

# Likely Suspects Framework & GWCT research

How historical & ongoing GWCT research might contribute to the LSF



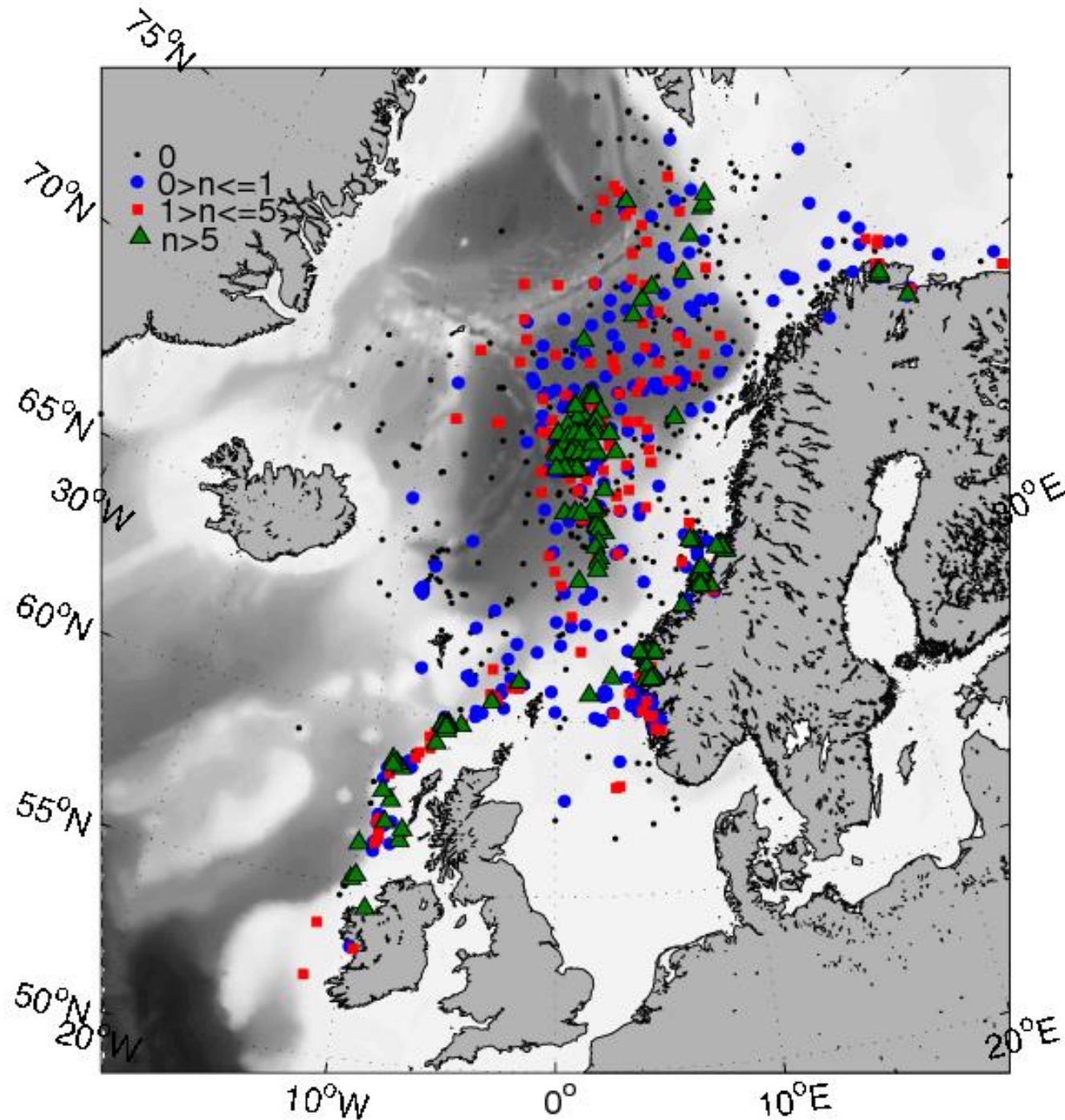
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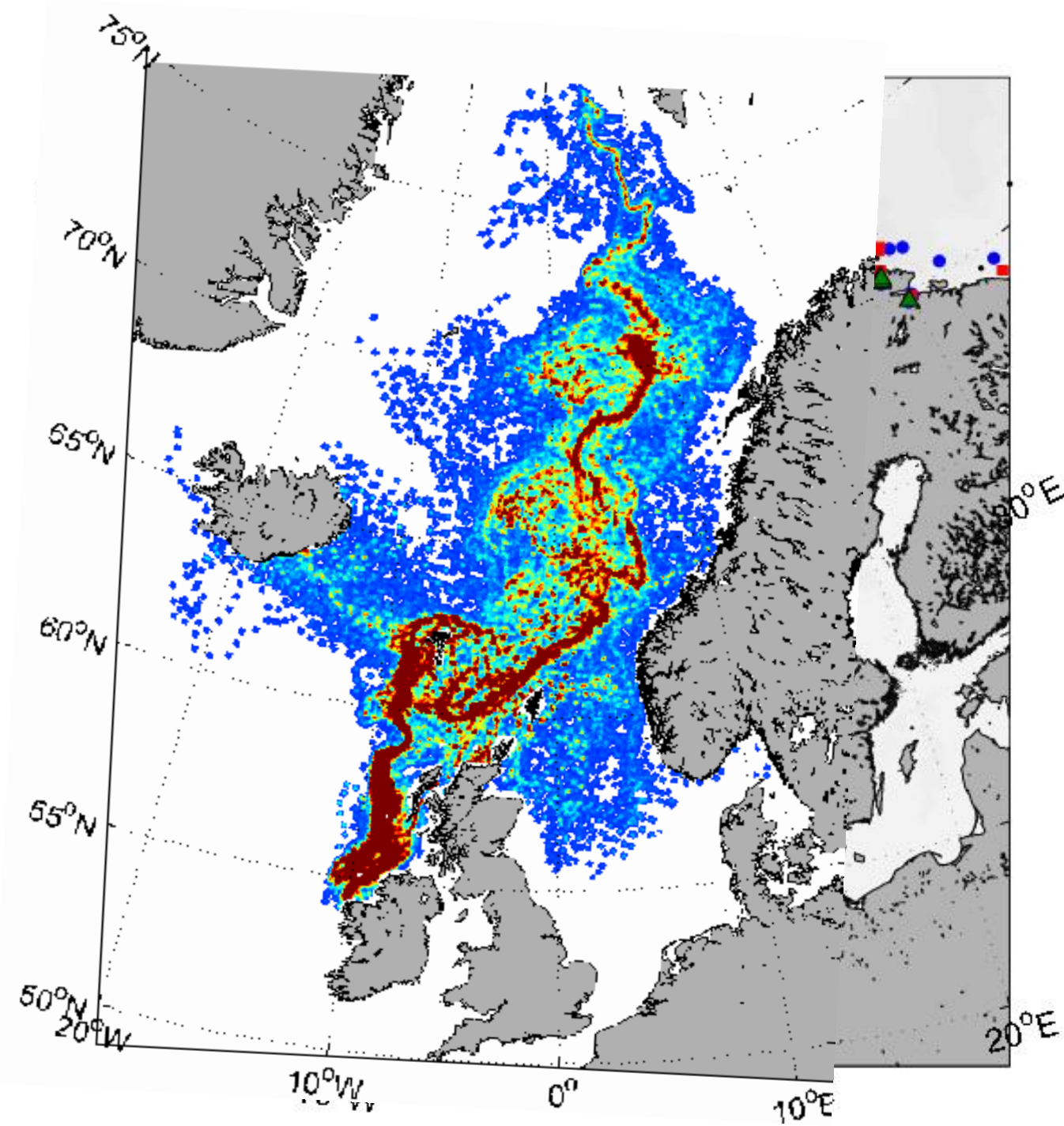


# Likely Suspects Framework (LSF)

- Started with the “Salmon at Sea (SALSEA)” project...









# Likely Suspects Framework (LSF)

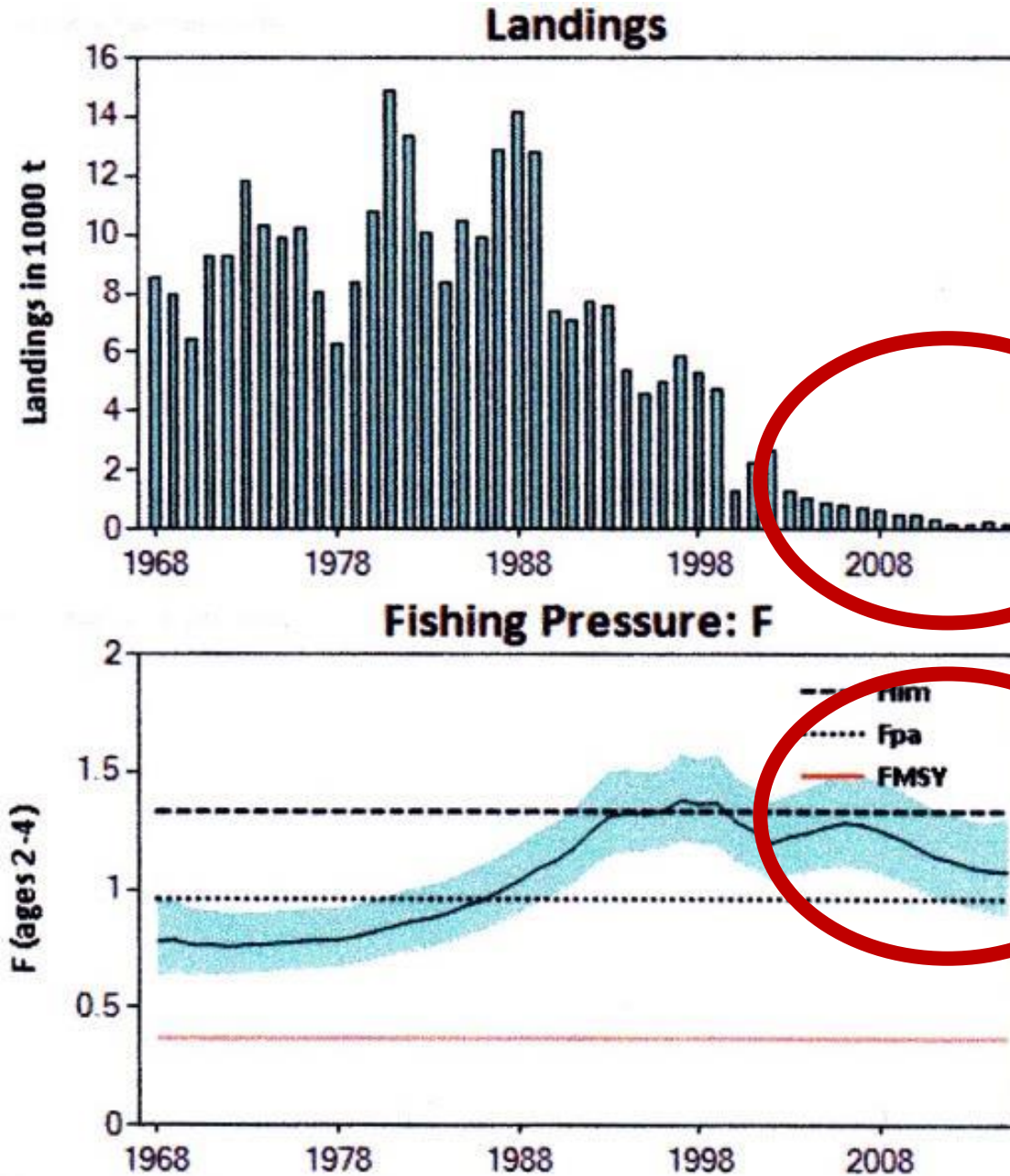
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and cod...





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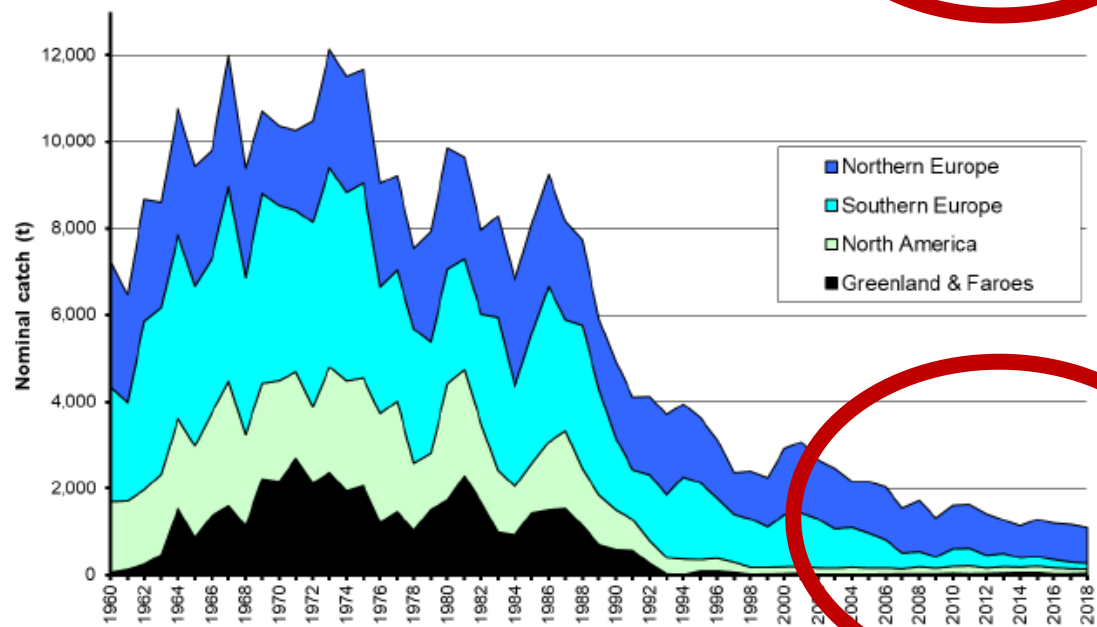
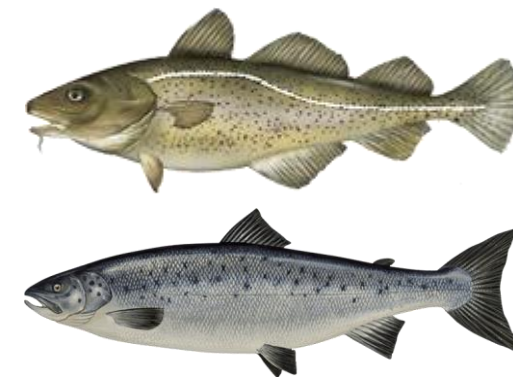
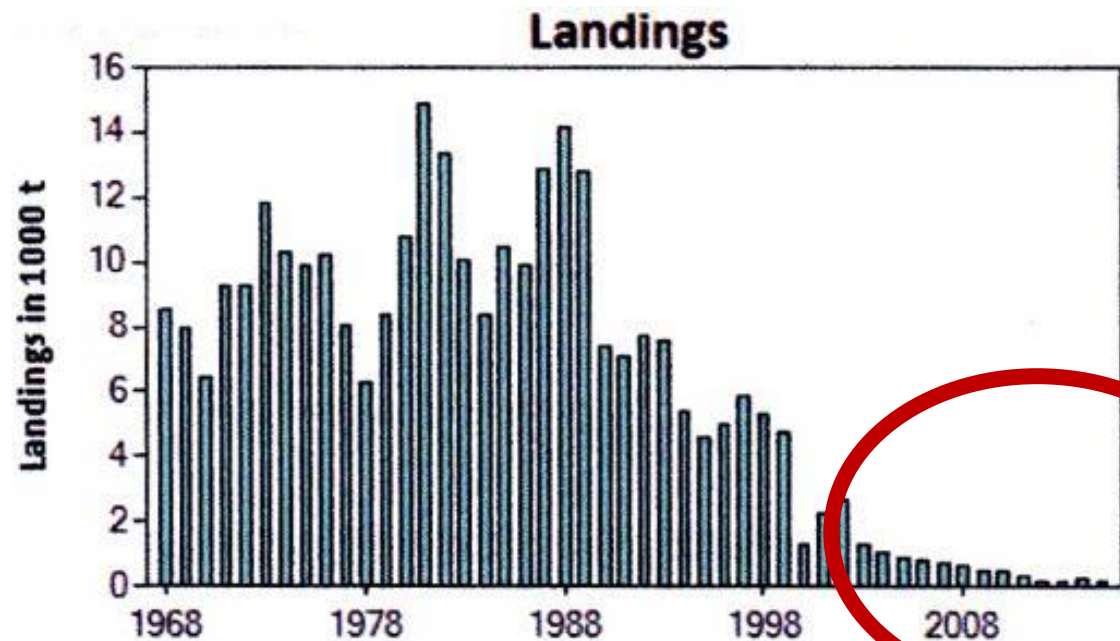


Discards?  
Emigration?  
Survey bias?

?



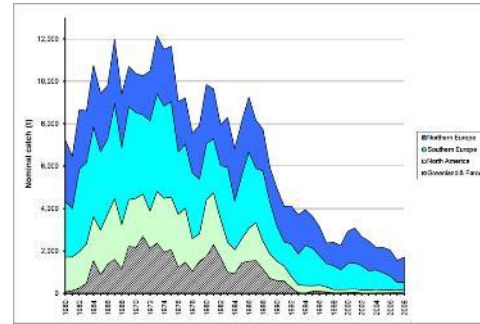
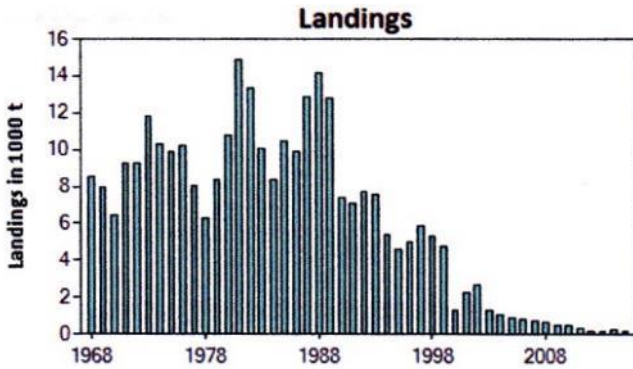
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# Likely Suspects Framework (LSF)



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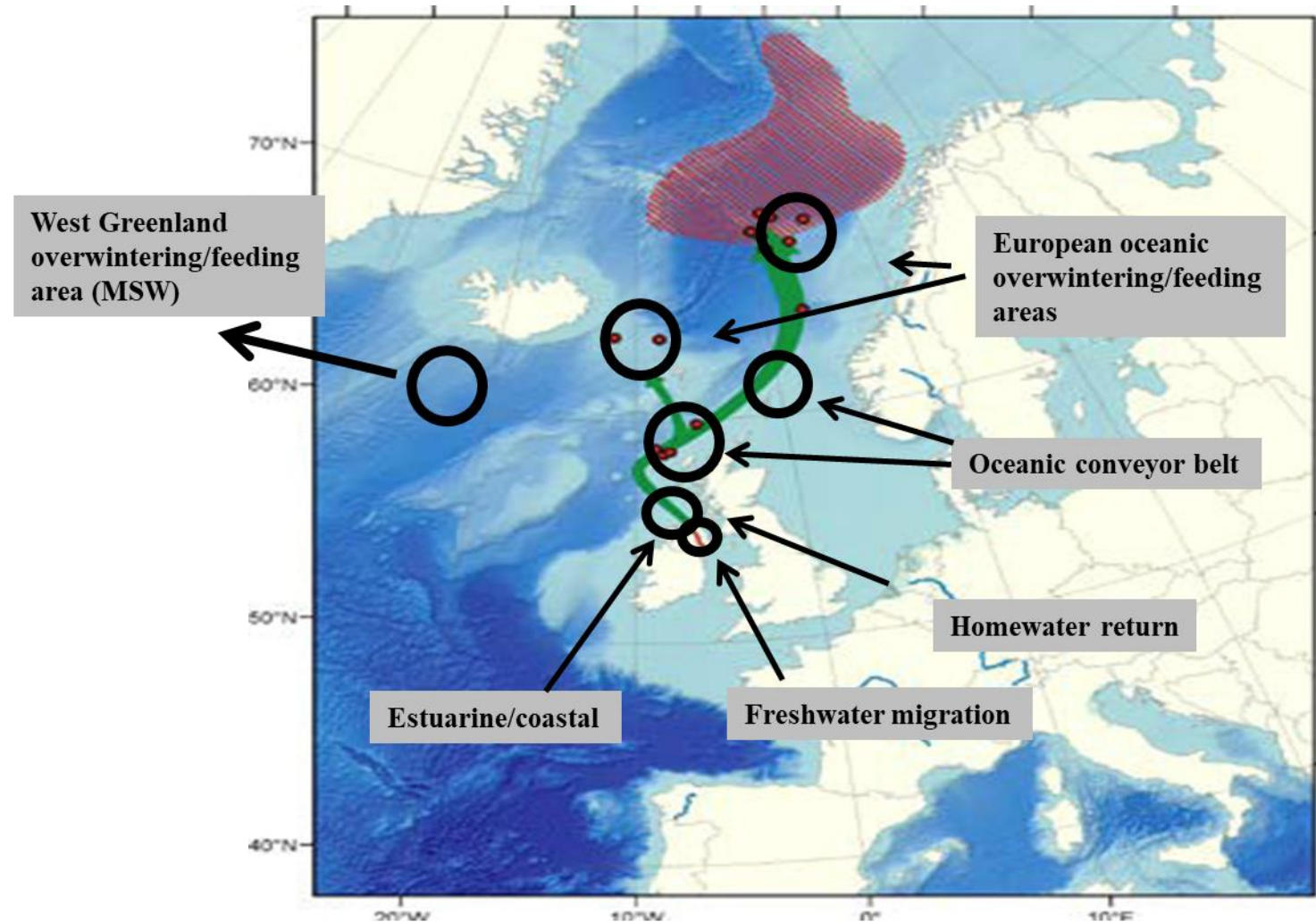


Atlantic salmon mortality at sea:  
Developing an evidence-based  
“Likely Suspects” Framework



# Ecosystem domains

- Locations in space & time
  - Salmon aggregations
  - Crucial to their life cycle
- Potentially significant mortality

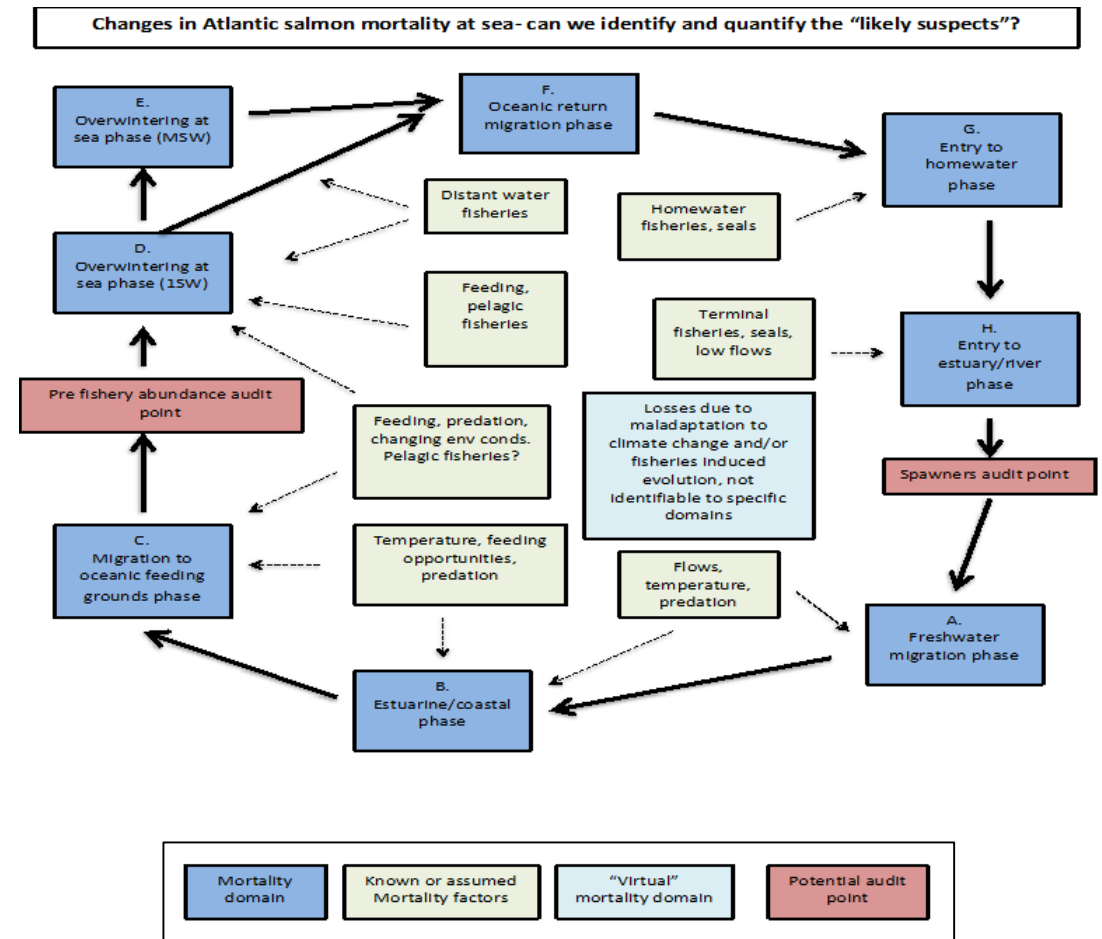
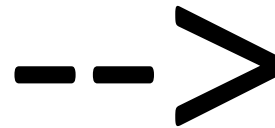


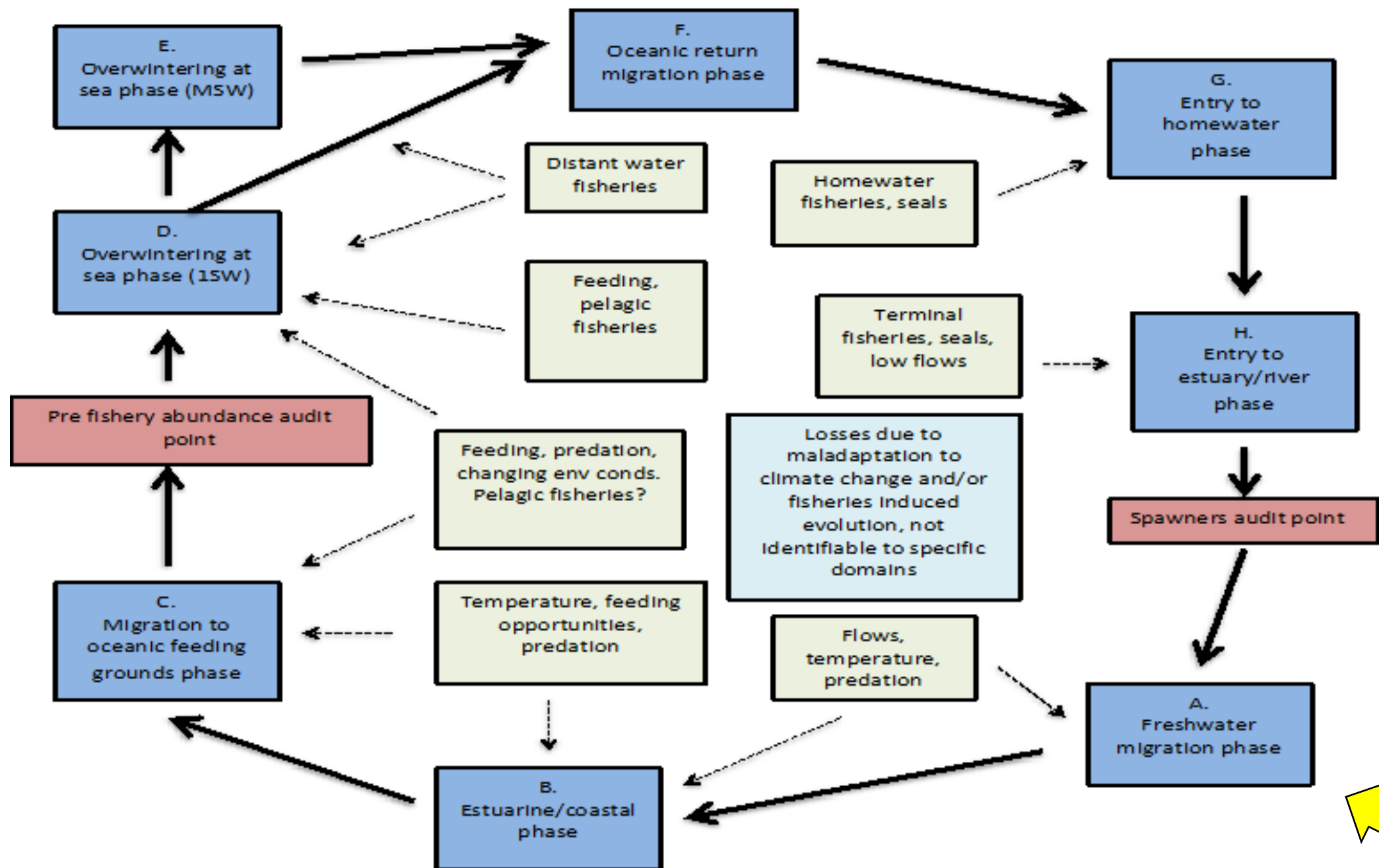
# LSF: a suite of testable hypotheses

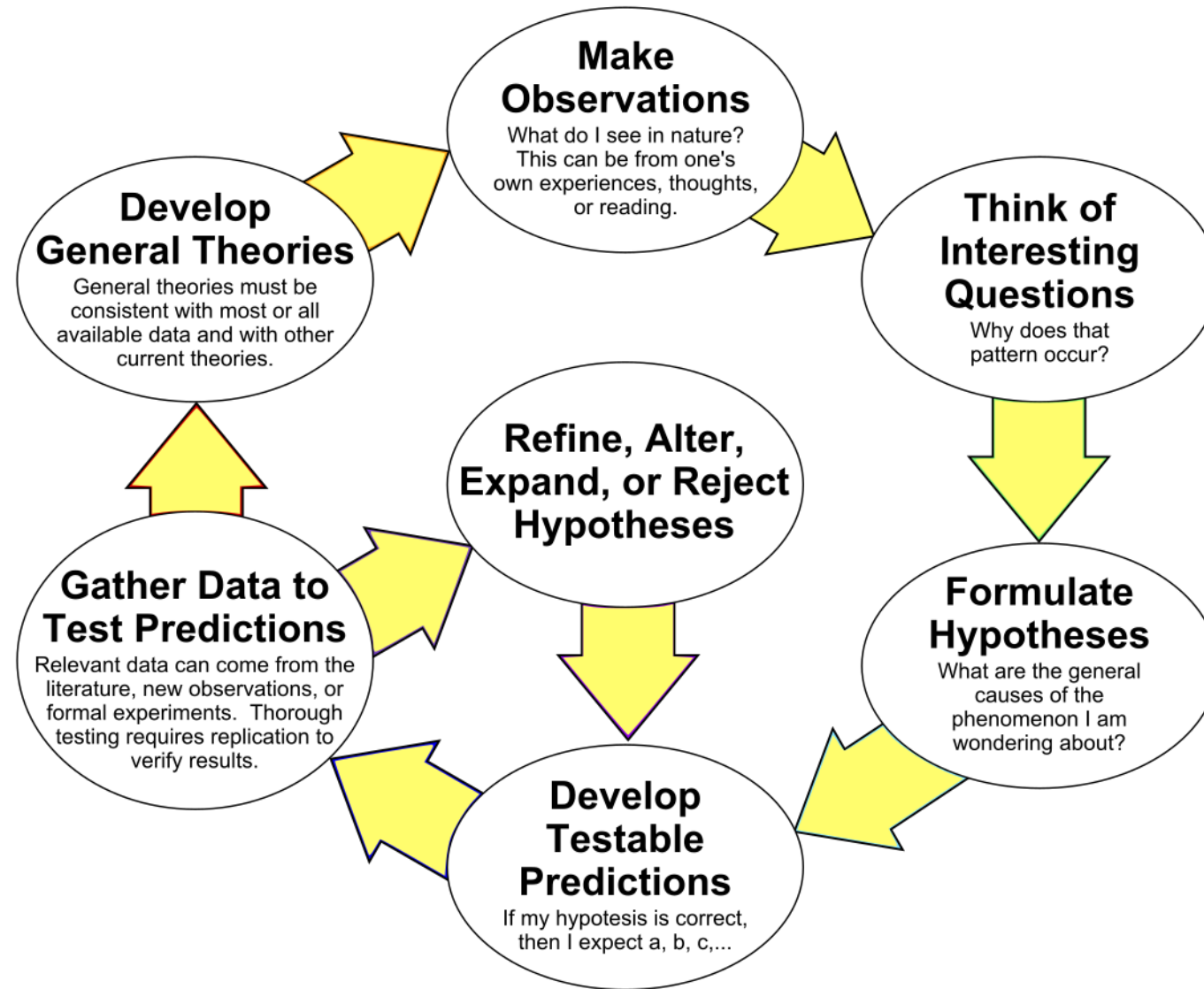
## Atlantic salmon mortality at sea: Developing an evidence-based “Likely Suspects” Framework

Walter Crozier, Ken Whelan, Mathieu Buoro, Gerald Chaput, Jason Daniels, Sue Grant, Kim Hyatt, James Irvine, Niall Ó'Maoiléidigh, Etienne Prévost, Etienne Rivot, Ian Russell, Michael Schmidt and Brian Wells

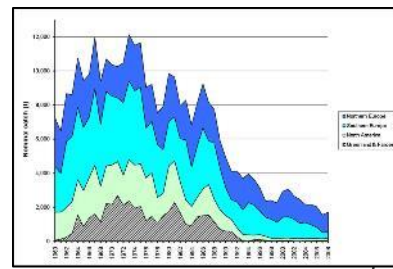
Based on a workshop organised by the Atlantic Salmon Trust, held in Edinburgh Tuesday, 6th November – Thursday, 8th November 2017.





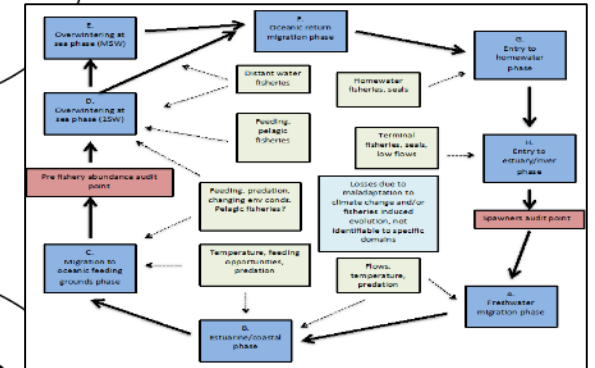






**Make Observations**  
What do I see in nature?  
This can be from one's own experiences, thoughts, or reading.

**Think of Interesting Questions**  
Why does that pattern occur?



**Formulate Hypotheses**  
What are the general causes of the phenomenon I am wondering about?

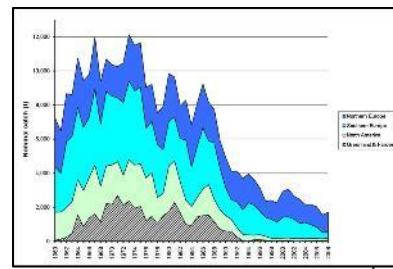
**Refine, Alter, Expand, or Reject Hypotheses**

**Develop Testable Predictions**  
If my hypothesis is correct, then I expect a, b, c,...

**Develop General Theories**  
General theories must be consistent with most or all available data and with other current theories.

**Gather Data to Test Predictions**  
Relevant data can come from the literature, new observations, or experiments. Thorough requires replication to verify results.

?



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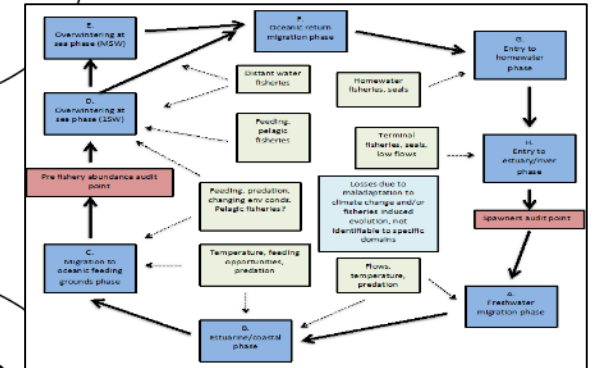
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**ICES**  
**CIEM**



**WKSsalmon**



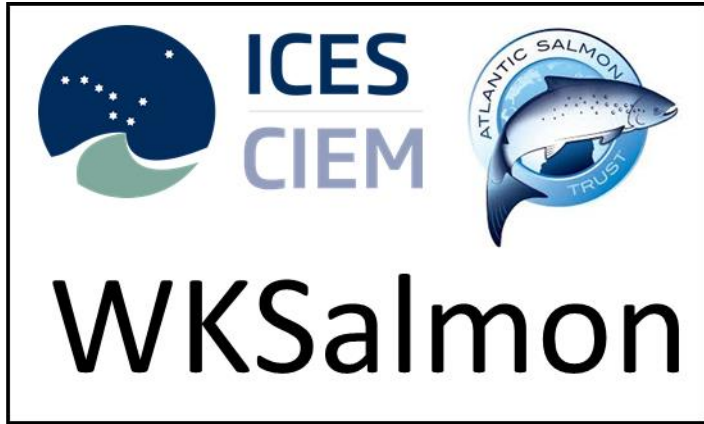


ICES  
CIEM



WKSalmom





## Three tasks\*

- 1) Identify data available to test hypotheses
  - 2) Collate data to test hypotheses
  - 3) Test the hypotheses
- 

\*Repeat 1-3 as required





# 1) Identify data

Meeting in ICES, Copenhagen, June 2019

“Identify data sources that could inform estimates of at-sea salmon mortality and the associated available data, including data from North Atlantic salmon as well as ecosystem data (e.g., oceanographic time-series)”



# WKSalmon

## 1) Identify data

E&W_Salmon_Metadata_Draft.xlsx - Excel													
Stephen Gregory													
File Home Insert Page Layout Formulas Data Review View Developer Help Tell me what you want to do													
A4 ToC index													
ToC index	Characteristic	What are the data, user entry	Specifics of the characteristics (conditional pulldown)	Type of observation (single, sequential)	Data type (obs, model)	Spatial resolution	Spatial location	Year coverage begins	Year coverage ends	Temporal resolution	Temporal period (specify)	Data storage type	Future contact
2.1	distribution_occurrence	Declared catch for net and fixed engine fisheries in UK(England and Wales)	occurrence	population	direct	Lat - Long	Regional and national levels	1956	2018	Month	March to August Winter for Faroes, August to October for West Greenland June to August	Flatfile	Provisional data available from the annual assessment of salmon stocks and fisheries in UK(England and Wales). Monthly catches at individual fishery level reported annually by Environment Agency.
2.1	distribution_occurrence	Adult and post-smolt salmon of E&W origin identified from tag recaptures from West Greenland and Faroes fisheries Returning adult salmon of E&W origin identified from tag recaptures from Irish and Northern Irish coastal fisheries	occurrence	multi-populations	direct	Lat - Long	West Greenland and Faroes	1960	2018	Season	June to August	Mixture	Data available in ICES tag compilation databases (published in ICES Cooperative Research Reports, Reddin et al. (2012) and Jacobsen et al. (2012))
2.1	distribution_occurrence	Smolt and juvenile salmon identified from the stomach contents of cormorants and goosanders, mainly from inland waters, in UK(England and Wales)	occurrence	multi-populations	direct	Other	UK(England and Wales)	1985	2006	Season	August	Flatfile	Data held by Cefas and Irish Marine Institute Diet paper in press. Database of fish species recorded in stomach samples from different locations available through Cefas. Note that much of the data relates to inland stillwater (non-salmonid) fisheries, but some data for rivers.
2.1	distribution_occurrence	Stable isotope analysis of salmon scale samples from UK(England and Wales)	occurrence	multi-populations	indirect	Other	North Atlantic	1980	2018	Season	All months Summer growth season after the first winter	Mixture	Data published in MacKenzie et al. (2012). Collaborative work on stable isotope analysis of salmon scale samples from E&W is continuing by Clive Trueman UK(England and Wales) and Jean-Marc Roussel (France), and Brian Hayden (Canada).
2.1	distribution_occurrence	Acoustic telemetry of post-smolt and adult movements through estuaries and coastal waters in UK(England and Wales), and across the English Channel.	occurrence	multi-populations	indirect	Lat - Long	UK(England and Wales)	1990	2018	Day	Various Summer season after the first winter	Mixture	Data available from numerous peer-reviewed papers. Acoustic telemetry has been conducted in the Rivers Tamar and Taff to study the marine survival of smolts as part of the NASCO SMOLTRACK I and II projects. Further work planned, possibly on River Dee. Post-smolt movement data for rivers discharging to the English Channel is being collected and compiled by the SAMARCH project.
2.1	distribution_occurrence	Simulated migration trajectories of post-smolts in the North Atlantic.	occurrence	multi-populations	indirect	Lat - Long	North Atlantic	1996	1997	Day	Various, depending on recapture date	Paper	Modelled data published in Booker et al. (2008).
2.5	abundance	Estimated abundance prior to marine fisheries of Atlantic salmon by age group (TSW and MSW) by year for UK(England and Wales), obtained by run reconstruction, posterior statistics (median, 5th, 95th percentiles)	prefishery abundance	multi-populations	indirect	Jurisdiction	UK(England and Wales)	1971	2018	Year	estimate for 1st January of first summer at sea	Flatfile	ICES Working Group North Atlantic Salmon report and the annual assessment of salmon stocks and fisheries in UK(England and Wales)
2.5	abundance	Estimated returns and spawners by age group (TSW and MSW) to UK(England and Wales) by year, obtained by run reconstruction, returns adjusted by monthly mortality rate from PFA, and spawners adjusted to take account of homewater catches - posterior statistics (median, 5th, 95th percentiles) Estimates of the number of adult returns for 16 monitored river	returns / spawners	population	indirect	Jurisdiction	UK(England and Wales) Selected monitored stocks	1971	2018	Year	Mean date of return 30 June for MSW and 31 Aug for TSW	Flatfile	ICES Working Group North Atlantic Salmon report and the annual assessment of salmon stocks and fisheries in UK(England and Wales) Reported in annual assessment of salmon stocks and fisheries in UK(England and

# GWCT salmon data

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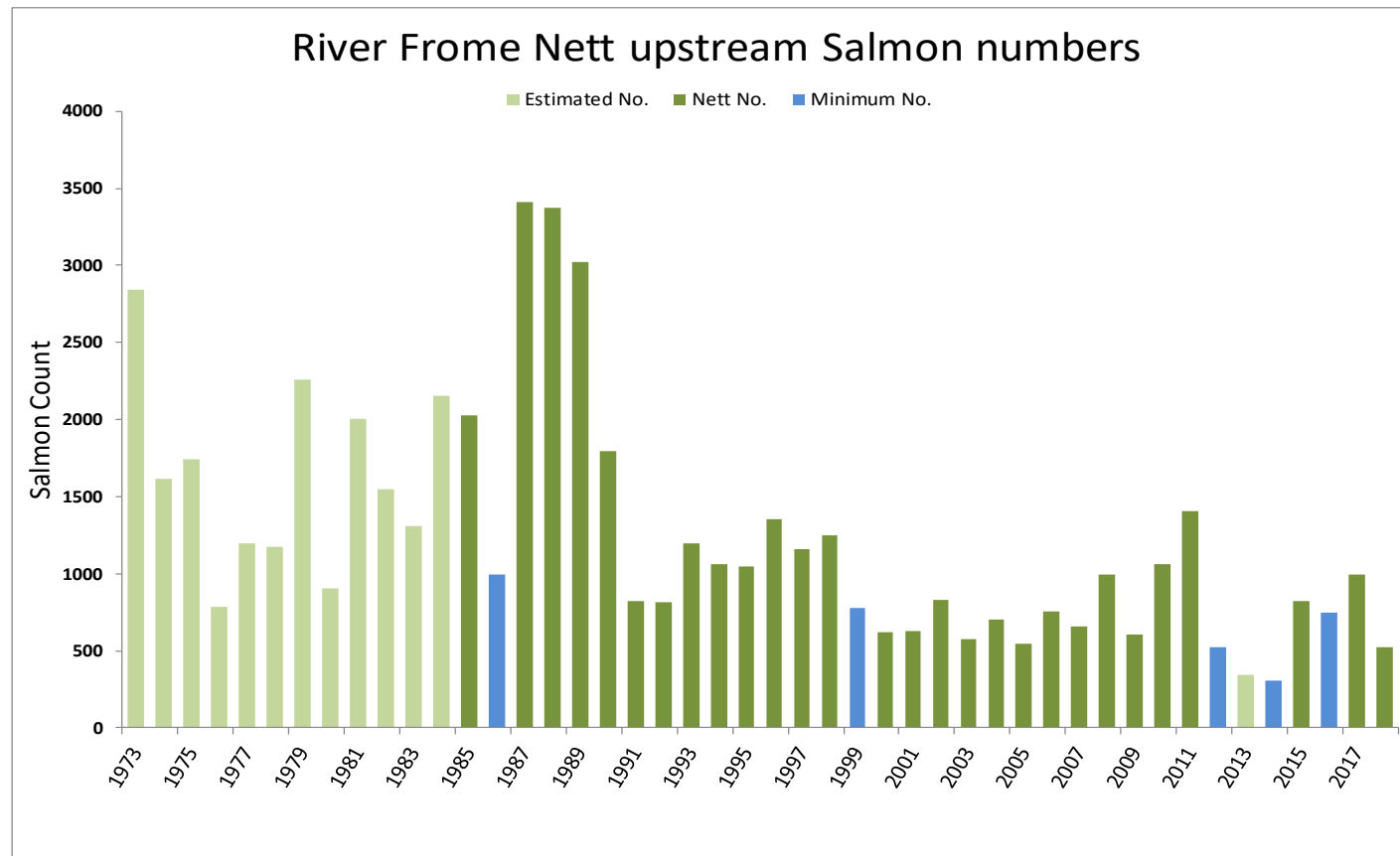
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# 45 years of adult counts

- Long-term adult abundance index



# 45 years of adult counts

- Long-term adult abundance index
- Submitted to ICES via E&W for calculation of
  - Pre-fisheries abundance
  - Spawner abundance

# 45 years of adult counts

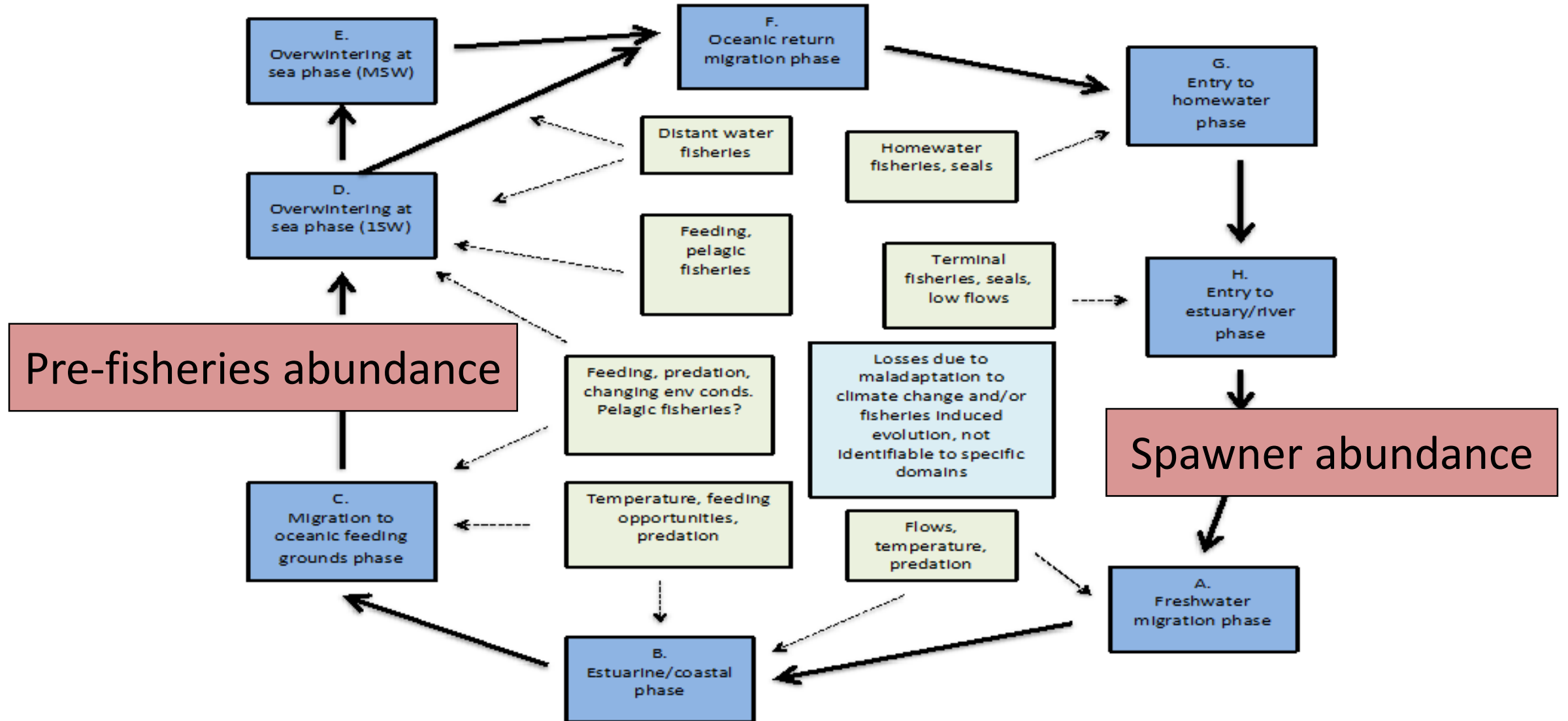
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Pre-fisheries abundance

nce

- Spawner abundance

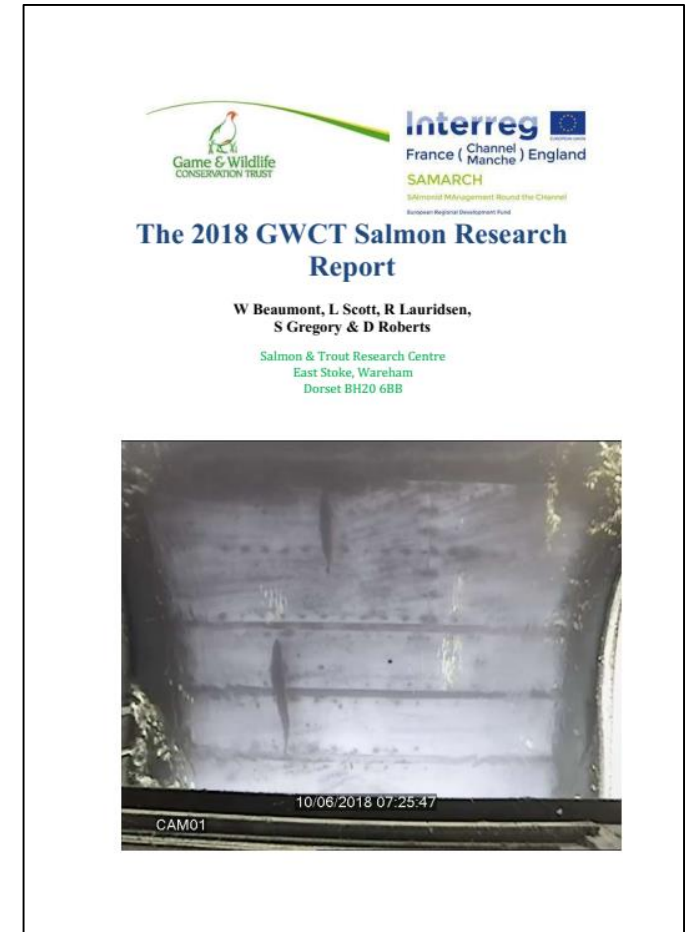
Spawner abundance





# 45 years of adult counts

- Long-term adult abundance index
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  - Pre-fisheries abundance
  - Spawner abundance
- Long-term spawning migration timings



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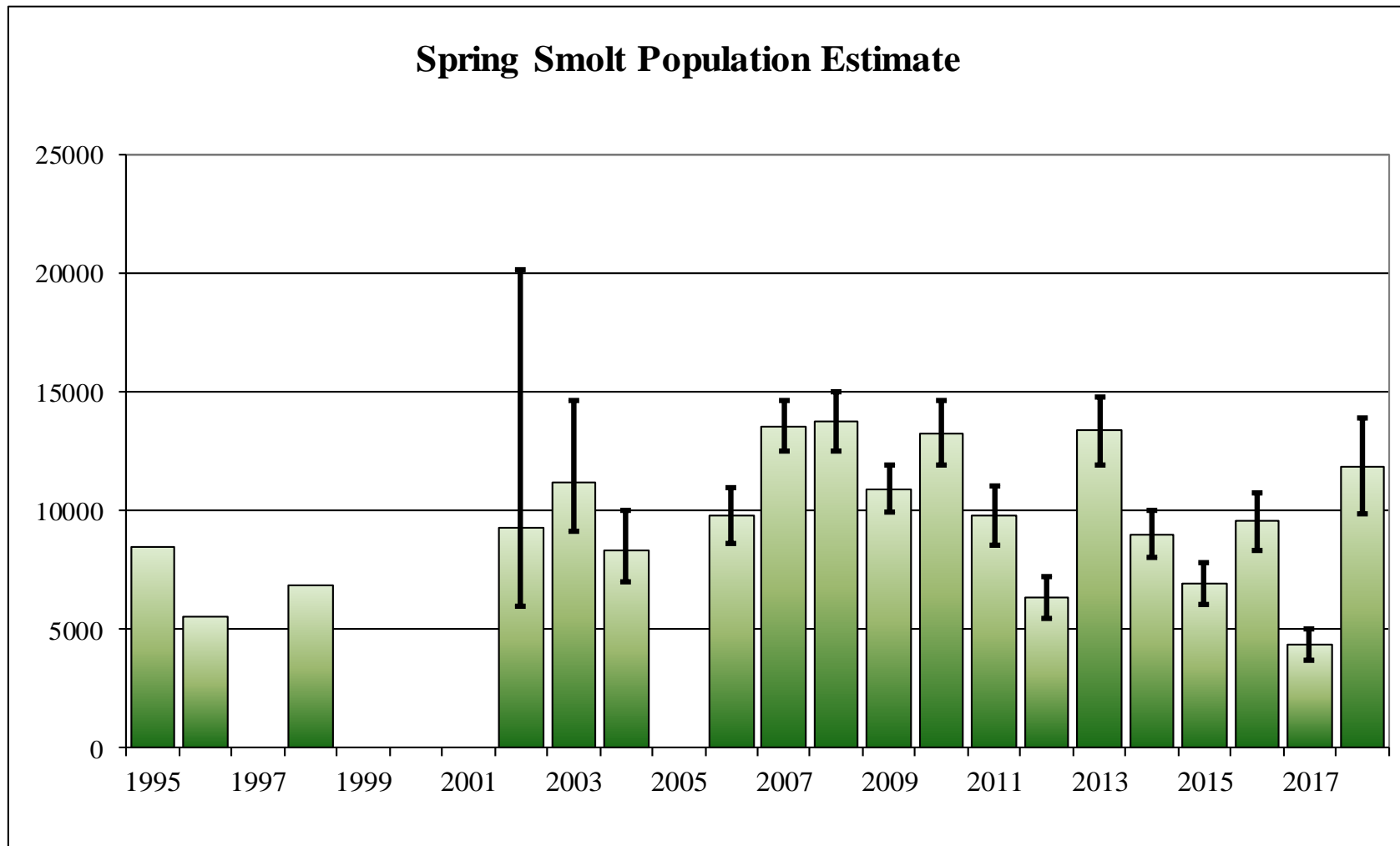
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# 17 years of smolt population estimates





# 17 years of smolt population estimates



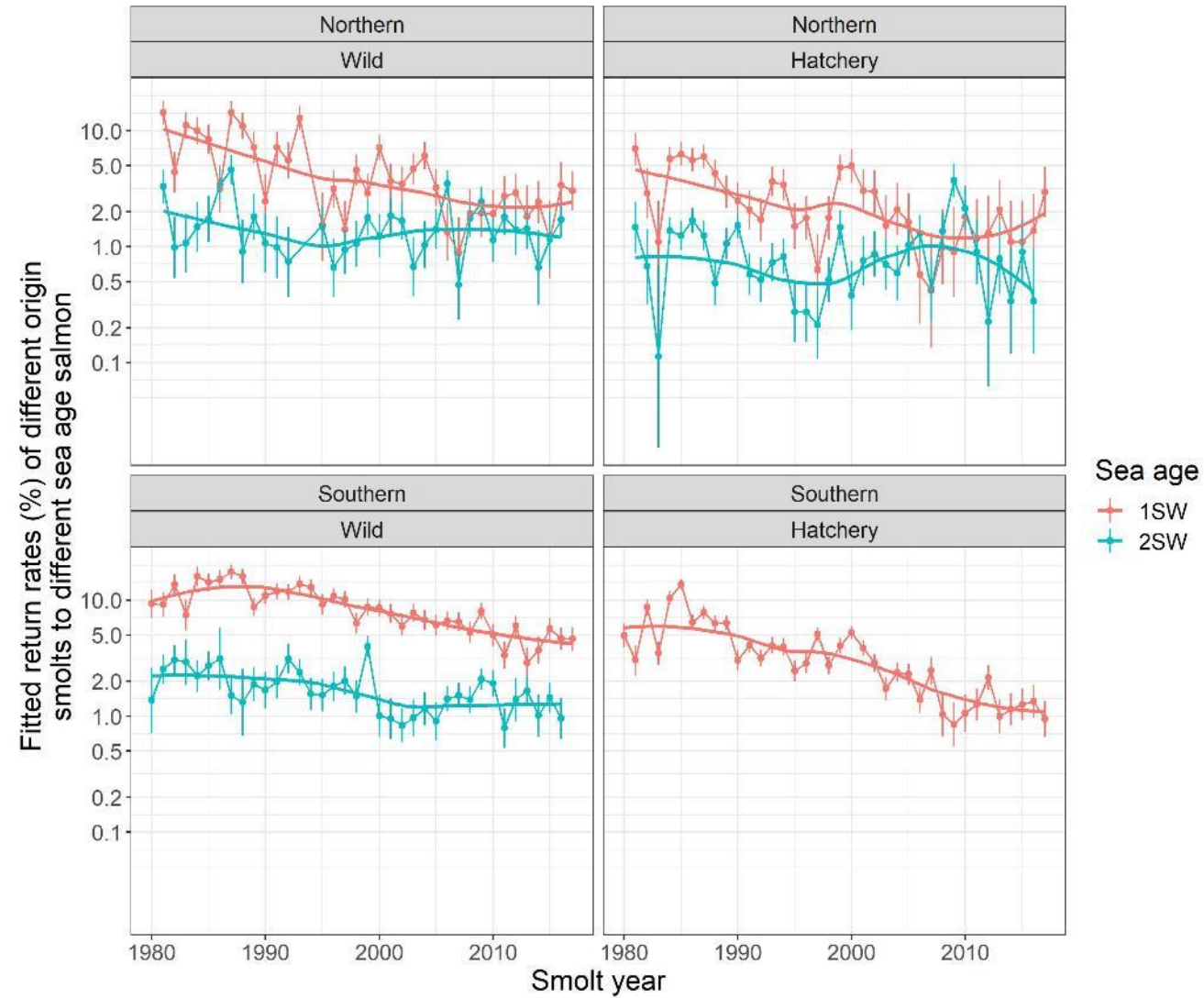
- Long-term record *cf.* other rivers across Atlantic Basin

# 17 years of smolt population estimates

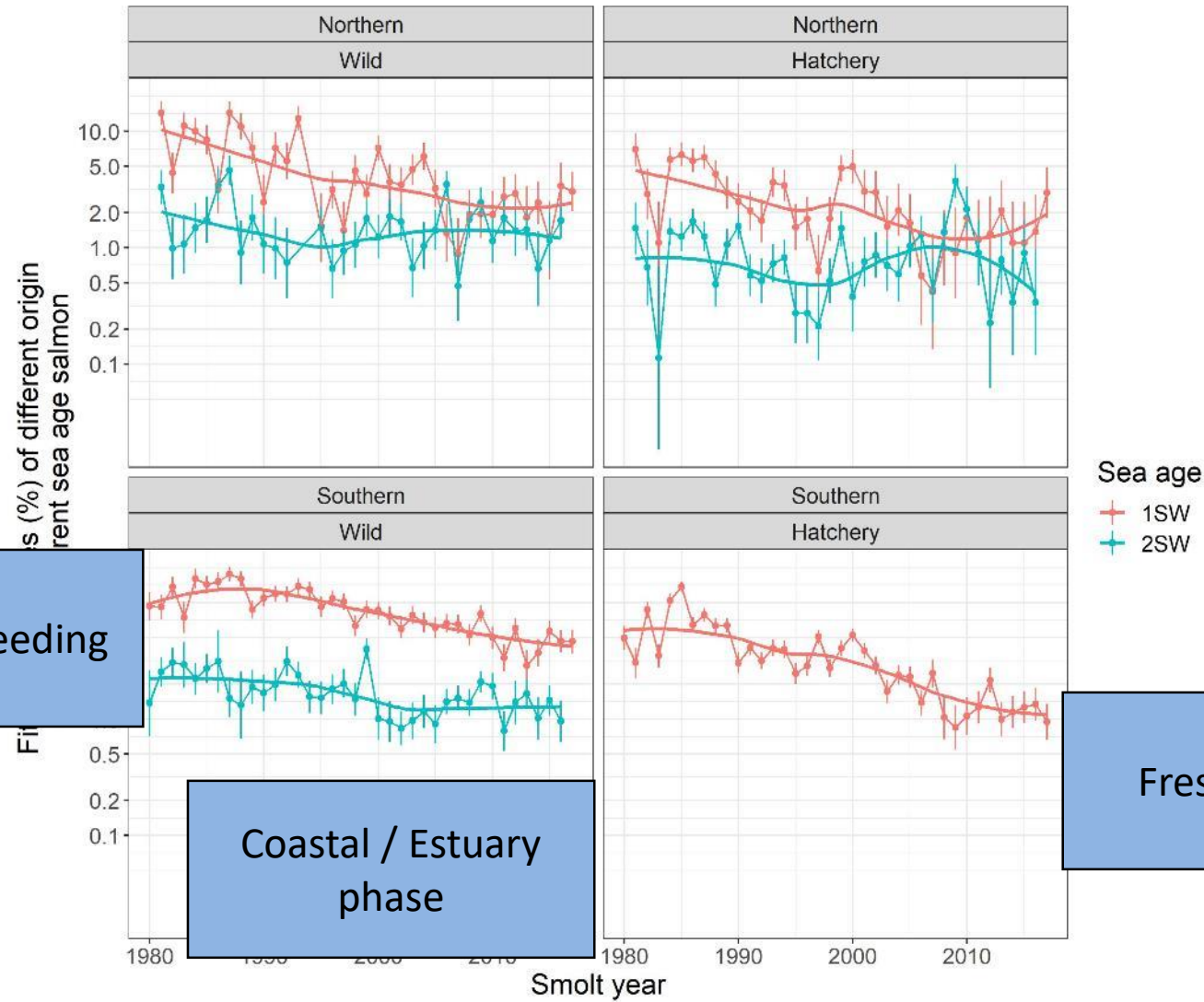


- Long-term record *cf.* other rivers across Atlantic Basin
- Submitted to ICES via E&W for calculation of
  - Marine survival

# 17 years of smolt population estimates



# 17 years of smolt population estimates

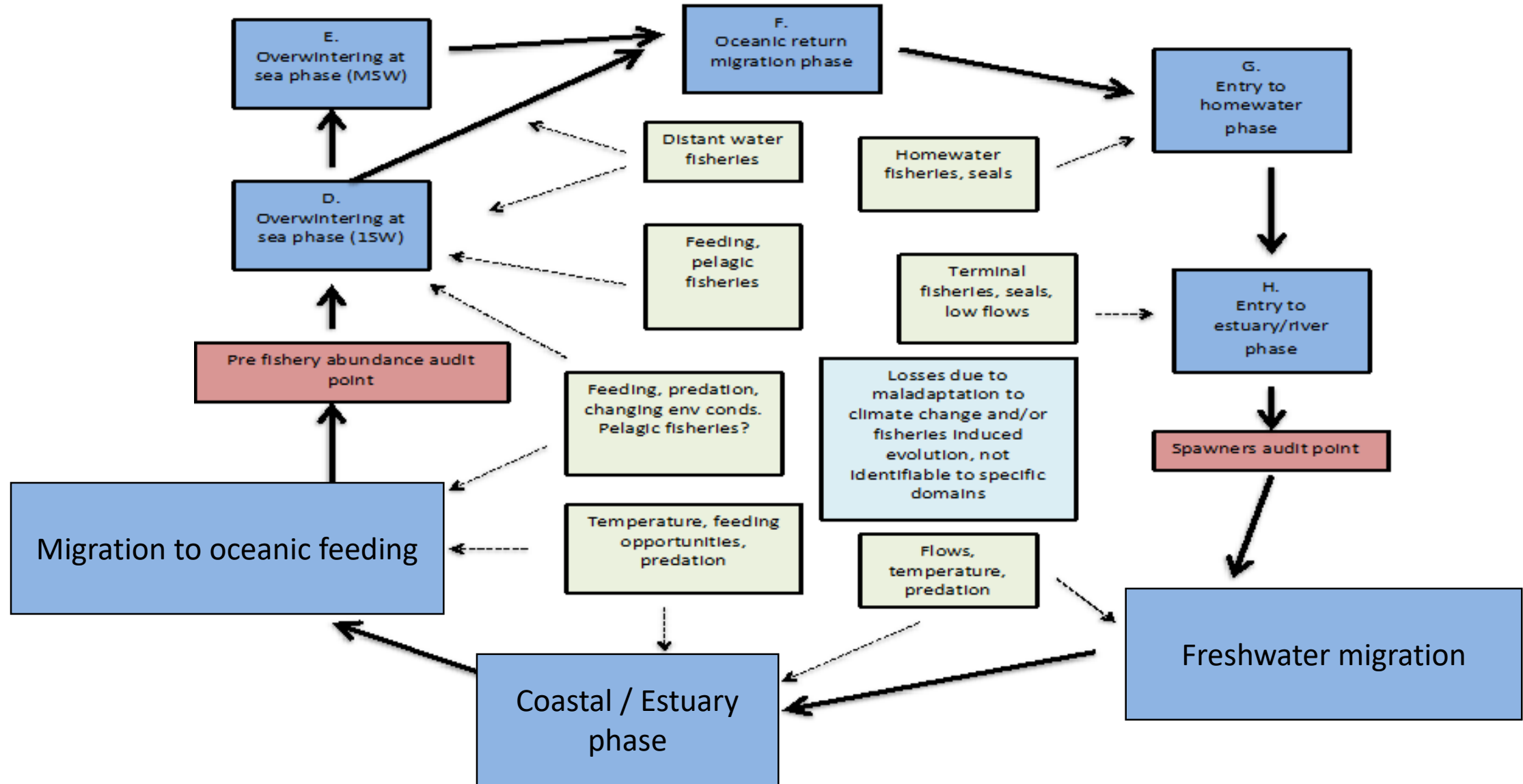


Migration to oceanic feeding

Coastal / Estuary  
phase

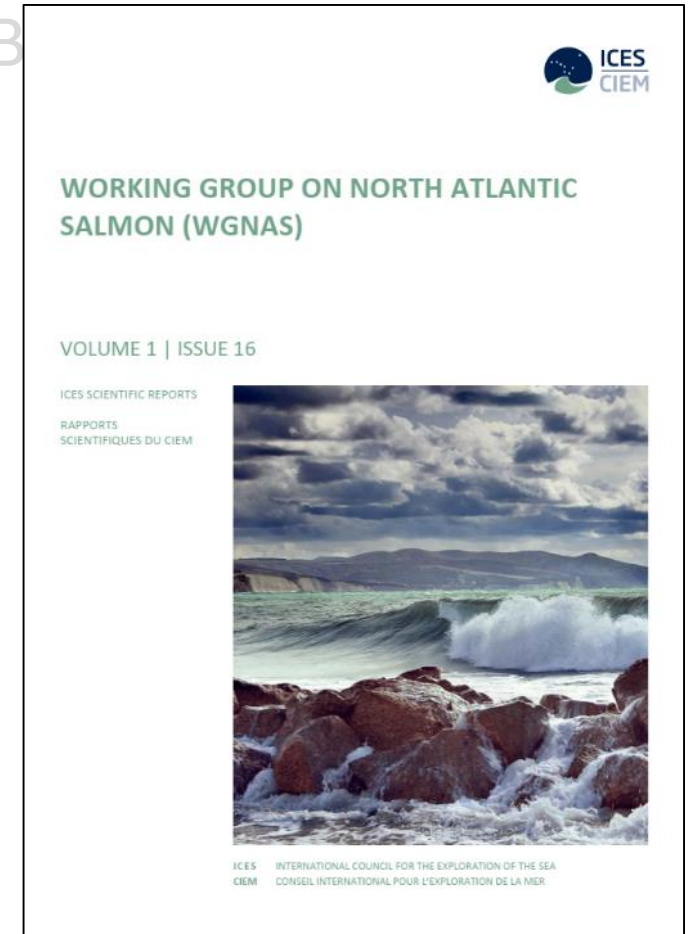
Freshwater migration





# 17 years of smolt population estimates

- Long-term record *cf.* other rivers across Atlantic B
- Submitted to ICES via E&W for calculation of
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- Long-term smolt migration timings



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# 17 years of detailed smolt data

- Individual data – Passive Integrated Transponders





# 17 years of detailed smolt data

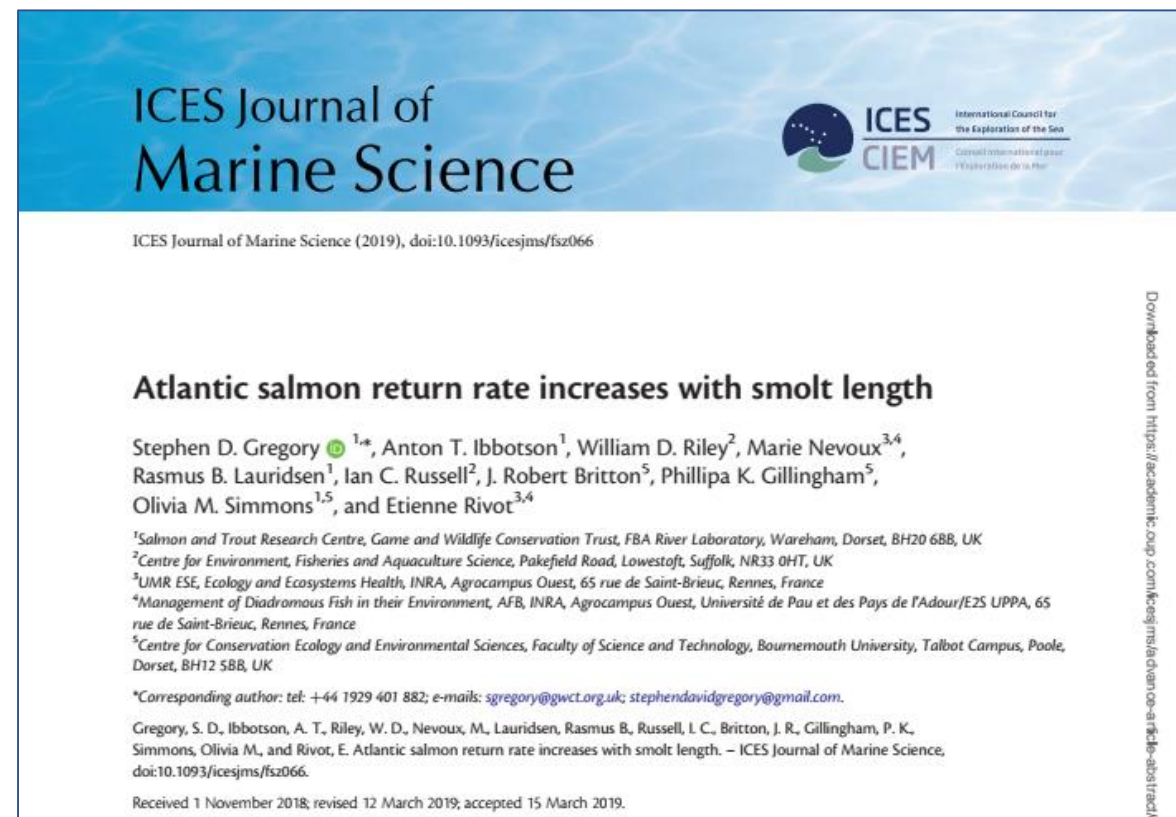
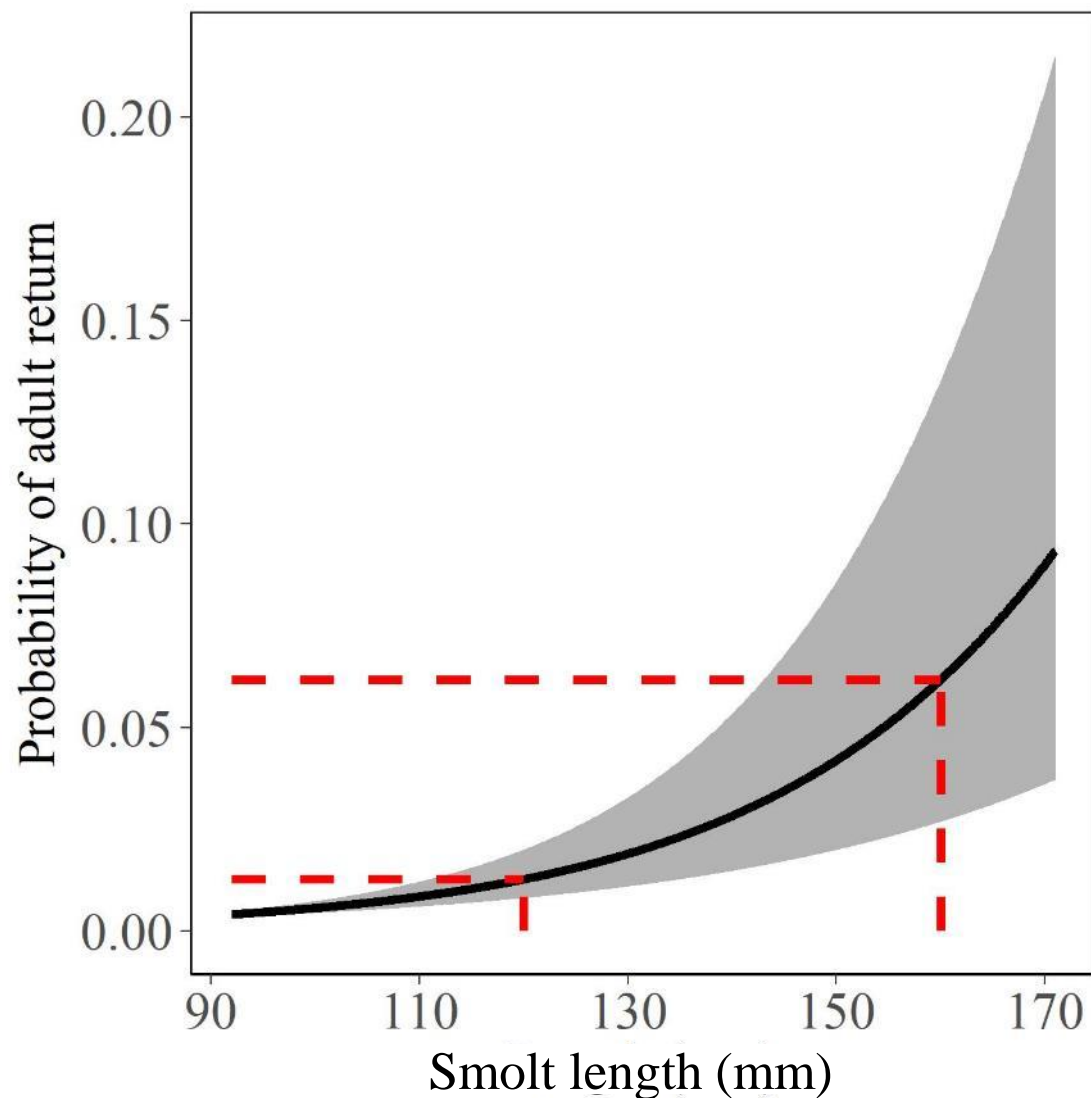
- Individual data – Passive Integrated Transponders
- Biometrics (length, weight, ...)



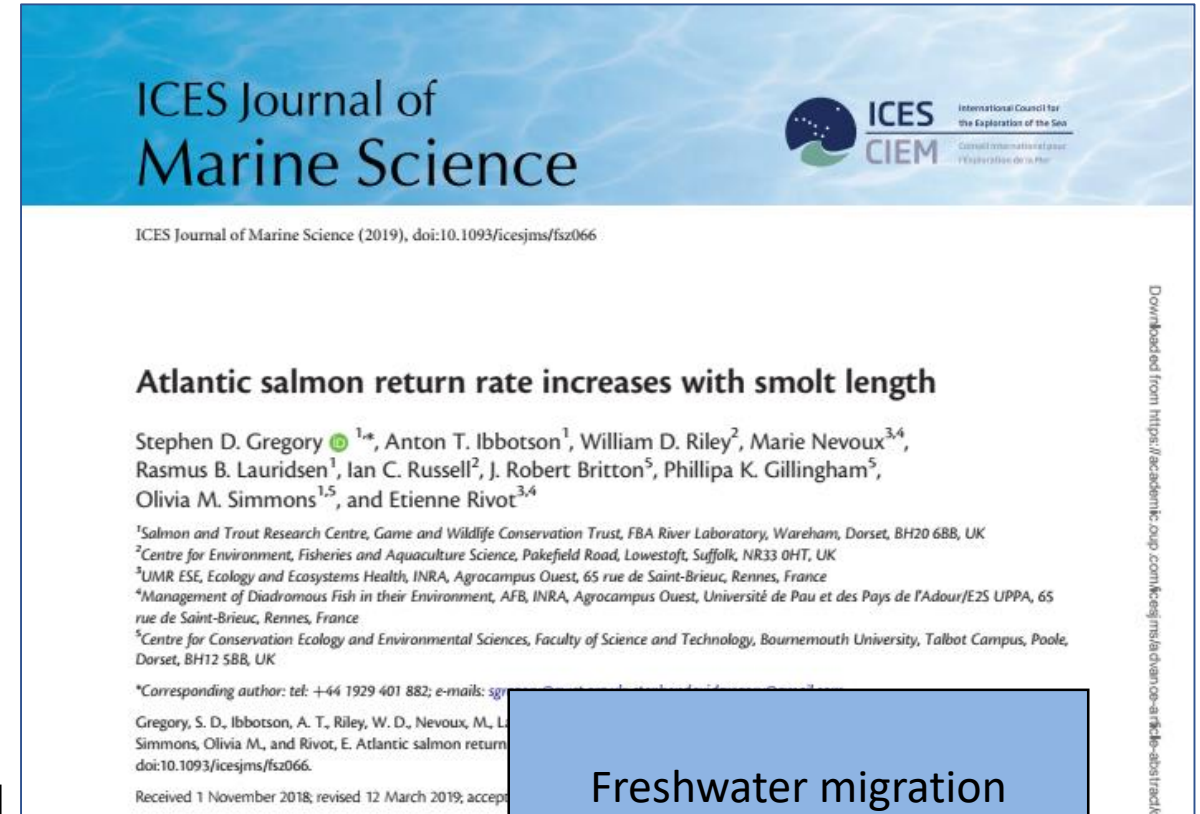
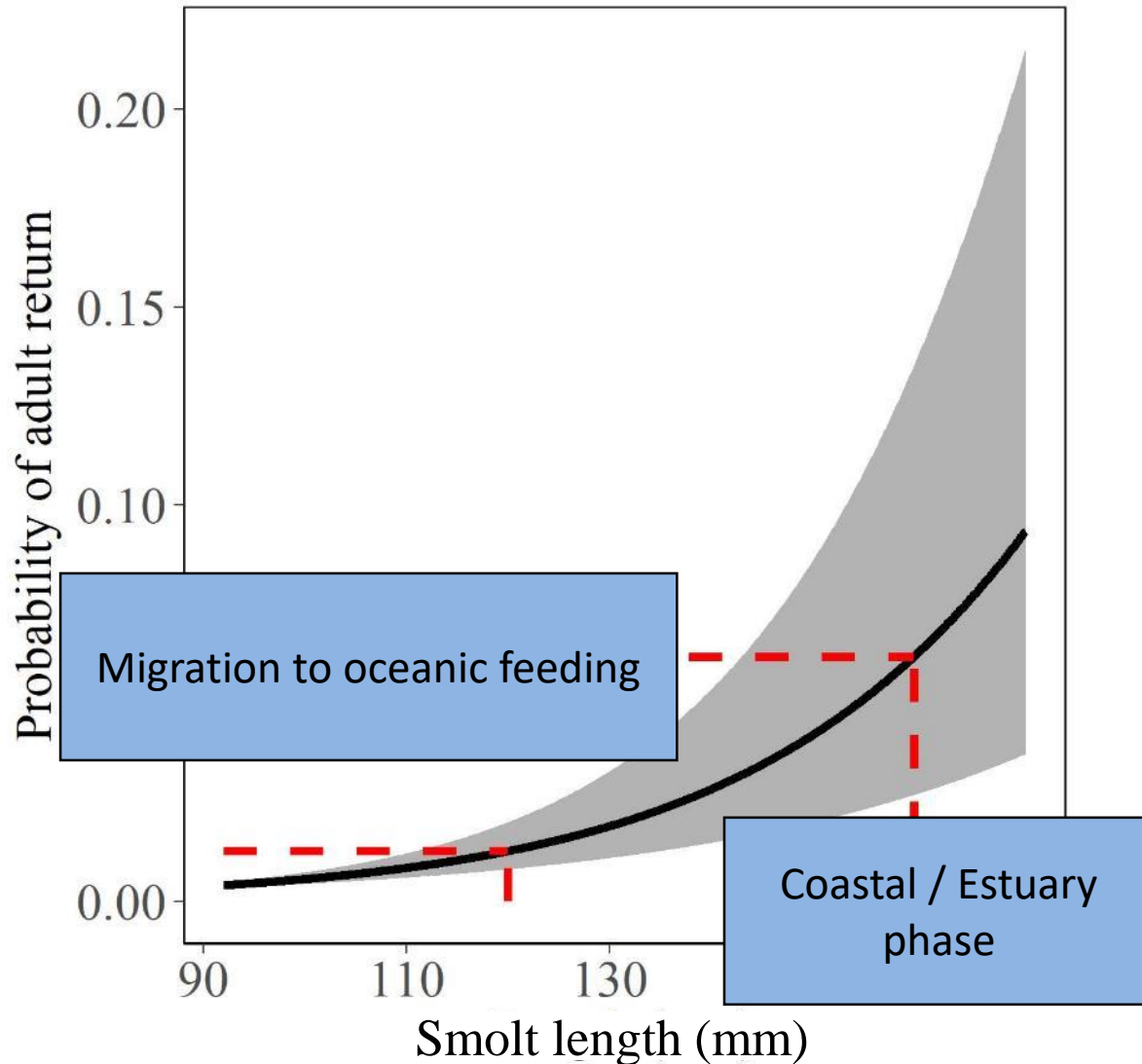
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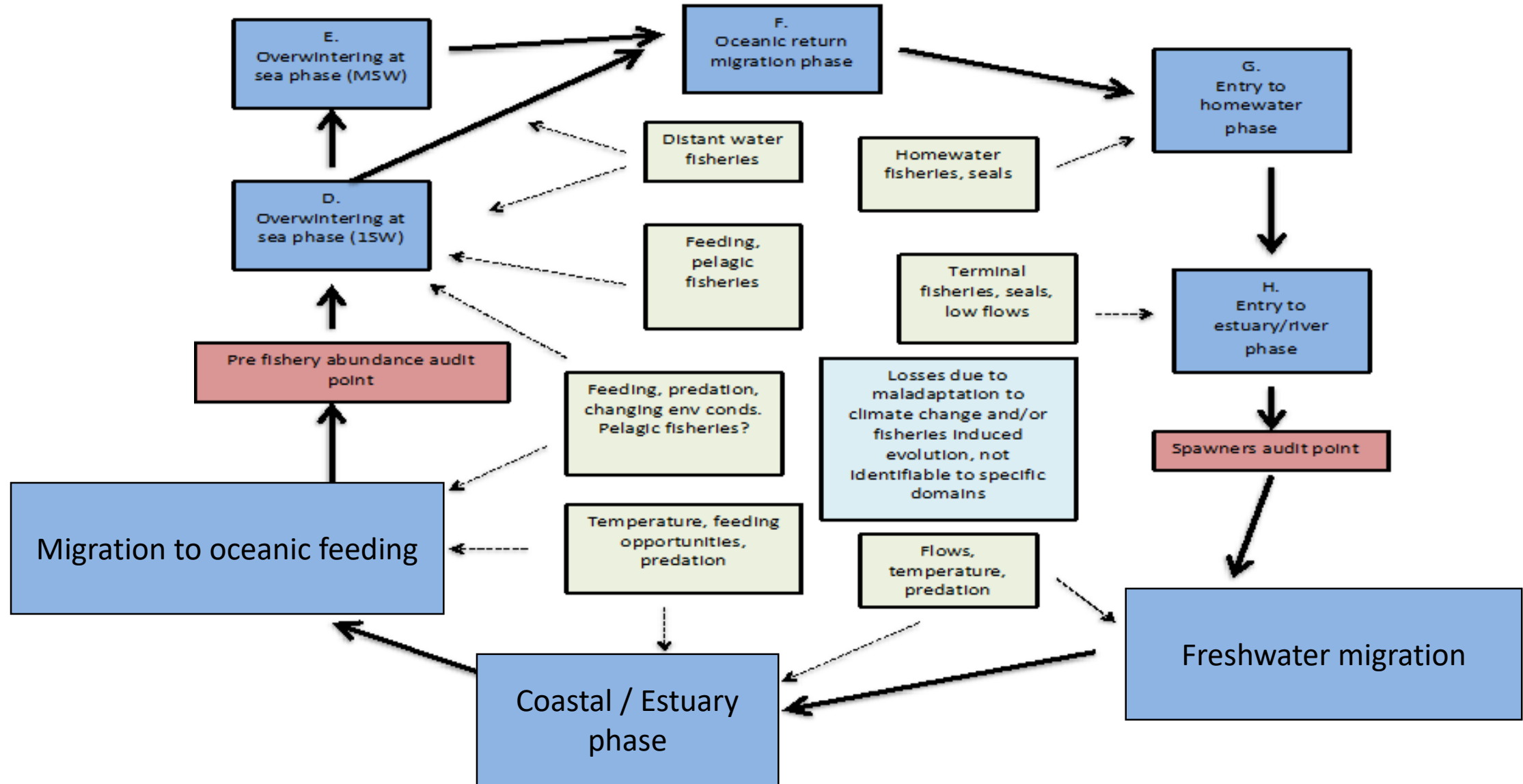
- Individual data – Passive Integrated Transponders
- Biometrics (length, weight, ...)
- Smolt length == proxy for influences of freshwater conditions on development?

# 17 years of detailed smolt data



# 17 years of detailed smolt data







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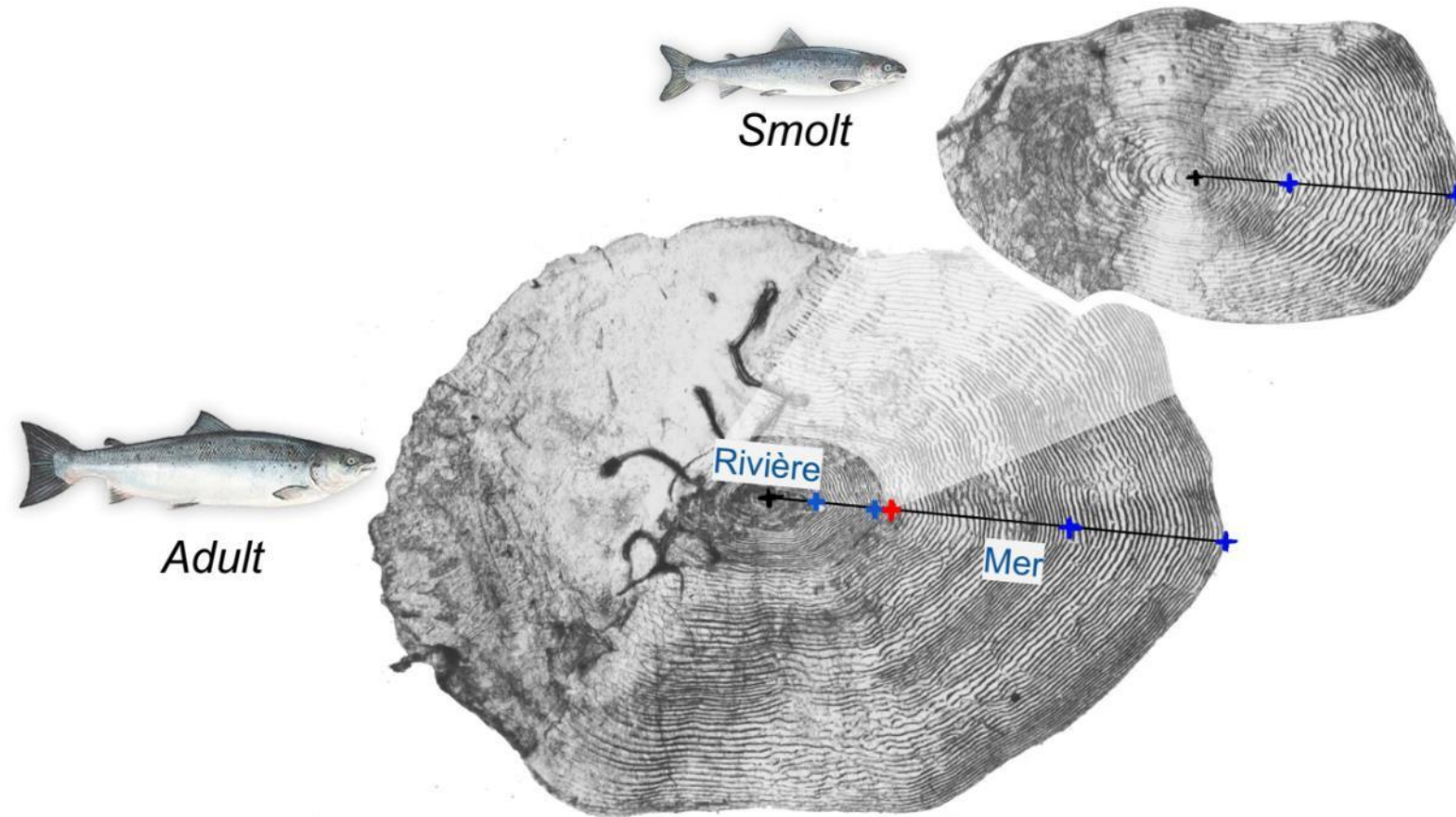
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# 1000s–100Ks scales for growth & sex

- Scales are biological archives

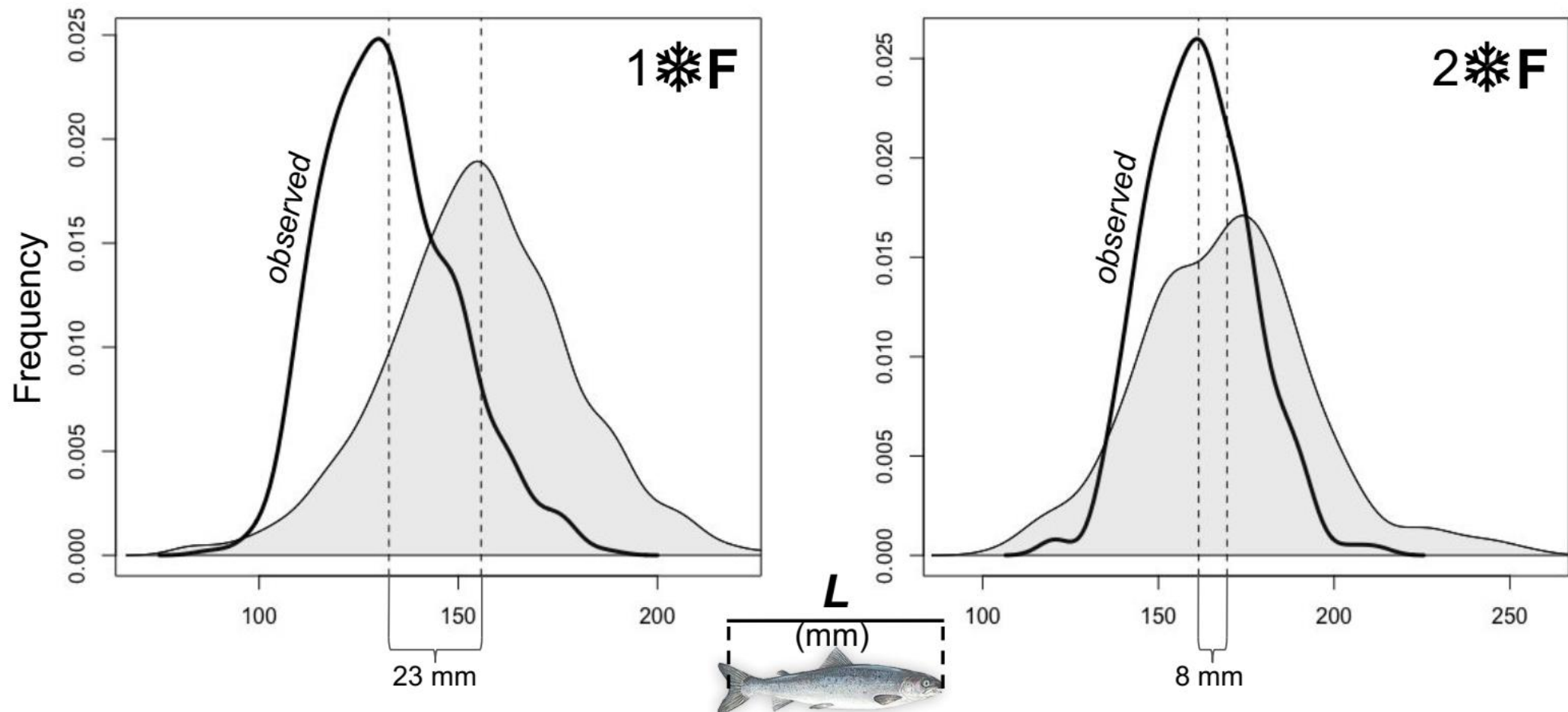


# 1000s–100Ks scales for growth & sex



- Scales are biological archives
- Compare growth histories among stages

# 1000s–100Ks scales for growth & sex



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- Scales are biological archives
- Compare growth histories among stages
- Genetic sex: stage-specific sex ratios

	♀	♂
Smolt	50	50
Adult	60	40



# 1000s–100Ks scales for growth & sex

- Scales are biological archives
- Compare growth histories among stages
- Genetic sex: stage-specific sex ratios
- Several other scale programmes -> BIG PICTURE 😊

1000s–100Ks scales for growth & sex



# Unlocking the ARCHIVE

- Several other scale programmes -> BIG PICTURE 😊

# ISOSCAPE



Game & Wildlife  
CONSERVATION TRUST

Overwintering at sea  
(non-maturing)

Overwintering at sea  
(maturing)



Migration to oceanic feeding

Oceanic return  
phase

Homewater entry

Coastal / Estuary  
entry

Freshwater migration

Coastal / Estuary  
phase

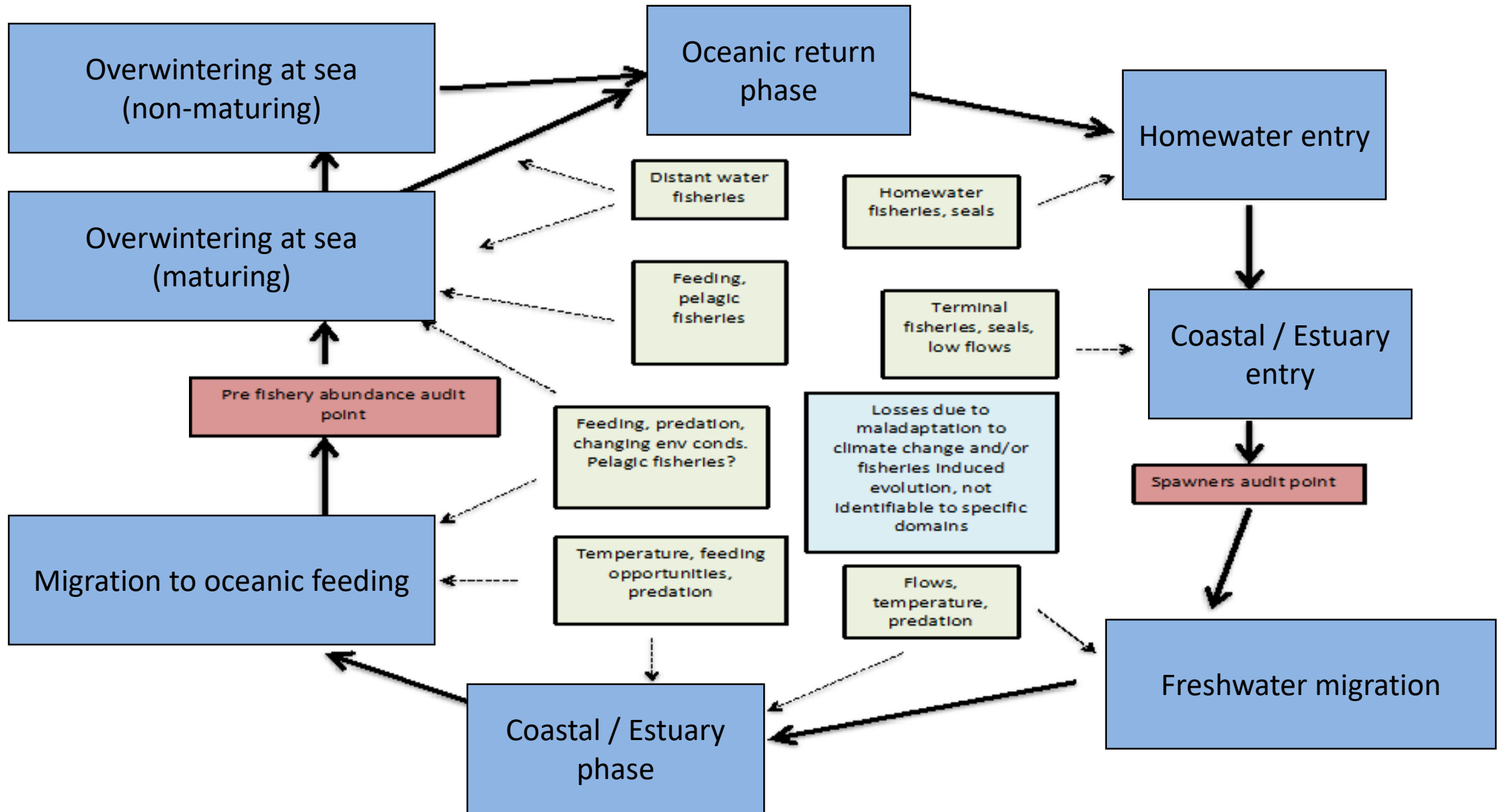
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# Unlock the ARCHIVE

programmes -> BIG PICTURE 😊

# CAPE



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# Lots of data on smolts in estuaries

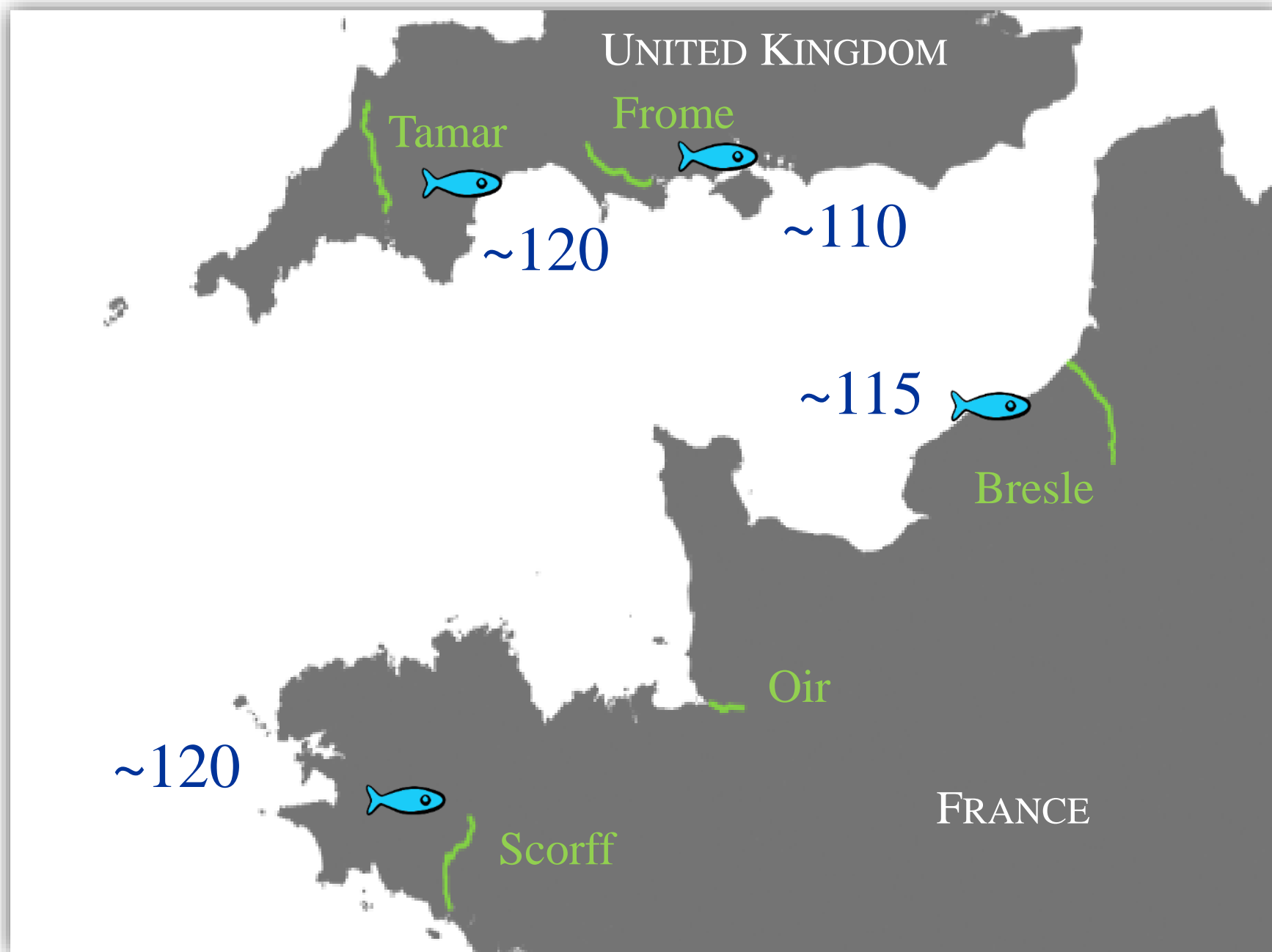


- Large multi-national, multi-river acoustic tracking study

(France: Bresle, Scorff; UK: Frome, Tamar)

- $n = 60$  salmon and 60 sea trout smolts in 2018-2019





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- Large multi-national, multi-river acoustic tracking study  
(France: Bresle, Scorff; UK: Frome, Tamar)
- $n = 60$  salmon and 60 sea trout smolts in 2018-2019
- Estuary loss rates, migration behaviours, ...

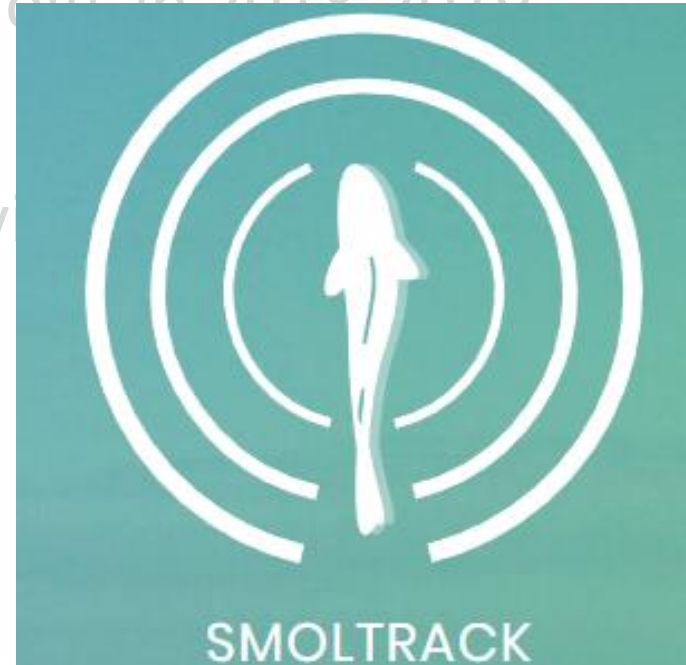


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- Large multi-national, multi-river acoustic tracking study  
(France: Bresle, Scorff; UK: Frome, Tamar)

- $n = 60$  salmon and trout smolts in 2018, 2019
- Estuary location and movement behavior

- Contributing to a bigger picture



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- Large multi-national, multi-river acoustic tracking study

(France: Bresle, Scorff; UK: Frome, Tamar)

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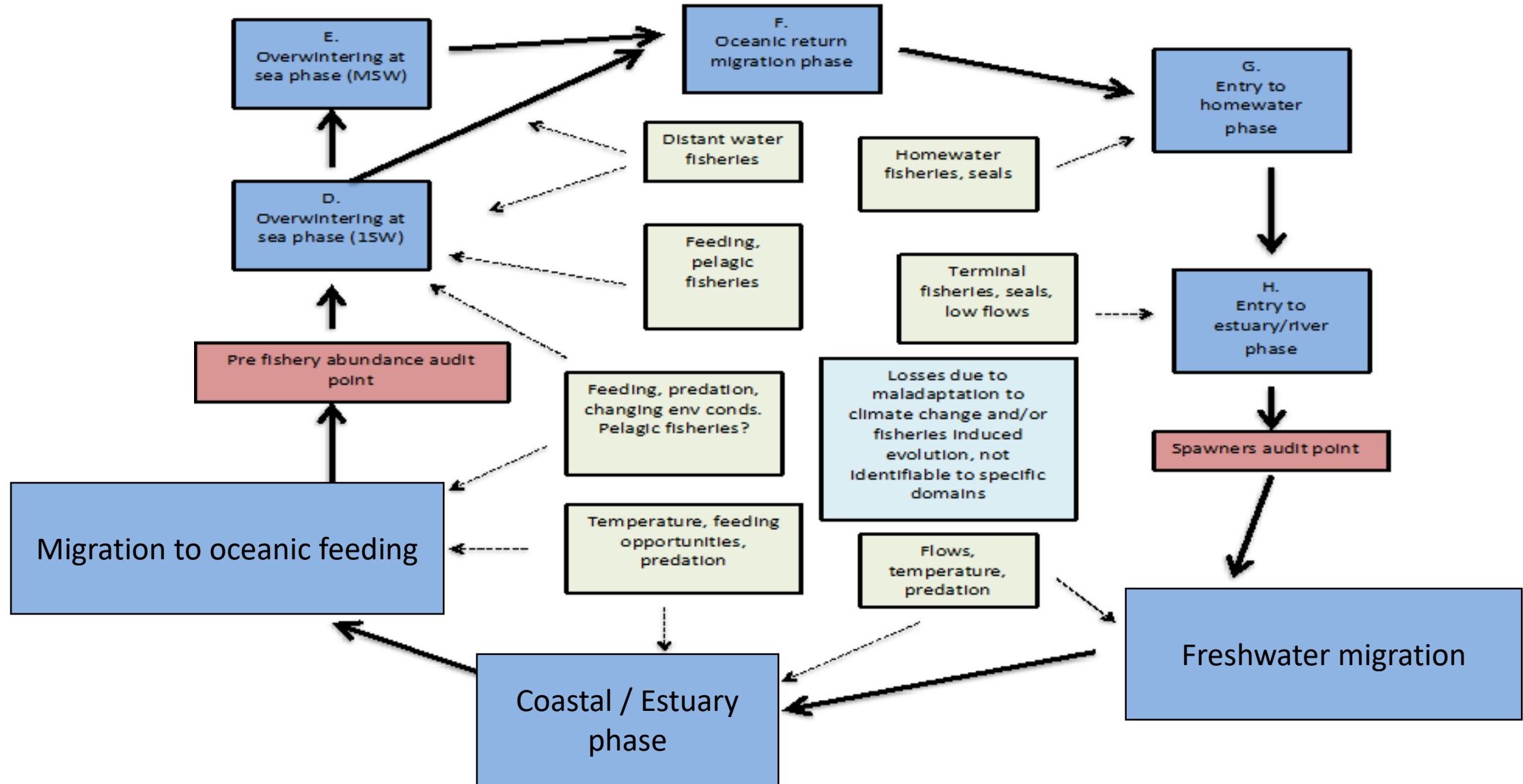


Migration to oceanic feeding

- Contributing to a bigger picture

Coastal / Estuary  
phase

Freshwater migration





So, what is special about the Frome?





# So, what is special about the Frome?

- RECAP

- Provides v. long-term continuous adult counts: 45 years
- Provides v. detailed smolt data: 17 years
- One of only 13 rivers providing wild salmon smolt marine survival estimates  
(2 x Iceland; 1 x Norway; 3 x Ireland; 1 x Scotland; 3 x England & Wales; [4 x France])
- Collecting abundant data on near-shore habitat use
- Only privately funded Index River in E&W



# So, what is special about the Frome?

- RECAP

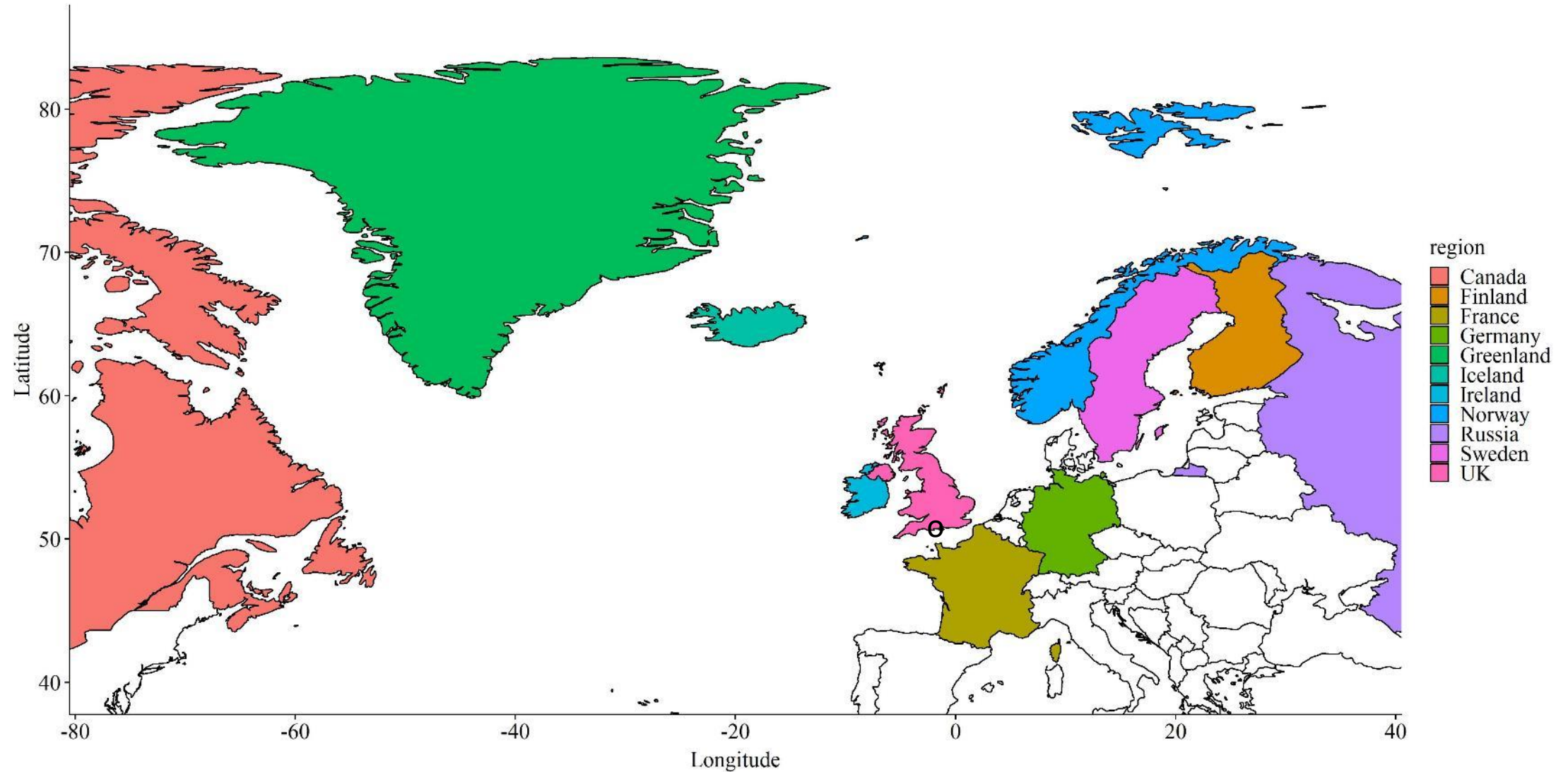
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- Most importantly, we are part of a bigger picture...

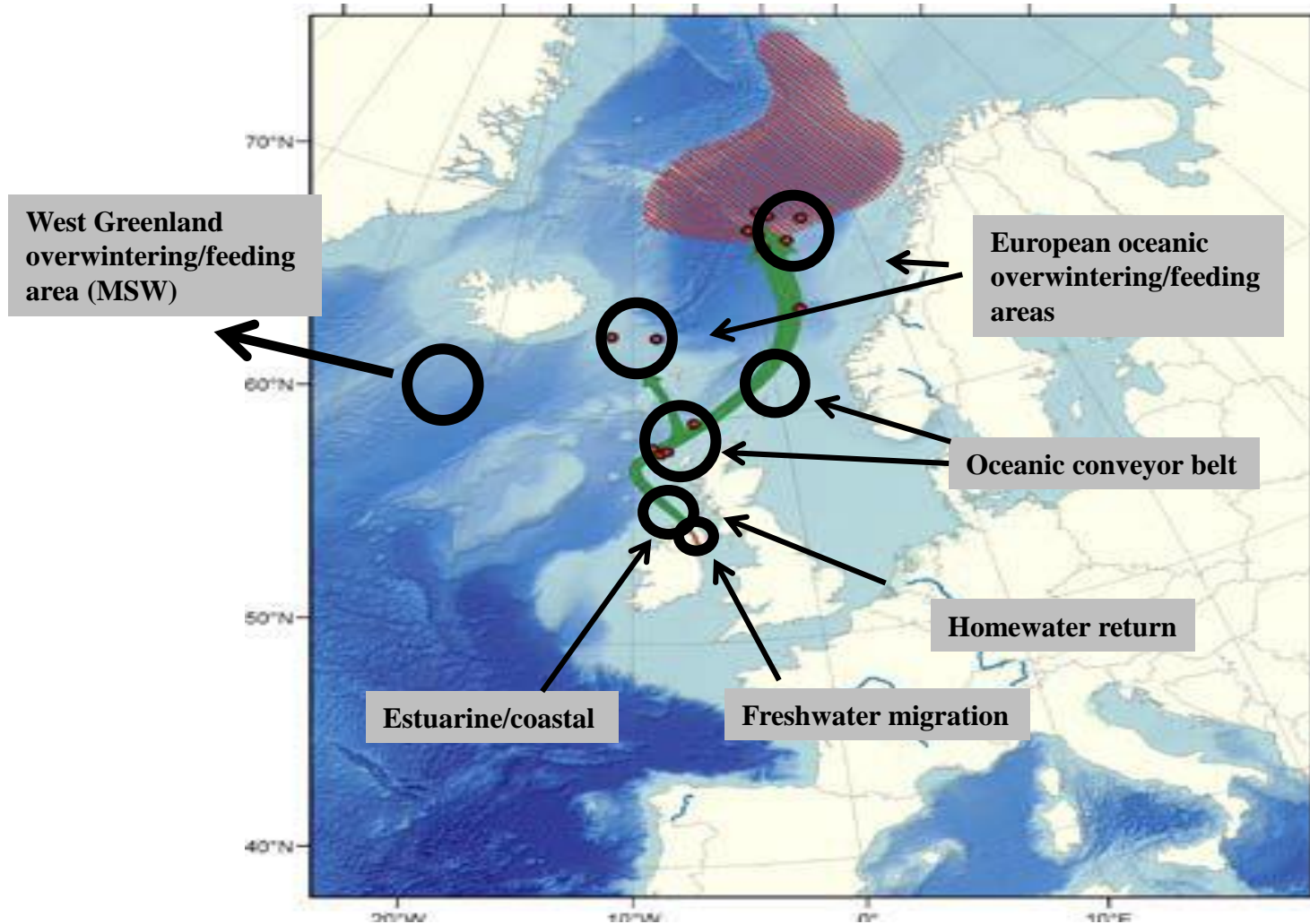


o = You are here

# WGNAS 2019 participants







○ Ecosystem domains?

