ICR(24)14

Proposal for an Updated Comprehensive trans-European Genetic Reference Baseline to Assign Atlantic Salmon (*Salmo salar*) to Rivers and Region of Origin across the Eastern North Atlantic

Presentation to the IASRB, NASCO

Annual General Meeting, Westport, Ireland.

2 June, 2024

Ensing, D., Gilbey, J., McGinnity, P., Verspoor, E., & Wennevik, V.

Statement of the International Atlantic Salmon Research Board on Future Research Priorities

Given that the vision of the International Atlantic Salmon Research Board (the Board) is:

> '*Factors causing salmon mortality at sea are understood to the level that supports the development of management actions by Parties to reduce mortality to recover, protect and conserve salmon stocks*'

and in the context of the climate change emergency, the Board has undertaken a review of its immediate research priorities. In doing so:

The Board has agreed the need to prioritise research into the future prospects for Atlantic salmon populations towards 2050, on both a basin-wide and regional scale, so as to support an adaptive management approach to their protection and conservation into the future.

The top research priorities for the Board in support of this, ranked in order of importance to the Board, are:

1. Basin-wide patterns of marine growth and survival of Atlantic salmon.
2. Migration of salmon at sea.
3. The impact of freshwater environment on mortality occurring at sea.
4. Potential interactions between pink salmon and Atlantic salmon.
5. Quantification of the mortality of Atlantic salmon caught as bycatch in pelagic and coastal fisheries.

The Board wishes to be informed of, and support in any way it can, research into each of these priority areas. However, the Board has agreed to pursue new research activities into addressing the top ranked area at this time, namely 'Basin-wide patterns of marine growth and survival of Atlantic salmon'.

Current State-of-the-Art in respect of European baseline

- International trans-European microsatellite genetic baseline for populations NE Atlantic salmon populations (developed in SALSEA), which has been incredibly valuable for elucidating the biology of regional stock specific groups in the sea and elucidating the nature of multiple mixed stock fisheries.

- Making the case for enhanced resolution - Upgrade timely, principally to increase the stock, regional, river specific resolution of assignments (strongly encouraged by recent efforts in the Barents Sea):

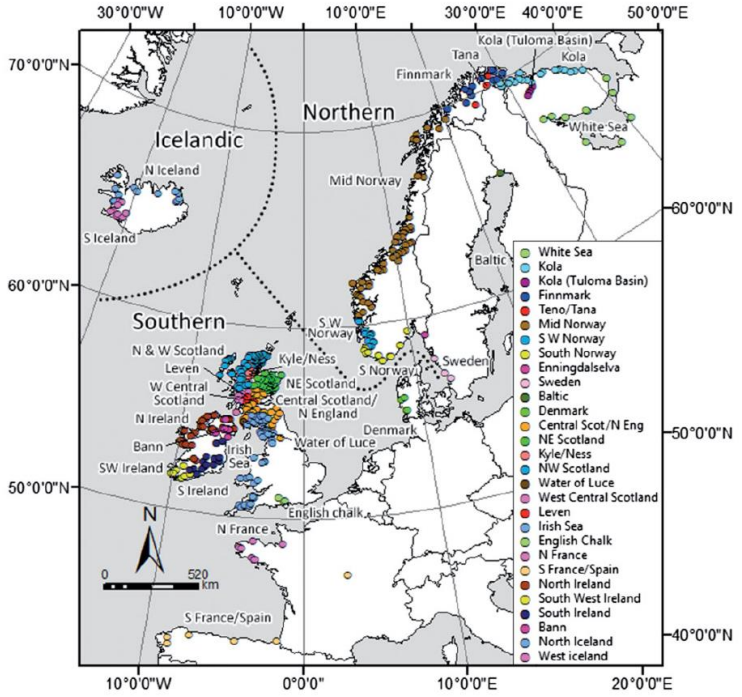


Table 1. Available genetic regional reference baselines for salmon in the eastern Atlantic.

Geographic Coverage	Samples	Markers	Assignment Resolution	Reference
Trans-Atlantic	80 fish, 2 rivers	11 microsatellites	2 units, EU/NA	King *et al.* (2005)
Trans-Atlantic	12 rivers	1 microsatellite, 1 mtDNA haplotype	2 units, EU/NA	Gilbey *et al.* (2005)
Trans-Atlantic	4,942 fish, 46 rivers	11 microsatellites	3 units, EU/US/CAN	Sheehan *et al.* (2010)
Trans-Atlantic	1,930 fish, 46 regions	6 microsatellites	2 units, EU/NA	Gilbey *et al.* (2017)
Trans-Atlantic	3,406 fish, 285 populations	96 SNPs	28 units	Jeffery *et al.* (2018)
Trans-Atlantic	319 populations	96 SNPs	30 units	Bradbury *et al.* (2021)
Eastern Atlantic	26,822 fish, 282 rivers, 467 sites	14 microsatellites	18 units	Gilbey *et al.* (2018)
Barents sea	185 populations	33 microsatellites	26 units	Ozerov *et al.* (2017)
Scotland and NE England	3,787 fish, 147 sites, 27 rivers	288 SNPs	18 units	Gilbey *et al.* (2016)
Northern Ireland	673 fish, 27 sites	7 microsatellites	6 units	Ensing *et al.* (2011)
Ireland	7,924 fish, 322 sites, 143 rivers	15 microsatellites	20 units	Anon (2008)
Southern Europe	3,730 fish, 57 rivers	12 microsatellites	8 units	Griffiths *et al.* (2010)
France	199 fish, 6 regions	17 microsatellites	6 units	Perrier *et al.* (2009)
Baltic Sea	2,337 fish, 32 stocks	8 microsatellites	3 units	Koljonen (2006)
Baltic Sea	3,394 fish, 36 locations	33 microsatellites	28 units	Vähä *et al.* (2016)
Baltic Sea	39 stocks	14 microsatellites	14 units	Koljonen *et al.* (2021)
Western Atlantic	9142 fish, 50 sites	3000 SNPs	14 units	Moore *et al.* (2014)
Western Atlantic	12,409 fish, 194 rivers	15 microsatellites	12 units	Bradbury *et al.* (2016)
Western Atlantic	1,485 fish, 35 populations	101 microsatellites	26 units	Bradbury *et al.* (2018)

Critical applications

- Mixed Stock Fisheries (East Greenland Fishery -initial motivation for project D. Ensing; West Greenland Fishery);

- Ongoing and Future efforts to elucidate the biology of the salmon at sea (critical for climate change) – non biased sampling (i.e. not depending on directed fisheries);

- Parameterising the new life cycle model (ICES WKSALMON; E. Rivot);

- Marine spatial planning (national & international re. decisions around locating offshore salmon farms and offshore power generation);

- Ongoing sampling programme (Norway) returns of post-smolts and older pre-adult stages; including reanalysis using higher resolution baseline (31 usats).

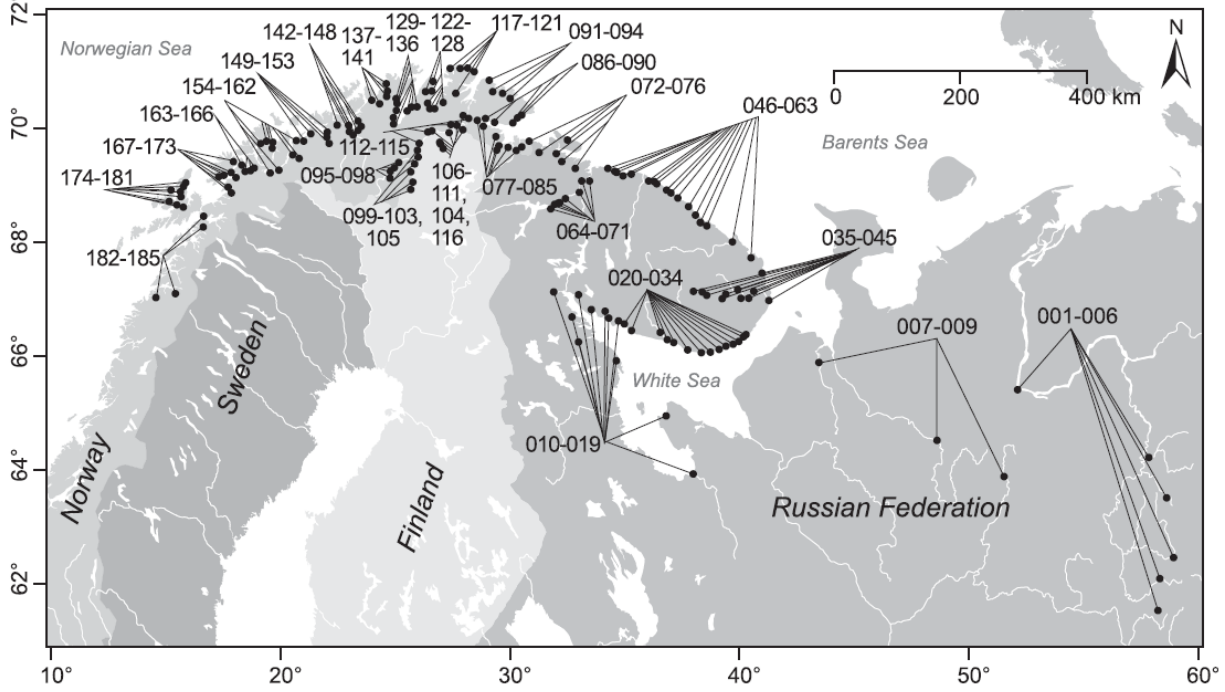
ICES Journal of Marine Science

ICES Journal of Marine Science (2017), doi:10.1093/icesjms/fsx041

Comprehensive microsatellite baseline for genetic stock identification of Atlantic salmon (*Salmo salar* L.) in northernmost Europe

Mikhail Ozerov[1,2†‡], Juha-Pekka Vähä[1,3*†‡], Vidar Wennevik[4], Eero Niemelä[5], Martin-A. Svenning[6], Sergey Prusov[7], Rogelio Diaz Fernandez[1], Laila Unneland[4], Anti Vasemägi[2,8], Morten Falkegård[6], Tiia Kalske[9], and Bente Christiansen[9]

Increasing Assignment Resolution
4 GAUs to 21 GAUs



NASCO WORKSHOP FOR NORTH ATLANTIC SALMON AT-SEA MORTALITY (WKSALMON2)

Recommended format for purpose of citation:

ICES. 2023. NASCO Workshop for North Atlantic Salmon At-Sea Mortality (WKSalmon, outputs from 2022 meeting). ICES Scientific Reports.

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Neil Banas, Geir Bolstad, Colin Bull, Andrew Campbell, Elvira DeEyto, Graeme Diack, Sophie Elliott, Stephen Gregory, Erica Head, David Johns, Ailbhe Kavanagh, Philip McGinnity, Kathy Mills, Marie Nevoux, Glenn Nolan, Etienne Rivot, Timothy Sheehan, Sophie Smout, Emma Tyldesley, Kjell Rong Utne, Eric Verspoor, Knut Wiik Vollset, Alan Walker, Vidar Wennevik, Ken Whelan

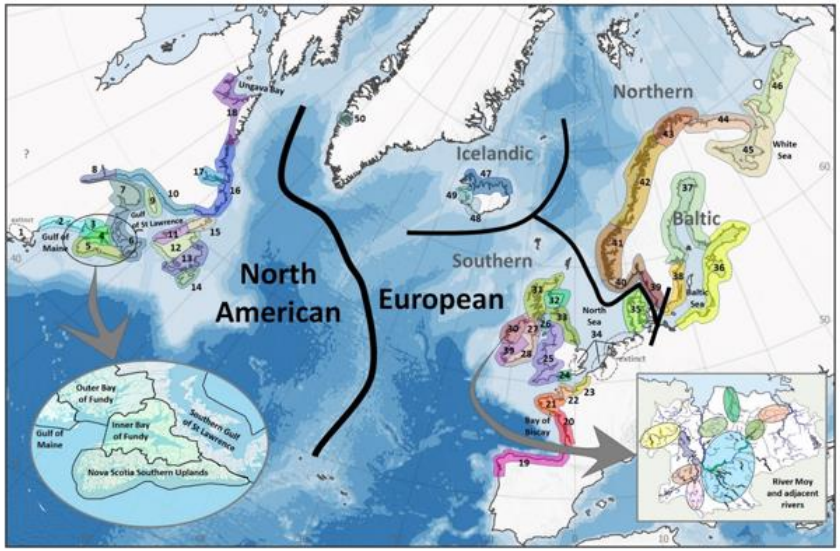


Figure 1. A synthesis of trans-range phylogeographic structuring observed across studies in Atlantic salmon resolved by screening of phylogenetically informative nuclear microsatellite and SNP variation. Figure is from Verspoor et al., (in prep)

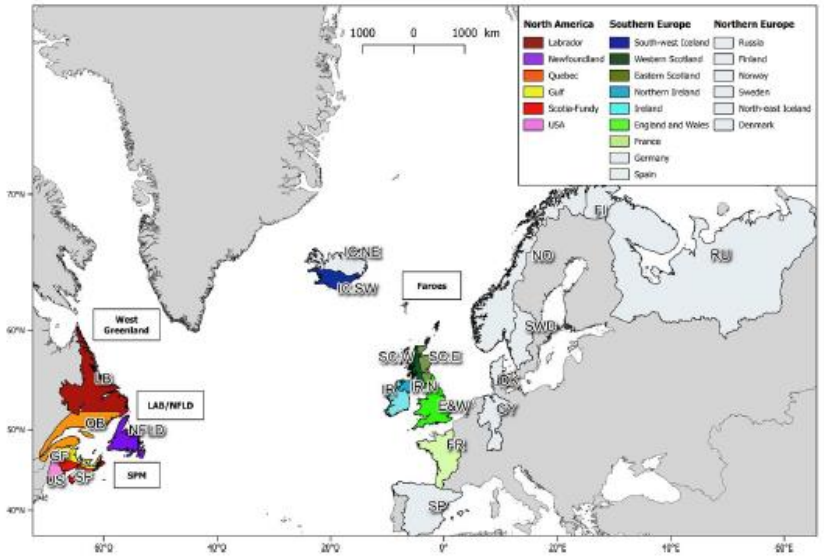
Received: 19 March 2018 | Accepted: 10 November 2018
DOI: 10.1111/faf.12345

ORIGINAL ARTICLE

WILEY FISH and FISHERIES

Evidence for spatial coherence in time trends of marine life history traits of Atlantic salmon in the North Atlantic

Maxime Olmos[1,2] | Félix Massiot-Granier[3] | Etienne Prévost[4] | Gérald Chaput[5] | Ian R Bradbury[6] | Marie Nevoux[1,2] | Etienne Rivot[1,2]



Elucidating stock units for new Life Cycle Model for ICES

(E. Rivot)

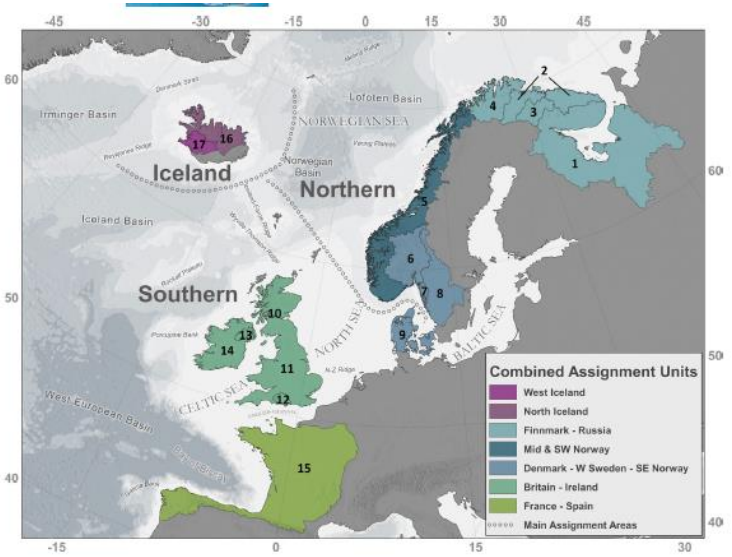
Received: 2 December 2020 | Revised: 27 May 2021 | Accepted: 3 June 2021
DOI: 10.1111/faf.12587

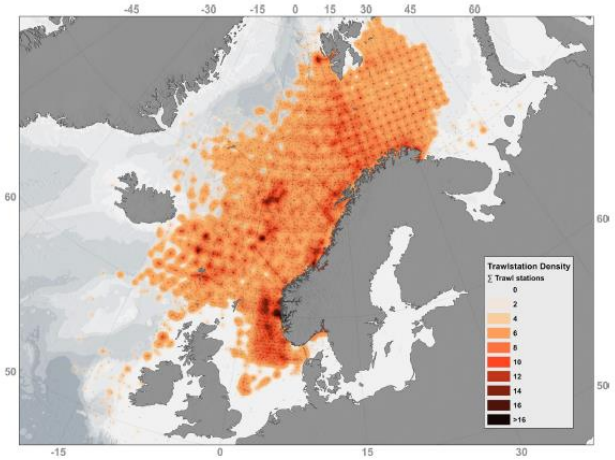
ORIGINAL ARTICLE

FISH and FISHERIES WILEY

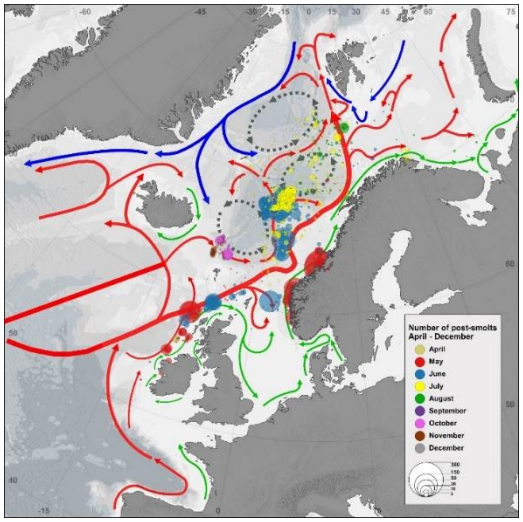
The early marine distribution of Atlantic salmon in the North-east Atlantic: A genetically informed stock-specific synthesis

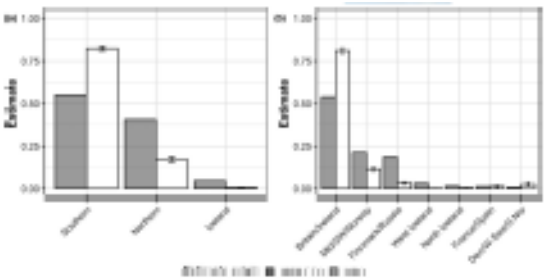
John Gilbey[1] | Kjell Rong Utne[2] | Vidar Wennevik[2] | Alexander Christian Beck[2] | Kyrre Kausrud[3] | Kjetil Hindar[4] | Carlos Garcia de Leaniz[5] | Corrine Cherbonnel[6] | Jamie Coughlan[7] | Tom F. Cross[7] | Eileen Dillane[7] | Dennis Ensing[8] | Eva García-Vázquez[9] | Lars R. Hole[10] | Marianne Holm[2] | Jens Christian Holst[11] | Jan Arge Jacobsen[12] | Arne J. Jensen[4] | Sten Karlsson[4] | Niall Ó Maoiléidigh[13] | Kjell Arne Mork[2] | Einar Eg Nielsen[14] | Leif Nøttestad[2] | Craig R. Primmer[15] | Paulo Prodöhl[16] | Sergey Prusov[17] | Jamie R. Stevens[18] | Katie Thomas[13] | Ken Whelan[19,20] | Philip McGinnity[7,13] | Eric Verspoor[21]





Mixed Stock Fisheries, Biology & Distribution





Fisheries Research 187 (2017) 110–119
Contents lists available at ScienceDirect
Fisheries Research
journal homepage: www.elsevier.com/locate/fishres

Genetic stock identification of Atlantic salmon caught in the Faroese fishery

John Gilbey[a,*], Vidar Wennevik[b], Ian R. Bradbury[c], Peder Fiske[d], Lars Petter Hansen[d], Jan Arge Jacobsen[e], Ted Potter[f]

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ICES Journal of Marine Science, 2022, 79, 2442–2452
DOI: 10.1093/icesjms/fsac182
Advance access publication date: 18 October 2022
Original Article

Genetic stock identification reveals greater use of an oceanic feeding ground around the Faroe Islands by multi-sea winter Atlantic salmon, with variation in use across reporting groups

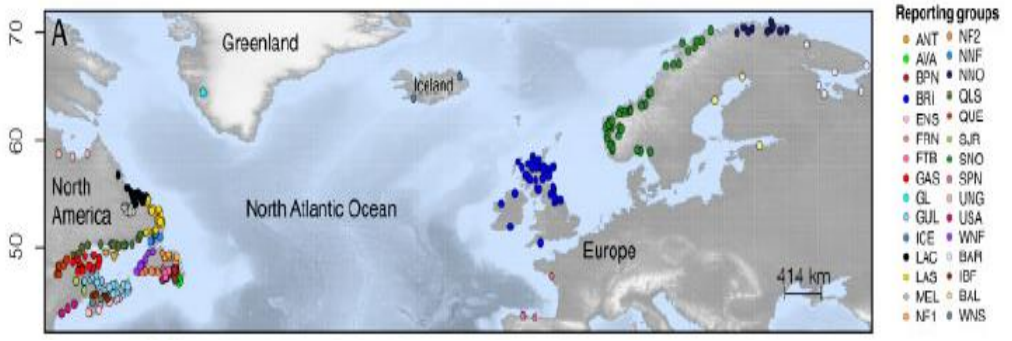
Ronan James O'Sullivan[1,*], Mikhail Ozerov[2], Geir H. Bolstad[3], John Gilbey[4], Jan Arge Jacobsen[5], Jaakko Erkinaro[6], Audun H. Rikardsen[6,7], Kjetil Hindar[3] and Tutku Aykanat[1]

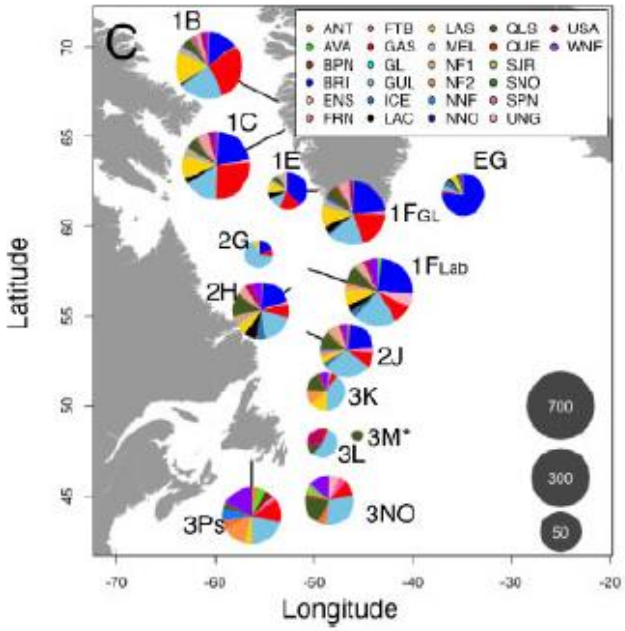
ICES Journal of Marine Science

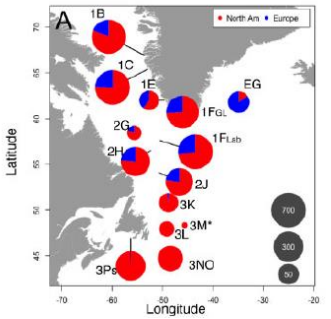
ICES Journal of Marine Science (2021), doi:10.1093/icesjms/fsaa152

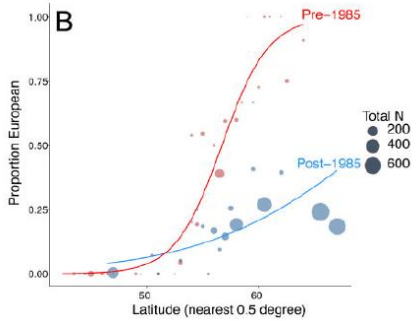
Range-wide genetic assignment confirms long-distance oceanic migration in Atlantic salmon over half a century

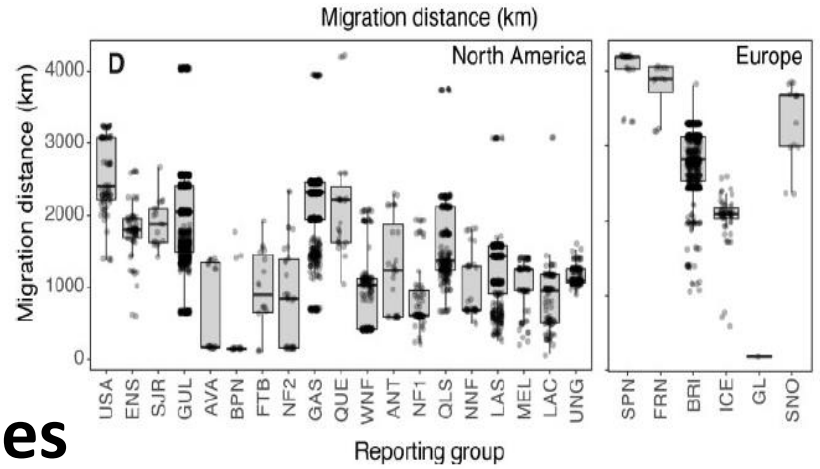
I. R. Bradbury [1,2]*, S. J. Lehnert[1], A. Messmer[1], S. J. Duffy[1], E. Verspoor[3], T. Kess[1], J. Gilbey[4], V. Wennevik[5], M. Robertson[1], G. Chaput[6], T. Sheehan[7], P. Bentzen[2], J. B. Dempson[1], and D. Reddin[8]





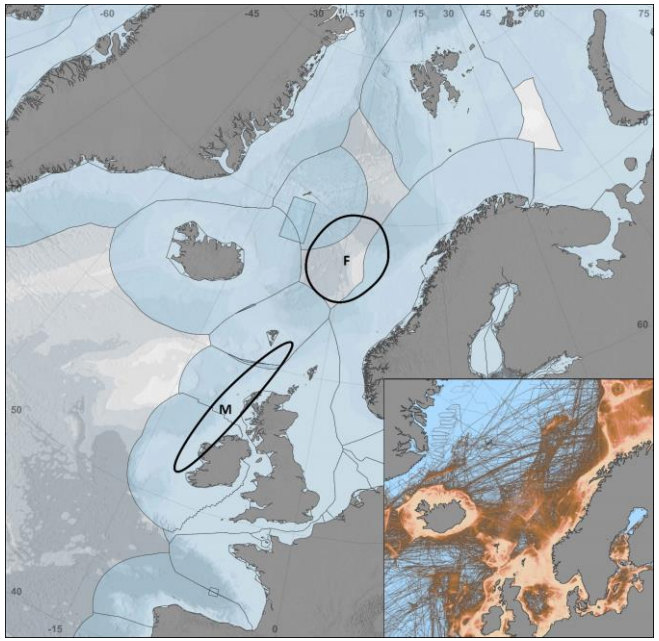




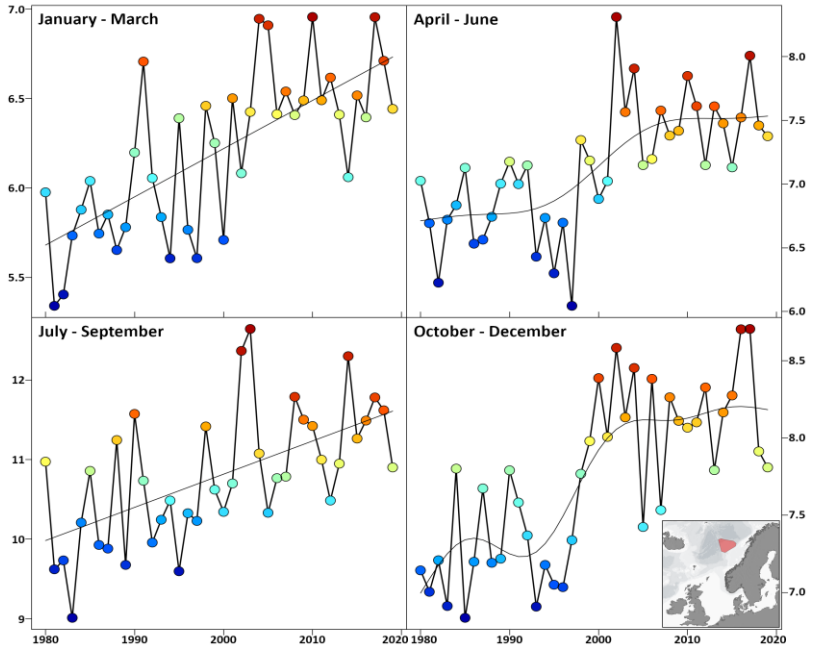


Potential of combining baselines

Pelagic fleets in international waters



Climate change



Examples of questions for discussion in the Autumn meeting would include:

- Whether a single trans-range (west and east Atlantic) baseline with the same set of markers would be optimal?
- Whether a single reference baseline required, or a hierarchy of baselines and associated hierarchical assignment analysis?
- What sort of marker type/s and technologies should the focus be on in any new development?
- Should the screening be done in individual laboratories, or could/should a commercial option and/or a central laboratory be utilised?
- Whether to include adaptive loci?
- Is there an opportunity and would it be useful to include other metrics into the assignment structure (e.g. otolith/lens/scale microchemistry/stable isotope)?
- Is there any requirement for GSI analytical method development to be incorporated in usable R packages, especially if a hierarchical approach is to be considered (e.g. Hsu and Habicht, 2024).

Report on Progress on IASRB Funded project

- Two day workshop was held in Ireland at the Marine Institute Facility in Newport Co. Mayo, 5-7 March 2024 with a summary report of discussions forwarded to NASCO;

- A summary of the discussions was presented (V. Wennevik) at ICES WGNAS in Galway, March 11-21 2024; valuable feedback received;

- Interest in participating in the next step, a virtual workshop to be held in October 2024, was received following survey from institutions undertaking genetic analysis in 14 countries - ;

- An exploration of the new 31 microsatellite panel developed for the KolArctic project to increase assignment resolution is currently being tested for Southern Norwegian, Scottish and Irish populations;

- Exploring possibility currently of extending assignment capacity of the Canadian snp panel (I. Bradbury) and baseline by screening Norwegian, Scottish and Irish samples (n=80 rivers).

Medium-term (over next 6 months-2 years)

Update May 2024: Medium-term goals to be addressed following short term discussions as set out above.

- Set-up consortium/project to update reference baseline across the species range in the eastern Atlantic
- Screen samples from across eastern Atlantic with optimum marker set
- Perform and publish marker set and power analysis
- Publication of Report to ICES WGNAS and IASRB
- Establish a large-scale international collaborative project and in conjunction with partners from the western Atlantic to update and apply the enhanced baseline across the species range to address questions of international importance relating to the biology of Atlantic salmon at sea
- Acquire appropriate- scale funding for this project (estimated at €1.0-3.0 million)

Longer-term (2+ years)

Update May 2024: Longer-term goals to be addressed when possible.

- Screen marine samples from areas of interest, and/or to address specific questions of importance and use enhanced resolution to examine stock specific distributions
- Establish an open Database of genetic baseline data
- Communicate project findings to stakeholders such as ICES Expert Groups and NASCO