

SEA LICE FACT SHEET

BRIEF VERSION

Do farmed salmon cause sea lice infestations in wild salmon stock?

Scientists don't think so. To date, no direct 'cause and effect' relationship between sea lice, salmon farms and wild salmon has been identified by the multitude of scientists studying the issue.

It is true that recent papers and models by scientists funded by environmental groups claim that sea lice are infecting juvenile wild pink salmon as they pass salmon farms in British Columbia during migration.

But the majority of scientific literature describing the contribution of sea lice from British Columbia salmon farms to wild stocks of fish remains contradictory, with some papers and models showing significant correlations and other reports concluding that lice originating in wild stocks were primarily responsible for new infections of other wild stocks.

The fact that sea lice infestations pass to and from wild salmon is agreed by scientists and environmental groups alike. However, it is debatable whether the transfer of sea lice from the farmed salmon to the wild salmon is on a sufficient scale to have an impact.

What are sea lice?

The term sea lice refers to several species of parasitic copepods that are commonly found on fish in the marine environment. Sea lice are naturally occurring parasites that have existed for millions of years and have been reported on wild ocean fish like salmon, stickleback and herring for centuries. Depending on their age, sea lice range in size from microscopic to easily seen by the naked eye. They can be found on the skin, fins and less frequently on the gills of their hosts. Sea lice feed predominantly on host mucus and skin.

The two most common species of sea lice reported on wild and farmed salmonids are *Lepeophtheirus salmonis* (infects salmonids only) and *Caligus clemensi* (infects a broad range of finfish, including salmonids).

The salmon louse has 10 life stages, each characterized by a molt, or transformation, that takes it from egg to adult. Once the young louse reaches the free-swimming stage called copepod, it is able to attach onto a host, where it grows to the adult stage and is able to produce eggs that are subsequently released into the water column, thereby completing the life cycle.

Sea lice occur naturally in the Northern Hemisphere. The parasite can lower the fitness of salmon and in some cases be lethal as it creates open lesions on the surface of the fish that compromises a fish's ability to maintain its saltwater balance.

Do sea lice impact consumers?

Sea lice do not affect human health. Traditionally in Europe, the presence of live sea lice on wild salmon was considered to be a sign of good quality fish. Today, the lice usually fall off or are cleaned off during harvesting or processing activities before the fish reach the consumer. There is no difference between sea lice found on farmed salmon and those found on wild salmon.

Do sea lice kill fish?

Sea lice are naturally found on wild salmon stock. Sea lice infections increase fish susceptibility to other diseases and diminish fish productivity. At very high infection levels, fish may even die. External damage also reduces fish value and marketability.

No studies to date thoroughly describe the lethality of sea lice to pink salmon. Fisheries and Oceans Canada reported in 2001 that pink salmon fry carrying up to 2.7 lice per fish appeared healthy. More recently, Fisheries and Oceans Canada research found no evidence that low levels of louse infection observed on juvenile pink and chum salmon in British Columbia's Broughton Archipelago affect growth rates or condition factors.

Does sea lice transfer take place between farmed and wild salmon?

It is possible. But to date, scientists who have studied the issue have not identified any direct 'cause and effect' relationship between sea lice, salmon farms and wild salmon. All the published work so far is based on correlations.

Because sea lice cannot survive in fresh water for more than two to three weeks, juvenile farmed salmon are free from sea lice when first introduced into the marine environment from fresh water. At some point after entering the grow-out phase, they become hosts to sea lice. Salmon farms are typically located in sheltered near-shore waters that are also commonly used by wild salmon during migration. Sea lice also are attracted to these areas because of numerous potential hosts, including the stickleback and other finfish common to the Broughton Archipelago.

Therefore, many scientists agree it is too simplistic to say that salmon farms are the culprit for sea lice infestations because there are other hosts besides salmon for the sea lice.

Lepeophtheirus salmonis, for example, is found on virtually all salmon, but also readily on sticklebacks, a common finfish in British Columbia.

Water temperature, salinity and sea currents may also impact the level of sea lice infestations at any given time on wild salmon. Hydrodynamic studies reveal that the top 25 meters to 40 meters of water generally flows seaward through the Broughton Archipelago under the influence of freshwater, reducing surface salinity from 15 parts per thousand (PPT) to 25 PPT from June through November of most years. Sea lice larvae do not consistently develop to an infectious stage at salinities of less than 30 PPT, providing a natural control in the archipelago.

Freshwater inputs in the Broughton Archipelago also force strong seaward flowing surface currents in the main channels that likely carry imbedded sea lice larvae significant distances during their development to the infective stage. As a result, ocean currents heavily influence

dispersion of sea lice during its early life stage. Particle tracking research predicts that sea lice released in the vicinity of two farms located deep in the archipelago are carried 10 km to 40 km from the farms before they become infective.

Can sea lice be traced back to its source?

New research is now being used to trace the origin of sea lice to help determine the best location for salmon farm sites and how to best mitigate the risk of any sea lice infections.

Using innovative technology, researchers have been able to discriminate between the sea lice collected from commercially reared Atlantic salmon and those collected from wild Coho salmon, reflecting different local conditions between the migrant wild and the farmed salmon. It now appears possible to differentiate between sea lice originating from wild or farmed salmon. Further studies could ultimately help guide coastal management and siting of farms.

How do salmon farms address sea lice?

Salmon farms are required by law to monitor sea lice. As of November 2003, all salmon farm sites must have a Fish Health Management Plan, required by the province and supported by the Department of Fisheries and Oceans Canada. These plans are a condition of license and as such are enforceable.

Salmon farmers have developed a variety of methods to prevent and treat sea lice outbreaks. Good farm maintenance and husbandry are helping to prevent outbreaks, and sea lice treatment products, such as Slice, are used to treat salmon to prevent disease outbreaks.

The Broughton Archipelago is seeing healthy returns of pink salmon. The population of pink salmon returning to British Columbia's Broughton watersheds has grown exponentially in the past decade. This growth occurred over a period during which the biomass of farm-raised Atlantic salmon also increased. The positive correlation in abundance between farmed salmon and wild salmon suggests that salmon farming, in and of itself, does not adversely affect the abundance of pink salmon.

SEA LICE FACT SHEET

IN-DEPTH VERSION

Sea lice...Why is it a controversy?

Sea lice may seem like small pests, but the parasites are causing big waves in British Columbia, home to one of the world's largest diversities of wild salmon and also to a developing salmon farming industry. The British Columbia coastline hosts more than 75 active salmon farms, where net-penned Atlantic salmon grow in sheltered bays along the shoreline. Environmental groups believe that sea lice on farmed salmon are infecting wild juvenile pink salmon as they migrate out to sea. Scientists disagree, saying research to date shows no significant transfer between sea lice from salmon farms to wild stocks of fish. The controversy has captured local public interest, polarized researchers and now threatens a \$700 million industry.

What are sea lice?

Sea lice is a common name that refers to several species of parasitic copepods that infect fish in the marine environment. Sea lice are naturally occurring parasites that have been reported to co-exist with finfish like salmon, stickleback and herring for centuries. They feed predominantly on the mucus of the fish, attaching to the fish's skin, fins and less commonly to the gills.

Most species of sea lice have 10 life stages, each characterized by a molt, or transformation, that takes it from egg to adult. Eggs hatch into a free swimming, noninfectious stage that undergoes two molts before transforming into the infectious copepod stage. The copepod stage is free-swimming and non-feeding up until the time it locates and attaches to a suitable host. Once attached to the host, it begins to feed, and after a series of molts reaches the adult stage. Once sea lice reach the adult stage they mate and produce eggs that hatch and release new larvae into the water column, thereby completing the life cycle.

Sea lice can lower the fitness of salmon and in some cases be lethal when in abundance, as they create open lesions on the surface of the fish that compromises a fish's ability to maintain its saltwater balance. Smaller and younger salmon are more likely to succumb to sea lice.

More than 13 species of sea lice live in British Columbia waters, according to Richard Beamish, senior scientist, Department of Fisheries and Oceans (DFO) Canada. The two most common species of sea lice are *Lepeophtheirus salmonis* (most commonly infects salmon) and *Caligus clemensi* (infects a broad range of finfish, including salmon). *Lepeophtheirus salmonis* is commonly found on all pacific salmon throughout the North Pacific and are abundant on virtually all adult salmon returning to spawn in British Columbia rivers.

What sparked the debate?

Although sea lice have been around for as long as scientists can remember, environmental groups have only recently blamed lice infestations for putting wild salmon stocks at risk.

British Columbia's Broughton Archipelago on northern Vancouver Island has received massive attention regarding sea lice infestations since the sharp decline of its 2002 pink salmon run. Many people, including conservationists, commercial fishermen and fisheries biologists believe

the salmon collapse derived from a large kill of outward migrating juvenile pink salmon in 2001, and that sea lice originating from local salmon farms caused the kill. There are 27 salmon farms in the Broughton area.

As a result of this incident, in 2002, the British Columbia Ministry of Agriculture, Fisheries, and Food worked with individual salmon farms to address the concerns being raised. One farm site agreed to voluntarily fallow (remove farmed Atlantic salmon from net-cages) along the presumed migration route of wild juvenile Pacific salmon to protect wild juvenile fish from any potential sea louse infestation.

Why is this controversy important to the aquaculture industry?

Although the farmed salmon industry was introduced to British Columbia only three decades ago, it is now the province's biggest agricultural export, bringing in more than \$300 million a year in profit. Most of the salmon farmed in the province is exported to the United States.

However, margins for farming salmon are small, making every feed pellet count.

Now, increased pressure from environmental organizations regarding sea lice infestations has created more challenges for salmon farmers, while a complex regulatory environment in British Columbia has added additional costs.

Put simply, sea lice are costly to fish farmers around the world. When abundant, they injure and kill fish, reduce growth rates and require expensive therapeutic pharmaceutical control treatment.

Do sea lice impact consumers?

Sea lice do not affect human health. Traditionally in Europe, the presence of live sea lice on wild salmon was considered to be a sign of good quality fish. Today, the lice usually fall off or are cleaned off during harvesting or processing activities before the fish reach the consumer. There is no difference between sea lice found on farmed salmon and those found on wild salmon.

However, the controversy threatens to limit salmon supply and increase the price of salmon, a dietary staple high in protein and omega-3 fatty acids.

Do sea lice transfer from farmed to wild fish?

To date, no direct 'cause and effect' relationship between sea lice, salmon farms and wild salmon has been identified by scientists who have studied the issue, reports Kenneth Brooks, senior scientist with consulting firm Aquatic Environmental Sciences, who has written reviews of the current scientific research on sea lice.

Scientists have been able to agree that because sea lice cannot survive in fresh water for more than two to three weeks, juvenile farmed salmon are free from sea lice when introduced into the marine environment from fresh water. They become hosts to sea lice at some stage after entering the grow-out phase. Why this happens is still unclear.

“Because the wild fish have sea lice initially, we don’t know whether there is a sufficient enough transfer of lice from farm fish to wild fish to make an impact on the levels of infection,” says Kevin Butterworth, a research associate at the Center for Aquaculture and the Environment, University of British Columbia. “If there is not a significant transfer of sea lice, then this whole issue is a moot point.”

Some work on the impact of sea lice on fish health has been done on sea trout and Atlantic salmon in Norway, says Butterworth. Research there has shown that sea trout and Atlantic salmon tend to be very susceptible to sea lice, he says.

“A lot of people have taken the Norwegian research directly and extrapolated it to the Pacific salmon,” Butterworth adds. “But this can be very dangerous, as the Atlantic and Pacific salmon are different species.” Pacific salmon launch an immune response and seem to be more robust, he says. In addition, Norwegian conditions and wild salmon to farmed salmon ratios are different. The lice may also vary in pathogenicity.

“We can’t simply assume that farm fish are the major source of sea lice because there are two species of sea lice and there are other hosts besides salmon for the sea lice,” says Beamish. *Caligus clemensi* is found on more than a dozen other species of fin fish. Thus, the *Caligus clemensi* that are found on the small pink salmon, and are often reported only as sea lice and not the species of sea lice, could come from a number of sources other than farmed salmon.”

Distinguishing sea lice species is important for another reason. The fact that salmon are not the only hosts for *Lepeophtheirus salmonis* is a new and important discovery, says Simon Jones, Fish Health Research Scientist, Fisheries and Oceans Canada, Aquaculture Division. Jones’ surveillance research in the Broughton Archipelago has determined that the stickleback has the same species of sea lice attaching to them as salmon. Jones is publishing new data on this discovery later this year in the *Journal of Parasitology*.

“It’s just too simplistic to say that salmon farms are the culprit for all sea lice infestations,” says Jones.

Is it possible sea lice come from wild salmon?

Yes. Recent studies examining monitoring data from BC farms can find no evidence that populations of sea lice are cycling through generations on farms, according to Jim Brackett, DVM and CEO of the BC Centre for Aquatic Health Sciences.

“So it looks like the sea lice are coming from the wild fish onto farmed fish,” Brackett says. The farm fish seem to go into the marine environment clean and pick up the lice from wild fish, he says. In fact, in the past three decades that the DFO and others have been monitoring disease, the only diseases detected on salmon farms in British Columbia are those that are found naturally in wild salmon populations.

“When the lice numbers on salmon farms get to a certain level they are treated,” Brackett adds. “That management has kept numbers of lice levels on fish relatively low in British Columbia.” Salmon farmers have developed a variety of methods to prevent and treat sea lice outbreaks. Good farm maintenance and husbandry are helping to prevent outbreaks, and therapeutic

pharmaceutical sea lice treatment products, such as Slice, are used to help treat salmon after an outbreak occurs.

Salmon farms are required by law to monitor sea lice. As of November 2003, all salmon farm sites must have a Fish Health Management Plan, required by the province of British Columbia and reviewed by the DFO. These plans are a condition of license and as such are enforceable.

A real problem with current sea lice research, however, is that no one is addressing how many lice are detrimental to the health of fish, says Butterworth. “We need to develop a health index so that if salmon get into a certain lice threshold, we can know there is an effect on their health,” he says.

No studies to date describe the lethality of sea lice to pink salmon. However, the DFO reported in 2001 that monitoring of juvenile pink salmon carrying up to 2.7 lice per infected fish appeared healthy. Jones has found no evidence that the low levels of infection were affecting growth rates or condition factors of juvenile pink or chum salmon in his monitoring work for the DFO. Jones says lab studies are underway to test the significance of lice on the health of pink and chum salmon.

“There is a huge gap in scientific knowledge in determining what it means when we see two sea lice or 10 lice on pink salmon,” says Jones. “Our lab studies are aimed at filling that gap.”

What other factors impact sea lice levels?

Another area of research gaining interest is how the influence of temperature, salinity and hydrodynamics impact the survival and dispersal of sea lice.

In recent research by Jones, studies are showing significant differences in sea lice abundance depending on where the Pacific salmon are collected, such as areas with low salinity and varying sea currents in the Broughton Archipelago. Monitoring studies have determined prevalence of sea lice increases as the pink and chum salmon migrate from east to west through the archipelago, but has been found on less than 50% of pink salmon fry as they exit the archipelago. Jones believes the weight of the host fish and the salinity level of the marine environment are the most important factors in determining the level of lice infection.

“Over the three years of data we’ve collected, we’ve found that sea lice tend to be lowest in areas where the salinity is lowest,” says Jones. “We also see clear trends over space and time that relate to the size of the fish and sea lice infection. Larger fish tend to have more mature lice on them and fewer lice, whereas immature fish that more recently enter the marine environment have more lice, but the sea lice are not as developed.”

Natural salinity in the Broughton Archipelago could explain the absence of any significant impact on cultured Atlantic salmon during the last decade, according to Brooks. Hydrodynamic studies reveal that the top 25 meters to 40 meters of water generally flows seaward through the Broughton archipelago under the influence of freshwater, reducing surface salinity from 15 PPT to 25 PPT from June through November of most years. Sea lice larvae do not consistently develop to an infectious stage at salinities of less than 30 PPT, providing a natural control in the archipelago, according to research conducted by Brooks.

Freshwater inputs in the Broughton Archipelago also force strong seaweed flowing surface currents in the main channels that likely carry imbedded sea lice larvae significant distances during their development to an infective stage, reports Brooks.

As a result, ocean currents heavily influence dispersion of sea lice at the nauplius stage, the first stage in the life of a sea louse after it has hatched out of its egg. A particle-tracking model predicts that nauplii released in the vicinity of two farms located deep in the archipelago are carried 10 km to 40 km from the farms before they develop into the infectious stage, according to Brooks.

British Columbia salmon farms are generally located in well-flushed environments over relative deep water. Therefore, juvenile pink and chum salmon are most exposed to sea lice infection as they migrate through shallow near shore waters where slow currents are expected, Brooks reports.

Can sea lice be traced back to its source?

There may be some hope in ending the debate over the source of sea lice with help from isotope tracing.

Butterworth is currently using stable isotopes to track adult salmon from farms and wild salmon as they migrate. Stable isotope signatures in the tissue of the fish reflect those of local food webs. Hence, animals that move between isotopically different food sources retain the information for a certain time, thus enabling origin and migration routes to be traced. Butterworth hopes to use this information to distinguish whether or not there is a transfer of sea lice.

“In the end, if there is not a significant transfer of sea lice farmed to wild salmon, sea lice on farmed fish will be a fish management problem and sea lice on wild fish is a wild fisheries management problem,” adds Butterworth.

References

- [Aquanet, Canada's Research Network in Aquaculture, Sea Lice Fact Sheet, August 2004](#)
- [Association of Aquaculture Veterinarians of British Columbia, A review of the recent sea lice publication by Krkosek et al., 2005.](#)
- Association of Aquaculture Veterinarians of British Columbia, *Sea Lice Fact Sheet*, 2005
- BC Salmon Farms Association, Salmon Farming Industry Fact Sheet: [Sea Lice & Pink Salmon in the Broughton Archipelago](#)
- BC Salmon Farmers Association, Salmon Farming Industry Fact Sheet: [Sea Lice & SLICE](#)
- Beamish, Richard. Senior Scientist, Fisheries and Oceans Canada. Telephone interview, April 2006.
- [Beamish, R.J., Neville, C.M., Sweeting, R.M., and Ambers, N.J. 2005. Sea lice on adult Pacific salmon in the coastal waters of Central British Columbia, Canada. *Fisheries Research* 76: 198-208.](#)
- Brackett, Jim. DVM and former CEO of BC Centre for Aquatic Health Sciences. Telephone interview, April 2006.
- Brooks, K. 2005. [The Effects of Water Temperature, Salinity, and Currents on the Survival and Distribution of the Infective Copepodid Stage of Sea Lice \(Lepeophtheirus Salmonis\) Originating on Atlantic Salmon Farms in the Broughton Archipelago of British Columbia, Canada](#) ; Ken M. Brooks Sr. Aquatic Environmental Sciences, 644 Old Eaglemount Rd., Port Townsend, WA.
- Butterworth, Kevin. Research associate, Centre for Aquaculture and the Environment, University of British Columbia. Telephone interview, April 2006.
- British Columbia Ministry of Agriculture, Fisheries, and Food (MAFF), [2004 Sea Lice Management Strategy](#)
- British Columbia Ministry of Agriculture, Fisheries, and Food (MAFF), *Fish Production and Farming in the Broughton Archipelago Area*, 2005
- British Columbia Ministry of Agriculture, Fisheries, and Food (MAFF), *Sea Lice Management* report, 2005
- Finstad, B. [The Physiological and Ecological Effects of Salmon Lice Infection on Anadromous Salmonids](#), In Speaking for the Salmon: Proceedings of the Summit of Scientists on Sea Lice, 2002.
- Krkosek, M., M.A. Lewis and J.P. Volpe, [Transmission dynamics of parasitic sea lice from farm to wild salmon](#), Proceedings of the Royal Society B, 2005.
- Johnson, Stewart. PowerPoint Presentation, Sea Lice Identification Workshop, 2004 (http://www.agf.gov.bc.ca/fisheries/health/Sealice/Sealice_workshop_color.pdf) Stewart C. Johnson, Senior Research Officer, Fish Health and Immunology, National Research Council Canada.
- Jones, Simon. Fish Health Research Scientist, Fisheries and Oceans Canada, Aquaculture Division. Telephone interview, April 2006.

MAFF, *Frequently Asked Questions on Salmon Aquaculture Policy in B.C.* 2003, BC Ministry of Agriculture, Food and Fisheries: Victoria, B.C.

MAFF, *Frequently Asked Questions About Sea Lice.* 2004, BC Ministry of Agriculture, Food and Fisheries, Victoria, B.C.

Marine Harvest, *About Sea Lice* fact sheet

Moore, P., "BC Salmon Safe From Science Scare", Greenspirit Strategies Ltd., Vancouver, Canada, 2005. [National Post: BC Salmon Safe from Science Scare - April 5, 2005](#)

SeaWeb, "Researchers Reveal the Infectious Impact of Salmon Farms on Wild Salmon", March 29, 2005

Watershed Watch Salmon Society, [Sea Lice and Salmon: Elevating the dialogue on the farmed-wild salmon story](#)