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

YEAR 10

MOWI Canada West

August 2021

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1.0 EXECUTIVE SUMMARY

2021 marked the tenth 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 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*), Pacific herring (*Clupea pallasii),* Dolly Varden *(Salvelinus malma)* and three-spined stickleback (*Gasterosteus aculeatus*) were also collected. In response to a change to the sampling permit issued by DFO, sockeye salmon (*O. nerka*) and chinook (*O. tshawytscha)* were not targeted this year, while coho were only targeted in limited numbers. To determine the environmental conditions at each site, 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 642 fish were retained for laboratory analysis. Of the 642 fish collected there were 516 pink salmon, 77 chum salmon, 30 coho salmon, 1 sockeye salmon, 5 Dolly Varden, 12 Pacific herring and 1 three-spined stickleback. A total of 98 *Lepeophtheirus salmonis* lice and 92 *Caligus clemensi* lice were identified on the 642 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 2021 program.

Table 1: Prevalence, abundance and average intensity of *L. salmonis* and *C. clemensi* lice on pink salmon from 2011 to 2021.

Year	*Lepeophtheirus salmonis*			*Caligus clemensi*		
	Prevalence	**Abundance**	**Average Intensity**	**Prevalence**	**Abundance**	**Average Intensity**
2011 (n = 611)	4%	0.04	1.09	13%	0.15	1.24
2013 (n = 612)	1%	0.01	1.00	4%	0.04	1.00
2014 (n = 500)	2%	0.02	1.00	5%	0.06	1.03
2015 (n = 460)	19%	0.13	1.17	21%	0.21	1.50
2016 (n = 336)	7%	0.07	1.14	16%	0.24	1.55
2017 (n = 189)	5%	0.07	1.30	10%	0.11	1.11
2018 (n = 201)	6%	0.07	1.17	11%	0.24	2.23
2019 (n = 194)	4%	0.04	1.11	7%	0.07	1.09
2020 (n = 204)	4%	0.04	1.11	7%	0.07	1.09
2021 (n=516)	13%	0.17	1.30	10%	0.13	1.30

2.0 INTRODUCTION

The 2021 sea lice study aimed to add information to the existing baseline studies (Pacificus 2011, 2013a and 2013b, 2014, 2015, 2016, 2017, 2018, 2019, 2020) 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 2021 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 nine 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 2021 sea lice study also helps fulfill Mowi's Aquaculture Stewardship Council (ASC) requirement to monitor wild salmonids. This is the tenth year of studying sea lice in Goletas Channel (Pacificus 2011, 2013a, 2014, 2015, 2016, 2017, 2018, 2019, 2020) and the eighth study year in the Shelter Bay area (Pacificus 2013b, 2014, 2015, 2016, 2017, 2018, 2019, 2020).

A total of 20 beach seine sites were sampled during the 2021 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 Aug 9, 2021)
[2] http://www.pac.dfo-mpo.gc.ca/fm-gp/maps-cartes/areas-secteurs/11-eng.html (Accessed Aug 9, 2021)

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*), sockeye salmon (*O. nerka*), Dolly Varden char (*Salvelinus malma*), 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 2021 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. Four of the locations remained operational during the 2021 sea lice study (Shelter Pass, Duncan Island, Doyle Island, and Bull

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

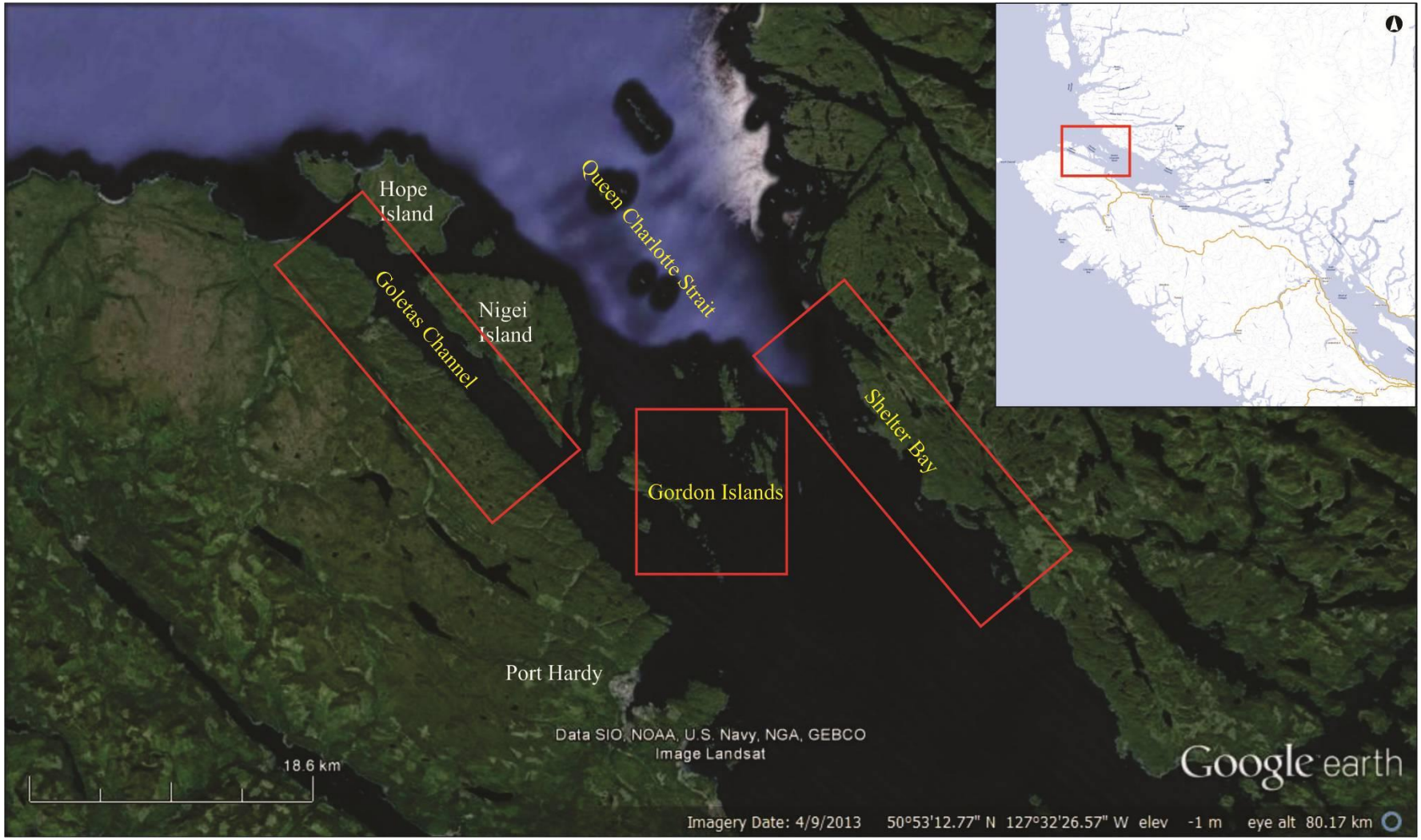

Figure 1: Overview map showing study locations (red boxes) for the 2021 sample year in relation to Port Hardy, Vancouver Island, BC.

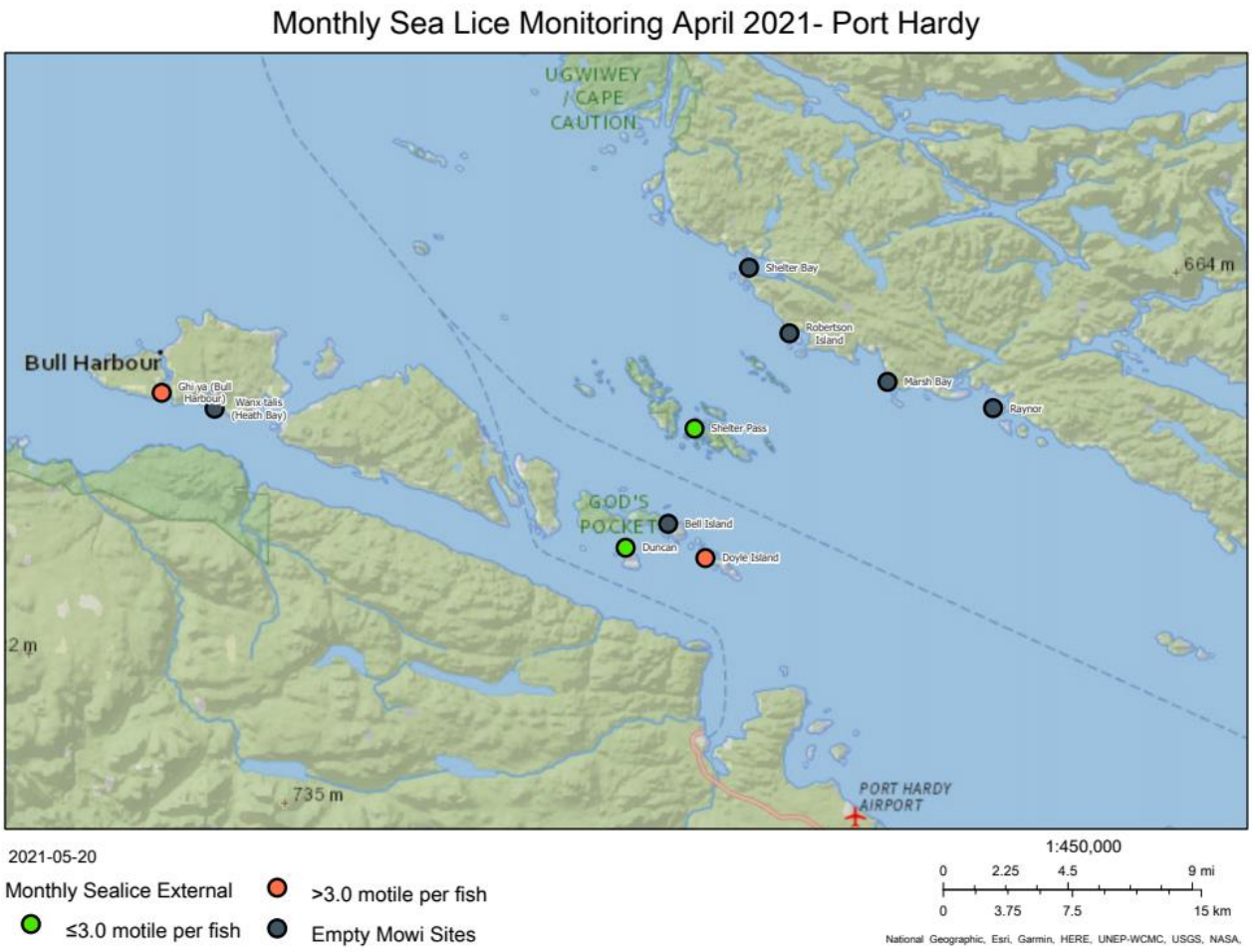

Figure 2: Location of Mowi fish farms along the BC coast in April 2021. Base map and data available from MOWI website (https://mowi.com/caw/sustainability/sea-lice-reporting/)

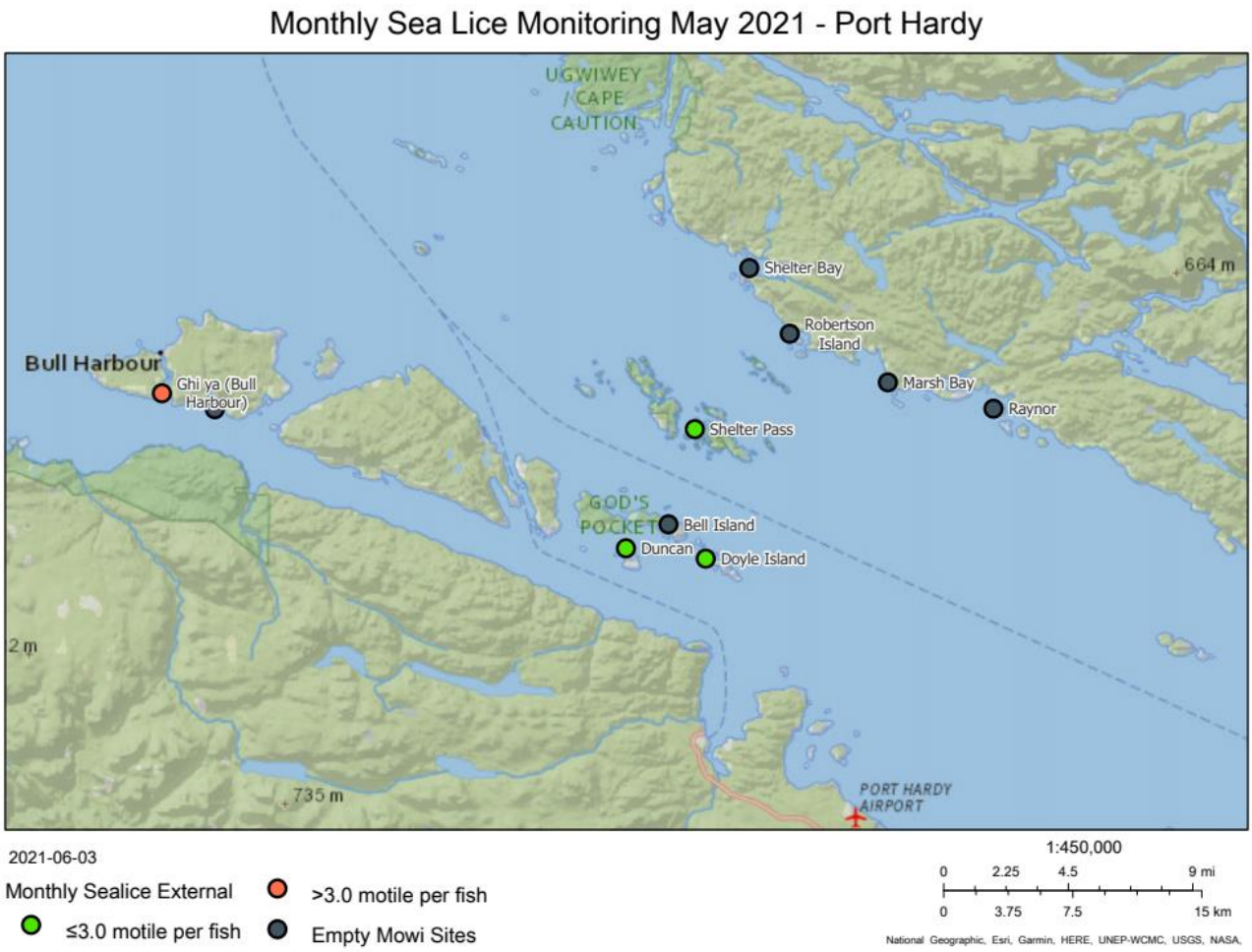

Figure 3: Location of Mowi fish farms along the BC coast in May 2021. Base map and data available from MOWI website (https://mowi.com/caw/sustainability/sea-lice-reporting/)

3.0 METHODOLOGY

To remain consistent with previous years of the sea lice study, the same methodology was employed during the 2021 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 twenty based on relative geographic locations, with site numbering remaining consistent with the 2017 to 2021 studies (Pacificus 2020, 2019, 2018, 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 tenth 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 2021 being no exception. In 2021, 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 eighth 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 2021 program.

The 2021 sea lice study, conducted in Goletas Channel and Queen Charlotte Strait, mostly followed the sampling regime of the previous six years of the study, where monthly sampling occurred in April and May. Field operations were slightly modified, like those utilized in 2020, in response to the ongoing COVID-19 pandemic. With consideration of the state of the pandemic, additional safety measures were employed, including the reduction of crew sizes, the utilization of two sampling vessels and increased cleaning measures throughout the field sampling events. Field crews consisted of 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 Net 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 2021 survey included pink salmon (*Oncorhynchus gorbuscha*), chum (*O. keta*), coho (*O. kisutch*), Chinook (*O. tshawytscha*), Dolly Varden (*Salvelinus malma*), three-spined stickleback (*Gasterosteus aculeatus*) and Pacific herring (*Clupea pallasii*). Although it was not a target species, one sockeye salmon (*O. nerka*) was misidentified in the field as a pink salmon and was retained for laboratory analysis. 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. 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 were 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 and consisted of temperature (^{0}C), dissolved oxygen (mg/L) and salinity (ppt) measurements at the surface (0m), 1m and 4m depths, with the exception of Site 4, which was not deep enough to take a reading at 4m (bottom depth reading was taken at 2.5m). 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.

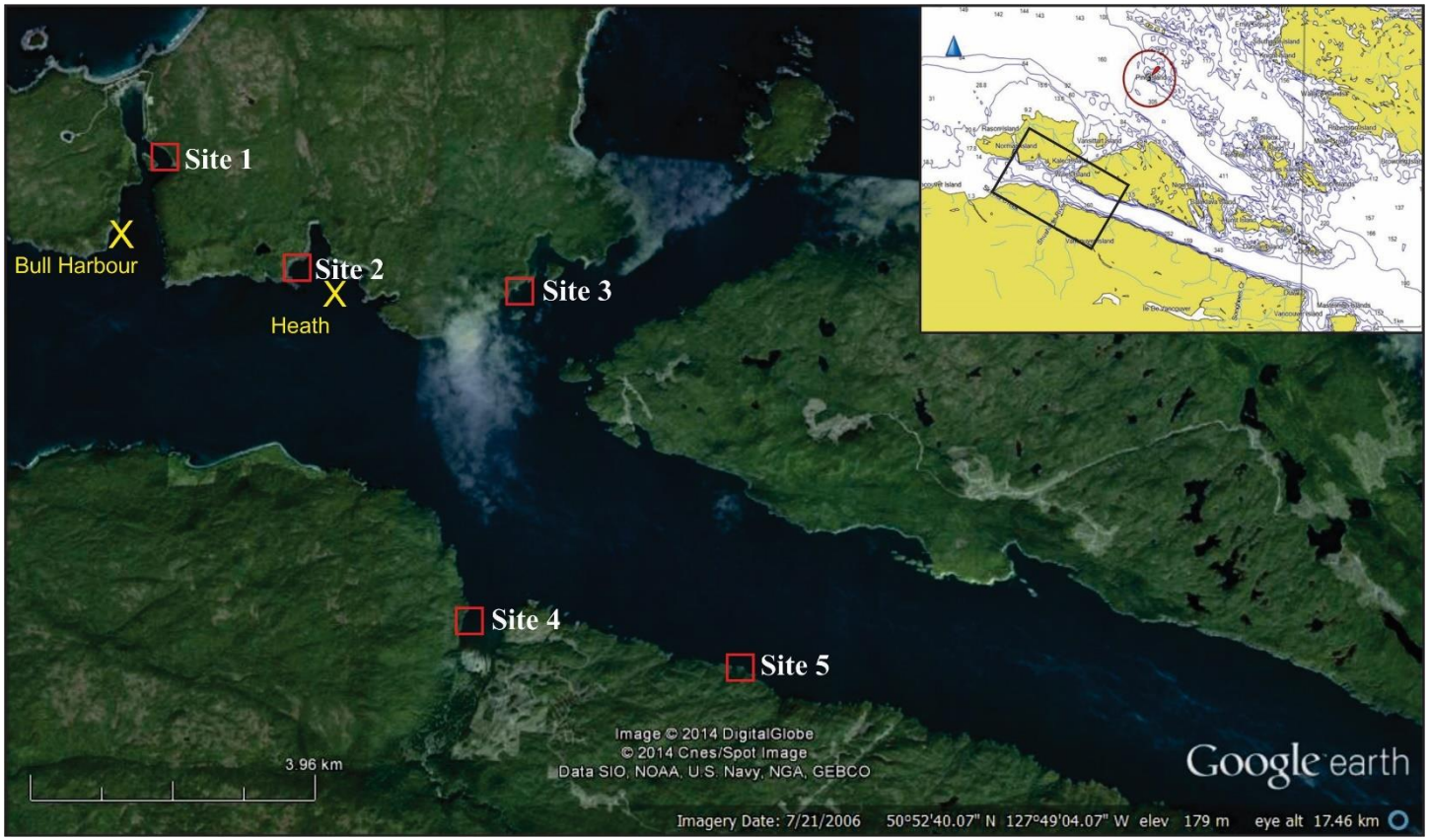

Figure 4: Location map of the sampling sites from 1 to 5 located on Vancouver Island and Hope Island examined during the 2021 sample year in Goletas Channel, British Columbia. The yellow "X" indicates locations of both active and inactive fish farms in the area.

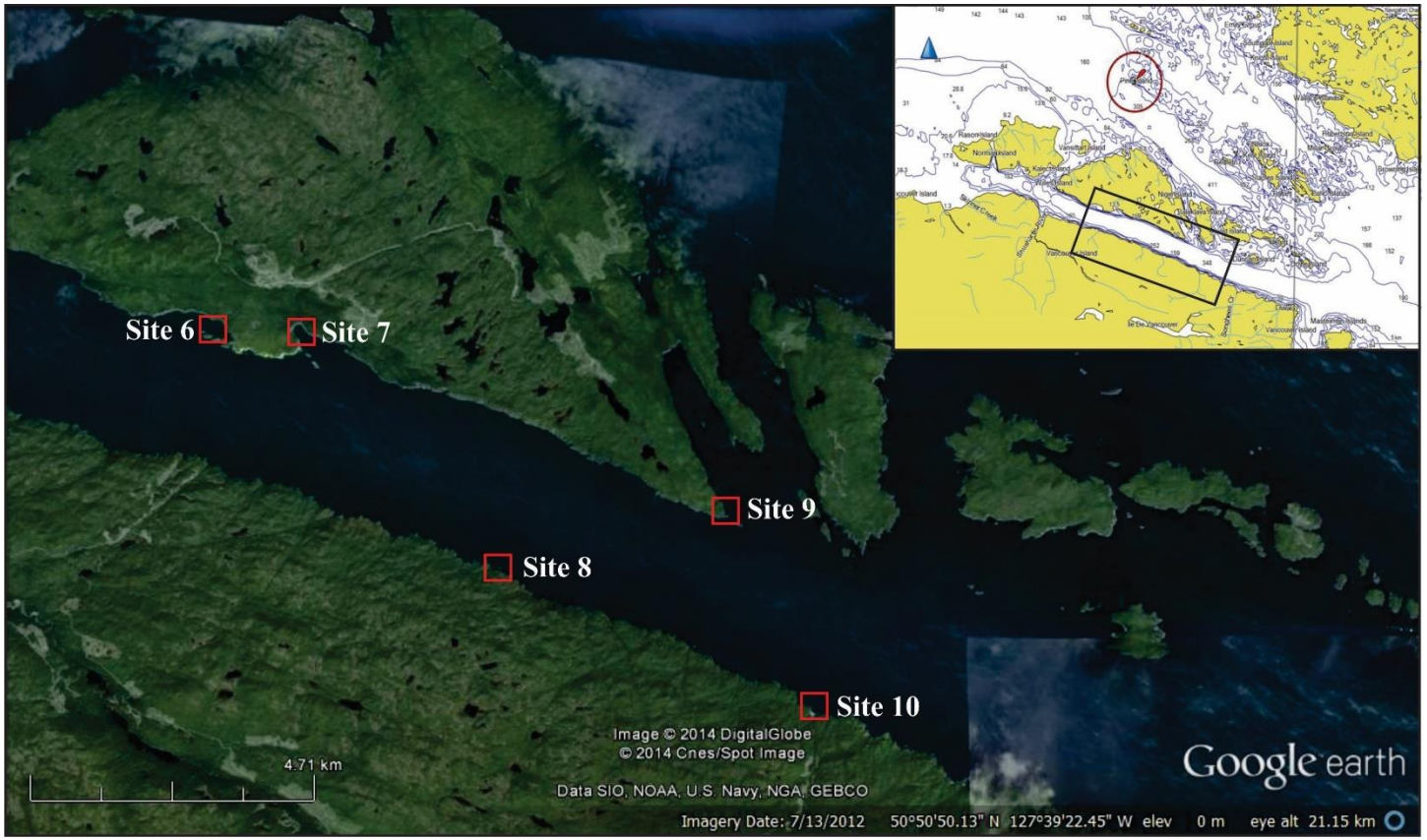

Figure 5: Location map of the sampling sites 6 to 10 located on Vancouver Island and Nigei Island examined during the 2021 sample year in Goletas Channel, British Columbia.

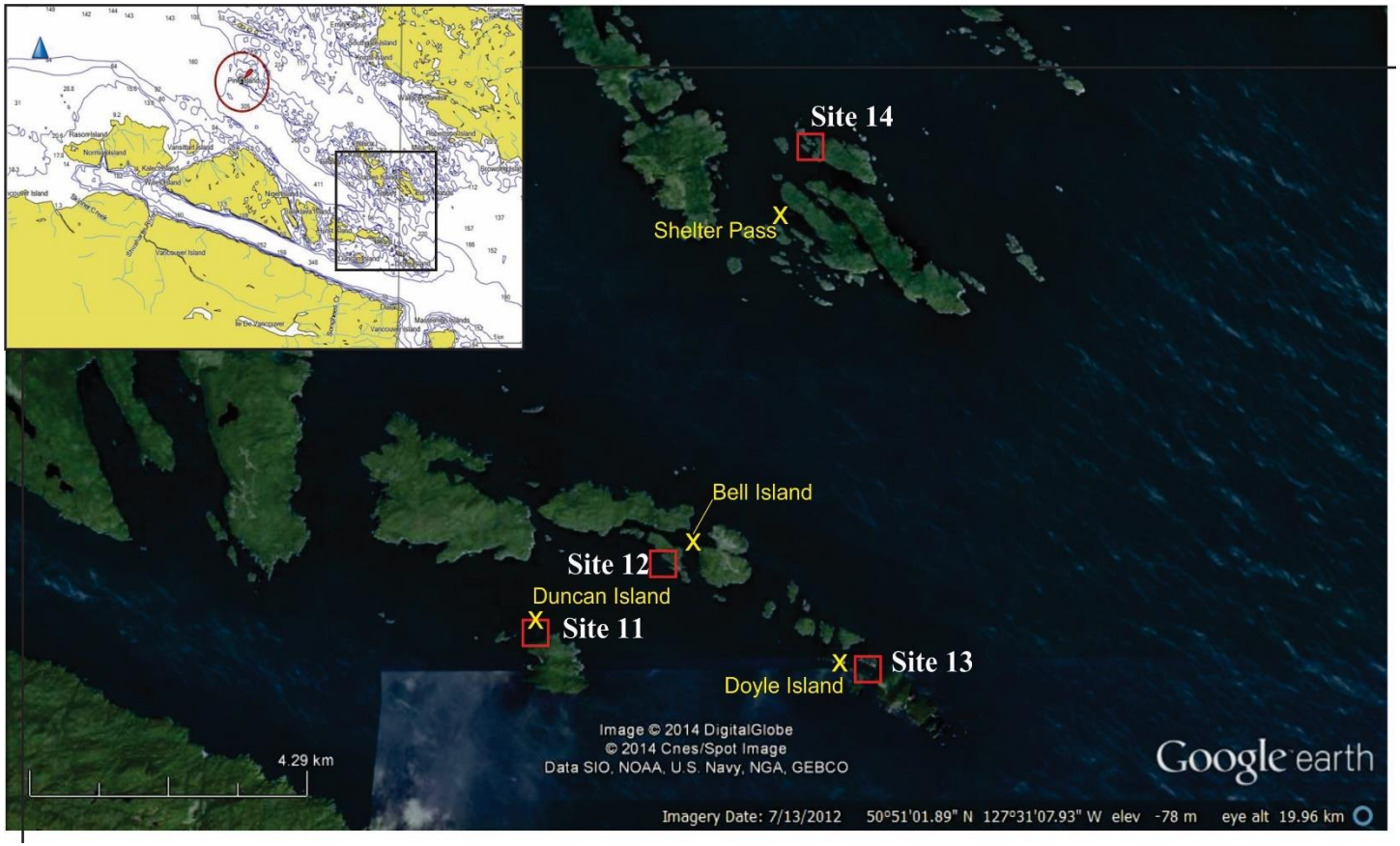

Figure 6: Location map of the sampling sites 11 to 14 located in the Gordon Group examined during the 2021 sample year in Goletas Channel, British Columbia. The yellow "X" indicates both active and inactive fish farm locations.

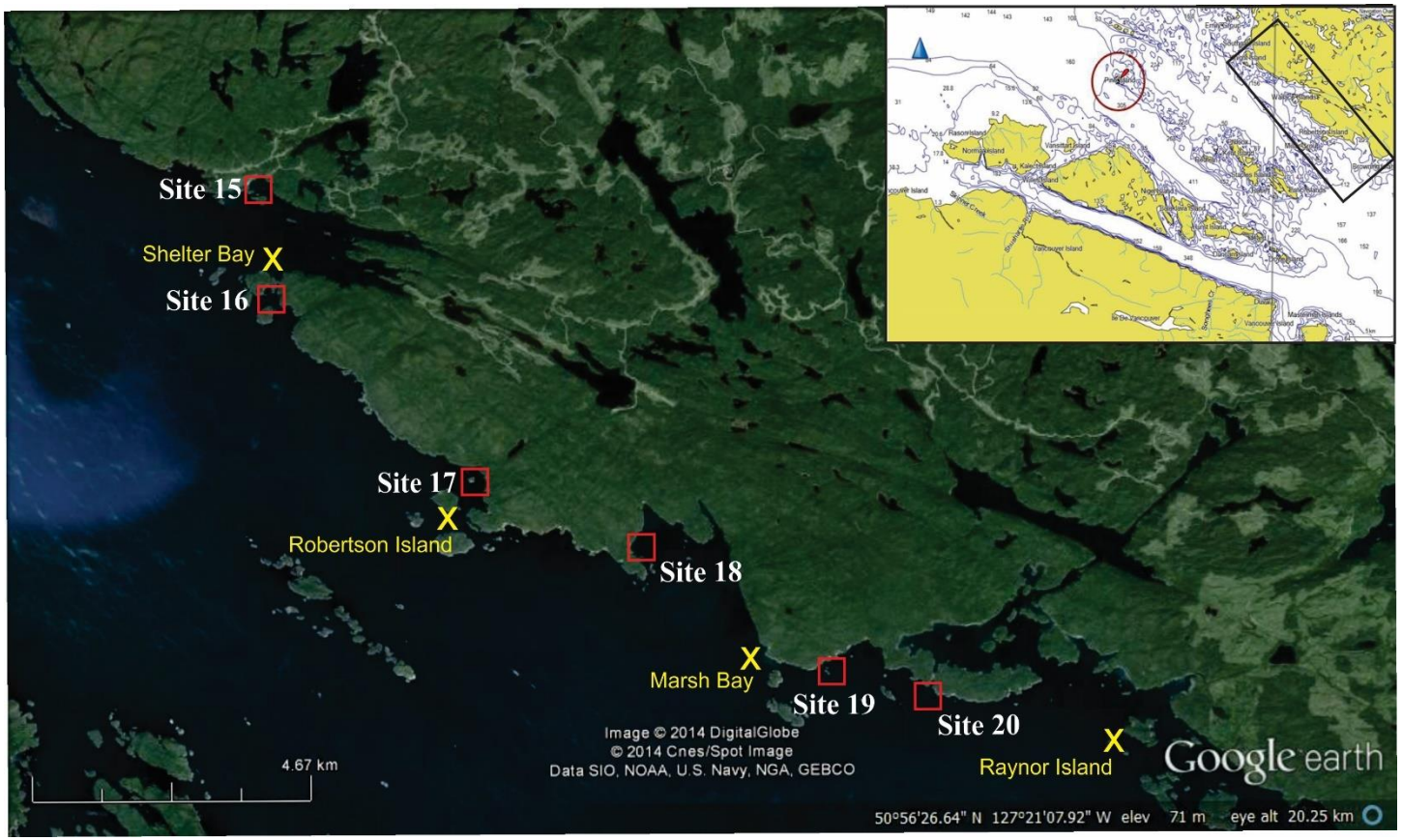

Figure 7: Location map of sampling sites 15 through 20 examined during the 2021 season. These sites are located in the Shelter Bay area of Queen Charlotte Strait, British Columbia. The yellow "X" indicates active and inactive fish farm locations.

4.0 RESULTS

Two rounds of beach seining were completed during the 2021 sample season. The first round occurred from April 12th to April 15th, 2021. The second round occurred from May 17th to May 20th, 2021. All 20 sites were sampled during the first and second rounds of the 2021 sample season.

A project total of 55 sets were completed during the 2021 season, 30 of which were successful at capturing target species. A total of 28 sets were completed during the April sampling, 16 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 seven sites; two 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 ten sites; seven 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 30 successful sets ranged from 1 to 56 of the target species and averaged 21 samples per successful set. A total of 642 samples were retained for laboratory analysis throughout the 2021 sea lice study. Of the 642 samples collected, 516 were pink salmon, 77 were chum salmon, 30 were coho salmon, one was a sockeye salmon, one was a three-spined stickleback, five were Dolly Varden, and 12 were Pacific herring. The sampling retention was highest for pink salmon (80.4%), followed by chum salmon (12%), coho salmon (4.7%), Pacific herring (1.9%), Dolly Varden (0.8%), sockeye salmon (0.2%) and Three-spined stickleback (0.2%); Tables 2 and 3 below provide a summary of the capture and collection totals for 2021.

Table 2: Distribution of fish species captured and sampled at Sites 1 through 20 during the 2021 sea lice study in Goletas Channel and Queen Charlotte Strait.

Site	Pink		Chum		Coho		Sockeye		Chinook		Dolly Varden		Herring		Stickleback		Capture Total	Sample Total
	# Captured	# Sampled	# 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	0	0	1	1
2	365	60	5	5	0	0	0	0	0	0	0	0	0	0	0	0	370	65
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	90	25	6	1	0	0	6	5	0	0	0	0	102	31
5	13	13	4	4	0	0	0	0	0	0	0	0	0	0	0	0	17	17
6	610	45	60	17	0	0	0	0	0	0	0	0	0	0	0	0	670	62
7	28	28	3	3	43	5	6	0	7	0	0	0	0	0	0	0	87	36
8	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1
9	10	10	0	0	0	0	0	0	0	0	0	0	0	0	1	1	11	11
10	56	47	1	1	0	0	0	0	3	0	4	0	0	0	0	0	64	48
11	4	4	0	0	0	0	0	0	0	0	0	0	1	1	0	0	5	5
12	520	86	303	7	0	0	0	0	0	0	0	0	0	0	0	0	823	93
13	93	73	15	3	0	0	0	0	0	0	0	0	0	0	0	0	108	76
14	110	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	110	32
15	13	13	1	1	0	0	0	0	0	0	0	0	0	0	0	0	14	14
16	201	31	40	31	0	0	0	0	3	0	0	0	0	0	0	0	244	62
17	0	0	0	0	0	0	0	0	0	0	0	0	11	11	0	0	11	11
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	95	31	1	1	0	0	0	0	0	0	0	0	0	0	0	0	96	32
20	132	42	3	3	0	0	0	0	0	0	0	0	0	0	0	0	135	45
Total	**2251**	**516**	**437**	**77**	**133**	**30**	**12**	**1**	**13**	**0**	**10**	**5**	**12**	**12**	**1**	**1**	**2869**	**642**

Table 3: Species sampled during the 2021 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	78.5	516	80.4
Chum salmon	15.2	77	12.0
Coho salmon	4.6	30	4.7
Sockeye salmon	0.4	1	0.2
Chinook Salmon	0.5	0	0.0
Dolly Varden	0.3	5	0.8
Herring	0.4	12	1.9
Stickleback	0.0	1	0.2
All species	**100.0**	**642**	**100.0**

4.1 Juvenile Salmonid Abundance, Distribution, Growth and Timing Patterns

Throughout the 2021 sea lice study, a total of 2869 fish were captured (target species only), of which 642 were retained for sampling (Tables 2 and 3). The vast majority of the specimens retained for sampling were salmonid species, although one three-spined stickleback and 12 Pacific herring were also collected for sea lice analysis. A total of 372 samples were collected during the first round of sampling in April (58% of the project total), while 270 samples were collected during the second round of sampling conducted in May (42% of the project total). Sites 3 and 18 did not yield any specimens over the course of the sampling program.

The average length and weight of all species sampled were observed to increase throughout each month of sampling (Table 4). Pink, chum, and coho salmon were captured in both April and May of 2021, while sockeye salmon, Dolly Varden, stickleback and herring were only captured during the May sampling period.

Table 4: Average lengths and weights of species collected during the 2021 sea lice study, by sampling month collected.

Species	Weight (g)		Length (mm)	
	April	May	April	May
Pink	0.34 (n=292)	1.04 (n=224)	33.86 (n=292)	46.06 (n=224)
Chum	0.41 (n=66)	1.27 (n=11)	34.97 (n=66)	48.45 (n=11)
Coho	6.63 (n=13)	9.76 (n=17)	81.0 (n=13)	11.53 (n=17)
Sockeye	-	14.80 (n=1)	-	109.0 (n=1)
Dolly Varden	-	29.40 (n=5)	-	140.6 (n=5)
Three-Spined Stickleback	-	0.66 (n=1)	-	43.0 (n=1)
Pacific Herring	-	27.4 (n=12)	-	133.17 (n=12)

4.2 Sea Lice Infestation

Lice Species Distribution

During the month of April, a total of 11 *L. salmonis* were identified on samples originating from Sites 5, 6, 7, 12, 13, 16 and 19. In May, a total of 87 *L. salmonis* were identified on samples from Sites 2, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14 and 20. A total of 15 *C. clemensi* were identified during the April sampling at Sites 4, 5, 6, 9, 12, 13 and 16. In May, 77 *C. clemensi* were found on fish samples originating from 2, 7, 8, 10, 11, 12, 13, 14, 17 and 20.

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, 115 of 642 fish (18%) were found to be infected by sea lice. A total of 190 sea lice were on 104 pink salmon, eight chum salmon, two coho salmon, one sockeye salmon, and seven Pacific herring.

The highest prevalence, abundance and intensity of sea lice infestation was found in juvenile sockeye salmon (100%, 1.0 and 1.0 respectively), however, due to the small sample size of sockeye (n=1) this number can be disregarded. The next highest prevalence and abundance of sea lice infestation was found in juvenile pink salmon (20% and 0.3 respectively). The highest average intensity was also found in pink smolts (5.1).

Table 5: Overall prevalence/abundance/intensity of *L. salmonis* and *C. clemensi* found on target species collected during the 2021 sea lice study.

Species	Sample size (n)	Total number of lice	Total number of fish infected	Prevalence (%)	Abundance	Intensity
Pink	516	157	104	20%	0.30	1.51
Chum	77	9	8	10%	0.12	1.13
Coho	30	2	2	7%	0.07	1.00
Sockeye	1	1	1	100%	1.00	1.00
Total	624	169	115	18%	0.27	1.47

Lice Species Prevalence, Abundance and Intensity in Pink Salmon

A total of 516 pink salmon were retained for laboratory sampling (Table 6), 292 of which were caught during the month of April and 224 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**
2	30.0%	0.43	1.44	13.3%	0.23	1.75
5	30.8%	0.46	1.50	0.0%	0.00	0.00
6	20.0%	0.29	1.44	6.7%	0.07	1.00
7	17.9%	0.29	1.60	7.1%	0.07	0.25
9	0.0%	0.00	0.00	10.0%	0.30	3.00
10	2.1%	0.02	1.00	2.1%	0.02	1.00
12	7.0%	0.08	1.17	10.5%	0.10	1.00
13	9.6%	0.12	1.29	12.3%	0.12	1.00
14	15.6%	0.16	1.00	37.5%	0.50	1.33
16	3.2%	0.06	2.00	6.5%	0.06	1.00
19	3.2%	0.03	1.00	0.0%	0.00	0.00
20	23.8%	0.29	1.2	9.5%	0.19	2
Total	**13.0%**	**0.17**	**1.34**	**9.9%**	**0.13**	**1.31**

Lice Species Prevalence, Abundance and Intensity in Chum Salmon

A total 77 chum salmon samples were retained for laboratory analysis (Table 7). Of those samples, 66 were captured in April and 11 were captured in May. *L. salmonis* and *C. clemensi* on juvenile chum salmon were identified on retained individuals from both sampling months.

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**
2	0.0%	0.00	0.00	20.0%	0.20	1.00
5	0.0%	0.00	0.00	25.0%	0.25	1.00
8	100.0%	1.00	1.00	100.0%	1.00	1.00
12	14.3%	0.14	1.00	42.9%	0.43	1.00
13	33.3%	0.33	1.00	0.0%	0.00	0.00
Total	**3.9%**	**0.04**	**1.00**	**7.8%**	**0.08**	**1.00**

Lice Species Prevalence, Abundance and Intensity in Coho Salmon

A total of 30 coho salmon samples were retained for laboratory analysis (Table 8), 13 of which were captured in April and 17 were captured in May. *C. clemensi* and *L. salmonis* on juvenile coho salmon were observed in April, while no sea lice were observed on juvenile coho salmon in May.

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**
4	0.0%	0.00	0.00	4.0%	0.00	1.00
7	20.0%	0.20	1.00	0.0%	0.00	0.00
Total	**3.3%**	**0.03**	**1.00**	**3.3%**	**0.03**	**1.00**

Lice Species Prevalence, Abundance and Intensity in Sockeye Salmon

A total of 1 sockeye salmon sample was retained for laboratory analysis (Table 9), which was 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**
4	100.00%	1.00	1.00	0.00%	0.00	0.00
Total	**100.0%**	**1.00**	**1.00**	**0.0%**	**0.00**	**0.00**

Lice Species Prevalence, Abundance and Intensity in Pacific herring

A total of twelve herring were captured and retained for laboratory analysis (Table 11). All samples were retained during the May sampling period. *L. salmonis* and *C. clemensi* on juvenile herring were identified on retained individuals.

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

Pacific Herring						
Site	***L. salmonis***			***C. clemensi***		
	Prevalence	**Abundance**	**Intensity**	**Prevalence**	**Abundance**	**Intensity**
11	100.00%	3.00	3.00	100.00%	4.00	4.00
17	0.00%	0.00	0.00	63.64%	1.27	2.00
Total	**8.3%**	**0.25**	**3.00**	**66.7%**	**1.50**	**2.25**

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 C2 stage (41.1%), followed by the Co, C1, PAM, PAF and AM stages (16.7%, 16.7%, 15.6%, 7.8% and 2.2% respectively). No other stages of *L. salmonis* were found on pink salmon submitted for laboratory analysis during the 2021 study.

The most prevalent life stage of *C. clemensi* observed on pink salmon was the C1 stage (31.3%), followed by the Co, C4, C2, AM, AF, C3, PAM and PAF stages (17.9%, 16.4%, 9.0%, 9.0%, 7.5%, 6.0%, 1.5% and 1.5% respectively).

Louse Life Stage on Chum Salmon

The most prevalent life stage of *L. salmonis* observed on chum salmon was the Co stage (100%). No other life stages of *L. salmonis* were observed on chum salmon samples submitted for laboratory analysis during the 2021 sea lice study.

The most prevalent life stage of *C. clemensi* observed on chum salmon samples submitted to the laboratory was the C1(66.7%), followed by the Co and C3 stages (6.7% and 16.7% respectively). 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 Co stage (100%). 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 (100%). No other life stages of *C. clemensi* were 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 (100%). No other life stages of *L. salmonis* were observed on sockeye salmon submitted for laboratory analysis.

C. clemensi was not identified on the sockeye salmon submitted for laboratory analysis.

Louse Life Stage on Pacific herring

The most prevalent life stage of *L. salmonis* found on Pacific herring samples was C2 stage (66.7%), followed by Co stage (33.3%). No other life stages of L. salmonis were observed on herring submitted for laboratory analysis.

The most prevalent life stage of *C. clemensi* found on Pacific herring samples were C1 and C3 stages (both 22.2%), followed by C2, C4, AM, Co, PAF and AF stages (16.7%, 11.1%, 11.1%, 5.6%, 5.6% and 5.6% respectively). The PAM life stage was observed on herring submitted for laboratory analysis.

Table 12: Numbers and life stages of *L. salmonis* and *C. clemensi* sea lice collected from target fish species sampled from April 12th to May 20th, 2021.

Species	April			May			
	Pink	Chum	Coho	Pink	Chum	Sockeye	Pacific Herring
LEP Co	3	2	1	12	1		1
LEP C1	5			10			
LEP C2				37		1	2
LEP PAM				14			
LEP PAF				7			
LEP AM				2			
LEP AF							
LEP Total	**8**	**2**	**1**	**82**	**1**	**1**	**3**
Cal Co	4	1		8			1
Cal C1	8	1	1	13	3		4
Cal c2				6			3
Cal c3				4	1		4
Cal C4				11			2
CAL PAM				1			
CAL PAF				1			1
CAL AM				6			2
CAL AF				5			1
CAL Total	**12**	**2**	**1**	**55**	**4**	**0**	**18**

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 2021 sea lice study can be found in Appendix 2.

Salinity

Average salinity of surface waters decreased from April to June from 35.9ppt to 30.2ppt. During the month of April, maximum salinity (37.8ppt) was recorded at Site 1, in Bull Harbour. The lowest surface salinity (27.2ppt) was recorded on the surface of Site 4, in Shushartie Bay. During the second round of sampling, in May, the highest surface salinity (32.1ppt) was recorded at Site 3, on the south side of Hope Island, while the lowest surface salinity (17.4ppt) 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 12th to May 20th, 2021). Average surface water temperature was 8.1°C in April and 9.2°C during the second round of sampling in May. In April, the lowest recorded surface temperature (7.5°C) was encountered at Site 20, east of Marsh Bay in the Shelter Bay area. The highest surface water temperature for April (9.6°C) was encountered at Site 12, between Bell and Heard Islands. The lowest surface water temperature during May (8.3°C) was encountered at Site 20, on the south side of Robinson Island. The highest surface water temperature (10.9°C) was encountered at Site 10, on the northern shore of Vancouver Island, diresctly south of Balaklava Island.

Dissolved Oxygen

The average surface levels of dissolved oxygen decreased throughout the study period. In April, the average level of dissolved oxygen at the surface (0m) was 11.4 mg/L; during the second round of sampling in May, average dissolved oxygen was 9.7 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 (9.7mg/L), while Site 12, between Bell and Heard Islands was found to have the highest levels in April (14.7/L). In May, the lowest level of dissolved oxygen recorded in surface waters was found at Site 20 (8.2mg/L), east of Marsh Bay in the Shelter Bay area. The highest surface dissolved oxygen level in May was recorded at Site 9 (11.6mg/L), on the southern tip of Nigei Island.

Table 13: Summary of surface (0m) water quality data collected at Sites 1 through 20 during the 2021 sea lice study, including temperature (°C), salinity (ppt), and dissolved oxygen (mg/L).

Site	April			May		
	Temp (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Temp (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)
1	7.6	37.8	10.4	9.2	32.0	9.3
2	7.9	37.2	10.2	9.3	31.9	10.1
3	7.6	37.4	10.0	9.1	32.1	9.4
4	8.4	27.2	11.4	9.6	17.4	9.8
5	7.8	35.4	12.3	8.8	30.5	9.1
6	8.1	37.0	12.2	9.5	30.9	9.3
7	7.9	36.5	11.5	9.1	31.5	9.5
8	8.7	36.7	13.2	10.5	29.2	12.6
9	7.8	36.7	11.3	9.7	31.4	11.6
10	7.9	36.1	12.1	10.9	29.4	12.6
11	8.1	36.6	11.0	9.3	31.4	10.0
12	9.6	36.4	14.7	8.9	31.4	9.8
13	8.1	36.6	10.1	9.2	31.5	10.2
14	8.3	36.8	10.9	9.1	31.6	9.3
15	9.4	34.4	10.7	9.8	29.5	9.1
16	7.9	36.1	12.1	8.6	31.3	8.4
17	7.8	36.5	10.4	8.6	29.3	8.3
18	7.7	36.3	10.5	8.5	30.9	9.3
19	7.7	36.3	10.6	8.5	29.6	8.4
20	7.5	36.4	9.7	8.3	31.1	8.2
Average	**8.1**	**35.9**	**11.4**	**9.2**	**30.2**	**9.7**

5.0 DISCUSSION

5.1 Sample Numbers

Of the 2869 target species captured, a total of 642 individual fish were retained for laboratory analysis from Goletas Channel and Queen Charlotte Strait for the 2021 sea lice monitoring study. Overall, this was an increase from the previous year's sampling effort (353 fish in 2020) and is the fourth highest number of fish retained for the study since it began (870 fish in 2013; 809 fish in 2011; 682 fish in 2015).

Target species sampled during the 2021 study included pink salmon, chum salmon, coho salmon, sockeye salmon, three-spined stickleback, Dolly Varden and Pacific herring. The majority of fish caught and retained for laboratory analysis were pink salmon (516 individuals). Smaller sample numbers of chum salmon (77 individuals), coho salmon (30 individuals), sockeye salmon (1 individual), Dolly Varden (5 individuals), three-spined stickleback (1 individual) and Pacific herring (12 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; 372 samples retained) compared to May (i.e. Round 2; 270 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 2021 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 7.5 ºC to 9.6 ºC then warmed up in May to a range of 8.3 ºC to 10.9 ºC. 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 1ºC 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 2021 study period, the average salinity levels decreased by 5.7 ppt from April to May. All sites which were sampled saw a decrease in salinity during that time period. 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, 2020) or decreasing (years 2017, 2018).

Average dissolved oxygen levels for the 2021 sea lice study decreased by 1.7 mg/L between April to May. The lowest recorded level during the sampling was 8.2 mg/L at site 20 located near mainland at the furthest inside the channel in May; and the highest recorded level was 14.7 mg/L at Site 12 in April. This dissolved oxygen range falls within the normal range 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 1.6 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. Unlike all previous years, the species of sea lice *C. clemensi* was not 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 0.34 g (n=292) in April, increasing to 1.04 g (n=224) 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 2021 survey is 1.5 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. 45% 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, 10% of chum were found to be infected with sea lice at an intensity of 1.13 and coho salmon were found to have an infestation rate of 7% at 1.0 intensity.

Based on the data obtained from laboratory analysis of field samples, *L. salmonis* was more prevalent than *C. clemensi* for the Goletas Channel and Queen Charlotte Strait study area in the 2021 study year. Of the 190 sea lice found during laboratory analysis of field samples, 52% were identified as *L. salmonis* and 48% were *C. clemensi*. The 2021 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 2021 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	190	52	48
2019	406	9	91
2020	157	32	68
2021	190	52	48

A comparison of data for juvenile pink salmon from all study years is shown in Table 14. Total number of sea lice encountered in 2021 was 190 which is higher than some previous years, however, this year a higher number of fish (n=642) 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)	4%	0.04	1.1	7%	0.07	1.1
2020 (n = 204)	4%	0.04	1.1	7%	0.07	1.1
2021 (n=515)	13%	0.18	1.3	7%	0.13	1.8

Prevalence of *L. salmonis* on pink salmon in 2021 was higher than in previous years, but lower than in 2015, with lice affecting 13% of the population. *C. clemensi* were found on 7% of the pink salmon population sampled, which is 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								
	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	7.60	7.60	7.50	37.80	37.08	37.20	10.37	9.86	9.61	**1**	9.20	9.20	9.10	31.99	32.00	32.07	9.28	9.24	8.85
2	7.90	7.70	7.60	37.21	37.22	37.23	10.19	9.86	10.38	**2**	9.30	9.30	9.20	31.87	31.89	31.93	10.08	10.32	9.42
3	7.60	7.60	7.60	37.39	37.41	37.41	10.03	9.93	9.55	**3**	9.10	9.00	9.00	32.05	32.11	32.09	9.42	8.50	8.48
4	8.40	7.90	7.80	27.20	35.96	37.25	11.40	10.91	10.39	**4**	9.60	8.90	8.70	17.36	31.88	32.17	9.79	8.15	7.84
5	7.80	7.80	7.70	35.41	36.82	36.98	12.30	11.90	11.72	**5**	8.80	8.90	8.80	30.52	31.61	31.75	9.12	9.14	8.75
6	8.10	8.10	8.00	36.96	36.98	37.01	12.19	11.94	11.70	**6**	9.50	9.00	9.10	30.87	31.50	31.77	9.34	9.85	8.37
7	7.90	7.90	7.80	36.46	36.89	36.93	11.48	10.47	10.90	**7**	9.10	8.80	8.80	31.48	31.58	31.61	9.47	9.20	9.99
8	8.70	8.50	8.10	36.73	36.78	36.86	13.24	12.91	12.79	**8**	10.50	9.40	8.90	29.18	31.25	31.53	12.63	11.93	9.95
9	7.80	7.80	7.80	36.68	36.71	36.72	11.28	10.74	10.88	**9**	9.70	9.50	8.90	31.42	31.46	31.62	11.58	11.68	9.94
10	7.90	7.90	7.90	36.10	36.65	36.81	12.08	11.92	11.75	**10**	10.90	10.80	1.60	29.40	29.99	30.35	12.57	12.49	12.58
11	8.10	8.10	8.00	36.55	36.56	36.58	11.04	10.83	10.66	**11**	9.30	9.20	9.10	31.42	31.45	31.51	10.23	10.01	9.85
12	9.60	9.20	8.10	36.41	36.47	36.52	14.65	13.85	11.53	**12**	8.90	8.90	8.90	31.40	31.40	31.41	9.77	9.74	9.83
13	8.10	8.10	8.10	36.55	36.60	36.60	10.10	9.91	10.36	**13**	9.20	9.20	9.10	31.45	31.43	31.44	10.20	10.40	10.49
14	8.30	8.30	8.30	36.84	36.89	36.91	10.92	11.37	12.78	**14**	9.10	9.00	8.90	31.63	31.63	31.68	9.32	9.30	8.89
15	9.40	8.40	8.20	34.42	35.61	36.61	10.73	11.69	10.98	**15**	9.80	8.80	8.90	29.49	31.07	31.51	9.10	8.46	11.97
16	8.00	7.90	7.80	36.78	36.77	36.79	11.36	10.69	11.39	**16**	8.60	8.50	8.50	31.29	31.40	31.58	8.35	8.40	10.47
17	7.80	7.80	7.60	36.46	36.48	36.51	10.44	10.17	10.50	**17**	8.60	8.40	8.30	29.25	31.43	31.54	8.31	8.01	7.85
18	7.70	7.70	7.70	36.34	36.35	36.36	10.46	10.35	10.34	**18**	8.50	8.50	8.50	30.90	31.36	31.43	9.33	8.67	8.44
19	7.70	7.70	7.60	36.33	36.35	36.41	10.58	10.70	9.96	**19**	8.50	8.40	8.40	29.57	30.96	31.36	8.37	8.14	8.14
20	7.50	7.50	7.50	36.43	36.43	36.44	9.68	9.64	9.43	**20**	8.30	8.30	8.30	31.12	31.25	31.34	8.16	8.14	8.11

APPENDIX 3: Raw Field Data Summary

2021 Goletas Channel and Queen Charlotte Strait Beach Seine

Beach Seine Summary			Date	April 2021							Site Total # Fish
Site #	Location	Sample	Pink	Chum	Coho	Sockeye	Chinook	Dolly Varden	Herring	Stickleback	
1	50° 54.753 N	retained	1	0	0	0	0	0	0	0	1
	127° 55.837 W	captured	1	0	0	0	0	0	0	0	1
2	50° 53.833 N	retained	29	3	0	0	0	0	0	0	32
	127° 54.220 W	captured	65	3	0	0	0	0	0	0	68
3	50° 53.698 N	retained	0	0	0	0	0	0	0	0	0
	127° 51.420 W	captured	0	0	0	0	0	0	0	0	0
4	50° 51.119 N	retained	0	0	10	0	0	0	0	0	10
	127° 52.011 W	captured	0	0	10	0	0	0	0	0	10
5	50° 50.782 N	retained	7	4	0	0	0	0	0	0	11
	127° 48.839 W	captured	7	4	0	0	0	0	0	0	11
6	50° 51.667 N	retained	35	17	0	0	0	0	0	0	52
	127° 46.712 W	captured	600	60	0	0	0	0	0	0	660
7	50° 51.692 N	retained	5	1	3	0	0	0	0	0	9
	127° 45.477 W	captured	5	1	3	0	0	0	0	0	9
8	50°49.487 N	retained	0	0	0	0	0	0	0	0	0
	127° 42.564 W	captured	0	0	0	0	0	0	0	0	0
9	50° 49.980 N	retained	10	0	0	0	0	0	0	1	11
	127° 39.147 W	captured	10	0	0	0	0	0	0	1	11
10	50°48.110 N	retained	17	1	0	0	0	0	0	0	18
	127° 37.890 W	captured	17	1	0	0	0	0	0	0	18
11	50°49.095 N	retained	4	0	0	0	0	0	0	0	4
	127° 33.311 W	captured	4	0	0	0	0	0	0	0	4
12	50°49.714 N	retained	56	4	0	0	0	0	0	0	60
	127°31.560 W	captured	400	300	0	0	0	0	0	0	700
13	50°48.831 N	retained	42	3	0	0	0	0	0	0	45
	127°28.678 W	captured	45	15	0	0	0	0	0	0	60
14	50°53.580 N	retained	0	0	0	0	0	0	0	0	0
	127° 29.362 W	captured	0	0	0	0	0	0	0	0	0
15	50° 58.577 N	retained	13	1	0	0	0	0	0	0	14
	127° 27.477 W	captured	13	1	0	0	0	0	0	0	14
16	50° 57.580 N	retained	30	31	0	0	0	0	0	0	61
	127° 27.254 W	captured	200	40	0	0	3	0	0	0	243
17	50° 55.920 N	retained	0	0	0	0	0	0	0	0	0
	127° 24.324 W	captured	0	0	0	0	0	0	0	0	0
18	50° 55.221 N	retained	0	0	0	0	0	0	0	0	0
	127° 22.516 W	captured	0	0	0	0	0	0	0	0	0
19	50° 54.241 N	retained	31	1	0	0	0	0	0	0	32
	127°19.289 W	captured	95	1	0	0	0	0	0	0	96
20	50° 53.990N	retained	12	0	0	0	0	0	0	0	12
	127° 17.859 W	captured	12	0	0	0	0	0	0	0	12
TOTAL RETAINED			292	66	13	0	0	0	0	1	**372**
TOTAL CAPTURED			**1474**	**426**	**13**	**0**	**3**	**0**	**0**	**1**	**1917**

Beach Seine Summary			Date	May 2021							Site Total # Fish
Site #	Location	Sample	Pink	Chum	Coho	Sockeye	Chinook	Dolly Varden	Herring	Stickleback	
1	50° 54.753 N	retained	0	0	0	0	0	0	0	0	0
	127° 55.837 W	captured	0	0	0	0	0	0	0	0	0
2	50° 53.833 N	retained	31	2	0	0	0	0	0	0	33
	127° 54.220 W	captured	300	2	0	0	0	0	0	0	302
3	50° 53.698 N	retained	0	0	0	0	0	0	0	0	0
	127° 51.420 W	captured	0	0	0	0	0	0	0	0	0
4	50° 51.119 N	retained	0	0	15	1	0	5	0	0	21
	127° 52.011 W	captured	0	0	80	6	0	6	0	0	92
5	50° 50.782 N	retained	6	0	0	0	0	0	0	0	6
	127° 48.839 W	captured	6	0	0	0	1	0	0	0	7
6	50° 51.667 N	retained	10	0	0	0	0	0	0	0	10
	127° 46.712 W	captured	10	0	0	0	0	0	0	0	10
7	50° 51.692 N	retained	23	2	2	0	0	0	0	0	27
	127° 45.477 W	captured	23	2	40	6	7	0	0	0	78
8	50°49.487 N	retained	0	1	0	0	0	0	0	0	1
	127° 42.564 W	captured	0	1	0	0	0	0	0	0	1
9	50° 49.980 N	retained	0	0	0	0	0	0	0	0	0
	127° 39.147 W	captured	0	0	0	0	0	0	0	0	0
10	50°48.110 N	retained	30	0	0	0	0	0	0	0	30
	127° 37.890 W	captured	39	0	0	0	3	4	0	0	46
11	50°49.095 N	retained	0	0	0	0	0	0	1	0	1
	127° 33.311 W	captured	0	0	0	0	0	0	1	0	1
12	50°49.714 N	retained	30	3	0	0	0	0	0	0	33
	127°31.560 W	captured	120	3	0	0	0	0	0	0	123
13	50°48.831 N	retained	31	0	0	0	0	0	0	0	31
	127°28.678 W	captured	48	0	0	0	0	0	0	0	48
14	50°53.580 N	retained	32	0	0	0	0	0	0	0	32
	127° 29.362 W	captured	110	0	0	0	0	0	0	0	110
15	50° 58.577 N	retained	0	0	0	0	0	0	0	0	0
	127° 27.477 W	captured	0	0	0	0	0	0	0	0	0
16	50° 57.580 N	retained	1	0	0	0	0	0	0	0	1
	127° 27.254 W	captured	1	0	0	0	0	0	0	0	1
17	50° 55.920 N	retained	0	0	0	0	0	0	11	0	11
	127° 24.324 W	captured	0	0	0	0	0	0	11	0	11
18	50° 55.221 N	retained	0	0	0	0	0	0	0	0	0
	127° 22.516 W	captured	0	0	0	0	0	0	0	0	0
19	50° 54.241 N	retained	0	0	0	0	0	0	0	0	0
	127°19.289 W	captured	0	0	0	0	0	0	0	0	0
20	50° 53.990N	retained	30	3	0	0	0	0	0	0	33
	127° 17.859 W	captured	120	3	0	0	0	0	0	0	123
TOTAL RETAINED			224	11	17	1	0	5	12		**270**
TOTAL CAPTURED			**777**	**11**	**120**	**12**	**11**	**10**	**12**		**953**