SEA LICE IN THE DISCOVERY ISLANDS

Independent Data Concludes Sea Lice Prevalence in the Discovery Islands is Unchanged, Remains Low

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WHAT YOU MIGHT BE HEARING:

“There’s been a 95% reduction in sea lice since the termination of the Discovery Islands salmon farms...”

Independently collected biological assessments demonstrate that the removal of salmon farms from the Discovery Islands region **have not changed the low levels of sea lice on out-migrating salmon in the region.**

SUMMARY

In December of 2020, a decision by the Minister of Fisheries and Oceans resulted in a policy that dictated no more farmed salmon could be stocked in the Discovery Islands region of British Columbia and that all salmon aquaculture licenses would expire in June 2022. This resulted in the effective removal of salmon farms in the Discovery Islands Region North of Campbell River. In 2021, established anti-salmon farming activists publicly claimed that sea lice levels on out-migrating juvenile wild salmon in the region, where salmon farms were in the process of being removed, have decreased by 95%. This claim has been taken up by multiple media and social media sources and used as a justification that the ministerial decision was correct. This claim is simply not true.

Since 2017, out-migrating juvenile wild salmon have been monitored annually by independent professional biological consultants in multiple salmon farming regions of British Columbia. During this time there has been no trends showing an increase in sea lice levels in wild salmon that have migrated past salmon farms in the Discovery Islands region. Sampling has continued in 2021 and this trend has not changed with the departure of salmon farms from the Discovery Islands.

Figure 1

The Discovery Islands region through which juvenile salmon migrate to the open ocean including Fraser River salmon.

In the following figures of the Discovery Islands region, orange dots indicate sampling regions. Inset graphs show the average levels of sea lice (all species and all stages) on Pink and Chum salmon. The region is divided into three subareas designated as:

- **Pre-exposure**
  Juvenile out-migrating salmon prior to when they may have had exposure to salmon farms.
- **Exposure**
  The region within the Discovery Islands where juvenile salmon would be, based on best available current information, swimming past salmon farms and potentially exposed to sea lice from farmed Atlantic Salmon.
- **Post Exposure**
  The region after which juvenile salmon have migrated past potential exposure from salmon farms.

According to activist claims, the levels were high between 2017 and 2020 but dropped dramatically in 2021. **This pattern is NOT reflected in the data as summarized in the following two figures.** A detailed analysis of these data and summaries of recent scientific research provide further information in response to these claims.

Figure 2

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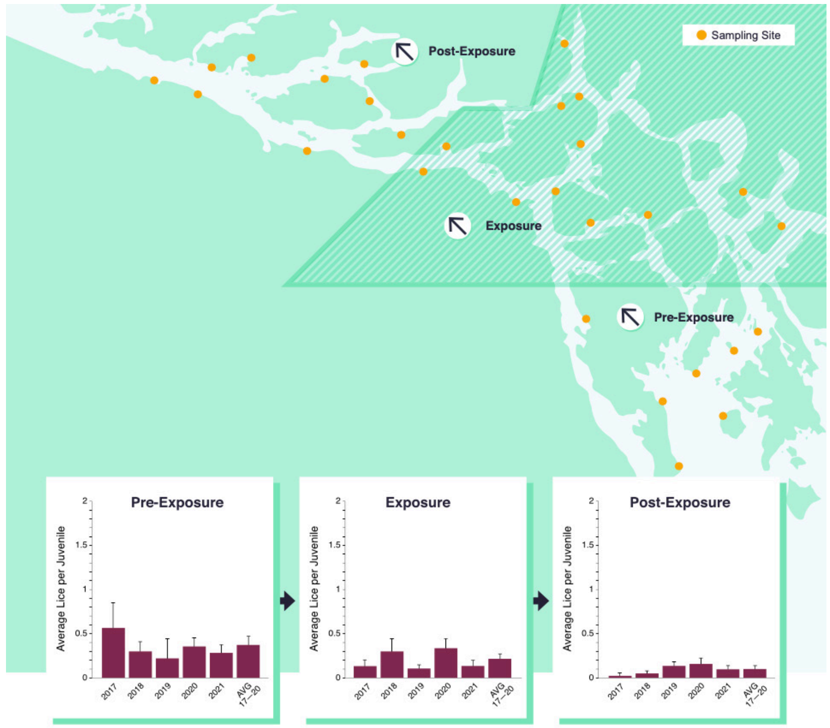
Summaries of sea lice abundance data for Pink salmon (Oncorhynchus gorbuscha) 2017–2021 by sampling subarea.



Note: Error bars = 95% Confidence Intervals, all data pooled by regions, lice counts include all stages and species of lice recorded.

Figure 3

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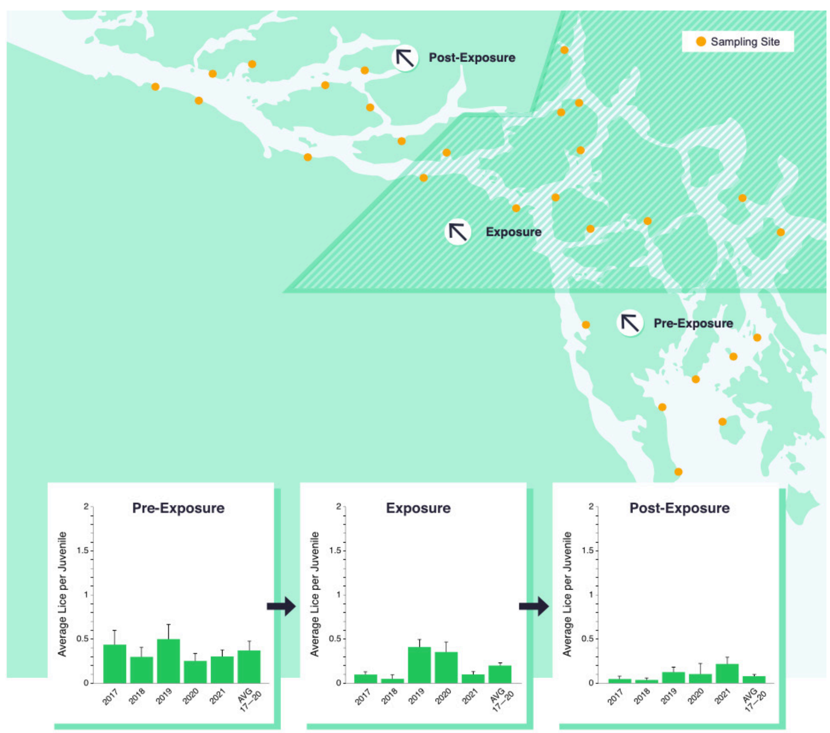
Summaries of sea lice abundance data for Chum salmon (Oncorhynchus keta) 2017–2021 by sampling subarea.



Note: Error bars = 95% Confidence Intervals, all data pooled by regions, lice counts include all stages and species of lice recorded.

DETAILED ANALYSIS

1. RECENT MEDIA CLAIMS

On May 30th 2021, anti-salmon farming activists posted the following photo and banner on Facebook showing juvenile salmon heavily infected with sea lice (left) claiming it was taken in 2020 and side by side, a photo of juvenile salmon with no sea lice (right). This image claimed that the photo of sea lice free salmon juveniles (right) was taken in 2021 and that this was the direct result of Fisheries Minister Bernadette Jordan removing salmon farms from the Discovery Islands.

Figure 4
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Sea Lice graphic
May 30

Source – Facebook May 30

The following day, Cortes Currents quoted that "sea lice numbers had plummeted 95% percent in the Discovery Islands (1).

> *"On Sunday I talked to a couple of people who monitor, they test the smolts for sea lice every year. They said they've seen a 95% reduction in sea lice. So last year each smolt that they caught had an average of 9 sea lice on them. This year, there was a total of 9 sea lice on 50 fish," was quoted in the article.*

Subsequently, this claim has been made on a number of platforms including a paid "opinion" professional video on "NowThis". There are a range of issues with these statements and this document sets out to highlight those issues by comparing these claims against independently collected and analysed scientific data and reviews.

Activist claims and the science supported data are shown in the following Table.

Table 1

Claims and Supported Facts

ACTIVIST CLAIM	OUTPUT
Sea lice levels were catastrophic in 2020 and Pink and chum salmon juveniles were "wrecked" with lice.	The levels of lice on wild salmon in the Discovery Islands have always been low.
Half of the farms were over the mandated threshold of three motiles per fish set by DFO.	Sea lice levels in 2020 were managed as per DFO requirements and below thresholds for treatment.
In 2021 after fish farms were not restocked, lice were no longer present on wild juvenile salmon.	The regular annual monitoring program showed sea lice levels have not changed after farms were not restocked.
"No farms = No lice"	Sea lice are a natural part of the salmon marine ecosystem

2. BACKGROUND — THE BIOLOGY OF SEA LICE

There are two species of sea lice that may infect salmon *Lepeophtheirus salmonis*, which is largely specific to salmon, and the more generalist louse *Caligus clemensi*. Both of these marine crustacean parasites are ectoparasitic copepods broadly called "sea lice". Sea lice have coevolved with Pacific and Atlantic salmon over millions of years (2).

Figure 5

Adult female salmon louse (*L. salmonis*) with egg strings.

Source: Trygve Poppe, Norwegian School of Veterinary Science (3)

C. clemensi is known to parasitize more than 80 species of fish and *L. salmonis*, the major species of interest, is principally confined to salmonids but is also found on three spine sticklebacks (*Gasterosteus aculeatus*), a small estuarine fish in British Columbia (4, 5).

Sea lice commonly occur on almost all adult pacific salmon in coastal British Columbia (6, 7). As salmon return from offshore, on their way to natal rivers to spawn, they carry eggs from sea lice which elevates the number of larval sea lice in coastal waters. These larval sea lice then infect juvenile Pacific salmon that have not yet migrated (8). The lifecycles of sea lice, like many parasites, is complex and many of the factors that affect sea lice population dynamics are still unknown. (9–11). For thorough reviews of sea lice biology and related science, readers are directed to the 2015 Canadian Science Advisory Secretariat report or the Jones and Beamish (eds) 2011 review of Salmon lice biology (10, 12).

3. REBUTTALS TO SPECIFIC ACTIVIST CLAIMS

3.1 Sea lice management on farms

What you might be hearing:
Salmon farms do not manage sea lice as required.

Reality:
Sea lice are managed on salmon farms and 90% of monthly averages are below the trigger threshold.

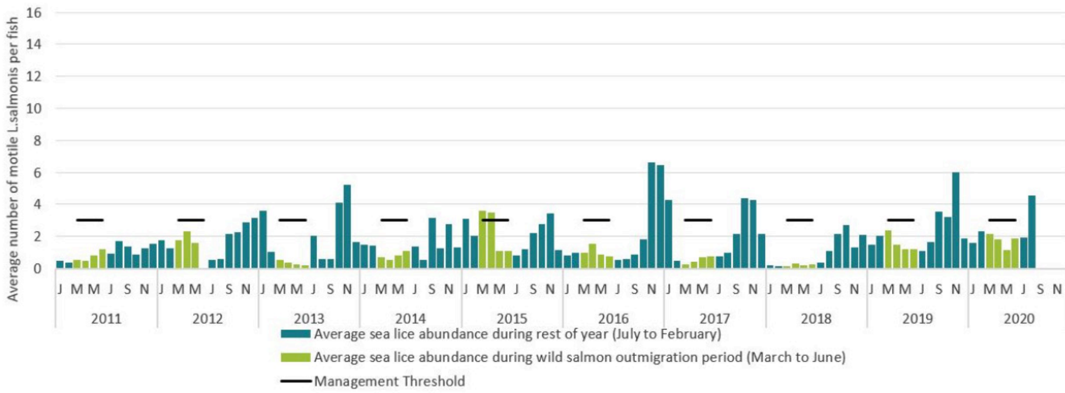
Sea lice not only infect wild salmon but also infect farmed salmon. There has been concern that farms along salmon migratory routes may act as reservoirs to increase infection on out-migrating wild salmon. Anti-salmon farming activists have advanced statements that have suggested salmon farms are solely responsible for sea lice infestations and that is simply not true.

Sea Lice on farmed salmon are managed by BC salmon farmers under veterinary supervision and are regulated and audited by Fisheries and Oceans Canada (DFO), which establishes a threshold of an average of three motile (adult) lice per farmed salmon. If the threshold is exceeded, treatment or early harvest is required. Data of sea lice levels on farms is posted to the DFO website regularly. DFO biologists and veterinarians conduct regular assessments throughout the year to verify the accuracy of licence holders' procedures and reporting.

Analysis of these data by DFO indicate that in the Discovery Islands region, sea lice levels have been below regulatory thresholds during salmon out-migrations for all but two months over the last 10 years (Figure 6). These data disproves activist statements that 50% of the farms in the Discovery Islands exceeded the three motile limit.

Figure 6

Sea lice abundance (*L. salmonis* motiles) at BC salmon farms in the Discovery Islands, 2011 — 2020.



Source: Fisheries and Oceans Canada https://www.pac.dfo-mpo.gc.ca/aquaculture/reporting-rapports/lice-ab-pou/index-eng.html

The BC salmon farmers approach to managing sea lice is referred to as integrated pest management, where a variety of environmentally friendly methods are alternated as required. These include an approved feed additive (Emamectin benzoate – trademarked Slice®) as well as bathing salmon in fresh water or fresh water with hydrogen peroxide (H_2O_2) marketed as Paramove 50 and approved by Health Canada, which breaks down into water and oxygen, or mechanical treatments that use water pressure or scrubbing brushes known as hydrolicers. Experimental vaccines are also being tested as well as the genetic potential for breeding increased resistance (13, 14).

Sea lice only inhabit the upper water column and recent advances in better understanding their biology is aiding in preventing infection (15–17). New culture systems being tested, such as semi-closed containment, are designed to keep sea lice from entering pens by drawing water from below the regions inhabited by planktonic (free swimming) larval sea lice (18, 19). The range of these technologies has been highlighted in the 2021 BC Salmon Farmers Technology report.

3.2 Sea lice levels on wild salmon juveniles

> ***What you might be hearing:***
> *Sea Lice monitoring in the Discovery Islands region shows that removing salmon resulted in 95% decreases in infection on out migrating juvenile salmon.*
>
> ***Reality:***
> *Sea Lice levels on juvenile salmon in the Discovery Islands are low and did not change after decreased production in the area.*

Independent Monitoring of Sea Lice on Wild Juvenile Salmon:

In addition to managing sea lice levels on farmed salmon, the industry also supports monitoring of sea lice levels on out-migrating juvenile salmon and these data is publicly reported. Third party biological consultants conduct annual monitoring of sea lice levels on out-migrating salmon juveniles at 29 sites, representing regions of the Discovery Islands corresponding to possible exposure to salmon farms and before (pre-exposure) and after passing the salmon farms (post-exposure) (Figure 7).

Figure 7

The approximate locations of the 29 beach seine sea lice monitoring sites in the Discovery Islands.

Source: https://mowi.com/caw/sustainability/wild-salmonid-lice-monitoring/

This program was initiated in 2017 and during the five years that this monitoring program has been conducted, sea lice levels have remained low. There has been no trend of increase in sea lice levels in wild salmon after sea lice have migrated past salmon farms in the region (20–24).

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Summaries of Sea Lice Data on Out-migrating Salmon:

After the Discovery Islands decision by Fisheries Minister Jordan in December of 2020, production was discontinued in the region and salmon farms were not restocked after adult fish were harvested. Sea lice monitoring on out-migrating salmon continued in 2021, including the area of the Discovery Islands where salmon farms are no longer stocking fish, shows that this trend continues as shown in Table 2 and Figures 9–10.

Table 2

A summary of the prevalence abundance and intensity on juvenile pink salmon samples from the Pre-exposure, Exposure and Post-exposure sub-area sites in the Discovery Islands between 2017 and 2021

	Pink Salmon				Chum Salmon			
Pre-Exposure Subarea								
Year	N	Prevalence	Abundance	Intensity	N	Prevalence	Abundance	Intensity
2017	97	23.7%	0.57	2.39	215	18.6%	0.44	2.38
2018	125	23.2%	0.30	1.31	123	24.4%	0.29	1.20
2019	40	12.5%	0.23	1.80	126	27.8%	0.49	1.77
2020	173	30.1%	0.36	1.19	112	19.6%	0.24	1.23
2021	139	24.5%	0.29	1.18	203	20.7%	0.29	1.38
Average	115	12.5%	0.35	1.57	156	22.2%	0.35	1.59
Exposure Subarea								
2017	168	13.7%	0.15	1.09	212	7.8%	0.09	1.15
2018	191	5.8%	0.06	1.09	362	4.4%	0.05	1.06
2019	293	10.9%	0.12	1.09	371	28.8%	0.42	1.47
2020	266	21.1%	0.34	1.63	315	20.6%	0.35	1.71
2021	380	12.1%	0.15	1.22	435	11.0%	0.13	1.10
Average	260	12.7%	0.20	1.20	339	14.5%	0.21	1.30
Post-Exposure Subarea								
2017	109	1.8%	0.02	1.00	212	3.8%	0.04	1.00
2018	118	3.4%	0.03	1.00	230	3.5%	0.03	1.00
2019	177	11.9%	0.14	1.19	371	10.0%	0.14	1.42
2020	139	13.7%	0.17	1.21	315	8.8%	0.10	1.17
2021	329	8.8%	0.10	1.14	435	17.1%	0.23	1.40
Average	174	7.9%	0.10	1.14	313	8.6%	0.11	1.20

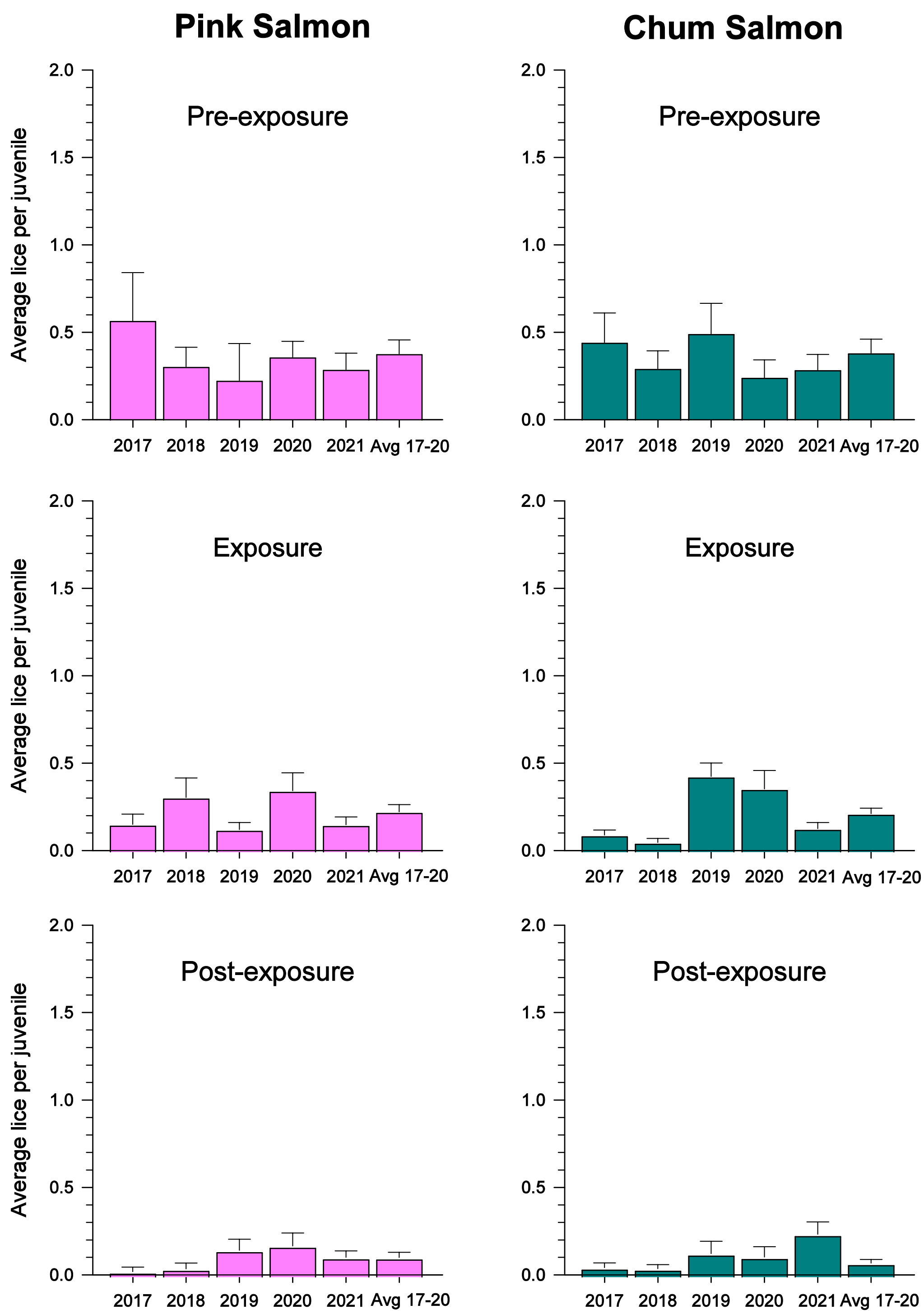
Data Source: Mainstream Biological Consulting 2017-2021 available at https://mowi.com/caw/sustainability/wild-salmonid-lice-monitoring/

Note = N = total number salmon juveniles sampled, lice data includes both species and all stages of lice observed through laboratory analysis.

KEY TERMS FOR DESCRIBING SEA LICE LEVELS ON SALMON:	
ABUNDANCE	The average number of sea lice per fish across the entire sampled population.
PREVALENCE	The number of fish sampled which had one or more lice when sampled — usually expressed as a percentage.
INTENSITY	The average number of sea lice per infected fish.
MOTILE LICE	Mature lice that can move across the surface of the fish.

Figure 8

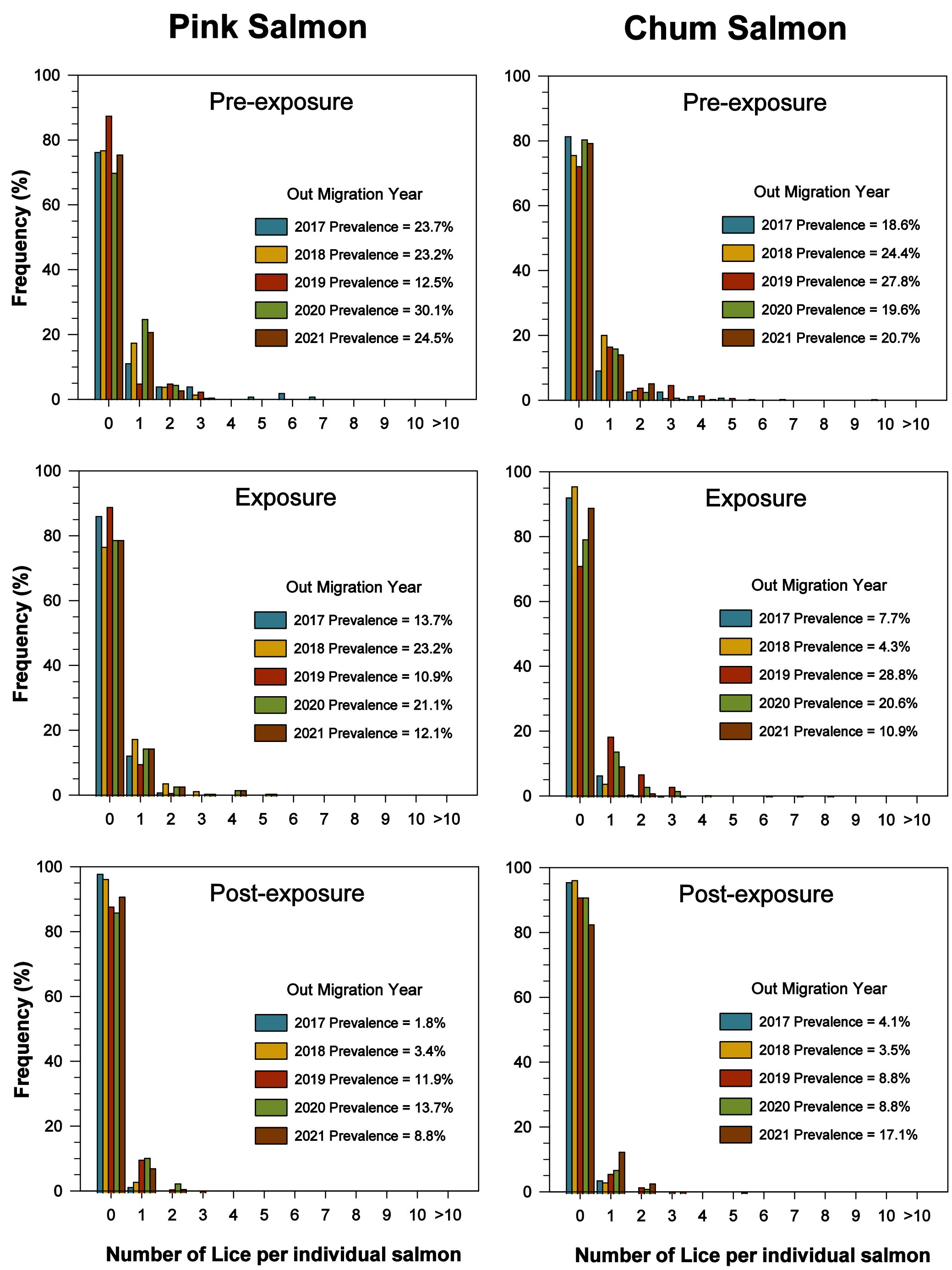
Abundance of Sea lice represented as average number by sampled juvenile salmon in Discovery Islands regions 2017–2018 by year and average of 2017–2020.



Note: All data pooled by regions, prevalence percentage in legends represents percentage of salmon sampled that had one or more lice observed, lice count includes all stages and species of lice recorded.

Figure 9

Prevalence of Sea lice on sampled juvenile salmon in Discovery Islands regions 2017– 2021 expressed as percent frequency of number of sea lice per individual salmon.



Note: All data pooled by regions, prevalence percentage in legends represents percentage of salmon sampled that had one or more lice observed, lice count includes all stages and species of lice recorded.

3.3 Lethality of sea lice to Juvenile salmon

What you might be hearing:
Even low numbers of sea lice are lethal to juvenile salmon.

Reality:
Photos of salmon with large sea lice crawling over their bodies is very dramatic but this is rare and not necessarily fatal to the juveniles.

Activist science originally proposed that while sea lice are considered benign on adult wild salmon, *L. salmonis* sea lice were a severe pathogen on juvenile salmon and speculated that as few as two motile lice of this species would be lethal to pink salmon (25). This has become a claim that is still repeated by anti-salmon aquaculture activists. Research by the same authors in 2009 disproved this speculation when they tested this hypothesis and found that there was very low survival of sea lice on juvenile pink and chum salmon (26). The narrative that arose after this was that sea lice might impair the immune system of juvenile salmon or affect their competitive ability (27, 28).

Pacific salmon species have different tolerances to both *L. salmonis* and *C. clemensi* sea lice (10, 29, 30). Experimental studies by DFO scientists have shown that when juvenile pink and chum salmon were exposed to levels of sea lice between 243–735 larval copepodid (planktonic larval) lice per fish, there were no increases in mortality (31). These researchers further identified that pink salmon have an innate resistance to sea lice that develops once juveniles are more than 0.3 grams (32). Additionally, juvenile pink salmon held in captivity feed on sea lice attached to cohorts and leaping has been shown to dislodge sea lice (33, 34). Nendick et al (35) reported that lice did not impede the swimming activity of juvenile pink salmon greater than one gram in body weight.

Research by Marty et al (36) determined that pink salmon deaths are caused by something other than sea lice, and that farm data supported the conclusion that farm sea lice did not significantly decrease pink salmon productivity after reviewing over a decade of farm and wild salmon data. This study concluded that adult pink salmon returns during the previous fall are a good predictor of sea lice prevalence in the spring, but farm sea lice numbers were not a good predictor of wild salmon survival (36).

During the Cohen commission on the decline of Sockeye salmon in 2011, experts were unable to find significant relationship between sea lice numbers on farmed salmon and Fraser River Sockeye salmon productivity (37, 38). Justice Cohen found that *“the most recent numbers for prevalence and intensity of Leps [L. salmonis] on Fraser River Sockeye juveniles are not a cause for concern”* (39).

Further studies have confirmed that direct mortality including Sockeye salmon is quite low (40, 41). Juvenile Sockeye salmon exhibit stress responses, primarily increased glucose levels which are pronounced during the first seven days of infection (30, 42). Overall Coho salmon are the most resistant to sea lice followed by Pink Salmon then Chinook, Steelhead, Chum and Sockeye and last Atlantic salmon (29).

3.4 Motile Sea lice found on juvenile salmon in Discovery Islands

What you might have seen:
Photos implying that mature (motile) lice on out-migrating juvenile salmon were acquired from exposure to farms.

Reality:
That cannot be the case for mature (motile) lice and the occurrences of lice with multiple motiles in this region is extremely rare.

Speculative claims were made in 2006 that juvenile salmon spent 2.5 months travelling 80 km through the region which would allow time for juvenile salmon to become infected with sea lice, and these sea lice would be capable of developing into adult (motile) lice that would reach lethal levels during this period (25). While the lethality claim is no longer made in primary science literature, the claim that motile lice are from exposure to salmon farms in the area remains a consistent claim by activists.

Sea lice data from the Discovery Islands (Table 3) demonstrate very low levels of motile (adult) sea lice have been consistently encountered on out-migrating salmon. During five years of independent sampling, only 63 salmon were found with motile lice from a total of 6881 juvenile salmon sampled (all species) at all 29 sites. Of these, only 21 fish were infected with the salmon specific louse *L. salmonis* and all but one infected salmon with motile *L. salmonis* had only one louse attached. Infection rates were higher for the generalist louse *C. clemensi*, with 42 individuals in total having more than one louse. Overall, during the five years of sampling the average prevalence of fish having any motile lice was less than 1%.

Table 3

Prevalence of motile (adult) lice in sampled juvenile salmon 2017– 2021 all locations within the Discovery Islands.

Year	2017	2018	2019	2020	2021	Total
Number juvenile salmon sampled	**1431**	**1297**	**1206**	**1181**	**1766**	**6881**
L. salmonis motile >1/juvenile	0	0	0	1	0	1
Percentage	0.00%	0.00%	0.00%	0.08%	0.00%	0.01%
L. salmonis motile 1/juvenile	0	3	4	9	4	20
Percentage	0.00%	0.23%	0.33%	0.76%	0.23%	0.29%
C. clemensi motile >1/juvenile	0	0	1	0	3	4
Percentage	0.00%	0.00%	0.08%	0.00%	0.17%	0.06%
C. clemensi motile 1/juvenile	6	6	9	5	12	38
Percentage	0.42%	0.46%	0.75%	0.42%	0.68%	0.55%
All motile lice >0/juvenile	**6**	**9**	**14**	**15**	**19**	**63**
Total Prevalence Adult Lice	**0.42%**	**0.69%**	**1.16%**	**1.27%**	**1.08%**	**0.92%**

Data Source: Mainstream Biological Consulting 2017-2021 available at https://mowi.com/caw/sustainability/wild-salmonid-lice-monitoring/

These numbers are consistent with other numbers observed in other initiatives. In the Broughton Archipelago Monitoring Plan (BAMP) between 2003 and 2012, the chances of encountering more than two adult female sea lice on a juvenile Pink salmon was 1 in 800 (0.13%) in 82,482 pink salmon sampled (43).

Furthermore, high levels of sea lice of any stage on juvenile salmon are actually rare in the region. During the 5 years of sampling in the Discovery Islands only 10 of 6534 (0.15%) juvenile Pink or Chum salmon sampled had total sea lice levels (all stages) greater than seven, and only one had levels greater than nine. This is also relatively consistent with monitoring at three locations within in the Broughton Archipelago by the Salmon Coast Field Station where total abundance of any species or stage of lice has been typically less than 2 per fish from 2006–2021 (44). As with the Discovery Island data, the removal of farms within the Archipelago has not been affecting low lice levels, prevalence and abundance in 2021 increased relative to 2020, and were similar to the levels observed in 2016 and 2017 (44).

Recent state of the art acoustical tagging work by Kintama Research has demonstrated that Sockeye smolts depart the Fraser River and move rapidly northward to the Discovery Islands during their migration. They have a residence time of 26–34 days in the Strait of Georgia, spending less than 25 minutes travelling past any farms, and their path northward is continuous at 10 — 38 km/day (45, 46).

This has important implications for infestation of out-migrating juvenile salmon. Sea lice growth is temperature dependant from extruded egg to mature adult for *L. salmonis*. On Atlantic salmon it is 40 days at 10.8 °C for males and 10 days longer for female lice (47–50).

As reviewed by Brookson (51), Sockeye salmon in the Strait of Georgia are exposed to the generalist louse species *C. clemensi*, which is also found on Pacific herring, and infection within the Strait provides sea lice enough time to mature into motile lice before fish arrive in the salmon farming area of the Discovery Islands. *L. salmonis* has also been found in high levels of prevalence on three spined sticklebacks and these may provide a reservoir for infection in the estuary when salmon smolts first leave fresh water (52)

Brookson et al (51) went on to state that *"in contrast, lice acquired in the Discovery Islands would not likely have moulted into motiles by the time of sampling"*. It is important to note that infections of *C. clemensi*, was 5, 7, and 39 times more abundant than the salmonid specialist, *L. salmonis*, on Pink, Chum, and Sockeye salmon, respectively (51). High levels of sea lice generally exceeding a prevalence of 60% on all species of juvenile Pacific salmon and on juvenile Pacific herring in the Gulf Islands area within the Strait of Georgia, British Columbia, in a region with no exposure to salmon farms (53). Additionally, the abundance of *L. salmonis* was monitored on juvenile Pink salmon collected from the ocean near the Skeena River and Chatham Sound between 2004 and 2006, in regions where there is no exposure to salmon farms with similar prevalence rates (54). Similarly juvenile sampling in Alaska in 2003 found prevalences of lice of 2.9% (Pink), 4.2% (Chum), 8.4% Sockeye, 53.2% in Coho sampled (55).

4. SUMMARY

Federal regulations require that lice levels must be kept low on BC Salmon farms to reduce risk to wild salmon. BC Salmon farmers take their responsibility to meet these requirements very seriously. Data collected by independent biologists have shown that in the Discovery Islands where salmon farms were closed in 2021, sea lice levels have been well managed on farms, sea lice levels on out-migrating salmon have been low and that the closure of the farms had no discernible effects on the rates of infection. This and other scientific studies are in direct contrast to inflammatory claims that have been made by anti-salmon farming activists.

Policy and regulation must be based on the best available science and it is disheartening to see policy being influenced by activism and political priorities. The results of hasty policy development creates true economic hardship in rural coastal communities. We all know other large complex factors are affecting wild salmon populations and their future survival. As salmon farmers and rural coastal community members, we want DFO and our political leaders to look deeper and focus efforts on climate changes and habitat restoration rather than use salmon farming as an easy scapegoat for political goodwill. Farming the ocean responsibly is essential for Canadian and global food security. Given the global certification of BC Salmon farming practices, Salmon farming is a keystone to Canada's Blue Economy future that should be encouraged in BC coastal waters.

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