Sea lice on juvenile wild salmon in the Broughton Archipelago, British Columbia 2017

Salmon Coast
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Introduction

The year-round presence of farmed salmon in coastal ecosystems has affected disease dynamics in wild Pacific salmon. The spill-over and spill-back of pathogens between farmed and wild salmon disrupts the natural separation of adult and juvenile salmon that protects young fish from parasites that adults may harbor (Fig. 1). In particular, sea lice (*Lepeophtheirus salmonis* and *Caligus clemensi*) can be transmitted to farmed salmon by wild adult salmon returning to spawn, amplify on farms over winter, and be transmitted back to juvenile salmon during the salmon's spring outmigration (Krkošek et al. 2006, 2007). Pink salmon (*Oncorhynchus gorbuscha*) and chum salmon (*O. keta*) are particularly vulnerable to farm-source sea lice because they enter the marine environment immediately after hatching, are small (<0.2 g), and lack scales (Brauner 2012).

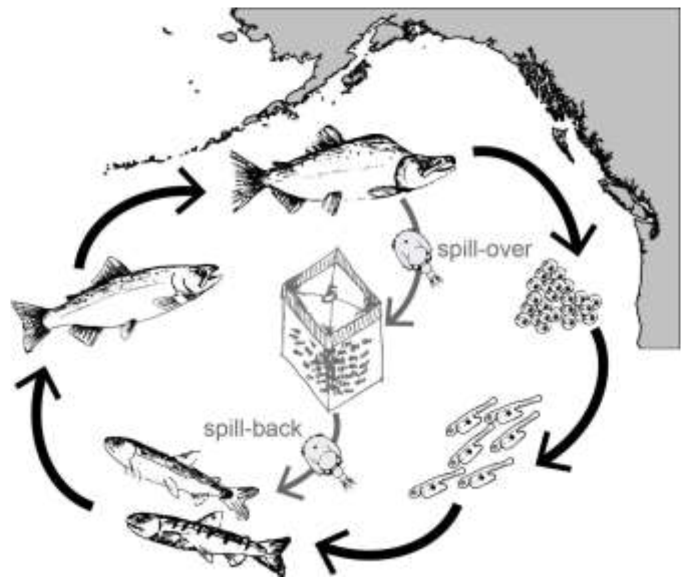

Fig. SEQ Fig. * ARABIC 1. Farmed salmon can amplify parasites and pathogens, such as sea lice, which can then spill-back to infect juvenile wild salmon in coastal ecosystems.

The Broughton Archipelago, in Musgamagw Dzawada'enuxw territory 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 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 monitoring of juvenile pink and chum salmon in the spring of 2017. Sea louse numbers on juvenile salmon were overall similar to 2016, marking the third year in a row of elevated sea-louse counts. As aquaculture continues to expand in the Broughton Archipelago and beyond, we highlight the need for continued monitoring and reporting of sea lice on both farmed and wild salmon.

Methods

We collected mixed schools of juvenile pink and chum salmon by 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 20 L buckets by dip net, taking care to minimize handling and avoid dislodging motile sea lice. At each site, we haphazardly selected 50 pink and 50 chum, if available, and measured and examined them for sea lice in seawater-filled Ziploc® bags.

We identified sea lice to species (*L. salmonis* or *C. clemensi*), sex, and stage using a 16x hand lens. We differentiated copepodid, chalimus A, chalimus B, preadult, and adult stage sea lice (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., 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, the species are grouped.

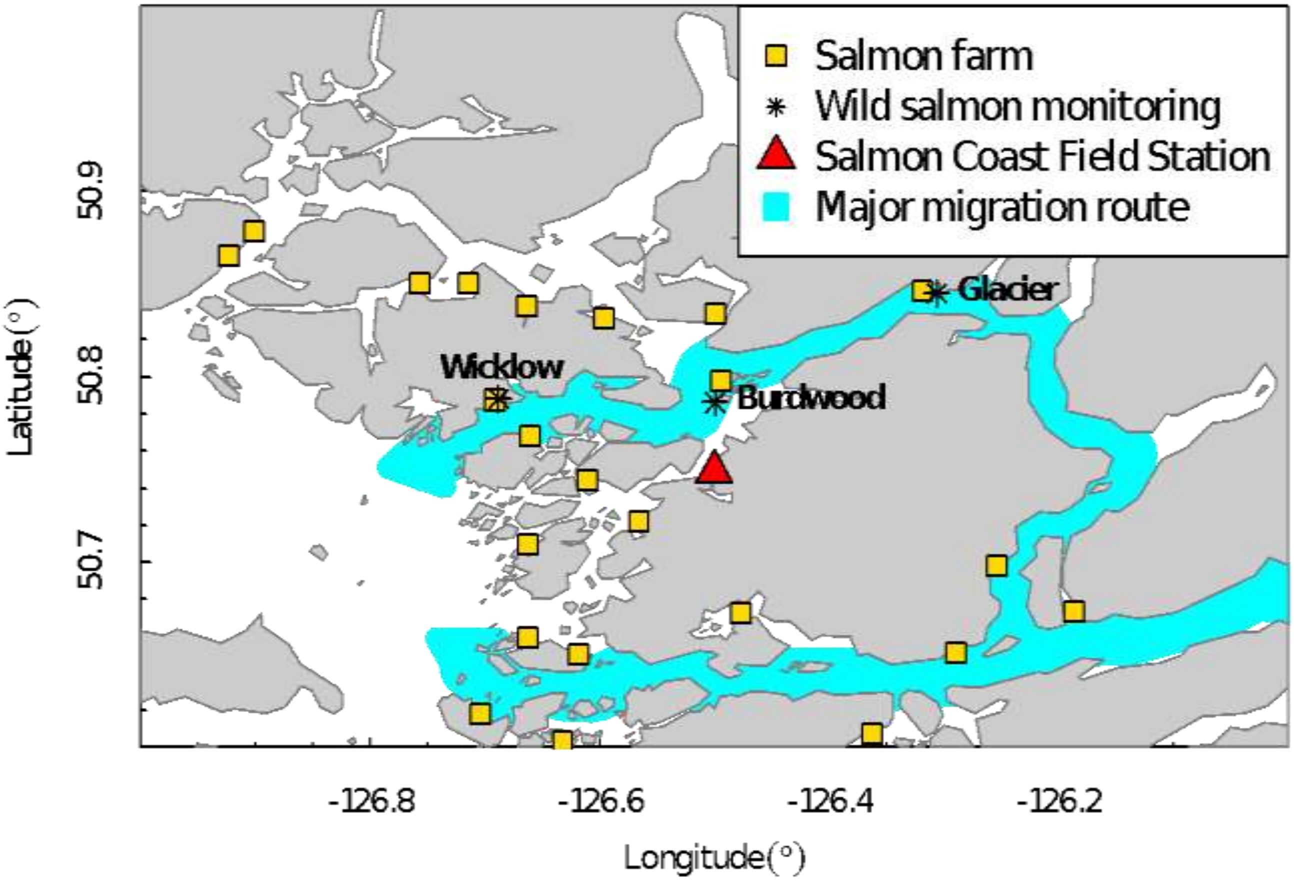

Fig. SEQ Fig. * ARABIC 2. Map of the study area showing the three locations (Glacier, Burdwood, and Wicklow) where juvenile salmon were collected, as well as the locations of salmon farms in the area.

In addition to sea lice, we noted scarring associated with sea lice (chalimus or motile scars), evidence of predator strikes, any hemorrhaging, damaged fins, eroded opercula, or other fish-health observations. Details of the sea-louse classification and fish health observations are outlined in Peacock et al. (2016) and available online at http://www.salmoncoast.org/research/sealice.

Fish with predator scars, or ones that were heavily infected, were lethally sampled this year. Their tissues were collected and sent to a lab for viral testing.

The sampling field crew was led by Lauren Portner, and supported by Salmon Coast staff and students from the Universities of Toronto, Alberta, and Simon Fraser. The Musgamagw Dzawada'enuxw Tribal Council also provided one field technician.

Results

We sampled 1,167 pink salmon and 975 chum salmon between April 6 and June 29, 2017. This was the smallest number of fish sampled since 2007, but it must be noted that search effort over the previous decade has been variable and so this does not necessarily reflect a decline in the abundance of juvenile salmon. The previous two years (i.e., 2015 and 2016), we had noted that the juvenile salmon tended to be larger than observed during the same week from 2001-2014 (Appendix A), perhaps due to earlier emergence associated with warmer-than-average temperatures (Bateman et al. 2016). However, this year we did not find many fish until mid-April, and their size was within the range of that observed historically (Appendix A).

Twenty-eight sockeye salmon were sampled opportunistically. All but three of these sockeye were found at Wicklow, and 15 of them in a single seine on June 22. Previous genetic analysis of sockeye captured in the Broughton suggest that the few sockeye we captured may have originated from the Nimpkish River on Vancouver Island (Scott Rogers, pers. comm.), and thus have a different infection history from juvenile salmon from the Broughton.

Sea-louse numbers on juvenile salmon were high relative to the past decade, resembling observations from 2016. In 2017, 56.3% of fish sampled had at least one sea louse of any stage or species (Fig. 3a). There were, however, fewer motile lice per fish with an average of 0.15 (0.14, 0.18), but more chalimus-stage lice with an average of 0.88 (0.81, 0.97), than in 2016 (Fig. 3b). The number of *L. salmonis* motiles was low throughout April but increased through May to similar numbers as in 2016 (Fig. 4a). The number of motile *C. clemensi* was also very low at the beginning of the season, but increased dramatically in June, though not as high as in 2016 (Fig. 4b). The abundance and prevalence of lice tended to increase from April to May, but varied among locations, usually being higher at Wicklow, the furthest site along the migration. There was a decline in copepodid and motile sea lice towards the end of June at all sites, while the prevalence of motile lice tended to increase (Fig. 5). This pattern of louse development on juvenile salmon as the season progressed was consistent among the three sites we visited (Fig. 5). At its highest, the prevalence of infection was greater than 80% at Glacier and Wicklow mid-season (Fig. 5).

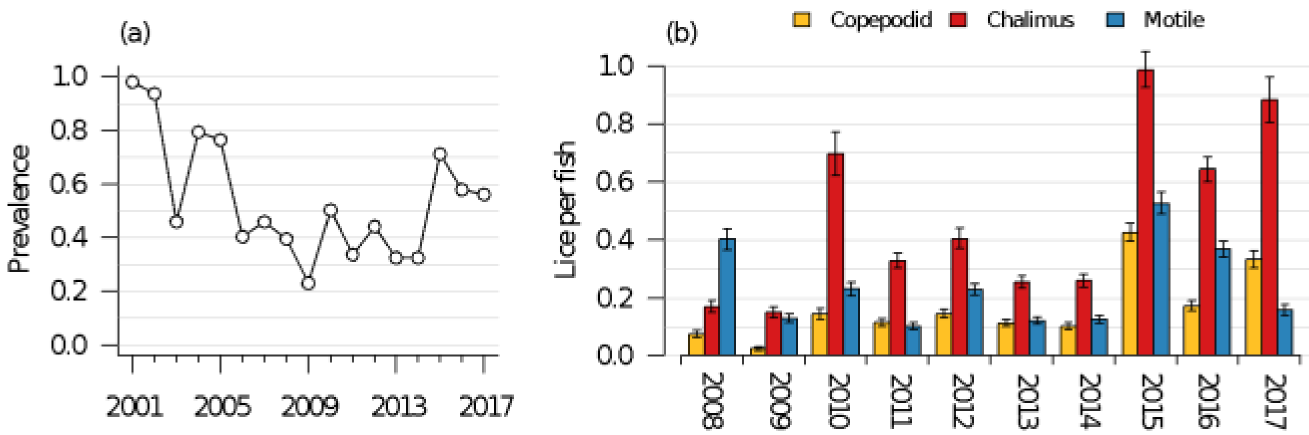

Fig. 3.(a) The proportion of fish examined that had at least one sea louse of any species or stage, from 2001-2017. (b) The mean number (±95% bootstrapped confidence intervals) of copepodid-, chalimus-, and motile-stage sea lice of both *C. clemensi* and *L. salmonis* species from 2006-2017.

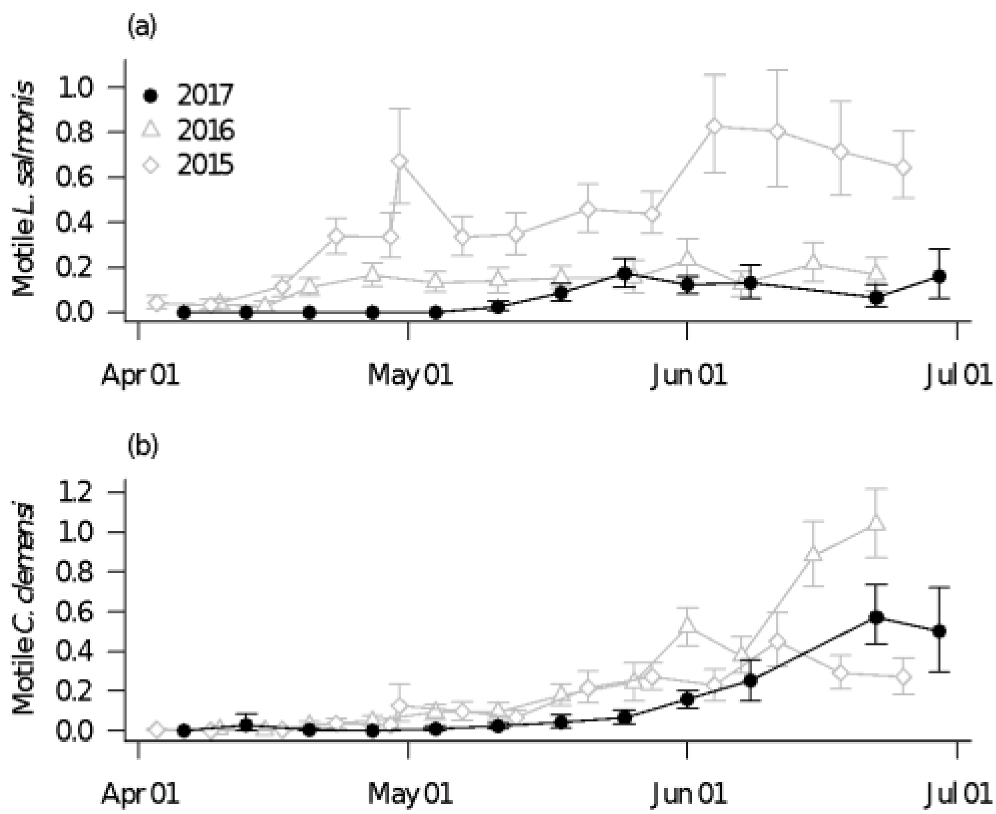

Fig. SEQ Fig. * ARABIC 4. The mean number of motile (a) *L. salmonis* and (b) *C. clemensi* (±95% bootstrapped confidence intervals) during 2016 and 2016 (grey diamonds and triangles, respectively) and in 2017 (solid black points).

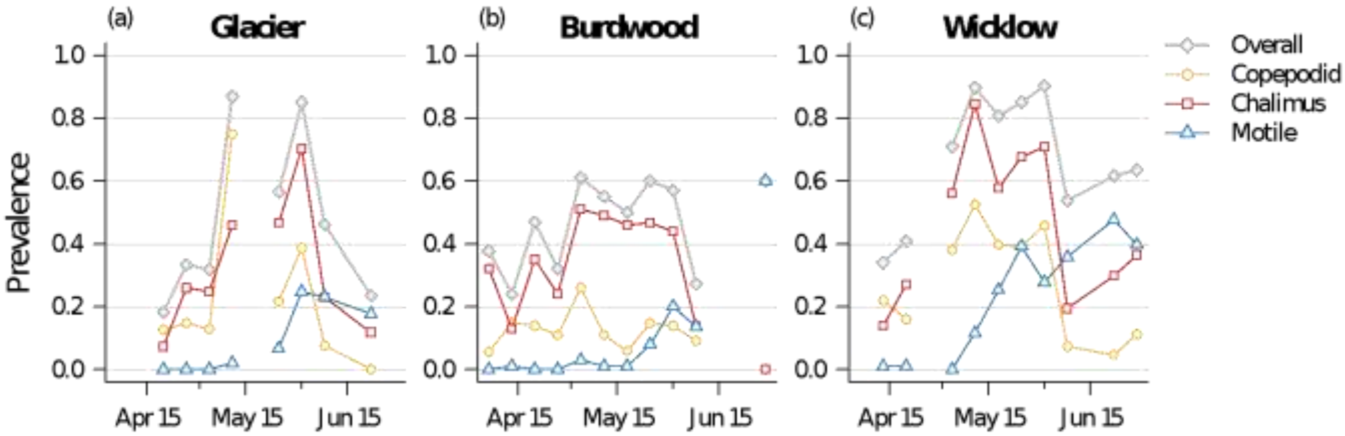

Fig. 5. Prevalence of any stage, copepodid, chalimus, and motile sea lice of both *C. clemensi* and *L. salmonis* on juvenile pink and chum salmon from April 6, 2017 to June 29, 2017 at the Glacier, Burdwood, and Wicklow locations (Fig. 2).

Conclusions

The prevalence and abundance of lice has been relatively high for three consecutive years, following a decade of relatively low numbers. Although changing environmental conditions likely play a role, management on salmon farms is clearly a factor affecting outbreaks on wild salmon (Bateman et al. 2016). These juvenile salmon monitoring data are publicly available at http://www.salmoncoast.org/research/sealice. It is our hope that they will be used to further our understanding of the factors influencing sea-louse infections on juvenile wild salmon so that management practices can be improved for the betterment of wild salmon in the Broughton Archipelago and elsewhere.

Acknowledgements

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Appendix A

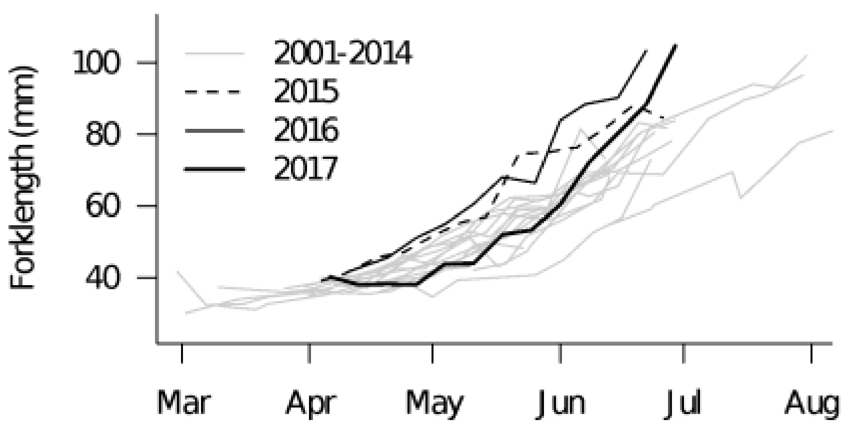

Fig. A1. The forklength (mm) of juvenile pink and chum salmon by week from the period 2001-2014 (grey lines), and in 2015 (dashed) and 2017 (bold).