

Projects of Interest to the Board and its Work

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Purpose

The purpose of this paper is to provide an update on projects of interest to the Board and its work, namely the SMOLTrack projects, the Likely Suspects Framework and the SAMARCH project.

Decisions

No decisions are required.

Background

At the 2020 Annual Meeting of the International Atlantic Salmon Research Board (the Board), ICR(20)16, it was agreed that an Agenda item would be retained in future years which focused on projects of interest to the Board and its work. This would include information on projects where NASCO has some ownership (such as EU-funded projects, the SALSEA-Track successor, when agreed, and the Likely Suspects Framework) and other relevant projects; those researchers could be invited to contribute information, CNL(20)12. The Board asked the Secretary to provide updates on projects where NASCO has some ownership and, through the Board and SAG members, to seek information on new and emerging projects that would be of interest to the Board and its work.

Prior to the 2022 Annual Meeting of the Board, the Secretariat asked Board members and SAG members to provide information on any new and emerging projects that they were aware of, that would be of interest to the Board and its work.

This paper contains updates on those on-going projects which have received Board funding. It also contains an update on the SAMARCH project, in Annex 1.

SMOLTRACK PROJECTS

The EU has provided funding to NASCO to support the following SMOLTrack projects:

- Understanding and comparing early mortality of European salmon populations at sea (SMOLTrack I completed);
- Comparing mortality of European salmon populations at sea using multiple -method telemetry studies (SMOLTrack II completed);
- Quantifying smolt survival from source to sea: informing management to optimise returns (SMOLTrack III ongoing. Update below); and
- Quantifying salmon survival from river exit to return as adult: Collecting thermal and behavioural data to refine smolt to adult survival indices (SMOLTrack IV ongoing. Update below).

The website for the projects is: <u>SMOLTRACK.</u> There is also information on the <u>Board website</u>.

SMOLTrack III: Quantifying smolt survival from source to sea: informing management to optimise returns

Summary of the Action

Recent marine survival estimates are amongst the lowest recorded in decades and indicate that

as little as 3% of wild smolts now survive to return as adults. In recent decades, survival at sea has generally been accepted as the key determinant of river stock abundance. However, recent research conducted in Denmark, England, Ireland, Spain, Sweden and Northern Ireland through the EC-funded SMOLTrack and related initiatives have indicated that smolt mortalities during the early outward migratory phase from 'source to sea' may be much greater than previously assumed. In addition, various studies have demonstrated that a reduction in negative pressures (e.g. predation, aquaculture) on smolts in this zone of influence can ultimately boost associated adult returns. Therefore, it has become apparent that significant knowledge gaps remain to comprehensively understand, quantify and partition the principal cumulative factors responsible for Atlantic salmon smolt survival during this critical life stage.

Successful outward migration is likely influenced by a variety of factors such as smolt size condition and physiological status, habitat structure, predation pressure, sea lice-induced mortality from salmon aquaculture (if present) and the effects of regional and local climatic conditions including flow and temperature regimes. The proposed project aims to identify and evaluate the relative contribution of several of the principal factors responsible for early smolt and post-smolt mortality in order to better inform the development of fisheries management strategies that may optimise natural smolt production and consequently enhance the probability of wild adult returns. The project will evaluate potential pressures on migrating smolts identified from several previous SMOLTrack work packages, including predator bottlenecks and thermal stressors. As migration survival is best assessed via telemetric studies, an additional central focus of this project is to validate the effect of tagging on fish behaviour in order to better ensure the accuracy of such assessments. In the freshwater, transitional and coastal zones, fisheries managers have much greater scope to implement successful measures to reduce pressures on out-migrating salmon compared to the vast oceanic environment, where the stock protection measures are principally limited to regulating commercial fisheries.

To address these issues, the following work packages (WP) comprise the project:

- WP1 Eval-smolt
- WP2 Thermo-smolt
- WP3 Hand-smolt

The following EU jurisdictions participate in the project: Denmark; Finland (new partner); England; Ireland; Northern Ireland; Portugal (new partner); Spain and Sweden.

The leader of the SMOLTrack Project, Professor Kim Aarestrup, DTU Aqua, provided the following update in April 2022.

Progress on SMOLTrack III

Most of the planned smolt tagging was carried out in 2021, despite the continuing Covid-19 problems.

Work Package 1: Eval-smolt

<u>Description</u>: wild smolt to adult survival will be assessed using two tagged groups (treatment and control). Both groups will be intercepted in freshwater and tagged with transmitters and Passive Integrated Transponder (PIT) tags during their outward migration. The control group will be released in freshwater at the tagging site. The treatment group will be transported downstream and released to avoid existing identified smolt-loss bottlenecks. Survival will be measured during migration via the transmitters and in adult returns to trap (via PIT tags).

In each project site, smolt survival with and without smolt bottlenecks will be established, testing the potential effect of the bottlenecks and lead to a predictive model showing the potential benefit of management actions towards removing or limiting bottleneck effects.

<u>Update:</u> studies were continued on the Eriff, Bush and Lima in 2021, after most were postponed due to Covid-19 in 2020. On the Eriff and Bush, the aim is to look at moving fish past the identified bottlenecks. On the Eriff, there was low survival in both groups. Potentially, the low survival is due to an unusual year and the study will be continued in 2022, with an increased focus on other potential causes of smolt loss especially in relation to capture, handling and tagging-related stress in combination with the presence of predators. On the Bush, tagged smolts released downstream of the bottleneck survived significantly better. This study will also be repeated in 2022. We anticipate the results from the two rivers will be ready for publication after another year of data and will fit very well into the project of our newly recruited PhD student. A camera study was performed in the Bush in spring 2021 (postponed from 2020).

Work Package 2: Thermo-smolt

<u>Description</u>: this WP aims to build upon the extensive latitudinal distribution of the partners to monitor the relationship between smolt run and related temperatures in the river and receiving sea waters. Associated temperature and hydraulic data will be collected and compiled from stations throughout the project study areas. These data will be matched to the smolt run in the selected rivers to understand if there is geographic variability in conditions which salmon smolts encounter. For each catchment in WP1 and WP2 the main natural and anthropogenic pressures will be identified so that the effects of streamflow and temperature can be isolated.

In addition, an applied study is planned to monitor the behaviour of a group of hatchery-reared smolts held at an elevated temperature $(+5^{\circ}C)$ for a month immediately prior to their migration into coastal waters and compare to that of an untreated group. Age and growth of smolts in all systems will be determined from scale samples.

Both studies will inform of potential thermal stress and the adaptability of the species at this vulnerable life stage under various temperature / climate scenarios.

<u>Update:</u> the run timing and temperature data collection continues among partners. In the Lima, smolt trapping was performed in 2021 to evaluate the timing of smolt migration and collect biometric data from migrating smolts via trapping. As the southernmost river basin in Europe with known salmon reproduction, the Lima may provide useful information on timing of smolt migration at this extreme location that can be compared across a latitudinal gradient of variation. Unfortunately, 2021 was a very bad smolt migration year in Portugal and only three salmon smolt were caught. The study will continue in 2022, but trapping will be moved to a tributary of the River Minho.

Work Package 3: Hand-smolt

<u>Description:</u> fish telemetry studies are based on the assumption that a tagged fish's behaviour is representative of untagged conspecifics. In the context of SMOLTrack and any similar study this assumption implies that the risk of predation for tagged fish is equal to that of the control. This WP will undertake a strategically important research study aimed at testing this assumption in the field. Published and unpublished evidence is available showing that the influence of tagging on predation risk is minimal, but a detailed study is required for the specific situation with migrating smolts to validate results for management and to address potential peer-review concerns (all countries) and advice for future study setup. We will compare the survival between groups of smolts, tagged with different methods, and evaluate their performance against control groups.

The research in the three WPs will apply various methods on wild salmon smolts to broaden

the understanding of indirect and direct causes for mortality in the transition from freshwater to the marine environment over the entire geographic distribution of salmon in NE Europe. In WP1, smolts will be caught, tagged with PIT, radio- or acoustic tags in rivers from Spain to Finland, and their fate after release determined.

The results from WP1 combined with downstream trap catch data will be used in WP2 to infer the temperature and flow conditions experienced by the various populations in order to understand and predict optimal thermal conditions for salmon smolt migration. The results will be matched to data from WP3 to understand potential uncertainties that may be associated with smolt predation studies which are based on results from tagged fish.

The new project will take advantage of, and expand, an existing platform within the SMOLTrack partnership of EU-wide salmonid telemetry knowledge. This, together with availability of existing partner datasets, extensive experience of migratory fish project delivery and the advantages arising from bulk purchasers of tagging technology, will ultimately facilitate the sharing of international best practices to EU members.

<u>Update</u>: DTU carried out a pilot study in 2020 comparing the survival between a group of smolts electro fished and tagged before the migration period with that of a similar group tagged in a trap. The study will continue in 2022 along with a similar study in the Ballycastle River in Northern Ireland.



Results from the first Hand-smolt study in Omme / Skjernå 2020. The two groups of tagged smolt showed similar survival from Skjern Å to outside Ringkøbing Fjord.

SMOLTrack III Outputs

Results are still being collected and processed. The results from the Danish kelt study are almost ready for submission. The overall smolt survival paper was submitted and is now in review.

SMOLTrack IV: Quantifying salmon survival from river exit to return as adult: Collecting thermal and behavioural data to refine smolt to adult survival indices

Summary of the action

Recent marine survival estimates are amongst the lowest recorded in decades and indicate that as little as 3% of wild smolts now survive to return as adults. In recent decades, survival at sea has generally been accepted as the key determinant of river stock abundance. However, recent research conducted in Denmark, England, Ireland, Spain, Sweden and Northern Ireland through the EC-funded SMOLTrack and related initiatives, have indicated that smolt mortality during the early outward migratory phase from 'source to sea' is greater than previously assumed. In

addition, various studies have demonstrated that a reduction in negative pressures (e.g. predation, aquaculture) on smolts in this zone of influence can ultimately boost associated number of adult returns. Therefore, it has become apparent that significant knowledge gaps remain to comprehensively understand, quantify and partition the principal cumulative factors responsible for Atlantic salmon smolt survival during this critical life stage. However, there is obviously a large mortality in the oceanic phase of Atlantic salmon. The studies into causes and consequences have primarily been done by modelling because detailed information about salmon behaviour and migration routes in the Ocean is scarce. Classic expeditions by ship are prohibitively expensive and furthermore restricted both in time and space and are also to some extent catch-per-unit effort limited. Telemetry has proven to be the only viable method to get detailed knowledge of this behaviour. In recent years a few studies using satellite tags have been published, giving information on salmon migration at sea. Unfortunately, the current PSAT tags are too large to deploy on smaller fish (i.e. smolts), hence the preferred animals to tag are large kelts and the PSATs are typically limited to a 12-month deployment. Hence, there is still a lack of behavioural data, especially for the smaller life stages, and there is a limitation in data describing the return migration from the feeding grounds in the Northern Atlantic.

Acquiring detailed information from salmon behaviour at sea is a challenge and will require a multifaceted approach. The proposed project aims to investigate the post-smolt behaviour during migration from coastal areas to the feeding grounds in the north Atlantic. Additionally, the project aims to identify and evaluate the potential for 'fit for purpose tagging' (FFPT) in the North Atlantic, using insight gained from pilot studies undertaken in previous SMOLTrack projects. Identifying ways to obtain detailed knowledge on coastal and ocean behaviour and migration will be a pre-requisite for a greater understanding of the factors governing behaviour and ocean survival for Atlantic salmon and can feed directly into fisheries management strategies that may optimise and naturally enhance the probability of wild adult returns.

To address these issues, the following work packages (WP) will comprise the project:

- WP1 OceanTemp-smolt
- WP2 FFPT-adult

The following EU jurisdictions participate in the project: Denmark; Finland; Ireland; Portugal; Spain and Sweden.

The following areas outside the EU also participate in the project: England and Northern Ireland.

The leader of the SMOLTrack Project, Professor Kim Aarestrup, DTU Aqua, provided the following update in April 2022.

Progress on SMOLTrack IV

WP1: Temperature experience of post-smolt migrating towards and returning from their ocean feeding grounds.

<u>Description</u>: this WP aims to record the range of temperatures that migrating salmon from smolt stage to adult river return experience over their full oceanic migration. It is recognised that marine temperatures are likely to influence survival and behaviours of smolts at sea. Yet data on the thermal environment experienced by migrants, initially in freshwater, and subsequently in transitional and marine waters are limited. Few data are available due to the small size of salmon smolt which cannot accommodate internal implantation of temperature-logger tags which typically exceed the tag burden smolts can tolerate. Recent advances in logger technology have resulted in increased miniaturisation and this presents a unique opportunity for SMOLTrack IV to collect a key dataset (thermal data for migrating salmon smolt). The project proposes to tag outgoing smolts with miniature Data Storage Tags (DST)

at several river sites across the latitudinal extent of the partnership. This newly developed tag will be implanted in suitably sized smolts on several rivers with a view to capturing freshwater, transitional waters and marine temperature data. With a maximum battery life of 14 months, when logging at 10 min intervals, it is likely that a full return cycle, from smolt to returning adult grilse, will be captured. DST tags must be recovered in order to download the data. This means that this study can only be carried out in systems with a full trap or where removal of the tagged fish is assured. Smolts will also be implanted with a PIT tag to trigger a DST tagged fish recovery at the trap site. With maximum survival rates of circa 5% at least 100 smolts per system will have to be tagged in order to provide a reasonable chance of recovering data.

Recovery of returning adults also presents opportunities to undertake some detailed additional studies, albeit on a small scale, as returns are likely to be low. Nonetheless, various tissues can be recovered and this presents opportunities to understand / map and validate life history aspects. For example, scales will allow for analysis of growth rates versus temperature at different life stages. Refining of salmon scale interpretation by associating it with temperature data may provide scope for validation. Variations in otolith elemental composition are used to reconstruct fish movements. Elemental 'tags' (i.e. otolith stable isotope analysis) may offer scope to assign salmon to specific oceanic areas as defined by isotopic gradients (isoscapes). Combining temperature with otolith chemistry data may offer scope to identify putative feeding residency locations and potentially to suggest potential migration pathways. While it is outside the scope of the present project, the partners will sample the necessary tissues from returning fish enabling the analysis to be performed at a later stage.

<u>Update:</u> in both River Erriff and River Bush, 100 smolts were tagged with temperature Data Storage Tags and PIT tags. The first fish are expected to return in the summer of 2022 and both rivers have enabled increased trap surveillance to collect returning tagged salmon. The tagging continues in 2022. As soon as the first tags are recovered, the data sets will be analysed and by then we will know much more about what to expect from the combined results from both years of tagging. The full dataset will be available by 2024.

WP2. The movement and thermal pathways of adult immature salmon at the feeding grounds and when returning to their natal rivers

<u>Description:</u> in this new SMOLTrack activity, we will go beyond smolts and try to gain information from larger, immature salmon caught at sea at the feeding areas. From earlier studies, we have some information about the migration of MSW / repeat spawners from the home river out to the feeding grounds. This was obtained by using Pop-up-satellite tags on salmon kelts from rivers across Europe. The method is limited in both time of deployment (max 12 months) and the necessary size of the fish (70+ cm). We need, however, data from smaller salmon moving from their natal river to the feeding areas and also from all salmon during their return journey. By intercepting foraging young salmon at sea and tagging these with electronic tags, it may be possible to gain useful insight into this stage of the salmon life cycle.

We wish to extend previous feasibility studies, testing the possibilities of catching salmon at sea, close to Greenland's East Coast and use these for studies of return migration. In the study, there are two stages; a) explore the possibilities of catching reasonable numbers of salmon in an unharmed condition in the Tassilaaq area of East Greenland and by genetic testing to establish the areas of origin of the salmon caught. b) tag salmon with either: 1. long life acoustic tags to record at sea / fjord / river hydrophones upon return; 2. to tag salmon with floating Archival tags (DST) to get information about migration behaviour and route on the return journey; or 3. to tag salmon with PSAT tags to get a clear image of their return migration path. Tagging will also be prioritised on salmon assigned to potential rivers / regions where the SMOLTrack partners are active, to optimise awareness.

Update: the previously postponed pilot study in eastern Greenland was undertaken in

September 2021. The project tested various possibilities of catching adult salmon in the area with the intention to gather information on their return migration. Use of long-lines was difficult and time consuming and failed to catch salmon. Setting of short gill-nets perpendicular from the coast consistently produced catches of salmon confirming high abundance of salmon in the area. Due to logistic reasons, trolling could only be tested during the last 3 days of the trip. After some adjusting of technique, two salmon were finally caught on lures with just a few hours of fishing. The fish were in great condition and were anaesthetized and tagged with floating DST-tags and released on site. In total, samples (tissue, stomach content and scales) from 40 salmon were collected. Salmon origin is currently being determined by genetic assignment. The results are promising for using this method to gain suitable salmon for tagging, similar to the tagging project in west Greenland.



Picture: First salmon caught, tagged and released in Eastern Greenland by SM-IV project.

LIKELY SUSPECTS FRAMEWORK PROGRAMME

The following information was provided by Colin Bull who is the Principal Investigator on the Likely Suspects Framework Programme

Background

At its 16th Annual Meeting (2017) the Board agreed to part-fund a workshop on the Likely Suspects Framework (LSF) concept, which had been developed by the Atlantic Salmon Trust (AST). The workshop, which further refined and developed the LSF concept, was held in Edinburgh in November 2017 and <u>the proceedings</u> were published in the AST Blue Book series.

In March 2018 Dr Walter Crozier attended a meeting of the ICES Working Group on North Atlantic Salmon and sought their support in principle for the LSF approach. Having received this support a full report on the project was provided to the Board at the 35th Annual Meeting of NASCO (2018). The meeting endorsed the LSF concept and agreed to request the Secretary to explore with ICES how best to integrate Atlantic salmon marine survival and population data with relevant ICES marine databases and to suggest that, as an initiative within the International Year of the Salmon, a number of joint workshops might be convened. This suggestion was subsequently agreed and the first of these workshops (WKSalmon) was held in June 2019 with the second scheduled for 2022.

<u>The Likely Suspects Framework</u> (LSF) is the flagship project of the <u>Missing Salmon Alliance</u>¹ (MSA). For salmon managers to adopt an adaptive management approach and to make evidence-based decisions, a detailed understanding is required of the mechanisms driving variation in salmon stock abundance. The LSF programme will assist by:

- providing vital new knowledge on the drivers of salmon mortality from across the lifecycle.
- generating new stock forecasting and scenario-testing capacities to support salmon managers' appraisal of options, and guide their activities

In 2020 and 2021 reports were delivered to the Board outlining project progress. The current report provides an update on project progress over the past 12 months.

Progress in 2021

- 1. Developing the core team remained a key focus of work in 2021. The core team of Principal Investigator (Colin Bull) and Database specialist (Graeme Diack) were joined in 2021 by a contract Ecological Modeller (Neil Banas), a post-doctoral researcher (Emma Tyldesley) and a PhD student (Aislinn Borland).
- 2. Supporting co-operative research and the ecosystems-based approach for Atlantic salmon, the LSF team have focused efforts on developing a shared Database: the MSA's <u>Central Data Resource</u> became live online in July 2021. This online portal provides a unique platform for knowledge exchange and supporting co-operative research on Atlantic salmon. In conjunction with mobilising data resources, the team have carried out an initial expert assessment and prioritisation of a sub-set of mortality hypotheses, and an assessment of regional ocean model hindcasts in support of the NASCO-ICES WKSalmon workshop series.
- **3.** Development of an underlying mortality framework as a stage-state model began in 2021, and is at an advanced stage. This will represent the generalised relationship between environmental and biological controls over individual salmon growth and survival in each of the main life stages. It will underpin the ongoing work on developing management decision support tools.
- 4. Building decision support tools for salmon managers was advanced in 2021 by 1. Convening a <u>one day workshop</u> with salmon managers from the UK to discuss knowledge gaps, provision of data and gather their input regarding a suitable pathway for development of a decision support tools to assist their work. 2. Beginning work on the underlying morality framework (above) and 3. Beginning technical options appraisal of a prototype decision support tool to guide development of tools that enable scenario-testing of stagespecific and cumulative effects on survival resulting from particular interventions.
- 5. Researching the drivers of salmon mortality at sea was advanced in 2021 by the commencement of new co-operative research project that examines the drivers of salmon

¹ The Missing Salmon Alliance (MSA) brings together leading salmon conservation organisations across the UK -the Atlantic Salmon Trust, Game & Wildlife Conservation Trust, Fisheries Management Scotland, The Rivers Trust and the Angling Trust. It aims to reverse the devastating collapse in wild salmon populations around the UK. By combining expertise, coordinating activities and advocating effective management solutions MSA is focused on ensuring that wild Atlantic salmon populations survive and thrive in rivers, lochs and seas for the next generation.

mortality during the first few months at sea, with a focus on marine prey fields and on building a suite of ecosystem indicators.

6. Developing science outputs that contribute to the evidence base and build external collaboration opportunities remain a high priority to assist with the future delivery of this ambitious programme. To this end, significant progress has been made with a number of primary science papers:

In press: The Likely Suspects Framework: the need for a life cycle approach for managing Atlantic salmon (*Salmo salar*) stocks across multiple scales. C.D. Bull, S.D. Gregory, E. Rivot, T.F. Sheehan, D. Ensing, G. Woodward & W. Crozier. *ICES Journal of Marne Science*.

Submitted: Enhancing data mobilisation through a centralised data repository for Atlantic salmon (*Salmo salar* L.): providing the resources to promote an ecosystem-based management framework. G. Diack, G., C.D. Bull, S.A. Akenhead, T. van der Stap, B. Johnson, E. Rivot, R. Patin, P.Y.Hernvanne, A. Schubert, T. Bird, M. Saunders & W. Crozier.

In preparation: E. Tyldesley, N.Banas, C.D. Bull. Disentangling how the ecosystem signals across trophic levels and scales contribute to variation in the survival of Atlantic salmon from Southern European stocks

7. Agreeing the way ahead for the LSF programme was undertaken in 2021 as a five year strategy document that identified and described five priority work packages (Table 1) matched to available resources to progress four key areas: the provision of resources for research (WP1), developing new management support tools (WP2,WP3) and catalysing new research into conditions that lead to salmon mortality (WP4, WP5). Figure 1 provides an overview of how these work packages feed into the delivery of the LSF programme aims. Work on many of these work areas is already underway, and formalising the timing and extent of a delivery plan will assist with future resource allocation.

Work package	Brief description
WP1: Continued development of the salmon data library to underpin the LSF process	This will build and develop a fully accessible Atlantic salmon knowledge hub. This will hold the data resources needed for LSF development and in time will support regional and catchment– level salmon management.
WP2: Building the suspects framework	This will use the knowledge from WP1 and other LSF work packages to statistically describe our understanding of salmon mortality processes across the salmon life-cycle. It will provide support for future management activities, in the first instance using available information from ICES Index rivers.
WP3: Building support tools for salmon managers	A prototype decision support tool was developed in 2020 and populated with indicative salmon survival rates. The prototype will be further developed to deliver an online interface providing new decision-support and guidance of relevance at the regional and river-specific scales.

Table 1. Work packages within the Missing Salmon Alliance Likely Suspects Framework five-year work programme

WP4: Populating the suspects framework: priority domains	This implementation study will examine the conditions that lead to salmon mortality during the early marine migration phase using time series data from six salmon Index rivers and newly derived knowledge of key ecosystem components. It will combine information from freshwater and the early marine migration to test two priority LSF priority mortality hypotheses (latent mortality effects from freshwater phase; mismatch with coastal seas productivity).
WP5: Populating the suspects framework: integrating across the life-cycle	This will capture new and emerging knowledge on the conditions that lead to salmon mortality in areas of the life-cycle not yet focused on within the LSF process. This will improve the models to provide a more detailed full life-cycle representation, benefitting management support outputs (WP3).



Figure 1. How the proposed strategic components of the programme feed into development of positive actions for Atlantic salmon through generation of guidance and advice

Secretariat Edinburgh 1 June 2022



SAMARCH 2022 INTERNATIONAL FORUM



SALMON AND SEA TROUT: SCIENTIFIC TOOLS FOR THEIR PROTECTION

17 AND 18 MAY 2022 - PLÉNEUF VAL ANDRÉ (FR - 22)

PARTICIPANT'S FILE



















Dear participants, speakers and friends,

I am delighted to welcome you to the **SAMARCH forum in Brittany** on the Pléneuf Val André site. Over the course of two days, scientists, managers, technicians and fishermen will discuss the preservation and safeguarding of migratory salmonids in estuarine and coastal areas. It is essential today to better understand the functional role of these areas to try to slow down or even reverse the decline of these populations in the North Atlantic.

Thanks to the extensive efforts made in freshwater by fishermen and their associations, State services, local authorities and their financial partners, we are fortunate enough to observe the gradual return of migratory fish to coastal rivers, as shown by the scientific monitoring conducted in both Normandy and Brittany. Unfortunately, the marine indicators are much more worrying. This is the challenge for the SAMARCH programme, of which this symposium is a part before the programme ends in June 2023.

Bretagne Grands Migrateurs is proud to be contributing to this major programme, which I am sure will provide scientific answers and improve the management of our large migratory species. I hope you all enjoy an excellent forum, filled with informative and constructive discussion.

Jean-Yves Moëlo, president of BRETAGNE GRANDS MIGRATEURS

CONTENTS

PROGRAMME	P4
BRETAGNE GRANDS MIGRATEURS AND SEINORMIGR	P6
SAMARCH: WHAT IS IT?	P7
KEY FINDINGS OF THE SAMARCH PROGRAMME	P8
SUMMARY OF PRESENTATIONS	P15

Programme TUESDAY, 17 MAY

9.30 am:	Welcome coffee
10 am:	
	- Jean-Yves MOËLO, president of Bretagne Grands Migrateurs
	Delphine ALEXANDRE, vice-president of health, water and biodiversity of the Brittany region
	Nathalie NOWAK, councillor for the environment of the Côtes d'Armor department
10.30–10.50 am:	Report on the objectives and content
	of the SAMARCH programme (Dylan ROBERTS, GWCT)
10.50 am–12.10 pm:	Introduction – Current knowledge and knowledge gaps
	in the marine phase of migratory salmonids
	10.50–11.15 am: Finally getting to grips with the complex life of Atlantic
	salmon at sea (Ken WHELAN, Atlantic Salmon Trust -Ireland-)
	11.15–11.40 am: Modelling population dynamics and stock assessment of
	salmon in the North Atlantic basin (Etienne RIVOT, Institut Agro)
	11.40 am–12.05 pm: The distribution of diadromous fish at sea and the role of
	Marine Protected Areas (MPAs) (Sophie ELLIOTT, Institut Agro / GWCT)
	12.05–12.25 pm: Discussion with the audience
12.30–2.00 pm:	Lunch
12.30–2.00 pm:	Lunch SESSION 1: Presentation of scientific work
12.30–2.00 pm:	Lunch SESSION 1: Presentation of scientific work from the SAMARCH programme on improving knowledge
12.30–2.00 pm:	Lunch SESSION 1: Presentation of scientific work from the SAMARCH programme on improving knowledge of migratory salmonids in estuaries and at sea
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Programme WEDNESDAY, 18 MAY

9 am:	Welcome speech: Isabelle GRYTTEN, head of the Natural
	Heritage department / Biodiversity, Geology and Landscape division of DREAL Bretagne
9.15 am: SES	SION 2: What planning and management tools are used for migratory salmonids?
	 9.15–9.40 am: Comparison of salmonid management and policy developments in France and the UK (Laurent BEAULATON, OFB and Lawrence Talks, EA) 9.40–10.05 am: The National Plan for Diadromous Migrators and its links to other existing tools for the preservation of these species (Marine PORTENEUVE, OFB-INRAE) 10.05–10.30 am: Regulating fishing for migratory salmonids in estuaries and at sea in Brittany and Normandy (Elise CARNET, DREAL Bretagne and Gwenaël ROBINEAU, OFB) 10.30–10.50 am: Discussion with the audience
10.50–11.10 am:	Coffee break
11.10 am:	SESSION 3: Feedback and examples
	of measures taken to preserve migratory salmonids in freshwater
	11.10–11.30 am: From data collection to data development (Laëtitia LE GURUN, BGM)
11.30	0–11.50 am: Managing recreational fishing for migratory salmonids in Brittany: regulations, reporting
	catches and new management strategy for salmon fishing (Marie-Andrée ARAGO, OFB)
	11.50 am-12.10 pm: RENOSAUM: moving towards new recreational salmon
	fishing regulations in Brittany (Etienne PRÉVOST, INRAE)
12.10-1	2.30 pm: Major pathological risks for migratory salmon: from UDN (a myth?) to reality (<i>Gyrodactylus</i>
	salaris) (Patrick GIRARD and Armand LAUTRAITE, Santé Poissons Sauvages association)
	12.30–12.50 pm: Discussion with the audience
12.50–2.30 pm:	Lunch
2.30–4.45 pm:	SESSION 4: Round table – Feedback and examples of measures taken to
	preserve migratory salmonids in estuaries and at sea
What is	the added value of Marine Protected Areas (MPAs) for the management of migratory salmonids?
	(Gwenola DE ROTON, OFB & Pauline BLANCHARD, OFB)
 How do you fact 	tor in the restoration of ecological continuity in coastal areas? What are the difficulties involved?
	(Christophe MAUGENDRE OFB & Pierre LEGENDRE, Morlaix Communauté)
	What are the potential impacts of offshore wind farms on salmonids?
	(Anthony ACOU, OFB & Lydie COUTURIER, France Énergies Marines)
	 How do you better manage migratory salmonid fisheries at sea and in estuaries?
	Reporting catches and bycatch (Guillaume LE PRIELLEC, CRPMEM),
	Risk analysis of bycatch (Vincent TOISON, OFB)
	A tool to raise awareness among recreational fishermen: Nav&Co (Marie LE BARON, OFB)
4.45 pm: Su	Immary and conclusion of the forum: Jean-Paul DORON, 1 st vice-president of
	FNPF and member of the SEINORMIGR board of directors
5.00 pm:	Closing of the Forum

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SALMON AND SEA TROUT: SCIENTIFIC TOOLS FOR THEIR PROTECTION

BRETAGNE GRANDS MIGRATEURS AND SEINORMIGR,

two associations that contribute to the restoration and management of migratory fish in the rivers of Brittany and Normandy



Bretagne Grands Migrateurs (BGM) is an association created in 1995 (when it was initially called "Ouest Grands Migrateurs"). On its registration, a "migratory fish" section was first included in the 1994 to 1999 State-Region Plan Contract. The parties to this contract are the four French Departmental Federations for Fishing and the Protection of the Aquatic Environment in Brittany.

The purpose of the association is to help restore and manage migratory fish populations in Brittany's rivers and their environment. BGM is responsible for coordinating the regional programme for the preservation and restoration of migratory fish and for running the Migratory Fish Observatory set up in 2011.

Find out more at: <u>www.observatoire-poissons-migrateurs-bretagne.fr</u>



Seine-Normandie Migrateurs is one of the eight major migratory fish associations in France, focusing on the Seine basin and Normandy.

Approved for environmental protection, the association works to safeguard and protect migratory fish in the Seine-Normandy basin. Its responsibilities include improving knowledge of migratory species, their management and the restoration of their migration routes, as well as providing recognised scientific expertise.

Find out more at: www.seinormigr.fr

The rivers of Brittany and Normandy provide favourable aquatic environments for diadromous migratory fish such as Atlantic salmon, sea trout, sea lamprey, shad and eels. However, these fragile populations have to cope with a number of pressures such as pollution, the degredation of spawning grounds, physical barriers and poaching among other things. The preservation and restoration of these species, which indicate that rivers are in good ecological condition, represent a major challenge to ecology, heritage and economics!



SAMARCH: WHAT IS IT?

SAMARCH is a seven-year project supported by the EU Interreg France (Channel) England Programme



France (Channel) England SAMARCH Cettion des sativoridés dans la Manche Tona surgées de dividegement régional



The SAMARCH (SAlmonid MAnagement Round the Channel) programme is funded by the Interreg "France (Channel) England Programme" for a period of seven years from 2017 to 2023. It aims to improve the management of salmon and sea trout populations in the Channel.

The SAMARCH project has a €9 million budget, 69% of which is financed by the Interreg "France (Channel) England" Programme, representing a contribution of €6.2 million.

By working with a consortium of 10 partners involved in scientific research and management, SAMARCH aims to create new knowledge on the biology and ecology of salmonids and to transfer this knowledge to improve regulations in France and the UK for the management of salmonids in estuaries and coastal areas. The ultimate aim is to help increase salmon and sea trout populations. To this end, research activities will focus on studying the behaviour of salmonid populations in estuaries and coastal areas to identify the main sources of mortality. This will involve:

- * Analysing DNA to map key sea trout habitats in the Channel
- * Studying the movements and mortality of smolts in estuaries
- * Providing new information on long-term changes in salmon growth rates from the analysis of historical scale collections
- * Enhancing understanding of the difference in life history between male and female salmon, which is essential to better manage populations.

Find out more at: www.samarch.org



SALMON AND SEA TROUT: SCIENTIFIC TOOLS FOR THEIR PROTECTION

7

Key findings of the SAMARCH programme

Salmonid populations have declined drastically in the last four decades. Multiple freshwater factors such habitat loss or alteration have been associated with this trend, but the recent decrease of marine return rates of Atlantic salmon suggest that salmonid populations are also significantly impacted during the marine phase. Reasons for this low marine return rate are yet to be fully understood, leading researchers, like those in the SAMARCH project to focus on the marine phase of the salmonids life cycle.

WP T1 – Tracking salmonid use of and mortality rates in transitional, coastal and marine waters

Author: Celine Artero, Game & Wildlife Conservation Trust

Work Package Leads: Celine Artero, Game & Wildlife Conservation Trust – Rasmus LAURIDSEN, Game & Wildlife Conservation Trust – Elodie Réveillac, La Rochelle Université

The main objective in the WP-T1 is to follow two species of salmonid: Atlantic salmon (*Salmo salar*, hereafter salmon) and anadromous brown trout (*Salmo trutta*, hereafter sea trout) during their migration to sea from freshwater to the marine environment via transitional waters (estuarine environment). It is important to dissociate the different environments that salmonids span during their migration to: (1) describe their migration route, behaviour in each environment and; (2) identify, the factors potentially impacting their survival during the migration.

WP-T1 is divided into 2 sub projects: the smolt tracking project and the kelt tracking project.

Smolt tracking project

The smolt tracking project tracked both salmon and sea trout smolts during their first migration to sea in fresh, transitional, and coastal waters. To do so, during the spring of 2018 and 2019, 835 wild salmon and trout smolts were acoustically tagged using 180 kHz Innovasea V5 tags (5mm diameter, 0.77g weight in air) in four catchments: the rivers Frome, Tamar, Bresle and Scorff. These acoustic tags transmit unique coded ultrasonic signals (containing an identification number, ID) recognised by submerged acoustic receivers deployed along their migration path.

This methodology enables the study of the spatio-temporal use of transitional and coastal waters by emigrating salmonid juveniles and their survival through these environments.

Key findings of the smolt tracking project:

- * Salmon smolts migrated significantly faster than trout smolts.
- * Trout smolts stayed on average 2 days longer in the estuaries than salmon smolts.
- * Salmon smolts migrated through the estuary with constant or increasing speed from freshwater to coastal environment, taking the shortest route whereas, trout smolts slowed as they transitioned through the estuaries on their way to sea.
- * Both salmon and trout smolts reduced their migration speed in the area around the salinity limit in all study sites.
- * Smolt loss was gradual along the estuaries and no specific areas accounted for pronounced increases in detection loss.
- * Trout smolts displayed a higher survival rate during their estuarine migration than salmon smolts.

Kelt tracking project

The kelt tracking project only focused on sea trout kelts, as most salmon do not survive after their first reproduction. Kelts are much bigger than smolts, providing the opportunity to use larger tags which have an extended battery life and/or have memory space to record environmental parameters. Tags with a recording capacity, called data storage tags (DST) do not require recording stations to be deployed on the fish migration path, and therefore extend the spatial coverage possibilities. Thanks to DSTs, it is possible to collect migration data not only in estuarine and coastal waters but also in the marine environment. However, DSTs do not transmit data therefore it is necessary to recover the tag to retrieve the data.

During the winters of 2018/2019, 2019/2020 and 2020/2021 a total of 314 sea trout kelts were tagged with both a 180 kHz Innovasea V9 tags acoustic tag, and a Cefas Technology Limited G5 data storage tag, in the Frome, Tamar and Bresle rivers, to follow their post spawning estuary and marine migration.

Key findings of the kelt tracking project:

- * 24% of the deployed sea trout tags have been recovered.
- * 67% of the recovered tags were found by beach walkers highlighting the great participation of the public in our research project.
- * Tags were found in every country with a coastline in the English Channel or southern North Sea.
- * The tagged sea trout exhibited a strong diving behaviour reaching depths of up to 80 m. However, the pattern of this diving behaviour appeared to vary between study rivers and by time of day.
- * Of the recovered tags 27% of the sea trout had been predated at sea.

Analysis of the DST data is ongoing, but will provide information on the at sea migration route of sea trout. Preliminary findings have shown that sea trout from France migrate to the UK coast and vice versa, and that individuals from both France and the UK share similar marine feeding habitat. This information underpins the need for international management of sea trout at sea.

WPT2 Developing novel genetic tools for managing migratory fish in Coastal and Transitional Waters (TCW)

Authors: Jamie STEVENS and Andrew KING, University of Exeter & Sophie LAUNEY and Mathieu VANHOVE, INRAE Rennes

Work Package Leads: Jamie STEVENS, University of Exeter & Sophie LAUNEY, INRAE Rennes

Objectives of the work package

In order to effectively manage trout populations, accurate information on life history and migration patterns is needed. For many rivers, we now have a good idea of the population size, location of spawning areas and potential threats (i.e. habitat and water quality, location of barriers to fish movement etc.). In-river trout populations can then be managed considering this information. However, while sea trout spend a significant proportion of their life at sea, for such an iconic fish, relatively little is known about the marine phase of their life cycle. Tracking (WPT1) is an excellent tool for following small numbers of fish, and previous studies have suggested that many sea trout stay close to their natal river, while a minority can move considerable distances. But these methods do not yield sufficient information for population-level studies. However, every fish carries its own natural unique genetic 'tag' or profile, which can be analysed and used to study the movements of sea trout in TCW.

The University of Exeter (UExe) and INRAE collaborated to build a genetic database incorporating DNA profiles of trout populations (sampled as juveniles) and associated metadata from potential source rivers of sea trout from the FCE area. This database will enable scientists and managers: (1) to determine the river of origin of adult sea trout sampled in the FCE area; (2) to understand how far sea trout travel from their natal river; (3) to identify the marine landscape («seascape») parameters that impact the movement of sea trout between rivers. Ultimately, INRAE and UExe will map the marine areas that are used preferentially by adult sea trout in TCWs. This will be used to advise managers and stakeholders regarding the impact of new coastal and offshore development projects, and/or the designation of marine protected areas.

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Main activities and results – what has been achieved and what is still going on

Genetic database

Samples were collected from brown trout parr from both UK and French rivers flowing into the English Channel/Manche, as well as from northeast England, the Bristol Channel and southeast Ireland (Figure 1).



Map showing the location of the 103 UK, Irish and French rivers sampled for the SAMARCH genetic baseline. Symbol colour indicates to which of 11 distinct genetic groups each river belongs.

FIGURE 1.

Map showing the location of the 103 UK, Irish and French rivers sampled for the SAMARCH genetic baseline. Symbol colour indicates to which of 11 distinct genetic groups each river belongs.

The current genetic baseline comprises nearly 3000 trout sampled from 103 UK, Irish and French rivers which have been genotyped at a suite of 94 genetic markers. The final database will cover 190 markers. Initial findings indicate significant genetic structuring across the region, with the identification of 11 genetic groups (Figure 1).

Assignment of sea-caught sea trout to their river of origin

As part of the SAMARCH project, UExe has been undertaking a programme of at-sea sampling, utilising local nets men at four locations around southern England (Appledore, Cawsand Bay, Kimmeridge Bay and Rye Harbour). In addition, sea trout have been obtained from commercial fisheries along the East Anglian coast and the Rhine/Meuse estuary as well as from sea trout caught in estuarine areas of the Taw/Torridge, Tamar and Sussex Ouse rivers.

Preliminary results suggest that each of our marine sampling locations represent mixed stocks of sea trout. For instance, as might be expected, the majority of fish sampled from Kimmeridge Bay assign to Hampshire Basin rivers (Figure 2). However, fish from Devon, Cornwall and southeast England were also sampled at-sea in the waters of Kimmeridge Bay. There is also a suggestion that French sea trout (from lower Normandy rivers) are present along the Dorset coast. Interestingly, several fish from northeast English rivers were caught at Kimmeridge, representing a migration distance in excess of 800 km from their natal rivers.



FIGURE 2.

Stock composition of sea trout sampled from Kimmeridge Bay, Dorset showing the proportion of fish assigned to each of 11 distinct genetic groups (known as reporting regions).

Identifying habitat features and areas important for sea trout in the Channel area

We aim to link genetic distances between populations and environmental variables from the marine environment. The studied variables go from hydrographic to anthropic features (temperature, currents, depth, substrate, chemicals, fishing pressure...). Each environmental variable will be associated to a cost distance (positive or negative depending on whether the variable facilitate or restrict sea trout movements in the sea). In a first step, theoretical work has allowed the development of a new method, based on machine-learning processes, that is able to handle multiple environmental predictors. It generates resistance maps, showing the most likely routes used by individuals between populations, and identifying the environmental parameters that will have an influence on these routes. The second step, applying this method to the sea trout data, is still on-going.

WPT3 – Salmon Stock Assessment: Data and modelling

Authors: Etienne Rivot (Institut Agro), Marie Nevoux (IN-RAE), Jamie STEVENS (University of Exeter), Andrew KING (University of Exeter) and Stephen Gregory (formerly Game & Wildlife Conservation Trust, now CEFAS)

Work Package Leads: Marie Nevoux (INRAE), Stephen Gregory (formerly Game & Wildlife Conservation Trust, now CEFAS) and Etienne Rivot (Institut Agro)

Introduction

Understanding the demographic and ecological mechanisms shaping the response of populations to multiple stressors is a prerequisite for scientific expertise on the population status and their sound science-based management. This is particularly critical in the context of rapidly changing ecosystems under climate change. This is even more challenging for salmonids that share their life cycle between a freshwater breeding habitat and the marine environment, and that interact with multiple single and/or synergistic factors at different points in time and space during their life cycle. Accumulated evidence suggests that key life history traits of salmonids (e.g. survival, growth, age or size at maturation) have changed in response to recent environmental changes; however, the precise magnitude of those changes, its variability among population and even between sexes, and the mechanisms that underline this variability remain largely unknown. As a consequence of those data and knowledge gaps, population dynamic models used for stock assessment (Stock Assessment Models, SAMs) and to derive biological management reference points (e.g., Conservation Limits) most often rely on inaccurate values of vital rates and do not consider the influence of environmental changes. Those strong assumptions could lead to inappropriate management decisions based on biased population productivity estimates.

In SAMARCH we provide new data and knowledge on the variability of life history traits of salmon and sea trout that bring new insights on the response of salmonids populations to environmental changes. This work will enhance stock assessment models for adaptive management plans to mitigate the effect of environmental change on salmonid stocks in England, France and at an international level. Previous work in SAMARCH has shown that "bigger is better" among salmon smolts migrating from SAMARCH rivers, that early summer growth at sea is a critical time for salmon

sex-specific life-history choices, and that national salmon SAMs could derive more accurate assessments using new information on sex ratios and that international salmon SAMs can and should use a more contemporary life-cycle approach to stock assessment. This update highlights work that builds on these earlier findings.

Data Analysis

The project capitalized and complemented biometric data and scale samples from seaward-migrating smolts and returning adults from five wild Atlantic salmon and four sea trout populations of southern England (Frome, Tamar) and northern France (Scorff, Oir, Bresle), collected over 49 years (1969-2017). SAMARCH provided the financial support to carry on running long-term monitoring programs over the last five years on all five rivers. For each of the five rivers, the abundance of seaward-migrating smolts and upstream returning adults was estimated. Fish traps were operated to count fish and collect scale samples from seaward-migrating smolts and returning adult. An unprecedented effort of scale reading was made to analyse growth variation during the freshwater and the marine phase among individuals, population, and over time. In order to analyse variations in sex ratio, and compare growth trajectories and maturation patterns within and between males and females, we assessed the genetic sex of each individual using DNA extracted from scales. Individual measurements of length and fecundity available on a large sample of females were also collated. Within SAMARCH, we developed a new information system to catalogue available biological samples and store the diversity of individual-based information from our different study sites within a unique framework. This database met international standards and ensured that the data is easily searchable and usable to answer key research and management questions, at the scale of the FMI zone, and beyond.

Based on this extensive database, we assessed the longterm trends in the sex ratio at different salmonid life stages (smolts and adults) and fecundity of adults in the SA-MARCH rivers, and investigated the factors contributing to these changes (e.g. body size, age). Results highlight that the sex ratio of returning fish was relatively stable for each sea age class over time, but that the average fecundity declined by 15% between 1985 and 2018, mostly driven by a decline in the mean body length and weight of returning multi sea-winter females. This suggests that SAMs might systematically overestimate eggs deposition, particularly in recent years, which could lead to overstate compliance

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with conservation limits. The novel data on sex ratio and fecundity will be incorporated in new SAMs to reduce their possible bias. This will encourage managers to derive more realistic conservation limits that recognize the changing ratio of females and the changes in mean body size within each sea age class.

River Tamar Study

A study on the River Tamar, UK, investigated the effect of updated sex ratio data on the conservation compliance for the river. Utilising archive scales samples and a highly accurate genetic sex test, the sex ratio within the one- and twosea winter adults was assessed over six years (2015-2020). For one-sea winter salmon, the genetically determined proportion of females was remarkably close to the default value historically used to calculate egg deposition for the Tamar. However, it was clear that the proportion of females in the two-sea winter age class was being significantly under-estimated. To determine the influence of changing sex ratios on calculated annual egg deposition rates, values were recalculated using the default historic and new genetically determined sex ratios. Application of annually derived genetically determined sex ratios had a generally positive effect on egg deposition estimates: egg deposition estimates increased by an average of > 6% compared to historic default values. Only for a single year (2016) did use of the annual sex ratio data result in a reduction in the deposition estimate. This study highlights the need to collect accurate, up-to-date data to inform and update salmon stock assessments. The genetically determined average proportion of females for each sea age class will be used to assess future conservation limit compliance for the Tamar.

Results

Analysis of salmon growth from scales reveal exciting new results on the response of populations to environmental changes. In particular, results reveal a strong decline of growth of salmon at sea after year 2005 common to all five populations. This decline is particularly marked during the first month of the marine life after the smolt sea-ward migration (first summer at sea). This declining growth at sea likely reveals recent environmental changes at sea, characterised by a rise in temperature and a decline in abundance and energetic quality of available salmon prey.

Further analyses of the demographic mechanisms revealed the critical influence of growth on salmon life history traits with a special interest on marine survival and maturation rate. Different results obtained on the Frome and on the Scorff revealed that body length at smolt migration may positively influence survival of post-smolt during the first months at sea. This builds on previous SAMARCH work that supports the "bigger-is-better" paradigm based on the hypothesis of size-selective mortality during ocean migration. Early results of another SAMARCH study show that the support for the "bigger is better" paradigm is a general phenomenon and not limited to the Frome and Scorff, but can be generalised to rivers from France to Norway. It is generally assumed that the migration of smolts through the estuary and coastal waters is a very critical phase of the life cycle, with extremely high mortality risk. Nevertheless, our analysis was not able to detect the effect of any additional environmental and anthropic pressure encountered by migrating smolts. This has important management implications as it exemplifies that, in addition to maximising the smolt number, maximising the length of the migrating smolt may also be an important leverage to maximise returns. We also show that growth during the first summer at sea partly controls the maturation age, with fish with a higher growth during the first summer at sea having a higher probability to mature after only one year spent at sea. This dependence of the maturation decision to growth at sea also highly depends upon the sex of fish, with females that need a higher growth at sea to mature than males. This result again has important management implications as growth at sea is ultimately susceptible to control the proportion of the different sea-age classes and sex-ratios in the returns, and hence the average fecundity of returning fish.

Modelling

To transfer those new data and knowledge to advance population dynamics and stock assessment models, we developed integrated stage- and sex-structured population models that articulate key demographic processes controlling survival at sea and maturation decision for males and females separately. Those models seek to better capture the effect of environmental changes at sea on salmon population dynamics and stock productivity by accounting for differences in life histories between males and females and the influence of changes in growth at sea on marine survival and maturation age. A novel pilot model was developed based on data available from the survey of the Scorff population (the Scorff is one of the ICES index rivers). It integrates the size selective mortality of post-smolt at sea, and the influence of growth at sea on the maturation rate through an effect that depends on sex. Results demonstrate that temporal variations of post-smolt survival mostly contribute to temporal variations of both the return rate and the reproductive potential as measured by the average number

of eggs spawned for one female migrating smolt. Although weaker, the contribution of the maturation rate is non-negligible in explaining the variability in the return rate especially of highly fecund 2SW females, thus highlighting that the dynamics and productivity of salmon population not only depends upon survival at sea but also on the maturation rate. By linking the growth of fish to return rate, sex and age structure of returns, and ultimately the reproductive potential, our model improves our ecological knowledge of the past influence of environmental conditions on population dynamics and productivity and could also be used to predict the effect of future environmental changes and to provide indicators for management decision making. A second model was also developed to capture patterns of change in salmon stock productivity and life history traits at the scale of the North Atlantic Ocean, and will be transferred to ICES WGNAS to improve forecasting of abundance of fish returning into different stock units, under different scenarios of environmental and management changes.



Work Package T4 – Stakeholder engagement, policy delivery and training

Authors: Dylan Roberts (Game & Wildlife Conservation Trust), Genoveva Esteban (Bournemouth University) Work Package Leads:

Training - Genoveva ESTEBAN (Bournemouth University), Ivan Bernez (Institut Agro)

Stakeholders and Policy – Dylan Roberts (Game & Wildlife Conservation Trust), Janina Gray (Salmon & Trout Conservation), Laurent Beaulaton (OFB), Gaëlle Germis (Bretagne Grands Migrateurs), Lawrence TALKS (Environment Agency), Maxime Potier (Seine Normandie Migrateurs) and Jérémie Corre (Normandie Grands Migrateurs – until 2019)

Partners Involved

- * L'Institut national d'enseignement supérieur pour l'agriculture, l'alimentation et l'environnement (Institut Agro)
- * Bretagne Grands Migrateurs
- * Office Français de la Biodiversité
- * Seine Normandie Migrateurs
- * Game & Wildlife Conservation Trust
- * Bournemouth University
- * Environment Agency
- * Salmon and Trout Conservation

Work Package Aims

This work package aims to engage with the relevant stakeholders from various sectors throughout the project to disseminate the projects aims, progress the findings, and effectively work with the regulators to deliver policy recommendations based on current best practice and the projects research results on both sides of the France/England Channel.

Stakeholders, include those in the:

- * Angling and recreational fisheries management and regulatory sectors
- * Inshore commercial fishing and regulatory sectors
- * Harbour, estuary, and inshore coastal management sectors
- * Marine spatial planning to include the renewable energy sector
- * Awareness raising of the declines of salmon and sea trout across their range

The project also aims to provide opportunities for undergraduate, MSc and PhD students to gain experience in salmon and sea trout conservation work and research, and fisheries and marine management.

Stakeholder Engagement

To raise awareness of the projects work to the above sectors the project has produced a digital communications strategy to include web site (www.samarch.org) Blog (www.samarch/blog) and a number of project videos. In addition, it has hosted a number of large events including:

- * SAMARCH project launch in Southampton in January 2018
- * A conference for key stakeholders and policy makers in the marine fisheries and management sectors at Mont St Michel Brittany in May 2018
- * A workshop on the marine tracking of salmonids in Southampton in November 2019
- * The International Forum in Brittany in May 2022
- * The project will host a workshop on marine management interactions with salmon and sea trout in November 2022
- * The project will host a final closing conference in March 2023

Policy Delivery

We are now in the final year of the project and the main focus is to develop policy recommendations to be considered by the regulatory bodies, based on current best practice and the projects research findings. To develop these recommendations the project has a dedicated Policy Group, which will release the recommendations later this year, along with the research results from the project. To facilitate the inclusion of SAMARCH's results in local policy, we organised a special meeting with French administrations in June 2021.

To facilitate the development of Best Practice the project has:

- * Reviewed and compared the fishery management tools used to protect salmon and sea trout in England and France.
- * Produced a report taking stock of the regulation of salmon and sea trout fishing in Brittany and western Normandy.
- * Submitted evidence on changes in salmon growth, marine survival

and sex ratios for salmon stocks assessment models.

Training

The project has thus far provided practical training opportunities for over 60 undergraduates, 20 MSc and two PhD students. They have gained experience from working with the project partners in a variety of areas, from tracking salmon smolts using acoustic telemetry technology, salmon stock assessment research and data management, to communications and organising and speaking at public events (interaction with over 4,000 school children and general public.

A full list of PhD, MSc, and undergraduate dissertations projects undertaken by students supported by the project will be available on the SAMARCH website.

SUMMARY OF PRESENTATIONS

TUESDAY, 17 MAY

Report on the objectives and content of the Salmonid Management Round the Channel (SAMARCH) programme, 2017 to 2023



AUTHOR: DYLAN ROBERTS,

SAMARCH project manager, Game and Wildlife Conservation Trust GWCT

The **SA**lmonid **MA**nagement **R**ound the **CH**annel project 2017 – 2023 (SAMARCH) has aimed to provide new transferable scientific evidence to inform the protection and management of salmon and sea trout in the estuaries and coastal waters of both the French and English sides of the Channel to reduce some of the anthropogenic pressures on these fish. The project has focused on three key areas:

- * The bycatch of salmon and sea trout in commercial inshore fisheries.
- * Challenges to salmonids caused by estuarine and inshore coastal activity and developments.
- * Strengthening salmon stock assessment models.

The project has utilised the research facilities on the salmon index rivers in the Channel area, the rivers Tamar and Frome in the South of England and the Scorff, Bresle and Oir in Northern France. During the next two days you will hear the key findings of the projects work and we look forward to discussing how this new information can be used to inform policy.

SAMARCH is part funded (69%) through the European Union Interreg Channel VA programme and involves 10 partners, five from the UK and five from France who are a blend of government, non-government and research organisations.

UK Partners	French Partners
Lead Partner: Game and Wildlife Conservation Trust	Institut national de recherche pour l'agriculture,
University of Exeter	l'alimentation et l'environnement
University of Bournemouth	L'Institut national d'enseignement supérieur pour
Environment Agency	l'agriculture, l'alimentation et l'environnement
Salmon and Trout Conservation	(l'Institut Agro)
	Bretagne Grands Migrateurs
	Office Français De La Biodiversité
	Seine-Normandie Migrateurs



Dr Celine Artero, lead researcher of the projects sea trout and salmon tracking programme at the fish trap at Gunnislake on the River Tamar, England. The project has tagged 315 sea trout kelts in three rivers to estimate their locations and swimming depths at sea © D. Roberts

TUESDAY, 17 MAY INTRODUCTION SESSION:

Current knowledge and knowledge gaps in the marine phase of migratory salmonids

Finally getting to grips with the complex lives of Atlantic Salmon at sea

AUTHOR: KEN WHELAN,

Research Director, Atlantic Salmon Trust

Over the past 15 years significant strides have been made in gaining an understanding of the complex lives of Atlantic salmon at sea. From the initial ground-breaking results of the SALSEA programme (2008 to 2011), through the scientific outcomes currently emanating from the Norwegian SeaSalar programme, this presentation will summarise the progress that has made to date. It will also outline work currently underway to assess the migration pathways of salmon in the North East Atlantic and some of the factors affecting the early lives of salmon at sea. Finally, the talk will summarise the major areas where detailed knowledge is still lacking and how we might tackle these in the years to come.



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SALMON AND SEA TROUT: SCIENTIFIC TOOLS FOR THEIR PROTECTION

17

TUESDAY, 17 MAY INTRODUCTION SESSION:

Current knowledge and knowledge gaps in the marine phase of migratory salmonids

Modelling population dynamics and stock assessment of salmon in the North Atlantic basin

AUTHOR: ETIENNE RIVOT

Institut Agro, UMR DECO Dynamique et Durabilité des Écosystèmes, Institut Agro, INRAE, Ifremer, Rennes CONTRIBUTORS: Etienne Rivot, Rémi Patin, Maxime Olmos, Pierre-Yves Hernvann, Marie Nevoux, Stephen Gregory, Cécile Tréhin, Etienne Prévost

Most populations of Atlantic salmon in the North Atlantic (NA) basin have experienced a sharp decline in numbers over the past 50 years. The causes are multifactorial. However, variations in the availability of trophic resources during the early marine phase, in response to changes in the marine ecosystem, have been identified as factors which greatly influence the growth and survival of salmon at sea.

It is important to understand the mechanisms inherent in populations' response to multiple pressure factors to: improve scientific expertise on the status of populations; anticipate their evolution under various management scenarios or environmental changes; and propose suitable management measures. Nevertheless, this remains a challenge for this migratory species which interacts with multiple factors at different life stages, in different environments and at different connected spatial scales. The difficulty is compounded by the dispersion of population monitoring data across multiple jurisdictions in the NA basin.

To better understand of the mechanisms underlying salmon population dynamics and the scientific bases of the assessment models used by the ICES Working Group on North Atlantic Salmon (ICES WGNAS), we have developed a life history model for all salmon populations in the NA basin. The dynamics of all 25 European and North American stock units taken into account by WGNAS are jointly analysed in a single model. Developed within a Bayesian framework, the model has assimilated the available data sets to estimate changes in marine survival and age at maturation since 1971. It quantifies the correlated variation of key life history traits between different populations which share habitats during part of their marine migration. The results show that a significant proportion of the variability is attributable to temperature fluctuations and primary productivity variations along the migration routes. To complement this model and to ensure effective transfer to stock assessment and management, we have developed a database and web interface which improves the transparency of the data used and the robustness of the data processing chain to stock assessment outputs.

This new modelling framework represents a major step towards gaining a better understanding of the ecology of salmon at sea and the mechanisms controlling population dynamics in the NA basin. It improves the explanatory and predictive capacity of the assessment model used by WGNAS, while encouraging more effective use of existing data. Furthermore it is easy to develop to incorporate new knowledge and data.

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TUESDAY, 17 MAY INTRODUCTION SESSION:

Current knowledge and knowledge gaps in the marine phase of migratory salmonids

The distribution of diadromous fish at sea and the role of Marine Protected Areas (MPAs)

AUTHOR: SOPHIE A. M. ELLIOTT 1, 4, 7

CONTRIBUTORS: Sophie A. M. Elliott^{1,4,7}, Laurent Beaulaton^{1,5}, Anthony Acou^{1,2}, Elodie Réveillac³, Etienne Rivot^{1,4}

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- 2) UMS OFB-CNRS-MNHN PatriNat, Station marine du Museum National d'Histoire Naturelle, 35800 Dinard, France
- 3) Littoral, Environnement et Sociétés (LIENSs), UMR 7266, La Rochelle Université-CNRS, 17000 La Rochelle, France
- 4) DECOD (Ecosystem Dynamics and Sustainability), Institut Agro, Ifremer, INRAE, Rennes, France
- 6) OFB, DRAS, 35042 Rennes, France
- 7) Game and Wildlife Conservation Trust, Salmon & Trout Research Centre, East Stoke, Wareham.







Declines in diadromous fish occurred due to anthropogenic pressures during the late twentieth century. Many diadromous fish which were commercially important, are now protected. In the past 25 years there has been a rise in Marine Protected Areas (MPAs), some of which are supposed to protect threatened diadromous fish (e.g. salmon, shad, lamprey). Yet, little is known about diadromous fish marine life history phases, and no observation-based distribution model exists for this group of species.

We collated a database of 168 904 hauls from fisheries observer bycatch data and scientific fisheries surveys, from across north-eastern Atlantic waters. We developed statistical models to estimate the distribution of diadromous fish at sea (three species of shad, two salmonids, two lampreys, the European eel, the thinlip mullet, smelt and the European flounder), while considering imperfect detection from gear types. We then developed a combined modelling approach to most accurately predict 'core' and 'unsuitable' areas of diadromous fish at sea distribution. The latter was to ensure the potential to adequately protect these species within MPAs whilst minimising impacts on sea-users.

All eleven species present (2003-2019) distribution were modelled within north-eastern Atlantic waters using a Bayesian hierarchical model. All species were observed within shallow coastal areas. Gear types with a higher probability of bycatch for each species were identified (e.g. demersal mobile trawls). 'Core' and 'unsuitable' areas of distribution were modelled with high accuracy (positive prediction rate >0.74 and negative prediction rate of >0.89). More than 60% of diadromous fish core areas were within the MPAs, yet less than 50% of MPAs which the species were present within protected these rare and data-limited species.

Given the coastal distribution of these species, they are exposed to higher anthropogenic pressures resulting from both terrestrial and marine environments. For MPAs to be effective accurate SDM is essential. By modelling accurate 'core' and 'unsuitable' areas, priority areas for protection within MPAs can be identified with specific management measures, minimising impacts on sea users.

Note: Some of this work is in revision within the Journal of Biological Conservation



Figure 1: Hierarchical Species distribution model probability of presence

SALMON AND SEA TROUT: SCIENTIFIC TOOLS FOR THEIR PROTECTION

Presentation of scientific work from the SAMARCH programme on improving knowledge of migratory salmonids in estuaries and at sea

WPT1 – The survival of smolts during their downstream migration: influence of biotic and abiotic parameters



AUTHOR: CÉLINE ARTERO, lead researcher of the SAMARCH WPT1 Tracking programme – GWCT

An acoustic telemetry study was carried out in spring 2018 and again in 2019 on two juvenile salmonid species (smolts), Atlantic salmon (*Salmo salar*) and sea trout (*Salmo trutta*), to quantify and explore the biotic and abiotic parameters influencing their survival when migrating down estuaries. To this end, V5-type acoustic tags (5 mm wide and 0.77 g, InnovaSea) were inserted into the abdominal cavity of the smolts. These acoustic tags emit a coded acoustic signal, containing an identification number, which is recognised and recorded by acoustic receivers previously deployed along their migratory routes at four study sites: the Tamar and the Frome, rivers located in the south of England, and the Bresle and the Scorff, two French rivers located in Somme and southern Brittany. Both species were monitored in parallel at all sites except the River Scorff where only salmon were represented.

The survival of smolts when migrating down estuaries was estimated from acoustic sensing using a hidden Markov capture-recapture model in which environmental parameters of the four study sites (dissolved oxygen level, salinity, temperature, flow rate, river type, and distance) as well as the characteristics of the tagged specimens (species, size, sex, age, condition, migration speed, and date of entering the estuary) were recorded. Various model structures were tested in order to study the spatio-temporal variability of smolt survival in estuaries.

The model incorporating both temporal and spatial variability in smolt survival was the most frugal. However, incorporating annual variability only slightly improved the performance of the model, highlighting variation in smolt survival along the estuary but little between years.

The results show that the type of species is the main variable which influences smolt survival rates. Indeed, during their downstream migration in estuaries, young trout displayed better survival rates than young salmon, regardless of the study site. Except for the River Frome, survival rates were very similar between study sites (on average 95% for trout and 89% for salmon).

In general, estuarine crossings resulted in losses of between 5% and 24% for the four smolt populations studied, highlighting the challenges that estuarine habitats present to smolt progression.



Presentation of scientific work from the SAMARCH programme on improving knowledge of migratory salmonids in estuaries and at sea

WPT2 - Sea trout in the Channel - what can we learn from genetic analysis?

AUTHORS: SOPHIE LAUNEY & M. VANHOVE, INRAE JAMIE STEVENS S & R .A. King, University of Exeter



To effectively manage trout populations, accurate information on life history and migration patterns is needed. Reliable information is now available for management of in-river populations. However, some trout spend a significant proportion of their life at sea (as sea trout) but relatively little is known about this phase of their life cycle. Tracking studies indicate that many sea trout stay close to their natal river, with some moving longer distances. However, such methods are typically restricted to studies on a single catchment (or a small number of rivers). Conversely, every fish carries its own unique genetic 'tag', which can be analysed and used to study the origins and movements of sea trout in coastal waters (TCW).

A genetic database incorporating DNA profiles of trout populations (and associated metadata) from potential source rivers of sea trout from the FCE area has been built by UExe and INRAE. In-river sampling has been undertaken by OFB, BGM and NGM/SEINORMIGR in France (as well as local anglers associations), and by GWCT and the Environment Agency in the UK. The baseline comprises genotypes from ~3000 trout sampled from 103 UK, Irish and French rivers and genotyped with 94 genetic markers. Initial findings indicate significant structuring across the region, with the identification of 11 distinct genetic groups.

This database will be used by scientists and managers:

- to determine the river of origin of adult sea trout sampled at sea in the FCE area and to understand how far sea trout travel from their natal river.

As part of the SAMARCH project, GWCT has undertaken atsea sampling, using local netsmen at four southern English locations; sea trout have also been obtained from two southern North Sea commercial fisheries, as well as other estuarine areas in UK and France. Preliminary results suggest that each of our marine samples represent mixed stocks of sea trout. At most locations, the majority of sea trout seem to originate from a geographically close river, but a not insubstantial minority of individuals have been found more than 800km from their natal river.

- to identify the marine landscape («seascape») parameters that impact the movement of sea trout between rivers.

We aim to link genetic distances between populations and environmental variables from the marine environment (from hydrographic to anthropogenic features). In a first step, we have developed a new method, based on machine-learning processes, that is able to handle multiple environmental predictors. This generates resistance maps, showing the most likely routes used by individuals between populations, and identifying the environmental parameters that will have an influence on these routes. Application of this method to the sea trout data, is on-going.

Ultimately, INRAE and UExe will map the marine areas that are used preferentially by adult sea trout in TCWs. This will be used to advise managers and stakeholders regarding the impact of new coastal and offshore development projects, and/or the designation of marine protected areas.

Note: Some of this work is in revision within the Journal of Biological Conservation



Sampling of juvenile trout (© S. Launey)

SALMON AND SEA TROUT: SCIENTIFIC TOOLS FOR THEIR PROTECTION

Presentation of scientific work from the SAMARCH programme on improving knowledge of migratory salmonids in estuaries and at sea

WPT3 - Tracing the life of salmon at sea by analysing their scales

AUTHOR: MARIE NEVOUX



Research Fellow – UMR DECOD (Ecosystem Dynamics and Sustainability) – INRAE, Institut Agro, Ifremer, Rennes, France

CONTRIBUTORS: Frédéric Marchand, Ludivine Lamireau, Julien Tremblay, Jean-Pierre Destouches, Nicolas Jeannot, Quentin Josset, William Beaumont, Luke Scott, Robert Hillman, Sophie Launey, Anne-Laure Besnard, Lisa Meslier, Pierre-Yves Boisson, Agnès Stark, Jamie Stevens, Andy King, Nadine Herrard, Benjamin Bagot, Etienne Rivot, Cécile Tréhin, Valentin Santanbien, Rémi Patin, Quentin Queiros, Stephen Gregory, Olivia Simmons

The life cycle of salmon takes place between rivers and the sea. However, most knowledge relates to their life in rivers, and there is very little information and direct observations on the life of salmon at sea. Nonetheless, the long-term monitoring conducted at counting stations during migration, as well as information on catches made by fishermen, can provide us with clues about the marine life of these fish. A detailed analysis of these clues will help us better understand how salmon respond to changes in their marine environment. Salmon scales are calcified structures which grow with the fish and consequently record growth over the course of a lifetime. The analysis of alternating periods of high and low growth is traditionally used to determine the age of fish. A more in-depth analysis of the microstructures of these scales provides a more detailed description of the different past growing seasons. In the SAMARCH project, we were able to mobilise the required resources to collect, analyse, catalogue and integrate knowledge about the sea life of salmon to inform management approaches. This project was carried out in a joint and concerted manner in five rivers in Southern England and Northern France and offers an original multi-population approach. For instance, we showed that most growth at sea takes place during the first summer after smolt migration. This is also the period when growth has been the most variable over the last 30 years, with a rapid and persistent decline since 2005 experienced by all five of the salmon study populations. This decline in growth coincides with a decrease in the size of the salmon on returning to the river. We also demonstrated that growth during this first summer partly determines age

at maturation, and therefore age on returning to the river. High-growth salmon are more likely to return as grilse after a winter at sea, whereas weaker-growth salmon will mainly return as spring salmon after two winters at sea. The genetic sexing of the salmon sampled on the five rivers, however, provides a new and contrasting view of the marine phase. While the growth of females and males at sea is similar, females appear to need to reach a larger size than males to initiate maturation and return to the river. As such, any decrease in marine growth would be likely to produce more spring salmon. By integrating demographic processes from the marine phase of the life cycle into a model, we investigated the relative impact of the observed changes on the number and age of salmon returning to the river. Our results show that growth reduction directly impacts fecundity but has so far contributed little to the observed variation in returns. We nevertheless found these variations to be mainly dependent on variations in the survival of salmon at sea.





Scale and juvenile salmon (© M. Nevoux)

Presentation of scientific work from the SAMARCH programme on improving knowledge of migratory salmonids in estuaries and at sea

Comparative analysis of the population dynamics and diet of the great cormorant (Phalacrocorax carbo) in the Argues (76) and Léguer (22) river basins

AUTHORS: ALEXANDRE CARPENTIER,



MNHN – University of Rennes 1 and MAXIME POTIER, SEINORMIGR CONTRIBUTORS: Marie Caroline Husset, MNHN – Yann Février, GEOCA – Floriane Lutz, SEINORMIGR, - Johanna Theys, BGM - Gaëlle Germis, BGM

As part of the Interreg SAMARCH project, a study designed to estimate the impact of predation by the great cormorant during an annual cycle on the populations of migratory salmonids in the Léguer (22) and Arques (76) basins was launched from January 2021 to March 2022. The main objectives of this study, which was conducted in partnership with a consortium of partners pooling their skills, were: i) to analyse the population dynamics of great cormorants on both sites by monitoring the spatial and temporal distribution of the species and ii) to describe the diet of cormorants, focusing on salmonids, by analysing the contents of droppings and biochemically analysing muscular and feather tissues collected from birds from regulations or in the field. Surveys were conducted monthly, with increased monitoring (weekly) when smolts were presumed to be migrating downstream. The initial results of the study tend to show contrasting population dynamics and predation behaviour, which differ according to various parameters such as the level of anthropisation of the basin, the naturalness of the estuary and abiotic parameters (seasonality and tides etc.). Nearly 370 pellets were collected and are currently being analysed. They should provide a relatively accurate picture of the level of predation pressure exerted on salmonids in relation to the presence of birds, in terms of the number and frequency of salmonids consumed, the size of individuals, and the birds' feeding habits (temporality and origin of prey in general: marine, estuarine, freshwater or mixed etc.)



Atlantic salmon otoliths (© A. Carpentier)



Great cormorants (Phalacrocorax carbo sinensis subspecies) (© Y. Février, GEOCA)



WPT4 - Management of salmonids in France and England and evolution of policies

AUTHORS: LAURENT BEAULATON,



OFB – R&D hub OFB-INRA-Agrocampus Ouest-UPPA for the Management of Diadromous Fish in their Environment, Rennes & Lawrence TALKS, Environment Agency

In this talk we will present a comprehensive overview of the management of salmonids in France and England.

In France, salmonids benefit from a dedicated management regime alongside other diadromous species in brackish and freshwater, thanks to nine (three in SAMARCH area) diadromous fish management committees (COmité de GEstion des POissons MIgrateurs aka CO.GÉ.PO.MI). These committees, which include government representatives and representative stakeholders, can adopt any appropriate management measure regarding professional and recreational fisheries. For example, in Britany, Seine-Normandy and Artois-Picardie, fishing quotas have been settled for recreational fisheries of salmon. They also establish the conservation status of diadromous species in their area and propose the adoption of management measures regarding other anthropogenic impacts (like ecological continuity disruption) to appropriate stakeholder or planning committees. In French marine waters there is no dedicated management for salmonids.

Salmonids also benefit from general conservation management and spatial planning. Those particularly relevant for them are the EU Habitats Directive, EU Water Framework Directive and EU Marine Strategy Framework Directive and all French regulations derived from these directives. For example, salmonids are taken into account in the designation of protected areas such as Special Areas of Conservation or French Marine National Parks. Diadromous species, including salmonids, are also the subject of one of the objectives of the Marine Strategic Planning Document (Document Stratégique de Façade aka DSF).

In England, the Environment Agency's aim is to restore the abundance, diversity and resilience of salmonid stocks by maximising the production of healthy wild smolts in freshwater and reducing mortality at sea (we operate to six miles offshore). To do this we work with Government, its agencies and partner organisations. We establish the conservation status of salmonid populations across 42 principal salmon rivers and 44 principal sea trout rivers and this is used to inform and drive the implementation of management measures. These include five key priorities: further reducing exploitation by nets and rods; removing barriers to migration and enhancing habitat; safeguarding sufficient flows; maximising spawning success by improving water quality; and improving marine survival. Detailed actions are set out in the England and Wales North Atlantic Salmon Conservation Organisation (NASCO) Implementation Plan 2019-2024 and progress is reported in England and Wales NASCO Annual Progress Reports. Significant management actions include closing all salmon netting in 2019 and rod anglers achieving 94% catch and release in 2021. Despite these measures, however, the status of England's salmon populations remains critical with increasingly stressful environmental conditions in fresh, transitional and marine waters impacting on salmonids because of climate change, diffuse pollution, habitat quality and barriers to migration, in particular.

The results of the SAMARCH project will be used to improve the protection of salmonids at sea. For example:

- * **Fish tracking.** By defining the migration routes and behaviour of salmonids in estuaries and coastal waters it will enable a review and potentially a strengthening of the current management measures to reduce the risks to salmonids at sea from pressures such as marine fisheries bycatch, marine renewables and dredging.
- * **Genetic Tool Development.** The evidence from the tracking of sea trout kelts and the genetic work will be used to identify the important areas for sea trout at sea and be used to inform marine spatial planning.
- * Salmonid Stock Assessment Models. By improving the way that the status of salmon and sea trout populations are assessed it will enhance and strengthen evaluations of conservation status, which are then used to drive investment to enhance salmonid populations.







What planning and management tools are used for migratory salmonids?

The National Plan for Diadromous Migrators and its links with other existing tools for the preservation of these species

AUTHOR: MARINE PORTENEUVE,

Research Engineer, National Plan for Diadromous Migrators – INRAE U3E Experimental Aquatic Ecology and Ecotoxicology – MIAME hub, OFB Research hub, INRAE, Institut Agro UPPA for the Management of Diadromous Fish in their Environment

The Ministry of Ecological Transition and the Ministry of Agriculture and Food have tasked the French Office for Biodiversity with the development of a national plan for diadromous migrants (PNMA), in line with Action H4 of the French salmon action plan. Furthermore, the European Union has co-financed this project as part of the International Year of the Salmon.

The species being studied are the diadromous fish and macro-crustaceans present in mainland France and the overseas departments and regions. Mainland France has 12 species of diadromous migratory fish, some of which are already subject to management measures at international, national, seaboard or catchment area level, but not all of which have the same protection status.

Launched in 2020, the joint creation process with stakeholders resulted in the approval of the draft plan in late 2021. The PNMA has a multi-species approach, whose value is highlighted in Action 42 of the biodiversity plan. It provides a global vision of the status and management practices of all these species. It also aims to complement existing management measures (PLAGEPOMI, SDAGE and DSF etc.) by supporting them with operational measures at national level. They are divided into six areas: land-sea link; fisheries; habitats and ecological continuity; hatcheries and restocking; monitoring – evaluation – prospects; and communication – awareness-raising – training.

The plan is scheduled to run for 10 years. The aim is to produce a concrete, operational and costed plan, in line with the national biodiversity strategy (SNB) 2021 to 2031. Following the mid-term review of the PNMA, it will be possible to make proposals for the drafting of the new PLAGEPOMI, SDAGE and strategic facade documents (DSF). The year 2022 will be used to implement some of the measures selected in an operational manner, to estimate the costs of implementation and to identify the financial partners.



Thème #1	Thème #2	Thème #3	Thème #4	Thème #5	Thème #6
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Référents thématiques	Référents thématiques	Référents thématiques	Référents thématiques	Référents thématiques	Référents thématiques
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The main topics of the National Plan for Diadromous Migrators

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SALMON AND SEA TROUT: SCIENTIFIC TOOLS FOR THEIR PROTECTION

WEDNESDAY, 18 MAY SESSION 2:

What planning and management tools are used for migratory salmonids?

Regulating fishing for migratory salmonids in estuaries and at sea in Brittany and Normandy

AUTHORS: ELISE CARNET, Head of Biodiversity, protected species – Natural Heritage department / Biodiversity, Geology and Landscape division – DREAL Bretagne & GWENAËL ROBINEAU, Technical SupportTechnician – Police department – Technical Support hub – Normandy Regional Directorate – OFB



In estuaries, fishing regulations are subject to both the river and sea domain. Upstream of the saltwater demarcation line, fishing is regulated by the Environmental Code (which regulates fishing in the river domain). Between the saltwater demarcation line and transverse limit of the sea, fishing is subject to the regulations for fishing in the sea domain. The sea authorities are therefore responsible for the part of the estuary downstream of the saltwater demarcation line.

Sea fishing for migratory fish and estuary fishing in Brittany is defined by order R53-2020-03-03-03, 3 March 2020 of, the prefect of the region of Brittany. This order regulates the general and specific provisions applicable to professional and recreational fishing, specifying in particular authorised fishing periods, regulated fishing areas, fishing gear and techniques.

Some coastal rivers do not have a transverse limit of the sea or saltwater demarcation line or they are inaccurate, leading to problems with enforcement and policing fishing. Other inaccuracies in the order governing sea and estuary fishing in Brittany have been reported at COGEPOMI meetings on Brittany's rivers, which led to a detailed review of the decree from 2021 to 2022, the aim being to have a new order applicable from 2023.

To identify the issues at stake in the review of the order, various consultations were held with bodies for leisure fishing in rivers, and professional and recreational fishermen in sea environments and estuaries. At the same time, a survey and mapping of the applicable regulations highlighted the gaps and inconsistencies in terms of zoning. These elements helped simplify and change the way migratory fish are taken into account in the regulations for the sea and estuaries.



Feedback and examples of measures taken to preserve migratory salmonids in freshwater

From data collection to data development

AUTHOR: LAËTITIA LE GURUN,

Project Manager – Bretagne Grands Migrateurs CONTRIBUTOR: Maxime Potier, SEINORMIGR

Bretagne Grands Migrateurs

From the field to management, data migrates! Studies and monitoring networks for migratory fish generate a large amount and variety of data, regarding on populations and their habitats. For the knowledge acquired to contribute to management decisions, it is essential to communicate and explain this information to those involved in water and aquatic environments.

In Brittany and Seine-Normandy, several regular data acquisition systems are deployed to improve knowledge, and monitor the situation of migratory salmonid stocks:

- * Monitoring of salmon and sea trout runs at counting stations to assess the number of anadromous fish
- * Monitoring of the reproduction of migratory salmonids to evaluate their stock of spawners and highlight colonisation fronts
- * Monitoring of the index of abundance of juvenile salmon by electric fishing to estimate annual recruitment
- * Monitoring of reported catches of migratory salmonids to assess fishing catches
- * Monitoring of index rivers (the Bresle, Oir and Scorff) to better understand the state and dynamics of salmon and sea trout populations.

For the past ten years, the Migratory Fish Observatory in Brittany and the Seine-Normandy basin dashboards, run respectively by Bretagne Grands Migrateurs (BGM) and Seine-Normandie Migrateurs (SEINORMIGR), have been working to centralise, develop and disseminate information to the network of stakeholders involved in migratory fish management and to the public. They are based, among other things, on key indicators for monitoring the state of populations, making it possible to set alert levels and assess the impacts of management. As tools which improve knowledge, they also fulfil the objective of assisting public policy decision-making (identification of hydroelectric facilities which most affect salmon, definition of salmon catch quotas, and salmon conservation limits etc.).



Salmon of the year / Sea trout © P. Rigalleau

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SALMON AND SEA TROUT: SCIENTIFIC TOOLS FOR THEIR PROTECTION

Feedback and examples of measures taken to preserve migratory salmonids in freshwater

Managing recreational fishing for migratory salmonids in Brittany: regulations, reporting catches and new management strategy for salmon fishing

AUTHOR: MARIE-ANDRÉE ARAGO



Head of the Police department at the OFB's Brittany Directorate

Fishing for migratory fish in France is governed by Articles R 436-44 to R 436-68 of the Environment Code. These articles defined in the decree of 16 February 1994, known as the diadromous decree. This decree sets up migratory fish management plans and migratory fish management committees, and determines the fishing methods to be used for migratory fish. These articles define the periods when salmonid fishing is prohibited, the minimum sizes of fish that can be caught, and salmon marking and catch reporting requirements.

In France, fishing for migratory salmonids is permitted in 13 departments in four regions (Hauts-de- France, Normandy, Brittany and Nouvelle-Aquitaine).

In Brittany, the first migratory fish management plan was drafted and approved in 1994. The measures concerning salmon aimed to make the exploitation of this resource more balanced by making the composition of catches closer to that of stocks, specifically via measures to extend the autumn fishing season to the lower parts of rivers.

At present, salmon fishing in Brittany is governed by a regional decree. This decree sets the total allowable catches (TACs) for the various Breton rivers, establishes an individual quota of six salmon, including two spring salmon, and reiterates the marking and reporting requirements. The annual departmental orders take up the recommendations of COGEPOMI and provide details on fishing methods and certain specific bans.

Since 1996, a method of managing fishing catches based on TACs has been in place for each basin. The aim is to leave the right amount of spawners at the end of the fishing season for the resulting egg deposition to maximise the potential number of catches in subsequent years.

The calculation of TACs is based on a simple model of the quantitative dynamics of salmon stocks. The parameters involved in the method, which was established by Prévost and Porcher in 1996, include the size of the production system, the carrying capacity and the productivity of the basin.

From 2000 onwards, given the greater fishing pressure on spring salmon, a specific spring salmon TAC needed to be enforced.

As knowledge was acquired, the TAC values for the various rivers were recalculated during the PLAGEPOMI revisions.

Even though this innovative method in 1996 made it possible to preserve salmon populations, limitations and misunderstandings have arisen:

- * The notion of a conservation limit is vague
- * The very high grilse TACs are very rarely reached, calling into question the TAC method
- * Whatever the state of the salmon population, a TAC can always be defined. The fishery should be closed if the salmon population is in trouble.

In 2017, COGEPOMI started to consider how to change the salmon management system. The RENOSAUM study (an acronym for "renovation of salmon management" in French) set about defining conservation limits for each river, developing all the data produced in Brittany, and revisiting the exploitation regulation system, focusing on making it straightforward, robust and understandable for stakeholders.

The RENOSAUM study was finalised and presented at a public meeting in March 2022. After considering the opinions of the fisheries authorities, a new decree defining the terms of salmon management will be issued for five years from 2023.

Feedback and examples of measures taken to preserve migratory salmonids in freshwater

RENOSAUM: moving towards new recreational salmon fishing regulations in Brittany

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OFB, INRAE and UPPA, in collaboration with the association Bretagne Grands Migrateurs (BGM), have decided to collaborate through the RENOSAUM project to revisit the regulations on salmon exploitation by angling in the rivers of Brittany. Carried out over a period of six years (2016 to 2022), RENOSAUM was the first project of its kind in France (and probably beyond) which facilitates the decision-making process for managing salmon populations: both in terms of the scope of the work carried out, the amount of data used, its regards for international recommendations (NASCO in particular), and the ongoing dialogue between scientists and those involved in the management of salmon populations which has governed its progress.

RENOSAUM now provides new knowledge for the 18 main salmon rivers in Brittany about: (i) the abundance of juvenile recruitment in the year and the return of adults; (ii) the exploitation of salmon in Brittany by angling; (iii) the mechanisms of generation renewal within the 18 populations studied.

This new knowledge covers the period 1987 to 2020 and served as a basis for: (i) establishing new conservation limits



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for each of the populations studied, which were themselves based on an updated operational definition of conservation; (ii) a comparative analysis of a very large set of exploitation regulation scenarios (~200).

New methods and tools were also developed during the project, mainly in the field of modelling, which are now available to update and extend the work already done in the future.

A comparative analysis of angling regulation scenarios in Breton rivers is the key outcome of the project. Its main findings can be summarised as follows: (i) for four rivers, none of the scenarios (i.e. even the absence of catches) respect conservation restrictions, due to lack of compliance with the first criterion used (i.e. controlling the risk of low recruitment); (ii) for the 14 other rivers being studied, the current conditions of exploitation intensity and population renewal do not require the exploitation of grilses to be restricted beyond the current fishing dates including an autumn extension; (iii) depending on the river, the exploitation of spring salmon should be restricted to a greater or lesser extent, primarily to satisfy the second conservation criterion (i.e. grilse balance vs. spring salmon catch); (iv) depending whether stability of catches is deemed a relevant criterion from an exploitation perspective, the most effective scenarios are based solely on TAC regulations or may include a check by fishing dates, which are more restrictive than those currently in force for spring salmon.

29

SALMON AND SEA TROUT: SCIENTIFIC TOOLS FOR THEIR PROTECTION

Feedback and examples of measures taken to preserve migratory salmonids in freshwater

Major pathological risks for migratory salmon: from UDN (a myth?) to reality (*Gyrodactylus salaris*)

AUTHORS: PATRICK GIRARD AND AR-MAND LAUTRAITE,

Santé Poissons Sauvages association

While many diseases affect wild Atlantic salmon, two deserve to be mentioned in particular because of the threat they pose to wild Atlantic salmon in Brittany: "UDN" and salmon fluke or *Gyrodactylus salaris*.

UDN – or ulcerative dermal necrosis – mainly affects Atlantic salmon spawners which complete their anadromous migration to breed. Identified in 1877 (the disease was first classified in Great Britain, including Scotland and Ireland), UDN is a recurrent problem that has been observed on and off for several decades in many coastal rivers of Brittany.

The disease is first characterised by the appearance of small grey areas of roughened skin initially only located on areas without scales (the head, opercula and fins). These skin lesions then develop into ulcers and necroses, quickly followed by a mycotic infection, most often caused by an oomycete of the genus *Saprolegnia*. The appearance of the lesions is usually preceded and accompanied by behavioural disturbances: the fish swim frantically, jump out of the water, and finally come to a standstill.

A cold-water disease (at 6–10°C) which is thought to occur only in freshwater, UDN has never been observed in fish farms. The cause(s) of these morbid episodes remain largely unexplained. While the epidemiology of UDN resembles that of an infectious disease, no infectious agents (viruses or bacteria) or parasites have been identified or demonstrated in the first instance.

In response to the concerns of amateur fishermen, BGM asked the Association Santé Poissons Sauvages (ASPS) to develop a study protocol to determine the aetiology of this disease and its contributing factors. A hypothesis of purely environmental origin will be studied.

Salmon fluke or *Gyrodactylus salaris* is so far unknown in France. This microscopic ectoparasite which lives on Atlantic salmon is mainly found in freshwater, although it can temporarily survive in brackish water. Rainbow trout can also harbour this parasite inconspicuously. This has been the case in Italy in a fish farm at least since the early 2000s. Originating from the Baltic Sea catchment area, *Gyrodactylus salaris* is virtually harmless to its natural host, the Atlantic salmon of the Baltic stock (co-adaptation). Conversely, the accidental introduction of *Gyrodactylus salaris* in Norway in 1975 into wild populations of salmon from the East Atlantic stock (resistent to the parasite), was extremely fatal: 90 to 99% of parr died in the contaminated rivers within a few years.

As early as 1980, the Norwegian authorities tried to eradicate *Gyrodactylus salaris* with drastic measures by introducing biodegradable fish poisoning (rotenone) into the infected catchments and then restocking them with healthy fish. Despite doing this for forty years, the parasite remains in places and attempts are now being made to treat wild fish by killing the parasite with solutions containing aluminium or zinc.

An epidemiological survey (conducted from 1998 to 2000) showed that this parasite was almost certainly absent from the river basins hosting salmon in France (including the rivers of the Armorican Massif), which happened to indicate the confusion in a 1996 publication between *Gyrodactylus salaris* and *Gyrodactylus teuchis* (a species discovered during the survey) which erroneously concluded that the former was present in French waters.

The true distribution of *Gyrodactylus salaris* in continental Europe has yet to be confirmed and it could be introduced through the movement of live salmonids or their fertilised eggs at any time. However, no specific measures to protect Atlantic salmon populations from the introduction of this dangerous parasite have been put in place in France since these results, which date back more than two decades.



UDN-like ulcerative lesions on the head of a salmon



Generalised saprolegniosis on salmon from the River Leff

As early as 1996, EU regulations introduced a series of zoosanitary barriers to prevent the introduction of the parasite into UK waters.

Implementing regulatory measures on the movement of live salmonids means attempts can be made to protect

wild Atlantic salmon populations from the introduction and catastrophic effects of *Gyrodactylus salaris*. To do so, the true status of our waters in relation to this parasite must first be scientifically established.

WEDNESDAY, 18 MAY SESSION 4:

Round table – Feedback and examples of measures taken to preserve migratory salmonids in estuaries and at sea

What is the added value of Marine Protected Areas (MPAs) for the management of migratory salmonids?

GWENOLA DE ROTON, Natural Heritage Project Manager: marine habitats and functionalities – Contact for the eastern Baie de Seine – Channel and North Sea Facade Delegation – OFB

PAULINE BLANCHARD, Project Manager for marine birds – Natura 2000 sites in North Brittany – Atlantic Facade Delegation, OFB

How do you factor in the restoration of ecological continuity in coastal areas? What are the difficulties involved?

CHRISTOPHE MAUGENDRE, Technical Support Engineer – Normandy Directorate, OFB

PIERRE LEGENDRE, Head of the Sea and Coast Department – Morlaix Communauté

What are the potential impacts of offshore wind farms on salmonids?

ANTHONY ACOU, DCSMM Scientific co-Manager of coastal fish and cephalopods, rare and/or diadromous species – OFB, OFB-CNRS-MNHN PatriNat department, MNHN marine station, Dinard – R&D hub OFB-INRA-Agrocampus Ouest-UPPA for the Management of Diadromous Fish in their Environment, Rennes

LYDIE COUTURIER, Research Fellow in marine ecosystems and EMT – France Énergies Marines

With the contribution of: ANTONIN GIMARD, Project Manager of "Industrial Uses, Sea Developments and Management of the Marine Environment" – Natura 2000 contact – Seine-Maritime coastline / Pays de Caux – Normandy Directorate – Channel and North Sea Facade – OFB

How do you better manage migratory salmonid fisheries at sea and in estuaries?

REPORTING CATCHES AND BYCATCH-GUILLAUME LE PRIELLEC, Administrative Secretary for fishing licences and authorisations, diadromous species and Télécapêche – CRPMEM

RISK ANALYSIS OF BYCATCH – VINCENT TOISON, Marine Biodiversity Officer – OFB Brest

ATOOLTORAISE AWARENESS AMONG RECREATIONAL FISHERS: NAV&CO – MARIE LE BARON, Project Manager – OFB Brest

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