Policy Brief on the Effect of Salmon Aquaculture on Wild Atlantic Salmon Populations

Purpose

The purpose of this paper is to provide a policy brief on the management implications of the key findings of the State of Knowledge studies on the 'Effect of Aquaculture on Wild Atlantic Salmon Populations', from the Expert Groups that performed the studies.

Decisions

- no decision is required

Sea Lice Impacts from Salmon Aquaculture

Policy and Management Implications

Wild Atlantic salmon (*Salmo salar*) populations across the North Atlantic are declining, impacted by various factors, including salmon lice (*Lepeophtheirus salmonis*) infestations linked to marine salmon aquaculture (Limburg and Waldman 2009; Chaput 2012). Salmon lice can proliferate at high densities in aquaculture settings, resulting in 'spillback' to wild salmon. This parasitic pressure compromises salmon health, affecting marine survival rates and reducing adult returns, with direct implications for conservation and fisheries (Vollset *et al.* 2023; Thorstad *et al.* 2015; Krkošek *et al.* 2007).

The current study, 'Does exposure to sea lice from aquaculture have a population-reducing effect on wild Atlantic salmon? A systematic review' by Larsen *et al.* evaluates the evidence on salmon lice impacts, highlighting the need for robust management practices across aquaculture-intensive regions.

Results of meta-analysis of randomised controlled trials (RCTs) comparing anti-parasitic treated and untreated salmon indicate that sea lice negatively impact wild salmon populations.

However, the true impact of sea lice on wild salmon populations may be greater than that reported from the analysis due to biases in experimental design and insufficient data on lice infestation pressure. These factors may underplay the true effect of sea lice on increasing marine mortality of salmon in the study and by extension, the true impact of sea lice from marine salmon farms on wild Atlantic salmon survival. The use of hatchery salmon as a proxy for wild salmon in experimental studies also results in lower estimates of lice impact on salmon survival as uptake of chemical treatment is not always effective and lice have developed resistence to chemical treatment over time. In addition, the level of impact of sea lice on salmon survival is likely understated as the negative impact of sea lice may be amplified when salmon smolts face additional mortality pressures.

Therefore, the true impact of sea lice from salmon aquaculture causing mortality of salmon at sea is greater than is currently understood due to bias and experimental inconsistancies difficult to control in the current experimental trials used to examine this impact.

Salmon aquaculture is undertaken across the North Atlantic range of Atlantic salmon and increased marine mortality of wild salmon due to sea lice impacts from aquaculture have been demonstrated in many individual studies (Thorstad *et al.* 2015). However, using the results of this combined study using systematic review and critical appraisal and subjecting the results to a random-effects meta-analysis has proven difficult in establishing the true scale of impact of sea lice on wild salmon populations.

Based on the findings of the present study, an increased level of precaution should be pursued to protect wild Atlantic salmon from the negative effects of sea lice from salmon aquaculture. All Atlantic salmon countries are members of the North Atlantic Salmon Conservation Organisation (NASCO). NASCO has adopted the policy document 'Guidance on Best Management Practices to address impacts of sea lice and escaped farmed salmon on wild salmon stocks', SLG (09)5, and this guidance should be followed to reduce wild salmon impacts from aquaculture.

Key Findings

The key findings of the study entitled 'Does exposure to sea lice from aquaculture have a population-reducing effect on wild Atlantic salmon? A systematic review' by Larsen, M.L, Rytwinski, T., Lennox, R.J., Gargan, P., Cooke, S.J., Harper, M., Dalvin, S., Shepard, S., Nilsen, F., Brady, D.C. and Vollset, K.W. are:

- evidence indicates that salmon lice from aquaculture negatively affects wild Atlantic salmon populations. Systematic review data show a reduction in survival and adult returns in salmon exposed to salmon lice;
- increased mortality linked to salmon lice infestations is documented in countries with significant salmon aquaculture, including Norway, Ireland, and Scotland, suggesting a widespread impact across the North Atlantic; and
- studies show a degree of bias due to limitations in study design, including inadequate documentation of salmon lice levels during out migration and the effectiveness of anti-parasitic treatments. These biases suggest that the true impact of salmon lice on wild salmon populations may be greater than current estimates.

Recommendations

1. Implement the NASCO 'Guidance on Best Management Practices to address impacts of sea lice and escaped farmed salmon on wild salmon stocks', SLG(09)5, across their entire North Atlantic range; specifically that '*100% of farms to have effective sea lice management such that there is no increase in sea lice loads or lice-induced mortality of wild salmonids attributable to the farms*'.
2. Expand monitoring of salmon lice to monitor and report sea lice levels in aquaculture areas regularly to ensure they remain within sustainable limits, particularly during key migration periods for wild salmon. and
3. Increase transparency and data sharing by Governments and aquaculture operations to support transparent reporting and data sharing on lice levels and aquaculture practices, facilitating more effective research and conservation strategies.

Conclusion

Taken together, implementation of these recommendations, based on the findings of the current study, offers the opportunity to increase safeguards in protecting wild Atlantic salmon from the negative impacts of sea lice from marine salmon farms. Implementation of the NASCO Guidelines and commitment to rigorous monitoring and research will support the resilience of wild salmon populations and contribute to the sustainable management of salmonid aquaculture.

Genetic Impacts from Salmon Aquaculture

Policy and Management Implications

Atlantic salmon (*Salmo salar*) is widespread throughout the North Atlantic with a very high level of intraspecific diversity, represented by a large level of genetic variation within and between populations and a large variety in phenotypes. This high level of intraspecific diversity is a prerequisite for the resilience of this species in an era of rapid climate change and threats from habitat degradations (Govaert *et al.* 2024; Des Roches *et al.* 2021). Genetic introgression of escaped farmed salmon in wild salmon populations is different from other threats in that it leads directly to changes in the function of the wild salmon and irreversibly weakens the viability and long-term possibility to adapt to environmental and climate changes. Genetic introgression of escaped farmed salmon is, therefore, regarded as the most serious threat to wild Atlantic salmon (Glover *et al.* 2017).

From facing a long list of different threats, the number of wild Atlantic salmon has declined dramatically over the last 50 years with 7 million in the early 1970s and only 2 million today. At the same time there has been a dramatic increase in the number of farmed salmon from about 2 million in the early 1980s to about 420 million in the 2020s (ICES 2024). Norway has by far the largest production of farmed salmon, followed by Scotland, the Faroe Islands, Canada, Iceland, Russia, the United States, Ireland and Northern Ireland. There are about 200 times more farmed salmon than wild salmon in the North Atlantic and at this geographical scale, there are no large regions free from salmon farming. Since Atlantic salmon aquaculture started more than 50 years ago, millions of farmed salmon have escaped and entered wild salmon rivers to spawn.

Key Findings

The key findings of the study, entitled 'Genetic introgression of farmed Atlantic salmon in wild salmon populations throughout its native range', by (alphabetically) Bolstad, G., Bradbury, I., Gilbey, J., Gudmundsson, L. A., Karlsson, S., Kess, T., McGinnity, P., Thorstad, E. and Wringe, B. are:

- comparison of existing data on the genetic integrity of wild Atlantic salmon to data on farmed salmon production shows the major producers of farmed salmon (Norway, Scotland, Canada, Iceland) in the North Atlantic have all undergone farmed-to-wild gene flow; and
- using molecular genetic markers to investigate genetic introgression of escaped farmed salmon in 481 salmon rivers, genetic introgression was detected in 57 % (275) of the investigated rivers, throughout the North Atlantic.

Recommendations

1. Implement the NASCO 'Guidance on Best Management Practices to address impacts of sea lice and escaped farmed salmon on wild salmon stocks', SLG(09)5, specifically that the International Goal of '*100% farmed fish to be retained in all production facilities*' is achieved.
2. Encourage and facilitate further monitoring of, and research on, genetic introgression.
3. Follow up investigations to monitor future trends.
4. Expand investigations to include more salmon populations in regions poorly covered so far.
5. Encourage and facilitate further monitoring and research of genetic introgression on the resilience of wild salmon and its ability to cope with other anthropogenic stressors, and in particular climate change. and

6. Encourage and facilitate collaboration between researchers and stakeholders throughout the North Atlantic.

Conclusion

Introgression of wild Atlantic salmon is widespread across the North Atlantic and is the most serious threat for the viability and ability to adapt to current and future environmental changes. The species-level alteration of wild Atlantic salmon and loss of intra-specific diversity from salmon aquaculture shown in the current study threatens the resilience of wild Atlantic salmon, a species that has declined to less than one third of its original abundance over the last 50 years.

References

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