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A review of the factual basis of interactions between farmed and wild salmon as it applies to salmon lice

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# Summary of report		:	*Accessibility:* **Open**
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Summary:

This is a summary of the report published in norwegian in April 2011.

An english version of the report as a whole will be published in August/September 2011.

The report entails a critical review of the factual basis concerning interactions between farmed and wild salmonids as it applies to salmon lice, with specific relevance to Norway.

The summary is in accordance with the report roughly divided into three main areas:

i) Population dynamics; various factors that affect stocks of wild (anadromous) salmonids
ii) Evaluation of the current knowledge concerning salmon lice; about occurrence of salmon lice, vectors and dispersion models
iii) Evaluation of the current knowledge concerning status reporting that forms the basis for decision makers / the management of wild salmonid stocks

1 Summary and conclusions

This report entails a critical review of the factual basis concerning interactions between farmed and wild salmonids as it applies to salmon lice.

This report is roughly divided into three main areas/chapters. The current knowledge is summarised below along with separate conclusions for each area.

Population dynamics; various factors that affect stocks of wild (anadromous) salmonids:
The development on both sides of the North Atlantic Ocean show the same population trends from a geographical perspective: In recent decades the stocks of wild salmon are described as stable in northern areas and decreasing towards the south in both Europe and North America (on both sides of the North Atlantic Ocean). In large parts of the southern area of distribution, the salmon population in river systems is regarded as threatened and/or extinct.

This relatively clear north-south gradient and correlation in the size of the populations of wild salmonids on such a large geographic scale suggests a common response by populations to large, global or sectorial environmental conditions (changes or variations that have an effect on population regulation of wild fish which are common and/or function the same over a large geographical area). There is increasing documentary evidence that the environmental conditions necessary for survival of anadromous salmonids during their marine life stage could explain such a correlation: Plausible explanations for population regulatory effects on such a large scale include climate changes and natural fluctuations in sea temperature that may cause fluctuations in the food availability and, consequently, of the marine survival for salmon.

Moreover, the common denominators for all areas in the south where local populations have become extinct or threatened (international level) are: High population density, intensive dam construction on major waterways, pollution (including acid rain) and total dewatering of streams.

The probability that the potential negative effects resulting from an increased occurrence of salmon lice in fish farms may have an effect on such a large geographical scale is virtually nonexistent. This is based on the following facts:

- Salmon stocks are influenced throughout their entire distributional range, including in areas where aquaculture does not occur.
- The decline is greatest in the south, where aquaculture occurs only on a small scale.
- The decline is least or nonexistent in northern parts of the distribution area, where the existence of aquaculture is greatest (exception – Tana River – refer to the text).
- No documented evidence exists on the causal relationship between increased salmon lice and a decline in salmon stocks, over such a large scale.

Evaluation of the current knowledge concerning salmon lice; about occurrences of salmon lice, vectors and dispersion models

Few descriptions exist of lice abundance in a more historic perspective. In the past, salmon lice infection was often registered on returning spawners, where as today registration of salmon lice infection is registered on outwardly migrating salmon smolts. To our knowledge there is no documentation that points to the fact that the level of infection of wild salmon at sea has changed in a historical perspective. However, it is also well documented that salmon lice infestations in coastal areas (immediately adjacent to fish farms) are more severe during times of the year, which in turn exposes migrating Atlantic salmon smolts to greater infection pressure than would normally have been the case without the presence of fish farms.

We have reviewed the literature that points out variation in salmon stocks in areas with and without aquaculture, and see that:

- The extent of salmon lice/infestation by salmon lice can be more severe periodically during the year in areas with aquaculture activity given the higher number of hosts (=correlation in occurrences of salmon lice and farmed fish).
- Local salmon lice abundance correlate and, in other instances, vary independent of the presence of aquaculture.
- Correlation has been detected in the amount of returning infested wild salmon and infestations of salmon lice in farms the following spring (infection can occur from wild fish to farmed fish).
- Correlation has been detected in the abundance of salmon lice infection on wild smolts and increased levels of salmon lice in fish farms (infection can occur from farmed to fish wild fish).
- It is documented that high levels of salmon lice can be deadly for salmon smolts.

On the contrary, we cannot see that there is documented evidence of a cause-effect relationship between the population size and the occurrence of salmon lice (as a separate factor). There are no instances to document that salmon lice are the <u>main reason</u> for change to the population dynamics. However, a lack of documented evidence does not have to mean a lack of connection; it can also mean that it is difficult to document whether there is a connection or not. There is, without doubt, a need for more knowledge on this area.

It has been established that brown trout, sea char and other species such as stickleback can be carriers and reservoirs for salmon lice. The sea trout lives in fjords and coastal waters year-round and can, therefore, sustain production of salmon lice year-round. It has been established as probable that wild brown trout makes a significant contribution to the maintenance of local salmon lice abundance.

It has been established as probable that infection by salmon lice resulting in osmo-regulatory problems can lead to behaviour such as premature returns. In spite of the fact that the description of this phenomenon is relatively new, we cannot see that there is documented evidence that this is a new phenomenon.

Weaker fish are possibly more susceptible to infestation by salmon lice than “robust”/non-weakened fish, but it remains uncertain how it can influence or contribute to the maintenance of the local abundance of salmon lice. However, it is known that acidification can indirectly affect survival of smolts in the marine phase as smolts that are exposed to an acidified environment (containing aluminium) have higher mortality resulting from infestation of salmon lice when compared with smolts from “healthy” freshwater environments.

To what extent Atlantic salmon might have developed resistance (in other words the degree to which natural selection for resistance against lice has taken place) remains uncertain. A possible effect of natural selection would be expected to increase with increasing salmon lice-related mortality. However, in populations where mortality is connected to (increased) infestation by salmon lice only at a low degree (low salmon-lice related mortality), natural selection for resistance against lice will not be of special significance.

Based on the available knowledge, we cannot find any existing scientific evidence documenting a simple/direct connection between the number of sexually mature female lice, essentially a product of the number of farmed salmon and the number of female lice per fish, and marine survival of wild salmonids, and the calculation/estimates of a sustainable level of lice is, therefore, not sufficiently knowledge-based.

The dispersion dynamics of salmon lice is extremely complex and parallel with the complexity in the fjord systems and along the coast generally. Variations in topography, climate, geographical location, flow conditions and local weather conditions can make a significant contribution to the dispersal pattern in terms of both time and space. Consequently, assumptions about “ideal localisation of fish farms” will involve a significant element of speculation. However, if speculation is permitted, it is possible on a general basis to mention that some areas in the fjord system appear to be more exposed than others.

In an ideal situation (where the goal is the most effective management of wild salmon stocks) it would be desirable that modelling of dispersal patterns is implemented more specifically, possibly separately for each fjord system, in order to be able to offer better advice about when delousing would be more effective.

Evaluation of the current knowledge concerning status reporting that forms the basis for decision makers / the management of wild salmonid stocks

Working parties and councils appointed to undertake assessments that will form the basis for management carry a major responsibility and, according to the regulations, have an obligation to ensure such evaluations are “objective and (scientifically-)knowledge-based”. Following a review of a large amount of material in connection with the compilation of this report, included reports that evaluate the threats to and status of wild salmonids, we believe we have revealed several instances where i) assertions are expressed without scientific basis, ii) there are instances of under-reporting of other probable contributing factors to negative development of salmon stocks, and iii) there are instances of over-reporting of negative effects of salmon lice (which is attributed to aquaculture).

If the goal is to protect/preserve wild stocks of anadromous salmonids, we recommend documentation of actual causes of population regulation and that an attemp is made to do something about these.

We are calling for more objective, scientific and integrated (in other words multifactorial) assessments to form the basis for decision making relating to the management of wild anadromous salmonids.

Excerpt from the (Norwegian) Nature Diversity Act:

Section 10: Ecosystem approach and cumulative environmental effects
Any pressure on an ecosystem shall be assessed on the basis of the ***cumulative environmental effects*** *on the ecosystem now or in the future.*