Sea Lice and Salmon: a Science Primer

How are lice from fish farms harming BC's wild salmon?

Major infestations of sea lice, on both wild and farmed salmon, have been reported everywhere salmon farms have been established. BC is no exception.

Sea lice are external or "ecto" parasites that feed on the mucous, blood and skin of salmon and other fish. While a few lice on a mature salmon may not cause serious damage, large numbers of lice on that same fish, or just a couple on a tiny juvenile salmon, can be harmful or fatal.

Today's practice of culturing thousands of salmon in coastal areas makes fish farms ideal breeding grounds for lice. Individual farms may each contain up to three-quarters of a million farmed salmon, and studies have shown that even if each farmed salmon has low numbers of lice per fish, collectively those lice may produce billions of eggs and infectious larvae each year. Where farms are concentrated, such as in the Broughton Archipelago, studies have shown that farms are responsible for some 95% of the total numbers of lice in marine waters, and that elevated levels of farm-source lice can be found as much as 30 km "downstream" of individual farms. In areas without farms, such as BC's central and north coasts, studies have found that lice are far less common and problematic.

Until the advent of large-scale salmon farming, wild juvenile fish did not encounter large numbers of parasitic lice in coastal waters. It was natural to find lice on adults, but adult fish did not normally come in contact with or infect juvenile fish, since their migrations did not overlap.

Today, juvenile salmon on spring migrations in coastal waters encounter billions of lice. A growing mountain of peer-reviewed scientific papers now implicate sea lice as a major cause of mortality of juvenile salmon—around the world.

In a recent consensus statement from a scientific workshop held in BC's Broughton Archipelago, participating international scientists issued a statement saying, "European governments (Ireland, Scotland, Iceland, and Norway and the European Union) have recognized that salmon farming can be hazardous to the environment, including the proliferation of sea lice on salmon farms, posing significant risk to wild salmonids. There was agreement at the meeting that the situation on the British Columbia coast has many parallels, but that the risks to pink and chum salmon are exacerbated by their small size at emergence into the marine environment."

In another workshop in Norway, scientists, managers, and industry representatives issued a similar statement confirming that farms were the major source of lice infecting wild fish, and that those lice cause damage to wild and farmed fish.

How do we gauge the scale of the damage?

Several studies have now shown that wild salmon have declined in many parts of the world with the advent of salmon farming. Two recent studies in particular have shed new light on the scale of impacts related to farm-source lice.

In one study of global impacts, in which all sources of mortality were considered, farms were implicated as the major cause of recent declines of wild fish in northern coastal waters containing wild and farmed salmon.

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Using a "meta-analysis" the academic researchers showed survival or abundance was reduced for Atlantic salmon, sea trout, and pink, chum, and coho salmon "in association with increased production of farmed salmon." In many cases, the reductions in survival (or abundance) were greater than 50%, and the authors concluded that the effects were "significant and negative."

In a second study published in *Science*, an academic and NGO team showed that "recurrent" louse infestations of wild juvenile pink salmon, all associated with salmon farms, have depressed wild pink salmon populations and placed them on a trajectory toward rapid local extinction. The authors said that, since louse-induced mortality of pink salmon is commonly over 80% and exceed previous fishing mortality, if outbreaks continue, then local extinction is certain, and a 99% collapse in pink salmon population abundance is expected in four salmon generations.

They also offered this succinct take-home message: Salmon farms can cause parasite outbreaks that erode the capacity of a coastal ecosystem to support wild salmon populations.

The impacts of lice also seem closely linked to the size and related vulnerability of infected fish. As a rough guide, extremely small fish that have not yet developed scales are the most vulnerable. This includes most pink salmon that have just entered the ocean. Yet larger fish are also at risk to lice as evidenced by laboratory studies and the extremely prominent demise of EU wild salmon, which are much larger and thus less vulnerable to parasitism.

Is the damage in BC contained to the Broughton? Is the Fraser at Risk?

The Broughton Archipelago has received enormous attention since the collapse of its 2002 pink salmon run. From an expected 3,600,000 salmon, only 147,000 spawners returned.

While many studies have focused on the heavily farmed Broughton, about two-thirds of BC's 133 farm licenses are located outside the Broughton proper. In fact, there are generally as many farms operating in the upper Strait of Georgia region in any given year, meaning Fraser salmon migrate north pass the general vicinity of some 31 fish farm tenures (not all active), before they even reach the Broughton area farms. Recent and preliminary research suggests that juvenile sockeye in the Discovery Islands region of Georgia Strait are being infested with lice from salmon farms. Evidence from several sources suggests many of these sockeye are Fraser River salmon. While we have much to learn about the origin and potential vulnerability of these sockeye, there are legitimate reasons to be concerned about the role that salmon farms play in contributing to early near-shore mortality of Fraser salmon (including sockeye). The precautionary response would be to immediately separate farmed and wild fish, thus eliminating the possibility of infestations and avoidable mortality.

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How can we reverse the damage—and at what cost?

The world's salmon farming industry spends millions of dollars every year combating sea lice. Lice can impair the growth and health of farmed fish, so louse control makes sense for industry. In most areas of the world, industry is also required to control lice on farmed salmon to help improve survival of wild salmon, especially during the spring when small and vulnerable wild salmon migrate past farms.

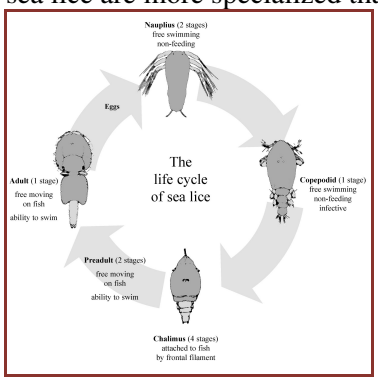
Effective louse control unfortunately seems very hard or impossible to achieve. A succession of chemical agents have been used in attempts to control lice, but lice have proven remarkably adept at developing resistance to most chemicals. The current "chemotherapeutant" of choice is SLICE, which kills lice by inhibiting the moulting and growth process. SLICE is not authorized for use in marine waters by Health Canada but farms are granted 'emergency' use permits to treat lice outbreaks. These 'emergency' applications have now become standard operating procedure for BC salmon farms. It appears that SLICE can effectively reduce lice over a period of days to weeks, but along with anticipated lice resistance to SLICE, fears remain over the unknown impacts of SLICE in the marine environment and the general effectiveness of louse control in areas with extremely small and vulnerable wild salmon.

Keep in mind that, even with "best practice" control programs for lice (not necessarily practised in BC), EU countries have not yet been able to reverse the damage to wild sea trout and Atlantic salmon. Populations of both species remain critically threatened. This is especially troubling news for BC, where wild juvenile salmon are much smaller and thus at the extreme end of the vulnerability scale (figure next page).

The Coastal Alliance for Aquaculture Reform believes that the only lasting solution to the "sea lice problem" is to separate farmed from wild fish, thus preventing the transfer of lice. This means placing farmed salmon that are highly susceptible to lice into closed containment systems, and emergency measures to remove farms from salmon migration routes.

More facts on sea lice

The sea louse, which resembles a tiny horseshoe crab, is well adapted to life as a marine ectoparasite. Its flattened head is covered by a shield, and its legs are specialized to allow it to grasp and feed on fish. Female sea lice have what looks like two tails trailing behind that are actually strings of eggs. Generally, a female sea louse may lay a few hundred eggs at one time, and may have up to six broods in her lifetime. A louse may be able to complete its entire lifecycle (egg to egg-bearing adult) in a little as 35 days. Lice generally can only live a few days in freshwater so they usually die when adult salmon enter freshwater to spawn. At least thirteen different species of sea lice live in BC waters. Only *Caligus clemensi, Lepeophtheirus cuneifer,* and *Lepeophtheirus salmonis* have been reported on farmed and wild salmon in BC. *Caligus clemensi* occur throughout the north Pacific, and along the west coast of BC and northwest coast of Washington. *Lepeophtheirus cuneifer* occur along the northern Pacific coast of Alaska and BC, while *Lepeophtheirus salmonis* is found throughout the northernmost portion of the Northern Hemisphere. All sea lice parasitize fish, but some sea lice are more specialized than



others. *Lepeophtheirus salmonis,* for example, is almost always found only on salmon. In BC waters, *Caligus clemensi* and *Lepeophtheirus salmonis* may damage both farmed and wild salmon, and are a major concern both for the fish farming industry and for salmon conservationists.

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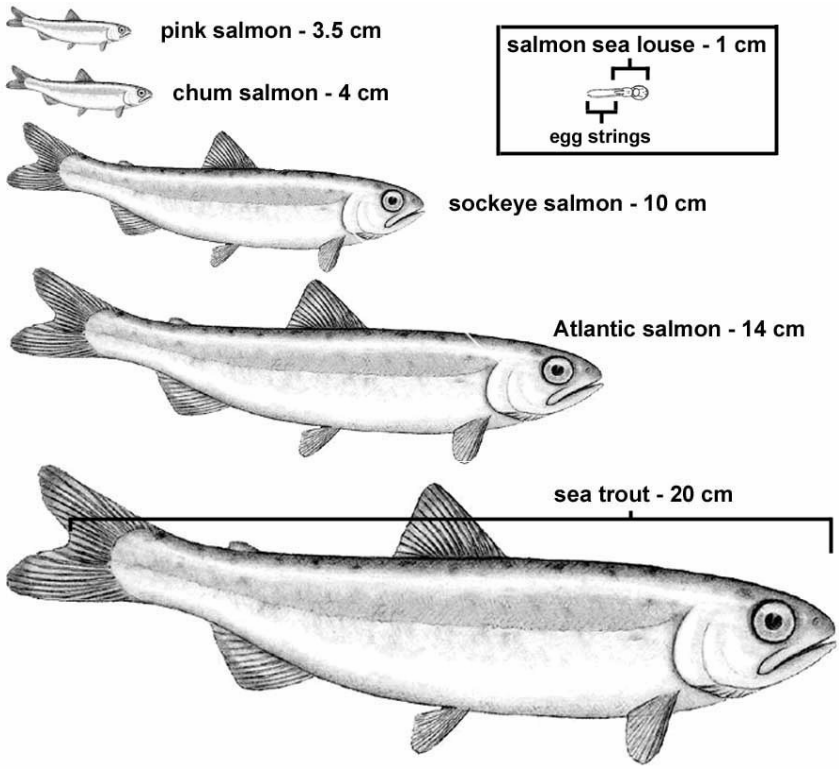
Small juvenile salmon are very vulnerable to lice. Europe's salmon (Atlantics and sea trout) have been severely impacted by farm derived lice. Wild juvenile Pacific salmon (pink, chum, sockeye) are even smaller when they enter marine waters, and are thus at even greater risk from farm-derived sea lice.



*Source of average fish lengths at the time smolts enter marine waters: pink and chum (Morton et al. 2004); sockeye (Groot and Margolis 1991); Atlantic (Scott and Crossman 1973); sea trout (Bagliniere and Maisse 1991).

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