



International Atlantic Salmon Research Board

ICR(20)07

***Report of the Working Group to Review the SALSEA-Track Programme and
the Inventory of Research Relating to Salmon Mortality in the Sea***

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At the Annual Meeting of the International Atlantic Salmon Research Board (the Board) in 2019, CNL(19)09, it was agreed that a Working Group would be established to review both the Inventory and the SALSEA-Track programme and to consider how the Inventory could be best updated and managed going forward.

The Working Group to Review the SALSEA-Track Programme and the Inventory of Research Relating to Salmon Mortality in the Sea met in London from 18-20 February 2020. The report of the meeting is attached as Annex 1.

The recommendations to the Board from the Working Group are highlighted below.

1. The SALSEA-Track Programme, in its current form, should be closed. A final report should be written and circulated to Parties / jurisdictions and the co-ordinators of projects linked to the SALSEA-Track programme;
2. That any successor to SALSEA-Track should have the following attributes: be problem focused with a clearly defined internationally relevant question, which was not solely developed based on the newest technology available; have clear SMART objectives; have clear timelines; have a clear budget; be at the basin-scale; and have an identified owner / co-ordinator. Additionally, it should address issues such as: data gaps / climate change / commonalities across the jurisdictions / mechanisms for supporting new technologies;
3. The Board confirms that survival at sea is still a principle focus for the Board's work;
4. The Inventory is no longer presented on the website in a series of static PDF documents, but that a single spreadsheet is posted so that users can more easily interrogate the Inventory;
5. In order to update the Inventory, the relevant portion of the spreadsheet be sent to the Parties in early November with a request that they update it. Parties should be asked to return the update by the end of December. The Secretariat should post an updated Inventory spreadsheet on the website at the end of January. That this process begins in November 2020;
6. Only the following categories are included in the Inventory: Country; Title; Status (completed / ongoing / new); Summary of Objectives (which the Parties will provide); Start Date; Topic Area; Geographic Area (of the research); Collaborating Countries; Contact Point (the relevant Member of the Board); Project Hyperlinks (where available);
7. Should the new process of updating the Inventory be implemented, Parties be asked that particular care is taken when a new project is added. Additionally, that the current Board member of the submitting Party verifies that the project meets the criterion of relating broadly to marine mortality prior to its submission to the Secretariat;
8. The Secretariat engages with the web designer and works to improve the prominence, searchability and utility of the new Board website and the presentation of the Inventory on that site;

9. The Secretariat considers how the utility of the updated website can best be evaluated with the use of hit statistics and related metrics, and that these statistics should be presented to the Board annually to understand the extent to which the Inventory is used; and
10. The metadata base be reviewed and consideration be given as to whether other areas of the Board's work require review, and that this review be conducted by the Board.

Secretariat
Edinburgh
7 April 2020

WGRSI(20)06

Report of the Working Group to Review the SALSEA-Track Programme and the Inventory of Research Relating to Salmon Mortality in the Sea

NEAFC Headquarters, London, UK

18 – 20 February 2020

1. Opening of the Meeting

- 1.1 The Chair, Ciaran Byrne (European Union) opened the meeting. He welcomed members of the Working Group to London and thanked them for agreeing to undertake the work assigned to them. Dr Byrne provided the following background about the SALSEA Programme, the Research Inventory and the reason for the review.

The SALSEA Programme

- 1.2 In 2005, the International Atlantic Salmon Research Board (the Board) adopted an international co-operative research programme, the [SALSEA Programme](#), that outlined a wide range of research on factors that may affect marine survival. The Board agreed that its focus should be on the research areas requiring international co-ordination, namely migration and distribution of salmon at sea. Under this programme there have been marine surveys in both the North-East (SALSEA-Merge) and North-West (SALSEA North America) Atlantic, enhanced sampling of the fishery at West Greenland (SALSEA West Greenland) and other smaller-scale projects.
- 1.3 In 2013, following completion of these projects, the Board reviewed its research priorities and agreed that a focus for future work should be to partition mortality of salmon among the phases of the marine migration. It established a Telemetry Sub-Group that reported in 2014 ([SAG\(14\)4](#)).
- 1.4 In 2014, the Board endorsed the need for an international acoustic tracking programme. It adopted a Resolution ([ICR\(14\)10](#)) encouraging Parties to continue the development of local collaborative telemetry projects, encouraging the development of large international collaborative projects building on local efforts and encouraging Parties to make efforts to identify funding sources. The Board noted that the telemetry programme should build on the success and identity of the SALSEA Programme.
- 1.5 In 2015, the Board received a report from its Telemetry Workshop that developed 12 outline project proposals ([ICR\(15\)3](#)). The 12 proposals are listed in section 4 below. The Board recognised that it would be important to liaise with the identified project leaders with a view to following progress and, where appropriate, to provide support to assist with their implementation. The Board also 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. As such, the 12 outline project proposals were officially unified under the new SALSEA-Track programme.
- 1.6 In 2019, the Board agreed that a review of the SALSEA-Track programme should be undertaken. The Board recognised that the 12 projects identified under the SALSEA-

Track programme have had mixed success in coming to fruition. It was acknowledged that SALSEA-Track projects were focused on acoustic tracking technology and that new tracking technology and methods have been developed in the lifetime of SALSEA-Track (e.g. ROAM). In addition, a number of new large-scale collaborative projects have been initiated whose objectives are in line with the objectives of SALSEA-Track and should be considered for inclusion in the programme.

- 1.7 The Board agreed to an inter-sessional review of the SALSEA-Track programme, which would allow this information to be considered at its meeting in 2020.

The Inventory

- 1.8 The [Inventory of Research](#) Relating to Salmon Mortality in the Sea (the Inventory) was established in 2002 and is updated annually. It was considered an essential tool in the development of research priorities for potential funding and in co-ordinating existing research efforts.
- 1.9 In 2009, a comprehensive review of the information contained in the Inventory was undertaken to identify areas where there may be merit in encouraging improved co-ordination of research and to highlight gaps in the research programme where new work might be undertaken ([SAG\(09\)10](#)).
- 1.10 A further review was undertaken in 2012 ([SAG\(13\)2](#)). Following that review the Board agreed that the Inventory should be reviewed every 3 or 4 years. Had this schedule been followed a review would have been due in 2017. However, the Board's Scientific Advisory Group (SAG) noted that one of the purposes of the review is to identify research needs and it recognised that the Board had already agreed that its priority was to partition mortality of salmon along their migration routes through telemetry studies (SALSEA-Track). The SAG also considered that it might be appropriate to wait until after the focal year of the International Year of the Salmon in 2019 to conduct the next review of the Inventory.
- 1.11 In 2018, the SAG recommended to the Board that the need for a further review of the Inventory should be reconsidered at the earliest in 2020. The Board agreed not to review the Inventory until 2020 at the earliest ([SAG\(18\)07](#)).
- 1.12 At the Annual Meeting of the Board in 2019, it was agreed that a Working Group would be established to review both the Inventory and SALSEA-Track programme and to consider how the Inventory could be best updated and managed going forward ([ICR\(19\)09](#)).
- 1.13 A list of the members of the Working Group is contained in Annex 1.

2. Adoption of the Agenda

- 2.1 The Working Group revised the Draft Agenda as presented and adopted it WGRSI(20)04 (Annex 2).

3. Consideration of the Terms of Reference, WGRSI(20)02

- 3.1 The Working Group discussed the Terms of Reference which are as follows:
 1. A Working Group reporting to the Board is established with the following high-level objectives:
 - a. Propose a future course for the SALSEA-Track programme by considering a full range of options;

- b. Recommend ways to streamline the reporting of progress on SALSEA-Track to the Board, including, among other things, an examination of whether updates on SALSEA-Track projects, in whatever form the programme takes after the review, should be included in the Inventory; and
 - c. Consider how the Inventory could be better updated and managed, to increase efficiency.
2. In carrying out the objectives set forth in paragraph one above, the Working Group will:
 - a. Evaluate progress made for, and likely future progress of, the 12 SALSEA-Track projects;
 - b. Review the Inventory to identify entries that support the twelve identified projects outlined within the SALSEA-Track programme;
 - c. Examine whether a broader spectrum of tracking, including new technologies, should be included in SALSEA-Track, or its successor;
 - d. Review processes related to the Inventory, including:
 - i. The process for maintaining and providing annual updates;
 - ii. The process of advertising to, or sharing the resource with, non-NASCO salmon researchers; and
 - iii. Propose modifications to reporting procedures and tools related to the Inventory;
 - e. Propose ways to enhance awareness of the Inventory, to encourage greater use;
 - f. Review projects in the Inventory to ensure they relate to investigating marine survival;
 - g. Review the categories used in the Inventory, including:
 - i. Ensuring that the projects are linked to the relevant NASCO research themes and the relevant SALSEA research heading, including any newly proposed SALSEA-Track category' and
 - ii. Propose revised categories if the current set is no longer considered to be appropriate;
 - h. Propose ways to ensure the annual costs are detailed for each project in the Inventory.

The Working Group had been asked to take into account the following documents and information:

- Resolution of the International Atlantic Salmon Research Board (Board) on Research on Salmon at Sea, [ICR\(14\)10](#);
- Report of NASCO's International Atlantic Salmon Research Board's Telemetry Workshop, [ICR\(15\)3](#);
- current status of SALSEA projects (WGRSI(20)03) (Annex 3);
- report of the 2012 review on 'the Future Direction of Research on Marine Survival of Salmon' SGFR(12)10
- the Inventory, [SAG\(19\)02](#);

- the Inventory return form;
- national initiatives; and
- current management priorities indicated by Parties.

3.2 The Working Group discussed the Terms of Reference. They noted that the outcome of paragraph 1a would determine how the rest of the Terms of Reference might be addressed.

4. Review of the SALSEA-Track Programme

4.1 A progress report on all projects and additional projects of interest was circulated in advance of the meeting (WGRSI(20)03 (Annex 3)). The document also included a section on prognosis and future developments related to each project.

4.2 The Working Group discussed the establishment of the SALSEA-Track programme. They noted that the original objectives of the programme were unclear, and that the programme was a collection of individual projects which were not integrated into a coherent theme. It was noted that without funding sources identified, with no overall programme co-ordinator, and without time boundaries, progress with some individual projects within the SALSEA-Track programme has been limited.

4.3 The Working Group further noted that there has been considerable progress on some of the original project ideas in SALSEA-Track, but this has been outside the programme itself. This progress is continuing with Parties conducting research themselves, and with Parties and researchers competing successfully for other funding sources.

4.4 In light of the discussion above, the Working Group made the following recommendation.

Recommendation 1: The SALSEA-Track Programme, in its current form, should be closed. A final report should be written and circulated to Parties / jurisdictions and the co-ordinators of projects linked to the SALSEA-Track programme.

4.5 The Working Group also noted that the co-ordinators of projects linked to the SALSEA-Track programme should be thanked for their work and informed that they will no longer be asked for annual updates. However, updates may still be appropriate under the Inventory.

5. Review of the SALSEA-Track Programme

a) Evaluation of the Progress Made for, and Likely Future Progress of, the Twelve Outline Project Proposals Developed at the Board’s Telemetry Workshop held in 2015.

5.1 The original proposal and latest update for each project can be found in WGRSI(20)03 (Annex 3), which was circulated to the Working Group in advance of the meeting. Updates for [2016](#), [2017](#), [2018](#) and [2019](#) are also available for some projects.

5.2 The Working Group considered this information and commented on each project.

<i>SALSEA-Track project</i>	<i>Working Group comments</i>
Drifters and BioProbes: Options for detecting acoustically tagged fish in large geographic areas (NAC and/or NEAC)	The Working Group notes that progress has been made and is continuing at the time of writing.
New Receiver Lines/Arrays/Grids (NAC)	The Working Group notes that over the last 5 years new receiver lines have

	come on board and new opportunities continue to be sought.
Platforms of Opportunity in the NAC area: Stationary Platforms of Opportunity Receiver Exchange (SPORE)	The Working Group notes that there has been a considerable increase in the number of Platforms of Opportunity that have been utilised. Researchers continue to consider opportunities for further expansion.
NAC kelt satellite tagging	The Working Group notes the work that has been completed to date and anticipates that this will continue subject to resources.
Generic Index River Sites in the NEAC area	The Working Group notes that no updates under the SALSEA-Track reporting procedure were ever received. The original project did not materialise as anticipated. However EU funding allowed the SMOLTrack projects to take place which include much of the research in the original proposal. Many of the original aims have been achieved and the SMOLTrack programme is ongoing.
Malin Head to Islay Receiver Array (NEAC)	The Working Group notes that some updates under SALSEA-Track reporting have been provided. However, the original project did not materialise as anticipated. Now, much of this research is being conducted under the SeaMonitor project and the Working Group is aware of a complimentary project, the Compass Project, which is also working in this area.
North Sea Loose Array (NEAC)	The Working Group notes that no updates have been provided on this project. The Working Group understands that no progress has been made.
West-coast Scottish arrays (NEAC)	The Working Group notes that there have been limited updates on this project. The original project did not materialise as anticipated. However, the Working Group is aware that a large-scale project has been funded recently which covers much of this research (the Scottish West Coast Tracking Project). The LICETrack Project compliments this initiative.

Studies of migration along the European shelf edge and into the Norwegian Sea using drifters/AUVs etc (NEAC)	The Working Group notes that limited updates under SALSEA-Track reporting were provided. The original project did not materialise as anticipated. However, some of this research is being conducted under the SeaMonitor Project.
NEAC kelt satellite tagging	The Working Group notes that there have been no updates provided on this project. The Working Group understands that some of this research was conducted under the project SALMOTRACK and is continuing under the SeaSalar project.
Sub-adult satellite tagging at Faroes	The Working Group notes that there have never been any updates on this project. The Working Group is not aware of any work in this area.
Adult satellite / acoustic tagging at Greenland	The Working Group notes that updates have been provided annually on this project. The Working Group is aware of ongoing work in this area and looks forward to future results.

b) Review of the Inventory to Identify Entries that Support the Twelve Identified Project Proposals.

5.3 In light of the recommendation that SALSEA-Track be discontinued in its current form, the Working Group agreed that completing this task was unnecessary.

c) Review of Other Salmon Tagging and Tracking Projects Relevant to SALSEA-Track

5.4 In light of the recommendation that SALSEA-Track be discontinued in its current form, the Working Group agreed that completing this task was unnecessary.

5.5. However, the Working Group is aware that there are numerous ongoing projects being undertaken by various parties that are relevant to SALSEA-Track. Summaries for the following projects were provided to the Working Group prior to its meeting (WGRSI(20)03 (Annex 3)).

- SeaSalar;
- the Moray Firth Tracking Project;
- SALmonid MAnagement Round the Channel (SAMARCH); and
- impacts of tagging on smolt survival.

d) Consideration of a Future Course for SALSEA-Track or its Successor

5.6 The Working Group noted that the Resolution referred to in Paragraph 1.4 still stands ([ICR\(14\)10](#)) and that the Board should continue to encourage Parties to develop collaborative tracking programs.

5.7 The Working Group discussed the appropriateness of developing a successor for

SALSEA-Track as well as the role that the Board could play in such an endeavour. The Working Group decided that the Board could play an important role as it provides a unique mechanism for co-ordinating basin-level international co-operation on projects.

5.8 The Working Group agreed that it would be appropriate for the Board to adopt a future successor for SALSEA-Track. The Working Group did not identify a specific successor project, but suggested that such a project should address issues such as data gaps, climate change, issues that are common across the jurisdictions, and mechanisms for supporting new technologies, etc. The Working Group also outlined a number of attributes that a potential project should possess:

- problem focused with a clearly defined internationally relevant question, which was not solely developed based on the newest technology available;
- clear SMART objectives;
- clear timelines;
- clear budget;
- at the basin-scale; and
- an identified owner / co-ordinator.

5.9 In light of the discussion above, the Working Group made the following recommendations.

Recommendation 2: The Working Group recommends that any successor to SALSEA-Track should have the following attributes: be problem focused with a clearly defined internationally relevant question, which was not solely developed based on the newest technology available; have clear SMART objectives; have clear timelines; have a clear budget; be at the basin-scale; and have an identified owner / co-ordinator. Additionally, it should address issues such as: data gaps / climate change / commonalities across the jurisdictions / mechanisms for supporting new technologies.

Recommendation 3: The Working Group recommends that the Board confirms that survival at sea is still a principle focus for the Board's work.

5.10 The Working Group agreed that the ROAM project may be an ideal successor to SALSEA-Track. ROAM is an acoustic tracking system where low frequency long ranging sound wave 'pongs' are emitted from ocean-moored sound sources and received by a tag equipped with a hydrophone attached to the study animal. A primary advantage of the ROAM approach is the long range of 'pongs' which could result in more accurate geolocation over a wider spatial and temporal range compared to traditional light-based methods and at a relatively low cost compared to traditional tracking methods. However, it should be noted that this technology is in the early stage of development and field testing is ongoing. Trials are planned between July and September 2020. A workshop to review the results from the field trials and decide on potential next steps may be possible in late autumn 2020.

5.11 ROAM may give the opportunity for the Board to adopt a signature project that requires cross-basin co-operative working. If, after the trials, ROAM is not deemed a feasible candidate successor to the SALSEA-Track programme, other projects may be considered, as long as they have the attributes set out above. Some example ideas were discussed by the Working Group:

- given the increase of telemetry investigation in the nearshore environments on both sides of the Atlantic in recent years, an international collaborative effort to compile, compare and analyse these data together may provide insights into factors impacting early marine survival across the species range; and
 - given the recent increased interest in extracting fine scale marine growth data from salmon scales on both sides of the Atlantic, an international collaborative effort to standardise the identification of important growth metrics or to compile, compare and analyse these data together may provide insights into factors impacting marine growth and survival across the species' range.
- 5.12 The Working Group noted that if a successor to SALSEA-Track were agreed, Parties would have to commit funding and other resources to ensure that the programme materialised.
- 5.13 **Action:** The Working Group also agreed that if ROAM is not deemed a feasible candidate successor to the SALSEA-Track programme and if there is a desire by the Board to consider other projects as a potential successor, that all Board members should canvass colleagues from their Party / jurisdiction for feedback as to what a candidate project could be.

6. Review of the Inventory

a) Review of the Process for Maintaining and Providing Annual Updates to the Inventory

- 6.1 The Chair reminded the Working Group of the current process of updating the Inventory. Each year in November the Inventory return form with the relevant section of the previous year's Inventory for each Party is sent out to all NASCO Parties and jurisdictions. The following information is sought:
- details of any changes to ongoing projects already included in the Inventory, together with a summary of progress since the last notification;
 - details of any projects which have been completed since the last notification, together with a summary of the main research findings arising from the project; and
 - details of any new projects which have commenced since the last notification, and details of new projects which have been approved and for which funding has been secured, and which will commence in the following calendar year.
- 6.2 For each project, full economic costs per annum (i.e. including staff costs, equipment costs and overheads) are requested. If the project involves collaboration between public and private partners a breakdown of the funding between these partners is sought.
- 6.3 The Board also seeks details of research projects being undertaken in relation to salmon mortality at sea by universities and other non-governmental institutions.
- 6.4 Once the Secretariat receives the information from the Parties / jurisdictions the full Inventory is updated. The updated Inventory is posted in five different formats on the Board's website:
- The [full research inventory as a pdf](#)
 - The [summary research inventory as a pdf](#)
 - A static table showing [Projects by SALSEA Work Package](#)

- A static table showing [Projects by Topic Area](#)
- A static table showing [Projects by Party](#)

6.5 The Working Group discussed the utility and relevance of the Inventory, when alternative means of accessing similar information is available, such as Google Scholar. They acknowledged that it appears that the Inventory is not widely used. The following statistics on visits to the Inventory website were discussed.

	Page Views	Unique Page Views	Avg Time on Page	Entrances	% Bounce Rate	% Exit
2015	379	295	01:27	147	51.70	38.79
2016	338	268	01:42	155	45.81	36.09
2017	335	273	01:33	167	40.72	36.42
2018	205	173	01:18	101	58.42	40.98
2019	78	66	01:46	43	76.74	52.56

- Page Views: number of times a page is viewed;
- Unique Page Views: number of sessions during which a page was viewed one or more times (i.e. page views from the same user during the same session are aggregated);
- Avg Time on Page: average time a visitor stays on the page (minutes and seconds);
- Entrances: number of times this was the first page viewed on site, e.g. linked to from a Google Search;
- % Bounce Rate: % of visitors that navigate away from the website after only viewing one page; and
- % Exit: % of visitors who exit the website from this page and do not go on to look at any other pages associated with the website.

6.6 The Working Group discussed the amount of work involved in updating the Inventory. They acknowledged that the work done by the Secretariat, the Party co-ordinators and project contacts who provide the updates, is significant. The Working Group agreed that the current system of updating the Inventory is disproportionate to the amount of interest it seems to engender.

6.7 In light of the discussion above, the Working Group agreed that both the process for updating the Inventory and the presentation of the Inventory should be simplified. The new process should be evaluated annually by the Board, with reference to website statistics, to assess if the overall benefits of producing the Inventory is worth the effort needed to update it. The following recommendations were made.

Recommendation 4: The Working Group recommends that the Inventory no longer be presented on the website in a series of static PDF documents, but that a single spreadsheet be posted so that users can more easily interrogate it.

Recommendation 5: The Working Group recommends that in order to update the Inventory the relevant portion of the spreadsheet be sent to the Parties in early November with a request that they update it. Parties should be asked to return the update by the end of December. The Secretariat should post an updated Inventory spreadsheet on the website at the end of January. The Working Group recommends that this process begin in November 2020.

b) Review of the Categories Used in the Inventory

6.8 The Working Group was reminded of the Categories currently used in the Inventory. These are: Jurisdiction; Project number; Title; Status (completed / ongoing / new); Summary of objectives; Research dates, Topic area; Objective / Issue; (Geographical) Area of research; Collaborating Countries; Co-ordinating scientist; Annual expenditure.

‘Topic area’ and ‘Objective / Issue’ relates to the following.

Topic Area	Objective/Issue
1. Long-term monitoring	a. Time series of marine survival/growth estimates
	b. Time series of marine survival in relation to environmental parameters (e.g. SST)
2. Distribution / migration in the sea	a. Distribution of salmon in the sea
	b. Migratory behaviour of individual fish
	c. Origin of catches in directed fisheries
	d. Migration and bioenergetic models
	e. Bycatches in pelagic fisheries
3. Life history / biological processes	a. Freshwater factors
	b. Pre-fishery recruitment marine factors
	c. Post-fishery recruitment marine factors
4. Development of methods	a. Post-smolt survey methods
	b. Electronic tag technology
5. Specific natural and anthropogenic factor	a. Fish farms
	b. Predation
	c. Obstructions to fish movements
	d. Pollutants

6.9 The Working Group discussed whether all the categories were necessary and valuable. It was agreed that fewer categories were needed and recommended that only the five main topic areas were required.

6.10 The Working Group also discussed the need and accuracy of the figures provided on annual funding. It was agreed that it was difficult for the project co-ordinator to provide these, especially given that much of the information provided did not take into account the in-kind funding by participants; it was, therefore, unclear how these data should be interpreted. The Working Group concluded that this information was not useful.

6.11 The Working Group also agreed that the Secretariat should no longer request full details of a project for inclusion in the Inventory. The Inventory should be considered a list of projects and if there was interest in the details of a project, those interested could make contact with the current Board member representing the Party / jurisdiction that the project is listed under to find out more. In light of the discussion above, the Working Group agreed the following recommendation.

Recommendation 6: The Working Group recommends that only the following categories are included in the Inventory: Country; Title; Status (completed / ongoing / new); Summary of Objectives (which the Parties will provide); Start Date; Topic Area; Geographic Area; Collaborating Countries; Contact Point (the current member of the Board representing the Party / jurisdiction that the project is listed under); Project Hyperlinks (where available).

c) Review of the Projects in the Inventory to Ensure they Relate to Investigating Marine Survival

- 6.12 The Working Group reviewed the projects and were broadly happy with those on the Inventory. However, it was noted that some projects listed in the Inventory did not easily fit into the categorisation of investigating marine survival. Given that this was originally the focus of the Inventory as defined by the Board, the Working Group agreed that in the future, greater emphasis should be on ensuring that only projects broadly relating to marine mortality be included.
- 6.13 Projects currently in the Inventory should remain, even if they appeared to be loosely related to marine survival, as the Working Group does not wish to discourage people from engaging. It also felt it may be awkward to remove a project when it had been on the Inventory for years and co-ordinators had responded to requests for updates throughout that time.
- 6.14 In light of the discussion above, the Working Group agreed the following recommendation.

Recommendation 7: The Working Group recommends that should the new process of updating the Inventory be implemented, Parties be asked that particular care is taken when a new project is added. The Working Group recommends that the current Board member of the submitting Party verifies that the project meets the criterion of relating broadly to marine mortality prior to its submission to the Secretariat.

d) Consideration of Methods of Increasing Awareness of the Inventory, Including Among Non-NASCO Salmon Researchers.

- 6.15 The Working Group felt that the recommended revisions to the Inventory should provide the opportunity for it to be useful. They agreed that making the Inventory dynamic and able to be interrogated as a spreadsheet would increase its utility.
- 6.16 There was further discussion about the presentation of the Inventory on the current and new Board website. As set out above, the Working Group agreed that the Inventory should be displayed on the current Board website as a spreadsheet. However, the NASCO and Board websites are being updated. This will allow the Inventory to be displayed in a more accessible format. It will also enable the prominence and searchability of the Inventory to be improved. The Working Group noted that the aim would be for the updated Board website to go live in July 2020.
- 6.17 In light of the discussion above, the Working Group agreed the following recommendations.

Recommendation 8: The Working Group recommends that the Secretariat engages with the web designer and works to improve the prominence, searchability and utility of the new Board website and the presentation of the Inventory on that site.

Recommendation 9: The Working Group recommends that the Secretariat considers how the utility of the updated website can best be evaluated with the use of hit statistics and related metrics, and that these statistics should be presented to the Board annually to understand the extent to which the Inventory is used.

7. Other Business

- 7.1 The issue of the metadatabase was raised.
- 7.2 In 2011, the Board recognised that recent international initiatives under the SALSEA

Programme had generated some databases, including biological and genetic databases generated under the SALSEA Merge project, and time series of data and historical tagging information compiled by ICES workshops supported by the Board. The Board also noted the existence of some historical marine survey samples, such as those generated by the international sampling programme at West Greenland, dating back forty years or more. The Board decided that it could play a role with regard to marine salmon survey data and sample co-ordination by establishing a metadatabase of existing datasets and sample collections. The metadatabase was not intended to be a vehicle to provide raw data to researchers and interested parties, but rather to increase awareness among researchers and other interested parties of the availability of these datasets / sample collections related to the marine phase of the Atlantic salmon.

- 7.3 The Working Group noted that many of the issues relating to the Inventory, such as relevance and utility, as set out above, may equally relate to the metadatabase.
- 7.4 There was also discussion about whether other areas of the Board's work might require review. The Working Group noted that a review of the metadatabase and other areas of the Board's work was outside the remit of the meeting but agreed the following recommendation.

Recommendation 10: The Working Group recommends that the metadatabase be reviewed and consideration be given as to whether other areas of the Board's work require review. The Working Group suggested that this review could be conducted by the Board as they didn't feel the review would warrant a separate Working Group.

8. Report of the Meeting

- 8.1 The Working Group agreed the report of its meeting by correspondence after the meeting.

9. Close of the Meeting

- 9.1 The Chair thanked the members of the Working Group for their work and wished them a safe journey home.

List of Participants

Ciaran Byrne	Inland Fisheries Ireland (Chair)
Tony Blanchard	Fisheries and Oceans Canada
Cathal Gallagher	Inland Fisheries Ireland
Peder Fiske	Norwegian Institute for Nature Research (NINA)
Tim Sheehan	NOAA Fisheries Service
Ken Whelan	Atlantic Salmon Trust
Emma Hatfield	NASCO Secretary
Wendy Kenyon	NASCO Assistant Secretary

WGRSI(20)04

Meeting of the Working Group to Review the SALSEA-Track Programme and the Inventory of Research Relating to Salmon Mortality in the Sea

NEAFC Headquarters, London, UK

18 – 20 February 2020

Agenda

1. Opening of the Meeting
2. Adoption of the Agenda
3. Consideration of the Terms of Reference, WGRSI(20)02
4. Review of the SALSEA-Track Programme
5. Consideration of SALSEA-Track, its relation to the Inventory and other projects
 - a) Evaluation of the Progress Made for, and Likely Future Progress of, the 12 Outline Project Proposals Developed at the Board’s Telemetry Workshop held in 2015;
 - b) Review of the Inventory to Identify Entries that Support the 12 Identified Project Proposals;
 - c) Review of Other Salmon Tagging and Tracking Projects Relevant to SALSEA-Track;
 - d) Consideration of a Future Course for SALSEA-Track or its Successor.
6. Review of the Inventory
 - a) Review of the Process for Maintaining and Providing Annual Updates to the Inventory;
 - b) Review of the Categories Used in the Inventory;
 - c) Review of the Projects in the Inventory to Ensure they Relate to Investigating Marine Survival;
 - d) Consideration of Methods of Increasing Awareness of the Inventory, Including Among Non-NASCO Salmon Researchers.
7. Other Business
8. Report of the Meeting
9. Close of the Meeting

WGRSI(20)03

***SALSEA-Track and other salmon tagging / tracking projects:
background and progress reports.***

SALSEA-Track is an ambitious research programme implemented in 2015. It consists of 12 independent telemetry-based projects designed to investigate salmon marine migration and mortality across the North Atlantic.

The original 12 telemetry-based projects were suggested areas for further investigation, some with more solid foundations than others. They were also designed to cover a wide geographic area. Their development was expected to have depended upon a range of factors, not least the capabilities of different research groups and the interests of the funding agencies. The research ideas were expected to develop as advances were made in tracking equipment and as more experience was gained with different tracking approaches. Some projects have made good progress but until very recently there has been limited success in implementing the programme, mainly because of a lack of funding.

Since 2015 a number of large-scale telemetry-based initiatives have started that align well with the objectives of the SALSEA-Track programme. New approaches are also being tested, which could improve the ability to monitor Atlantic salmon marine migration over vast areas.

This paper provides some background to each of the 12 independent telemetry-based projects designed to investigate salmon marine migration and mortality across the North Atlantic and shows progress where this has been possible. It also provides information on some other projects that have been brought to the attention of the NASCO Secretariat as being of relevance, with their potential to improve the ability to monitor Atlantic salmon marine migration in different areas.

1. SALSEA-Track

Drifters and BioProbes: Options for detecting acoustically tagged fish in large geographic areas (NAC and/or NEAC)

Line arrays for detecting the movement of acoustically tagged animals and to estimate survival rates have been used in many locations with relatively narrow passage points and in locations in which the movement of animals is assumed to be generally unidirectional. Using line arrays in areas in which animals can disperse over much broader areas is a challenge because of the narrow spatial coverage afforded by these arrays and the short time period which acoustically tagged animals may be in the vicinity of any of the receivers in the array. The use of bioprobes or drifter arrays may be informative in these areas.

Progress report (John Kocik and Fred Whoriskey)

Update on Progress: Funded by the Canadian Atlantic Salmon Research Joint Venture, MetOcean SVP Lagrangian current-following surface drifter buoys have been developed. Annually, hundreds of surface drifters are deployed worldwide by national authorities in support of the World Meteorological Organization's efforts to better predict global weather patterns. This technological development provides an option to national authorities to upgrade their drifters when they purchase them to include acoustic tracking capabilities. These buoys have the potential to be deployed in ocean regions where moored acoustic arrays are lacking

or are not feasible due to logistical (e.g. depth) or other (e.g. trawling) constraints, increasing receiver coverage in support of planned animal telemetry studies. A proof-of-concept field test in the Labrador Sea was conducted in 2019 with the deployment of the first acoustic receiver-equipped surface drifter. The buoy was launched in the Labrador Current off the coast of Nunatsiavut in association with the government of Nunatsiavut and Oceans North, and successfully operated for a month before being caught in a current eddy and beaching.

Prognosis and future developments: This tool now offers opportunities to affordably expand acoustic receiver coverage in support of at-sea tracking of Atlantic salmon. Presently, a multi-partner application led by DFO (M. Robertson) successfully passed through the Letter of Intent phase and a full proposal is being submitted to the Environmental Studies Research Fund to track Atlantic salmon through areas off Canada's east coast where offshore oil and gas production / exploration is occurring. This application if successful will include the use of the surface drifters to track smolts and to monitor environmental conditions. The technology is available for use in other studies. Co-ordinated discussions with national authorities responsible for annual purchases of surface drifters and those who are interested in the tracking capability would be useful. Applicability may be informed by modelling efforts described in SRBTW(14)4 (New Receiver Lines/Arrays/Grids (North American Commission area)).

New Receiver Lines/Arrays/Grids (NAC)

Additional receiver detection points would greatly advance our understanding of the marine phase of Atlantic salmon. Additional receiver arrays at key location would provide more robust stock-specific estimates of mortality, migration routes and dynamics during the first year at sea. A number of different potential receiver arrays have been suggested, each addressing a specific aim and information need, but other locations could also be considered.

Progress report (Tim Sheehan, John Kocik, and Jon Carr)

New receiver lines were added in the Northwest Atlantic in 2018. ASF and DFO initiated a receiver array along the coast of Labrador (i.e. Port Hope Simpson Line) in 2017. The array was doubled in 2018, covering a distance of 32 km from shore. Detections of Canadian and USA origin post-smolts have been identified on the Port Hope Simpson Line each year.

A proposal is working its way through the Atlantic Fisheries Fund (Ocean Tracking Network-Dalhousie University) to provide an acoustic receiver line across the mouth of the Bay of Fundy (southwestern Nova Scotia to south-eastern New Brunswick) in support of tracking projects that are investigating the ecology and survival of inner and outer Bay of Fundy salmon, and the interactions of wild salmon with the salmon farming industry in the region. Progress on the file was halted due to the Canadian federal election in 2019. We await word on when action will reinitiate on the file. Should the programme be reactivated and depending on timing, it might be possible to have some of the equipment installed in 2020.

The Norwegian University of Science and Technology (NTNU) and the Ocean Tracking Network will be installing a small network of acoustic receivers in a fjord system in Southern Greenland (Tasiusaq) in summer 2020. While the prime focus of the work is migration of Arctic charr, any acoustically tagged salmon that venture into the area will be recorded and reported.

With regards to adding acoustic receiver capacity of / to marine autonomous vehicles, OTN has added two new Slocum Gliders and one SV3 Wave Glider to its fleet, and is planning on adding an additional 1-2 Wave Gliders to increase North Atlantic Ocean receiver coverage especially in areas where moorings are logistically difficult or costly to maintain. OTN continues working within the nascent Ocean Gliders Canada and international partners 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.

Through the Canada Atlantic Salmon Research Joint Venture, the Nova Scotia Salmon Association, DFO, NOAA, OTN and the Atlantic Salmon Federation (ASF) funding was secured to model the efficacy of candidate line arrays and grid structure. A movement ecology modeller was hired and a manuscript describing designs on the Labrador Shelf is expected in 2020. Next steps will be to advance the design work by incorporating current and temperature metrics to advise on the efficacy of different glider and likely drifter paths. This work will continue into 2021.

Prognosis and future developments

- continue to look for cost-efficient opportunities to expand or add new acoustic receiver lines in the Northwest Atlantic;
- continue to look for opportunities to expand and utilize the OTN marine autonomous vehicle fleet; and
- continue efforts to model the efficacy of line arrays and grid structures to monitor the marine migration of Atlantic salmon in the Northwest Atlantic. Results from these modelling efforts will allow researchers to evaluate the efficacy of future open ocean acoustic-based efforts.

Platforms of Opportunity in the NAC area: Stationary Platforms of Opportunity Receiver Exchange (SPORE)

Receivers deployed on existing buoys and platforms associated with collection of environmental monitoring (oceanography and weather buoys) and offshore commercial enterprises (fishing, aquaculture, offshore energy etc.) can be a cost-effective way to obtain baseline acoustic monitoring data. These associations of fish location data with environmental data provide an opportunity to exchange information and expertise with oceanographers and others to better understand seasonal salmon distributions in changing oceans.

Progress report (John Kocik)

Update on Progress: NOAA maintained extant opportunistic arrays in 2019 and worked to connect OTN with the NOAA whale passive acoustic group. Due to workload and funding considerations, work was focused within the Gulf of Maine region. All ocean observing buoys in the University of Maine program (i.e. Gulf of Maine Ocean Observing System) are fitted with acoustic receivers for year-round monitoring. In addition, the inner Penobscot Bay area is monitored from April-December annually. More than 20 other species, including Atlantic salmon, have been detected to date on this vast Gulf of Maine acoustic platforms of opportunity network. These data are retrievable through the Ocean Tracking Network Data portal: [Gulf of Maine NEFSC NERACOOS-GoMOOS Buoys](https://members.oceantrack.org/OTN/project?ccode=GMG) (<https://members.oceantrack.org/OTN/project?ccode=GMG>). Additional partnerships (e.g. lobster fishers) are being considered and could expand coverage seasonally. Expansion of opportunities in the northwest Gulf of Maine and associated waters of the Bay of Fundy remains a mutual NOAA and DFO goal.

Prognosis and future developments: Continue to look for opportunities to expand the Gulf of Maine acoustic platforms of opportunity network. Efforts will remain focused on the Gulf of Maine region, which may provide benefits to US Atlantic salmon monitoring efforts in addition to numerous other species that migrate through the Gulf of Maine, but will provide

limited benefit to non-US salmon population monitoring efforts. However, knowledge of highly migratory predators that move north concurrent with salmon migration will be useful for assessing threats to Atlantic salmon.

NAC kelt satellite tagging

PSATs offer the ability to provide information on stock-specific migration routes, behaviour and mortality of post-spawned Atlantic salmon kelts. When combined with results from ongoing post-smolt acoustic telemetry projects, insights may also be gained into the commonalities of kelt and post-smolt migration patterns.

Progress report (Tim Sheehan and Jon Carr)

The ASF has been releasing acoustic and PSAT tagged kelts into various Gulf of St. Lawrence river systems for a number of years. Efforts have been focused on the released tagged kelts from the Miramichi River system but tagged kelts have also been released into the Restigouche (acoustic and PSAT) and Cascapédia (acoustic) rivers. A 2017 article was published, which reported results from the Miramichi River tagging project. Another article was published in 2019 that investigated ocean predation events from PSAT tagged Miramichi and Restigouche salmon, as well as salmon stocks from 4 European countries. Reduced tagging efforts have continued on these systems, but resources have been re-allocated towards sub-adult PSAT tagging efforts at Greenland and therefore no new domestic kelt tagging efforts outside of the Gulf of St. Lawrence in Canada or the USA have been initiated.

Prognosis and future developments

- plans are underway between ASF and Fisheries and Oceans Canada to track Cascapédia River kelts with 10 PSAT and 25 acoustic tags in spring 2019;
- presently, a multi-partner application led by DFO (M. Robertson) successfully passed through the Letter of Intent phase and a full proposal is being submitted to the Environmental Studies Research Fund to track Atlantic salmon kelt from multiple rivers in eastern Canada beginning in 2021 using acoustic and PSAT tags through areas off Canada's east coast where offshore oil and gas production/exploration is occurring; and
- unless new resources are identified, there is a low likelihood of kelt tagging being initiated in any US river systems.

Generic Index River Sites in the NEAC area

The proposal would be to establish at least four index sites (build on existing index rivers and/or establish new index rivers) spread over the NEAC area, with the aim of quantifying marine survival from leaving to returning to the river; quantifying where the mortalities occur by partitioning mortality among river mouth/estuary, near coastal area, and the remaining stay at sea; quantifying variation in mortality among years; and analysing critical periods for mortality and possible causes of mortality

Progress report (Kim Aarestrup)

The objectives set originally for this project have, to a certain degree, been addressed by the highly successful SMOLTrack projects (with SMOLTrack I and SMOLTrack II completed and SMOLTrack III commencing in January 2020, for two years). In this set of projects, hands-on salmon scientists have tagged and tracked salmon smolts and kelts with both acoustic-, radio- and PIT tags. To date nine countries are participating and the project covers the entire distribution areas within EU (from Portugal in South to Finland in North).

The SMOLTrack projects have not aimed at setting up new Index Rivers as it was deemed too costly, so the projects have specifically used existing infrastructure and ongoing studies to ensure maximum ‘bang for the buck’. The project has quantified smolt survival rates throughout the geographic range, using acoustic telemetry through river mouths and in near coastal areas by deploying arrays of acoustic receivers in river mouths/estuaries and as far out on the coast as possible. This has enabled separation of total sea mortality into mortality in 1) river mouth/estuary, 2) near coastal area, and 3) remaining stay at sea (Flávio et al 2019). This has given new insight to the importance of early migratory mortality, the high variability between years and further shedding light on some potential caveats, with the existing Index rivers standard way of calculating ocean survival (Flávio et al 2019). The SMOLTrack projects has also used radio telemetry to determine the ultimate fate of smolts not surviving the migration and identifying critical periods for mortality. Furthermore, the project is working on determining avian predation pressure and relate that to actual survival of smolts. Documentation have been produced showing that both avian- and in-river predation as important factors to consider when managing salmon populations. SMOLTrack III will investigate more sites and specifically address if management options such as moving fish past predation hotspots may alleviate the predation pressure and hence overall survival. The SMOLTrack project partners are determined to continue in the years to come and aim to address several more topics identified in the original project specification.

The SMOLTrack projects have thus answered points 2 and 4 from the list below and the results will answer 3) when more seasons are added. Point 1) regarding total sea survival is not fully answered at this stage, but the results will have important implications as to how to estimate ‘return-rates’ in index rivers. Potential continuation of the projects will aim to provide sea mortality from leaving the river to returning to the river.

1. Quantify total sea survival, from leaving the river to returning to river;
2. Quantify where the mortalities occur by separating total sea mortality into mortality in 1) river mouth/estuary, 2) near coastal area, and 3) remaining stay at sea;
3. Quantify variation in mortality among years; and
4. Analyse critical periods for mortality and possible causes for mortality.

References:

- Flávio, H, Aarestrup, K, Jepsen, N, Koed, A. Naturalised Atlantic salmon smolts are more likely to reach the sea than wild smolts in a lowland fjord. *River Res Applic.* 2019; 35: 216– 223. <https://doi.org/10.1002/rra.3400>
- Flávio, H, Kennedy, R, Ensing, D, Jepsen, N, Aarestrup, K. Marine mortality in the river? Atlantic salmon smolts under high predation pressure in the last kilometres of a river monitored for stock assessment. *Fish Manag Ecol.* 2019; 00: 1– 10. <https://doi.org/10.1111/fme.12405>

Malin Head to Islay Receiver Array (NEAC)

The development of telemetry receiver arrays in the North Atlantic/Irish Sea area would allow researchers to investigate a number of key issues impacting the productivity of a number of United Kingdom and Irish Atlantic salmon stocks and other marine species migrating through this area. Key questions to be addressed are: what is the mortality during the early marine phase of Foyle, and Irish Sea salmon; what is the usage of the north channel by basking shark and other elasmobranchs; what is the usage of the north channel by cetacean species; what is the movement of sea trout in the north channel?

Progress Report: Integrated into ‘SeaMonitor’ project (see below).

North Sea Loose Array (NEAC)

A broad distribution of receivers deployed on existing platforms and moorings in the area between Scotland and Norway may provide partial coverage of a relatively narrow area sectioning the North Sea from the Atlantic. Possible sites could be oceanographic and weather buoys and particularly offshore commercial enterprises (fishing, aquaculture, offshore energy, etc.). Some of these will provide environmental monitoring in addition to acoustic monitoring data. The aim is to use these opportunities to cover approximately 30% of the area along a rough line from Northern Scotland to Southern Norway.

Progress Reports for this project have been requested annually since the telemetry workshop, but none have been received.

West-coast Scottish arrays (NEAC)

Plans for tracking smolts are currently being prepared as part of programme of work involving Marine Scotland Science and the freshwater fisheries and aquaculture sectors. The initial focus of development of investigations into possible interactions between aquaculture and wild salmon has been establishment of experiments using fish treated with agents that kill parasites. This work is being coupled with models of lice dispersion from salmon farms. Salmon smolts have already been tracked in a pilot project in Loch Linnhe. The possibility of extending that work to develop models of salmon dispersal patterns is being assessed. There is also an early stage assessment of the feasibility of establishing a curtain of acoustic listening devices between the Hebrides and mainland Scotland.

Progress Report (John Armstrong, Mark Bilsby and Alan Wells)

At present there is little information on the distributions of salmon smolts over time as they leave the Scottish coasts. Such information is important for informing spatial planning decisions, particularly in relation to salmon aquaculture. It is impractical to track salmon smolts from many river systems and hence there is a need to develop a general model of dispersal. To this end, Marine Scotland Science has developed particle tracking models that predict dispersal depending on swimming vectors of smolts, coupled with local water currents. It is now necessary to ground truth such models by experimental determination of swimming vectors and empirical estimates of smolt movements and distributions at sea.

The Atlantic Salmon Trust, Fisheries Management Scotland and Marine Scotland Science are collaborating to oversee a project to start to map locations of acoustically-tagged salmon smolts at sea. Glasgow University are providing field tagging teams in support. This project is designed to be capable also of detecting smolts tagged in the EU Sea Monitor project being conducted to the south.

In 2020, an array of receivers will be established extending to the north and south of the Outer Hebridean Islands and between the islands. A further array will be deployed within the Minch. Smolts will be captured and tagged in a number of rivers in the west and south-west of Scotland. The main objectives at this pilot stage will be to determine whether the arrays pick up tags and are capable of differentiating among several possible swimming vectors. It is anticipated that as a next stage (subject to availability of funding), a grid array of receivers will be deployed within the Minch to refine further the actual swimming vectors of smolts and so develop a dispersal model that can be used for planning.

Studies of migration along the European shelf edge and into the Norwegian Sea using drifters/AUVs etc (NEAC)

A particle drift model, developed as an output from the SALSEA Merge project (2009 to 2011), indicated a strong likelihood that most southern European post-smolts (Spain, France, Ireland and UK) use the European shelf edge current as a marine 'highway', following currents to summer/autumn feeding grounds in the Norwegian sea. The SALSEA-Merge model assumed that much of the movement of post-smolts was a result of passive transport. This model and the associated hypotheses surrounding the migration paths of southern European post-smolts should be tested to see if it accurately portrays smolt migration, particularly in areas where smolts leaving freshwater have to migrate significant distances against the residual coastal and oceanic currents. Similarly, wind driven currents could have marked effects on migration routes and more information on movements of post-smolts in key areas would greatly assist in developing such models further. Potential methods to test the current migration hypotheses include deploying acoustic tag detection systems on a range of bioprobes, drifters, autonomous underwater vehicles (AUVs also known as gliders), oceanographic buoys, ocean monitoring stations and buoys attached to fixed fishing gear. Deployment of fixed receivers on oceanic platforms or establishing oceanic monitoring stations would be difficult in areas where the shelf edge was distant from the coastline. Where the shelf edge was closer, e.g. off the North West of Ireland, such platforms or arrays could be considered which would allow tracking of post-smolts from Spain, France, Ireland and the UK. Fixed moorings could be employed on the shelf and potentially on the upper continental slope. Alternatively, deployment of AUVs would allow strategic tracking of post-smolts at key points along the shelf edge which narrow to only 10s or 20s of kms. These AUVs would allow confirmation of pre-suppositions relating to the use of the shelf edge as a marine 'highway' as well as providing information on survival of electronically tagged groups of post-smolts released from each of the southern European salmon producing countries.

Progress Report: Integrated into 'SeaMonitor' project (below).

NEAC kelt satellite tagging

Atlantic salmon kelts from different rivers migrate in spring to feeding areas before returning after one or more years. Kelts from different rivers use separate feeding areas that are defined by oceanographic processes which vary from year to year. The use of satellite tags will allow researchers to address: the extent of fine-scale population mixing/segregation in the ocean; stock-specific and population structure (spatial and age) migration strategies; mortality/success in relation to habitat occupation in feeding area; return/ predation rates and type; migration dynamic linkages with oceanographic conditions

Progress Reports for this project have been requested annually since the telemetry workshop, but none have been received.

Sub-adult satellite tagging at Faroes

The application of PSATs to salmon captured and released at the Faroe Island, combined with genetic assignment techniques, will allow researchers to investigate: the partitioning of mortality between life stages; the extent of fine-scale population mixing/segregation in the ocean; stock-specific and population structure (spatial and age) homeward migration strategies; mortality/success in relation to habitat occupation in feeding areas; return/ predation rates and type; and migration dynamic linkages with oceanographic conditions.

Progress Reports for this project have been requested annually since the telemetry workshop, but none have been received.

Adult satellite/acoustic tagging at Greenland

This technology, in combination with genetic assignment methods, offers the ability to provide information on stock-specific migration routes, behaviour and mortality during the second year at sea.

Progress report (Tim Sheehan and Jon Carr)

Update on Progress: A five-year collaborative study was initiated in 2018 by the Atlantic Salmon Federation (Canada), NOAA Fisheries Service (USA), Fisheries and Oceans Canada, and the Association of Fishers and Hunters (Greenland) to track salmon fitted with pop off satellite tags (PSATs) from Greenland to coastal regions of origin. Funding for the project is provided by primary as well as additional project partners (e.g. Equinor, Canada's Atlantic Salmon Research Joint Venture and the Atlantic Salmon Trust).

Tagging occurred from September-October in 2018 and 2019 near Qaqortoq Greenland. Atlantic salmon are primarily captured via trolling and tagged with PSATs (Microwave Telemetry Inc. (Colombia, Maryland) X-tags). Genetic assignments were conducted for all tagged fish to determine region of origin.

In 2018, a total of 17 Atlantic salmon were captured; 12 were tagged and released with PSATs, 2 with acoustic tags and 3 were not tagged but only sampled. Of the 12 PSAT-tagged salmon six individuals were identified as North American origin and 6 were identified as European origin. For the North American origin salmon, one was identified as originating from the USA reporting group, 4 from the Gaspé Peninsula reporting group, and 1 from the Ungava Bay reporting group. All 6 European origin salmon were identified as originating from the United Kingdom / Ireland reporting group. A total of 8 tags popped off and transmitted collected data. Data are currently being processed and analysed.

In 2019, a total of 25 Atlantic salmon were captured; 20 were tagged and released with PSATs, 4 with acoustic tags and 1 was not tagged but only sampled. Genetic assignments results to determine region of origin are not available yet. As of December 31, 2019, 4 tags have popped off and have transmitted data. Tags are programmed to remain active until May 1, 2020. Shortly after that date, all data from the 2019 tagging effort will be in hand and will be processed and analysed.

Fishing in the Qaqortoq region appeared to be poor in 2018 and 2019 based on anecdotal information received from local fishers and low trolling catch rates. Exploratory trolling in 2017 resulted in ~1.43 fish caught per trolling hour compared to the ~0.15 salmon caught per hour in 2018 and 2019.

The five-year study referenced above focuses on the use of 'traditional' PSATs and light-based geolocation to map migration routes of tagged salmon. The ASF and NOAA is also partnering with researchers from the Woods Hole Oceanographic Institute (WHOI), among others, on the development and testing of the ROAM (RAFOS Ocean Acoustic Monitoring) approach to marine tracking.

ROAM is an acoustic tracking system where low frequency long ranging sound wave "pongs" are emitted from ocean moored sound sources and received by a tag equipped with a hydrophone attached to the study animal. A primary advantage of the ROAM approach is the long range of the "pongs" which could result more accurate geolocation over a wider spatial and temporal range compared to traditional light-based methods. However, it should be noted that this technology is in the early stage of development and field testing is ongoing.

Prognosis and future developments

- the primary project partners (ASF and NOAA) have developed a five-year project plan (2018-2022) and barring any unforeseen circumstances or outcomes will continue to implement that plan;
- in 2020, the sampling period will remain from September through October, taggers will be scheduled to minimize overlap and maximize days fished, efforts will be put forth to increase the fishing effort via additional fishing vessels, and efforts will be put forth to explore the efficacy of shore-based gillnetting to increase access to adequate numbers of salmon towards the objective of tagging 50 salmon with PSATs annually;
- ASF and NOAA continue to seek opportunities and communicate with potential future partners to develop a robust acoustic monitoring network in the region to expand current acoustic tagging efforts for Atlantic salmon and other species captured at Greenland;
- project partners continue to pursue additional funding opportunities to supplement and continue this work; and
- ASF and NOAA will continue to work with the Woods Hole Oceanographic Institute on the development and testing of the ROAM (RAFOS Ocean Acoustic Monitoring) approach to marine tracking and if appropriate will transition from traditional light-based PSAT tags to ROAM PSAT tags.

SeaMonitor Project (Ross McGill and Niall Ó Maoiléidigh)

The ‘Malin Head to Islay Receiver Array’ SALSEA-Track project (NEAC) and the ‘Studies of migration along the European shelf edge and into the Norwegian Sea using drifters/AUVs’ SALSEA-Track project (NEAC) have now been integrated under the EU’s INTERREG VA Programme (Environment Theme) in the SeaMonitor project.

SeaMonitor Project Description

In December 2018, the project was successful in securing €4.6 million in funding in an INTERREG VA (Ireland, N. Ireland and Scotland) call resulting in the formation of the SeaMonitor project.

Led by the Loughs Agency, a cross border UK / Ireland body, the project has nine partners: i.e., Loughs Agency (UK, Ireland), Marine Institute (Ireland), Queens University Belfast (UK), Agri-Food and Biosciences Institute for Northern Ireland (UK), University of Glasgow (UK), University College Cork (Ireland), Galway-Mayo Institute of Technology (Ireland), Ocean Tracking Network - Dalhousie University (Canada), and University of California Davies (USA).

The INTERREG VA SeaMonitor project is a novel and comprehensive project focusing on a wide range of issues across the Programme Area (Scotland, Ireland and N. Ireland). It will directly deliver the INTERREG V objective of developing cross-border capacity for the monitoring and management of marine protected areas and species. It will result in a corresponding increase in cross-border monitoring and management capacity. This will facilitate the development and growth of a regional ‘blue economy’ based on its maritime resources and the alignment of regional activities with the EU’s Atlantic Strategy through the potential of e.g., developing and strengthening the growth of marine tourism, providing management plans and enabling sustainable development to occur in often sensitive environments.

The project will deliver five models, three management plans / groups, two of which relate directly to salmonids (i.e. management plan for salmon in the Foyle and Clyde) and extend the INTERREG VA COMPASS network of buoys from the east coast of the island of Ireland to the north establishing a physical connection of acoustic receivers between the island of Ireland and Scotland thus providing a tangible monitoring network to the INTERREG programme. SeaMonitor has been jointly developed by all the partners and will be jointly implemented with partners working together across a range of activities.

SeaMonitor will establish a network of buoys for regional seas, including telemetry and oceanographic monitoring (e.g. for seals, cetaceans and salmonids).

Salmonid Elements of SeaMonitor update:

Malin Head to Islay Receiver Array (NEAC)

A total of 108 Acoustic Listening Stations (ALS) are planned to be deployed at different locations across the North Channel from Malin Head to Scotland (Islay), aka ‘the Main array’, to detect the presence of acoustically tagged fish and marine mammals. Ship time from the Marine Institute’s RV Celtic Voyager for this element of the project has been scheduled for February / March 2020.

A further 40 ALSs are planned for deployment in coastal areas (Foyle estuary, west coast Donegal, North Coast of N. Ireland) to detect not only salmonids but skate and basking sharks. Acoustic cetacean monitors will also be deployed in the region.

Tagging of salmon will take place from several locations in N. Ireland (Bush and Foyle), Scotland (Clyde) and Ireland (Burrishoole, Boyne, Shannon and Lee). The aim is to tag a minimum of 250 smolts per year across the target rivers of the project.

All procurement for the staff, receivers and tags is complete. Operational details have been organised with the Marine Institute Ocean Science Services (Research Vessel Operations).

Animal welfare licences haven been received for the project and for the individual tag teams.

The locations of the main and the Foyle acoustic listening stations are detailed below (Figure 1).

The receivers will be serviced in September 2019 and redeployed.



Figure 1. Locations of acoustic receivers for SeaMonitor project

Studies of migration along the European shelf edge and into the Norwegian Sea using drifters/AUVs etc (NEAC).

The SeaMonitor project will concentrate on use of an AUV rather than drifters and will focus initially on the shelf edge northwest of Ireland and west of Scotland. The AUV has been ordered and is expected to be in service by May of 2020. The initial trials will allow range testing of onboard acoustic receiving capabilities for smolt tracking. The Marine Institute's vessel Celtic Voyager will allow the AUV to be deployed along the shelf edge during May and June at strategic locations to opportunistically locate migrating tagged smolts and to refine the smolt migration model developed under the SalseaMerge project.

The AUV will then be used to profile the shelf edge for current speed and other dynamics using an ADCP and other onboard profiling equipment.

Project duration

The project end date is 31 Dec 2022. The array will be deployed for this period and will allow release of tagged smolts in 2020, 2021 and 2022 for subsequent tracking. The AUV will be used in strategic locations of previously identified post-smolt migration during the same period to opportunistically locate migrating tagged smolts and to provide data to model the migrations of salmon in the ocean in the early stages of the migration using behavioural and oceanic parameters.

Communications

Excellent synergies and collaboration have also been made between the three INTERREG VA funded marine research projects (SeaMonitor, COMPASS, MARPAMM) in terms of communications. Discussions are taking place on a joint website and joint conference in 2020. There is a Twitter account (@SeaMonitor1) with over 250 followers.

SeaMonitor attended the European Tracking Network (ETN) meeting in Palma Spain 15-17 Oct. and is now a member. It has recently been agreed that the project will host the next annual meeting of the ETN in Derry N. Ireland in November 2020. SeaMonitor also recently attended COMPASS and MarPAMM annual meetings.

The project would like to invite any and all institutions outside of the project that have tagged or intend to tag marine species with acoustic transmitters in the region to send us their information so that they can trace any transmissions downloaded from the SeaMonitor arrays and share data accordingly.

2. Other Projects

I. SeaSalar (contact: Eva Thorstad, www.seasalar.no)

The Atlantic Salmon At Sea – factors affecting their growth and survival (SeaSalar) project is funded by the Norwegian Research Council and is not part of the SALSEA-Track programme. The Norwegian Institute for Nature Research (NINA) is the lead institution, with the Institute of Marine Research and the Arctic University of Norway as main partners.

The main aims of the SeaSalar research programme are to examine factors impacting variation in marine survival of Atlantic salmon over time and in different geographical areas – and to establish a long-term inter-institutional collaboration for present and future projects. The project aims to build a knowledge platform and study how the marine survival of Atlantic salmon is affected by abiotic and biotic variables. This will be done by studying the physical and biological environment at sea that can potentially influence Atlantic salmon growth and survival, mapping the marine distribution and migration routes, analyse the variation in growth and survival over time and geographic areas and combining data to identify factors affecting

marine survival. The project will use both existing datasets and new technologies and modelling, including the use of new electronic tagging technologies. The project started on 1 August 2018 and will last for four years.

The project is mainly reported through international publications, and through other dissemination and communication to the public through oral presentations, social media, other media etc. (and through news on the project web site). The project has been running for a year now, and the scientific publications so far are presented under the news on the web site. The most recent publication is not yet presented there but is listed below. The project is reported to the Norwegian Research Council and there is no progress report beyond that. It is possible that the Research Council might publish some short popular updates from the project.

Strøm, J.F., Thorstad, E.B., Rikardsen, A.H. 2019. Thermal habitat of adult Atlantic salmon *Salmo salar* in a warming ocean. J. Fish Biol., 10 pp. DOI: 10.1111/jfb.14187

II. The Moray Firth Tracking project (2019 – 2020 summary by Louise Chavarie, AST Tracking Co-ordinator)

In 2018 the Atlantic Salmon Trust and partners launched the Missing Salmon Project to understand the fate of salmon smolts from seven rivers that discharge into the Moray Firth, Scotland. The clear aim of the project for 2019 was to find out where the fish were going missing. Over the course of 2018 the project raised £1.3million to turn the concept into a reality and the practical element commenced in early 2019. Please note that from the 1st January 2020, the Moray Firth Tracking Project will come under the auspices of the Missing Salmon Alliance.

The layout of the project is described in Figure 2, below.

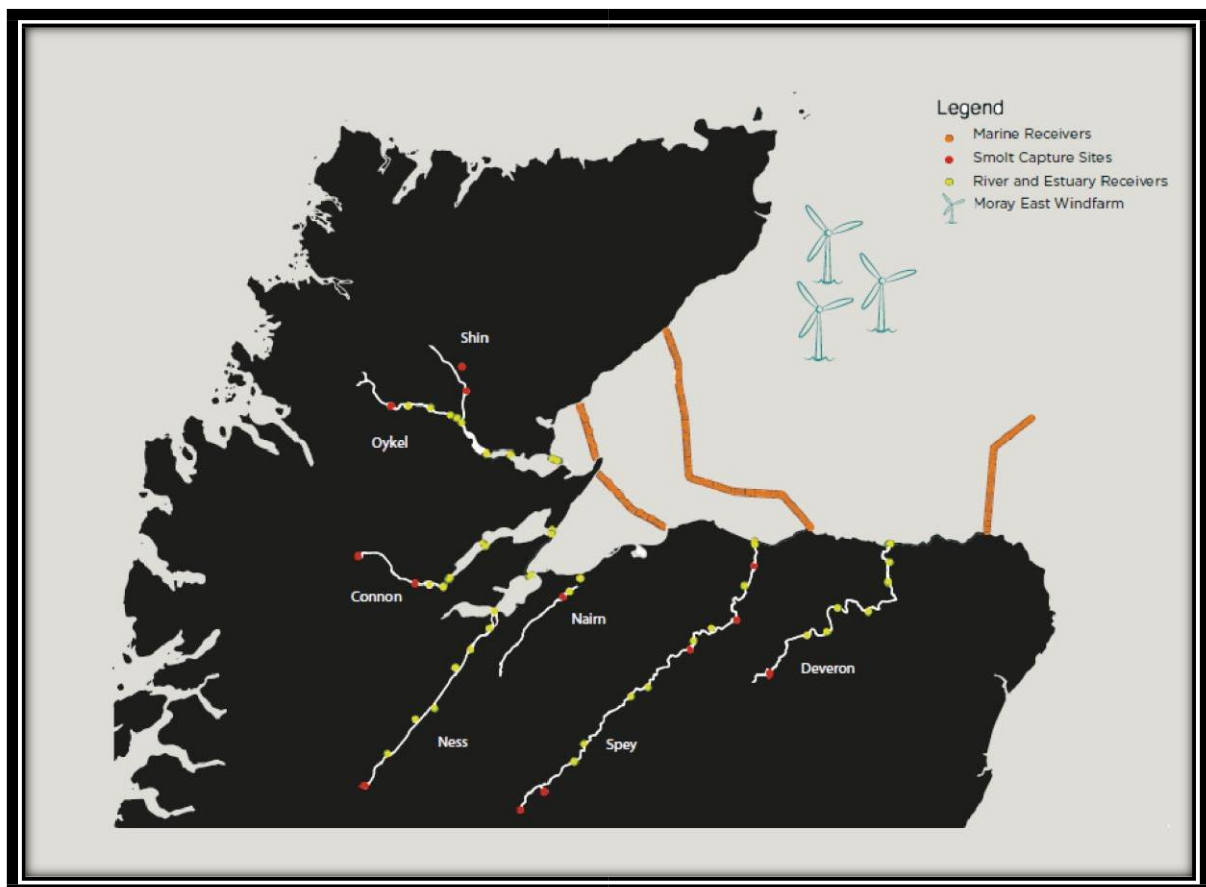


Figure 2. Moray Firth Tracking Project Layout.

A total of 800 salmon and 50 sea trout were successfully tagged and followed down each of the seven rivers and out to the last complete array to the east of the Spey. A proportion were then detected on the Fraserburgh array (the most easterly array in the Moray Firth).

The key findings of the 2019 study were:

- of the tagged salmon smolts, low percentages of confirmed successful migrants were found to have reached the downstream receivers (i.e., River Conon: 33.3%, River Deveron: 38%, River Findhorn: 64%, River Ness: 9%, River Oykel 49%, River Shin: 79% and River Spey: 59.1%);
- of the tagged salmon smolts that have reached the downstream receivers, high percentages of confirmed successful migrants were found in the estuary and coastal waters (i.e., River Conon: 19.2%, River Deveron: 34%, River Findhorn: 40%, River Ness: 9%, River Oykel: 9%, River Shin: 34.2% and River Spey: 46.3%). The pattern of 'missing salmon' was dampened in the marine environment when compared to the freshwater environment; and
- overall, the salmon smolts showed strong directional movement, heading east and north east out of the Moray Firth.

Building on the successful delivery of the 2019 programme the next two years of the project will focus on what are the suspects or pressures responsible for the fish going missing. This is with a particular focus on freshwater, where the majority of the loss of fish occurred. In addition, the programme will also look to repeat the work from 2019 to look at year-to-year variability and look at the route smolts take once they leave the Moray Firth. The findings from the programme will feed directly into the Likely Suspects Framework. In addition, the work was captured by film (https://www.youtube.com/watch?v=V_MiK1JtFzQ) and still photography to highlight the work to the public and increase awareness.

Freshwater Study 2020

As the rivers are the priority areas for understanding where fish are going missing the number of receivers will be doubled to increase the resolution at which the problem can be looked at. A total of 700 salmon will be tagged in the seven rivers shown in Figure 2, as a repeat of the 2019 work. Alongside the tagging work a predator study will be commissioned and is described in a separate paper.

Marine Study 2020

The two inner arrays (Dornoch and Inner Moray Firth) and Fraserburgh will be dropped and the receivers used to increase the number placed in the rivers. The Spey Bay to Brora array will be maintained as the work in 2019 indicated a very high efficiency in detecting tagged fish and acceptable losses from fishing activities. This configuration of the array for 2020 will allow for estuary and coastal mortality information to be collected in a comparable way to 2019.

An addition to the project will be the trial use of a buoyancy glider to track smolt migration outside of the Moray Firth. This will add to the limited knowledge on Scottish smolt migration routes by validating the Marine Scotland smolt dispersal model with real information. The exact route of the glider is currently being determined with the University of East Anglia and Marine Scotland. However, it is likely to be the offshore area to the north east of the Moray Firth.

The key deliverables of the 2020 programme will be:

1. Build on the success of the 2019 programme to ensure the results are valid between years and are real;

2. Start to understand the pressures responsible for the high loss of salmon in the freshwater environment;
3. Increase our understanding of smolt migration routes by locating them further out at sea and validating the smolt dispersal model;
4. Support the Likely Suspects Framework by providing key information on domains and associated pressures; and
5. Demonstrate to the public the plight of salmon and what is being done to better understand and tackle the problem.

Project Partnership

The project partnership will be led by the Atlantic Salmon Trust and will comprise University of Glasgow, Marine Scotland, University of East Anglia and the Fishery Boards and Trusts within the Moray Firth area.

III. Salmonid Management Round the Channel (SAMARCH)(Dylan Roberts)

SAMARCH is a €7.8m five-year project (2017-2022) part funded by the France England Interreg Channel programme. The project will provide new transferable scientific evidence to inform the management of salmon and sea trout (salmonids) in the estuaries and coastal waters of both the French and English sides of the Channel.

The SAMARCH project will :

- provide novel information on the survival and migration of young salmon and sea trout in four estuaries of the Channel area;
- provide novel information on the movements and swimming depths of adult sea trout in the Channel;
- create a genetic data base for trout on both sides of the Channel;
- create a map of areas that are important for sea trout in the Channel based on sea scape;
- provide new information to further improve the models used in England and France to manage their salmonid stocks;
- train students in the management of coastal and transitional waters;
- engage with stakeholders throughout the project; and
- inform current and develop new policies for the better management of salmonid stocks in our coastal and transitional waters.

Updates are provided reasonably regularly on the project website <https://samarch.org/>

A two-day telemetry workshop was held recently as part of the project, see <https://samarch-telemetry.org/programme/>

The project is now in the latter part of its third year. To date, the project has focused heavily on data and information collecting on the five main rivers included in the project, the Frome and Tamar in the South of England and the Scorff, Oir and Bresle in Northern France. Years four and five will focus on policy development. The project consists of four main Work Packages based on telemetry, genetics and data collection, modelling and policy development.

Key milestones thus far include: -

Work Package 1 Telemetry

Smolts - In the springs of 2018 and 2019, a total of 359 sea trout and 457 salmon smolts were acoustically tagged with Vemco V5 180 kHz acoustic tags in the lower reaches of the rivers Frome, Tamar, Scorff and Bresle and tracked to where the estuaries meet the open sea using a network of some 60 receivers. The data is currently being analysed, a report will be available in late spring 2020.

Sea trout Kelts – In the winters of 2017, 2018 and so far over the winter of 2019 / 2020 (to 11 January 2020), 143 sea trout kelts have been tagged with Vemco V9 180 kHz acoustic tags, Cefas technology data storage tags (DST) and PIT tags on the rivers Frome, Tamar and Bresle. Of the 99 tags deployed in winters 2017 and 2018 we have a DST recovery rate of around 25% with varying degrees of information on them. A further 150 sea trout kelts will be tagged in January and February 2020 and the tags will be recovered in spring, summer and autumn 2020. This will conclude the kelt fieldwork.

Work Package 2 Genetics

Construction of Genetic data base of trout in the channel area – Some 2000 samples of trout have been collected from 80 rivers on both sides of the Channel. These have been analysed for SNPs and construction of the database is underway.

Genetic sexing – The project aims to sex some 25,000 juvenile and adult salmon and sea trout over 25 years from scales. Thus far some 50% of the scales have been analysed.

Capture of salmonids in coastal waters sea – The project obtained dispensation from the Environment Agency to fish for salmonids with gill nets within 6 miles of the English side of the Channel to obtain genetic samples from marine salmonids and to investigate the impact of coastal nets on these fish. In spring and summer 2019, two commercial fishermen were hired to set gill nets off the channel coast. The fishermen fished for 23 days using a total of 600m of gill net each day. In total, 27 adult sea trout, 7 post smolts, 5 grilse and 1 salmon were captured representing 1.7 salmonids captured per day from the near coast. This work will be repeated in 2020. The fish are being analysed for genetics to identify their natal river.

Work Package 3 Data collection and modelling

The project is contributing towards the cost of continued data collection on juvenile and adult salmon from the Frome, Scorff and Oir salmon index rivers 2017 to 2022.

The project is currently advertising a two year post doc position through Agrocampus Quest, who will be in charge of developing and evaluating Atlantic salmon population models to investigate the drivers and mechanisms of spatial and temporal variability in life histories and population dynamics.

PhD projects

Adult salmon – A PhD project based at INRA is in its second year. It has two main objectives:

1. Investigating the mechanisms responsible for sex-specific long-term changes in salmon life history traits; and
2. Integrating the knowledge gained on maturation mechanisms and size selective mortality at sea in a life-cycle model structured by size, age and sex with a focus on the marine phase.

Juvenile salmon - A PhD project based at GWCT is in its second year. The objectives are:-

1. Assess the environmental and biological factors determining the variability in the overwinter growth rates of juvenile Atlantic salmon;

2. Test the influence of migration phenology and environmental factors on Atlantic salmon migration behaviour;
3. Implement a multi-state CMR state-space model to test the effect of Atlantic salmon smolt body length versus other factors on their subsequent marine return rate; and
4. Generalise the multi-state CMR state-space model to test effect of smolt length on marine return rate in populations throughout Europe.

Work Package 4 stakeholder engagement and policy development

Given the project is in its data collection and analysis phase the main focus thus far has been on stakeholder engagement. This has been through organising a number of meetings and events including: -

1. Project launch in Southampton in January 2018;
2. SAMARCH Forum event in Mont Saint Michel in May 2018;
3. SAMARCH salmonid Telemetry Workshop in Southampton in November 2019;
4. Project staff attend ICES trout and salmon working groups;
5. Project staff attend NASCO meetings;
6. Project staff attend key meetings with regulatory bodies and their working groups in England and France; and
7. The project is engaging with the newly formed Missing Salmon Alliance (MSA) and discussing the potential for integration of the data and results into the MSA's Likely Suspects Framework.

IV. Impacts of tagging on smolt survival (John Armstrong)

Marine Scotland Science will commence a project in 2020 (with first tagging of smolts in 2021) to evaluate the impacts of tagging and tag size on subsequent survival of salmon smolts. The project will use smallest acoustic tags and tagging of pre-smolts as a 'minimum impact baseline' for comparison with effects of larger tags and of handling and tagging fish as they emigrate from the river. The project is funded and will involve collaboration with Fisheries Management Scotland members on four east coast rivers. The project will inform on-going work funded by the Atlantic Salmon Trust to assess losses of tagged smolts within rivers.

Secretary of the International Atlantic Salmon Research Board
Edinburgh
15 January 2020