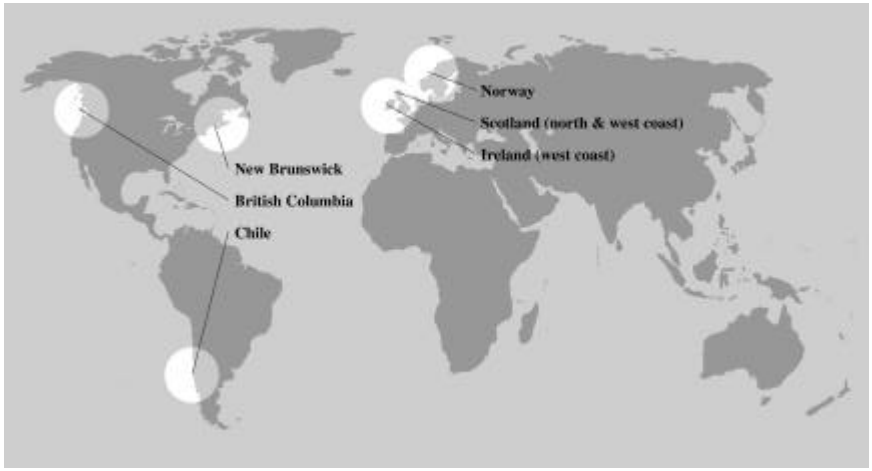
Sea Lice and Salmon: BC Briefing Note

Coastal Alliance for Aquaculture Reform (October 2005)

What's a sea louse? Why do we hear so much about them?

Sea lice are small marine parasites commonly associated with fish (especially salmon). There are 13 known species of sea lice in the marine waters of British Columbia, but the common 'salmon louse' is the one we hear the most about. The Latin name for the salmon louse is *Lepeophtheirus salmonis*, pronounced Lep-the-op-the-yur-us—or Leps, for short.

Sea lice thrive by feeding on the skin, mucous and flesh of fish (they cannot harm humans). Sea lice are common on adult salmon, and usually don't cause major physical damage. In contrast, sea lice have always been rare on juvenile salmon—at least, until the advent of salmon aquaculture. Now, 'epizootics' or outbreaks of sea lice on juveniles are commonly observed—except in areas free of farms (Alaska, northern BC). British Columbia's juvenile salmon are simply the latest of the world's wild salmon to exhibit such infestations, with lice outbreaks documented each spring since 2001 in the Broughton Archipelago's actively farmed waters (the area off NE Vancouver island).



Outbreaks of sea lice have been observed on wild and farmed salmon in the northern hemisphere and on farmed salmon in Chile

Sea lice and sea lice impacts have attracted a lot of attention, and for many reasons. Unlike disease, habitat loss, pollution, or other environmental issues, sea lice, though tiny, are a very visible threat to the health of wild salmon and thus attract considerable attention from the media and public. Large numbers of the world's juvenile wild salmon are regularly infested with lice, and when wild

salmon populations inevitably decline, attention is focused on the most likely source of those lice—open net-cage salmon farms—and on government support for this industrial practice. Government also actively downplays or denies the problem and dismisses the scientific process used to examine an increasingly obvious link between farming and lice outbreaks, thus pitting inflexible policy against wild salmon protection and an electorate who value wild salmon.

Are farms the primary source of lice? And what's behind the "uncertainty," inaction, and angst?

The first question is no longer debated in Europe, where farming has been practised much longer than in Canada. Research has shown that:

- Concentrations of lice larvae have been found in **Scotland's** marine waters only when farms contain adult lice-bearing salmon; when farms are empty or when uninfected smolts are first put in, no larvae are found (McKibben & Hay 2004);

- Lice on **Norway's** 220 million farmed salmon were estimated to have produced 145 billion eggs in 1990 during the 2-month spring migration of wild salmon (Heuch and Mo 2001); reductions in allowable lice loads after 1991 temporarily reduced "coastal infection pressure" until production of farmed fish increased;

- Some 78-97% of all parasitic lice found in coastal waters of **Scotland**, **Ireland** and **Norway** come from salmon farms (the remainder come mainly from escaped farm salmon; Butler 2002);

- Many studies from around the **world** have found significantly elevated levels of lice parasitizing juvenile **char**, **salmon** and **trout** collected near farms (as opposed to areas free from farms).

In **Canada**, recently published (peer reviewed) non-government organization (NGO) and academic research has also shown significantly higher lice numbers on juvenile salmon collected near Broughton farms. An academic researcher working near a single Broughton farm also found:

- Juvenile salmon **did not pick up lice** until the fish reached this farm;
- Louse infection risk **near this farm** was **73 times** higher than normal;
- The measurable infection **'footprint'** extended **30 km** past the farm.

On November 18, 2004, 25 scientists gathered at **Simon Fraser University** to review findings from the Broughton and elsewhere and concluded that, based on the **weight of evidence approach** used to advance science**:**

- Salmon farms contribute sea lice to wild fish;
- In Central BC, there are more lice on juvenile wild fish near farms;
- Sea lice can kill juvenile fish, even at low infestation levels;
- There is suggestive evidence of population impacts.

Furthermore, these scientists concluded that traditional condition factor measures were “not sensitive” to louse damage on juvenile fish. Nor was there sufficient evidence or rigor in study design to support claims that sticklebacks are the primary louse louse host in the Broughton area.

Certain interests have also claimed that population declines of pink salmon in the main Broughton rivers may have been caused by “overspawning.” A recent report by the Pacific Fisheries Resource Conservation Council authored by prominent academic scientists examined high spawning returns in salmon and concluded that there was “No evidence to support anything like a ‘collapse’ or ‘near-collapse’” from “overspawning” (www.fish.bc.ca). Another report (PFRCC 2004) also says “Government research … has skirted the issues of detecting whether or not there is a link between sea lice on farmed [and] wild salmon and whether sea lice are contributing to pink salmon mortality.”

Despite the overwhelming weight of evidence linking farms and lice on juvenile fish, government continues to:

- **Downplay** and **deny** the link—and the impacts to wild salmon;
- **Claim** “no definitive proof” of the link has been found (such as chemical or biological matches for lice on farms and wild fish);
- **Exploit** remaining **uncertainty** in attempts to maintain inflexible **status quo policy** and support of industry;
- **Unscrupulously shift** the **burden of proof** to the conservation community and public;
- **Dismiss** academic and NGO consensus statements and the weight of evidence approach **accepted by science**;
- **Claim** the situation in BC is “different than Europe” thus requiring **more study** before action is taken—without even carefully or openly examining what has been learned and done in Europe.

The high level of concern around this obvious threat to wild salmon and government’s role has fuelled a growing lack of public trust in government and impeded progress toward establishing a truly sustainable industry.

How severe is the threat to wild salmon?

We are only now beginning to measure and understand the full impacts of lice on the world’s wild salmon. These impacts have been felt and measured the longest in Europe. Sea trout populations have been hit especially hard in Scotland,

Ireland, and Norway. Wild Atlantic salmon populations have also plummeted. Each year, an estimated 30-50% of all sea trout and 48-86% of salmon smolts leaving Norway's rivers are killed by farm-source lice. Farmed salmon in the North Atlantic now outnumber wild salmon by nearly 50:1.

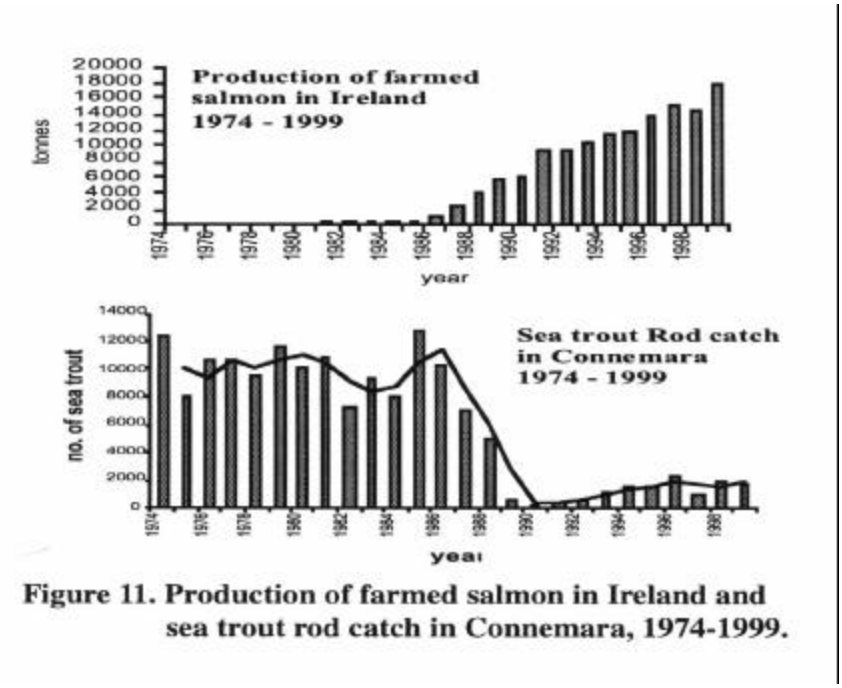


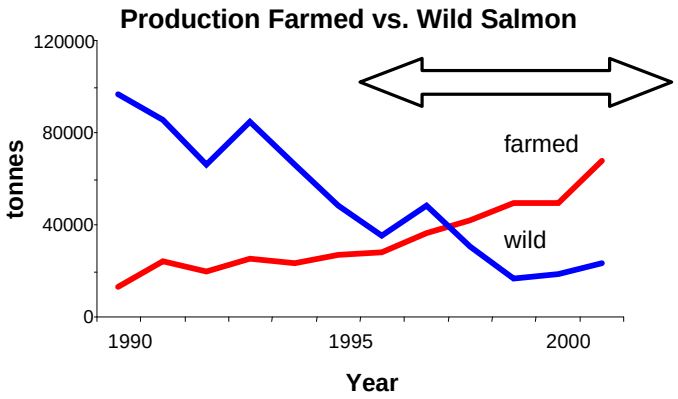
Figure 11. Production of farmed salmon in Ireland and sea trout rod catch in Connemara, 1974-1999.

In **Canada**, juvenile pink and chum salmon in British Columbia's Broughton Archipelago have experienced severe sea lice outbreaks every year now for the past 5 years. In only one year—the 2003 "partial fallow" of farms—was the prevalence of lice on juvenile salmon below 80%. When farms were partially fallowed (that is, emptied of adult fish and the lice these fish host and produce), "only" 36% of all juvenile salmon collected near farms had lice. When all salmon from a single Broughton farm were removed, researchers found that lice infecting juvenile fish near this farm **decreased 42-fold** (Morton et al. 2005).

Evidence suggests that heavy infestations on juvenile salmon are directly responsible for low returns of adult pinks in the following fall. Heavy infestations on juveniles in 2001 and 2002 were followed by exceptionally low returns of adults. The smaller outbreak of 2003 was followed by a relatively high return of adults in 2004. Low returns of pink salmon in 2005 in several Broughton rivers also likely reflect high louse-induced mortality (high infestations) in 2004.

So why are we only now seeing the problem in BC? Especially since farms have been here for years, and we had a 7-year moratorium on new farms?

It's true that farms have been located along the coast for many years, but the industry started small and has grown rapidly. There are now some 127 total tenures and 84 active farms. Farmed fish production now easily exceeds the landed weight of wild salmon from commercial fisheries. The moratorium also applied only to new farms, not the number of fish in existing farms, which increased dramatically during the moratorium.



Arrow denotes new farm moratorium (1995-2002)

In a recent article on hurricanes and global warming (Kluger 2005) scientists describe how complex systems such as the atmosphere are known to move from one "steady" or "stable" state to another with only very brief transitions in between. To understand these "alternate stable states" the author suggests we think of water, which when put over a flame becomes hotter and hotter until suddenly it turns into steam; climate itself also responds as if it's being controlled by a dial, but occasionally it acts as if it's controlled by a switch.

Similarly, changes in parasite density can occur rapidly (Gunderson and Holling 2002). Periodic "flips" from one stable state to another, in the jargon of science, are "mediated by changes in slow process that suddenly trigger a fast response or escape from a state."

Many of us have heard these "flips" referred to as "tipping points." No one, however, has measured if Broughton farms have "flipped" or "tipped" between low and high louse production "stable states." Logic and the weight of evidence suggest that they have. Broughton-area louse production from farmed fish was likely at a "low stable state" after farms were first introduced. Current louse (and salmon) production levels are now significantly higher and likely far outstrip parasite contributions from wild fish.

How high? A look at Marine Harvest's web site shows that farms contained some 2.3 million fish on December 31, 2003 each hosting an average of 2.7 egg-

bearing lice. Simple math reveals this to be a total of 6.2 million “gravid” (egg-bearing) lice. Considering that the average louse is capable of laying 250 or more eggs, lice on these farmed fish may have been contributing more than **1.5 billion eggs** to the marine waters of the Broughton to ring in the New Year and welcome the coming migration of wild juvenile salmon.

What is being done in Europe? In BC? And is it enough?

Norway has long recognized and attempted to minimize the louse threat. Norway enacted the Norwegian Action Plan Against Salmon Lice in 1997. The plan requires legal limits for maximum numbers of lice (currently no more than an average of 0.5 gravid lice per farmed fish), compulsory reporting of lice loads, strategic regulations for treatment, and monitoring of salmon infection.

Ireland and **Scotland** have adopted similar louse reporting and control measures. Area Management Agreements have been developed to help coordinate farm fish production and louse treatment, in order to minimize “**coastal infection pressure,**” particularly during the critical spring migration period of juvenile salmonids.

Despite these efforts, wild salmon stocks damaged by sea lice have not recovered in most areas of Europe. Increased farm production has generally offset many management actions (such as lower legal limits for lice), meaning that lice numbers in European waters generally remain the same.

In **British Columbia**, current regulations require that, when mobile lice levels (all stages) reach three (March to July) or six (July to March) per farmed salmon, a plan is worked out with the salmon farm company veterinarian to either treat with a chemical pesticide or harvest the fish early. In working out and implementing the plan there is often no action for a number of weeks or even months during which time lice levels and production can increase.

From a manager’s perspective, it is difficult to compare these regulations to Europe’s, let alone, assess whether they are biologically relevant in Canada. It is important to remember that juvenile pink and chum salmon (weighing less than half a gram) are more than **10 times smaller** than Atlantic salmon smolts, and thus much more susceptible to louse parasitism. Research indicates that juvenile salmon may succumb to lice at infestations levels of or above **one louse per gram** of fish, meaning that a salmon weighing less than half a gram may be unable to survive an infection of a single adult louse (Finstad 2002).

Broughton farms contained 800,000 fewer adult salmon at the start of 2003—the one and only “partial fallow” year. These fish likely produced only about half as many lice as in 2004, and lice prevalence on juvenile chum and pink salmon was the lowest (36%) in the past 5 springs (Morton et al. 2005).

Unfortunately, the effectiveness of fallowing and other management practices continues to be hampered by inconsistent policy, and a lag in the adoption of standard European practices. Despite the documentation of lice outbreaks on juvenile fish in each of the last five years, fallowing has been attempted just once. Slice (emamectin benzoate) continues to be the control treatment of choice, despite the controversy surrounding its unknown impact on the marine environment, and concerns about lice developing resistance to such chemotherapeutants (Bright and Dionne 2004).

Unfortunately, too, government research into the problem continues to be plagued by insufficient funding and attention, and government "spin" on the problems. Realistic solutions to concerns raised by NGO groups, academics, and the public remain elusive. A recent review (National Centres for Excellence 2003) of federal funding for aquaculture was critical of a perceived bias toward enhancing production and industry efficiency at the expense of environmental research. Provincial funding for aquaculture research (BC Aquaculture and Research Development fund) is similarly regarded by many as industrially biased and insufficiently transparent. Provincial programs have ignored research priorities identified at the scientists' roundtable on sea lice, despite attempts by an NGO committee member to introduce these recommendations.

Are there other scientific concerns surrounding lice?

Yes. Lice are also known "vectors" or carriers of such diseases as infectious salmon anaemia (ISA). Lice may thus be able to transmit other diseases between salmon, including the IHN (kidney disease) virus commonly found in salmon farms (SFU Summit of Scientists on Sea Lice Proceedings 2002).

Are Salmon farmers also concerned about lice?

Lice are also a burden to salmon farmers. Lice can increase stress and reduce growth of farmed salmon, result in downgrading of fish (from physical scarring), and other management challenges. It's estimated that Scottish farmers spent between $48 and 72 million in 2001 attempting to control lice. One recent paper from eastern Canada estimated that lice cost the typical New Brunswick farmer nearly $350,000 per crop (in downgrading, mortality, stress-related growth reduction, labour and chemical costs).

Perhaps the largest cost of lice, however, is the loss of public confidence in the sustainability of currently favoured open net-cage farming practice—and in government, itself.

Can government protect wild salmon and also promote salmon farming?

There have now been four reports from the offices of the auditor general critical of Fisheries and Oceans' conflicting mandates. The AG offices say that DFO cannot be both a protector of wild fish and a promoter of unsustainable fish farming practices.

Nothing has been done to eliminate this conflict (such as moving aquaculture to another ministry). Instead, DFO has dug in its heels and stepped up its promotion of fish farms, and its public denial of the threats and weight of evidence.

DFO has also proclaimed a wild salmon policy despite concerns that it does not even acknowledge aquaculture to be a recognized threat to the biodiversity of wild salmon (www.farmedanddangerous.org). Even one of government's own MPs has publicly admitted that the new wild salmon policy is only "half the equation" because it does not protect salmon from aquaculture threats.

What can be done and who's being asked to protect wild fish and the public interest?

The recent history of open net cage aquaculture in BC and around the world begs the question: can open net-cage salmon farming be "fine-tuned" sufficiently to eliminate its impacts on wild fish?

A recent review of Norway's sea lice action plan—in place since 1997—suggests that, despite all of Norway's efforts to minimize impacts, the situation remains much the same as when the plan was enacted. Total louse numbers in coastal waters have not changed much, despite stricter regulations on allowable louse densities, because the number of farmed fish (lice hosts) has steadily risen. Nor have researchers witnessed significant recoveries of wild fish, except in a few cases of intensive fallowing (e.g., some areas of Scotland).

While the infection rates of lice on juvenile salmon in BC may be reduced with better siting of farms, coordinated production and treatment, and consistent fallowing, the problem is unlikely to simply go away, especially if farming continues to expand locally and coastwide.

All this has led many to believe that open net-cage aquaculture and wild salmon might never be compatible, meaning we must be far more innovative in looking at other ways to do business (practice truly sustainable aquaculture). One suggestion is to adopt closed containment technology, originally suggested by the salmon farmers themselves to control algae bloom impacts. Many promising technologies and potential solutions (such as tax incentives) are available, but government and industry, apparently content to subsidize open-net cage

aquaculture through environmental damage, have held up the exploration of such technologies by claiming (but not proving using full-cost accounting) prohibitive costs. Meanwhile, government continues to subsidize a marginally performing industry in Canada with taxpayer money ($20 million in July 2005 to New Brunswick farmers), while simultaneously devaluing wild salmon and the public interest. For more on “solutions”, visit www.farmedanddangerous.org

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