SEA LICE

Association of Aquaculture Veterinarians of British Columbia

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Contact:
Jim Brackett, DVM
CEO, BC Centre for Aquatic Health Sciences
Box 277
Campbell River, BC
250 286 6102
250 286 6103
250 202 5409 cell phone

Under provincial regulation the British Columbia Ministry of Agriculture, Food and Fisheries (BC MAFF) requires all salmon farms to have a comprehensive Fish Health Management Plan (FHMP) as a condition of license. These plans include mandatory monthly or more frequent sea lice monitoring for Atlantic salmon at all marine net pen sites. This monitoring is done and paid for by the farms. See http://www.agf.gov.bc.ca/fisheries/health/Sealice_monitoring_results.htm

Periods of juvenile salmon out-migration have been determined by Fisheries and Oceans Canada. During these periods BC MAFF requires mandatory action if sea lice levels exceed 3 mobile lice/fish. In the Broughton area lice levels must be at these low levels before March 1st. To ensure that sea lice numbers are being sampled and reported properly, BC MAFF audits sampling by the farms on a random basis. For example, in 2005 during the peak smolt out migration 50% of the active salmon farms in BC will be sampled by BCMAFF fish health staff. During the first two weeks in March 2005 the BCMAFF Fish Health Veterinarian attended a number of farms in the Broughton area and confirmed that the lice levels on the farms were being properly sampled and controlled as per the management agreement between BCMAFF and the industry.

Complete monitoring numbers for all farms in area 3.3, which includes the Broughton Archipelago, are shown at http://www.agf.gov.bc.ca/fisheries/health/Sealice/Sealice_atl_3.3.pdf and http://www.agf.gov.bc.ca/fisheries/health/Sealice/Sealice_atl_3.3_05.pdf (2004 and 2005 respectively).

As health professionals involved in managing the health of farmed salmon in British Columbia we have concerns that the recent article by Krkosek et. al.[1], a mathematical scenario of how sea lice might be transmitted from farmed salmon to wild salmon, is too simplistic in its approach and therefore potentially seriously misleading in its conclusions.

Infection does not equal disease. Simplistic "presence/absence" models have not proven to be accurate for other situations, particularly if there are wildlife species involved, in this case, wild fish. Established terrestrial animal disease models took years to develop, in part because expression of disease is a complex combination of factors involving the host, pathogen and environment. In this case, the mere presence of lice (which are normal fauna of salmon) gives no estimate of the impact on the host populations, the pink and chum salmon. By contrast, the level of lice reported on farms in BC in the last two years is much lower than that reported in Europe and has rarely caused significant damage to the farmed fish.

A mathematical model is only as good as its assumptions. Several of the assumptions in this model are of concern:

a. The model does not differentiate the lice species being counted except for the gravid female life stage. Secondly, within the gravid females the *Caligus* species dominated, yet when the numbers were applied to the model all lice were treated as one species. *Lepeoptheirus* and *Caligus* species have different biology, ecology and pathology and the species effects must be separated whereas in this paper the lice species are combined together. This is a serious flaw in the study.

b. The implications of the strong net outward water flow in the area were ignored. Lice larvae, if present, would not be infective for approximately 7 days after hatch at the water temperatures that occurred during this time in 2003. If the farms are contributing significantly to the lice burden on the wild fish then, according to oceanographic information available for the area[2], the infective stages should be seen many kilometers downstream of the farm, not at the farm site.

c. The researchers have not been able to address lineage of the lice. In other words, without using isotopes or some other traceable signature it is not possible to know whether the source of lice seen on the juveniles was from the farms or from a wild source.

Mathematical models are usually proposed so that they can be further tested. In this case the researchers did not have access to the raw farm data. The only information available to them was information posted on one company's website which provides average lice numbers (*Lepeoptheirus salmonis* only) for a single standard pen. There was no information about the incidence or distribution of lice on the farm, nor was there any information about the presence of *Caligus* on the farm. Thus, the model cannot properly estimate the farm contribution of either *Lepeoptheirus* or *Caligus* to the infections on wild fish.

Finally, the outputs of a model must be ground truthed against actual outcome, in this case the impact of the presence of sea lice on the health of the pink and chum stocks. Measures of "health" include but are not limited to stock returns and medical indices. In this case stock returns were available. The subjects of this study were adult pink salmon returns in 2004 that resulted

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[1] M.Krkosek, M.A. Lewis and J.P. Volpe, 2005. Transmission dynamics of parasitic sea lice from farm to wild salmon. Proc. R. Soc. B (2005).

[2] Brooks, K. 2003 An assessment of the threat to Pink salmon (*Onchorhynchus gorbuscha)* runs in the Broughton Archipelago of British Columbia, Canada posed by sea lice (*Lepeophtherius salmonis*) infections originating in cultured Atlantic salmon (*Salmo salar*). Ken M Brooks Sr. Aquatic Environmental Sciences, 644 Old Eaglemount Rd, Port Townsend Washington, USA.

from the outward migration in the spring of 2003. Pink salmon returns in the fall of 2004--approximately one million fish--were at historical average levels.

The model proposed by Krkosek et al was based on less than complete data from one farm in BC at one point in time. While the salmon farming industry must live up to its responsibilities and must continue to monitor for potential negative impacts, the conclusions of the article are too sweeping and not supported. A robust disease model would consider the biology of the fish and the lice and the environmental parameters that affect both hosts and pathogens. It would also consider the health management and lice prevention measures on the farms and the history of the wild salmon stocks in the Broughton Archipelago.