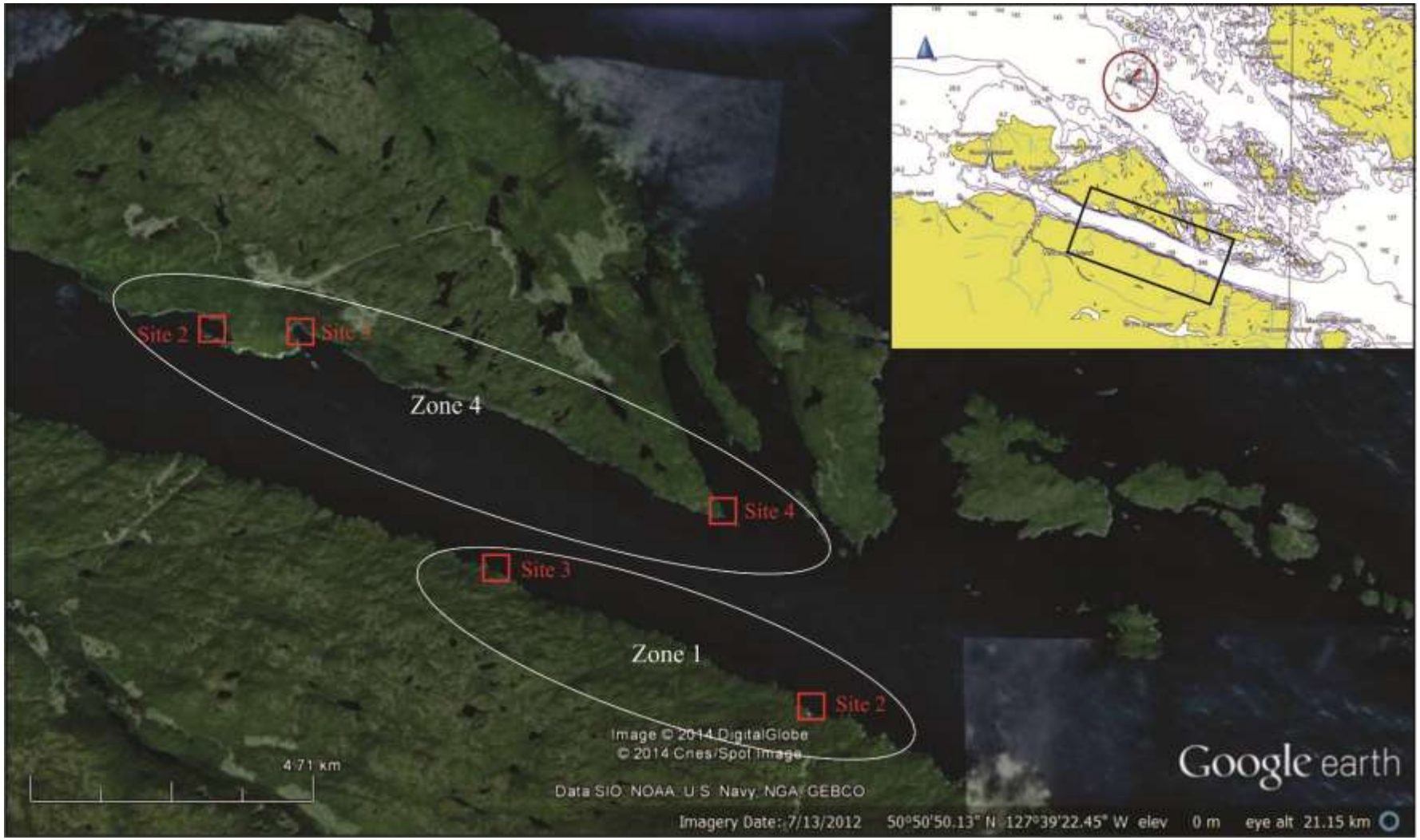

Figure 3: Location map of the sampling sites in Zone 1 (Vancouver Island) and 4 (Nigei Island) examined during the 2015 sample year in Goletas Channel, British Columbia. The yellow "X" indicates active and inactive fish farm locations.

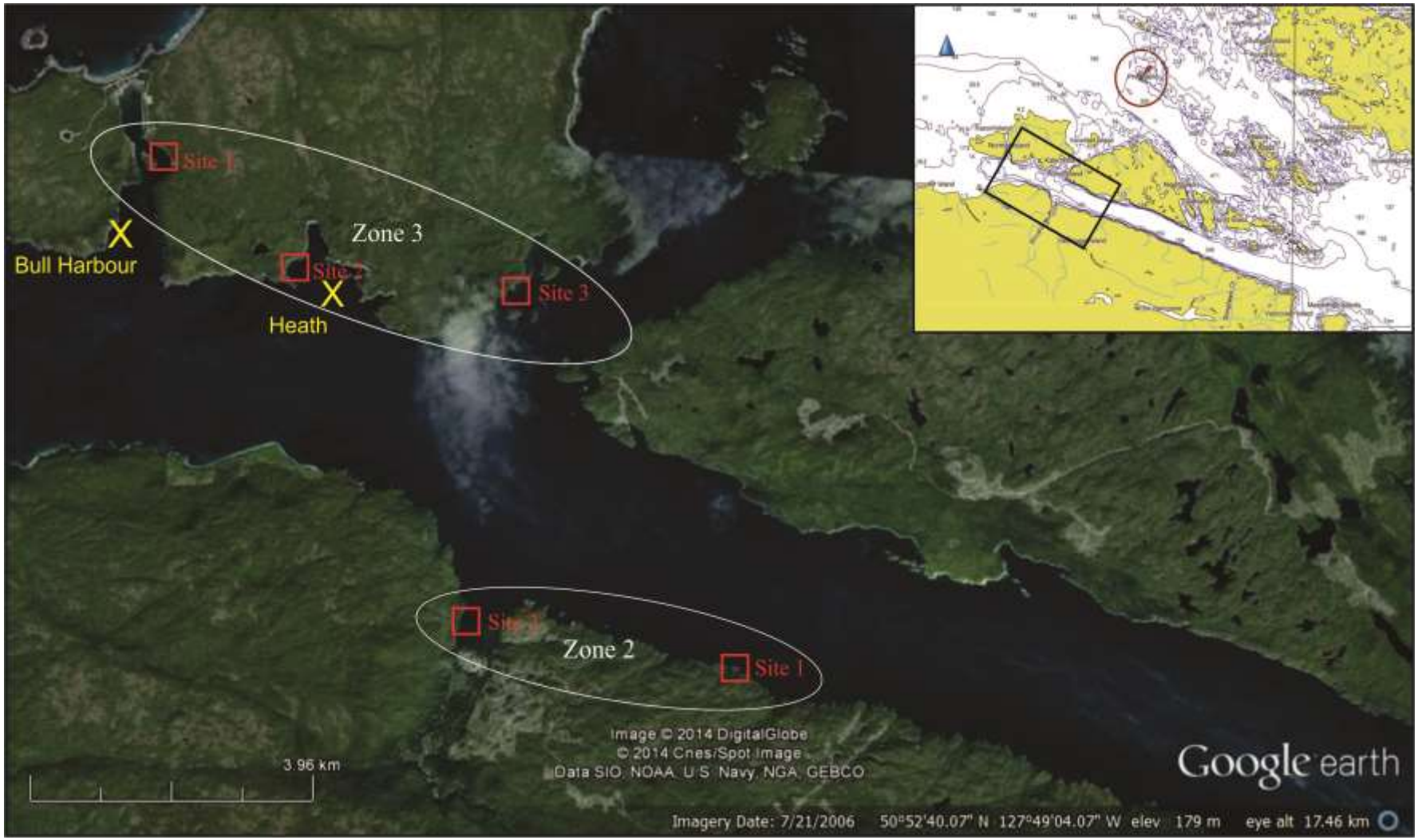

Figure 4: Location map of the sampling sites in Zone 2 (Vancouver Island) and Zone 3 (Hope Island) examined during the 2015 sample year in Goletas Channel, British Columbia**.** The yellow "X" indicates active and inactive fish farm locations.

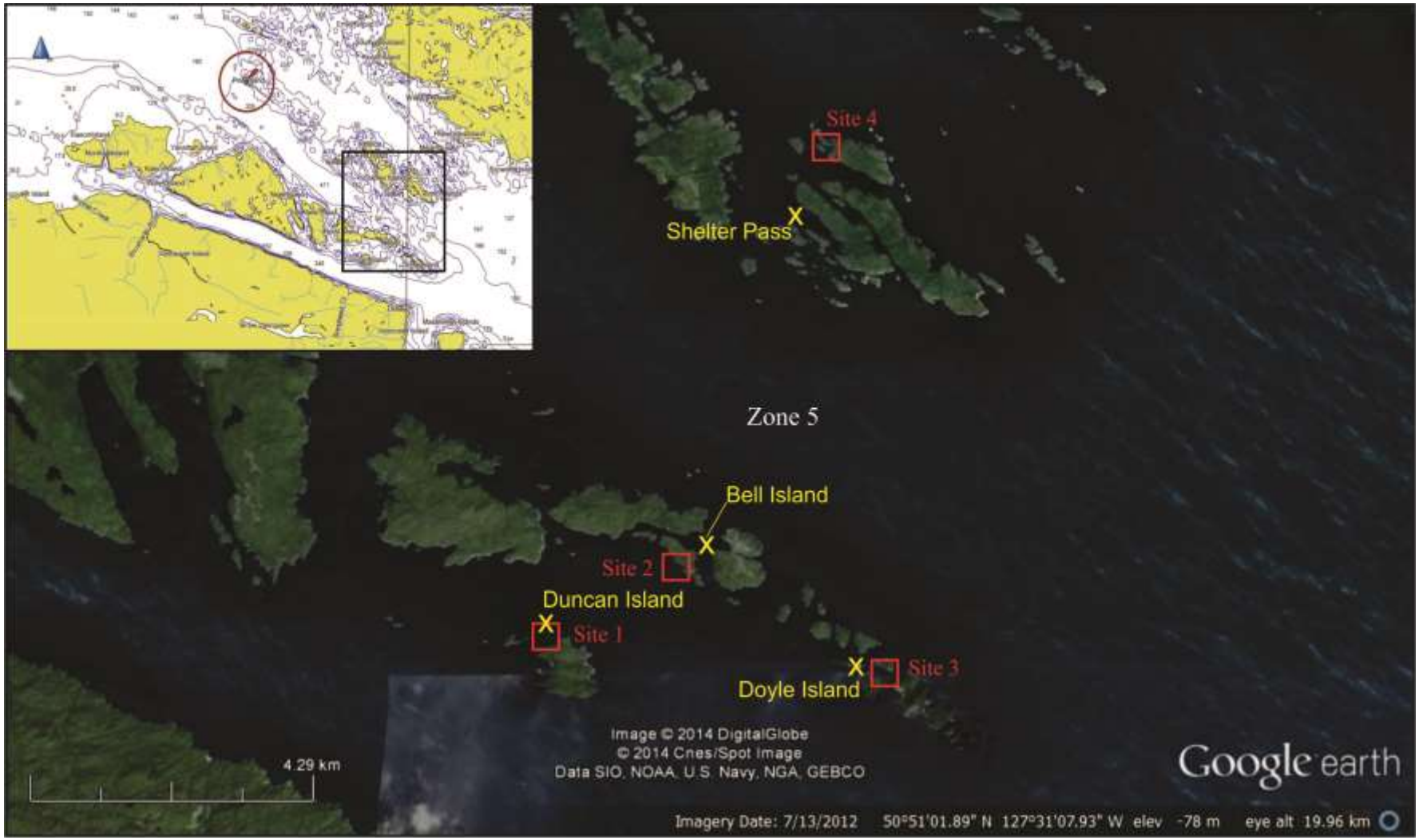

Figure 5: Location map of the sampling sites in Zone 5 (Gordon Group) examined during the 2015 sample year in Goletas Channel, British Columbia. The yellow "X" indicates active and inactive fish farm locations.

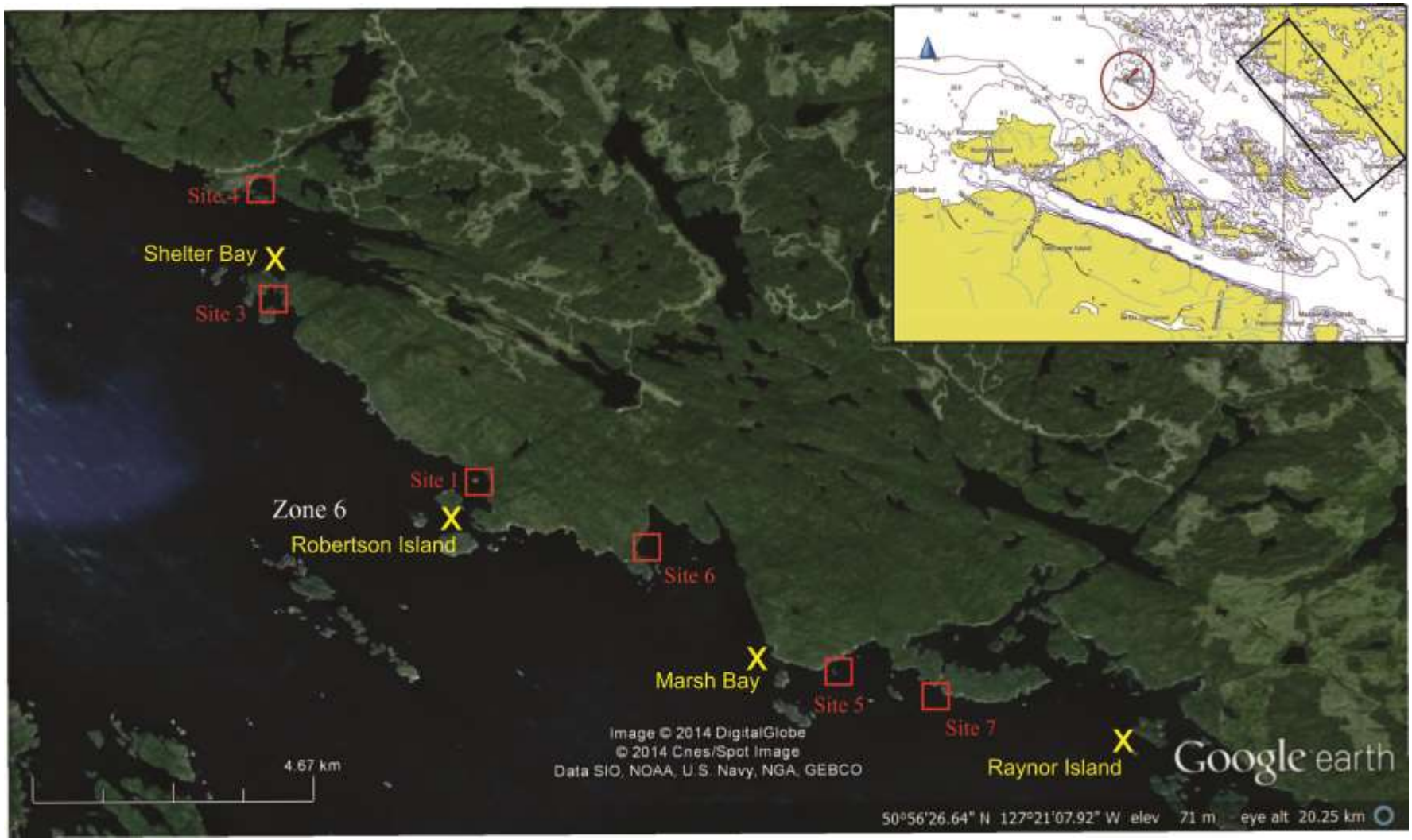

Figure 6: Location map of sampling sites in Zone 6 (Shelter Bay area) examined during the 2015 sample year in Queen Charlotte Strait, British Columbia. The yellow "X" indicates active and inactive fish farm locations.

Results

Two cycles of beach seining were completed during the 2015 sample season. The first cycle occurred on April 7th, 8th, 9th and 14th, 2015. The second cycle occurred from May 11th to May 14th. All 20 sites were sampled during the 2015 sample year.

A project total of 56 sets were completed during the 2015 season, 28 of which were successful at capturing target species. A total of 27 sets were completed during the April cycle, 15 of which were successful at capturing target species. A total of 29 sets were completed during the May cycle, 13 of which were successful at capturing target species.

During the April cycle, the crew was unable to capture fish within the first seine attempt at six sites; two of the subsequent sets resulted in the capture of target species. During the May cycle, the crew was unable to capture fish within the first seine attempt at nine sites; again, two of the subsequent sets resulted in the capture of target species.

The number of samples obtained in each of the 28 successful sets ranged from 1 to 65 target species and averaged 24.4 samples per successful set. A total of 682 samples were retained for laboratory analysis, 460 were pink salmon, 106 were chum, 71 were coho, 41 were sockeye, 1 was a Dolly Varden char and 3 were herring. A summary of sample totals by zone and by month is provided in Table 1.

Table 1: Summary of sample totals for juvenile salmonids collected in Goletas Channel and Queen Charlotte Strait, BC during the spring of 2015.

Zone	Sample Period		Zone Totals	% of Total Catch by Zone
	April	May		
1	37	66	103	15.1%
2	10	67	77	11.3%
3	26	37	63	9.2%
4	26	3	29	4.3%
5	116	142	258	37.8%
6	113	39	152	22.3%
Monthly Total	328	354	682	
Monthly % of Total Catch	48.1%	51.9%		

Juvenile Salmonid Abundance, Distribution, Growth and Timing Patterns

The project total of target species captured was 682 fish, all but three herring were salmonid species. 328 samples were collected during the April cycle (48.1% of the project total), and 354 samples were collected during the May cycle. (51.9% of the project total).

During the month of April, the breakdown of the monthly sample total by zone was as follows: 11.3% of samples were collected in Zone 1, 3.0% in Zone 2, 7.9% in Zone 3, 7.9% in Zone 4, 35.4% in Zone 5, and 34.5% in Zone 6. In May, the breakdown of the monthly sample total by zone was as follows: 18.6% of samples were collected in Zone 1, 18.9% in Zone 2, 10.5% in Zone 3, 0.8% in Zone 4, 40.1% in Zone 5 and 11.0% in Zone 6.

In April, salmonid samples were collected in every Zone, however only 10 samples were collected in Zone 2. Similarly, samples were obtained from every Zone during the month of May, however only 3 samples were collected in Zone 4. The highest proportions of salmonids were collected in Zones 5 and 6 in April. For the month of May the highest proportions were found in Zone 5.

The average length and weight of the salmonid specimens increased throughout each sampling month for all species collected (Table 3). Pink, chum and coho salmon were captured during each sampling month. Three herring were collected during April's sampling period. During May's sampling period, 1 Dolly Varden char was collected.

Sea Lice Infection

Lice Species Distribution

During the month of April a total of 38 *L. salmonis* were identified; originating from Zones 1, 5 and 6. A total of 19 *L. salmonis* originated from Zone 6, 16 from Zone 5 and three from Zone 1. In May a total of 45 *L. salmonis* were identified; none originated from Zones 2 or 3. A total of 24 originated in Zone 5, 14 from Zone 1, six from Zone 6 and one single louse originated in Zone 4.

A total of 30 *C. clemensi* were identified during the April cycle, one originated from Zone 5, two originated from Zone 3 and 27 originated from Zone 6. During May's cycle, a total of 583 *C. clemensi* were identified in five zones; no lice were identified on samples from Zone 4. A total of 481 *C. clemensi* originated from Zone 1, 47 from Zone 3, 28 from Zone 2, 22 from Zone 5 and five from Zone 6.

Table 2: Distribution of *L salmonis* and *C. clemensi* by Zone in Goletas Channel and Queen Charlotte Strait during the spring of 2015.

Zone	*Fish Sample*	*L. salmonis*	*Fish Sample*	*L. salmonis*	Louse Zone Total	*Fish Sample*	*C. clemens*	*Fish Sample*	*C. clemens*	Zone Total
	April		May			April		May		
1	37	3	66	14	17	37	0	66	481	481
2	10	0	67	0	0	10	0	67	28	28
3	26	0	37	0	0	26	2	37	47	49
4	26	0	3	1	1	26	0	3	0	0
5	116	16	142	24	40	116	1	142	22	23
6	113	19	39	6	25	113	27	39	5	32
Fish Total	328		354		**682**	328		354		**682**
Louse Total		38		45	**83**		30		583	**613**

Lice Species Prevalence, Abundance and Intensity in Pink Salmon

A total of 460 pink salmon were retained for lab sampling, 266 of which were caught during the April cycle, and 194 during May's cycle.

The mean prevalence (percentage of fish that were infected) for all sea lice was 22.8% on pink salmon. *L. salmonis* prevalence was 9.0% in April, and 13.92% in May. *C. clemensi* prevalence on pinks increased from 6.0% in April, to 23.20% in May.

The mean abundance (average number of sea lice on all fish sampled) for all sea lice was 0.337 on pink salmon. *L. salmonis* abundance on pink salmon was 0.113 in April and 0.155 in May. *C. clemensi* abundance on pinks was 0.090 in April, and 0.366 in May.

The mean intensity (average number of sea lice on infected fish) for all sea lice on pink salmon was 1.48. *L. salmonis* intensity on pink salmon was 1.25 in April and 1.11 May. *C. clemensi* intensity on pink salmon was 1.50 in April and 1.58 in May.

Refer to Table 3 for more information regarding species prevalence, abundance and intensity.

Lice Species Prevalence, Abundance and Intensity in Chum Salmon

A total of 106 chum salmon samples were retained for lab analysis. Of those samples, 57 were captured during April and 49 were captured during May's sampling cycle.

Mean prevalence for all sea lice on chum salmon was 23.6%. *L. salmonis* prevalence was 12.3% for the April sample cycle and 16.3% for May. C. *clemensi* prevalence on chum was 10.5% in April and 12.2% in May.

The mean abundance for all sea lice on chum salmon was 0.377. *L. salmonis* abundance on chum salmon was 0.140 in April and 0.204 in May. Similarly, *C. clemensi* abundance increased from 0.105 in April to 0.327 in May.

The mean intensity for all sea lice on chum salmon was 1.6. Intensity of *L.salmonis* increased from 1.14 in April to 1.25 in May. *C. clemensi* intensity also increased from 1.00 in April to 2.67 in May.

Refer to Table 3 for more information regarding species prevalence, abundance and intensity.

Lice Species Prevalence, Abundance and Intensity in Coho Salmon

A total of 71 coho salmon samples were retained for lab analysis, two of which were captured during April's sample cycle while the remaining 69 were captured during May's sample cycle.

No lice were observed on either of the fish from April. *C. clemensi* showed an overall greater prevalence, abundance and intensity on coho salmon than *L. salmonis*.

Mean prevalence for all sea lice on coho salmon was 49.3%. *L. salmonis* prevalence was 5.8% while *C. clemensi* prevalence was 50.7%.

Mean abundance for all sea lice on coho salmon was 5.83. *L. salmonis* prevalence was 0.072 and *C. clemensi* abundance was 5.928.

Mean intensity for all sea lice on coho salmon was 11.83. *L. salmonis* intensity was 1.25 and *C. clemensi* was 11.69.

Refer to Table 3 for more information regarding species prevalence, abundance and intensity.

Lice Species Prevalence, Abundance and Intensity in Sockeye Salmon

A total of 41 sockeye salmon samples were retained for lab analysis. All retained sockeye were captured during the May sample cycle. No *L.salmonis* were observed on sockeye during lab analysis. Lice prevalence, abundance and intensity values reflect the May sampling cycle and only *C. clemensi* were observed on sockeye for the 2015 lice survey.

C. clemensi prevalence on sockeye was 56.1%, abundance was 2.122 and intensity was 3.78.

Refer to Table 3 for more information regarding species prevalence, abundance and intensity.

Lice Species Prevalence, Abundance and Intensity in Herring and Dolly Varden

A total of three herring were captured during the April sample cycle and retained for lab analysis. No lice were identified on any of the herring samples.

One individual Dolly Varden was captured during the May sample cycle and retained for lab analysis. No lice were identified on the single Dolly Varden sample.

Table 3: Temporal changes in *L. salmonis* and *C clemensi* presence on salmonids in Goletas Channel and Queen Charlotte Strait, BC (pink salmon values highlighted in blue).

					L. salmonis					C. clemensi				
Month	Species	Number sampled	Ave Weight (g)	Ave Length (mm)	Total # Lice	# Fish Infected	Prevalence	Abundance	Intensity	Total # Lice	# Fish Infected	Prevalence	Abundance	Intensity
April	Pink	266	0.40	36	30	24	9.0%	0.113	1.25	24	16	6.0%	0.090	1.50
	Chum	57	1.00	43	8	7	12.3%	0.140	1.14	6	6	10.5%	0.105	1.00
	Coho	2	11.31	102	0	0	0.0%	0.000	0.00	0	0	0.0%	0.000	0.00
	Herring	3	0.06	20	0	0	0.0%	0.000	0.00	0	0	0.0%	0.000	0.00
May	Pink	194	1.67	52	30	27	13.9%	0.155	1.11	71	45	23.2%	0.366	1.58
	Chum	49	1.45	47	10	8	16.3%	0.204	1.25	16	6	12.2%	0.327	2.67
	Coho	69	12.44	102	5	4	5.8%	0.072	1.25	409	35	50.7%	5.928	11.69
	Sockeye	41	6.47	78	0	0	0.0%	0.000	0.00	87	23	56.1%	2.122	3.78
	Dolly Varden	1	62.18	185	0	0	0.0%	0.000	0.00	0	0	0.0%	0.000	0.00

Louse Life Stage on pink salmon

The most prevalent life stage of *L. salmonis* observed on pink salmon was the C3 stage (26.7%), followed by the copepodid stage (20.0%), C2 (15.0%), C1 and pre-adult stage (both 13.3%), C4 (10.0%) and adult stage (1.7 %).

The most prevalent life stage of *C. clemensi* observed on pink salmon was the C1 stage (69.5%), followed by C3 (11.6%), C2 (9.5%), C4 (4.2%), copepodid stage (3.2%) and adult stage (2.1%). No pre-adult *C. clemensi* were identified on pink salmon during the lab analysis.

Refer to Figure 7 for *L. salmonis* and *C. clemensi* prevalence on pink salmon.

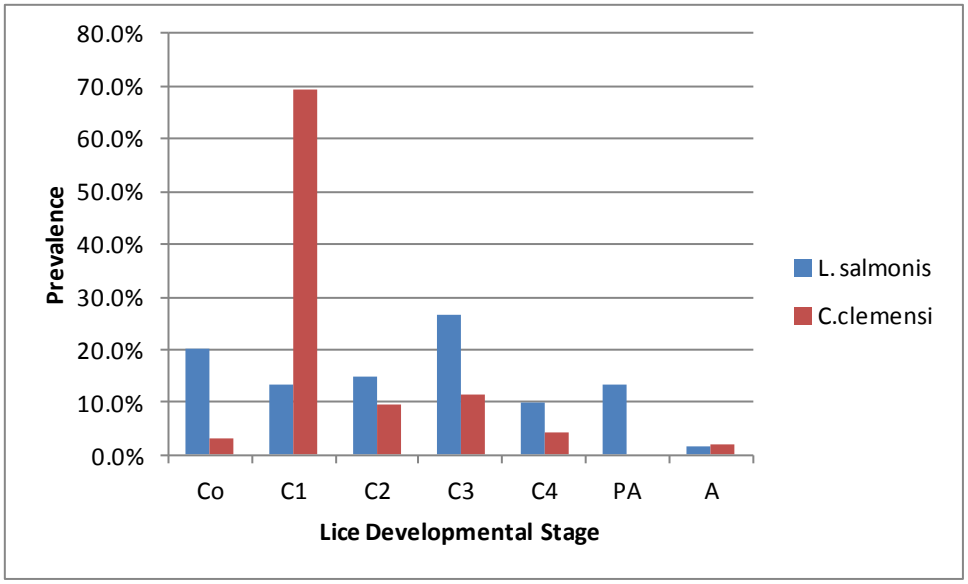

Figure 7: Developmental stages of *Lepeophtheirus salmonis* and *Caligus clemensi* present on juvenile pink salmon in Goletas Channel and Queen Charlotte Strait in the 2015 study period. The development stages are as follows: Co, copepodid; C1-C4, chalimus I to IV, PA, pre-adult (both sexes); A, adult (both sexes).

Louse Life Stage on chum salmon

A total of 106 chum salmon were retained for lab analysis during the April and May sampling event. The most prevalent life stage of *L. salmonis* observed on chum salmon was the C3 stage (33.3%), followed by the C4 stage (22.2%), C1 and C2 (both 16.7%), and pre-adult (11.1%). No copepodid stage or adult *L. salmonis* were observed on chum salmon.

The most prevalent life stage of *C. clemensi* observed on chum salmon was the C1 stage (63.6%), followed by C2 (27.3%), then copepodid and C3 stage (both 4.5%). No C4, pre-adult, or adult stage *C. clemensi* were identified on chum salmon during the lab analysis.

Refer to Figure 8 for *L. salmonis* and *C. clemensi* life stage and prevalence on chum salmon.

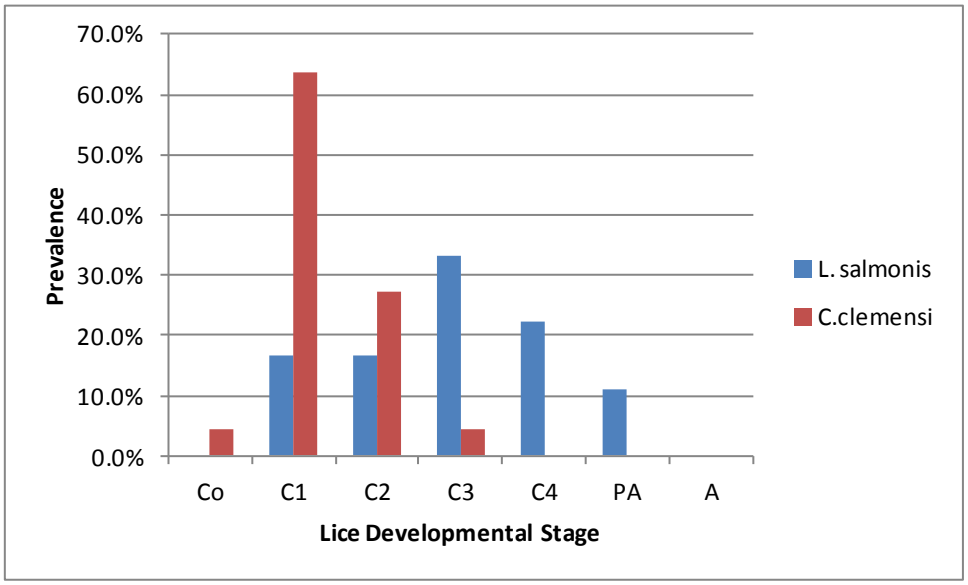

Figure 8: Developmental stages of *Lepeophtheirus salmonis* and *Caligus clemensi* present on juvenile chum salmon in Goletas Channel and Queen Charlotte Strait in the 2015 study period. The development stages are as follows: Co, copepodid; C1-C4, chalimus I to IV, PA, pre-adult (both sexes); A, adult (both sexes).

Louse Life Stage on coho salmon

A total of 71 coho salmon were retained for lab analysis during 2015 sample year. There were no lice, *L. salmonis* or *C. clemensi* identified on the two fish captured during the April sampling cycle. In May the most prevalent life stage for *L. salmonis* was the copepodid stage (60%) followed by C1 (40%).

The most prevalent life stage of *C. clemensi* identified on juvenile coho salmon was the C1 stage (92.9%) followed by copepodid stage (3.9%), adult lice (1.7%), C2 (1.2%) and C3 (0.2%). There were no C4 stage or pre-adult lice identified on any of the juvenile coho.

See Figure 9 for a graphical summary of the *L. salmonis* and *C. clemensi* life stage and prevalence on juvenile coho salmon.

Louse Life Stage on sockeye salmon

A total of 41 sockeye salmon were retained for lab analysis. No sockeye were captured during the April cycle, therefore all lice were identified in May. There were no observations of *L. salmonis* on any of the analyzed sockeye. The most prevalent life stage of *C. clemensi* was C1 (87.4%) followed by C2 (11.5%) and adult lice (1.1%). No copepodid stage, C3, C4 or pre-adult stage lice were identified on retained sockeye salmon.

Refer to Figure 9 for *C. clemensi* life stage and prevalence on sockeye salmon.

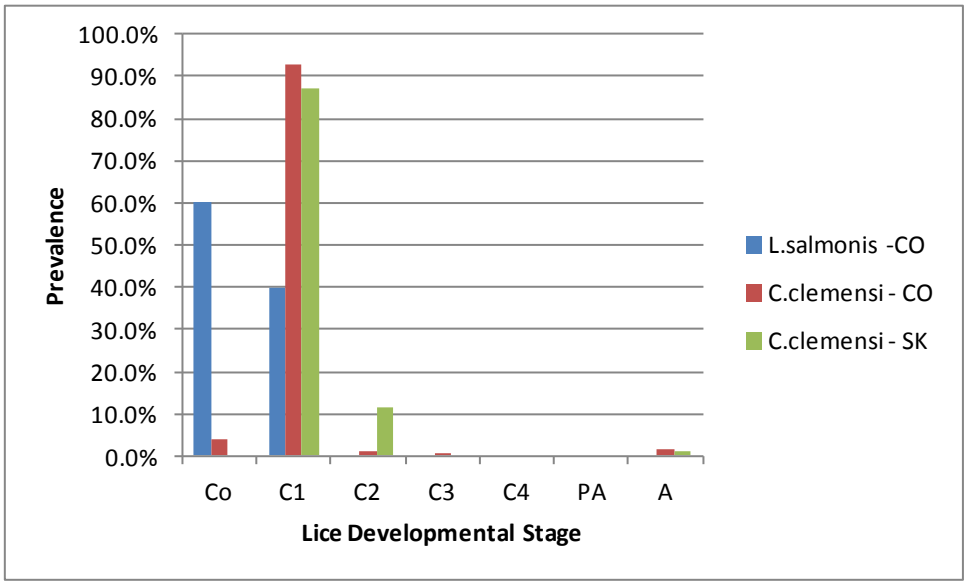

Figure 9: Developmental stages of *Lepeophtheirus salmonis* and *Caligus clemensi* present on juvenile coho and sockeye salmon Goletas Channel and Queen Charlotte Strait in the 2015 study period. The development stages are as follows: Co, copepodid; C1-C4, chalimus I to IV, PA, pre-adult (both sexes); A, adult (both sexes).

Water Quality - Salinity and Temperature

Salinity and temperature were recorded at each site throughout the entire study period at the surface (0m), 1m depth and 4m depth. Average salinity and average temperature were calculated for the entire study area at each sample depth. Results for average salinity at each depth over the entire study area are presented in Figure 10. Results for average temperature at each depth over the entire study area are presented in Figure 11.

Average salinity made a noticeable increase from April to May for all sample depths. For the month of April, there was a subtle increase in salinity from the surface to 1m depth indicating some stratification of fresh and saltwater during that time frame. During the month of April maximum salinity (31.36 ppt) was recorded at the 4m depth at Site 3 in Zone 3; Shadwell Passage side of Hope Island. Minimum salinity (18.75 ppt) was recorded on the surface at Site 2 in Zone 1; Songhees River estuary.

For the month of May, average salinity values were relatively uniform from the surface to 4m depth. During the month of May, maximum salinity (34.05 ppt) was recorded at the 4m depth at Site 4 in Zone 6; the northwest portion of Shelter Bay. Minimum salinity (31.07 ppt) was recorded at the surface and 1m depth at Site 1 in Zone 6; Robertson Island.

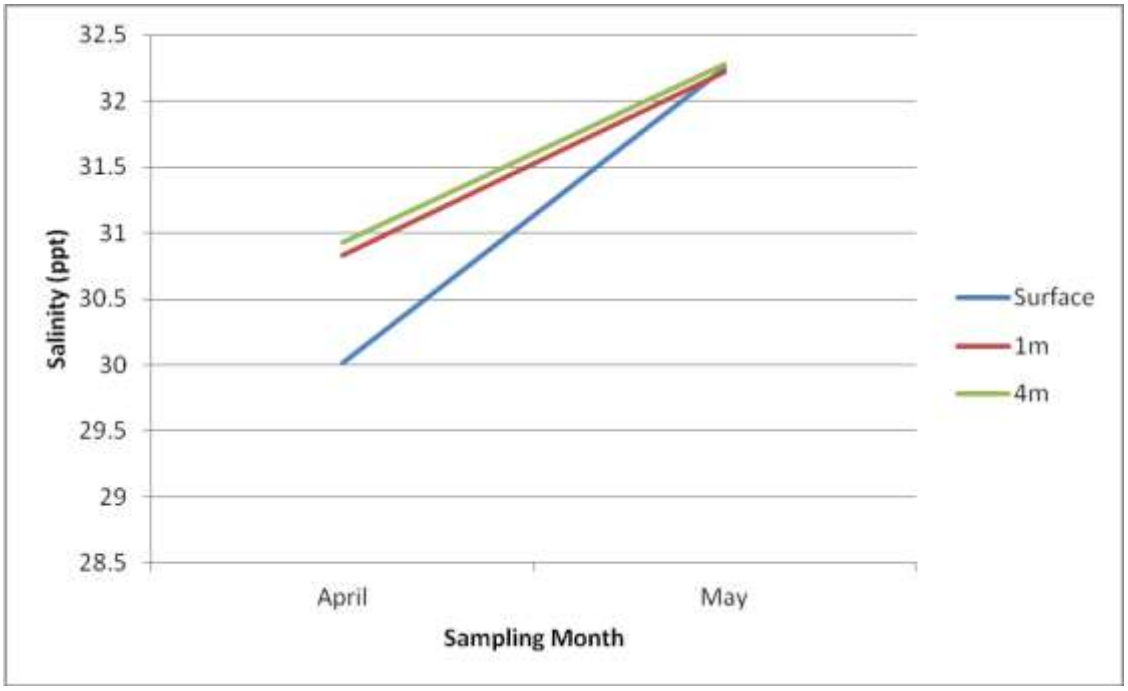

Figure 10: The average salinity recorded at the surface, 1m and 4m depth during the 2015 study period.

The average water temperature for the entire study area decreased from April to May. Average water temperature at the surface was 9.6°C in April and 8.8°C in May. At 1m water depth, average water temperature was 9.6°C in April and 8.8°C in May. At 4m water depth, average water temperature was 9.5°C in April and 8.6°C in May. For the month of April, the lowest recorded temperature (7.7°C) was recorded at the surface at Site 2 in Zone 1, Songhees River. The highest temperature for April (11.4°C) was recorded at the surface at Site 4 in Zone 6; northwest Shelter Bay. In May the lowest recorded temperature (6.8oC) was recorded at the 4m depth at Site 4 in Zone 6; northwest Shelter Bay. The highest temperature recorded in May (9.9oC) was found at the surface and 1m depths of Sites 2 and 3 in Zone 5.

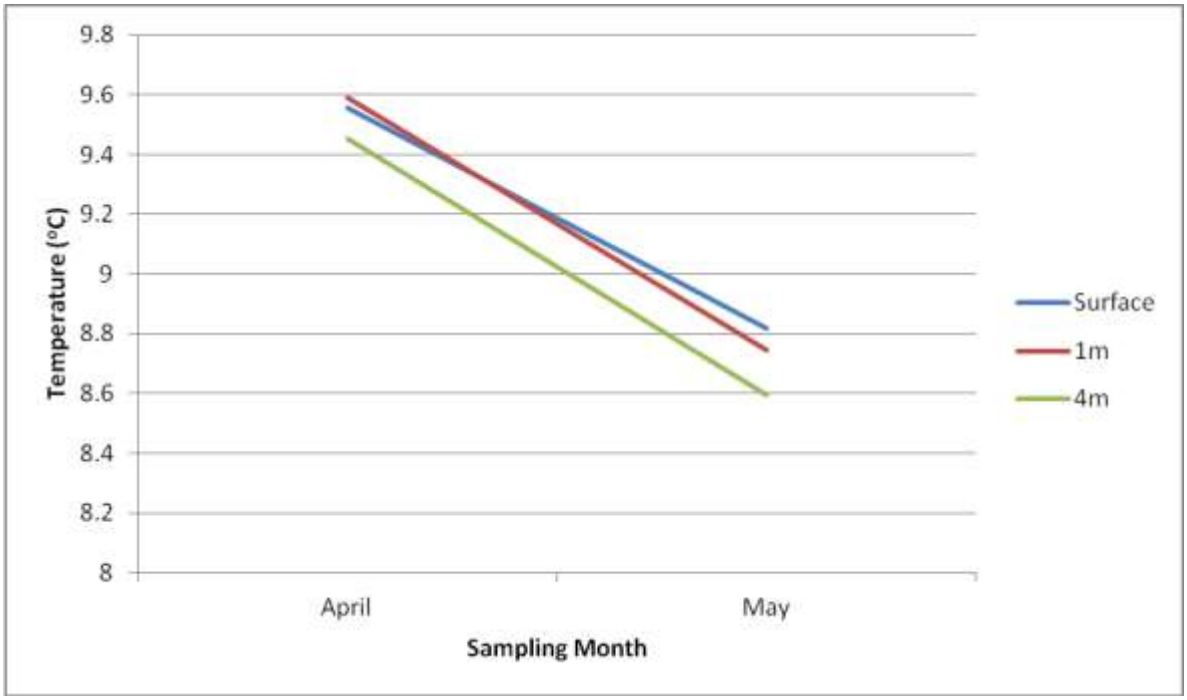

Figure 11: Average water temperature for April and May during the 2015 study period.

Discussion

Sample numbers

There were a total of 682 individual fish captured and retained for lab analysis from Goletas Channel and Queen Charlotte Strait for the 2015 study year. Overall this was a slight increase from the 579 individual fish retained for sea lice analysis during the 2014 study year as well as the sample totals for April and May during the 2011 and 2013 study years which were 578 and 540 respectively.

Salmonids sampled this year included pink, chum, coho and sockeye salmon. The majority of fish caught and retained for lab analysis were pinks (460 individuals). Smaller sample numbers of chum (106 individuals), coho (71 individuals) and sockeye (41 individuals) were also retained and analyzed in the lab.

Distribution

A summary of sample percentages by zone is presented in Table 4. In order to accurately compare numbers between study years, the sample percentages for April and May were extracted from the total sample numbers for the 2011 and 2013 study years when sampling occurred on four cycles.

Fish capture distribution for the 2015 study year was similar to sample distribution in the 2014 study year for Zones 2, 3 and 5. In Zone 2, the percentage of the total sample only decreased by approximately 1.7% from 13.00% in 2014 to 11.29% in 2015. In Zone 3 the percentage of the total sample increased slightly from 6.90% in 2014 to 9.24% in 2015. In Zone 5 the percentage of the total sample also increased slightly from 32.10% in 2014 to 37.83% in 2015.

Greater variability between the 2014 and 2015 study years was observed in Zones 1, 4 and 6. In Zone 1 the percentage of the total sample nearly tripled from 5.90% in 2014 to 15.10% in 2015. The percentage of the total sample from Zone 4 was less than half of what it was in 2014 dropping from 8.80% to 4.25% in 2015. Finally, in Zone 6 the percentage of the total sample for 2015 was 22.29%, while in 2015 it was 33.30%.

Over the course of the entire study period, there was some variability in sample size from April to May. A significantly smaller number of salmonids were captured and retained from Zones 1 and 2 in April (37 and 10 respectively) than there were in May (66 and 67 respectively).

Conversely, a greater number of fish were captured and retained from Zones 4 and 6 during the April cycle (26 and 113 respectively) than there were during the May cycle (3 and 39 respectively). Fish numbers were relatively consistent for Zones 3 and 5 between April (26 and 116 respectively) and May (37 and 142 respectively). As suggested in reporting from previous years, variability in the success of sample capture may be linked to changes in fish behavior relative to the tide cycle (Pacificus 2013). It has been suggested that juvenile salmonids may have a tendency to migrate closer to shore on a rising tide; this may result in more successful sets during a rising tide since fish are more susceptible to being captured by the beach seine. However, the following data also indicates that certain sites have a tendency to be consistently more productive for juvenile salmonids regardless of the tide cycle.

Table 4: A comparison of sample percentage for the months of April and May, by zone for the 2011, 2013, 2014 and 2015 study years. (Note: Zone 6 (Shelter Bay) was not sampled during the 2011 study year and in 2013 Zone 6 was not sampled in April or May).

Year	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
2011	20.83%	10.41%	8.62%	25.13%	35.01%	n/a
2013	18.70%	23.52%	15.37%	20.93%	20.93%	n/a
2014	5.90%	13.00%	6.90%	8.80%	32.10%	33.30%
2015	15.10%	11.29%	9.24%	4.25%	37.83%	22.29%

Over the last four study years, certain sites have consistently produced significantly more samples than other sites. Taking into consideration only the sample numbers for April and May the "hot-spots" in 2011 were Site 3 in Zone 1, Site 3 in Zone 3 and Site 2 in Zone 5. In 2013, the "hot-spots" for April and May were identified at Site 1 in Zone 2, Site 2 in Zone 3 and Sites 1 and 3 in Zone 5. In 2014, the April and May "hot-spots" were Site 1 in Zone 2, Site 3 in Zone 3, and Sites 1 and 3 in Zone 5. Zone 6 (Shelter Bay) was not sampled in 2011 and in 2013 the Zone did not get sampled until June. However, in 2014 Sites 3 and 7 in Zone 6 were considered "hot-spots" for April and May.

In 2015, some of the "hot-spots" mentioned above were once again identified as "hot-spots". The 2015 "hot-spots" were as follows: Site 3 in Zone (also identified in 2011); Site 2 in Zone 3 (also identified in 2013 and 2014); Site 3 in Zone 5 (also identified in 2013 and 2014); Site 3 in Zone 6 (also in 2014). Site 4 was added to Zone 5 in 2014; this site was considered a "hot-

spot" in 2015 but there was no sampling here prior to 2014, therefore this was the first year it was considered a "hot-spot".

Timing

A total of two cycles of beach seining took place in the 2015 study year. Beach seining during the first cycle occurred predominantly during the second week of April, with one day of seining during the third week due to poor weather conditions during the second week. Beach seining during the second cycle was completed during the second week of May.

Results from 2011, indicated that the peak timing for pink salmon smolt migration occurred from April to June (Pacificus 2011). A comparison of the number of juvenile pink salmon retained by cycle for 2011, 2013 and 2014 showed that the 2015 sample numbers were comparable to the previous study years (Figure 12). The highest proportion of pink salmon were retained in Cycle 2 (April) in all study years. The sample totals for pink salmon captured during the 2015 study year show a similar trend to the totals of the previous three study years. This trend suggests that the peak of the pink salmon smolt migration is being intercepted during beach seines conducted in April.

Insufficient catch data is available to accurately compare timing trends for other species. This is the fourth year for sea lice monitoring and data collection discerning juvenile salmon migration. Prior to 2011, no data existed for juvenile salmonid behaviour and migration in Goletas Channel and Queen Charlotte Straits.

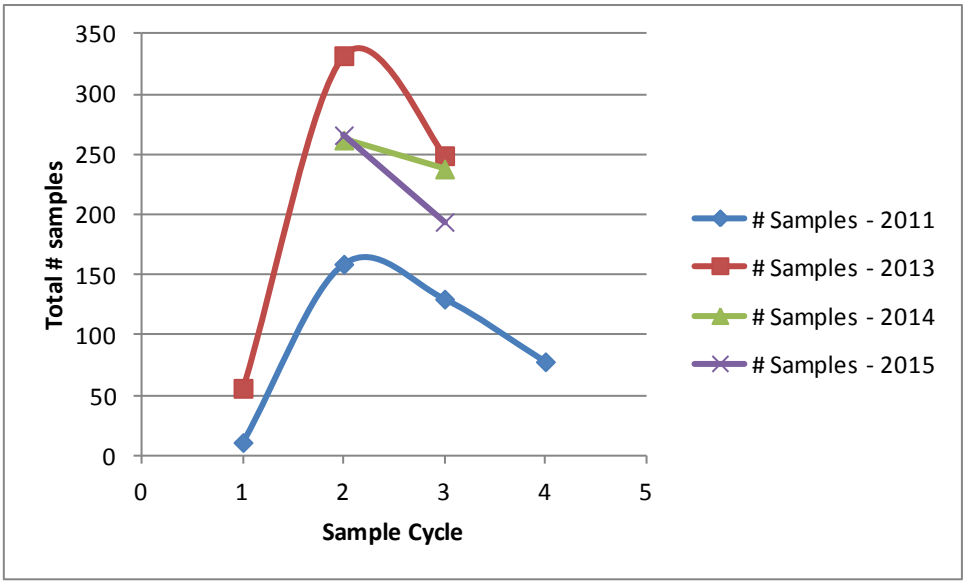

Figure 12: A comparison of the number of pink salmon juveniles retained during the 2011, 2013, 2014 and 2015 sea lice studies.

Water Quality

Water quality data for the 2015 study year differed from past study years based on a comparison of mean water temperature and mean salinity from all study years (Figures 13 and 14). In all three previous study years, water temperature increased from April to May; however mean water temperature in 2015 showed a marked decrease from April to May. During the 2011 study year, mean water temp showed a slight increase from April to May, but during the 2013 and 2014 study years, mean temperature increased by more than 1^{o}C from April to May. During the 2015 study year mean water temperature decreased by more than 1^{o}C from April to May.

In all three previous years, mean salinity for the study area remained relatively constant from April to May. During the 2015 study year, average salinity increased by over 1 ppt from April to May.

It should be noted, that water quality data for 2011 is only available for Zones 1-5 (Goletas Channel) and not for Zone 6 (Shelter Bay, Queen Charlotte Strait).

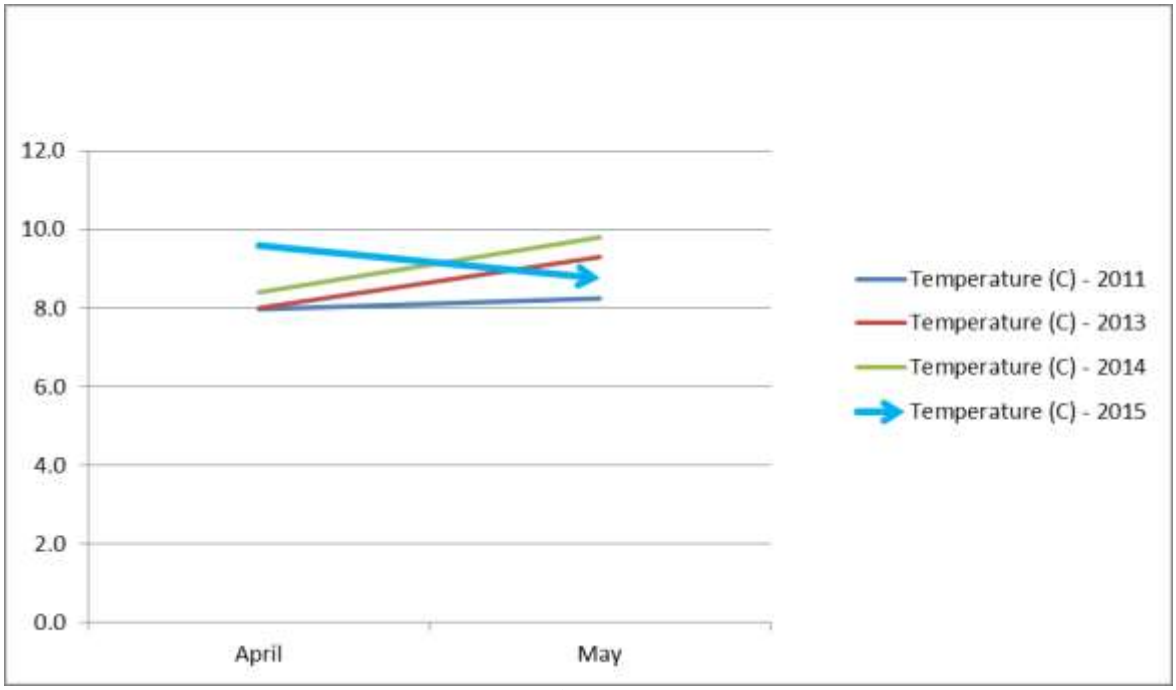

Figure 13: A comparison of temperature (^{o}C) and salinity (ppt) for 1m depths at sampling locations in Goletas Channel and Queen Charlotte Strait during the 2011, 2013, 2014 and 2015 sampling period.

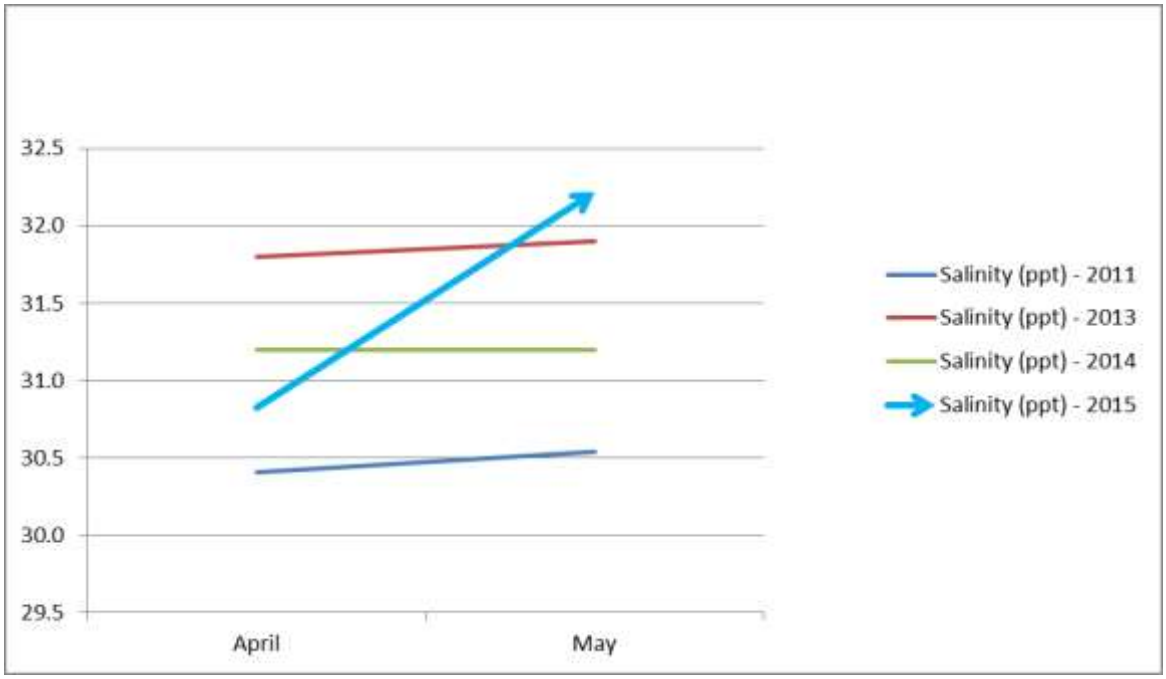

Figure 14: A comparison of temperature (^{o}C) and salinity (ppt) for 1m depths at sampling locations in Goletas Channel and Queen Charlotte Strait during the 2011, 2013, 2014 and 2015 sampling period.

Sea lice

Sea lice intensity (average number of lice per infected fish) was 1.48 for all sea lice over the entire study period. Intensity for *L. salmonis* was 1.25 in April and 1.11 in May, while intensity for *C. clemensi* was 1.50 for April and 1.58 for May. Average weight for juvenile pink salmon was 0.40g in April and increased to 1.67g in May. The threshold level for lethal infection stated in Jones and Hargreaves 2009 is 7.5 lice (*L. salmonis*) per fish averaging less than 0.7g in weight. Based on the Jones and Hargreaves conclusion, lice intensity on juvenile pink salmon observed during this survey is well below the threshold for lethal infection.

In Nendick et al (2011), experimental sea lice infection (*L. salmonis*) on juvenile pink salmon negatively affected swimming performance of only the smallest fish (≤0.34g). In addition, reduction in maximum swimming velocity was dependant on sea lice life stage, and not infection intensity; infection with a single louse of Chalimus 3 stage or higher would impact swimming performance in juvenile pink salmon weighing 0.34g or less.

Of the 139 individual juvenile pink salmon weighing less than 0.34g two were infected with a Chalimus 3 stage or higher *L. salmonis*; one individual was infected with a single Chalimus 3 while the other was infected with two lice, one Chalimus 3 and one Chalimus 4. Based on the Nendick et al (2011) findings, maximum swimming velocity of these two individuals would be reduced. No other small fish (i.e. ≤0.34g) were infected with a Chalimus 3 stage or greater.

Based on the summary data in Table 2, *C. clemensi* was more prevalent than *L. salmonis* for the Goletas Channel and Queen Charlotte Strait study area in the 2015 study year. Of the 696 sea lice identified during the lab analysis, 88% were *C. clemensi*. This trend remains similar to the trends observed in previous years. In 2014, of the 42 sea lice identified during the lab analysis, 76% were *C. clemensi* (Pacificus 2014). Similarly, in 2013 *C. clemensi* accounted for 76% of identified sea lice (Pacificus 2013a) while in 2011, 80% of the identified sea lice were *C. clemensi* (Pacificus 2011).

Through a comparison of data from all study years, sea lice prevalence, abundance and intensity were higher in the 2015 study year. 2014 showed some of the lowest values for sea lice prevalence, abundance and intensity for both *L. salmonis* and *C. clemensi* (Refer to Appendix 2 for raw data from 2011, 2013 and 2014). Taking into consideration the sample

size in all study years, a comparison of the total number of lice and the total number of infected salmonids identified in each year illustrates this difference (Table 5).

Table 5: A comparison of the total number of lice and the total number of infected salmonid identified in each study year.

Year	*L. salmonis*		*C. clemensi*	
	Total # of Lice	Total # of infected fish	Total # of Lice	Total # of infected fish
2011 (n = 809)	41	34	209	140
2013 (n = 870)	14	14	52	34
2014 (n = 578)	10	10	32	31
2015 (n = 682)	83	71	613	132

Pink salmon was the only species captured during all sampling cycles in all study years (2011, 2013, 2014, and 2015). Based on the 2011 and 2013 results for salmonid outmigration timing and the average weight and size of the salmonids, sampling effort in 2014 was focused within April and May. Again in 2015, sampling effort focussed on the months of April and May. As a result, sea lice prevalence and infectious rates on pink salmon were only compared for the months of April and May between the four study years.

Over the past four study years the prevalence of *L. salmonis* on juvenile pink salmon has followed a similar trend of increasing from the April sampling period to May (Figure 15). However, during the 2015 study year, the overall prevalence of *L. salmonis* on juvenile pink salmon was much greater than previous years. Based on the results of the past three study years, *L. salmonis* prevalence in April ranged from 0% to 0.38% and showed little-to-no increase into the month of May (0% in 2011, 0.6% in 2013 and 3.36% in 2014). During the 2015 study year, prevalence in April was 9.0% and increased to 13.9% during the month of May, an increase of 4.9%.

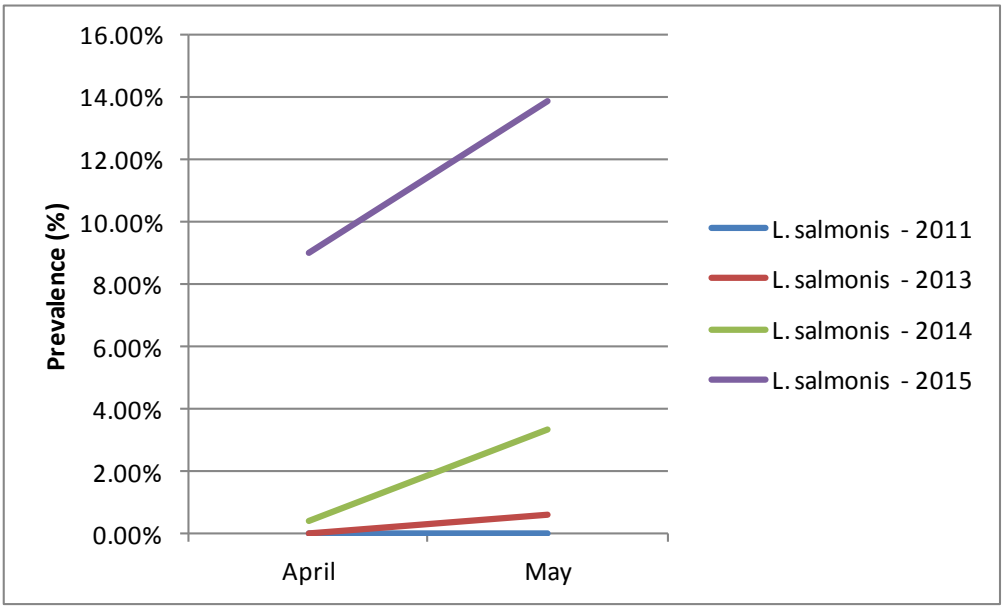

Figure 15: A comparison of the prevalence of *L. salmonis* on pink salmon captured in Goletas Channel and Queen Charlotte Straits during the spring of 2011, 2013, 2014 and 2015. 2015

With the exception of the 2011 study year, *C. clemensi* prevalence on juvenile pink salmon also followed a similar trend of increase from April to May over every study year. In 2011, *C. clemensi* prevalence showed a decrease from 9.1% in April to 1.8% in May. Much like the trend for *L. salmonis*, prevalence of *C. clemensi* increased from April to May during the 2015 study year. However, the overall prevalence values for *C. clemensi* in 2015 were much higher than prevalence values in years past (Figure 16). During the 2013 and 2014 study years C. clemensi prevalence in April was 1.8% and 1.15% respectively and increasing to 5.2% and 10.5% respectively in May. In 2015, C. clemensi prevalence on pink salmon was 6.0% in April and increased to 23.20% in May an increase of 17.2%.

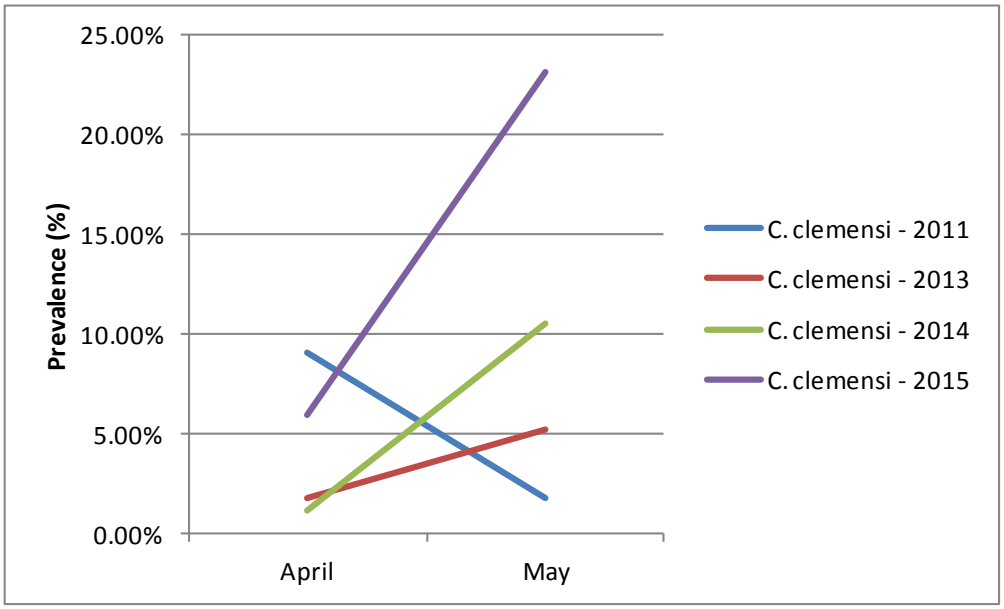

Figure 16: A comparison of the prevalence of *C. clemensi* on pink salmon captured in Goletas Channel and Queen Charlotte Straits during the spring of 2011, 2013, 2014 and 2015.

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Appendix 1: Raw Field Data Summary

2015 Goletas Channel and Queen Charlotte Strait Beach Seine

Beach Seine Summary			April 7-10, 14 2015						May 11-14 2015					Site Total # Fish
Site #	Location	Sample	Pink	Chum	Coho	Pacific Herring	Chinook	Unidentified	Pink	Chum	Coho	Sockeye	Dolly Varden	
Zone 1 (VI south)														
Site 2	50°48.110 N	retained	**1**								**1**			**2**
	127° 37.890 W	captured	1								1			2
Site 3	50°49.487 N	retained	**31**	**5**	**0**		**0**		**30**	**1**	**29**	**5**		**101**
	127° 42.564 W	captured	41	5	0		0		63	1	29	5		144
Zone 2 (VI north)														
Site 1	50° 50.782 N	retained	**9**	**1**							**6**			**16**
	127° 48.839 W	captured	9	1							6			16
Site 2	50° 51.119 N	retained									**30**	**30**	**1**	**61**
	127° 52.011 W	captured									130	80	1	**211**
Zone 3 (Hope Isl)														
Site 1	50° 54.753 N	retained												**0**
	127° 55.837 W	captured												**0**
Site 2	50° 53.833 N	retained	**15**						**30**		**2**	**5**		**52**
	127° 54.220 W	captured	15						30		2	5		52
Site 3	50° 53.698 N	retained	**11**											**11**
	127° 51.420 W	captured	11											11
Zone 4 (Nigei Isl)														
Site 2	50° 51.667 N	retained							**1**	**2**				**3**
	127° 46.712 W	captured							1	2				3
Site 3	50° 51.692 N	retained	**20**	**3**	**2**	**1**								**26**
	127° 45.477 W	captured	20	3	2	1								26
Site 4	50° 49.980 N	retained												**0**
	127° 39.147 W	captured												0
Zone 5 (Gordon Isls)														
Site 1	50°49.095 N	retained	**30**	**9**							**1**	**1**		**41**
	127° 33.311 W	captured	77	9							1	1		88
Site 2	50°49.714 N	retained	**11**						**41**	**9**				**61**
	127°31.560 W	captured	11						400	9				420
Site 3	50°48.831 N	retained	**34**	**0**					**30**	**30**				**94**
	127°28.678 W	captured	80	0					600	100				780
Site 4	50°53.580 N	retained	**30**			**2**			**30**					**62**
	127° 29.362 W	captured	90			2			1000					1092
Zone 6 (Shelter Bay)														
Site 1	50° 55.920 N	retained	**1**											**1**
	127° 24.324 W	captured	1											1
Site 3	50° 57.580 N	retained	**33**	**14**					**30**	**7**				**84**
	127° 27.254 W	captured	300	14					300	7				621
Site 4	50° 58.577 N	retained							**1**					**1**
	127° 27.477 W	captured							1					1
Site 5	50° 54.241 N	retained	5											**0**
	127°19.289 W	captured	5											0
Site 6	50° 55.221 N	retained	**3**						**1**					**4**
	127° 22.516 W	captured	3						1					4
Site 7	50° 53.990N	retained	**32**	**25**										**57**
	127° 17.859 W	captured	550	25										575
			1214	57	2	3	0	0	2396	119	169	91	1	4052
TOTAL RETAINED			**266**	**57**	**2**	**3**	**0**	**0**	**194**	**49**	**69**	**41**	**1**	**682**

*** retained fish are first row for each site in bold, caught fish are second row for each site in regular print.

2014 Goletas Channel and Queen Charlotte Strait Beach Seine:

Beach Seine Summary		April 8-11 2014						May 12-15 2014				Site Total # Fish
Site #	Location	Pink	Chum	Coho	Sockeye	Chinook	Unidentified	Pink	Chum	Sockeye	Coho	
Zone 1 (VI south)												
Site 2	50°48.110 N	**2**	**0**	**0**	**0**	**0**	**0**	**20**	**0**	**0**	**0**	**22**
	127° 37.890 W	2	0	0	0	0	0	20	0	0	0	**22**
Site 3	50°49.487 N	**11**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**12**
	127° 42.564 W	11	1	0	0	0	0	0	0	0	0	**12**
Zone 2 (VI north)												
Site 1	50° 50.782 N	**33**	**4**	**0**	**1**	**1**	**0**	**1**	**4**	**0**	**0**	**44**
	127° 48.839 W	46	4	0	4	1	0	1	4	0	0	**60**
Site 2	50° 51.119 N	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**20**	**10**	**31**
	127° 52.011 W	1	0	0	0	0	0	0	0	20	200	**221**
Zone 3 (Hope Isl)												
Site 1	50° 54.753 N	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
	127° 55.837 W	1	0	0	0	0	0	0	0	0	0	**1**
Site 2	50° 53.833 N	**29**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**31**
	127° 54.220 W	182	2	0	0	0	0	0	0	0	0	**184**
Site 3	50° 53.698 N	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**8**
	127° 51.420 W	8	0	0	0	0	0	0	0	0	0	**8**
Zone 4 (Nigei Isl)												
Site 2	50° 51.667 N	**2**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**
	127° 46.712 W	2	3	0	0	0	0	0	0	0	0	**5**
Site 3	50° 51.692 N	**2**	**0**	**0**	**10**	**0**	**1**	**31**	**1**	**0**	**1**	**46**
	127° 45.477 W	2	1	20	10	0	1	32	1	0	1	**68**
Site 4	50° 49.980 N	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	127° 39.147 W	0	0	0	0	0	0	0	0	0	0	**0**
Zone 5 (Gordon Isls)												
Site 1	50°49.095 N	**31**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**31**
	127° 33.311 W	300	0	0	0	0	0	0	0	0	0	**300**
Site 2	50°49.714 N	**30**	**0**	**0**	**0**	**0**	**0**	**30**	**0**	**0**	**0**	**60**
	127°31.560 W	650	0	0	0	0	0	6000	0	0	0	**6650**
Site 3	50°48.831 N	**30**	**0**	**0**	**0**	**0**	**0**	**35**	**0**	**0**	**0**	**65**
	127°28.678 W	500	0	0	0	0	0	10000	0	0	0	**10500**
Site 4	50°53.580 N	**0**	**0**	**0**	**0**	**0**	**0**	**30**	**0**	**0**	**0**	**30**
	127° 29.362 W	0	0	0	0	0	0	3000	0	0	0	**3000**
Zone 6 (Shelter Bay)												
Site 1	50° 55.920 N	**30**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**31**
	127° 24.324 W	49	0	0	0	0	0	1	**0**	**0**	0	**50**
Site 3	50° 57.580 N	**31**	**2**	**0**	**0**	**0**	**0**	**30**	**0**	**0**	**10**	**73**
	127° 27.254 W	78	3	0	0	0	0	400	0	0	10	**491**
Site 4	50° 58.577 N	**1**	**0**	**0**	**0**	**0**	**0**	**30**	**0**	**0**	**0**	**31**
	127° 27.477 W	1	0	0	0	0	0	37	0	0	0	**38**
Site 5	50° 54.241 N	n/a	n/a	n/a	n/a	n/a	n/a	**0**	0	0	0	**0**
	127°19.289 W	n/a	n/a	n/a	n/a	n/a	n/a	0	0	0	0	**0**
Site 6	50° 55.221 N	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	127° 22.516 W	0	0	0	0	0	0	0	0	0	0	**0**
Site 7	50° 53.990N	**20**	**8**	**0**	**0**	**0**	**0**	**30**	**0**	**0**	**0**	**58**
	127° 17.859 W	20	8	0	0	0	0	37	0	0	0	**65**
		1853	22	30	14	1	1	19528	5	20	211	21685
TOTAL RETAINED		**262**	**20**	**0**	**11**	**1**	**1**	**238**	**5**	**20**	**21**	**579**

*** retained fish are first row for each site in bold, caught fish are second row for each site in regular print.

2013 Goletas Channel Beach Seine:

Beach Seine Dates		April 1-2, 2013			May 6-8, 2013				June 3-5, 2013					Site Total # Fish
Lab Analysis Dates		April 8, 2013			May 16-31, 2013				June 21-26 and July 4, 2013					Site Total # Fish
Site #	Location	Pink	Chinook	on-salmon	Pink	Coho	Sockeye	Chum	Pink	Chinook	Coho	Sockeye	Dolly Varden	
Zone 1 (VI south)														
Site 1	50° 47' 13.115" N	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**5**	**0**	**2**	**10**
	127° 34' 36.832" W	1	1	1	0	0	0	0	0	0	5	0	2	**10**
Site 2	50° 48' 6.617" N	**4**	**2**	**0**	**30**	**0**	**0**	**15**	**1**	**0**	**0**	**0**	**0**	**52**
	127° 37' 55.582" W	4	2	0	3000	0	0	15	1	0	0	0	0	**3022**
Site 3	50° 49' 26.579" N	**7**	**0**	**0**	**30**	**0**	**0**	**10**	**30**	**0**	**2**	**0**	**0**	**79**
	127° 42' 36.213" W	7	0	0	350	0	0	10	150	0	2	0	0	**519**
Zone 2 (VI north)														
Site 1	50° 50' 32.792" N	**30**	**5**	**0**	**30**	**16**	**0**	**25**	**30**	**5**	**0**	**0**	**0**	**141**
	127° 48' 16.983" W	94	5	0	275	16	0	25	3500	5	0	0	0	**3920**
Site 2	50° 51' 1.563" N	**2**	**0**	**0**	**0**	**14**	**3**	**0**	**0**	**0**	**16**	**0**	**1**	**36**
	127° 51' 36.418" W	2	0	0	0	14	3	0	0	0	65	0	1	**85**
Site 3	50° 52' 24.844" N	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**15**	**0**	**1**	**1**	**0**	**19**
	127° 54' 13.108" W	0	0	0	2	0	0	0	15	0	1	1	0	**19**
Zone 3 (Hope Isl)														
Site 1	50° 54' 40.388" N	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
	127° 55' 42.765" W	0	0	0	0	1	0	0	0	0	0	0	0	**1**
Site 2	50° 53' 48.141" N	**3**	**0**	**0**	**30**	**0**	**0**	**5**	**30**	**0**	**0**	**0**	**0**	**68**
	127° 53' 17.963" W	0	0	0	3500	0	0	5	92	0	0	0	0	**3597**
Site 3	50° 53' 40.083" N	**1**	**2**	**0**	**30**	**0**	**0**	**11**	**11**	**0**	**0**	**0**	**0**	**55**
	127° 51' 34.341" W	1	2	0	3800	0	0	11	11	0	0	0	0	**3825**
Zone 4 (Nigei Isl)														
Site 1	50° 52' 12.580" N	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**1**	**0**	**0**	**0**	**0**	**3**
	127° 48' 40.430"W	0	0	0	0	0	0	2	1	0	0	0	0	**3**
Site 2	50° 51' 42.071" N	**4**	**0**	**0**	**30**	**0**	**0**	**8**	**1**	**0**	**0**	**0**	**0**	**43**
	127° 46' 33.619" W	4	0	0	1400	0	0	8	1	0	0	0	0	**1413**
Site 3	50° 51' 42.928" N	**3**	**0**	**0**	**30**	**0**	**0**	**3**	**0**	**1**	**0**	**0**	**0**	**37**
	127° 45' 30.676" W	3	0	0	126	0	0	3	0	1	0	0	0	**133**
Site 4	50° 49' 54.803" N	**1**	**0**	**0**	**30**	**0**	**0**	**2**	**30**	**0**	**0**	**0**	**0**	**63**
	127° 39' 12.223" W	1	0	0	150	0	0	2	30	0	0	0	0	**183**
Zone 5 (Gordon Isls)														
Site 1	50° 49' 3.788" N	**0**	**0**	**0**	**30**	**0**	**0**	**6**	**30**	**0**	**16**	**0**	**0**	**82**
	127° 33' 16.194" W	0	0	0	350	0	0	6	250	0	37	0	0	**643**
Site 2	50° 49' 52.875" N	**0**	**0**	**0**	**30**	**0**	**0**	**13**	**0**	**0**	**0**	**0**	**0**	**43**
	127° 30' 52.353" W	0	0	0	700	0	0	13	0	0	0	0	0	**713**
Site 3	50° 48' 49.921" N	**0**	**0**	**0**	**30**	**0**	**0**	**4**	**30**	**4**	**0**	**0**	**0**	**68**
	127° 28' 40.714" W	0	0	0	3500	0	0	4	10000	4	0	0	0	**13508**
TOTAL RETAINED		**55**	**11**	**1**	**344**	**15**	**19**	**95**	**213**	**10**	**30**	**2**	**4**	**799**

*** retained fish are first row for each site in bold, caught fish are second row for each site in regular print. Please note: This data represents the field data recorded during beach seines and does not reflect corrections made during lab analysis of samples. Therefore, discrepancies may be present between field and lab data.

2013 Queen Charlotte Strait Beach Seine:

Beach Seine Summary		06-Jun-13			03-Jul-13			Site Total # Fish
Site #	Location	Pink	Coho	Chum	Pink	Chinook	Herring	
Shelter Bay								
Site 1	50°55'58.90"N	**30**	**0**	**0**	**9**	**0**	**31**	**70**
	127°24'19.94"W	500	0	0	9	0	500	1009
Site 2	50°56'42.39"N	**0**	**0**	**0**	**n/a**	**n/a**	**n/a**	**0**
	127°26'02.88"W	0	0	0				0
Site 3	50°57'41.21"N	**0**	**3**	**0**	**1**	**1**	**0**	**5**
	127°27'16.18"W	0	3	0	1	1	0	5
Site 4	50°58'37.90"N	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	127°27'25.39"W	0	0	0	0	0	0	0
Site 5	50°59'15.24"N	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	127°30'21.21"W	0	0	0	**0**	**0**	0	0
TOTAL RETAINED		**30**	**3**	**0**	**10**	**1**	**31**	**75**
		500	3	0	10	1	500	1014

2011 Goletas Channel Beach Seine:

Beach Seine Summary		March 30-April 1, 2011			April 27-29, 2011			May 30-June 3, 2011					June 28 30-July 4, 2011				Site Total # Fish
Site #	Location	Pink	Chum	Coho	Pink	Chum	Chinook	Pink	Chum	Coho	Herring	Dolly Varden	Pink	Chum	Coho	Herring	
Zone 1 (VI south)																	
Site 1	50° 47' 13.115" N	**0**	**0**	**3**	**3**	**0**	**0**	**0**	**7**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**13**
	127° 34' 36.832" W	0	0	3	3	0	0	0	7	0	0	0	0	0	0	0	13
Site 2	50° 48' 6.617" N	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**4**
	127° 37' 55.582" W	0	0	0	0	0	0	1	0	0	0	6	0	0	0	0	7
Site 3	50° 49' 26.579" N	**2**	**0**	**0**	**31**	**7**	**0**	**31**	**30**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**101**
	127° 42' 36.213" W	2	0	0	731	7	0	68	171	0	0	0	0	0	0	0	979
Zone 2 (VI north)																	
Site 1	50° 50' 32.792" N	**1**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**
	127° 48' 16.983" W	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	3
Site 2	50° 51' 1.563" N	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**3**	**45**	**0**	**0**	**0**	**0**	**0**	**0**	**49**
	127° 51' 36.418" W	0	0	0	1	0	0	0	3	259	0	0	0	0	0	0	263
Site 3	50° 52' 24.844" N	**0**	**0**	**0**	**18**	**0**	**0**	**0**	**0**	**0**	**0**	**5**	**0**	**0**	**0**	**0**	**23**
	127° 54' 13.108" W	0	0	0	18	0	0	0	0	0	0	7	0	0	0	0	25
Zone 3 (Hope Isl)																	
Site 1	50° 54' 40.388" N	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**
	127° 55' 42.765" W	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2
Site 2	50° 53' 48.141" N	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	127° 53' 17.963" W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Site 3	50° 53' 40.083" N	**0**	**0**	**0**	**34**	**11**	**2**	**0**	**0**	**0**	**0**	**0**	**35**	**36**	**0**	**0**	**118**
	127° 51' 34.341" W	0	0	0	1000	11	2	0	0	0	0	0	40	42	0	0	1095
Zone 4 (Nigei Isl)																	
Site 1	50° 52' 37.046" N	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	127° 50' 2.288" W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Site 2	50° 51' 42.071" N	**4**	**0**	**0**	**1**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**9**
	127° 46' 33.619" W	4	0	0	1	0	0	3	0	0	0	0	0	0	1	0	9
Site 3	50° 51' 42.928" N	**0**	**0**	**0**	**0**	**0**	**0**	**44**	**33**	**5**	**30**	**0**	**0**	**0**	**0**	**30**	**142**
	127° 45' 30.676" W	0	0	0	0	0	0	60	140	5	500	0	0	0	0	45	750
Site 4	50° 49' 54.803" N	**0**	**0**	**0**	**36**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**40**
	127° 39' 12.223" W	0	0	0	380	4	0	0	0	0	0	0	0	0	0	0	384
Zone 5 (Gordon Isls)																	
Site 1	50° 49' 3.788" N	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**30**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**31**
	127° 33' 16.194" W	0	0	0	1	0	0	0	160	0	0	0	0	0	0	0	161
Site 2	50° 49' 52.875" N	**0**	**0**	**0**	**31**	**6**	**0**	**30**	**30**	**0**	**0**	**0**	**46**	**30**	**14**	**0**	**187**
	127° 30' 52.353" W	0	0	0	411	6	0	685	1331	0	0	0	1251	80	14	0	3778
Site 3	50° 48' 49.921" N	**3**	**2**	**0**	**2**	**0**	**0**	**30**	**30**	**4**	**0**	**0**	**18**	**8**	**0**	**0**	**97**
	127° 28' 40.714" W	3	2	0	2	0	0	36	70	4	0	0	18	8	0	0	143
TOTAL RETAINED		**11**	**2**	**3**	**159**	**30**	**2**	**139**	**163**	**54**	**30**	**8**	**99**	**74**	**15**	**30**	**819**

*** retained fish are first row for each site in bold, caught fish are second row for each site in regular print.

Appendix 2: Summarized Data from lab analysis

2015 Study Year

					L. salmonis					C. clemensi				
Month	Species	Number sampled	Ave Weight (g)	Ave Length (mm)	Total # Lice	# Fish Infected	Prevalence	Abundundance	Intensity	Total # Lice	# Fish Infected	Prevalence	Abundundance	Intensity
April	Pink	266	0.40	36	30	24	9.0%	0.113	1.25	24	16	6.0%	0.090	1.50
	Chum	57	1.00	43	8	7	12.3%	0.140	1.14	6	6	10.5%	0.105	1.00
	Coho	2	11.31	102	0	0	0.0%	0.000	0.00	0	0	0.0%	0.000	0.00
	Herring	3	0.06	20	0	0	0.0%	0.000	0.00	0	0	0.0%	0.000	0.00
May	Pink	194	1.67	52	30	27	13.9%	0.155	1.11	71	45	23.2%	0.366	1.58
	Chum	49	1.45	47	10	8	16.3%	0.204	1.25	16	6	12.2%	0.327	2.67
	Coho	69	12.44	102	5	4	5.8%	0.072	1.25	409	69	50.7%	5.928	11.69
	Sockeye	41	6.47	78	0	0	0.0%	0.000	0.00	87	23	56.1%	2.122	3.78
	Dolly Varden	1	62.18	185	0	0	0.0%	0.000	0.00	0	0	0.0%	0.000	0.00

2014 Study Year

					L. salmonis					C. clemensi				
Month	Species	Number sampled	Avg Weight (g)	Avg Length (mm)	Total # Lice	# Fish Infected	Prevalence	Abundunance	Intensity	Total # Lice	# Fish Infected	Prevalence	Abundunance	Intensity
April	Pink	262	0.37	34.06	1	1	0.38%	0.004	1.00	3	3	1.15%	0.011	1.00
	Chum	20	0.49	36.70	0	0	0.00%	0.000	0.00	1	1	5.00%	0.050	1.00
	Chinook	1	0.05	39.00	0	0	0.00%	0.000	0.00	0	0	0.00%	0.000	0.00
	Sockeye	11	3.78	72.00	0	0	0.00%	0.000	0.00	0	0	0.00%	0.000	0.00
	non salmonid	1	0.92	43.00	0	0	0.00%	0.000	0.00	0	0	0.00%	0.000	0.00
May	Pink	238	1.18	48.43	8	8	3.36%	0.034	1.00	25	24	10.50%	0.105	1.04
	Chum	5	1.21	45.40	0	0	0.00%	0.000	0.00	1	1	20.00%	0.200	1.00
	Coho	21	13.83	104.19	0	0	0.00%	0.000	0.00	2	1	9.52%	0.095	2.00
	Sockeye	20	8.20	91.10	1	1	5.00%	0.050	1.00	0	0	0.00%	0.000	0.00

2013 Study Year: Goletas Channel

					L. salmonis					C.clemensi				
Month	Species	#	Avg wt (g)	Avg Ln(mm)	total # lice	# fish infected	Prevelance	Abundance	Intensity	total # lice	# fish infected	Prevelance	Abundance	Intensity
April	Pink	55	0.32	32.4	0	0	0.0%	0.00	0.0	1	1	1.8%	0.02	1.0
April	Chinook	11	0.39	35.6	0	0	0.0%	0.00	0.0	0	0	0.0%	0.00	0.0
April	non-salmonid	1	0.39	35	0	0	0.0%	0.00	0.0	0	0	0.0%	0.00	0.0
	Total	67												
May	Pink	344	0.82	42.1	2	2	0.6%	0.01	1.0	18	18	5.2%	0.05	1.0
May	Chum	95	1.19	46.7	2	2	2.1%	0.02	1.0	7	5	5.3%	0.07	1.4
May	Coho	15	9.19	92	0	0	0.0%	0.00	0.0	0	0	0.0%	0.00	0.0
May	Sockeye	19	6.23	82.58	2	2	10.5%	0.11	1.0	3	1	5.3%	0.16	3.0
	Total	473												
June	Pink	213	2.25	58.3	4	4	1.9%	0.02	1.0	7	7	3.3%	0.03	1.0
June	Chinook	6	5.12	76.8	0	0	0.0%	0.00	0.0	1	1	16.7%	0.17	1.0
June	Coho	30	23	121.6	2	2	6.7%	0.07	1.0	4	2	6.7%	0.13	2.0
June	Sockeye	2	3.6	68.5	0	0	0.0%	0.00	0.0	0	0	0.0%	0.00	0.0
June	Dolly Varden	4	26.7	136.2	1	1	25.0%	0.25	1.0	0	0	0.0%	0.00	0.0
		255			13					41				

2013 Study Year: Queen Charlotte Strait

					L. salmonis					*C.clemensi*				
Month	Species	# Sampled	Avg wt (g)	Avg Ln(mm)	total # lice	# fish infected	Prevelance	Abundance	Intensity	total # lice	# fish infected	Prevelance	Abundance	Intensity
June	Pink	30	2.5	59.4	0	0	0.0%	0.00	0.0	1	1	3.3%	0.03	1.0
June	Coho	3	27.5	129.7	1	1	33.3%	0.33	1.0	0	0	0.0%	0.00	0.0
	Total	33												
July	Pink	9	1.86	59.1	0	0	0.0%	0.00	0.0	3	3	33.3%	0.33	1.0
July	Chinook	1	39.9	155	0	0	0.0%	0.00	0.0	0	0	0.0%	0.00	0.0
July	Herring	31	0.4	38.6	0	0	0.0%	0.00	0.0	7	6	19.4%	0.23	1.2
	Total	41												

2011 Study Year: Goletas Channel

Capture	Dates	Species	# of fish	Avg Lth (mm)	Avg wt (g)	*L. salmonis*					*C. clemensi*					Salinity	Temperature
						total # lice	# fish infected	Prevelance	Abundance	Intensity	total # lice	# fish infected	Prevelance	Abundance	Intensity	ppm	°C
First Capture	March 30 - April 1, 2011	Pink	11	31.3	0.28	0	0	0%	0	0	2	1	9.1%	0.18	2.0	30.4	8.0
		Chum	2	36.0	0.46	0	0	0%	0	0	0	0	0.0%	0.00	0.0		
		Coho	3	80.0	4.93	0	0	0%	0	0	0	0	0.0%	0.00	0.0		
		Total	**16**														
Second Capture	April 27 - 29, 2011	Pink	164	36.8	0.55	0	0	0%	0	0	4	3	1.8%	0.02	1.3	30.5	8.2
		Chum	21	44.9	1.01	0	0	0%	0	0	5	4	19.0%	0.24	1.3		
		Non Salmonid	2	38.0	0.62	0	0	0%	0	0	0	0	0.0%	0.00	0.0		
		Total	**187**														
Third Capture	May 30- June 3, 2011	Pink	298	53.8	2.20	12	12	4%	0.04	1	30	28	9.4%	0.10	1.1	31.0	10.3
		Chum	43	80.7	9.36	2	2	5%	0.05	1	18	13	30.2%	0.42	1.4		
		Coho	11	96.6	14.99	0	0	0%	0.00	0	1	1	9.1%	0.09	1.0		
		Herring	30	34.7	0.35	1	1	3%	0.03	1	8	7	23.3%	0.27	1.1		
		Dolly Varden	8	135.6	36.50	2	1	13%	0.25	2	3	2	25.0%	0.38	1.5		
		Total	**391**														
Fourth Capture	June28 - July 4, 2011	Pink	138	85.8	9.20	12	10	7%	0.09	1.2	61	46	33.3%	0.44	1.3	31.1	9.9
		Chum	46	115.6	23.89	8	5	11%	0.17	1.6	16	11	23.9%	0.35	1.5		
		Coho	4	118.5	27.97	3	2	50%	0.75	1.5	1	1	25.0%	0.25	1.0		
		Herring	30	35.5	0.48	1	1	3%	0.03	1	60	23	76.7%	2.00	2.6		
		Total	**218**														