

(Interim) Report on Sea Lice Assessment on Wild Salmon Collected in Strait of Georgia, Discovery Islands and Johnstone Strait, BC

Spring 2016 Collection

Introduction

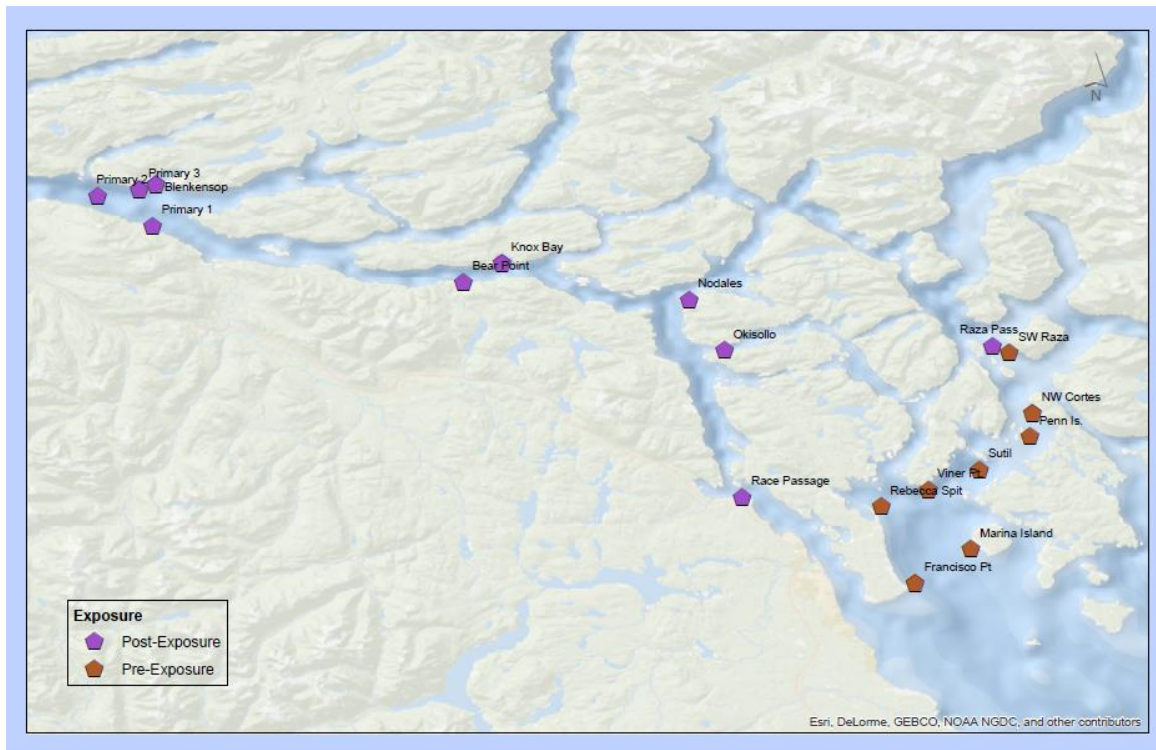
The BC Centre for Aquatic Health Sciences (BC CAHS) was contracted by Marine Harvest Canada, Cermaq Canada, Grieg Seafood BC, and Fisheries and Oceans Canada to enumerate and identify sea lice on sample fish provided. Juvenile fish were collected from 20 different sites in the Campbell River area of BC. A total of 1037 juvenile fish were received in June 2016 were collected in May-June 2016. Fish were thawed and examined for sea lice attachment or presence. Lice, if present were identified to the species level (*Lepeophtheirus salmonis* and *Caligus clemensi*) and life stage (motile stage and chalimus stag) Fish were weighed, measured for fork length and identified to species. This Interim report provides summary information from the analysis done and data submitted to date.

Methods

Fish and sea lice were assessed according to BC CAHS SOP #66 *Sea Lice Assessment on Wild Salmon Protocol*.

In 2016 the areas sampled were the north Strait of Georgia/Desolation Sound (referred to as 'Pre-Exposure' sites) and sites in the Discovery Islands and Johnstone Strait (referred to as "Post-Exposure sites).

In 2016 sampling took place, mid-May to mid-June by DFO staff on the Nordic Queen out of Campbell River, BC. A description sampling protocol will follow in the final report.



2016 DFO Sea Lice Survey Locations

Date: Friday, September 16, 2016 1:550,000
 Author: BC Centre for Aquatic Health Sciences Society
 Coordinate System: GCS WGS 1984
 Datum: WGS 1984
 Units: Degree



Figure 1. Locations of sampling stations in 2016

Figure 1 illustrates the locations of the 8 Pre-Exposure sites and 12 Post-Exposure sites. Pre-Exposure is defined as the area before fish would encounter any active fish farms and Post-Exposure is the area of fish farms and locations past fish farms as the fish travel north through Johnstone Strait from Strait of Georgia.

Results

	Site	Coho	% of total	Pink	% of total	Chum	% of total	Sockeye	% of total	chinook	% of total	Herring	% of total	Stickleback	% of total
Pre Exposure	Marina Is.	1		25		5		34		1					
	NW Cortes	2		7		1		3							
	Penn Is.	4		39		38		42		2		0		10	
	Viner Point	1		22		26		44		1					
	Sutil			4		2		23							
	Rebecca Spit	2		4		2		22						2	
	SW Raza	6		9		43		15		4				1	
	Francisco Pt	3		18		10		60		3					
	Totals		19	4%	128	24%	127	23%	243	45%	11	2%	0	0%	13
Post Exposure	Okisollo			24		6		77		1		1			
	Primary 1			8		7		41							
	Primary 2			9		2									
	Primary 3							15							
	Nodales			10		2		18							
	Race Passage			33		13		16							
	Raza Pass	3		13		16		60		5					
	Raza	2		8		9		11						2	
	Bear Point			6		1		9							
	Blenkinsop							9							
	Deepwater Bay			6		5		34							
	Knox Bay					1		14							
Totals		5	1%	117	24%	62	13%	304	61%	6	1%	1	0%	2	0%

Table 1. Sites sampled with total number of each species caught with percentage of totals for 2016.

Table 1 lists the areas and total number of fish sampled from each site in Pre and Post-Exposure areas. Of the 1037 fish received, Pink Salmon, *Oncorhynchus gorbuscha* accounted for 24% of the fish sampled in both the areas. Chum Salmon, *O. keta*, accounted for 23% of the fish sampled in the Pre-Exposure area and 13% of the fish sampled in the Post Exposure area. The largest percentage of fish examined were Sockeye salmon, *O. nerka*, with 45% in the Pre-Exposure area and 63% of the fish in the Post-Exposure area.

	Site	Coho		Pink		Chum		Sockeye		Chinook	
		Avg wt(g)	Avg. length(mm)	Avg wt(g)	Avg. length(mm)	Avg wt(g)	Avg. length(mm)	Avg wt(g)	Avg. length(mm)	Avg wt(g)	Avg. length(mm)
Pre Exposure	Francisco Pt			11.2	99.7	15.3	111	12.6	102.7		
	Marina Is.			11.2	102.2			9.7	96.1		
	NW Cortes										
	Penn Is.			12.7	104.5	14.5	110	12.1	102		
	Rebecca Spit							12.7	106.5		
	SW Raza					11.8	99.2	7.8	90.6		
	Sutil							7.1	88.1		
	Viner Point			10.9	102.2			12.4	101.6		
	Total	35.2	139.7	11.4	104.1	13.8	105.8	10.4	97.4	17.9	115.2
Post Exposure	Bear Point										
	Blenkinsop										
	Deepwater Bay			9.4	94.2			9.1	96.1		
	Knox Bay							8.8	95		
	Nodales							8.4	92.3		
	Okisollo			12	106.2			10	98		
	Primary 1							11.9	104.6		
	Primary 2										
	Primary 3							8.6	93.1		
	Race Passage			13.7	107.2	16.5	113	12.4	104		
	Raza							8.3	92		
Raza Pass			10.5	99.5	11.2	98	9.4	94.3			
	Total			11.4	101.7	12.9	103.4	9.8	97.2		

Table 2. Summary of average fork length and average weight of fish sampled in 2016 by Site. No result is calculated if n<10.

Table 2 summarizes the average weights and lengths of the fish caught in 2016 in each area. There is no difference between average weight or length of any species between the areas samples. If there were less than 10 fish as a representatives of the population, no analysis was done. As only 5 Coho were caught in the Post-Exposure area, no average weight or length was calculated.

Sea Lice infection levels

Area	N=	<i>Lepeophtheirus salmonis</i>			<i>Caligus clemensi</i>		
		Prevalence	Abundance	Average Intensity	Prevalence	Abundance	Average Intensity
Pre-Exposure	541	13%	0.2	1.4	36%	1.2	3.3
Post Exposure	496	17%	0.2	1.2	49%	1.9	3.9

Table 3. *L. salmonis* and *C. clemensi* prevalence on all the fish sampled 2016 from Pre-Exposure and Post –Exposure areas.. See Appendix A for definitions of lice levels.

L. salmonis prevalence, overall, was 13% in the Pre-Exposure sites and 17% in the Post-Exposure sites. The abundance was equal at 0.2 louse per fish and the average intensity was almost the same at 1.4 and 1.2 respectively for each area.

C. clemensi prevalence was much higher than the *L. salmonis*. The Pre-Exposure area had a prevalence of 36% and the Post –Exposure area had a prevalence of 49%. There was little difference in the Abundance and Intensity of infection of *C. clemensi* was the almost the same between the Pre and Post-Exposure areas.

Area	Site	N=	<i>Lepeophtheirus salmonis</i>			<i>Caligus clemensi</i>		
			Prevalenc	Abundanc	Average Intensity	Prevalenc	Abundanc	Average Intensity
Pre-Exposure	Francisco Pt	60	0%	0.0	0.0	38%	0.7	1.8
	Marina Is.	34	15%	0.2	1.2	53%	1.3	2.4
	NW Cortes	3						
	Penn Is.	42	17%	0.2	1.4	71%	3.5	4.9
	Rebecca Spit	22	23%	0.2	1.0	68%	1.9	2.7
	SW Raza	15	27%	0.3	1.3	60%	2.5	4.2
	Sutil	23	1%	0.0	2.0	4%	0.2	4.6
	Viner Point	44	2%	0.0	1.2	5%	0.3	5.6
	Sockeye overall	243	16%	0.2	1.3	40%	1.3	3.3
Post Exposure	Bear Point	9	0%	0.0	0.0	67%	3.6	5.3
	Blenkinsop	9	78%	0.8	3.5	100%	4.2	4.2
	Deepwater Bay	34	26%	0.2	0.8	29%	0.9	3.0
	Knox Bay	14	14%	0.1	1.0	100%	4.9	4.9
	Nodales	18	28%	0.3	1.0	89%	1.9	2.1
	Okisollo	89	19%	0.0	0.2	56%	2.7	4.9
	Primary 1	41	39%	0.1	0.2	100%	4.3	4.3
	Primary 2	0						
	Primary 3	15	20%	0.3	1.3	100%	4.5	4.5
	Race Passage	16	6%	0.1	1.0	50%	1.3	2.6
	Raza	11	27%	0.3	1.0	64%	1.4	2.1
	Raza Pass	60	27%	0.3	1.3	68%	2.9	4.3
	Sockeye overall	316	23%	0.2	0.7	69%	2.8	4.1

Table 4. Prevalence of *L. salmonis* and *C. clemensi* on Sockeye Salmon in the Pre-Exposure and Post- Exposure areas by site.

Table 4 summarizes all the prevalence of both species of sea lice on Sockeye salmon from each of the sample locations. Infection levels on juvenile Sockeye Salmon *L. salmonis* and *Caligus clemensi* were used as these fish were the largest component of the sample sizes and allowed for best comparison of results between areas.

Overall, the prevalence of *L.salmonis* on Sockeye salmon was 16% in the Pre-Exposure area and 23% in the Post Exposure area. *Caligus* levels are higher than *L. salmonis* levels for all sites with an overall prevalence of 40% in the Pre-Exposure area and 69% in the Post –Exposure area.

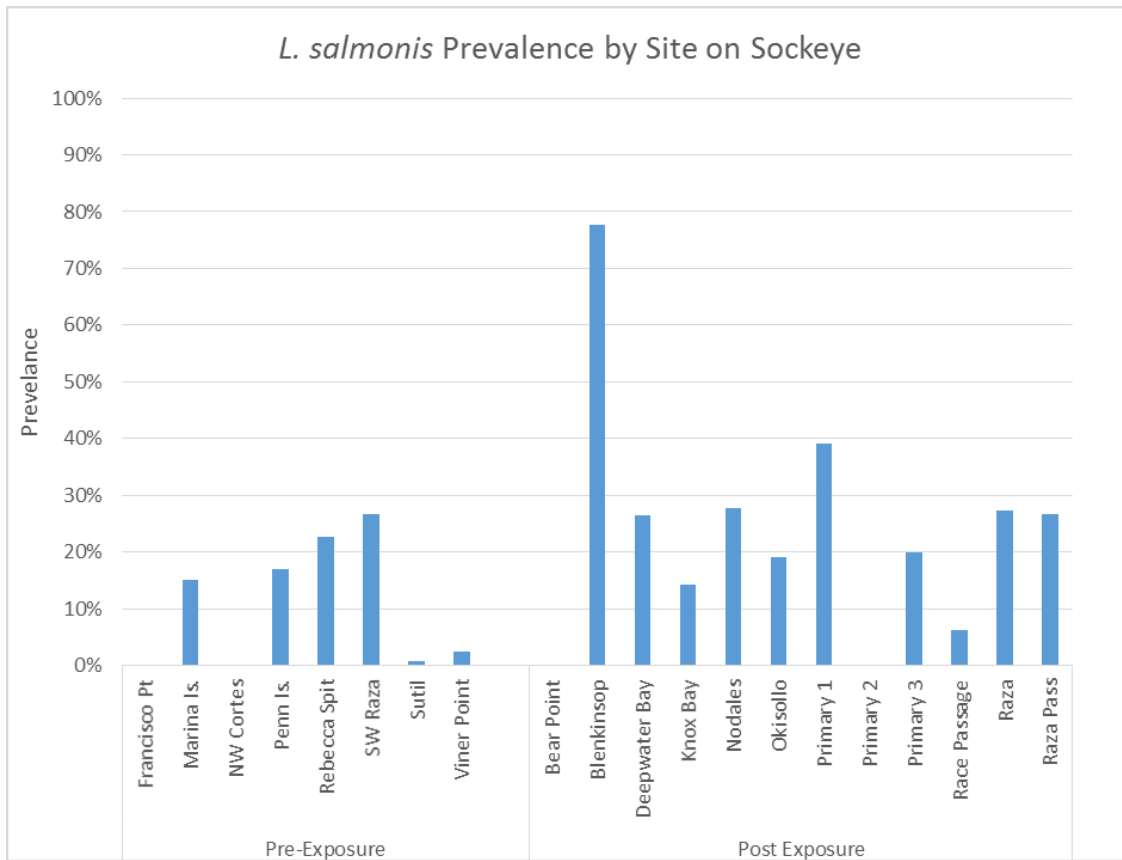


Figure 2. *Lepeophtherius salmonis* prevalence by site.

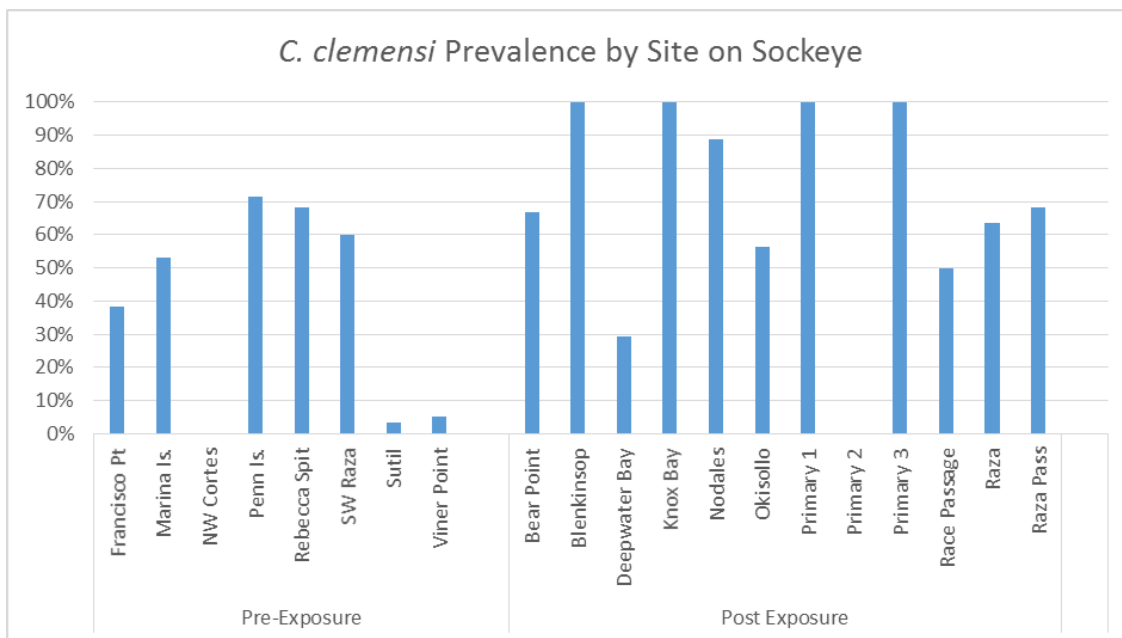


Figure 3. *Caligus clemensi* prevalence by site.

Figures 2 and 3 show the prevalence of *L. salmonis* and *C. clemensi* for each of the sites sampled in Pre-Exposure area and Post-Exposure area. *L. salmonis* levels are slightly higher in the Pre-Exposure area (see Table 4 for overall prevalence by site). One site, Blenkinsop, showed a high prevalence of 73%. This site had a very small sample size of 9 Sockeye salmon. Small sample sizes may result in skewed results.

C. clemensi prevalence is lower in the Pre-Exposure area (40%) than in the Post-Exposure area (69%).

Refer to Table 4 for more information regarding prevalence, abundance and intensity levels for each site sampled.

Sea Lice Life stage

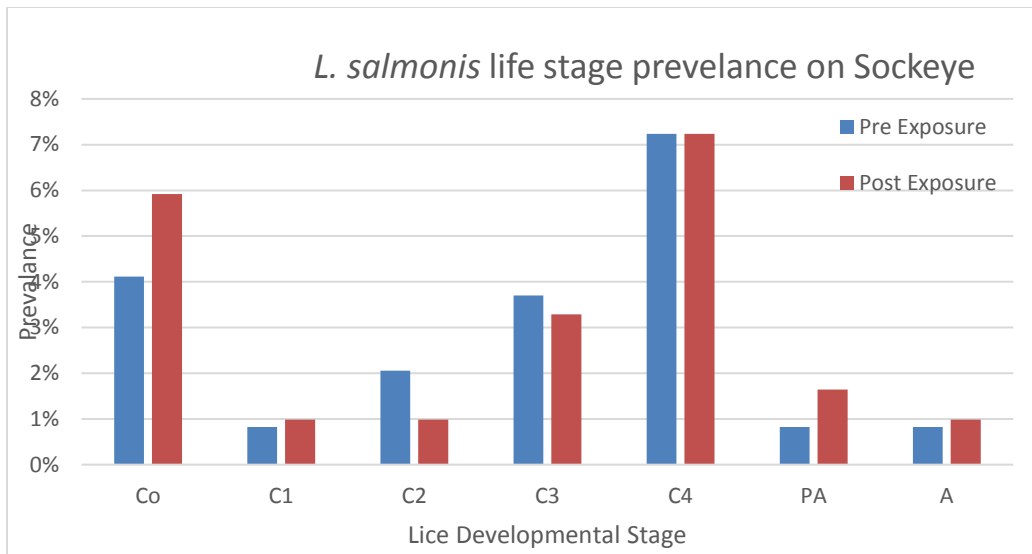


Figure 4. *L. salmonis* prevalence by life stage on all species of salmon in Pre-Exposure and Post Exposure areas.

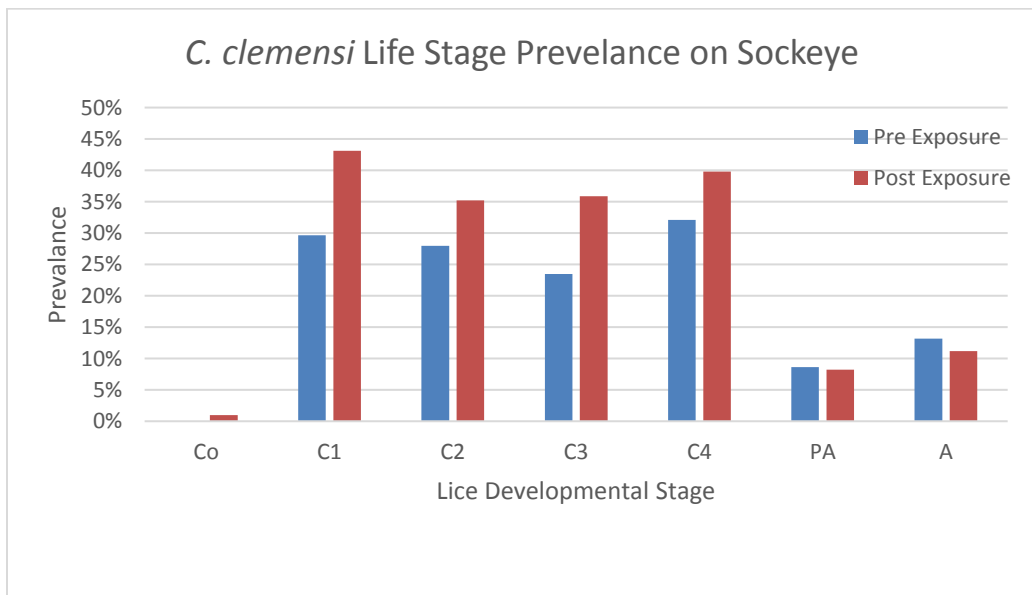


Figure 5. *C. clemensi* prevalence by life stage for Pre-Exposure and Post Exposure areas.

Figure 4 and 5 illustrate infection levels of chalimus stages and motile stages of both species of lice. Chalimus stages are attached stages (stages 1 through 4) and the motile stages are Pre-Adult (PA) and Adult (A). There is little to no

difference in the prevalence of these stages in the Pre-Exposure and Post-Exposure areas for both *L. salmonis* and *C. clemensi*.

There is no difference between the prevalence Pre and Post Exposure for either louse species. The most prevalent life stage of *L. salmonis* is the C4 stage (7% in the Pre-Exposure area and 7% in Post Exposure). The next most prevalent stage is the copepodid (C0) stage (4% Pre Exposure and 6% Post Exposure).

There is a much higher prevalence of *C. clemensi* stages than *L. salmonis* stages. All chalimus stages, with exception of the C0 stage, have an infection level of around 30%. The Pre-Adult and Adult prevalence is lower at 10% for both Pre and Post Exposure area.

Water Quality- Salinity and Temperature

Results to follow in final report

Discussion

There were a total of 1037 fish sampled in spring of 2016 from the Campbell River area. Salmonids sampled included Pinks, Chum, Coho, Sockeye, and Chinook salmon. Also sampled were stickleback and one herring. The majority of the fish caught were sockeye salmon.

Both species of louse were present with >50% of the fish being lice free. Overall, infection levels of *L. salmonis* levels on all species of fish caught in May-June 2016 in the Campbell River area was very low. Conversely, *C. clemensi* infection levels were higher on all salmon species. There would appear to be little difference in *L. salmonis* prevalence between the areas before fish farms (Pre-Exposure) and those areas around and past fish farms (Post-Exposure). *Caligus* infection levels were slightly higher Post –Exposure than Pre-Exposure and double that of the *L. salmonis* infection levels

3.

Appendix A

Definitions

Prevalence: the number of hosts infected with one or more sea lice divided by the number of hosts examined. For example: if 10 salmon were sampled and 3 of them had 2 sea lice each, then 3/10 salmon are infected for a prevalence of 30%.

Abundance: the number of sea lice divided by the total number of hosts examined. For example, using the example above if 10 salmon were sampled and three had 2 sea lice each, then 3 salmon x 2 sea lice =6 sea lice total. Abundance would then be 6/10 or 0.6.

Intensity: the number of sea lice on a single salmon. For example, using the same 10 fish we have 3 salmon infected with 2 lice. Total Lice 6 divided by infected salmon (3) gives intensity of 2 lice/fish. Intensity should be interpreted with size of fish as a factor. An Intensity of 2 on a fish <1g has a greater affect than an Intensity of 2 on a 10 g fish.