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

YEAR 9

Tlatlasikwala First Nation
MOWI Canada West

August 2020

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1.0 EXECUTIVE SUMMARY

2020 marked the ninth year of the sea lice study in Goletas Channel and Queen Charlotte Strait, conducted by Pacificus Biological Services (Pacificus). The study was conducted for Mowi Canada West (Mowi) and the Tlatlasikwala First Nation and helps fulfill the Aquaculture Stewardship Council's (ASC) requirement of monitoring wild salmonids by studying the abundance, prevalence and intensity of sea lice on juvenile wild salmon. Like previous years, beach seining for juvenile salmonids was conducted at 20 sites in two rounds of sampling throughout April and May. Up to 30 specimens of each target species were collected at each of the sampling sites. The samples were then sent for laboratory analysis to determine the level of sea lice infestation. The target fish species for the present study were juvenile pink salmon (*Oncorhynchus gorbuscha*), although samples of juvenile chum salmon (*O. keta*), coho salmon (*O. kisutch*), sockeye salmon (*O. nerka*), chinook (*O. tshawytscha)*, Pacific herring (*Clupea pallasii)* and three-spined stickleback (*Gasterosteus aculeatus*) were also collected. To determine the environmental conditions at each site sampled, water temperature, salinity, and dissolved oxygen data were recorded at each sampling location. Over the course of the two sampling events (April and May), a total of 353 fish were retained for laboratory analysis. Of the 353 fish collected there were 204 pink salmon, 48 chum salmon, 61 coho salmon, 34 sockeye salmon, two chinook salmon, and four three-spined stickleback. A total of 50 *Lepeophtheirus salmonis* lice and 107 *Caligus clemensi* lice were identified on the 353 fish samples collected during sampling efforts. Table 1 provides a summary of the prevalence, abundance, and average intensity for both sea lice species found on pink salmon juveniles (target species) for all study years. Considering the ongoing COVID-19 situation at the time of the field sampling, specific protocols aimed at reducing the risk of virus transmission were implemented for the duration of the 2020 program.

Table 1: Prevalence, abundance and average intensity of *L. salmonis* and *C. clemensi* lice on pink salmon from 2011 to 2020.

Year	*Lepeophtheirus salmonis*			*Caligus clemensi*		
	Prevalence	**Abundance**	**Average Intensity**	**Prevalence**	**Abundance**	**Average Intensity**
2011 (n = 611)	4%	0.0	1.1	13%	0.2	1.2
2013 (n = 612)	1%	0.0	1.0	4%	0.0	1.0
2014 (n = 500)	2%	0.0	1.0	5%	0.1	1.0
2015 (n = 460)	19%	0.1	1.2	21%	0.2	1.5
2016 (n = 336)	7%	0.1	1.1	16%	0.2	1.6
2017 (n = 189)	5%	0.1	1.3	10%	0.1	1.1
2018 (n = 201)	6%	0.1	1.2	11%	0.2	2.2
2019 (n = 194)	9%	0.1	1.1	17%	0.2	1.1
2020 (n = 204)	9%	0.1	1.1	17%	0.2	1.1

2.0 INTRODUCTION

The 2020 sea lice study aimed to add information to the existing baseline studies (Pacificus 2011, 2013a and 2013b, 2014, 2015, 2016, 2017, 2018, 2019) of ambient sea lice levels present in Goletas Channel and Queen Charlotte Strait, British Columbia (Figure 1) by continuing to study the rate of *L. salmonis* and *C. clemensi* infestation during the 2020 salmonid outmigration period (April and May). The study was conducted on behalf of Mowi Canada West (Mowi) and the Tlatlasikwala First Nation. As no historical data exists for Goletas Channel and Queen Charlotte Strait prior to the establishment of the program in 2011, the primary objective of the project was to add to the data that has been collected over the previous eight years of the study. Secondary objectives of the project included determining the life history characteristics of sea lice in the Goletas Channel and Shelter Bay area, as well as the abundance, life stage, and distribution of the two species targeted (*L. salmonis* and *C. clemensi*). Observations regarding smolt outmigration timing, abundance, and distribution patterns were also collected. The 2020 sea lice study also helps fulfill Mowi's Aquaculture Stewardship Council (ASC) requirement to monitor wild salmonids. This is the ninth year of studying sea lice in Goletas Channel (Pacificus 2011, 2013a, 2014, 2015, 2016, 2017, 2018, 2019) and the seventh study year in the Shelter Bay area (Pacificus 2013b, 2014, 2015, 2016, 2017, 2018, 2019).

A total of 20 beach seine sites were sampled during the 2020 sample year. All 20 sites were the same sites sampled since 2015; study years prior to 2015 had additional sites that are no longer sampled. 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, and 12-16.

Sea lice within the family Caligidae are known to be the most common species of sea lice in marine environments (Boxaspen 2006). Two common genera within this family, *Lepeophtheirus* and *Caligus,* have previously been identified on salmonids within the Pacific Ocean (Butterworth et al. 2008). As the two species of sea louse most commonly found on salmonids off of British Columbia's coast, *Lepeophtheirus salmonis* and *Caligus clemensi* were chosen as the focal species of sea lice for the present study.

[1] http://www.pac.dfo-mpo.gc.ca/fm-gp/maps-cartes/areas-secteurs/12-eng.html (Accessed July 30, 2020)
[2] http://www.pac.dfo-mpo.gc.ca/fm-gp/maps-cartes/areas-secteurs/11-eng.html (Accessed July 30, 2020)

L. salmonis and *C. clemensi* are parasitic copepods that have been found on all species of juvenile Pacific salmon, as well as juvenile herring within the coastal waters of British Columbia (Beamish et al. 2009). As members of the family Caligidae, *L. salmonis* and *C. clemensi* have similar developmental cycles that differ in the timeline of developmental stages. Development of the two species is also highly variable depending on certain environmental conditions, such as water temperature. Both species of lice start out as eggs, and hatch two motile Nauplius stages (nauplius 1 and 2). From the nauplius stage, the lice progress into a motile, parasitic copepodid (Co) stage of development, where they find and attach to a host. Once attached to a host, the lice progress through several sessile chalimus stages (C1 and C2 for *L. salmonis*, C1, C2, C3 and C4 for *C. clemensi*). While in the chalimus stages 1 through 3, the lice are attached to the host by a frontal filament. However, during the final stage, the lice become motile once more on the host. The lice then progress into pre adult males (PAM) and pre adult females (PAF), then into reproductively viable adult males (AM) and adult females (AF).

Environmental conditions that have the potential to affect sea lice survival, growth, and reproduction rates include water temperature and salinity. Reproduction and development rates of *C. curtus, C. elongates* and *L. salmonis* were observed to increase with rising water temperatures in Atlantic studies (Saksida et al. 2015). In addition, the rate of incubation in water with salinity less than 15 parts per thousand (ppt) showed failure to produce viable nauplii (Jones and Johnson 2015). There was a certain tolerance for freshwater influence found; however, rising salinity and warmer temperatures were determined to be beneficial for sea lice development and survival.

The target species for the present study were pink salmon smolts (*Oncorhynchus gorbuscha*), although samples of juvenile chum salmon (*O. keta*), coho (*O. kisutch*), Chinook salmon (*O. tshawytscha*), sockeye salmon (*O. nerka*) salmon, cutthroat trout (*O. clarkii*), Dolly Varden char (*Salvelinus malma*) and three-spined stickleback (*Gasterosteus aculeatus*) and juvenile herring (*Clupea pallisii*) were also retained for analysis, when encountered. No Atlantic salmon (*Salmo salar*) were observed during the 2020 sampling activities. All fry and smolt samples were captured via beach seine and sent for laboratory analysis at the BC Center for Aquatic Health Sciences in Campbell River, BC.

Ten Mowi fish farms were located within the study area. Five of the locations remained operational during the 2020 sea lice study (Marsh Bay, Shelter Bay, Duncan Island, Doyle Island,

and Bull Harbour), with the remaining five being left fallow (Heath Bay, Raynor Island, Bell Island Shelter Pass and Robertson Island) (Figures 2 and 3).

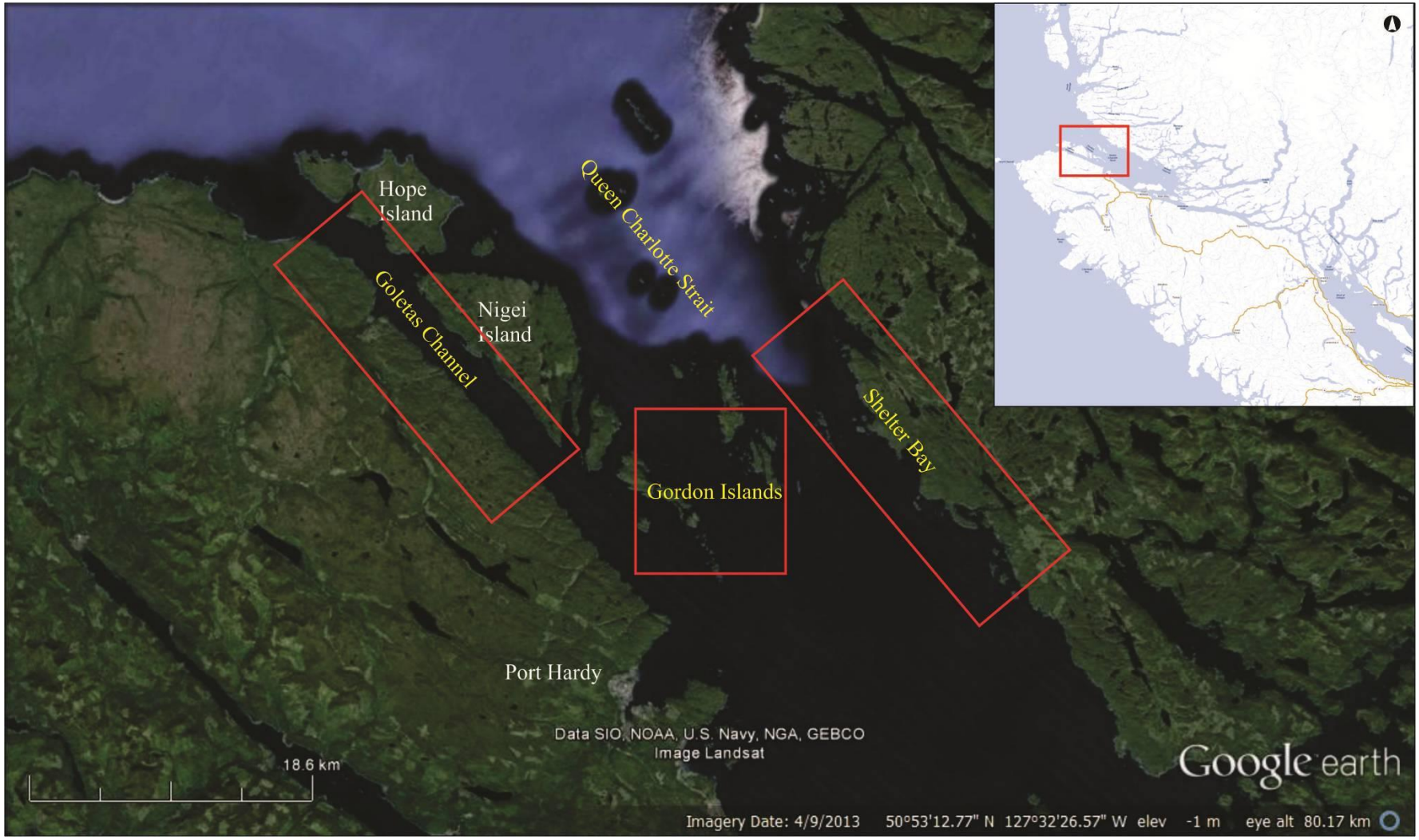

Figure 1: Overview map showing study locations (red boxes) for the 2020 sample year in relation to Port Hardy, Vancouver Island, BC.

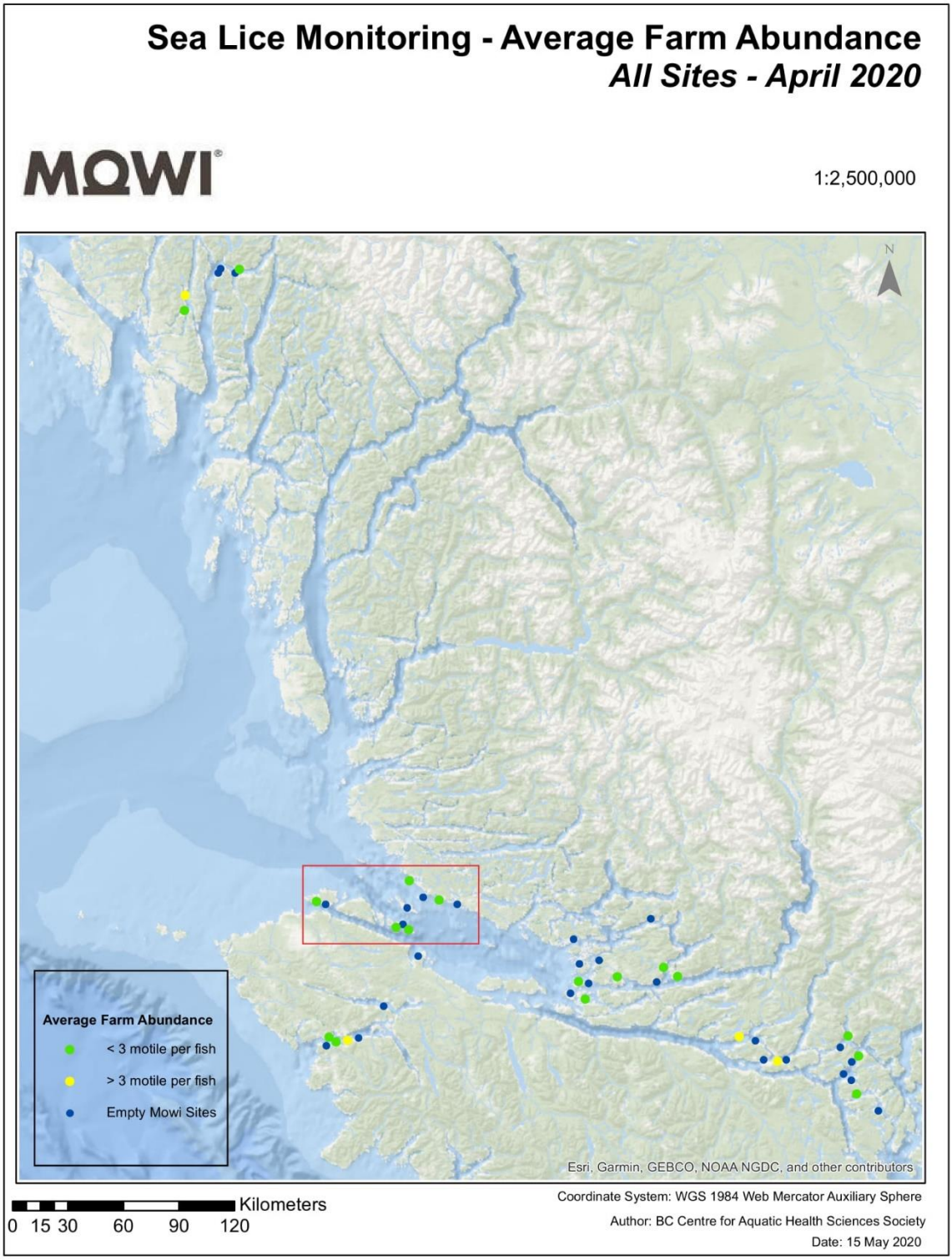

Figure 2: Location of Mowi fish farms along the BC coast in April 2020. The 2020 sea lice study area has been outlined in red. Base map and data available from MOWI website (https://mowi.com/caw/sustainability/sea-lice-reporting/)

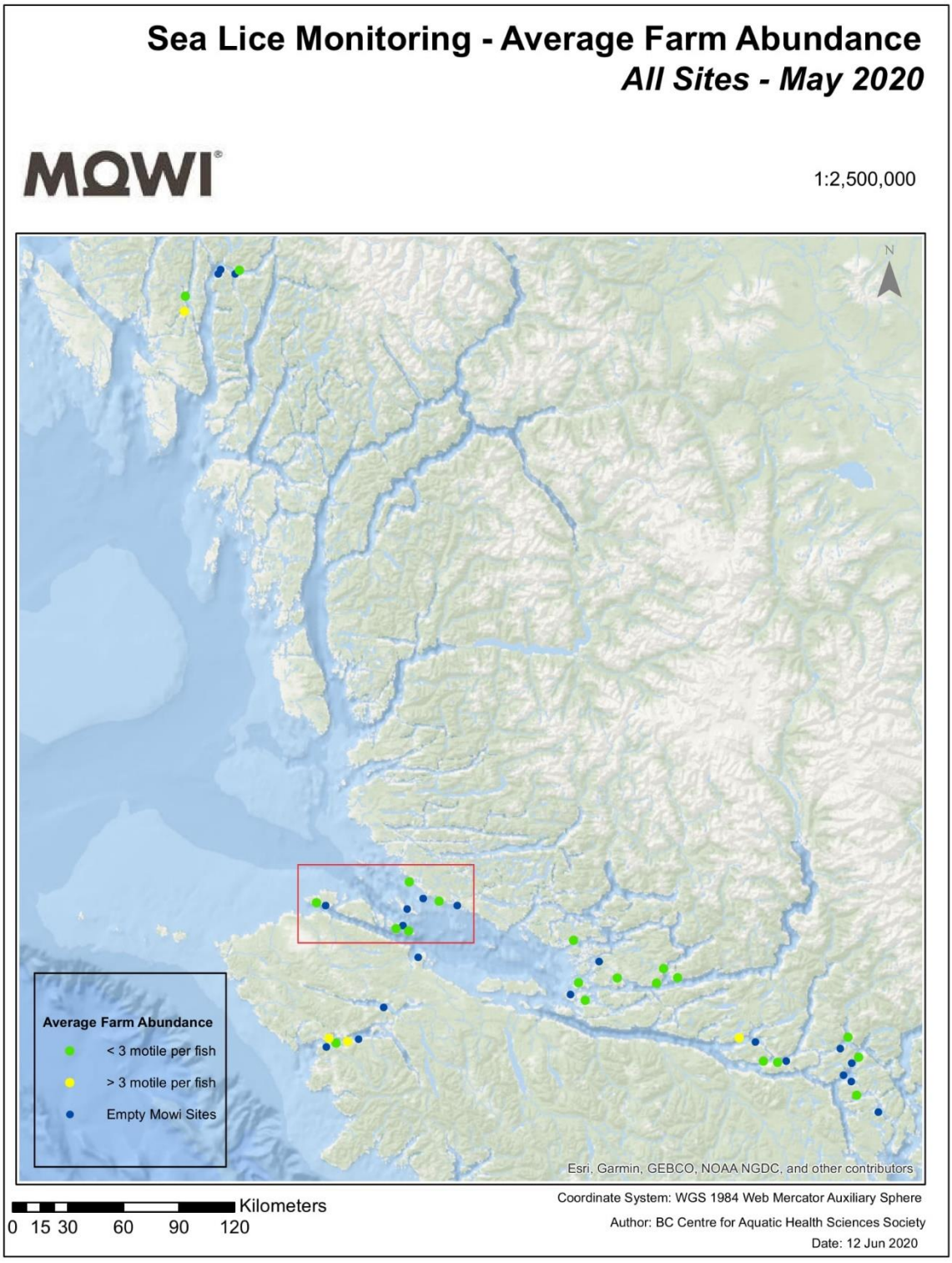

Figure 3: Location of Mowi fish farms along the BC coast in April 2020. The 2020 sea lice study area has been outlined in red. Base map and data available from MOWI website (https://mowi.com/caw/sustainability/sea-lice-reporting/)

3.0 METHODOLOGY

To remain consistent with previous years of the sea lice study, the same methodology was employed during the 2020 season as preceding years. The area surveyed consisted of 20 beach seine sampling locations within Queen Charlotte Strait. The 20 sites were identified with a number from one through 20 based on relative geographic locations, with site numbering remaining consistent with 2017, 2018 and 2019 studies (Pacificus 2019, Pacificus 2018, Pacificus 2017). All sample locations were chosen based on the presence of appropriate habitat characteristics and the likelihood of juvenile salmonids holding in these locations during the project time frame. Efforts were made to evenly distribute sites throughout the survey area.

This is the ninth year of sea lice monitoring at Sites 1 to 14, all located within Goletas Channel. Since 2014, sample sites have remained relatively the same throughout each sample year, with 2020 being no exception. In 2020, Sites 4, 5, 8 and 10 were located on the west side of Goletas channel, on Vancouver Island (Figure 5 and 6). Sites 1, 2, and 3 were located on Hope Island (Figure 6), Sites 6, 7 and 9 were located on Nigei Island (Figure 5) and Sites 11 through 14 were located around the Gordon and Deserter Group of Islands (Figure 7). This is the seventh year of sea lice monitoring at Sites 15 to 20, located northeast of Port Hardy in the Shelter Bay area of Queen Charlotte Strait (Figure 8). Sites 15 through 20 have been sampled on an annual basis since 2014 and were included in the 2020 program.

The 2020 sea lice study, conducted in Goletas Channel and Queen Charlotte Strait, mostly followed the sampling regime of the previous five years of the study, where monthly sampling occurred in April and May. However, in the 2020 study, crew sizes were reduced, and two sampling vessels were utilized in order to meet additional safety measures in response to the COVID-19 pandemic. Field crews consisted four individuals, 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.

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 site location was performed from the boat for approximately five minutes at a distance of 10-20m from the shore in order to assess the presence of salmonids. Observations from this survey were used to help focus seining efforts; if fish were observed during the survey, the net would be set to encompass the area in which the fish were observed. However, if no fish were observed during the search, then the set was performed in the area where fish were most likely to be present based on the examination of the site at the present tide.

At least one sampling event was conducted via beach seine at each sample site. However, 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). Upon capture of target species during beach seine events, specimens were randomly selected for laboratory analysis. A maximum of 30 sample fish per target species were retained from each site for laboratory sea lice analysis in each monthly sample. Target species for the 2020 survey included pink salmon (*Oncorhynchus gorbuscha*), chum (*O. keta*), sockeye (*O. nerka*), coho (*O. kisutch*), Chinook (*O. tshawytscha*), Dolly Varden (*Salvelinus malma*), cutthroat (*O. clarkii*), three-spined stickleback (*Gasterosteus aculeatus*) and Pacific herring (*Clupea pallasii*). The remaining fish captured in the seine net were identified to species level, enumerated, and released.

Sample specimens retained for laboratory analysis were placed in sample bags and immediately euthanized with a Tricaine methanesulfonate (TMS) overdose. Samples in two-ounce bags were given 1.0 ml of a 240 mg/L TMS solution, while samples in four-ounce bags were given 5.0 ml of TMS solution. Bag sizes were chosen based on the size of specimens. Each sample bag, having been pricked with a tack prior to usage, was then placed in a bucket where the solution drained out. Sample bags for each site were placed together in a larger bag 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 then frozen once they were transported back to Port Hardy after each field sampling day.

Upon completion of the monthly sampling, the frozen sample specimens were transported to the BC Centre for Aquatic Health Sciences (CAHS) in Campbell River, BC for laboratory analysis. Specimens were identified to species and analyzed for wetted weight and fork length. In addition, microscopic sea lice counts were completed on each fish sample collected. Each sea lice

encountered was identified to species, sexed, enumerated, and classified to life stage. 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 cases where less than ten individuals per species per month were collected, prevalence, abundance and intensity of louse infestations was calculated but will not be discussed further within this report due to the increased potential for errors arising from small sample sizes. Values arising from small sample sizes are still represented in the tables found within this report; however, any utilization of this data should be done with the appropriate context given to the small sample size.

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, captured fish were placed in a seawater-filled tote with air stones 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 (with the exception of one day due to a technical issue) and consisted of temperature (^{0}C), dissolved oxygen (mg/L) and salinity (ppt) measurements at the surface (0m), 1m and 4m depths. 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 were 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.

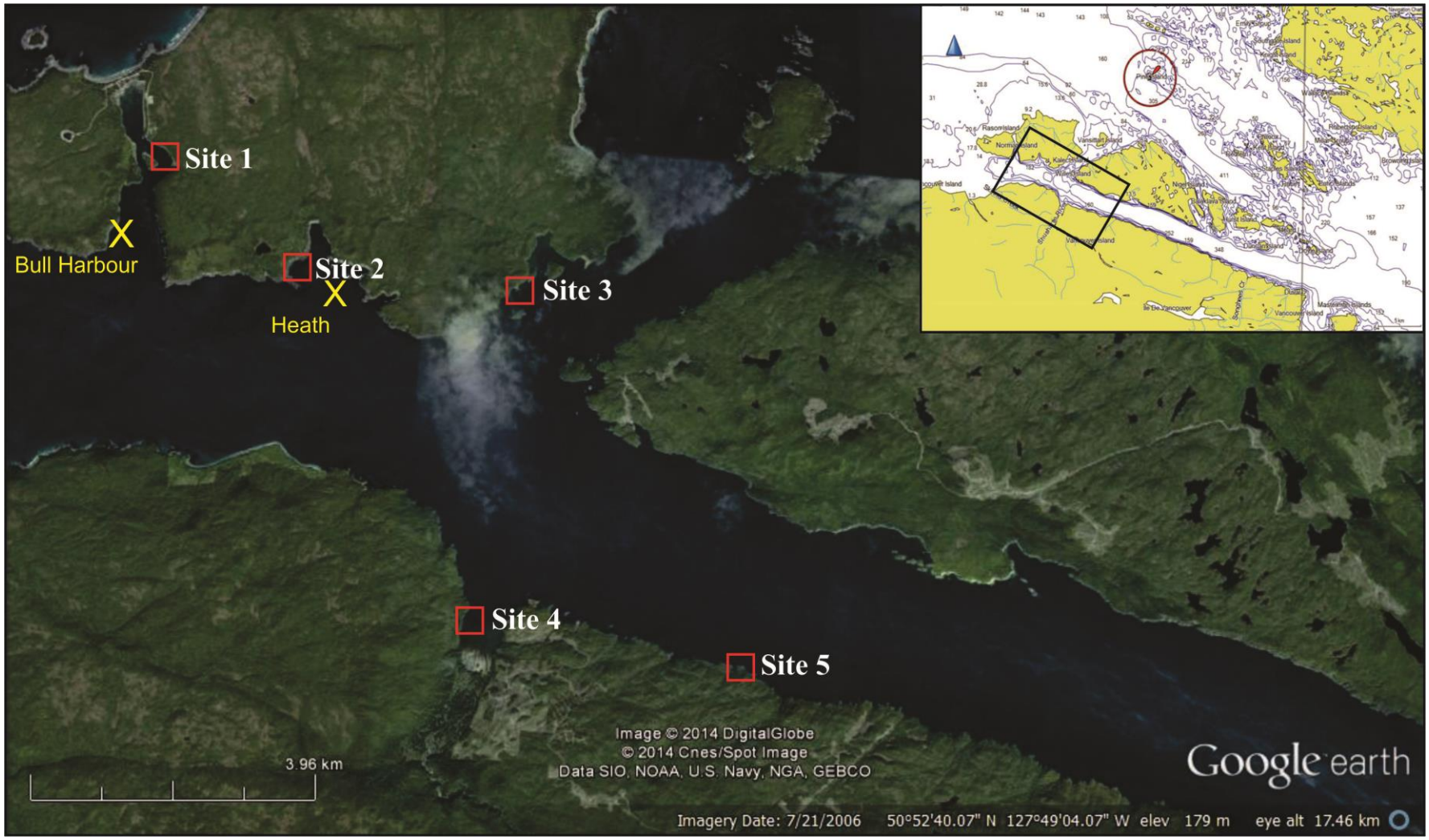

Figure 4: Location map of the sampling sites from 1 to 5 located on Vancouver Island and Hope Island examined during the 2020 sample year in Goletas Channel, British Columbia. The yellow "X" indicates locations of both active and inactive fish farms in the area.

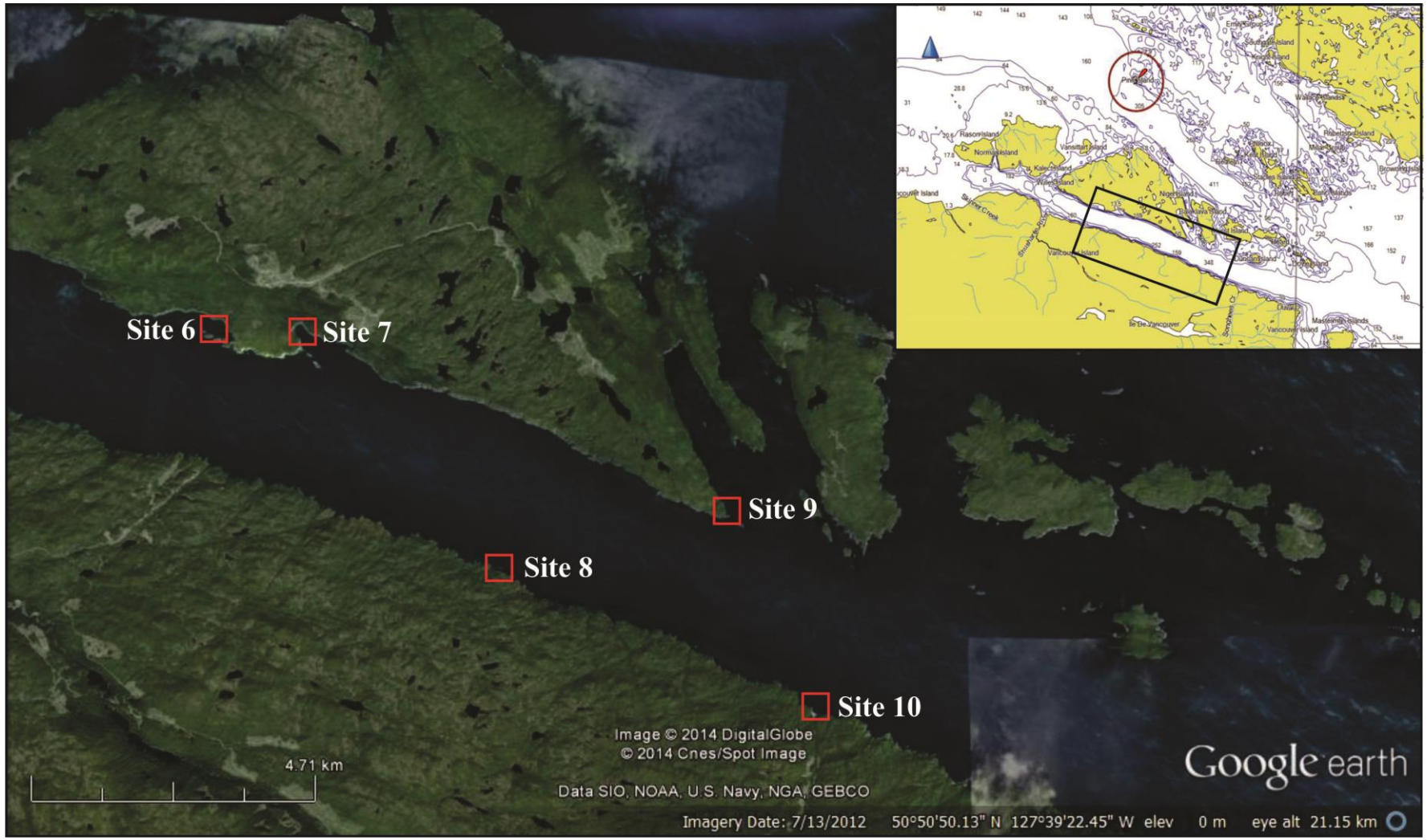

Figure 5: Location map of the sampling sites 6 to 10 located on Vancouver Island and Nigei Island examined during the 2020 sample year in Goletas Channel, British Columbia.

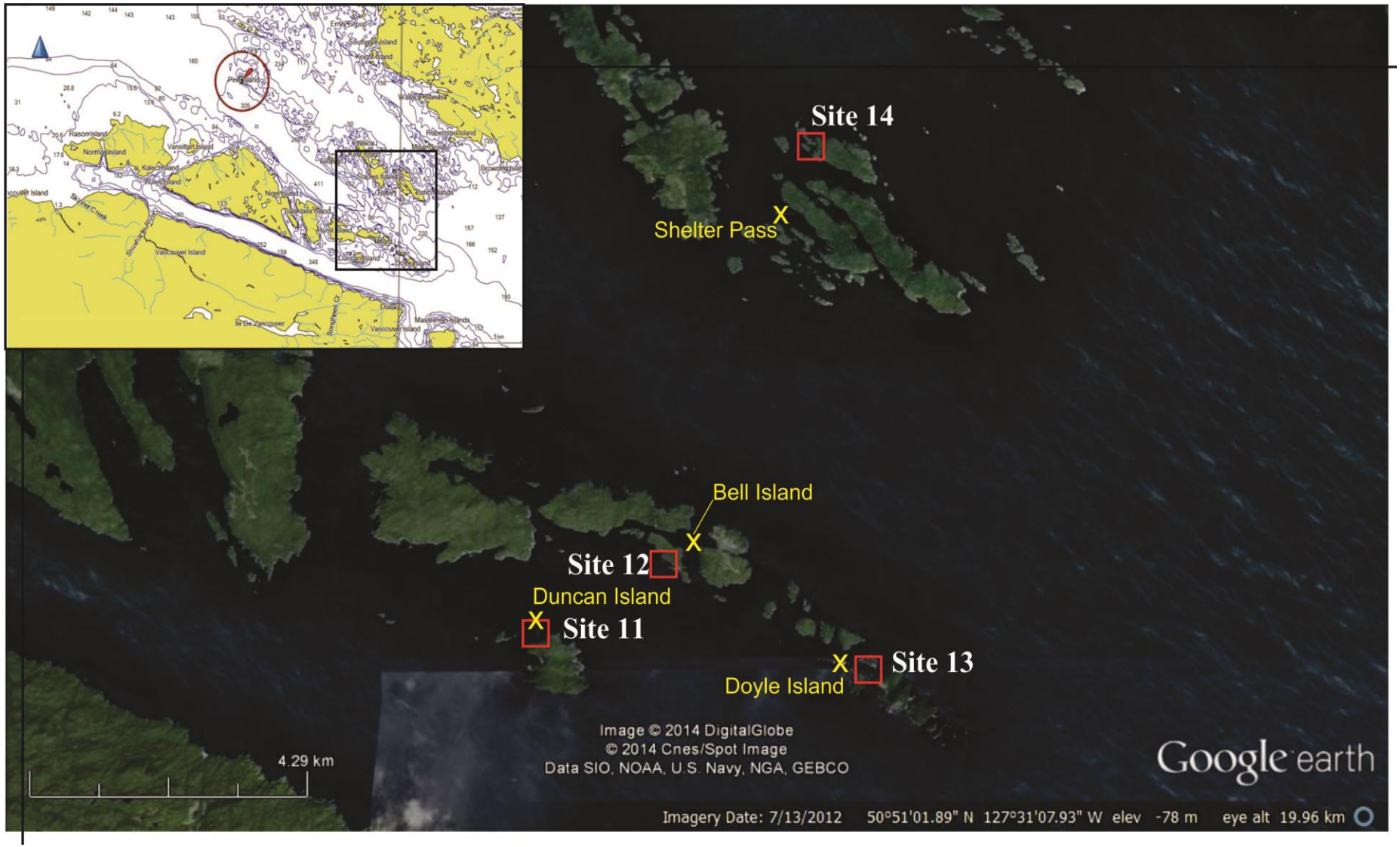

Figure 6: Location map of the sampling sites 11 to 14 located in the Gordon Group examined during the 2020 sample year in Goletas Channel, British Columbia. The yellow "X" indicates both active and inactive fish farm locations.

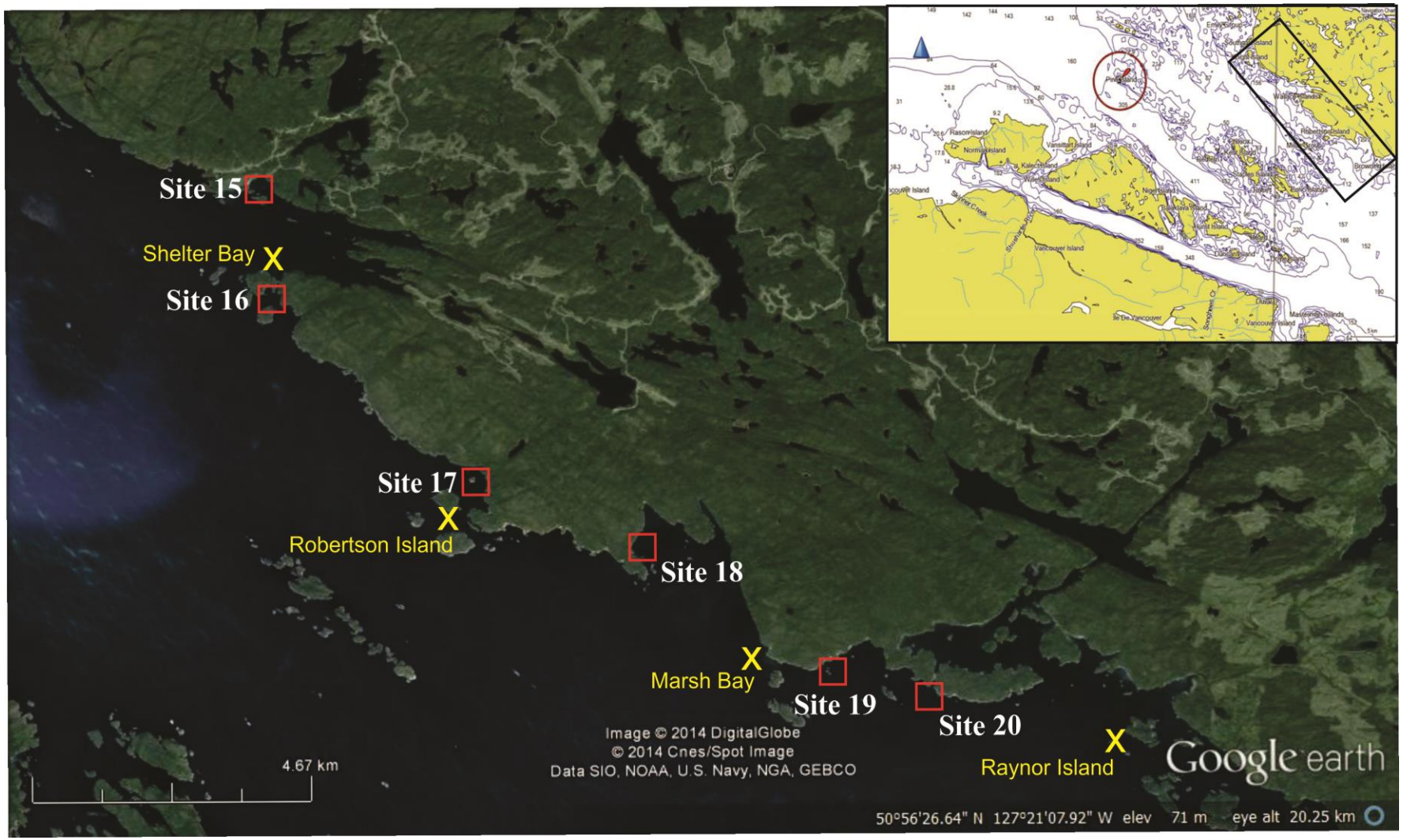

Figure 7: Location map of sampling sites 15 through 20 examined during the 2020 season. These sites are located in the Shelter Bay area of Queen Charlotte Strait, British Columbia. The yellow "X" indicates active and inactive fish farm locations.

4.0 RESULTS

Two rounds of beach seining were completed during the 2020 sample season. The first round occurred from April 15th to April 19th, 2020. The second round occurred from May 19th to May 23rd, 2020. All 20 sites were sampled during the first and second rounds of the 2020 sample season.

A project total of 59 sets were completed during the 2020 season, 27 of which were successful at capturing target species. A total of 32 sets were completed during the April sampling, 13 of which were successful at capturing target species. A total of 27 sets were completed during the May sampling, 14 of which were successful at capturing target species.

During the April sampling, no fish were captured within the first seine attempt at twelve sites; five of the subsequent sets resulted in the capture of target species. During the May sampling, no fish were captured within the first seine attempt at eleven sites; however, only two of the subsequent sets resulted in the capture of target species.

Data presented within this report have been adjusted to reflect the identification completed during laboratory analysis of samples due to the higher accuracy of identification in a laboratory setting compared to field identification of juvenile salmonids. As a result of more accurate lab identification, the actual number of specimens retained was, in some cases, greater than the maximum number of samples originally intended (30 samples retained per species, per site).

The number of samples obtained in each of the 27 successful sets ranged from 1 to 31 of the target species and averaged 13 samples per successful set. A total of 358 samples were retained for laboratory analysis throughout the 2020 sea lice study. Of the 358 samples collected, 204 were pink salmon, 48 were chum salmon, 61 were coho salmon, 34 were sockeye salmon, two were chinook salmon, four were three-spined stickleback, and five were herring. Herring were determined to be in the adult life stage, which were not a target life-stage for this study. As such, herring were excluded from the analysis within this study, resulting in the total number of samples discussed to be 353. The sampling retention was highest for pink salmon (57.8%), followed by coho salmon (17.3%), chum salmon (13.6%), sockeye salmon (9.6%), Three-spined stickleback (1.1%) and Chinook salmon (0.6%; Tables 2 and 3 below provide a summary of the capture and collection totals for 2020.

Table 2: Distribution of fish species captured and sampled at Sites 1 through 20 during the 2020 sea lice study in Goletas Channel and Queen Charlotte Strait.

Site	Pink		Chum		Coho		Sockeye		Chinook		Dolly Varden		Three-spined Stickleback		Capture Total	Sample Total
	# Captured	# Sampled	# Captured	# Sampled	# Captured	# Sampled	# Captured	# Sampled	# Captured	# Sampled	# Captured	# Sampled	# Captured	# Sampled		
1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1
2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1
3	24	24	2	2	0	0	0	0	0	0	0	0	0	0	26	26
4	0	0	6	6	0	0	0	0	0	0	0	0	0	0	6	6
5	3	3	3	3	1	1	0	0	0	0	0	0	0	0	7	7
6	0	0	7	7	0	0	0	0	0	0	0	0	0	0	7	7
7	123	34	4	4	140	30	72	30	1	1	0	0	0	0	340	99
8	345	61	4	4	0	0	0	0	0	0	0	0	0	0	349	65
9	1	1	0	0	7	7	0	0	0	0	0	0	0	0	8	8
10	2	2	16	16	23	23	4	4	0	0	0	0	0	0	45	45
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	13	13	2	2	0	0	0	0	0	0	0	0	0	0	15	15
13	1	1	0	0	0	0	0	0	1	1	0	0	0	0	2	2
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	4	4	2	2	0	0	0	0	0	0	0	0	4	4	10	10
16	23	23	0	0	0	0	0	0	0	0	0	0	0	0	23	23
17	2	2	0	0	0	0	0	0	0	0	0	0	0	0	2	2
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	133	34	2	2	0	0	0	0	0	0	0	0	0	0	135	36
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**676**	**204**	**48**	**48**	**171**	**61**	**76**	**34**	**2**	**2**	**0**	**0**	**4**	**4**	977	353

Table 3: Species sampled during the 2020 sea lice study examined by percent of total capture, the collection (retained for sampling) total, and corresponding collection percentage (number of individual species collected out of total number of fish collected).

Species	Capture total (% of total)	Collection total	Collection %
Pink salmon	69.2	204	57.8
Chum salmon	4.9	48	13.6
Coho salmon	17.5	61	17.3
Sockeye salmon	7.8	34	9.6
Chinkook salmon	0.2	2	0.6
Three-spined stickleback	0.4	4	1.1
All species	**100.0**	**353**	**100.0**

4.1 Juvenile Salmonid Abundance, Distribution, Growth and Timing Patterns

Throughout the 2020 sea lice study, a total of 977 fish were captured (target species only), of which 353 were retained for sampling (Tables 2 and 3). The vast majority of the specimens retained for sampling were salmonid species, although four three-spined stickleback were also collected for sea lice analysis. A total of 119 samples were collected during the first round of sampling in April (33.7% of the project total), while 234 samples were collected during the second round sampling conducted in May (66.3% of the project total). Sites 11, 14, 18, and 20 did not yield any specimens over the course of the sampling program.

The average length and weight of pink and chum salmon were observed to increase throughout each month of sampling. The average weight of sampled coho salmon showed a similar increase, however, the average weight of sampled coho salmon decreased from April to May (Table 4). Pink, chum, and coho salmon were captured in both April and May of 2020, while sockeye and chinook salmon were only captured during the May sampling period. Three-spined stickleback were also only collected during the May sampling period.

Table 4: Average lengths and weights of species collected during the 2020 sea lice study, by sampling month collected.

Species	Weight (g)		Length (mm)	
	April	May	April	May
Pink	0.6 (n=87)	1.6 (n=117)	39.4 (n=87)	52.3 (n=117)
Chum	0.7 (n=24)	1.4 (n=22)	39.8 (n=24)	49.4 (n=22)
Coho	18.4 (n=7)	19.1 (n=54)	119.1 (n=7)	113.5 (n=54)
Sockeye	-	16.1 (n=33)	-	110.7 (n=33)
Chinook	-	26.3 (n=2)	-	129.5 (n=2)
Three-Spined Stickleback	-	0.2 (n=4)	-	30.5 (n=4)

4.2 Sea Lice Infestation

Lice Species Distribution

During the month of April, a total of nine *L. salmonis* were identified on samples originating from Sites 7, 8, 12, and 16. In May, a total of 41 *L. salmonis* were identified on samples from Sites 2, 3, 4, 7, 8, 10, 15, and 19. A total of 25 *C. clemensi* were identified during the April sampling at Sites 5, 8, 9, 10, 12, 13, and 16. In May, 82 *C. clemensi* were found on fish samples originating from Sites 3, 5, 7, 8, 10, 13, 15, 17, and 19.

The mean prevalence (percentage of fish that were infected compared to the number of fish sampled), the mean abundance (average number of sea lice on all fish sampled), and the mean intensity (average number of sea lice on infected fish) were calculated for each species in Table 5 and for each species at each site in Tables 6 through 10.

Counts of both species of sea lice observed (*L. salmonis* and *C. clemensi*) were combined to calculate prevalence and abundance (Table 5). Out of the target species sampled, 106 of 353 fish (30.0%) were found to be infected by sea lice. A total of 157 sea lice were on 51 pink salmon, six chum salmon, 25 coho salmon, 21 sockeye salmon, one chinook salmon, and two three-spined stickleback.

The highest prevalence and abundance of sea lice infestation was found in juvenile sockeye salmon (61.8% and 1.4 respectively). The highest average intensity was also found in sockeye smolts (2.2). The juvenile pink salmon population sampled in Goletas Channel and Shelter Bay area in 2020 had an overall prevalence of 25.0%, an abundance of 0.3, and an average intensity of 1.2 identified sea lice per infected fish (Table 5).

Table 5: Overall prevalence/abundance/intensity of *L. salmonis* and *C. clemensi* found on target species collected during the 2020 sea lice study.

Species	Sample size (n)	Total number of lice	Total number of fish infected	Prevalence (%)	Abundance	Intensity
Pink	204	59	51	25.0%	0.3	1.2
Chum	48	7	6	12.5%	0.1	1.2
Coho	61	41	25	41.0%	0.7	1.6
Sockeye	34	47	21	61.8%	1.4	2.2
Chinook	2	1	1	50.0%	0.5	1.0
Three-spined Stickleback	4	2	2	50.0%	0.5	1.0
Total	**353**	**157**	**106**	**30.0%**	**0.4**	**1.5**

Lice Species Prevalence, Abundance and Intensity in Pink Salmon

A total of 204 pink salmon were retained for laboratory sampling (Table 6), 87 of which were caught during the month of April and 117 during the month of May. *L. salmonis* and *C. clemensi* on juvenile pink salmon were identified on retained individuals from both sampling months.

Table 6: Prevalence, abundance and intensity of *L. salmonis* and *C. clemensi* at each sampling location where samples of pink salmon were retained.

Pink Salmon						
Site	*L. salmonis*			*C. clemensi*		
	Prevalence	Abundance	Intensity	Prevalence	Abundance	Intensity
1	0.0%	0.00	0.00	0.0%	0.00	0.00
2	100.0%	1.00	0.00	0.0%	0.00	0.00
3	8.3%	0.08	1.00	4.2%	0.04	1.00
5	0.0%	0.00	0.00	33.3%	0.67	2.00
7	9.1%	0.09	1.00	12.1%	0.12	1.00
8	6.6%	0.08	1.25	34.4%	0.36	1.05
9	0.0%	0.00	0.00	0.0%	0.00	0.00
10	0.0%	0.00	0.00	0.0%	0.00	0.00
12	23.1%	0.23	1.00	7.7%	0.08	1.00
13	0.0%	0.00	0.00	100.0%	1.00	1.00
15	50.0%	0.50	1.00	0.0%	0.00	0.00
16	13.0%	0.17	1.33	4.3%	0.04	1.00
17	0.0%	0.00	0.00	50.0%	0.50	1.00
19	5.9%	0.06	1.00	11.8%	0.15	1.25
Total	**9.5%**	**0.10**	**1.11**	**17.4%**	**0.19**	**1.09**

Lice Species Prevalence, Abundance and Intensity in Chum Salmon

A total 48 chum salmon samples were retained for laboratory analysis (Table 7). Of those samples, 24 were captured in April and 24 were captured in May. *C. clemensi* on juvenile chum salmon was observed in both sampling months, while *L. salmonis* on juvenile chum salmon was only observed during the May sampling period.

Table 7: Prevalence, abundance and intensity of *L. salmonis* and *C. clemensi* at each sampling location where samples of chum salmon were retained.

Chum Salmon						
Site	***L. salmonis***			***C. clemensi***		
	Prevalence	**Abundance**	**Intensity**	**Prevalence**	**Abundance**	**Intensity**
3	0.0%	0.00	0.00	0.0%	0.00	0.00
4	16.7%	0.17	1.00	0.0%	0.00	0.00
5	0.0%	0.00	0.00	33.3%	0.33	1.00
6	0.0%	0.00	0.00	0.0%	0.00	0.00
7	0.0%	0.00	0.00	0.0%	0.00	0.00
8	0.0%	0.00	0.00	25.0%	0.50	2.00
10	0.0%	0.00	0.00	12.5%	0.13	1.00
12	0.0%	0.00	0.00	0.0%	0.00	0.00
15	0.0%	0.00	0.00	0.0%	0.00	0.00
19	50.0%	0.50	1.00	0.0%	0.00	0.00
Total	**4.2%**	**0.04**	**1.00**	**8.3%**	**0.10**	**1.25**

Lice Species Prevalence, Abundance and Intensity in Coho Salmon

A total of 61 coho salmon samples were retained for laboratory analysis (Table 8), 8 of which were captured in April and 53 were captured in May. Similarly, to chum salmon, due to the small sample size of sockeye collected during the two months of the program, results will not be interpreted further (see *Section 3.0 – Methodology* for further explanation).

Table 8: Prevalence, abundance and intensity of *L. salmonis* and *C. clemensi* at each sampling location where samples of coho salmon were retained.

Coho Salmon						
Site	***L. salmonis***			***C. clemensi***		
	Prevalence	**Abundance**	**Intensity**	**Prevalence**	**Abundance**	**Intensity**
7	16.7%	0.20	1.20	36.7%	0.63	1.73
9	0.0%	0.00	0.00	14.3%	0.14	1.00
10	13.0%	0.17	1.33	34.8%	0.48	1.38
Total	**13.1%**	**0.16**	**1.25**	**32.8%**	**0.51**	**1.55**

Lice Species Prevalence, Abundance and Intensity in Sockeye Salmon

A total of 34 sockeye salmon samples were retained for laboratory analysis (Table 9), all of which were collected during the May sampling period. Due to the small sample size of sockeye collected during the two months of the program, results will not be interpreted further (see *Section 3.0 – Methodology* for further explanation).

Table 9: Prevalence, abundance and intensity of *L. salmonis* and *C. clemensi* at each sampling location where samples of sockeye salmon were retained.

Sockeye Salmon						
Site	***L. salmonis***			***C. clemensi***		
	Prevalence	**Abundance**	**Intensity**	**Prevalence**	**Abundance**	**Intensity**
7	30.00%	0.57	1.89	53.33%	0.93	1.75
10	0.00%	0.00	0.00	25.00%	0.50	2.00
Total	**26.5%**	**0.50**	**1.89**	**50.0%**	**0.88**	**1.76**

Lice Species Prevalence, Abundance and Intensity in Chinook Salmon

A total of two salmon were captured and retained for laboratory analysis (Table 11). All samples were retained during the May sampling period. Due to the small sample size of sockeye collected during the two months of the program, results will not be interpreted further (see *Section 3.0 – Methodology* for further explanation).

Table 11: Prevalence, abundance and intensity of *L. salmonis* and *C. clemensi* at each sampling location where samples of chinook salmon were retained.

Chinook Salmon						
Site	*L. salmonis*			*C. clemensi*		
	Prevalence	Abundance	Intensity	Prevalence	Abundance	Intensity
7	0.00%	0.00	0.00	0.00%	0.00	0.00
13	0.00%	0.00	0.00	100.00%	1.00	1.00
Total	**0.0%**	**0.00**	**0.00**	**50.0%**	**0.50**	**1.00**

Lice Species Prevalence, Abundance and Intensity in Three-spined Stickleback

A total of four three-spined stickleback were captured and retained for laboratory analysis (Table 11). All samples were retained during the May sampling period. Due to the small sample size of sockeye collected during the two months of the program, results will not be interpreted further (see *Section 3.0 – Methodology* for further explanation).

Table 11: Prevalence, abundance and intensity of *L. salmonis* and *C. clemensi* at each sampling location where samples of three-spined stickleback were retained.

Three-Spined Stickleback						
Site	*L. salmonis*			*C. clemensi*		
	Prevalence	Abundance	Intensity	Prevalence	Abundance	Intensity
15	0.00%	0.00	0.00	50.00%	0.50	1.00
Total	**0.0%**	**0.00**	**0.00**	**50.0%**	**0.50**	**1.00**

Louse Life Stage

Louse life stage was determined through laboratory analysis, the distribution of which can be found in Table 12. Louse life stages determined in the analysis include parasitic copepodid (Co), chalimus stages (C1 and C2 for *L. salmonis* and C1 through C4 for *C. clemensi*), pre adult males (PAM) and pre adult females (PAF), as well as viable adult males (AM) and adult females (AF).

Louse Life Stage on Pink Salmon

The most prevalent life stage of *L. salmonis* observed on pink salmon was the C1 and C2 stages (both 33.3%), followed by the PAM, PAF, and AM stages (14.3%, 9.5%, and 9.5% respectively). No other stages of *L. salmonis* were found on pink salmon submitted for laboratory analysis during the 2020 study.

The most prevalent life stage of *C. clemensi* observed on pink salmon was the C1 stage (63.2%), followed by the C2 (15.8%), Co (7.9%), C3 (5.3%), C4 (2.6%), PAM (2.6%), and AM (2.6%) stages. The PAF and AF stages of *C. clemensi* were not identified on pink salmon samples submitted for laboratory analysis.

Louse Life Stage on Chum Salmon

The most prevalent life stage of *L. salmonis* observed on chum salmon was the C2 and PAM stages (both 50.0%). No other life stages of *L. salmonis* were observed on chum salmon samples submitted for laboratory analysis during the 2020 sea lice study.

The most dominant life stage of *C. clemensi* observed on chum salmon samples submitted to the laboratory was the C1(60.0%), followed by the Co stage (40.0%). No other life stages of *C. clemensi* were identified on any of the chum salmon submitted for laboratory testing.

Louse Life Stage on Coho Salmon

The most prevalent life stage of *L. salmonis* observed on coho salmon was the PAM and PAF stages (both 30.0%), followed by the C2 stage (20.0%), and the AM and AF stages (both 10%). No other life stages of *L. salmonis* were observed on coho salmon submitted for laboratory analysis.

The most prevalent life stage of *C. clemensi* identified on juvenile coho salmon was the C1 stage (35.5%), followed by the C3 (25.8%), AM (22.6%), and the Co, C2, C4, PAF, and AF stages (all 3.2%). The PAM stage of *C. clemensi* was not observed on coho salmon submitted for laboratory analysis.

Louse Life Stage on Sockeye Salmon

The most prevalent life stage of *L. salmonis* found on sockeye salmon samples was C2 stage (47.1%), followed by the C1 (29.4%), PAF (17.6%), and AM (5.9%) stages. No other life stages of *L. salmonis* were observed on sockeye salmon submitted for laboratory analysis.

The most prevalent life stage of *C. clemensi* identified on juvenile sockeye salmon samples was the C1 stage (33.3%), followed by the C3 (26.7%), AM (23.3%), and Co, C2, C4, PAF, and AF stages (all 3.3%). The PAM life stage of *C. clemensi* was not identified on any of the sockeye salmon submitted for laboratory analysis.

Louse Life Stage on Chinook Salmon

There were no life stages of *L. salmonis* observed on chinook salmon submitted for laboratory analysis during the 2020 sea lice study.

The only life stage of *C. clemensi* identified on chinook salmon submitted for laboratory results was the C1 stage (100%).

Louse Life Stage on Three-spined Stickleback

There were no life stages of *L. salmonis* observed on three-spined stickleback submitted for laboratory analysis during the 2020 sea lice study.

The only life stage of *C. clemensi* identified on three-spined stickleback submitted for laboratory results was the C1 stage (100%).

Table 12: Numbers and life stages of *L. salmonis* and *C. clemensi* sea lice collected from target fish species sampled from April 15th to May 23rd, 2020.

Species	April			May					
	Pink	Chum	Coho	Pink	Chum	Coho	Sockeye	Chinook	Three-spined stickleback
LEP Co	0	0	0	0	0	0	0	0	0
LEP C1	5	0	0	2	0	0	5	0	0
LEP C2	4	0	0	3	1	2	8	0	0
LEP PAM	0	0	0	4	1	3	0	0	0
LEP PAF	0	0	0	2	0	3	3	0	0
LEP AM	0	0	0	2	0	1	1	0	0
LEP AF	0	0	0	0	0	1	0	0	0
LEP Total	**9**	**0**	**0**	**13**	**2**	**10**	**17**	**0**	**0**
Cal Co	3	2	0	0	0	1	1	0	0
Cal C1	13	2	1	11	1	16	10	1	2
Cal c2	3	0	0	3	0	1	1	0	0
Cal c3	1	0	0	1	0	3	8	0	0
Cal C4	0	0	0	1	0	1	1	0	0
CAL PAM	0	0	0	1	0	1	0	0	0
CAL PAF	0	0	0	0	0	0	1	0	0
CAL AM	0	0	0	1	0	2	7	0	0
CAL AF	0	0	0	0	0	5	1	0	0
CAL Total	**20**	**4**	**1**	**18**	**1**	**30**	**30**	**1**	**2**

4.3 Water Quality – Salinity, Temperature, and Dissolved Oxygen

Salinity, temperature, and dissolved oxygen data were recorded at each site throughout the entire study period. Measurements were taken at the surface (0m), as well as at 1m and 4m depths. Surface water quality data for the entire study area have been documented in Table 13. The full set of water quality data recorded during for the 2020 sea lice study can be found in Appendix 2.

Salinity

Average salinity of surface waters increased slightly from April to June from 30.8ppt to 31.5ppt. During the month of April maximum salinity (31.3ppt) was recorded at Site 3, on the south side of Hope Island. The lowest surface salinity (30.6ppt) was recorded on the surface of both Site 7, in Loquillilla Cove on the southern shore of Nigei Island, and Site 19, near the Nankivell Islands near the Marsh Bay site. During the second round of sampling during May, the highest surface salinity (32.3ppt) was recorded at Site 3, on the south side of Hope Island, while the lowest surface salinity (29.1ppt) was recorded on the surface of Site 4 in Goletas Channel.

Temperature

The average surface water temperature for the entire study area increased throughout the study period (April 15th to May 23rd, 2020). Average surface water temperature was 8.8°C in April and 10.4°C during the second round of sampling in May. In April, the lowest recorded surface temperature (8.1°C) was encountered at Site 20, east of Marsh Bay in the Shelter Bay area. The highest surface water temperature for April (9.9°C) was encountered at Site 9, at Boxer Point on Nigei Island. The lowest surface water temperature during May (9.0°C) was encountered at Site 18, north of Stuart Point near the Marsh Bay Site. The highest surface water temperature (12.1°C) was encountered at Site 1, in Bull Harbour on Hope Island.

Dissolved Oxygen

The average surface levels of dissolved oxygen increased throughout the study period. In April, the average level of dissolved oxygen at the surface (0m) was 8.6 mg/L; during the second round of sampling in May, average dissolved oxygen was 9.4 mg/L at the surface. Site

20, east of Marsh Bay in the Shelter Bay area was found to have the lowest dissolved oxygen level in April (7.7mg/L), while Site 8, in Goletas Channel on northern Vancouver Island, was found to have the highest levels in April (9.4mg/L). In May, the lowest level of dissolved oxygen recorded in surface waters was found at Site 20 (8.3mg/L), east of Marsh Bay in the Shelter Bay area. The highest surface dissolved oxygen level in May was recorded at Site 1 (11.2mg/L), in Bull Harbour on Hope Island.

Table 13: Summary of surface (0m) water quality data collected at Sites 1 through 20 during the 2019 sea lice study, including temperature (°C), salinity (ppt), and dissolved oxygen (mg/L).

Site	April			May/June		
	Temp (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Temp (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)
1	9.3	30.9	8.7	12.1	32.1	11.2
2	9.6	31.3	8.5	11.5	32.2	10.3
3	8.8	31.2	9.2	10.7	32.3	9.7
4	8.3	30.7	8.0	10.8	29.1	9.0
5	8.8	30.9	8.9	10.7	31.6	9.1
6	9.0	30.9	9.1	11.1	31.7	9.4
7	9.9	30.6	8.9	10.3	31.7	8.2
8	9.1	30.8	9.4	11.4	32.1	10.0
9	9.0	30.8	8.1	10.3	31.8	9.3
10	8.8	30.8	8.3	10.8	31.3	9.3
11	8.8	30.7	9.1	10.5	31.5	10.3
12	9.2	30.7	9.0	-	-	-
13	8.8	30.7	9.2	10.6	-	-
14	8.3	30.8	8.3	9.8	-	-
15	8.9	30.7	8.8	10.1	-	-
16	8.8	30.8	8.3	9.6	-	-
17	8.8	30.8	8.7	9.4	-	-
18	8.3	30.7	8.2	9.0	31.2	8.5
19	8.3	30.6	8.0	9.1	31.1	8.7
20	8.1	30.7	7.7	9.1	31.1	8.3
Average	**8.8**	**30.8**	**8.6**	**10.4**	**31.5**	**9.4**

5.0 DISCUSSION

5.1 Sample Numbers

Of the 977 target species captured, a total of 353 individual fish were retained for laboratory analysis from Goletas Channel and Queen Charlotte Strait for the 2020 sea lice monitoring study. Overall, this was a decrease from the previous years sampling effort (520 fish in 2019) and is the second lowest number of fish retained for the study since it began (260 fish in 2018) with the vast majority of years having a larger number of fish sampled (819 fish in 2011; 874 fish in 2013; 579 fish in 2014; 682 fish in 2015;598 fish in 2016; and 378 fish in 2018).

Target species sampled during the 2020 study included pink salmon, chum salmon, coho salmon, sockeye salmon, chinook salmon, and three-spined stickleback. The majority of fish caught and retained for laboratory analysis were pink salmon (204 individuals). Smaller sample numbers of chum salmon (48 individuals), coho salmon (61 individuals), sockeye salmon (34 individuals), chinook salmon (two individuals), and three-spined stickleback (four individuals) were also retained for analysis.

5.2 Distribution

In order to facilitate comparisons between study years and simplify individual site analysis, the sites were renamed in 2017 to Sites 1 through 20. The original site names can be found in Appendix 1, for reference.

Some variability existed in the size of samples collected in April (i.e. Round 1; 119 samples retained) compared to May (i.e. Round 2; 234 samples retained). As suggested in reporting from previous years, this 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 behaviour is thought to potentially increase the number of 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.

5.3 Water Quality

Water temperatures for the 2020 study year were consistent with previous years of the study based on a comparison of mean water temperature among all study years (with the exception of 2015). The water temperature in April at the sample sites ranged between 8.1 ^{o}C to 9.9 ^{o}C then warmed up in May to a range of 9.0 ^{o}C to 12.1 ^{o}C. In previous years of the study, the water temperature also increased during the same time of year from April to May. This is consistent with all the previous study years, except for 2015 when mean water temperature exhibited a 1^{o}C decrease over the same time period. Detailed water quality results for previous years of the sea lice monitoring study can be found in the corresponding reports from Pacificus.

In the 2020 study period, the average salinity levels increased by 0.7 ppt from April to May. All sites which were sampled saw an increase in salinity during that time period except for site 4 which was located near the outflow of a river in Shushartie Bay. Note that Sites 12 through 17 were not recorded for salinity during the May sampling due to equipment malfunction. In previous years, average salinity at the sites from April to May fluctuated - either remaining constant (during years 2011, 2013, 2014) or increasing (years 2015, 2016, 2019) or decreasing (years 2017, 2018).

Average dissolved oxygen levels for the 2020 sea lice study increased by 0.8 mg/L between April to May. The lowest recorded level during the sampling was 7.7 mg/L at site 20 located near mainland at the furthest inside the channel in April; and the highest recorded level was 11.2 at Bull Harbour in May. This dissolved oxygen range falls within the normal rage of levels obtained in surface waters of marine environments.

5.4 Sea lice

Sea lice intensity (number of lice per infested fish) was determined to be 1.5 for all sea lice over the entire study period with a prevalence (total number of lice per total number of fish) of 30% of sampled fish infected by sea lice. Similarly, to all previous years, the species of sea lice *C. clemensi* was more prevalent than *L. salmonis*. Pink salmon represent the greatest number of species captured, so interpretation of this data will be most representative of the population.

Average weight for juvenile pink salmon was 0.6 g (n=87) in April, increasing to 1.6 g (n=117) in May. The threshold level for lethal infestation stated in Jones and Hargreaves 2009 is 7.5 lice (*L. salmonis*) per juvenile pink salmon averaging less than or equal to 0.7 g in weight.

The lice intensity on juvenile pink salmon observed during the 2020 survey is 1.2 lice/fish which falls below the threshold for lethal infestation.

In Nendick et al (2011), experimental sea lice infestation (*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 infestation intensity; infestation with a single louse of chalimus 3 (C3) stage or higher would impact swimming performance in juvenile pink salmon weighing 0.34g or less. One third of the Pink Salmon infected had lice in live stages higher than C3, however most of these infected fish weighed greater than the threshold level mentioned above.

While pink salmon were the primary species analysed, it is important to note some of the results of other juvenile salmon species sampled. While the sample size of the other species were smaller, 61.8% of Sockeye were found to be infected with sea lice at an intensity of 2.2 and Coho salmon were found to have an infestation rate of 41.0% at 1.6 intensity.

Based on the data obtained from laboratory analysis of field samples, *C. clemensi* was more prevalent than *L. salmonis* for the Goletas Channel and Queen Charlotte Strait study area in the 2020 study year. Of the 157 sea lice found during laboratory analysis of field samples, 68% were identified as *C. clemensi* and 32% were *L. salmonis*. The 2020 results are shown in comparison to previous years in Table 14.

Table 14: Overall contribution of *L. salmonis* and *C. clemensi* for all infested samples obtained in 2020 compared to previous years of the study.

Year	Total number of sea lice sampled (*L. salmonis* and *C. clemensi*)	Contribution of *L. salmonis* (%)	Contribution of *C. clemensi* (%)
2011	250	16	84
2013	66	21	79
2014	42	24	76
2015	1020	40	60
2016	516	21	79
2017	34	38	62
2018	157	32	68
2019	406	9	91
2020	157	32	68

A comparison of data for juvenile pink salmon from all study years is shown in Table 14. Total number of sea lice encountered in 2020 was 157 which is lower than some previous years, however, this year a lower number of fish (n=353) were also captured compared to some previous years. A comparison of previous years with a weighting of numbers of sea lice over sample size can be seen in Table 15.

Table 15: The prevalence, abundance and intensity of *L. salmonis* and *C. clemensi* found on samples of juvenile pink salmon over the past nine study years.

Year	*Lepeophtheirus salmonis*			*Caligus clemensi*		
	Prevalence	Abundance	Average Intensity	Prevalence	Abundance	Average Intensity
2011 (n = 611)	4%	0.04	1.1	13%	0.15	1.2
2013 (n = 612)	1%	0.01	1.0	4%	0.04	1.0
2014 (n = 500)	2%	0.02	1.0	5%	0.06	1.0
2015 (n = 460)	19%	0.13	1.2	21%	0.21	1.5
2016 (n = 336)	7%	0.07	1.1	16%	0.24	1.6
2017 (n = 189)	5%	0.07	1.3	10%	0.11	1.1
2018 (n = 201)	6%	0.07	1.2	11%	0.24	2.2
2019 (n = 194)	9%	0.10	1.1	17%	0.19	1.1
2020 (n = 204)	9%	0.10	1.1	17%	0.19	1.1

Prevalence of L. salmonis on pink salmon in 2020 remained similar to levels observed through the previous eight years of study, with lice affecting 9% of the population. C. clemensi were found on 17% of the pink salmon population sampled, also within the normal range seen in previous study years.

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APPENDIX 1: Site Numbering Scheme Change

Former Name	New Site Number
Zone 1 Site 2	10
Zone 1 Site 3	8
Zone 2 Site 1	5
Zone 2 Site 2	4
Zone 3 Site 1	1
Zone 3 Site 2	2
Zone 3 Site 3	3
Zone 4 Site 2	6
Zone 4 Site 3	7
Zone 4 Site 4	9
Zone 5 Site 1	11
Zone 5 Site 2	12
Zone 5 Site 3	13
Zone 5 Site 4	14
Zone 6 Site 1	17
Zone 6 Site 3	16
Zone 6 Site 4	15
Zone 6 Site 5	19
Zone 6 Site 6	18
Zone 6 Site 7	20

APPENDIX 2: Environmental Data

Site	April										May/June								
	Temperature (°C)			Salinity (ppt)			Dissolved Oxygen (mg/L)				Temperature (°C)			Salinity (ppt)			Dissolved Oxygen (mg/L)		
	Surface	1m	4m	Surface	1m	4m	Surface	1m	4m	Site	Surface	1m	4m	Surface	1m	4m	Surface	1m	4m
1	9.30	8.80	8.40	30.91	31.25	31.31	8.65	8.51	7.85	**1**	12.10	12.00	11.00	32.06	32.05	32.16	11.19	12.00	11.75
2	9.60	9.40	9.00	31.33	31.32	31.33	8.54	8.46	8.60	**2**	11.50	10.90	10.70	32.16	32.15	32.16	10.32	11.03	10.22
3	8.80	8.80	8.60	31.20	31.21	31.21	9.23	8.99	0.24	**3**	10.70	10.70	10.50	32.33	32.23	32.23	9.69	9.65	9.77
4	8.30	8.30	8.40	30.67	31.15	31.24	7.95	7.89	7.95	**4**	10.80	10.60	10.60	29.14	31.58	31.58	9.00	8.96	9.19
5	8.80	8.70	8.50	30.86	30.95	31.20	8.86	8.28	8.46	**5**	10.70	10.70	10.70	31.61	31.62	31.63	9.13	9.08	9.08
6	9.00	8.90	8.70	30.93	30.91	30.91	9.06	9.31	9.22	**6**	11.10	11.10	10.90	31.69	31.69	31.69	9.44	9.44	9.79
7	9.90	9.20	8.90	30.55	30.82	30.85	8.86	8.47	8.45	**7**	10.30	10.20	10.20	31.69	31.74	31.76	8.18	8.42	8.50
8	9.10	9.20	8.90	30.77	30.80	30.83	9.44	8.92	8.57	**8**	11.40	11.20	11.10	32.06	32.09	32.09	9.97	9.96	10.12
9	9.00	8.90	8.70	30.76	30.81	30.84	8.14	8.16	8.00	**9**	10.30	10.20	10.20	31.78	31.72	31.72	9.30	9.20	9.19
10	8.80	8.70	8.70	30.77	30.77	30.80	8.31	8.18	8.20	**10**	10.80	10.70	10.70	31.27	31.62	31.63	9.33	9.35	9.33
11	8.80	8.80	8.80	30.67	30.67	30.67	9.06	8.99	9.35	**11**	10.50	10.40	10.40	31.48	31.52	31.54	10.27	10.26	10.06
12	9.20	9.10	9.10	30.65	30.65	30.65	9.02	9.02	9.03	**12**	-	-	-	-	-	-	-	-	-
13	8.80	8.80	8.80	30.69	30.68	30.68	9.20	9.03	9.04	**13**	10.60	-	-	-	-	-	-	-	-
14	8.30	8.30	8.30	30.83	30.84	30.85	8.25	8.25	8.64	**14**	9.80	-	-	-	-	-	-	-	-
15	8.90	8.90	8.60	30.68	30.70	30.78	8.80	8.60	7.80	**15**	10.09	-	-	-	-	-	-	-	-
16	8.90	8.60	8.00	30.83	30.90	30.89	9.99	10.03	9.65	**16**	9.60	-	-	-	-	-	-	-	-
17	8.80	8.70	8.40	30.79	30.81	30.83	8.69	8.62	8.29	**17**	9.40	-	-	-	-	-	-	-	-
18	8.30	8.20	8.10	30.68	30.67	30.68	8.20	8.16	8.17	**18**	9.00	9.00	9.00	31.23	31.23	31.22	8.49	8.32	8.27
19	8.30	8.30	8.20	30.57	30.64	30.69	8.03	8.00	7.83	**19**	9.10	9.10	9.00	31.13	31.14	31.15	8.72	8.50	8.57
20	8.10	8.10	8.10	30.71	30.71	30.72	7.73	7.58	7.53	**20**	9.10	9.10	9.10	31.11	31.11	31.12	8.27	8.24	8.42

APPENDIX 3: Raw Field Data Summary

2020 Goletas Channel and Queen Charlotte Strait Beach Seine

Beach Seine Summary			Date	April 15-19						Site Total # Fish
Site #	Location	Sample	Pink	Chum	Coho	Sockeye	Chinook	Dolly Varden	Stickleback	
1	50° 54.753 N	retained	1	0	0	0	0	0	0	1
	127° 55.837 W	captured	1	0	0	0	0	0	0	1
2	50° 53.833 N	retained	0	0	0	0	0	0	0	0
	127° 54.220 W	captured	0	0	0	0	0	0	0	0
3	50° 53.698 N	retained	7	1	0	0	0	0	0	8
	127° 51.420 W	captured	7	1	0	0	0	0	0	8
4	50° 51.119 N	retained	0	0	0	0	0	0	0	0
	127° 52.011 W	captured	0	0	0	0	0	0	0	0
5	50° 50.782 N	retained	1	0	1	0	0	0	0	2
	127° 48.839 W	captured	1	0	1	0	0	0	0	2
6	50° 51.667 N	retained	0	0	0	0	0	0	0	0
	127° 46.712 W	captured	0	0	0	0	0	0	0	0
7	50° 51.692 N	retained	3	1	0	0	0	0	0	4
	127° 45.477 W	captured	3	1	0	0	0	0	0	4
8	50°49.487 N	retained	30	4	0	0	0	0	0	34
	127° 42.564 W	captured	280	4	0	0	0	0	0	284
9	50° 49.980 N	retained	0	0	7	0	0	0	0	7
	127° 39.147 W	captured	0	0	7	0	0	0	0	7
10	50°48.110 N	retained	2	16	0	0	0	0	0	18
	127° 37.890 W	captured	2	16	0	0	0	0	0	18
11	50°49.095 N	retained	0	0	0	0	0	0	0	0
	127° 33.311 W	captured	0	0	0	0	0	0	0	0
12	50°49.714 N	retained	13	2	0	0	0	0	0	15
	127°31.560 W	captured	13	2	0	0	0	0	0	15
13	50°48.831 N	retained	1	0	0	0	0	0	0	1
	127°28.678 W	captured	1	0	0	0	0	0	0	1
14	50°53.580 N	retained	0	0	0	0	0	0	0	0
	127° 29.362 W	captured	0	0	0	0	0	0	0	0
15	50° 58.577 N	retained	2	0	0	0	0	0	0	2
	127° 27.477 W	captured	2	0	0	0	0	0	0	2
16	50° 57.580 N	retained	23	0	0	0	0	0	0	23
	127° 27.254 W	captured	23	0	0	0	0	0	0	23
17	50° 55.920 N	retained	1	0	0	0	0	0	0	1
	127° 24.324 W	captured	1	0	0	0	0	0	0	1
18	50° 55.221 N	retained	0	0	0	0	0	0	0	0
	127° 22.516 W	captured	0	0	0	0	0	0	0	0
19	50° 54.241 N	retained	3	0	0	0	0	0	0	3
	127°19.289 W	captured	3	0	0	0	0	0	0	3
20	50° 53.990N	retained	0	0	0	0	0	0	0	0
	127° 17.859 W	captured	0	0	0	0	0	0	0	0
TOTAL RETAINED			87	24	8	0	0	0	0	119
TOTAL CAPTURED			337	24	8	0	0	0	0	369

Beach Seine Summary			Date	May 19-23, 2020						Site Total # Fish
Site #	Location	Sample	Pink	Chum	Coho	Sockeye	Chinook	Dolly Varden	Stickleback	
1	50° 54.753 N	retained	0	0	0	0	0	0	0	**0**
	127° 55.837 W	captured	0	0	0	0	0	0	0	**0**
2	50° 53.833 N	retained	1	0	0	0	0	0	0	**1**
	127° 54.220 W	captured	1	0	0	0	0	0	0	**1**
3	50° 53.698 N	retained	17	1	0	0	0	0	0	**18**
	127° 51.420 W	captured	17	1	0	0	0	0	0	**18**
4	50° 51.119 N	retained	0	6	0	0	0	0	0	**6**
	127° 52.011 W	captured	0	6	0	0	0	0	0	**6**
5	50° 50.782 N	retained	2	3	0	0	0	0	0	**5**
	127° 48.839 W	captured	2	3	0	0	0	0	0	**5**
6	50° 51.667 N	retained	0	7	0	0	0	0	0	**7**
	127° 46.712 W	captured	0	7	0	0	0	0	0	**7**
7	50° 51.692 N	retained	31	3	30	30	1	0	0	**95**
	127° 45.477 W	captured	120	3	140	72	1	0	0	**336**
8	50°49.487 N	retained	31	0	0	0	0	0	0	**31**
	127° 42.564 W	captured	65	0	0	0	0	0	0	**65**
9	50° 49.980 N	retained	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
	127° 39.147 W	captured	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
10	50°48.110 N	retained	**0**	**0**	**23**	**4**	**0**	**0**	**0**	**27**
	127° 37.890 W	captured	**0**	**0**	**23**	**4**	**0**	**0**	**0**	**27**
11	50°49.095 N	retained	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	127° 33.311 W	captured	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
12	50°49.714 N	retained	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	127°31.560 W	captured	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
13	50°48.831 N	retained	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**
	127°28.678 W	captured	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**
14	50°53.580 N	retained	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	127° 29.362 W	captured	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
15	50° 58.577 N	retained	**2**	**2**	**0**	**0**	**0**	**0**	**4**	**8**
	127° 27.477 W	captured	**2**	**2**	**0**	**0**	**0**	**0**	**4**	**8**
16	50° 57.580 N	retained	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	127° 27.254 W	captured	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
17	50° 55.920 N	retained	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
	127° 24.324 W	captured	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
18	50° 55.221 N	retained	0	0	0	0	0	0	0	**0**
	127° 22.516 W	captured	0	0	0	0	0	0	0	**0**
19	50° 54.241 N	retained	31	2	0	0	0	0	0	**33**
	127°19.289 W	captured	130	2	0	0	0	0	0	**132**
20	50° 53.990N	retained	0	0	0	0	0	0	0	**0**
	127° 17.859 W	captured	0	0	0	0	0	0	0	**0**
TOTAL RETAINED			117	24	53	34	2	0	4	**234**
TOTAL CAPTURED			**339**	**24**	**163**	**76**	**2**	**0**	**4**	**608**