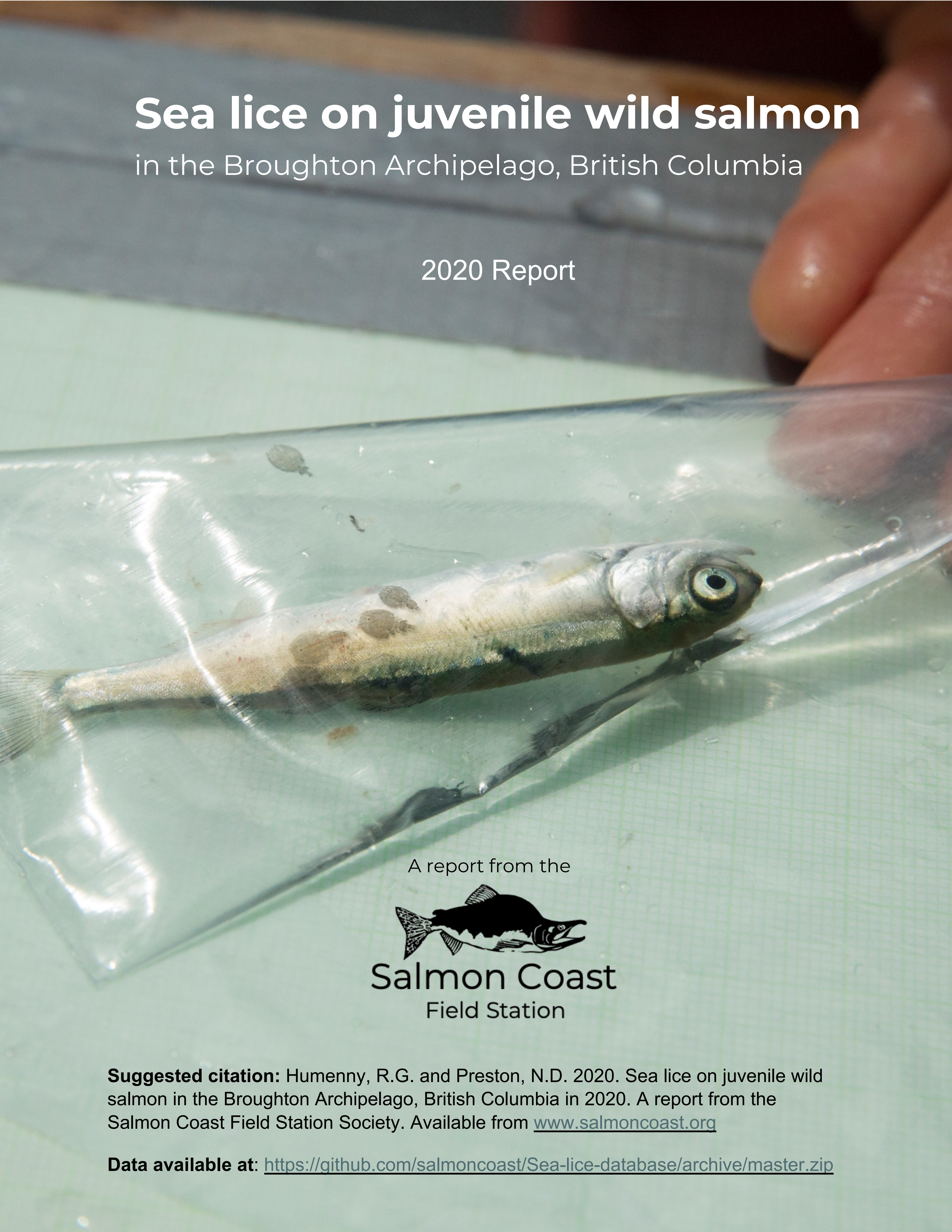


Sea lice on juvenile wild salmon

in the Broughton Archipelago, British Columbia

2020 Report

A report from the

Salmon Coast
Field Station

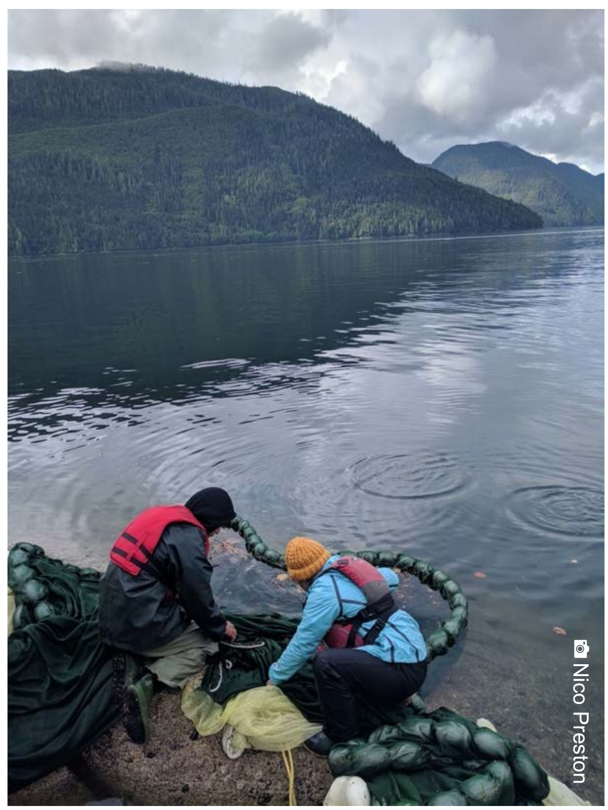
Suggested citation: Humenny, R.G. and Preston, N.D. 2020. Sea lice on juvenile wild salmon in the Broughton Archipelago, British Columbia in 2020. A report from the Salmon Coast Field Station Society. Available from www.salmoncoast.org

Data available at: https://github.com/salmoncoast/Sea-lice-database/archive/master.zip

Sea lice on juvenile wild salmon: 2020 Report

Summary

- Sea lice are ectoparasites that feed on the skin, blood, and muscle tissues of salmon. They can be transmitted via larvae dispersing between wild and farmed salmon, potentially creating health concerns for farmed fish and out-migrating wild juvenile salmon.
- To measure sea louse infection levels on wild juvenile salmon, we caught up to 50 pink and up to 50 chum salmon at three sites, weekly, and examined them live in clear plastic bags. We counted all sea lice present, and recorded the life stage, sex, and species for each sea louse. We then released the fish back into the ocean. Mortality from handling was minimal.
- We examined a total of 1181 pink salmon, 784 chum salmon, and 24 sockeye salmon between April 2nd and June 19th, 2020.
- Sea louse numbers in 2020 dropped from 2019 and were similar to the numbers observed in 2018 and from 2006 to 2014. Of the fish sampled, 43% had at least one sea louse and louse counts averaged 0.71 lice per fish.
- The 2020 field season coincided with the second year of a staggered phase out (2019-2024) of ten salmon farms in the Broughton Archipelago. Two of the three farms adjacent to our sampling locations were removed or fallow from the start of the 2020 field season.

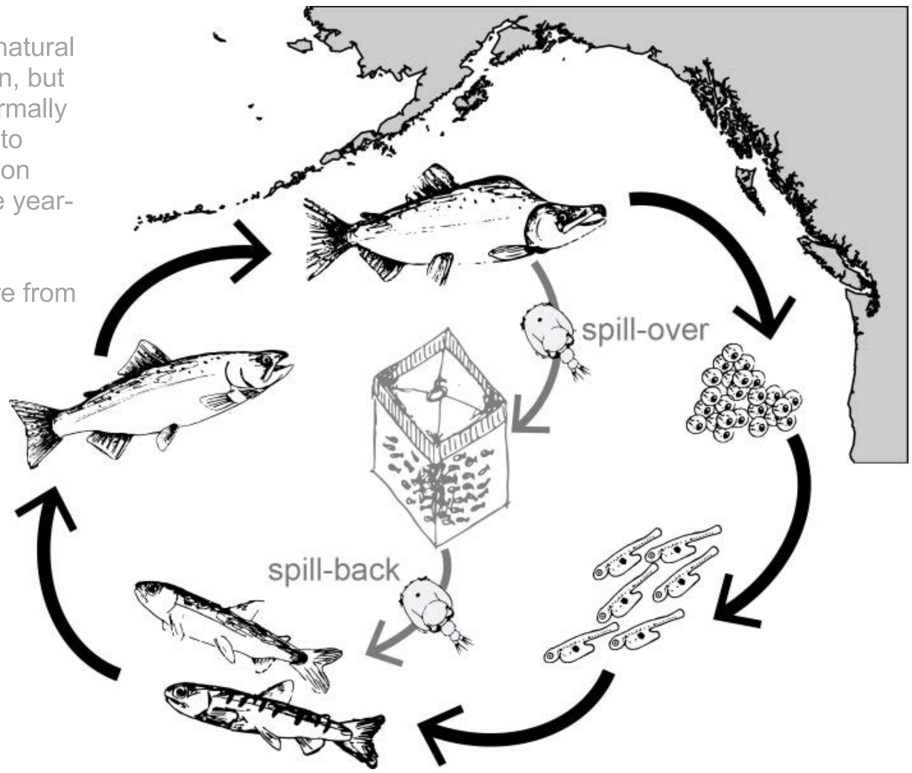


Robert Humenny and Juliana Speier beach seining for juvenile salmon during sampling in spring 2020.

Introduction

The year-round presence of farmed salmon in coastal ecosystems has affected disease dynamics in wild Pacific salmon. The transmission of parasites between farmed and wild salmon has disrupted the spatiotemporal segregation between returning adults and out-migrating juvenile salmon, thereby exposing juvenile fish to ectoparasites carried by adult salmon (Fig. 1). In particular, sea lice (*Lepeophtheirus salmonis* and *Caligus clemensi*) can be transmitted to farmed salmon by wild adult salmon returning to spawn, maintained in farms over winter, then transmitted to out-migrating wild juvenile salmon in spring (Krkošek et al. 2006, 2007). This contributes to higher levels of sea lice on wild juvenile salmon (Krkošek et al. 2006).

Fig. 1. Sea lice are a natural parasite of wild salmon, but migration of adults normally reduces transmission to juvenile salmon. Salmon farms can harbour lice year-round and amplify the infection pressure on juvenile salmon. Figure from Peacock (2015).



Pink salmon (*Oncorhynchus gorbuscha*) and chum salmon (*O. keta*) are particularly vulnerable to the farm-source sea lice, because these salmon enter the marine environment immediately after hatching, when they are small (<0.2 g), and lack scales (Brauner 2012).

The Broughton Archipelago, located on the south coast of British Columbia, has been at the centre of research into the effects of sea lice on wild salmon. Researchers based at Salmon Coast Field Station have monitored juvenile salmon for sea lice at three sites near salmon farms (Fig. 2) since 2001, producing the longest continuous record of sea lice on juvenile salmon in relation to farm activity (Peacock et al. 2016). Here, we report on our continued monitoring of juvenile pink and chum salmon in the spring of 2020.

Methods

In April, May, and June, 2020, we caught mixed schools of juvenile pink and chum salmon via beach seine from three sites in the Broughton Archipelago on a weekly basis (Fig. 2). We transferred salmon from the bunt of the seine net into 20L buckets by dip net, taking care to minimize handling and avoid dislodging motile sea lice. Once in the buckets, we haphazardly selected 50 pink and 50 chum, if available, then measured and examined the fish for sea lice with a magnifying hand lens in seawater-filled Ziploc® bags, and then released the fish.

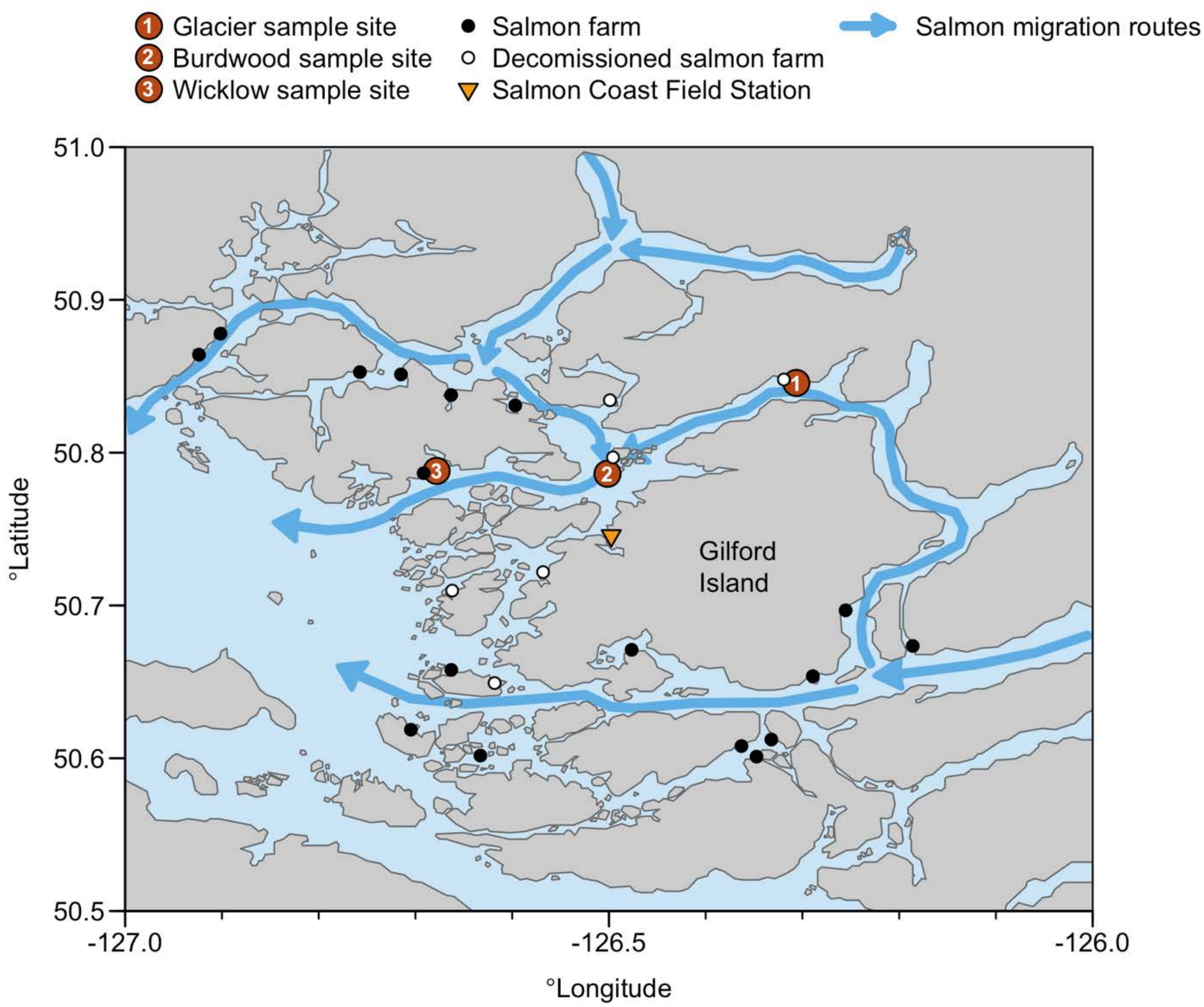


Fig. 2. Map of the study area showing the three locations (Glacier, Burdwood, and Wicklow) where juvenile salmon were collected, as well as the locations of the salmon farms in the area and the locations of decommissioned farm sites.

We identified sea lice to species (*L. salmonis* or *C. clemensi*), sex, and stage, as possible, using a 16x hand lens. The stage classes we considered were: copepodid, chalimus A, chalimus B, pre-adult, and adult (Hamre et al. 2013). For pre-adult and adult *L. salmonis*, we were able to further identify lice to sex, and noted gravid lice (i.e., lice with egg strings). For chalimus-stage sea lice, we could not distinguish *L. salmonis* and *C. clemensi* by hand lens and so, for this stage only, we grouped the species together.

Results

We examined 1181 pink salmon and 784 chum salmon between April 2 and June 19, 2020. Of the 1181 pink we examined, 481 were from Glacier, 428 were from Burdwood and 272 were from Wicklow (Fig. 3). Of the 784 chum we examined, 176 were from Glacier, 473 were from Burdwood and 135 were from Wicklow. We also examined 24 sockeye salmon (*O. nerka*) as bycatch in our beach seines: 6 from Glacier, 1 from Burdwood, and 17 from Wicklow. Sockeye have different life histories than pink and chum salmon and may not have migrated past different farms. Due to low sockeye sample size and the possibility of different infection histories from pink and chum, we exclude the sockeye from our analysis of sea lice prevalence and abundance.

Due to interannual variability in search effort, we cannot interpret differences in sample size as a reflection of differences in the abundance of juvenile salmon across years. This year, because of the COVID 19 pandemic, we took the precaution of reducing our sampling crew for the majority of the season. Sampling with a reduced crew likely had an effect on our ability to spot and catch fish and may have influenced our sample size. Despite these caveats we frequently observed large schools of juvenile salmon, mostly pink, at the Glacier site (Fig. 3d), which is in contrast to the low numbers spotted at Glacier in 2018.

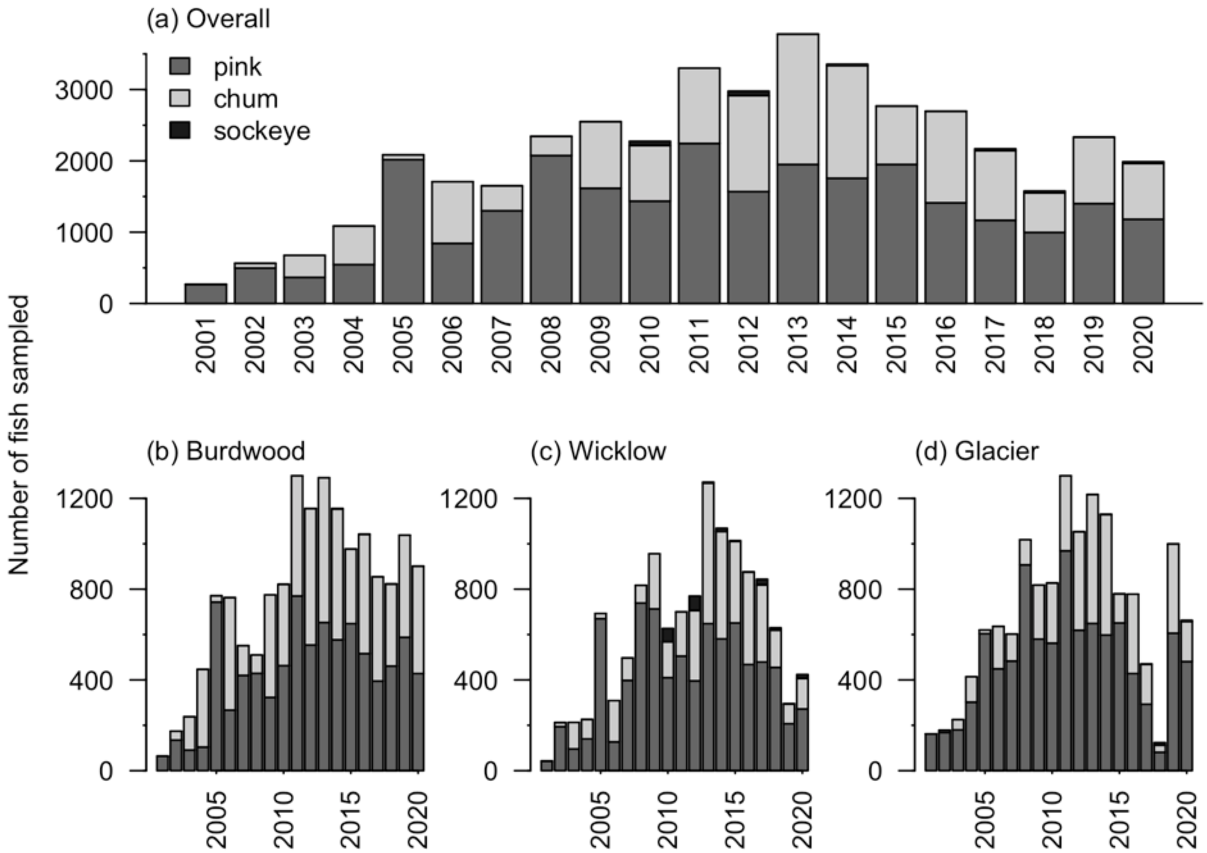


Fig. 3. Distribution of juvenile salmon examined for sea lice by year (2001-2020), species (pink, chum, and sockeye), and location (c-d).

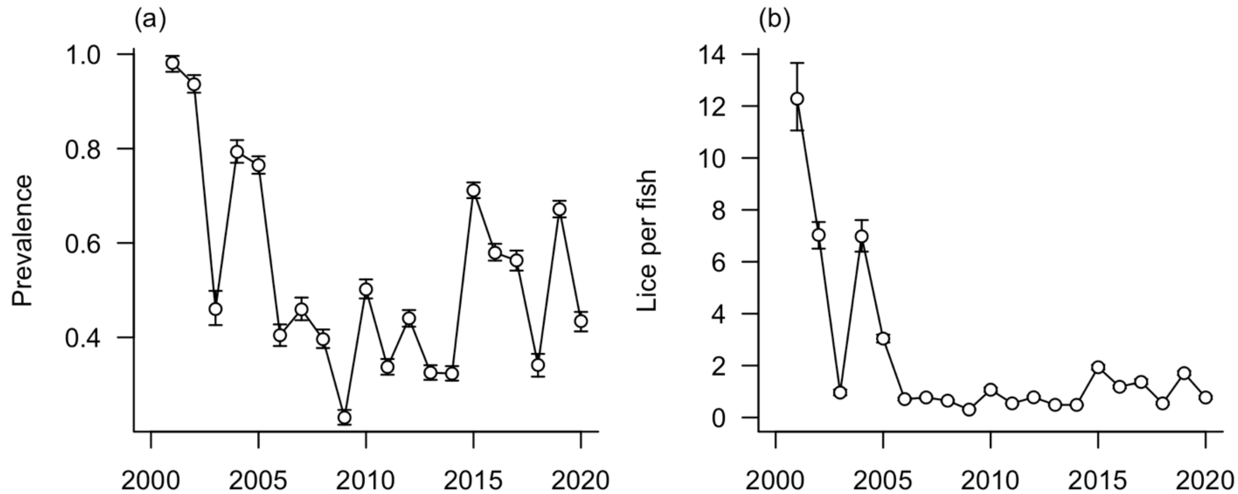


Fig. 4. (a) The proportion of fish examined that had at least one sea louse of any species or stage (i.e., prevalence). (b) The mean number of sea lice of any species or stage per fish. Error bars show 95% bootstrapped confidence intervals.

Sea louse numbers on juvenile salmon were low in 2020 relative to 2019, and were similar to sea louse levels found in 2018 and from 2006 to 2014 (Fig. 4). The average number of lice of any stage or species was 0.71 (bootstrapped 95% confidence interval: 0.66, 0.76). The breakdown of average lice per fish by louse stage was: 0.24 (0.22, 0.27) for the copepodid stage, 0.25 (0.22, 0.28) for the chalimus stage, and 0.22 (0.20, 0.24) for the motile stage (Fig. 5).

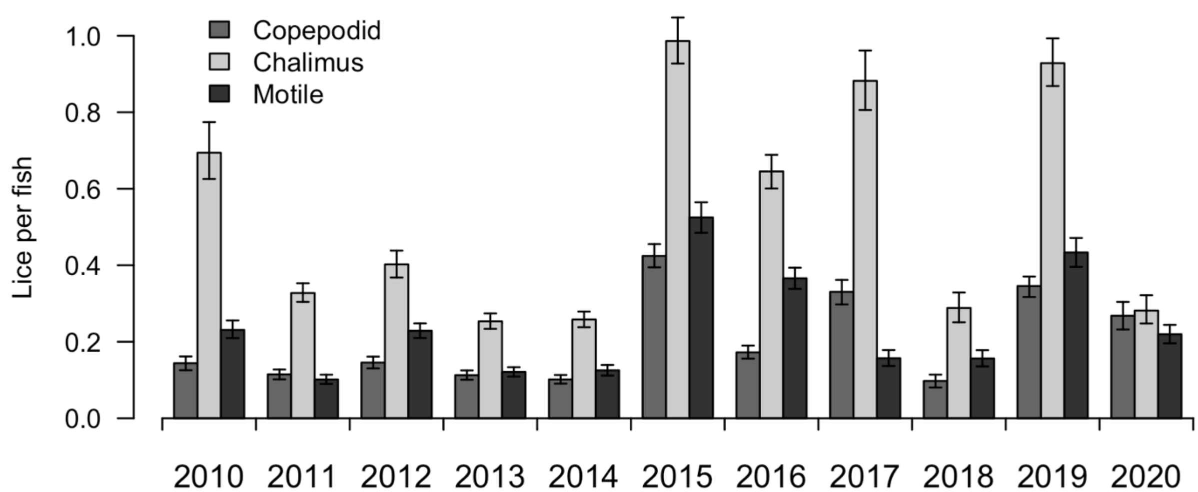


Fig. 5. The mean number of copepodid-, chalimus-, and motile-stage sea lice of both *C. clemensi* and *L. salmonis* species from 2010 to 2020. Error bars show 95% bootstrapped confidence intervals.

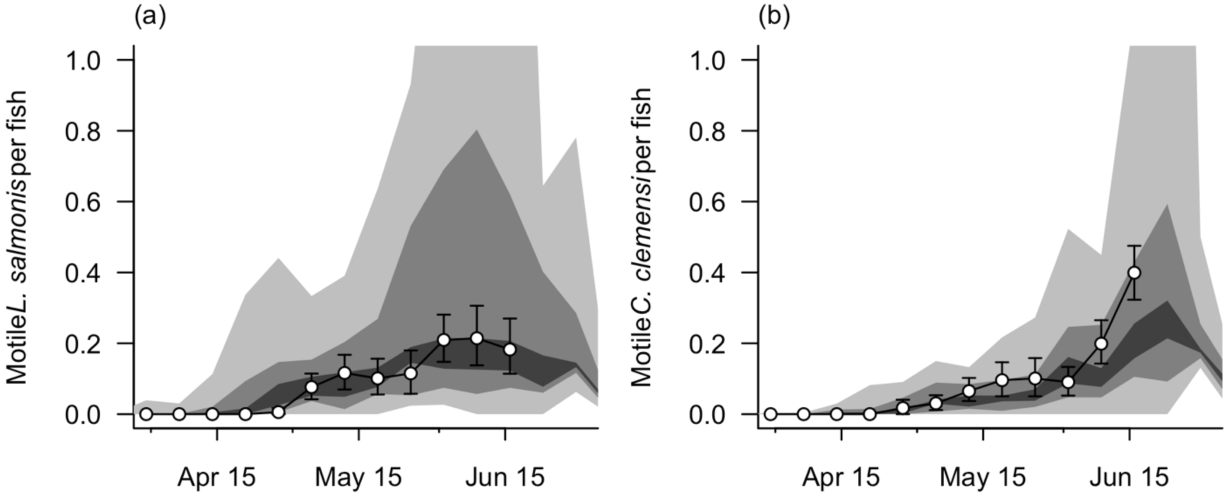


Fig. 6. The mean number of motile (a) *L. salmonis* and (b) *C. clemensi* each week during the 2020 field season (open points). The grey shading shows the percentiles of the historical weekly motile counts from 2001-2020 (lightest grey = range, darkest grey = 40th to 60th percentile, intermediate grey = 20th to 80th percentile).

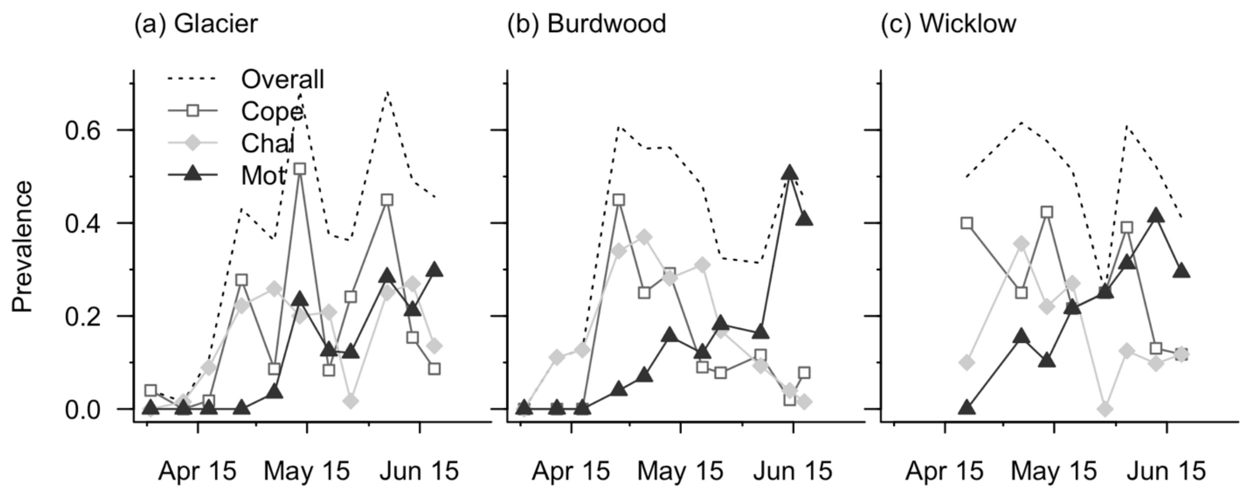


Fig. 7. Prevalence of any stage (dotted line), copepodid, chalimus, and motile sea lice of either *C. clemensi* or *L. salmonis* on juvenile pink and chum salmon from April 1 to June 19, 2020 at Glacier, Burdwood, and Wicklow.

The abundance of *L. salmonis* remained low throughout the season but rose slightly as the season progressed and reached its highest point in June (Fig. 6a). The abundance of *C. clemensi* also remained low throughout the season but increased considerably in late June (Fig. 6b). Prevalence of lice began to rise in late April and no site constantly displayed the highest prevalence or abundance across all sampling dates. Louse prevalence was lowest at the Burdwood group on April 2nd when none of the 42 salmon caught had lice. Louse prevalence was highest at Glacier on May 13th and June 6th when 68% of the 60 and 101 fish, respectively, examined were infected by at least one louse (Fig. 7).

Discussion

Sea louse prevalence and abundance in 2020 decreased considerably from 2019, to levels previously observed from 2006 to 2014 and in 2018. Although changing environmental conditions likely play a role in the differences in louse levels across years, the presence of open-net salmon farms remains a factor affecting sea louse outbreaks on wild salmon (Bateman et al. 2016). The removal of two of these farms and thus approximately 1.6 million Atlantic salmon from key migration routes of the salmon we sampled likely contributed to the drop in louse levels observed this year. The continuation of this monitoring program will be particularly relevant over the coming years as more salmon farms are removed from the Broughton Archipelago. Maintaining a data set that spans this period will support further research on the relationship between farms and sea louse infection on juvenile salmon.

These juvenile salmon monitoring data are publicly available on Github at https://github.com/salmoncoast/Sea-lice-database/archive/master.zip. It is our hope that they will be used to further understanding of the factors influencing sea-louse infestations on juvenile wild salmon, with the possibility to inform and improve salmon-farm management practices, for the betterment of wild salmon in the Broughton Archipelago and beyond.

A juvenile pink salmon being examined for sea lice in a clear plastic bag.

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Acknowledgements

Our sites are located within Musgamagw Dzawada'enuxw traditional territory and we are grateful for the opportunity to work in this region.

Thank you to everyone who assisted with sea licing this season: Alex Morton, Amy Kamarainen, Juliana Speier, and Sophia Speier. Thanks to Mark Lewis and the University of Alberta for contributing a research vessel, instruments, and seine net.

This monitoring would not be possible without the continued support of Alexandra Morton and Raincoast Research Society. We also gratefully acknowledge the support of the Sitka Foundation, Canada Summer Jobs Program, MakeWay (formerly Tides Canada), Patagonia Environmental Grants, and the University of Toronto.

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Salmon Coast Field Station is a charitable society and remote hub for coastal research. Established in 2001, the Station supports innovative research, public education, community outreach, and ecosystem awareness to achieve lasting conservation measures for the lands and waters of the Broughton Archipelago and surrounding areas.

Cover photo: A Juvenile pink salmon infested with sea lice is being examined non-lethally in a clear plastic bag. Stephanie Peacock