David Suzuki Foundation

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Parasites & Disease

SEA LICE

Sea-lice infestations originating from salmon farms constitute one of the most pressing threats to B.C. wild salmon – and, indeed, to wild salmon around the world. This is one reason we advocate for salmon farming to be moved to closed systems that separate farmed and wild fish. Wild salmon face many threats, so where a threat exists that we can readily control, we have a responsibility to do so.

Years of studies published in highly respected peer-reviewed journals have built a strong weight of evidence that sea lice from fish farms are responsible for significant and preventable damage to wild pink and chum salmon in B.C.'s Broughton Archipelago. In B.C., sea-lice infestations are not restricted to the Broughton Archipelago but have also occurred in the Discovery Islands. Sea-lice infections in other salmon-farming regions – including Scotland, Ireland, and Norway – have also had negative effects on wild stocks. There is sufficient reason to be concerned that the problem for B.C.'s wild fish goes beyond the well-researched Broughton Archipelago. Precautionary action is needed and justified. We must separate the farmed and wild fish, and we need major retailers to become a positive force for changing salmon-farming practices.

What Are Sea Lice and What Role Do Salmon Farms Play?

Sea lice are natural parasites that attach to and feed on salmon, consuming mucus, skin, muscle, and blood. In high numbers, lice cause stress, osmotic failure (disturbed salt-water balance), increased susceptibility to viral or bacterial infection, and ultimately death. Sea lice are considered common and benign on adult salmon, but they are naturally rare on juvenile wild salmon. Where there are no fish farms, there are few sea lice on juvenile wild salmon, because the wild adult salmon that carry the parasite are offshore when juveniles enter the sea.

Juvenile pink salmon infected with sea lice.

Industrial fish farms, however, create densely packed host populations dangerously near B.C.'s wild salmon rivers. Because the farmed fish are held in net pens, they are exposed to parasites that infect wild fish or other nearby farms. Sea lice infect the farmed salmon, which then amplify the parasite in the surrounding environment. In B.C., wild juvenile salmon often migrate past several salmon farms before they reach the open ocean. In the Broughton Archipelago, the wild juvenile pinks and chums are chronically exposed to high abundances of sea lice for their first two to three months of marine life.

One louse can easily kill the smallest juvenile pink or chum salmon. Juvenile pink and chum salmon do not have thick protective scales and are simply too small to tolerate lice. The juvenile salmon become infected as they migrate past the salmon farms, and many die. Since sea-lice infestations began in the Broughton Archipelago in 2001, sea lice have commonly killed over 80 per cent of the annual pink salmon returns to the area, causing a rapid four-year decline. If the sea lice infestations continue the Broughton, pink salmon are expected to collapse to one per cent of their historical abundance in a further four years, and local extinction is certain.

Chemical Treatments Aren't the Answer

Salmon farms in B.C. use a drug called SLICE (emamectin benzoate) to remove sea lice. The chemical is mixed into the salmon feed. The salmon consume the chemical and absorb it into their bodies. When the sea lice feed on the salmon, they consume the toxin and eventually die. Because SLICE is a toxin, the farmed fish are not allowed to be harvested for human consumption for one month following treatment. In parts of Europe and South America, sea lice have already evolved resistance to SLICE. There are also concerns for valuable non-target animals. Because SLICE is a general crustacean neurotoxin, it may also affect crab, lobster, shrimp, prawns, and planktonic copepods that are important food for wild fish. Widespread use of an environmental toxin to control sea lice is simply bad environmental policy.

Alternative Theories Versus the Weight of Evidence

Some supporters of industrial fish farming have proposed other causes for sea-lice infestations and have claimed wild salmon populations are not impacted. But the science does not support these claims. For example, Alexandra Morton and scientists have responded to the false alternative theories and claims regarding sea lice and salmon in the Broughton Archipelago. See below for more information.

Conclusion

The scientific, peer-reviewed, published research supports a weight of evidence that sea lice from salmon farms threaten wild B.C. salmon. The work has been done by independent scientists, often with seed money from groups like the David Suzuki Foundation. The majority of funding for the work comes from independent research bodies like the National Sciences and Engineering Research Council of Canada (NSERC) that judge applications on their scientific merit. The work has been published in top peer-reviewed journals including *Science*, *Proceedings of the National Academies of Science of the USA*, the *Proceedings of the Royal Society of London*, the *Canadian Journal of Fisheries and Aquatic Sciences*, the *Transactions of the American Fisheries Society*, and the *North American Journal of Fisheries Management*.

Proponents of continued open net-cage farming have not published any findings to refute the relationship between sea lice, salmon farms, and wild salmon mortality and population declines. They also have not used the scientific peer-review process to challenge the studies mentioned here. Instead, they have used non-scientific forums such as the Internet and newspaper editorials to spread doubt about the research. Policy-makers may not have the expertise to evaluate their claims, and they have avoided settings where the scientists who have done the research are present to defend their work.

Unfortunately, and inexplicably, Fisheries and Oceans Canada (DFO) officials and the province of B.C. have also taken this approach, maligning peer-reviewed research outside of appropriate channels and advocating for policies based on work that has not undergone the same rigorous process of peer review and assessment. Non-government organizations and other concerned citizens have been forced to lead the investigations that have now established the weight of evidence. Now, the government agencies charged with protecting wild salmon and the environment must act on the results and take the necessary steps to protect wild salmon - or else make it clear why they will not.

Alternative Theories Versus the Weight of Evidence

• **Sticklebacks are cited as over-wintering hosts for sea lice and a source of the observed infestation of juvenile wild salmon.**

• **Fact:** Very few gravid *L. salmonis* (sea lice) have been observed on sticklebacks. In 2006, researchers (Jones et al.) experimentally infected sticklebacks with *L. salmonis* and did not observe any develop to motile stages. Even if sea lice mature to motile stages on sticklebacks and then disperse in search of a salmonid host, as others have hypothesized, these lice would be without a host from early winter through late March when juvenile wild salmon enter seawater. The patterns of sea lice infecting juvenile pink and chum salmon migrating past farms can only be explained by sea lice dispersing from the location of the salmon farms.

• **Wintering sea lice buried in estuarine sediments are cited as a source of the spring infestation of juvenile wild salmon.**

• **Fact:** No *L. salmonis* have ever been reported in ocean sediments, anywhere.

• **Large wintering wild salmon populations are cited as the source of early-spring sea-lice infestation of juvenile wild salmon.**

• **Fact:** Although chinook salmon were once abundant during winter in the Broughton Archipelago, neither local fishermen nor government test boats can find them anymore. If there are any wintering, adult, lice-bearing wild salmon, their population is vastly smaller than the several million lice-bearing farmed salmon now found year-round in the archipelago.

IN ALL, the claims about other sources of sea lice do not amount to anything substantial. Yes, some background levels of sea lice can be found in the wild environment. Martin Krkosek and his co-authors published peer-reviewed papers in 2005 and 2007 that used models confirmed with direct experiments to show that background levels of lice in non-farmed areas do exist but at low levels (fewer than five per cent of fish are infected). These are levels that wild populations have evolved to tolerate. The background levels are overwhelmed by the number of lice coming from the farmed salmon.

• **Overspawning caused the pink salmon collapse in 2002.**

• **Fact:** There is no evidence for salmon population collapse due to over-spawning. Field researchers observed abundant schools of juvenile salmon leaving the

archipelago in 2001. The abundant schools could not have been observed if over-spawning occurred because the juveniles would have been killed when they were deposited as eggs during the spawning season. Field researchers observed high abundances of sea lice on the juvenile salmon as well as abundant schools of heavily damaged and dying juvenile salmon. Sea lice are the most likely cause of the collapse. Furthermore, subsequent sea-lice infestations in later years have caused continued failures in Broughton pink salmon runs. These subsequent failures cannot be attributed to over-spawning because there are so few spawners.

• The massive 2001 pink salmon fry out-migration exceeded capacity and starved.

• Fact: The weights of uninfected fry in 2001 were normal and do not suggest an inadequate food resource. The juvenile salmon were heavily infested with sea lice in spring 2001, and the infestations were highly correlated with adult-stocked salmon farms (Morton and Williams 2002).

• If salmon farms are the cause of sea-lice infestation on wild juvenile salmon, sea lice would have appeared at the onset of salmon farming in 1987.

• Fact: The first salmon farms in the area were stocked with 125,000 chinook salmon per site. Chinook have one of the highest resistances to sea-lice infestations of any type of salmon. In the 1990s, the industry shifted to Atlantic salmon. In 1995, a moratorium in B.C. capped influx of new sites, but B.C. farm-salmon production continued to climb. The sites were simply stocked with more fish (up to 1.3 million per site). When there are many hosts in the environment it is easier for parasites to find one and infect it. This leads to parasite outbreak conditions when host densities are high. As in Norway and Ireland, more hosts mean more sea lice.

• The Broughton Archipelago simply has more sea lice than elsewhere in B.C.

• Fact: In areas without salmon farms, *L. salmonis* infect fewer than five per cent of juvenile wild pink salmon in the early spring (Krkosek et al. 2007). Researchers are finding high sea-lice infestation rates of juvenile pink and chum salmon associated with salmon farms in another region of B.C. outside the Broughton Archipelago – the Discovery Islands (Morton et al. 2008). In this area, salmonids from B.C.'s biggest salmon-bearing river, the Fraser River, swim through narrow channels densely clustered with salmon farms. Emerging research is indicating that young salmon and young-of-the-year herring are infected near stocked salmon farms in this area (Morton et al. in press).

• DFO (Fisheries and Oceans Canada) found pink and chum salmon are more resistant to sea lice than reported by Morton and Routledge.

• Fact: DFO examined sea-lice susceptibility in larger and thus more resistant fish than the ones that are being infected and killed in the Broughton Archipelago. The DFO research looked at pink salmon averaging 10.6 grams and chum salmon averaging 12.4 grams. Morton and Routledge (2005b) observed mortality in lice-infected pink and chum salmon averaging 1.7 grams, before scale development. The fish they examined were starting their natural migration out of rivers and were caught outside salmon farms. Because sea-lice impact is host-size dependant, it is not surprising that Morton and Routledge (2005b) recorded much higher mortality than Jones et al. (2006).

• DFO data do not show a relationship between sea-lice infestation of juvenile wild salmon and salmon farm sites.

• Fact: DFO have not presented or published an analysis of their data that tests for the effect of salmon farms on sea-lice infestations of wild juvenile salmon.

• DFO has published research stating that sea-lice infestation does not decrease "condition factor" in juvenile wild salmon.

• Fact: *Condition factor* is a term from fisheries biology used as an indicator for overall health. It compares weight to length. When first infected with sea lice, pink and chum salmon fry feed voraciously and for a time remain robust. Then they stop feeding, lie still on the surface, non-responsive to movement from above and unable to school. Morton and Routledge (2005a) dubbed these "loners". Loners do have low condition factor values and die within days in the captive environment. In the wild, the behaviour of these fish would expose them to higher predation rates by birds and fish and thus selectively remove them from the population sampled by DFO. Thus DFO's sample would have contained large numbers of juvenile salmon that were infected with sea lice but still feeding. This is misleading, because the fate of these fish would not have been recorded by DFO.