International Atlantic Salmon Research Board *Knowledge Gaps in Pink Salmon Research Related to Impacts on Atlantic Salmon* *(Submitted to the Board by the Chair of NASCO's Pink Salmon Working Group)*	**ICR(26)06** **Agenda item: 7**

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(Submitted by the Chair of NASCO's Pink Salmon Working Group)

Background

Pink salmon is a species that, in its native range, is known to have wide-ranging impacts on other species and entire ecosystems. In this note, we list the major knowledge gaps related to impacts on Atlantic salmon, which fall into three categories:

i. The impact of pink salmon on Atlantic salmon.
ii. The impact that corrective and monitoring measures taken on pink salmon may have on Atlantic salmon.
iii. Methodologies used in relation to pink salmon.

Specific knowledge gaps in each of these three categories are outlined below.

i. The Impact of Pink Salmon on Atlantic Salmon

Impact of juvenile pink salmon in rivers and near coastal areas:

- When do pink salmon hatch, smoltify, and migrate to sea, and how are these timings influenced by environmental and biological drivers?
- How long do juvenile pink salmon juveniles remain in different rivers and river sections before migrating to sea as smolts, to what extent do they feed during this period, and what is their diet composition?
- How do high densities of juvenile pink salmon affect Atlantic salmon juveniles in terms of competition for food and space, physiological stress, habitat use, feeding and growth, ultimately survival until the smolt stage?
- How long do pink salmon feed in river mouths, fjords and other near-shore habitats during their marine migration, and at what densities might they influence the movement patterns and feeding of out-migrating Atlantic salmon smolts?

Impact of pink salmon during the feeding migration in the ocean:

- Pink salmon have been shown to influence other species at the ecosystem level within their native range in the Pacific Ocean. However, current densities in the Barents Sea and the Atlantic Ocean are likely too low, relative to other marine fish species, for similar large-scale effects to be expected. Consequently, investigating such ecosystem level impacts is not considered an immediate research priority. Nevertheless, studies of pink salmon migration routes and diet, based on individuals caught in marine surveys or as bycatch, will still provide valuable information. Understanding how marine temperatures and other ocean conditions influence pink salmon survival, migration, and growth at sea will also improve our ability to predict the extent and dynamics of their invasion.

Impact of adult pink salmon in rivers before, during and after spawning:

- What cues do introduced pink salmon use to select rivers for entry, and are certain river characteristics associated with a higher likelihood of invasion than others?
- How do adult pink salmon, before and during spawning, impact adult Atlantic salmon in terms of migration delays, altered behaviour, and changes in spatial distribution caused by competition for space, crowding, and aggressive interactions?
- How far upstream do pink salmon migrate, and do environmental or biological factors determine their migration distance?
- To what extent do pink salmon spawn in the same habitat as Atlantic salmon, or do they utilise a broader range of substrates and thereby occupy larger areas of riverbed?
- What are the impacts of marine-derived nutrient input from dead pink salmon on Atlantic salmon, particularly on juvenile growth, and on the age and size of smolts, which may subsequently influence later life stages?
- How can pink salmon act as a vector for pathogens and what are the impacts of adult pink salmon, including carcasses, on the health of Atlantic salmon, including eggs in redds?

The potential impacts listed above are likely scale-dependent and should be examined across rivers of varying sizes and differing pink salmon densities. In addition, the influence of pink salmon on predator dynamics warrants closer examination, particularly how changes in predator abundance or behaviour driven by pink salmon presence may indirectly affect Atlantic salmon through altered predation pressure, competition, or food web interactions.

ii. The Impact that Corrective and Monitoring Measures Taken on Pink Salmon May Have on Atlantic Salmon

- What is the threshold at which corrective measures should be implemented in a river or region, considering both the expected negative impacts of pink salmon (which are linked to the questions listed above) and the potential adverse effects that such measures may have on Atlantic salmon?
- In relation to assessing the need for corrective measures: What is the potential spread and production capacity of pink salmon in the Barents Sea and North Atlantic Ocean region, considering the geographic extent of suitable river and marine habitats, the amount of accessible spawning and rearing habitat in rivers, and the smolt-production potential of these systems?
- In relation to planning and evaluating corrective measures: What are the homing and straying rates of pink salmon in the Barents Sea and Atlantic Ocean region, and consequently, which rivers and regions are likely to benefit from corrective actions implemented in a given river or area?
- What are the impacts of bank-to-bank traps and the various net types used to capture pink salmon on the upstream and downstream migration of Atlantic salmon?
- At present, pink salmon in the Barents Sea and North Atlantic region form an odd-year population with a strict two-year life cycle, meaning that corrective measures are required every second year. However, the age structure of the population should be monitored to determine whether they begin to adopt a more variable age composition, as has occurred in introduced pink salmon populations in the Great Lakes.

iii. Methodologies Used in Relation to Pink Salmon

- How reliably can eDNA detect pink salmon at low population densities within a watershed? Specifically, how long does eDNA remain detectable, and how far is it transported downstream under varying conditions such as water discharge, temperature, and other environmental factors?
- What is the persistence of eDNA derived from decomposing pink salmon spawners, and how well can spring detections of juveniles be distinguished from signals originating from the previous season's spawning adults?
- Can eDNA methods be developed to more accurately relate detection signals to species abundance?
- How can AI-based solutions be used to distinguish pink salmon from Atlantic salmon and thereby reduce the need to handle Atlantic salmon in bank-to-bank traps?
- To what extent can otolith geochemical signatures reliably discriminate the river or regional origin of returning individuals?