



**International Atlantic Salmon Research Board**

**ICR(18)03**

*Progress Report on SALSEA - Track*



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1. At its 2013 meeting, the Board had agreed that a particular focus of its work should be studies to partition mortality of salmon among the phases of its marine migration. In 2014, the Board adopted a Resolution on Research on Salmon at Sea, ICR(14)6, which, among other things:
  - encourages NASCO Parties to continue the development of local collaborative telemetry projects;
  - encourages the development of large international collaborative telemetry projects that together build upon and expand local efforts; and
  - requests NASCO Parties to make efforts to identify funding sources to support telemetry projects.
2. To support an integrated collaborative telemetry programme, the Board organised a Telemetry Workshop in December 2014. At this Workshop, twelve outline project proposals for telemetry-based research were developed. In 2015, the Board recognised the high value of the SALSEA brand and the strong impact of NASCO as the international forum for consultation and co-operation on wild Atlantic salmon. The Board had re-affirmed its commitment to an international telemetry project under the SALSEA brand, named SALSEA - Track. Specifically, in 2015 the Board agreed that it would support SALSEA - Track as a continuing commitment to understanding the factors affecting mortality of salmon at sea, to make funds available to prepare a vision statement for SALSEA - Track and to advance existing initiatives towards an integrated collaborative telemetry programme.
3. The Board recognised that if the international telemetry programme is to proceed, it would be important to follow progress in taking forward the twelve outline projects and, where appropriate, provide support to assist with their implementation. Last year, the Board had confirmed that it endorsed these twelve projects but noted that, if they changed substantially, they should be referred to the Board's Scientific Advisory Group (SAG). It was recognised that there might be scope to combine some of these projects into larger projects within the NAC and NEAC areas. The SALSEA - Track brochure had been developed, in consultation with members of the Board / SAG and a professional fund-raiser, prior to the Board's 2016 meeting and has been widely distributed and well received. In 2017 and early 2018, funding was made available through a European Union funding mechanism to support three projects relating to marine mortality.
4. This paper provides an update on progress with the twelve outline projects and on the funding from the EU and details new telemetry projects reported through the inventory of research relating to salmon mortality at sea.

#### **Progress on the twelve outline projects**

5. In accordance with the Board's request that progress in taking forward the twelve outline projects be followed, the contact for each project was requested to provide an update on progress to date, identifying any challenges in progressing the projects and advising of any assistance the Board may be able to offer to support implementation of the projects and in

disseminating information relating to them. The responses received are summarised below:

<p>Drifters and BioProbes: Options for detecting acoustically tagged fish in large geographic areas (NAC and/or NEAC)</p>	<p><b>Progress report (John Kocik and Fred Whoriskey):</b> The Ocean Tracking Network has contracted MetOcean and Vemco to produce a cost-effective, real-time recording drifter buoy. Three initial units have been received and are undergoing modifications to prepare them for field testing in autumn 2018.</p>
<p>New Receiver Lines/Arrays/Grids (NAC)</p>	<p><b>Progress report (Tim Sheehan, John Kocik, Jon Carr and Fred Whoriskey and Martha Robertson):</b> Some progress has been made on this project in 2016. With regards to adding acoustic receiver capacity of/to marine autonomous vehicles, OTN has ordered two new Slocum Gliders and intends to order two SV3 Wave Gliders within calendar year 2018 to increase its fleet and add North Atlantic Ocean coverage. OTN is also working within the nascent Ocean Gliders Canada to arrange to place acoustic receivers on gliders operating within marine areas used by salmon during their marine migration, including the Labrador Sea. OTN has also been working through the Horizon 2020 AtlantOS program to partner with a variety of agencies and programs (DFO, OSNAP, OceanSITES, University of Washington, others) that have established fixed moorings in the North Atlantic Ocean and Labrador Sea to add acoustic receivers to the moorings. An inventory of potential buoys has been developed, maintenance schedules for them have been identified, possible gear conflicts (i.e. notably the presence and cycling of ADCPs (acoustic Doppler current profilers) co-deployed on the buoys) are being evaluated, and we hope to begin some deployments in 2018. We are also working with teams from the University of Windsor interested in tracking Greenland halibut in the Norwegian Sea, and with a team from Dalhousie University, Memorial University of Newfoundland and the Groundfish Enterprise Allocation Council that plans to deploy additional receivers in 2018 on the continental shelf off of Newfoundland. These deployments will complement our ability to track the marine movements of salmon with acoustic telemetry.</p> <p>Starting in 2015, ASF deployed a second line of receivers (N=28) in the Strait of Belle Isle (SoBI) to measure the efficiency of the existing line and calibrate stage specific survival estimates for post-smolt traveling through the Gulf of St Lawrence. ASF and DFO deployed a new receiver array along the Labrador coast about 80km north of SoBI (near Port Hope Simpson) in 2017. Twenty acoustic release VR2AR receivers were deployed extending 16 km from the shore towards the shelf. This array will be expanded in 2018 with the addition of 20 new receivers.</p> <p>With this developing capacity, what is now needed is a solid plan/idea for the science that needs to be done, identification of critical new infrastructure that might need to be added, and identification of how the science and infrastructure will be sustained for the necessary time period. In support of this, a telemetry workshop took place in Halifax Nova Scotia in December 2017 designed to build upon a workshop held in December 2014 by the North Atlantic Salmon Conservation Organization's (NASCO) International Atlantic Salmon Research Board (IASRB). Partners and invited experts were assembled to develop a collaborative and</p>

	<p>coordinated telemetry program in North America within which would be nested individual telemetry projects occurring across the species range in the Northwest Atlantic. The scope of the workshop was to review past and ongoing studies in the North Atlantic to help inform future research based on data needs/gaps, to further discussions related to North American and Greenland related SALSEA-Track components, and to develop a path forward for research programs to estimate and partition marine mortality of wild Atlantic salmon by improving our knowledge of salmon migration and distribution patterns. The workshop was supported by the Atlantic Salmon Research Joint Venture and a final report will be available in autumn 2018.</p>
<p>Platforms of Opportunity in the NAC area: Stationary Platforms of Opportunity Receiver Exchange (SPORE)</p>	<p><b>Progress report (John Kocik):</b> The NOAA team maintained extant opportunistic arrays in 2017 and continued working with the whale passive acoustic group. Due to expanded work in the Narraguagus Bay area and overall telemetry workload and funding issues, the telemetry monitoring on lobster traps (t-MOLT) and coastal rivers projects were suspended for 2017-2018. These platforms were often deployed after post-smolts left US waters or in river systems without tagged smolts so impacts to salmon monitoring are minimal. With expanded availability of acoustic releases, NOAA is considering again partnering with lobstermen to evaluate this platform for 12 month monitoring. Expansion of opportunities in the northwest GoM and associated waters of the Bay of Fundy remains a mutual NOAA, ASF, and DFO goal.</p>
<p>NAC kelt satellite tagging</p>	<p><b>Progress report (Tim Sheehan and Jon Carr):</b> No significant progress has been made to date due to resource needs, and current commitments. Tentative conversations within the US and with ASF as to possibly pursuing this type of effort have been conducted, but if this project were to be conducted it would not be until 2019/2020 at the earliest. However, ASF has continued their kelt tagging efforts in the Gulf of St. Lawrence (Miramichi and Restigouche rivers, and Cascapedia), but no new efforts outside of the Gulf have been initiated.</p>
<p>Generic Index River Sites in the NEAC area</p>	<p>No progress report received.</p>
<p>Malin Head to Islay Receiver Array (NEAC)</p>	<p><b>Progress report (Paddy Boylan):</b> SeaMonitor is an EU INTERREG V application which aims to investigate the migration of mobile marine species (Atlantic salmon, sea trout, basking shark and common skate) through the use of acoustic tracking technology on the north coast of the island of Ireland and the west coast of Scotland. The project proposes setting up a network of acoustic receivers in conjunction with two Autonomous Underwater Vehicles (AUV's) (Figure 1). In addition hydrophones would be deployed to investigate cetacean presence / distribution and common seals satellite tagged (on the east coast of Ireland - also potentially used as bioprobes for acoustically tagged fish). A decision on funding is expected in July 2018.</p>
<p>North Sea Loose Array (NEAC)</p>	<p>No progress report received.</p>
<p>West-coast Scottish arrays (NEAC)</p>	<p>No progress report received.</p>
<p>Studies of migration along the European shelf edge and into the</p>	<p>No progress report received.</p>

Norwegian Sea using drifters/AUVs etc (NEAC)	
NEAC kelt satellite tagging	No progress report received.
Sub-adult satellite tagging at Faroes	No progress report received.
Adult satellite/acoustic tagging at Greenland	<b>Progress report (Tim Sheehan and Jon Carr):</b> Planning (ASF, NOAA) continues in preparation of a multi-year satellite/acoustic tagging effort at West Greenland starting in 2018. Field activities in 2017 focused on exploring the feasibility of capturing study animals via trolling with rod and reel. Trolling was conducted for a total of 10 hours, 11 salmon were hooked, and 7 were landed. The landed fish ranged in size from 66-74 cm total length; all within the size range for consideration for tagging. Tagging activities will be initiated in 2018 and are expected to continue through 2021 at a minimum. Tagging in 2018 will utilize traditional pop-off satellite tags (PSAT, Microwave Telemetry Inc. X-tags). Tagging in 2019 will utilize traditional pop-off satellite tags (Microwave X-tags) and the new ROAM pop-off satellite tags. Tagging in 2020 and beyond will utilize ROAM PSAT tags only. Opportunities for increased acoustic tagging are being considered. Preliminary funding for the project is expected to come from NOAA, ASF, and the Woods Hole Oceanographic Institute and external funding opportunities will also be pursued. Discussions with potential collaborators with interests in European origin salmon, other species that also utilize the coast of Greenland and or the Labrador Sea, and other researchers interested in acoustic telemetry methods in the Labrador Sea are continuing.

6. The response to our request for progress reports and identification of factors hindering implementation for the twelve outline projects has not resulted in information for all projects. However, for those that have responded, some have indicated that lack of resources remains an issue. In the first phase of the SALSEA Programme, the Board had sought support from professional fund-raisers, Brakeley Consultants and we have maintained contact with one of those involved in the earlier work (Anne Conner) who remains very keen on the work of the Board. She volunteered to review the SALSEA - Track brochure and believes that together with the companion 'Salmon at Sea' brochure, which was developed following the Salmon Summit in 2011, the information available is informative and should be attractive to potential funders including corporates, foundations and high-worth individuals.
7. Identifying potential funders and attracting their interest in SALSEA - Track is a considerable undertaking that requires specialist skills. It would also require a clear description of the planned research and the funding required before funders could be identified and approached. The process would require professional support and Anne Conner's minimum contract would be for around £12,000 (for around 20 days of her time). However, this would only be feasible if we had planned and costed projects that could be presented to potential funders.
8. The Resolution on Research on Salmon at Sea, ICR(14)10, which encourages NASCO Parties to continue the development of local collaborative telemetry projects, should also be supportive of applications for funding and the Board can also support telemetry projects through endorsements as it has for the twelve outline projects.

## **EU funding to the IASRB**

9. Following the Board's 2016 meeting, applications for funding through EU 'Grants for an action' were completed for two projects and these were approved for funding (up to 80% of eligible costs). A further application, under the same funding mechanism, for a third project was made and approved in late 2017. A summary of the projects and a brief report on their progress is provided below.

### *Understanding and comparing early mortality of European salmon populations at sea*

10. *Summary:* Over recent decades, the abundance of wild Atlantic salmon stocks has been in decline throughout their migratory range despite the significant management measures put in place both domestically and at an international level. There is evidence that the initial mortality, immediately after smolts enter salt water, is very high and that this 'point mortality' may explain most of the variation seen in return rates of salmon. Estuarine and near shore mortalities may also be occurring in the part of the marine life cycle where management intervention is feasible. This project will determine the mortality of salmon smolts and post-smolts during their migration through the lower parts of rivers, estuaries/fjords and near-shore areas through case studies using telemetry in rivers in five areas: Denmark, England, Ireland, Northern Ireland and Spain. Mortality of kelts migrating on the same route will also be investigated in Denmark. In combination with other published results, the research will provide crucial input on marine mortality to existing models used for assessment purposes and test if the measured initial mortality can explain observed variation in return rates. If causality between post-smolt mortality and run size can be established, the findings may inform future management and conservation of (some) Atlantic salmon stocks.

**Total project cost (including in-kind contributions):** €18,300

**EU contribution to the IASRB:** €99,800

**Partners:** DTU Aqua (National Institute of Aquatic Resources), Denmark; Centre for Environment, Fisheries & Aquaculture Science (Cefas), UK; Xunta de Galicia, Spain; Agri-Food and Biosciences Institute (AFBI), UK. In-kind contribution from Inland Fisheries Ireland.

11. *Progress to date:* The Smoltrack project was initiated on January 1 2017, involving partners from Northern Ireland, England, Ireland, Spain and Denmark. The purpose of the project is to determine the mortality of salmon smolts/postsmolts during their migration through the lower parts of rivers, estuaries/fjords, and nearshore areas through case studies using telemetry in rivers of five areas: Denmark, England, Ireland, Northern Ireland and Spain. Additionally, mortality of kelts migrating on the same route will also be investigated in Denmark. Salmon will be tagged with acoustic transmitters and their subsequent migration will be followed via acoustic listening stations. This will provide novel data on lower-river and estuarine/coastal behavior and mortality, as well as to evaluate the method's applicability in a broader context. Beside the scientific aims, the project is intended to bring together a group of experts to provide advice on best practices and SOP for this type of studies.

The project tagging has now been completed including the second season that was enabled due to the good central purchase agreement made on Telemetry equipment. A second

workshop was held in Pontevedra, Spain in March 2018, where the progress was evaluated and Standard Operating Procedures (SOP) updated. All partners managed to tag the necessary fish. At all places there is a loss of smolt during the initial migration through the lower river and estuary. The specific regions differ, with some having the largest mortality in Freshwater, while others have the largest loss in the estuary (Table 1). Predation is suspected to be the main reason.

	Tagged	Lost FW (%)	Lost Estuary (%)	Survived (%)
Ulla, Spain	100	92	3	5
Minho, Spain	50	44	2	54
Bush, Northern Ireland	99	62	13	62
Eeriff, Ireland	40	70	0	30
Tamar, England	100	29	13	58
Skjern, Denmark	265	25	33	42

The results are being processed, but some site specific papers are expected to be produced, as well as an overall paper on the results.

***Comparing mortality of European salmon populations at sea using multiple -method telemetry studies***

12. *Summary:* The Smoltrack II project was initiated on January 1 2018, involving partners from Northern Ireland, England, Ireland, Spain, Sweden and Denmark. The project aims to expand the platform and collaboration of Smoltrack I by including more partners (Sweden is included now, taking the total number of study sites to eight). The geographical span of the project now ranges over all of the salmon distribution area in the EU from north to south and east to west. The project specifically aims to identify specific predators causing the documented loss of smolts from the Smoltrack I project and make comparisons between survival of wild and hatchery-reared salmon smolts. Blood sampling will be used to evaluate smolt quality and sex as they exit rivers to test if gender and physiological background affects the chance of survival. Lastly, the project will do a pilot study to test the feasibility to tag genetically assigned large salmon at the Faroe Islands or Greenland and track the return migration.

**Total project cost (including in-kind contributions): €39,000**

**EU contribution to the IASRB: €260,000**

**Partners:** DTU Aqua (National Institute of Aquatic Resources), Denmark; Centre for Environment, Fisheries & Aquaculture Science (Cefas), UK; University of Göteborg, Sweden, Xunta de Galicia, Spain; Agri-Food and Biosciences Institute (AFBI), UK and Inland Fisheries Ireland, Ireland.

13. *Progress to date:* The first project tagging (smolts) in 2018 has been completed. The data are not yet finally compiled (Automatic listening station and manual tracking has to be completed first). A workshop was held in Pontevedra, Spain in March 2018 (in prolongation of the Smoltrack I workshop), where studies and analysis were discussed and agreed and the Standard Operating Procedures for Smoltrack I were adapted for the present project, including procedures for bloodsampling and genetic analyses. The pilot study on salmon at sea is still in the planning phase and awaits discussion with North American colleagues in mid-June 2018.



*Sea lice model for the sustainable development of Atlantic salmon fisheries and aquaculture*

14. *Summary:* This project proposes to develop a sea lice integrative model developing and refining hydrodynamic modelling, environmental variables, sea lice production on salmon farms and other data requirements to support sustainable development of aquaculture and wild salmon stocks. Existing modelling tools have been developed in Norway and Scotland. These models simulate dispersal of larval sea lice based on farm production, hydrodynamics, water temperature and salinity, and have been used to identify the role of specific salmon farming sites as recipients or sources of sea lice. In order to make directly comparable estimations of lice dispersal, and hence larval concentrations and infection pressure, the models need to be standardised. The work carried out in each country can also benefit from the exchange of ideas to ensure optimal solutions are arrived at. For this reason, we will seek to form a network that will meet with the objective of developing a standard model that can be plugged into any hydrodynamic model of local currents to generate sea lice dispersal patterns. This project will contribute to developing best management practice for sea lice control and define a range of production strategies aiming at reducing the presence of sea lice and their negative impacts, both on farmed and wild Atlantic salmon.

**Total project cost (including in-kind contributions):** €18,604

**EU contribution to the IASRB:** €239,994

**Partners:** Inland Fisheries Ireland. In-kind contributions from Norwegian Institute for Nature Research; Institute of Marine Research, Norway; Marine Science Scotland; National University of Ireland, Galway

15. *Progress to date:* A project workshop took place in Dublin on March 2<sup>nd</sup> 2017. Partners gave an overview of the use of sentinel cages for monitoring sea lice distribution in Norway and Scotland and possible sampling strategies were discussed. Discussion took place on hydrodynamic model development and the “Dispersal Model for Sea Lice” used in Norway was discussed. The model estimates abundance and distribution of infective salmon lice copepodids with a high resolution in time and space. It uses real values of current, temperature, salinity from numerical current models. Coastal, wind and freshwater runoff models feed into a fjord model and the pathogen model is generated based on hatched eggs (farmed fish only), vertical behaviour, development / growth and mortality. Uncertainties in the model include hatching success (mortality) and no. of eggs in egg strings, reported lice counts and sources of lice from wild fish. Results of the model are validated from field observations.

An overview of sea lice hydrodynamic modelling in Scotland (POLCOMS hydrodynamic modelling) was also presented. The hydrodynamic model is based on surface currents and tracking of biological particles informed by knowledge of sea lice biology and behaviour (this has been validated against historic datasets). Additional overview was given on the Scottish Shelf Model (FVCOM) which is climate-based integrated with passive particle tracking (four seasons, model yet to be fully validated). This model shows connectivity of lice emanating from aquaculture installations over substantial areas of the Scottish coast. It was stated that POLCOMS is more relevant to the present project.

Data requirements for the development of an Irish model was also discussed. An EFDC model will be used for Ireland (c. 70 m resolution). Data on bathymetry; tides; horizontal

currents (will be monitored under sentinel cages); vertical current structure; determination of haloclines and thermoclines; and salinity/ temperature structure will be collected. Quantification of river inflows (salinity and temperature etc.; diffuse runoff) will also be undertaken. Temperature and salinity sensors will be deployed in the study area, Killary Harbour. Accounting for significance of upwelling / down-welling was discussed. Initial horizontal and spatial distributions of lice and data on life cycle durations and characteristics are required. Data on mortality effects, light, temperature, salinity, density, current speed, vertical migration etc. as well as data on mortality and decay rates are required.

Based on the workshop discussions, the sampling strategy for use of bag nets and sentinel cages to provide data for model development was finalised. Discussions also progressed on development of a standard model that can be used with any hydrodynamic model of local currents to generate sea lice dispersal patterns.



*Scottish type sentinel cage used in Killary harbor*



*Deploying sentinel cages in Killary harbour*

16. The funding provided by the European Commission of approximately €800,000 is very much appreciated and has contributed to projects costing approximately €2 million in total being implemented.

### **Inventory of research**

17. The inventory of research relating to salmon mortality at sea, SAG(18)02, includes 22 ongoing projects related to the migratory behaviour of individual fish (C16, C18, C25, C27, C29, C30, C31, C32, C33, De4, De5, De7, Ir12, Ir13, Ir14, Ni4, N18, U4, U5, U10, U13, U16). One new project involving tracking individual fish has been included since last year as follows:

**De7:** SMOLTRACK – Exploring the mortality of smolts and post-smolts during their migration through the lower rivers, estuaries/fjords and near-shore areas.

## **In summary**

18. SALSEA - Track is a novel and exciting project proposal that has the potential to answer key questions relating to the conservation and management of Atlantic salmon. The success of the project is entirely dependent upon extensive international co-operation and partnerships between scientists, public sector funders, private sector foundations, NGO groups and industry. If the necessary co-ordination and funding come together, it will undoubtedly have a high profile. Given that the Board has committed to support SALSEA - Track as a continuing effort to understanding mortality of salmon at sea, there are a number of measures it may wish to consider in order to further its goal of advancing an integrated, collaborative telemetry programme. The Board has previously recognised that it could play an important role by: supporting fund-raising initiatives; providing funds as resources permit; endorsing projects; serving as a forum for information exchange and collaboration among research groups; and facilitating co-ordination of the research programme.
  
19. The Board has, of course, already played a significant role in support of this initiative by funding the Telemetry Workshop that brought together the key scientists who may collaborate in future telemetry studies on salmon and at which the outline project proposals, subsequently endorsed by the Board, were developed. It has adopted a Resolution and it has prepared a brochure which should be supportive of telemetry studies. The Board's inventory indicates that one new telemetry study has been initiated since last year. The NASCO / IASRB have now successfully applied for EU funding to support three projects related to mortality of salmon at sea. The International Year of the Salmon, although focused on outreach activities in the North Atlantic, may be supportive of research relevant to SALSEA - Track. If the Board is to engage in fund-raising to support the twelve outline projects, it will need professional advice and that will need clarification of the research to be conducted and its cost. The Board will need to consider its further role in taking forward SALSEA - Track and we look forward to discussing this further at the Annual Meeting.

Chairman and Secretary of the IASRB  
Edinburgh  
6 June 2018