Prevalence of Sea Lice
(*Lepeophtheirus salmonis* and *Caligus clemensi*)
on Juvenile Salmonids Captured in Quatsino Sound, BC 2015

Prepared for

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Summary

Beach seine sampling was conducted on behalf of Marine Harvest Canada in Quatsino Sound, BC in 2015. Sampling was completed to monitor sea lice abundance, prevalence and intensity on juvenile wild salmon within Quatsino Sound and Holberg Inlet in support of the Aquaculture Stewardship Certification process for Marine Harvest Canada finfish aquaculture sites in the area.

Sampling was conducted during two separate sampling events in April and May 2015, selected to coincide with the peak outmigration period of juvenile salmonids. Sampling was completed at 10 sites within Quatsino Sound and Holberg Inlet, BC. The sites were selected based on their locations relative to existing aquaculture sites located in the area.

Thirty individuals from each fish species (all salmonids or sticklebacks) or the total number of captured individuals from a species (if less than 30 were captured) were collected at each of the 10 sites during the sampling events. Water quality measurements including dissolved oxygen, temperature and salinity were recorded at each site during each sampling event.

Collected sample fish were frozen and delivered to the Center for Aquatic Health Sciences for laboratory analysis. Sea lice observed on the individual fish specimens during laboratory analysis were identified as either *Lepeophtheirus spp.* or *Caligus spp*. The lice were recorded by life stage and the sex of pre-adult or adult motile lice was determined. Sea lice infection data was tabulated by CAHS and provided to Mainstream Biological Consulting for reporting.

A total of 177 juvenile chum salmon (*Oncorhynchus keta*), 21 juvenile coho salmon (*O. kisutch*), 12 chinook salmon (*O. tshawytscha*), one pink salmon (*O. gorbuscha*) and seven threespine stickleback (*Gasterosteus aculeatus*) underwent analysis for sea lice infection. No sockeye salmon (O. *nerka*) were analyzed for sea lice infection.

A total of 37 chum smolts, 7 coho, two chinook and four threespine stickleback were found to be infected with sea lice, resulting in an abundance of 0.45 sea lice per fish for the 218 samples inspected. No sea lice were observed on the one pink salmon that was

analyzed in the lab. The overall infection rate of juvenile salmonids and stickleback was 22.9% and the infection rates by species were as follows:

- Chum salmon – 20.9%
- Coho salmon – 33.3%
- Chinook salmon – 16.7
- Pin salmon – 0%
- Threespine stickleback – 57.1%

A total of 42 *Lepeophtheirus spp.* lice of various life stages were identified on 25 fish and 57 *Caligus spp.* lice were identified on 34 fish. There were nine chinook salmon that were infected by both species of lice.

This report represents the first year of beach seining and sea lice analysis conducted in Quatsino Sound and Holberg Inlet. This report is limited to the summary of collected data.

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1.0 Introduction

At the request of Marine Harvest Canada, beach seine sampling to capture fish for inspection for sea lice infection took place at 10 sites located in Quatsino Sound, BC (Figure 1). The sample collection occurred during sample events on April 14, 2015 and May 12, 2015. These weeks were selected to coincide with the estimated peak outmigration dates of juvenile salmonids.

Parasitic copepods from the family Caligidae (sea lice) found in the coastal waters of British Columbia are divided into two genus (*Lepeophtheirus spp.* and *Caligus spp.*). Eleven species of *Lepeophtheirus* have been identified infecting fish in the Pacific Ocean, while only one species of *Caligus* (*Caligus clemensi*) have been identified (Margolis and Arthur 1979; McDonald and Margolis, 1995). Both of these genuses have similar life histories and developmental stages (Kabata, 1972; Johnson and Albright, 1991a). The sea lice hatch from eggs and develop through two free-swimming naupilii stages before developing into an infectious free-swimming copepodid. At this point, the sea lice attach to their host and develop through four chalimus stages. The chalimus are "non-motile" and are attached to their host by a frontal filament. The final chalimus stage terminates as the sea lice become "motile" and are no longer attached to their hosts by the frontal filament. The sea lice can now move freely on the fish as they develop through a pre-adult stage before becoming reproductively viable adults.

Interest in sea lice and their interaction with juvenile salmonids in near shore environments has been the ongoing focus of both media reports and scientific study in coastal British Columbia. This interest followed claims, made in 2001 and 2002, of high levels of sea lice infections on salmonids in the Broughton Archipelago (Morton *et al*., 2004). Morton *et al.* (2004) concluded that sea lice abundance on juvenile pink (*Oncorhynchus gorbuscha*) and chum (*O. keta*) salmon were higher at sample sites located near salmon farms. These results lead to the speculation by Morton *et al*. (2004) and others that sea lice infections may be negatively contributing to the survival of juvenile salmonids in the Broughton Archipelago.

Marine Harvest Canada requested monitoring of sea lice abundance, prevalence and intensity on juvenile wild salmon within Quatsino Sound and Holberg Inlet in support of the Aquaculture Stewardship Certification process for their aquaculture sites within the area.

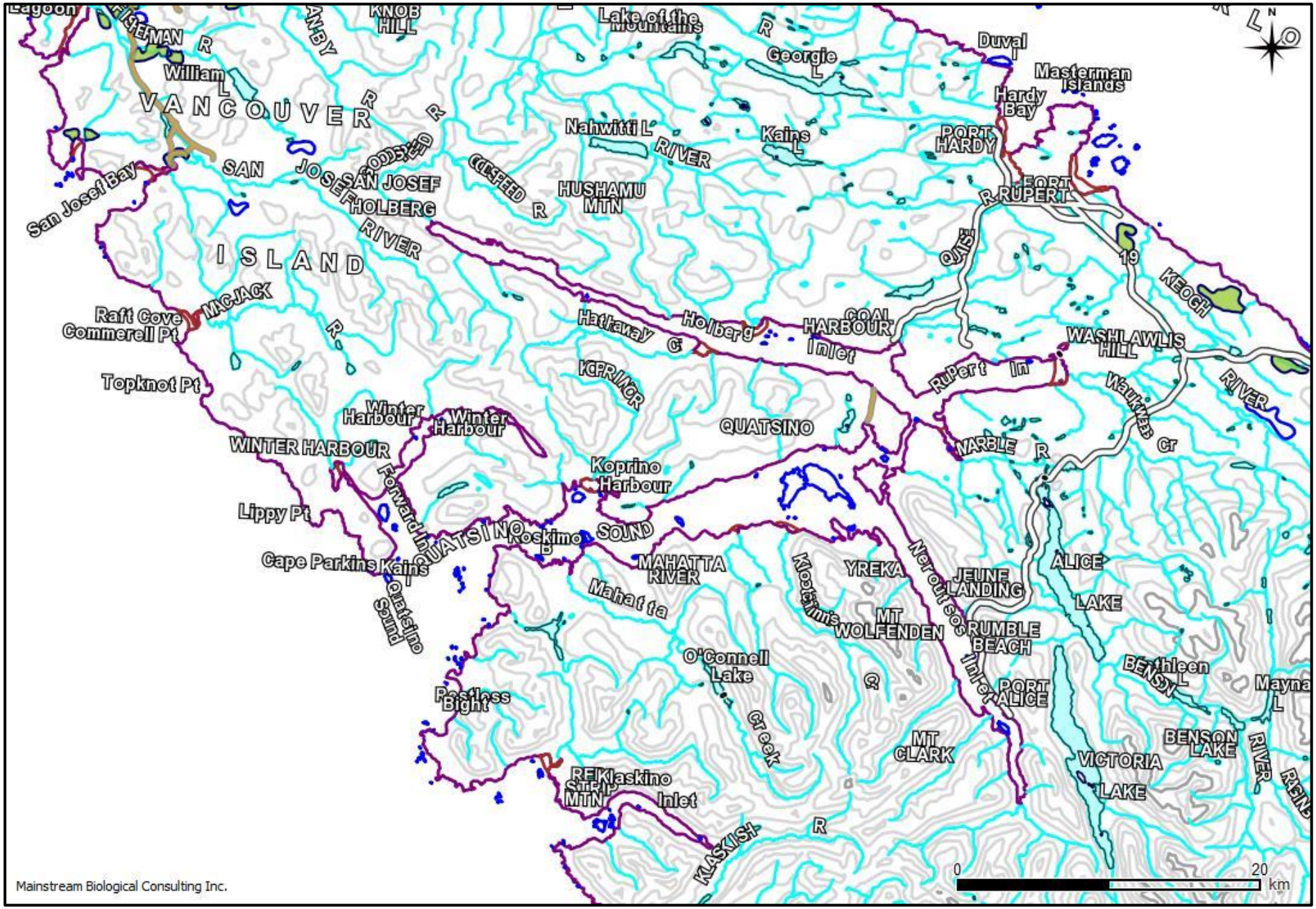

Figure 1: An overview map showing the location of Quatsino Sound and Holberg Inlet on the west coast of northern Vancouver Island, BC.

2.0 Methods

The fish inspected for sea lice infection were collected from 10 sites in Quatsino Sound and Holberg Inlet, BC. These sites were chosen based on their locations relative to existing Marine Harvest Canada aquaculture sites in the area. The sites were sampled twice in 2015 (April 14 and May 12, 2015).

2.1 Site Locations

The 10 sites at which beach seining was conducted to collect specimens for sea lice analysis consisted of seven sites within Quatsino Sound and three sites in Holberg Inlet (Figure 2). The approximate locations of the 10 beach seine sites are shown in Figure 2. GPS coordinates collected in the field for the sites are presented in Table 1.

Table 1: The site number and location of the 10 beach seine sites where fish were collected for sea lice analysis in Quatsino Sound and Holberg Inlet in 2015.

Site #	UTM Coordinates (NAD 83)		
	UTM Zone	Easting	Northing
1	9	594113	5604358
2	9	598764	5603542
3	9	599381	5603384
4	9	587297	5593031
5	9	585851	5591387
6	9	581818	5591805
7	9	580210	5590249
8	9	578392	5590120
9	9	578608	5592552
10	9	579737	5594278

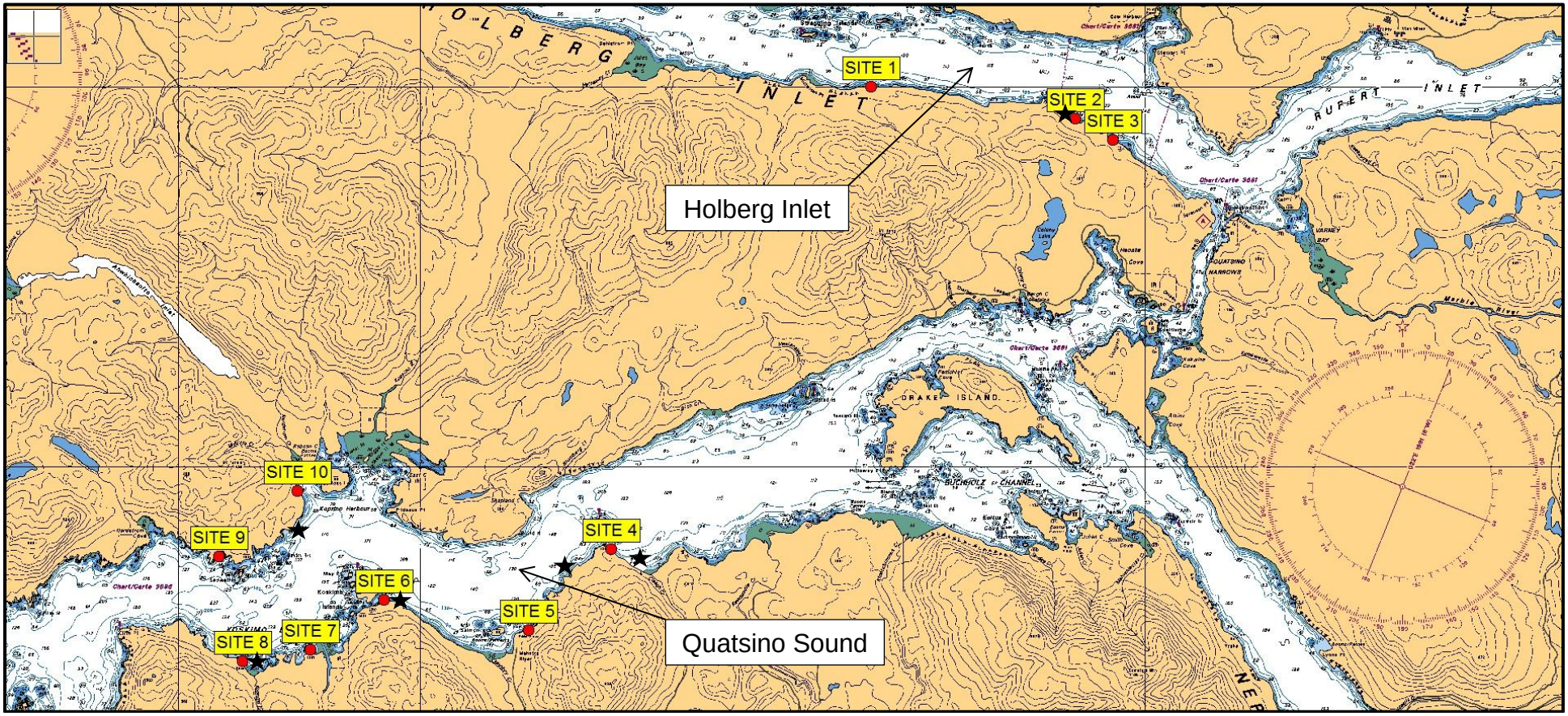

Figure 2: The locations of the 10 beach seine sites in Quatsino Sound and Holberg Inlet sampled in 2015. Marine Harvest Canada aquaculture site locations are indicated with a black star.

2.2 Field Procedures

Procedures for beach seining, fish collection and field data recording were used coast wide for juvenile salmon sampling by Mainstream Biological Consulting staff since 2004 were used during sampling in Quatsino Sound and Holberg Inlet in 2015.

An 18ft Boston Whaler, powered by a 50 horsepower outboard motor, was used to access the beach seine sites. A 150 ft (45.7 m) long by 12 ft (3.7 m) deep beach seine net was used to capture specimens. The net was constructed in three 50 ft (15.2 m) sections. The centre bunt section consists of one-quarter inch diameter diamond mesh, while the two side panels (wings) consist of half-inch diameter diamond mesh. Floats were located every 30 cm along the top-line and a lead line weighted the bottom of the net.

A three-person crew was utilized to conduct the beach seine sets and retrieve samples in a consistent manner at each of the ten selected sites. All beaches were approached slowly by boat and one crewmember was put ashore with the towline from one end of the beach seine net. The onshore crewmember held the towline at one side of the sample site, while the second crewmember ensured the net deployed smoothly off the bow of the boat. The third crewmember backed the boat in a wide semicircle towards the opposite side of the sample site. When the net was fully deployed, the second crewmember stepped into the shallow water with the towline or tossed it to the awaiting crewmember on shore. A slow retrieval of the net began immediately while the boat tied to the middle of the bunt by the third crewmember.

As the net was slowly retrieved, the probe of a YSI85 water meter was placed just below the water surface at the stern end of the boat, to collect dissolved oxygen, salinity and water temperature data. The YSI85 meter was calibrated weekly with de-ionized water while traveling to the sample sites.

Two crewmembers retrieved the net evenly from opposite ends ensuring that the lead line remained as close to the bottom as possible. All retrieved netting was piled on the beach above the water level. As the retrieval reached the net bunt, the lead line was retrieved at a faster rate than the floats to allow the netting of the bunt to form a bag under the captured fish. The lead line was then pulled up onto the beach above the

water level. One crewmember worked their way around the outside of the net in the shallow water to ensure the floats stayed above the surface of the water. In this manner a small, shallow bag formed from the bunt of the net held the captured fish in the water.

All crewmembers participated in the collection of individual fish to ensure that captured fish remained in the net for as short a period of time as possible. The net was manipulated, if necessary, in response to rising or falling tides in order to ensure the captured fish remained in the net and were held in sufficient water to minimize stress. The level of sufficient water was dependant on the size and numbers of captured fish, but was generally thought of as enough water to minimize fish contact with the net or with other fish.

A total of 30 individuals from each target species captured or all of the individuals from each specimen group present (if less than 30) were collected as samples for sea lice infection analysis. Individual fish were "swam" into an appropriately sized whirlpac bag. All handling of fish was kept to a minimum. Each individual fish bag was then placed in a species specific pile on the beach.

When all the required fish were collected, a total catch number for each species was recorded. The fish remaining in the net were counted out of the seine net, or an estimate of the remaining fish was made (estimates were used when it appeared that more than 500 individuals from any given species remained in the net). The total of fish remaining in the net was added to the number of retained individuals to calculate a total capture number for a given species.

A crewmember recorded all the information from the beach seine in a standardized format in a field notebook. The information recorded included the following:

- The site number (Site 1-10) and week number (Week 1 or 2);
- The date;
- The time at the end of the individual fish collection;
- Comments on weather and oceanic conditions;
- Comments regarding wildlife present near the sample site;
- Total capture and retained fish numbers for each specimen group; and
- Dissolved oxygen (ppm), water temperature (°C) and salinity (ppt) to one decimal place.

The retained fish from each site were packaged separately in re-sealable bags and labelled with the site number (Site 1-10) and the week number (Week 1 or 2). Site sample bags were placed in a portable freezer, which was plugged into the boat's battery. The specimens were transferred to a freezer immediately upon return from the field.

The beach seine net was reloaded onto the bow of the boat. Crewmembers scanned the net for obvious holes, which were repaired immediately if found. The YSI85 meter was shut off and stored, and all gear and coolers were reloaded into the boat.

The above procedures for beach seine net deployment and retrieval, as well as those described for fish collection, were repeated at all 10 sample sites. A thorough inspection of the beach seine net took place after all sites were completed. All holes regardless of size were mended at this time.

2.3 Laboratory Procedures

Collected sample fish were frozen and delivered to the Center for Aquatic Health Sciences (CAHS) for laboratory analysis. Sea lice observed on the individual fish specimens during laboratory analysis were identified as either non-motile chalimus, or motile pre-adults and adults. Lice identified as being in any of the four chalimus stages were identified as *Lepeophtheirus spp.* or *Caligus spp*. Motile lice, either pre-adults or adults, were identified as either *Lepeophtheirus spp.* or *Caligus spp.* and the sex of the louse was determined. Sea lice infection data was tabulated by CAHS and provided to Mainstream Biological Consulting for reporting.

Data provided by CAHS also included measured length (fork length for salmonids, total length for non-salmonids) in millimetres and weight (recorded to the nearest tenth of a gram). Lengths and weights were recorded with the specimen's corresponding sea lice analysis results.

2.4 Data Analysis

Beach seine fish sample composition is summarized by species and site. Collected fish species data on weight and fork length are summarized by mean and median for chum salmon as this was the only species with sufficient sample numbers to warrant analysis in 2015. Sea lice infection rates were determined by species. Prevalence, as

defined as the number of fish found to have one or more sea lice compared to the total number of fish, was determined by species. Abundance, as defined as the total number of sea lice observed compared to the total number of fish, was also determined by species.

Statistical analysis of the spatial and temporal distribution of sea lice was not conducted. Spatial and temporal analysis has been limited to the simple presentation and discussion of the number of sea lice found on fish specimens collected from each site during each of the sampling events.

3.0 Results

The following sections outline the results of beach seine collection and subsequent sea lice inspection of juvenile salmonids and three spine stickleback from Quatsino Sound and Holberg Inlet, BC, collected in 2015. The complete field data for each individual beach seine site can be found in Appendix I.

3.1 Water Quality Parameters

Surface measurements of dissolved oxygen, temperature and salinity, taken during beach seining at each of the 10 sites during the two sample periods, are presented in Table 2. The average dissolved oxygen reading on April 14, 2015 was 9.7 mg/L and 8.5 mg/L on May 12, 2015. Average surface water temperature readings increased from 9.5 °C in April to 12.1 °C in May. The average salinity measurement collected at all sites over the sample period increased from 22.3 in April to 29.5 in May.

Table 2: Water quality parameters collected at beach seine sites in Quatsino Sound and Holberg Inlet in 2015.

Site	April 14, 2015			May 12, 2015		
	DO (mg/L)	Temp. (°C)	Salinity (ppt)	DO (mg/L)	Temp. (°C)	Salinity (ppt)
1	9.7	8.7	14.0	6.9	11.6	27.5
2	10.1	8.0	13.8	6.9	11.9	28.4
3	9.5	8.4	18.1	7.4	12.5	28.0
4	9.3	9.7	26.2	8.2	11.6	30.2
5	8.8	9.6	26.5	7.5	11.2	29.8
6	9.9	10.5	27.2	7.9	12.1	30.3
7	9.4	10.1	24.3	8.1	12.3	29.9
8	9.9	10.0	20.2	9.8	12.7	30.4
9	9.5	10.0	26.5	10.3	11.9	30.4
10	10.6	10.4	26.3	11.6	13.5	29.8
Average	**9.7**	**9.5**	**22.3**	**8.5**	**12.1**	**29.5**

3.2 Fish Sample Composition

A total of 497 individuals from the target fish species (salmonids and stickleback) were captured during the beach seine sampling conducted in Quatsino Sound and Holberg Inlet, BC in 2015. Of those, 218 individual fish (43.9 %) were collected as sample specimens and underwent analysis for sea lice infection.

Fish species collection totals recorded on the field data sheets were compared to the actual number of fish that underwent analysis for sea lice infection. The comparison of the reported numbers of each species collected in the field to the lab species identification of fish that underwent analysis for sea lice infection found differences in species totals (Table 3). The discrepancies resulted in an increased number of chum salmon, with decreases in the number of coho, chinook and sockeye salmon. The numbers presented in this report are based on the fish species identification of collected samples as done in the lab by CAHS.

Table 3: Comparison of the fish species totals between field data as done by Mainstream Biological Consulting and lab species identification done by CAHS.

Species	Field Fish Species Identification (MBC)	Lab Fish Species Identification (CAHS)
Chum salmon	159	177
Coho salmon	30	21
Sockeye salmon	1	0
Chinook salmon	19	12
Pink salmon	1	1

The grand total of collected fish from each species and the percentage that it represents of the total beach seine captured population is presented in Table 4. A summary of the total number of fish captured and collected as specimens at each site over the collection period can be found in Table 5. The sample total given in Table 4 and 5 are the corrected numbers based on counts done in the lab during sea lice analysis. Weekly totals of fish captured and collected as specimens at each site over the entire collection period can be found in Appendix II.

Chum salmon (*O. keta*) smolts were captured in significantly greater numbers than any other species. A total of 440 chum salmon were captured, representing 88.5% of all captured salmonids. The majority of these captures were form Sites 1, 3 and 8. Coho

salmon were the next most commonly caught species with a total capture of 30 fish, followed by chinook salmon (19), threespine stickleback (7) and pink salmon (1).

Table 4: The grand total of collected individuals of each fish species captured in Quatsino Sound and Holberg Inlet, BC in April and May 2015, and the percentage of the total captured population that they represent.

Common Name	Total of individuals at all sites		
	Capture Totals	Collection Totals	Collection %
threespine stickleback	7	7	100
chum salmon	440	177	40.2
coho salmon	30	21	70.0
sockeye salmon	0	0	-
chinook salmon	19	12	63.2
pink salmon	1	1	100
All species	**497**	**218**	**43.9**

Table 5: The number of captured fish (Total Capture) and the corrected number of individual fish collected (Total Sample) from each of the 10 sample sites in Quatsino Sound and Holberg Inlet, BC in April and May 2015.

	Chum		**Coho**		**Pink**		**Chinook**		**TSB**		**Total Capture**	**Total Sample**
	Capture Total	Sample Total	Capture Total	Sample Total	Capture Total	Sample Total	Capture Total	Sample Total	Capture Total	Sample Total		
Site 1	237	60	20	20	0	0	2	2	**1**	1	**260**	**83**
Site 2	4	4	0	0	0	0	9	9	**3**	3	**16**	**16**
Site 3	143	60	0	0	1	1	8	8	**2**	2	**154**	**71**
Site 4	5	5	0	0	0	0	0	0	**0**	0	**5**	**5**
Site 5	0	0	0	0	0	0	0	0	**0**	0	**0**	**0**
Site 6	0	0	0	0	0	0	0	0	**1**	1	**1**	**1**
Site 7	0	0	3	3	0	0	0	0	**0**	0	**3**	**3**
Site 8	51	30	2	2	0	0	0	0	**0**	0	**54**	**33**
Site 9	0	0	5	5	0	0	0	0	**0**	0	**5**	**5**
Site 10	0	0	0	0	0	0	0	0	**0**	0	**0**	**0**
Total	**440**	**159**	**30**	**30**	**1**	**1**	**19**	**19**	**7**	7		

3.3 Fish Size

Analysis of weight and length data was completed for chum salmon only as they were the only species of fish with sufficient sample numbers to warrant this analysis. The weight of 177 chum smolts collected during the two sample events ranged from 0.31 g to 9.78 g and averaged 2.17 g (SD = 2.2). The fork length of the chum smolts ranged from 32 mm to 92 mm and averaged 52.5 mm (SD = 16.6).

3.4 Sea Lice Infection

3.4.1 Infection Rates

A total of 177 chum, 21 coho, 12 chinook salmon, one pink salmon and seven threespine stickleback (TSB) were inspected for sea lice infection (n = 218 fish). Prevalence was defined as the number of fish found to have one or more sea louse compared to the total number of fish. Abundance was defined as the total number of sea lice observed compared to the total number of fish (Table 6). Sea lice counts of both species observed (*L. salmonis and C. clemensi*) were added together for the prevalence and abundance calculations, due to the very low instance of lice.

A total of 37 chum smolts, 7 coho, two chinook and four threespine stickleback were found to be infected with sea lice, resulting in an abundance of 0.45 sea lice per fish for the 218 samples inspected. No sea lice were observed on the one pink salmon that was analyzed in the lab.

Table 6: Results of analysis for sea lice infection on salmonid smolts collected by beach seine in Quatsino Sound and Holberg Inlet, BC in 2015.

Species	Sample size (n)	Total number of lice observed	Total number of fish infected	Prevalence (%)	Abundance
chum	177	80	37	20.9	0.45
coho	21	12	7	33.3	0.57
pink	1	0	0	0.0	0.0
chinook	12	2	2	16.7	0.17
TSB	7	5	4	57.1	0.71
Total	**218**	**99**	**50**	**22.9**	**0.45**

3.4.2 Infection Rates by Sea Lice Species

A total of 42 *Lepeophtheirus spp.* sea lice of various life stages were identified on 25 sample fish and 57 *Caligus spp.* sea lice were found on 34 sample fish (Table 7; Appendix III). There were nine chinook salmon that were infected by both species of sea lice.

Table 7: The number of lice in each life stage by species identified on sample fish from Quatsino Sound and Holberg Inlet in 2015. LEP = *Lepeophtheirus spp.* CAL = *Caligus spp.*

Life Stage[1]	Number of lice
LEP Co	2
LEP C1	3
LEP C2	11
LEP C3	16
LEP C4	7
LEP PAM	0
LEP PAF	2
LEP AM	1
LEP AF	0
TOTAL LEP	**42**
CAL Co	2
CAL C1	33
CAL C2	10
CAL C3	5
CAL C4	6
CAL PAM	0
CAL PAF	0
CAL AM	1
CAL AF	0
TOTAL CAL	**57**

[1] Lice life stage codes: Co = copepodid, C1-4 = chalimus 1-4, PAM = pre-adult male, PAF = pre-adult female, AM = adult male, AF = adult female.

3.4.3 Spatial and Temporal Analysis

Statistical analysis of temporal and spatial differences of sea lice infection was not completed. The number of sea lice found on collected samples (all species) at each of the 10 sites during each of the two sample weeks is shown in Table 8. There was an increase in the number of sea lice found from 43 in sampling week 1 (April 14, 2015) to 56 in sampling week 2 (May 12, 2015). Site 1 and Site 8 had the highest number of sea lice on collected sample fish.

Table 8: The number of sea lice found on collected samples from each of the 10 sample sites during each of the two sample weeks in Quatsino Sound and Holberg Inlet, BC in 2015. Blanks indicate sites where no fish were captured or collected for sea lice analysis during that sample week.

	Number of Lice										Weekly
Week	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**	**Site 10**	**Total**
1	2	2	1	4			0	34			43
2	28	0	9			1		5	13		56
Site Total	**30**	**2**	**10**	**4**		**1**	**0**	**39**	**13**		**99**

4.0 Conclusions and Recommendations

This report represents the first year of beach seining and sea lice analysis conducted in Quatsino Sound and Holberg Inlet. This report is limited to the summary and presentation of collected data although some possible conclusions and recommendations are presented.

A total of 37 chum smolts, 7 coho, two chinook and four threespine stickleback were found to be infected with sea lice, resulting in an abundance of 0.45 sea lice per fish for the 218 samples inspected. No sea lice were observed on the one pink salmon that was analyzed in the lab. The infection rates by species were as follows:

- Chum salmon – 20.9%
- Coho salmon – 33.3%
- Chinook salmon – 16.7
- Pin salmon – 0%
- Threespine stickleback – 57.1%

Sampling during 2015 was scheduled to coincide with the peak outmigration of juvenile salmonids although the low number of captures indicates that sampling may have been conducted too late in the season. In order to account for seasonal variation in outmigration an expanded sample period or earlier sample period is recommended.

There was an increase in the number of sea lice found from 43 in sampling week 1 to 56 in sampling week 2. Site 1 and Site 8 had the highest number of sea lice on collected sample fish. The high number of sea lice recorded at Site 1 is interesting as juvenile salmonids collected at this sample site would not yet have passed any active farm sites during their outmigration (Figure 2). This could indicate that there may be a high number of sea lice naturally occurring in this area (Holberg Inlet). Additional sampling over consecutive years is required in order to further investigate the naturally occurring background levels of juvenile salmonid sea lice infection within Holberg Inlet, BC where aquaculture sites are not currently actively operating.

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Appendix I – Field Data

Week 1

Site	Week	Date (dd/mm)	Time	DO (mg/L)	Temp. (C)	Salinity (ppt)
1	**1**	**14/04**	**10:05**	**9.7**	**8.7**	**14.0**
Weather	Calm, clear					
Comments						
Samples	**# Captured**			**# Specimens**		
chum	34			30		
chinook	2			2		
stickleback	1			1		

Site	Week	Date (dd/mm)	Time	DO (mg/L)	Temp. (C)	Salinity (ppt)
2	**1**	**14/04**	**10:30**	**10.1**	**8.0**	**13.8**
Weather	Clear, calm.					
Comments						
Samples	**# Captured**			**# Specimens**		
chinook	5			5		
stickleback	3			3		

Site	Week	Date (dd/mm)	Time	DO (mg/L)	Temp. (C)	Salinity (ppt)
3	**1**	**14/04**	**10:45**	**9.5**	**8.4**	**18.1**
Weather	Clear, calm					
Comments						
Samples	**# Captured**			**# Specimens**		
chum	51			30		
Chinook	1			1		
Pink	1			1		
Stickleback	1			1		

Site	Week	Date (dd/mm)	Time	DO (mg/L)	Temp. (C)	Salinity (ppt)
4	**1**	**14/04**	**11:35**	**9.3**	**9.7**	**26.2**
Weather	Clear, calm.					
Comments						
Samples	**# Captured**			**# Specimens**		
chum	5			5		

Site	Week	Date (dd/mm)	Time	DO (mg/L)	Temp. (C)	Salinity (ppt)
5	**1**	**14/04**	**11:50**	**8.8**	**9.6**	**26.5**
Weather	Clear, calm.					
Comments	No target species captured.					

Site	Week	Date (dd/mm)	Time	DO (mg/L)	Temp. (C)	Salinity (ppt)
6	**1**	**14/04**	**12:10**	**9.9**	**10.5**	**27.2**
Weather	Windy – 10 knots NW					
Comments	No target species captured.					

Site	Week	Date (dd/mm)	Time	DO (mg/L)	Temp. (C)	Salinity (ppt)
7	**1**	**14/04**	**12:25**	**9.4**	**10.1**	**24.3**
Weather	Windy – 10 knots NW					
Comments						
Samples	**# Captured**			**# Specimens**		
Coho	3			3		

Site	Week	Date (dd/mm)	Time	DO (mg/L)	Temp. (C)	Salinity (ppt)
8	**1**	**14/04**	**12:45**	**9.9**	**10.0**	**20.2**
Weather	Pouring rain, windy					
Comments						
Samples	**# Captured**			**# Specimens**		
chum	51			30		
Sockeye	1			1		

Site	Week	Date (dd/mm)	Time	DO (mg/L)	Temp. (C)	Salinity (ppt)
9	**1**	**14/04**	**13:15**	**9.5**	**10.0**	**26.5**
Weather	Pouring rain, ground swell.					
Comments	No target species captured.					

Site	Week	Date (dd/mm)	Time	DO (mg/L)	Temp. (C)	Salinity (ppt)
10	**1**	**14/04**	**13:30**	**10.6**	**10.4**	**26.3**
Weather	Calm, cloudy.					
Comments	No target species captured. Poor set location.					

Week 2

Site	Week	Date (dd/mm)	Time	DO (mg/L)	Temp. (C)	Salinity (ppt)
1	**2**	**12/05**	**09:26**	**6.9**	**11.6**	**27.5**
Weather	Clear, calm.					
Comments	Fish observed jumping off shore.					
Samples	**# Captured**			**# Specimens**		
chum	203			30		
Coho	20			20		

Site	Week	Date (dd/mm)	Time	DO (mg/L)	Temp. (C)	Salinity (ppt)
2	**2**	**12/05**	**10:02**	**6.9**	**11.9**	**28.4**
Weather	Clear and calm.					
Comments	Lots of fish observed well off shore.					
Samples	**# Captured**			**# Specimens**		
chum	4			4		
Chinook	4			4		

Site	Week	Date (dd/mm)	Time	DO (mg/L)	Temp. (C)	Salinity (ppt)
3	**2**	**12/05**	**10:18**	**7.4**	**12.5**	**28.0**
Weather	Clear and calm.					
Comments	Set on small school of fish.					
Samples	**# Captured**			**# Specimens**		
chum	92			30		
Chinook	7			7		
Stickleback	1			1		

Site	Week	Date (dd/mm)	Time	DO (mg/L)	Temp. (C)	Salinity (ppt)
4	**2**	**12/05**	**11:10**	**8.2**	**11.6**	**30.2**
Weather	Clear and calm.					
Comments	Strong tidal current at site. No target species captured.					

Site	Week	Date (dd/mm)	Time	DO (mg/L)	Temp. (C)	Salinity (ppt)
5	**2**	**12/05**	**11:25**	**7.5**	**11.2**	**29.8**
Weather	Clear and calm.					
Comments	No target species captured.					

Site	Week	Date (dd/mm)	Time	DO (mg/L)	Temp. (C)	Salinity (ppt)
6	**2**	**12/05**	**11:45**	**7.9**	**12.1**	**30.3**
Weather	Clear and calm.					
Comments	Saw two fish jump in area of set.					
Samples	**# Captured**			**# Specimens**		
Stickleback	1			1		

Site	Week	Date (dd/mm)	Time	DO (mg/L)	Temp. (C)	Salinity (ppt)
7	**2**	**12/05**	**12:00**	**8.1**	**12.3**	**29.9**
Weather	Clear and calm.					
Comments	Low tide. No fish seen anywhere at site. No target species captured.					

Site	Week	Date (dd/mm)	Time	DO (mg/L)	Temp. (C)	Salinity (ppt)
8	**2**	**12/05**	**12:20**	**9.8**	**12.7**	**30.4**
Weather	Clear and calm.					
Comments	Low tide. No fish observed.					
Samples	**# Captured**			**# Specimens**		
Coho	2			2		

Site	Week	Date (dd/mm)	Time	DO (mg/L)	Temp. (C)	Salinity (ppt)
9	**2**	**12/05**	**12:40**	**10.3**	**11.9**	**30.4**
Weather	Clear and calm.					
Comments	Set done in small bay just north of site. Some fish observed in the bay.					
Samples	**# Captured**			**# Specimens**		
Coho	5			5		

Site	Week	Date (dd/mm)	Time	DO (mg/L)	Temp. (C)	Salinity (ppt)
10	**2**	**12/05**	**13:00**	**11.6**	**13.5**	**29.8**
Weather	Clear, light breeze.					
Comments	Set done further into bay. No fish observed. No target species captured.					

Appendix II – Weekly Capture and Collection Sample Totals

Capture totals by week and sample site. Collection totals are equal to capture totals if the capture total was less than 30. If the capture total was greater than 30, collection totals are assumed to be 30 unless a different collection total is given in parenthesis.

Site 1

Sample Date (mm/dd)		4/14	5/12	Catch Totals	Sample Totals
Sample Week		1	2		
Scientific Name	**Common Name**				
Gasterosteus aculeatus	threespine stickleback	1		**1**	**1**
Oncorhynchus keta	chum salmon	34	203	**237**	**60**
Oncorhynchus kisutch	coho salmon		20	**20**	**20**
Oncorhynchus nerka	sockeye salmon				
Oncorhynchus tshawytscha	chinook salmon	2		**2**	**2**
Oncorhynchus gorbuscha	pink salmon				

Site 2

Sample Date (mm/dd)		4/14	5/12	Catch Totals	Sample Totals
Sample Week		1	2		
Scientific Name	**Common Name**				
Gasterosteus aculeatus	threespine stickleback	3		**3**	**3**
Oncorhynchus keta	chum salmon		4	**4**	**4**
Oncorhynchus kisutch	coho salmon				
Oncorhynchus nerka	sockeye salmon				
Oncorhynchus tshawytscha	chinook salmon	5	4	**9**	**9**
Oncorhynchus gorbuscha	pink salmon				

Site 3

Sample Date (mm/dd)		4/14	5/12	Catch Totals	Sample Totals
Sample Week		1	2		
Scientific Name	**Common Name**				
Gasterosteus aculeatus	threespine stickleback	1	1	**2**	**2**
Oncorhynchus keta	chum salmon	51	92	**143**	**60**
Oncorhynchus kisutch	coho salmon				
Oncorhynchus nerka	sockeye salmon				
Oncorhynchus tshawytscha	chinook salmon	1	7	**8**	**8**
Oncorhynchus gorbuscha	pink salmon	1	1	**1**	**1**

Site 4

Sample Date (mm/dd)		4/14	5/12	Catch Totals	Sample Totals
Sample Week		1	2		
Scientific Name	**Common Name**				
Gasterosteus aculeatus	threespine stickleback				
Oncorhynchus keta	chum salmon	5		**5**	**5**
Oncorhynchus kisutch	coho salmon				
Oncorhynchus nerka	sockeye salmon				
Oncorhynchus tshawytscha	chinook salmon				
Oncorhynchus gorbuscha	pink salmon				

Site 5

Sample Date (mm/dd)		4/14	5/12	Catch Totals	Sample Totals
Sample Week		1	2		
Scientific Name	**Common Name**				
Gasterosteus aculeatus	threespine stickleback				
Oncorhynchus keta	chum salmon				
Oncorhynchus kisutch	coho salmon				
Oncorhynchus nerka	sockeye salmon				
Oncorhynchus tshawytscha	chinook salmon				
Oncorhynchus gorbuscha	pink salmon				

Site 6

Sample Date (mm/dd)		4/14	5/12	Catch Totals	Sample Totals
Sample Week		1	2		
Scientific Name	**Common Name**				
Gasterosteus aculeatus	threespine stickleback		1	**1**	**1**
Oncorhynchus keta	chum salmon				
Oncorhynchus kisutch	coho salmon				
Oncorhynchus nerka	sockeye salmon				
Oncorhynchus tshawytscha	chinook salmon				
Oncorhynchus gorbuscha	pink salmon				

Site 7

Sample Date (mm/dd)		4/14	5/12	Catch Totals	Sample Totals
Sample Week		1	2		
Scientific Name	**Common Name**				
Gasterosteus aculeatus	threespine stickleback				
Oncorhynchus keta	chum salmon				
Oncorhynchus kisutch	coho salmon	3		**3**	**3**
Oncorhynchus nerka	sockeye salmon				
Oncorhynchus tshawytscha	chinook salmon				
Oncorhynchus gorbuscha	pink salmon				

Site 8

Sample Date (mm/dd)		4/14	5/12	Catch Totals	Sample Totals
Sample Week		1	2		
Scientific Name	**Common Name**				
Gasterosteus aculeatus	threespine stickleback				
Oncorhynchus keta	chum salmon	51		**51**	**30**
Oncorhynchus kisutch	coho salmon		2	**2**	**2**
Oncorhynchus nerka	sockeye salmon	1		**1**	**1**
Oncorhynchus tshawytscha	chinook salmon				
Oncorhynchus gorbuscha	pink salmon				

Site 9

Sample Date (mm/dd)		4/14	5/12	Catch Totals	Sample Totals
Sample Week		1	2		
Scientific Name	**Common Name**				
Gasterosteus aculeatus	threespine stickleback				
Oncorhynchus keta	chum salmon				
Oncorhynchus kisutch	coho salmon		5	**5**	**5**
Oncorhynchus nerka	sockeye salmon				
Oncorhynchus tshawytscha	chinook salmon				
Oncorhynchus gorbuscha	pink salmon				

Site 10

Sample Date (mm/dd)		4/14	5/12	Catch Totals	Sample Totals
Sample Week		1	2		
Scientific Name	**Common Name**				
Gasterosteus aculeatus	threespine stickleback				
Oncorhynchus keta	chum salmon				
Oncorhynchus kisutch	coho salmon				
Oncorhynchus nerka	sockeye salmon				
Oncorhynchus tshawytscha	chinook salmon				
Oncorhynchus gorbuscha	pink salmon				

Appendix III – Sea Lice Analysis Data

Data from sample fish infected with *Lepeophtheirus spp.* sea lice collected in Quatsino Sound and Holberg Inlet, BC, in 2015. Lice life stage codes: Co = copepodid, C1-4 = chalimus 1-4, PAM = pre-adult male, PAF = pre-adult female, AM = adult male, AF = adult female.

Date of seine	Site	Date Examined	Fish Species[1]	Fish #	Length (mm)	Weight (g)	LEP Co	LEP C1	LEP C2	LEP C3	LEP C4	LEP PAM	LEP PAF	LEP AM	LEP AF	LEP Total
14-Apr-15	8	16-Apr-15	Chum	**2**	43	0.72			1							1
14-Apr-15	8	16-Apr-15	Chum	**5**	43	0.83			1	4	2					7
14-Apr-15	8	16-Apr-15	Chum	**6**	49	1.35	1									1
14-Apr-15	8	16-Apr-15	Chum	**14**	50	1.37				2						2
14-Apr-15	8	16-Apr-15	Chum	**16**	43	0.97			2							2
14-Apr-15	8	16-Apr-15	Chum	**20**	50	1.53			1							1
14-Apr-15	8	16-Apr-15	Chum	**22**	48	1.24		1	1	3						5
14-Apr-15	8	16-Apr-15	Chum	**25**	43	0.83			1							1
14-Apr-15	8	16-Apr-15	Chum	**26**	38	0.49		1								1
14-Apr-15	8	16-Apr-15	Chum	**28**	42	1.15		1								1
14-Apr-15	8	16-Apr-15	Chum	**31**	42	0.78			1							1
14-Apr-15	4	20-Apr-15	Chum	**35**	45	0.94				1						1
14-Apr-15	4	20-Apr-15	Chum	**36**	45	0.87				1						1
14-Apr-15	3	20-Apr-15	Chum	**77**	35	0.37	1									1
12-May-15	6	19-May-15	Stb	**115**	57	2.07					1					1
12-May-15	8	19-May-15	Chum	**116**	80	5.82				2						2
12-May-15	9	19-May-15	Chum	**127**	83	6.77				1						1
12-May-15	9	19-May-15	Chum	**128**	90	8.18							1			1
12-May-15	9	19-May-15	Chum	**129**	92	9.78				1	3					4
12-May-15	3	20-May-15	Chum	**136**	55	1.85			1							1
12-May-15	3	20-May-15	Chum	**147**	72	4.25							1			1
12-May-15	3	20-May-15	Chum	**154**	66	3.36				1						1
12-May-15	3	20-May-15	Stb	**160**	63	2.33			1		1					2
12-May-15	3	20-May-15	Chin	**165**	48	1.50			1							1
12-May-15	1	21-May-15	Chum	**208**	84	7.15								1		1

[1] Stb=threespine stickleback, P=pink salmon, Co=coho salmon, chum=chum salmon, chin=chinook salmon.

Data from sample fish infected with *Caligus sp.* sea lice collected in Quatsino Sound and Holberg Inlet, BC, in 2015. Life stage codes: Co = copepodid, C1-4 = chalimus 1-4, PAM = pre-adult male, PAF = pre-adult female, AM = adult male, AF = adult female.

Date of seine	Site	Date Examined	Fish Species[2]	Fish #	Length (mm)	Weight (g)	CAL Co	CAL C1	CAL C2	CAL C3	CAL C4	CAL PAM	CAL_PAF	CAL AM	CAL AF	CAL Total
14-Apr-15	8	16-Apr-15	Chum	**5**	43	0.83		1								1
14-Apr-15	8	16-Apr-15	Chum	**6**	49	1.35		3								3
14-Apr-15	8	16-Apr-15	Chum	**9**	39	0.66		1								1
14-Apr-15	8	16-Apr-15	Chum	**16**	43	0.97		2								2
14-Apr-15	8	16-Apr-15	Chum	**27**	52	1.65		3								3
14-Apr-15	8	16-Apr-15	Chum	**28**	42	1.15		1								1
14-Apr-15	4	20-Apr-15	Chum	**36**	45	0.87		2								2
14-Apr-15	2	20-Apr-15	Stb	**47**	59	1.89		1								1
14-Apr-15	2	20-Apr-15	Stb	**48**	57	1.58		1								1
14-Apr-15	1	20-Apr-15	Chum	**101**	39	0.53	1									1
14-Apr-15	1	20-Apr-15	Chum	**112**	38	0.51	1									1
12-May-15	8	19-May-15	Chum	**116**	80	5.82					3					3
12-May-15	9	19-May-15	Chum	**127**	83	6.77			4							4
12-May-15	9	19-May-15	Chum	**128**	90	8.18			1	1						2
12-May-15	9	19-May-15	Chum	**129**	92	9.78				1						1
12-May-15	3	20-May-15	Chum	**138**	58	2.24					1					1
12-May-15	3	20-May-15	Chum	**156**	69	3.92			1							1
12-May-15	3	20-May-15	Chin	**167**	48	1.65		1								1
12-May-15	1	21-May-15	Co	**169**	90	8.95		1								1
12-May-15	1	21-May-15	Co	**170**	115	19.77		2	1							3
12-May-15	1	21-May-15	Chum	**174**	71	4.08					1					1
12-May-15	1	21-May-15	Co	**177**	92	8.80								1		1
12-May-15	1	21-May-15	Chum	**180**	79	6.10				1						1
12-May-15	1	21-May-15	Co	**181**	109	16.04			1							1
12-May-15	1	21-May-15	Co	**184**	94	9.55		1	1							2
12-May-15	1	21-May-15	Chum	**191**	76	5.52		3								3
12-May-15	1	21-May-15	Chum	**194**	79	5.90		3	1							4
12-May-15	1	21-May-15	Chum	**196**	91	8.48		2								2
12-May-15	1	21-May-15	Chum	**197**	61	2.37				1						1
12-May-15	1	21-May-15	Co	**205**	93	11.52		1								1
12-May-15	1	21-May-15	Chum	**213**	74	5.04		1								1
12-May-15	1	21-May-15	Chum	**214**	71	4.48		1								1
12-May-15	1	21-May-15	Chum	**216**	76	5.20		1								1
12-May-15	1	21-May-15	Co	**217**	100	10.65		1		1	1					3

[2] Stb=threespine stickleback, P=pink salmon, Co=coho salmon, chum=chum salmon, chin=chinook salmon.