Elucidating the Marine Behaviour of Atlantic Salmon

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Atlantic salmon is highly prized as a recreational and commercial resource in the Northern hemisphere. Their large size, impressive leaping capability, long migration and exceptional homing ability have lead many authors to describe it as "the king of freshwater fishes". Although spawning and juvenile growth occurs in freshwater, the species is usually anadromous and undertake the bulk of their lifetime growth during a 1-4 year long sea migration covering large areas in the open ocean. Here they increase their weight from 10-50 grams at the start of their migration, to 1 to over 30 kg before they return to spawn. Unlike most Pacific salmon that all die after spawning, post-spawners (kelts) of Atlantic salmon may survive and migrate to sea again, and subsequently return to spawn one or several times more. Contrary to the vast literature on the salmon life cycle in freshwater, remarkably little is know on the life at sea despite the importance of this life phase for the total production of the species. Therefore, the Norwegian lead project, "Salmotrack", was initiated in 2006 where different electronic tracking methods are being used to map migrations of salmon and other northern anadromous salmonid fishes during different life-phases, with special emphasis on marine migrations.

The "Salmotrack" project coordinates available logistics and equipment in order to maximize the synergetic effects of each subproject. It utilizes telemetry techniques like PIT, acoustic, archival, radio and most recently pop-up satellite archival tags (PSAT). Almost all life stages of salmon have been covered, including juveniles and smolts in rivers, post-smolts in fjords, open ocean migrations of adults, returning adults in fjords and rivers, kelts (post-spawners) in the river and fjord and escaped farm salmon. Two post-doc positions, three PhD positions and several master and bachelor students have been, or are directly involved in the project. The project is managed by the University of Tromsø in northern Norway with Dr. Audun H. Rikardsen as the project leader. As all the skills required in such a project are rarely embedded in only a few persons, it involves extensive Norwegian and international cooperation. This includes scientists from Canada, Denmark, England, Finland, Iceland, and Ireland, that together hold various competencies needed from different disciplines, including salmon ecology, telemetric and tagging expertise, oceanography and mathematical statistical skills. There is also a large set of logistics involved in obtaining and tagging the fish in sufficient numbers from different locations.

The necessity of such studies is underlined by the severe decline in the species over the last decades. Atlantic salmon is now protected under the endangered species act in the USA and listed as threatened in several European countries. Proper management action to restore populations will require detailed knowledge of all life stages.

The majority of knowledge that exists about the marine phase comes from fishing and classical marine cruises. This gives some information on the distribution and marine feeding. However, marine cruises are very expensive, time consuming and also give the classical problem of being "CPUE based" (i.e., you can only catch salmon where and when you fish for them) and say nothing about where the fish was before capture (or in case of release, after).

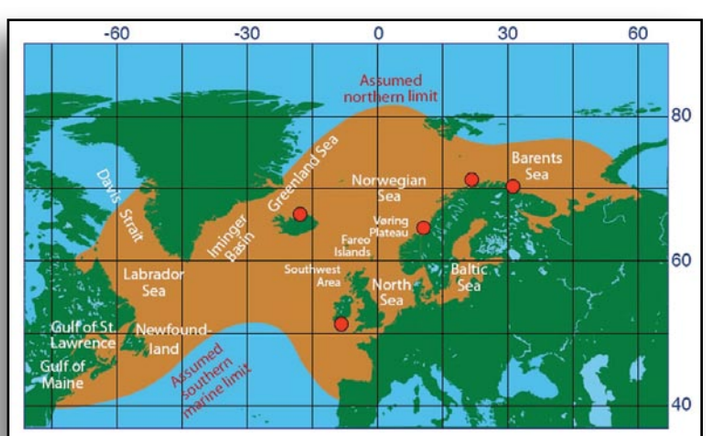
Photo by Salmotrack

Audun is releasing the first PSAT out of several tagged post-spawn Atlantic salmon (kelt) into the Alta Fjord in northern Norway.

However, the development of electronic tagging (DST and PSAT tags etc.) has provided a tool to gather catch independent continuous high-resolution information on depth, temperature and geo-location information, making it possible to track long-term individual migration behaviour of salmon at sea. The vast number of data these methods can bring holds the potential to model the behaviour at sea, given sufficient quality of data. PSAT technology specifically gives the advantage of a direct position observation in the sea shortly after the tag detaches from the fish and comes to the surface. Light measurements can furthermore be used for a more detailed mapping of the migration by modelling the sunset and sunrise times.

The Salmotrack-project has since 2008 attempted to unravel some of the mysteries of Atlantic salmon behaviour in the open sea by employing various methods including PSAT tags. Therefore, extensive effort has been (and still is) put on developing a tagging, handling and data analysing procedure that could maximise the data information gathered by each fish. For example, it was a challenge to get the PSAT to stay on the fish for up to one year, as well as to track these animals above the Arctic Circle by use of sunset and sunrise due to the midnight sun and dark winters at these latitudes. The most important field season so far will be 2010 where we intend to tag salmon in a number of rivers around Europe in order to map the migration pattern of salmon from different regions, including northeast, northwest and southern part of Norway, Ireland and Iceland (see map). We hope to be able to expand the tagging areas in the near future, as well as possibly including other species, and to share experiences and cooperate with new research scientists in this regard.

The current size and configuration of the PSAT tags dictate an external attachment on rather large fish. Therefore, we tag only adult post-spawn Atlantic salmon (kelts) on the return migration to the sea. Initial tagging has been performed and the results are very promising and will hopefully generate many new insights to the marine biology of this fascinating animal. We hope to keep you updated on this in the near future.



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Map of the assumed ocean distribution of Atlantic salmon at sea (area in brown) and recent PSAT tagging locations (red dots). Rikardsen & Dempson 2010.