COLLOQUE INTERNATIONAL
SAMARCH 2022

ORGANISÉ PAR Bretagne Grands Migrateurs

EN COLLABORATION AVEC seinormigr

SAUMON & TRUITE DE MER :

DES OUTILS SCIENTIFIQUES AU SERVICE DE LEUR PROTECTION

17 & 18 MAI 2022 - PLÉNEUF VAL ANDRÉ (FR – 22)

AMÉLIORONS LA GESTION EN ESTUAIRE & EN MER

SAMARCH

Interreg France (Channel Manche) England
SAMARCH
Gestion des salmonidés dans la Manche
Fonds européen de développement régional

Côtes d'Armor le Département

Région BRETAGNE

Modélisation de la dynamique des populations et évaluation des stocks de saumons à l'échelle du bassin de l'Atlantique nord

Etienne Rivot

UMR DECOD, Institut Agro, Rennes

&

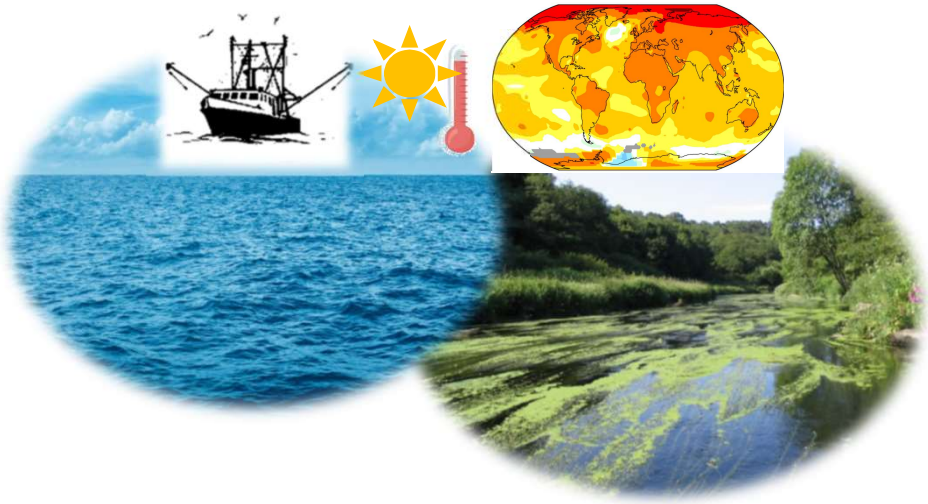
Stephen Grégory, Pierre-Yves Hernvann, Marie Nevoux, Maxime Olmos, Rémi Patin, Etienne Prévost, Olivia Simmons, Cécile Tréhin

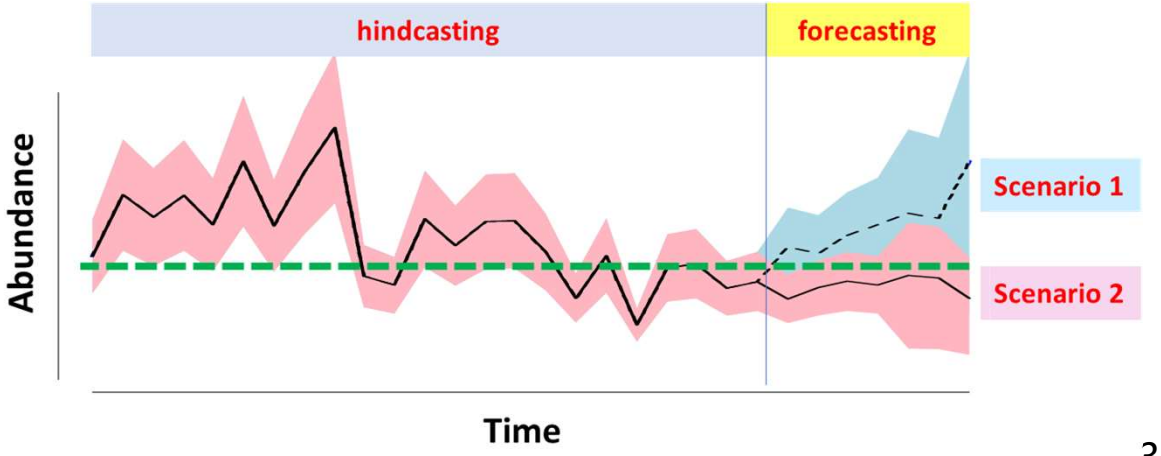
Embedding stock assessment and management within an ecosystem based approach

- Improve on understanding the mechanisms that shape the response of populations to multiple pressures

Ecosystem based management

- Evaluate population status
- Predict the response to future conditions/scenarios
- Evaluate management options





Anadromous fish and bio-complexity

Oncorhynchus spp.

Salmonids spp.

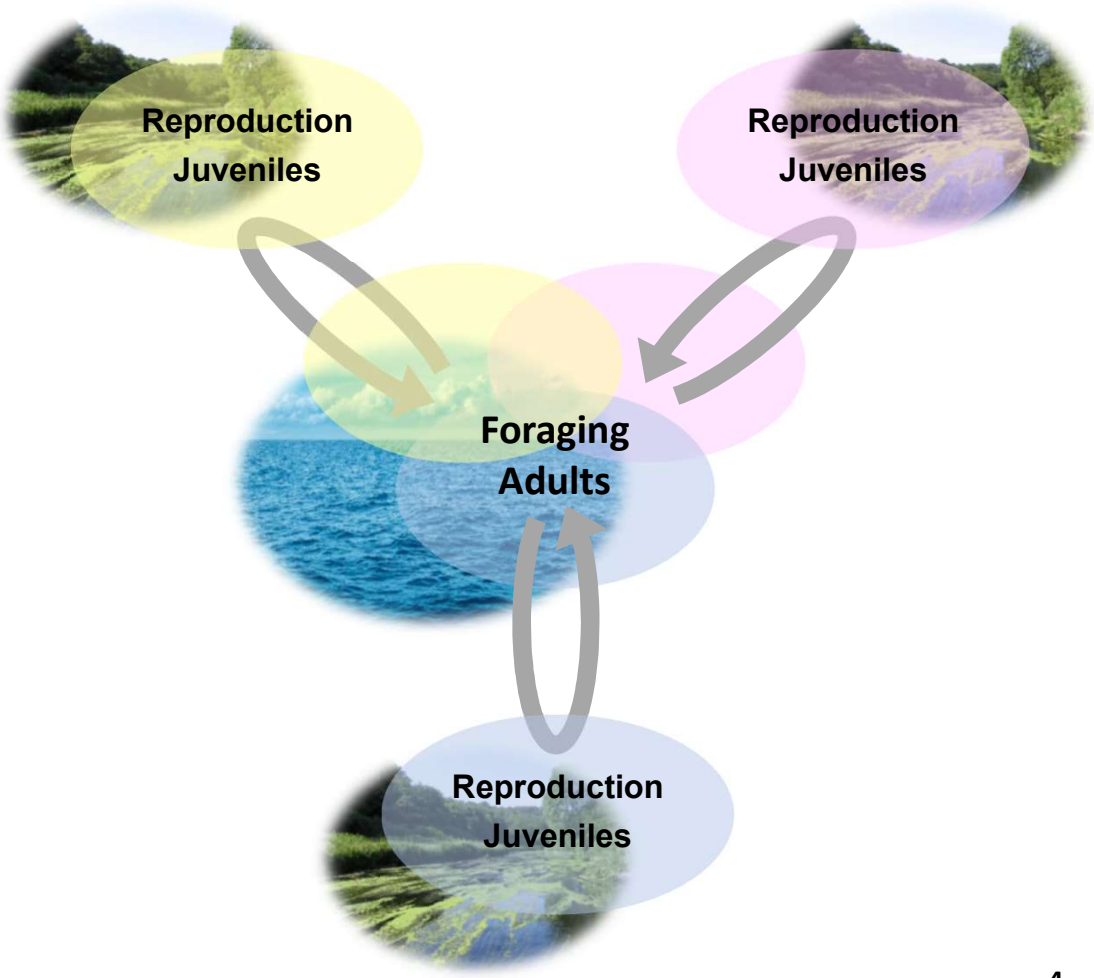
Shads spp.

Bio-complexity

- Use freshwater / marine habitats
  - → combinations of drivers and mechanisms in a hierarchy of scales
- Multiple reproductive strategies

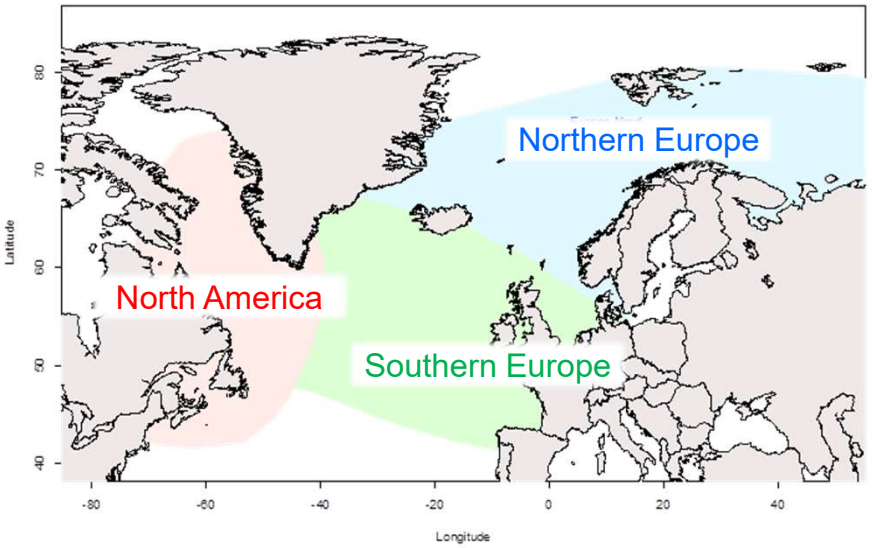
Data complexity

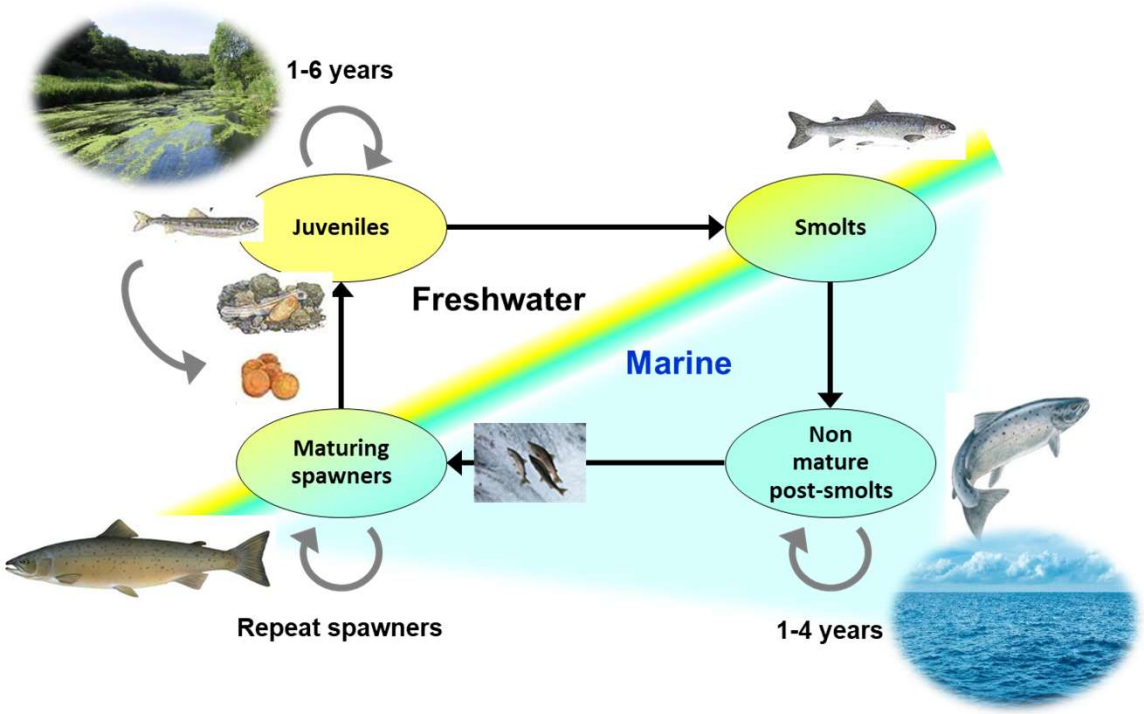
- Data are dispersed and may concern different levels of aggregation
- Marine phase is more difficult to observe



Atlantic salmon

- North Atlantic ocean
- > 2500 rivers
- High level of homing





- Diversity of life histories (intra-specific biodiversity)
  - 1-6 years in freshwater before smoltification
  - 1-4 years at sea before returns

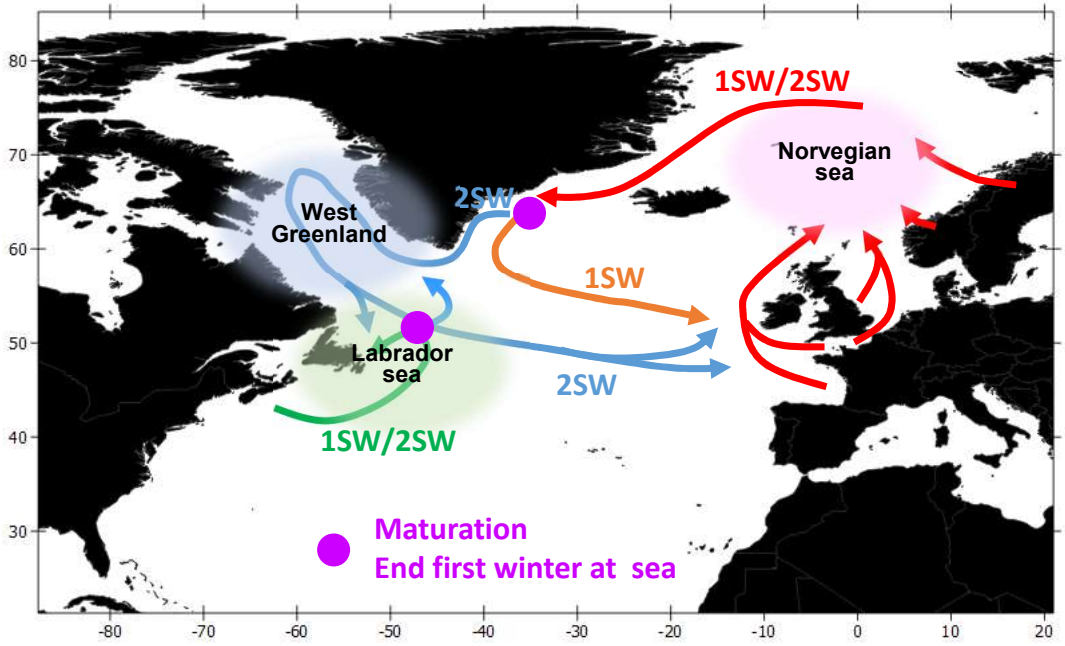
The marine phase - a « grey » box

- Most available data (and historical research) concern the **freshwater phase**

- **Marine phase** remains more mysterious

  Available data mostly rely on indirect clues and from fish caught as adults after the marine phase

Migration routes are partially known



Migration routes (partially) depend upon fish origin

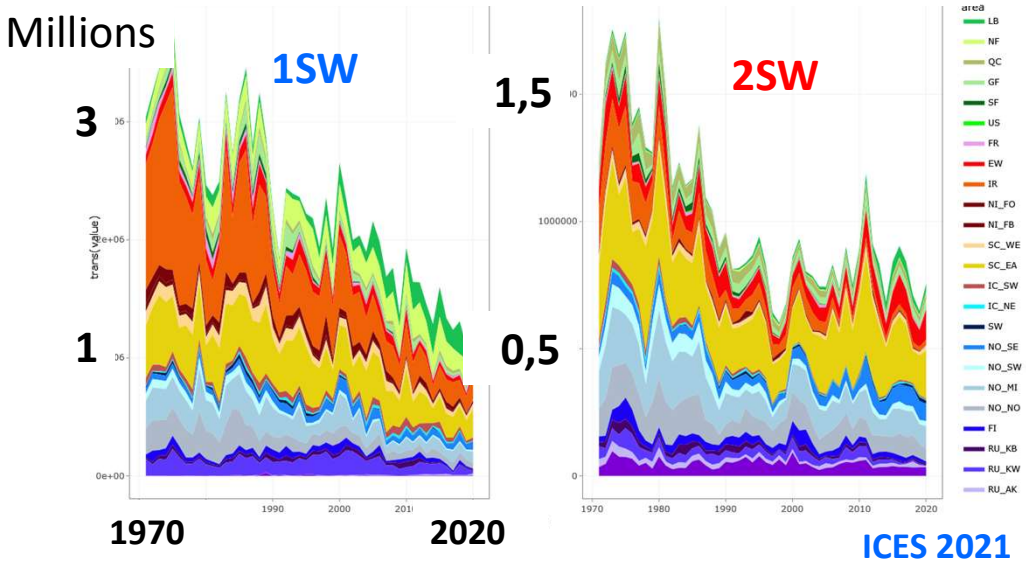
- Factors susceptible to affect specific population or groups of populations simultaneously

Migration routes (partially) depend upon life histories

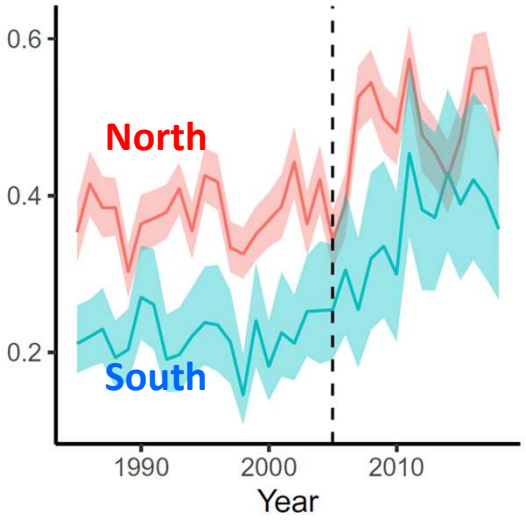
- 1SW/2SW fish shared the same habitat during the first year at sea before maturation
- Non maturing (2SW) fish have a different habitat during the 2nd year at sea

Some strong warning signals

Returns in 25 countries/regions



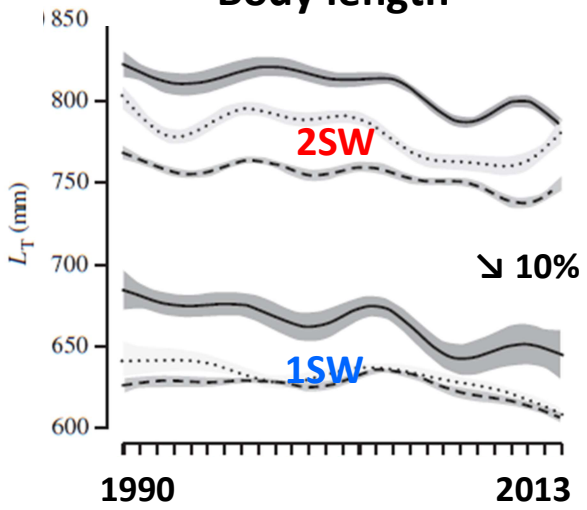
Proportion MSW in returns



Norway

Vollset et al. 2022

Body length



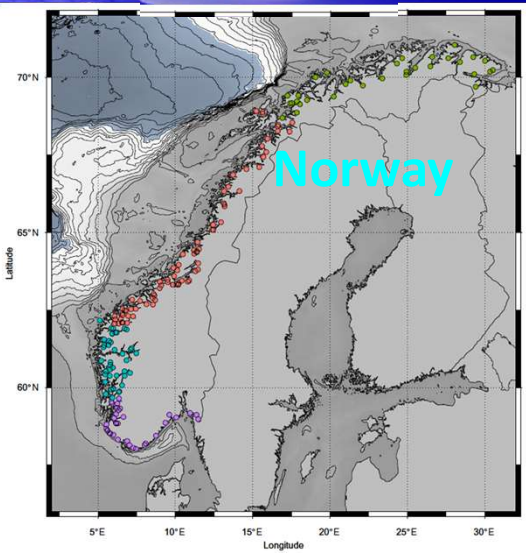
France
South West
Normandy
Brittany

Bal *et al*. 2017

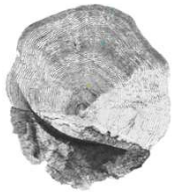
- ↘ in abundance of returns
- Changes in sea-age composition of returns
- ↘ in body length & weight of returning fish

➔ **Changes in survival, growth and life histories**

H A response to major changes in the North Atlantic Ocean triggered by bottom-up processes

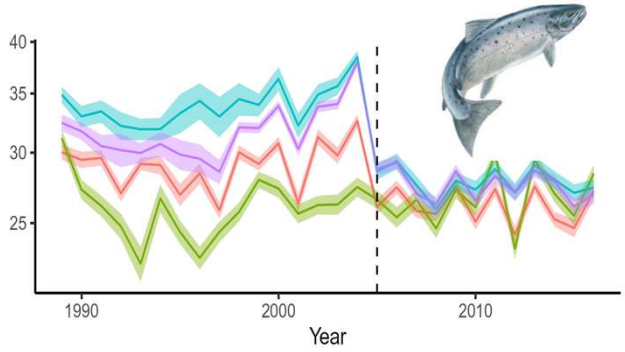


Vollset et al. 2022
180 rivers
1989-2017
Growth from 50000 scales
Ecosystemic data

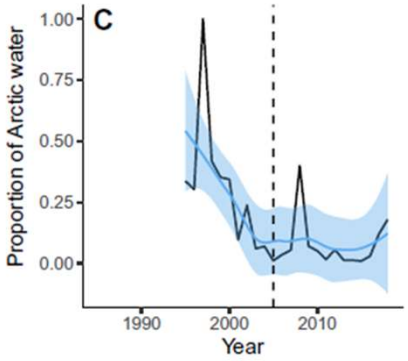


Beaugrand and Reid, 2012 ; Mills et al., 2013 ;
Renkawitz et al., 2015 ; Woodward et al. 2021 ;
Vollset *et al*. 2022, Harvey et al. 2022

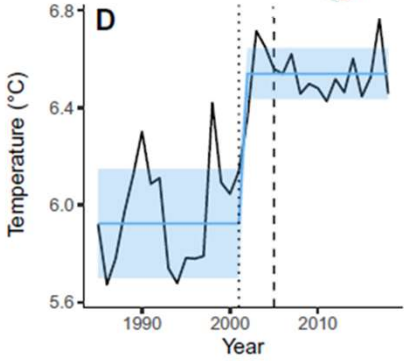
↘ growth



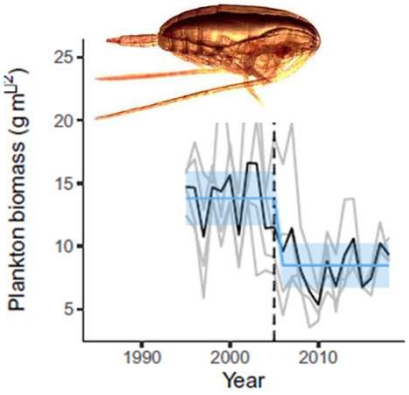
↘ extend Arctic water

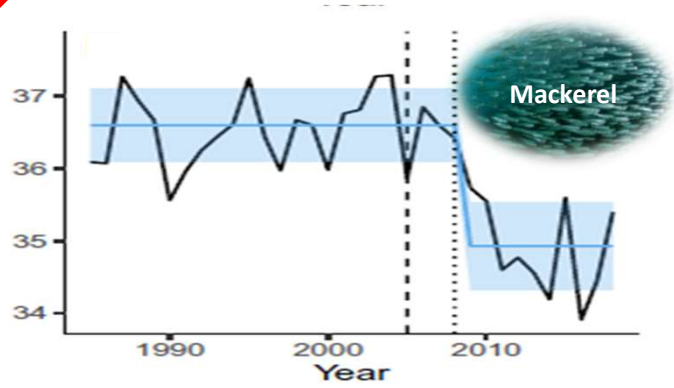


↗ SST



↘ Prey quantity & energetic quality





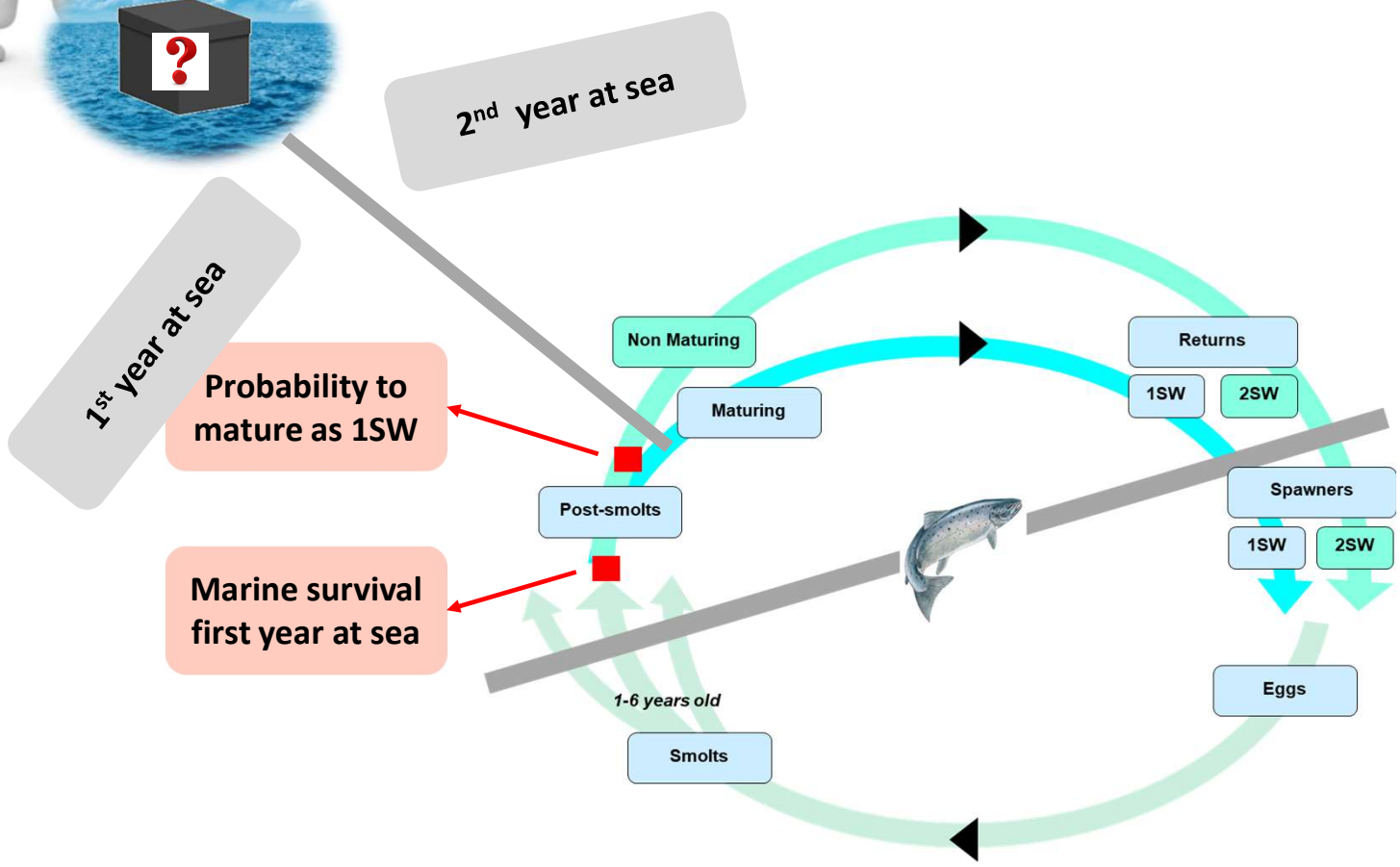
Objectives

- **A common pattern for all populations at the scale of the N Atlantic basin ?**
  - What about south European populations ?

- **How environmental changes affect population dynamics ?**
  - Survival rate
  - Proportion maturing 1SW

- **Transfer this gain of knowledge to improve on stock-assessment methodology**
  - Improve on mechanisms to enhance explicative and predictive ability of models

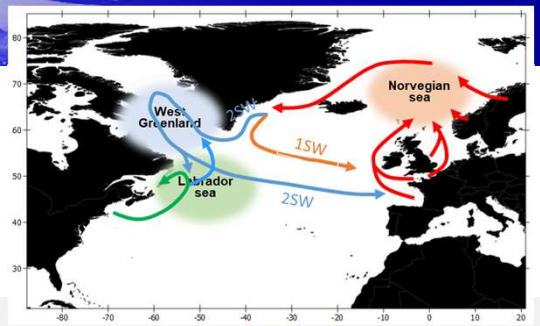
Stage-based population models (life cycle models)



- Track the cohorts dynamics and variability of life histories
- Use multiple sources of data to estimate key demographic parameters

  & evaluate hypotheses on the sources of variations

Integrating across scale



Basin scale

- Partitioning out pop. specific / shared signals
- Assess influences of factors at different spatial scales

River scale

- Specific ecological context
- High resolution data → improve mechanisms

NASCO OCSAN ← WGNAS ICES CIEM

- Assess the status of stocks in all jurisdictions
- Evaluate management options for mixed stock fisheries (WG & Faroes)

Local/regional agencies and public authorities

- Manage habitat
- Set conservation limits
- Manage homewater fisheries

A stage-based population model for population dynamics and stock assessment in the North Atlantic Bassin

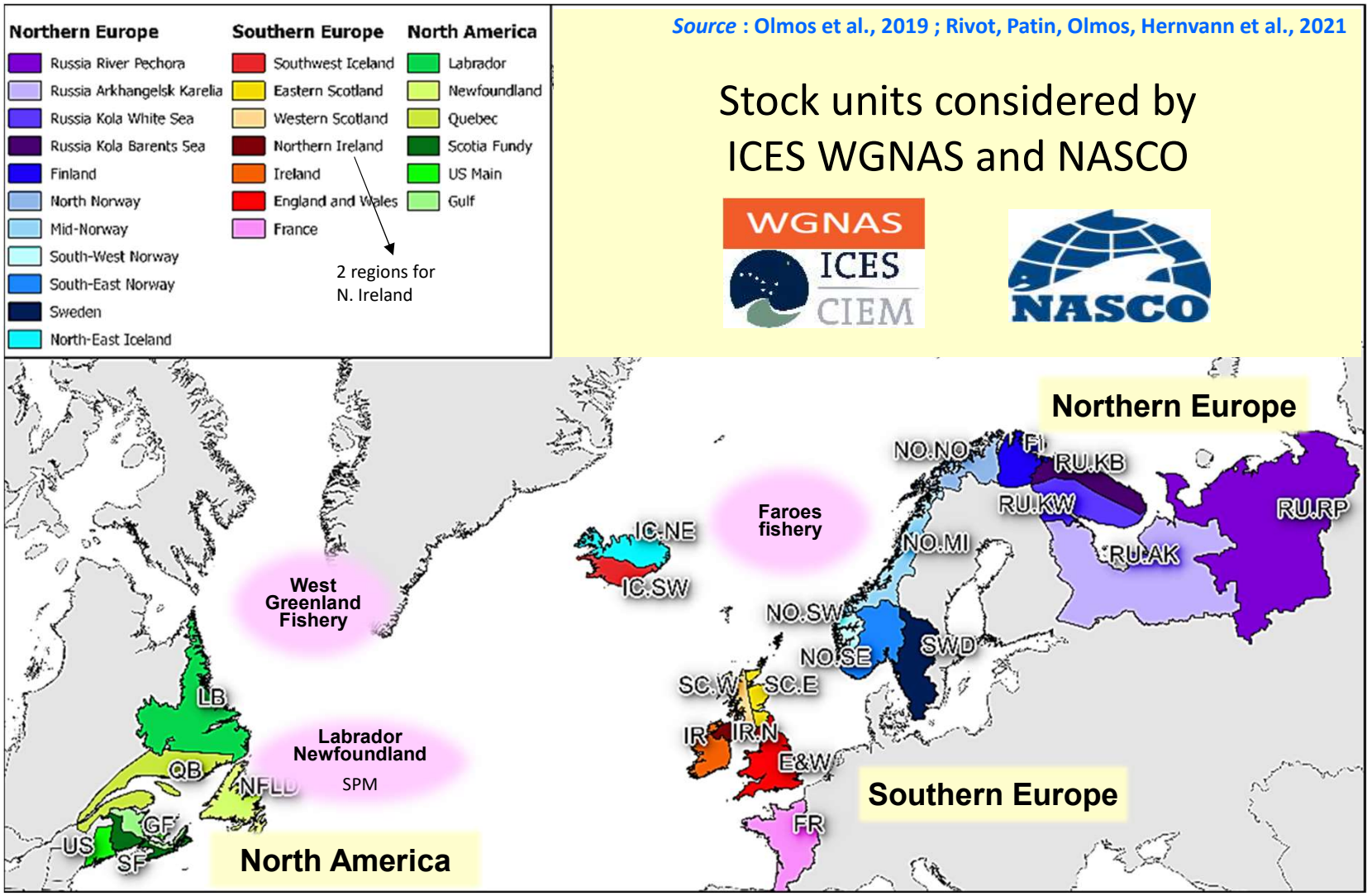
We need data and models at the scale of index rivers to improve mechanisms

A stage-based population model for population dynamics and stock assessment in the North Atlantic Bassin

We need data and models at the scale of index rivers to improve mechanisms

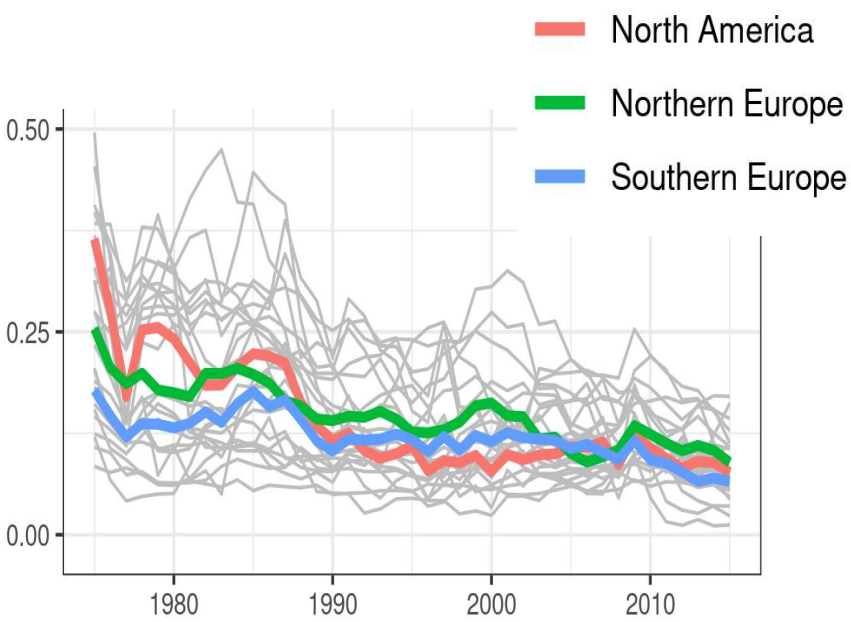
https://sirs.agrocampus-ouest.fr/discardless_app/WGNAS-ToolBox

- 25 SU considered by ICES/NASCO
- Times series of data ~ 50 years 1971-today



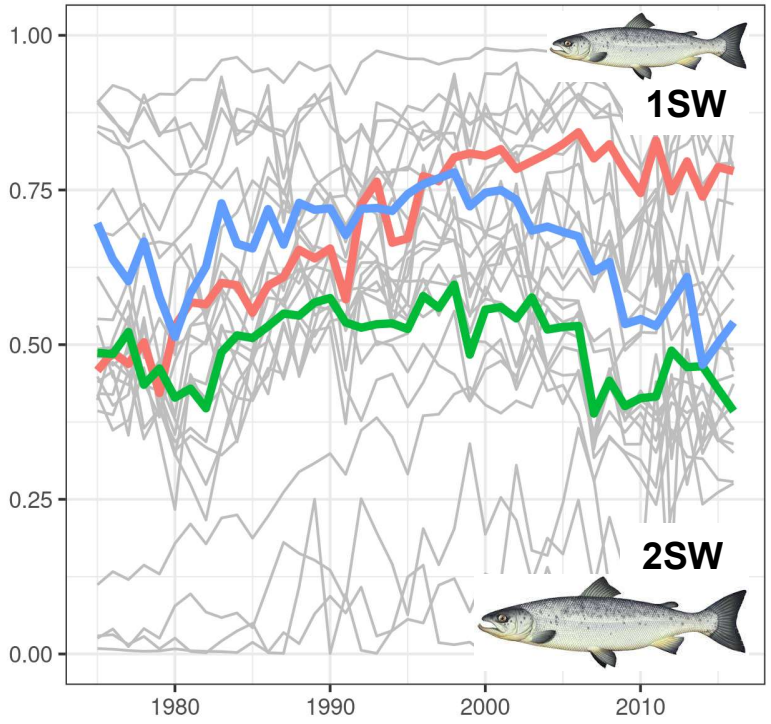
Spatial synchrony in marine survival and proportion maturing as 1SW

Survival 1st year at sea



Rivot, Patin, Olmos et al., 2021

% maturation as 1SW

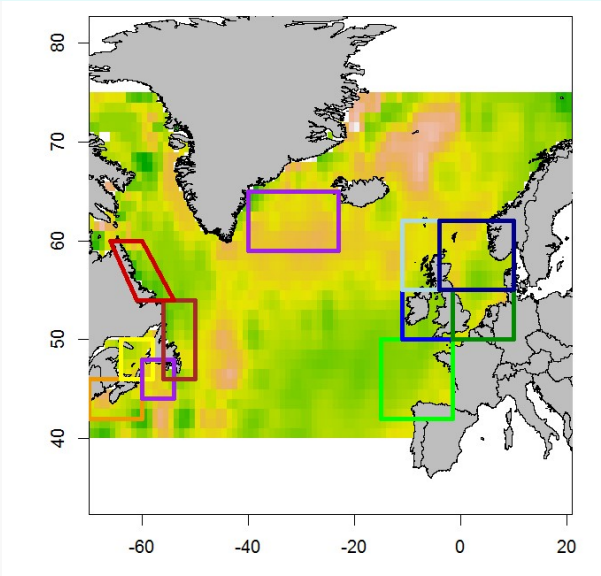


➔ Shared signal explains **~ 40%** of the variability in marine survival and proportion maturing as 1SW

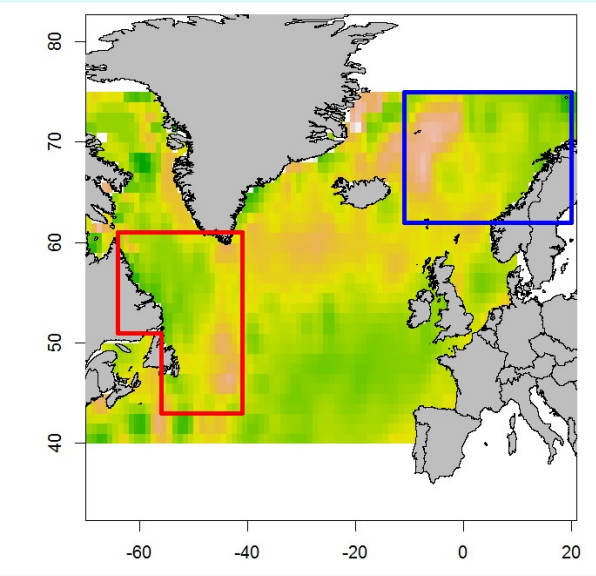
Evaluate hypotheses regarding the role of environmental factors in Space-Time domains in accordance with migration routes

Do survival correlates with proxies of trophic conditions

Transition habitat - Specific to each SU
Late spring - early summer



Foraging habitat- Shared by all SU / CSG
Late summer - fall



	Specific – late spring, early summer	**SST** **PP**	**6%** **3%**
→	Shared – late summer, fall	SST PP	20% 15%

Olmos et al. 2020

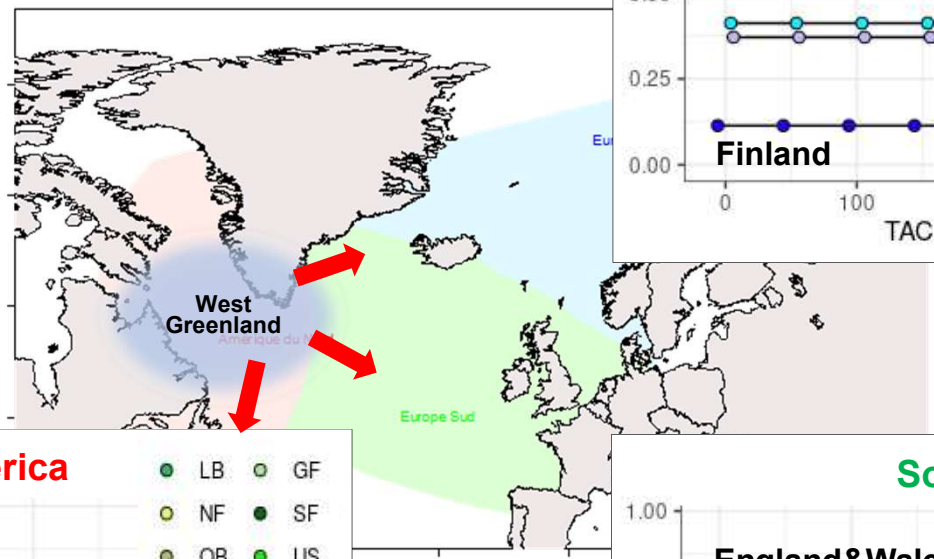
Evaluate catch options for mixed stock fisheries

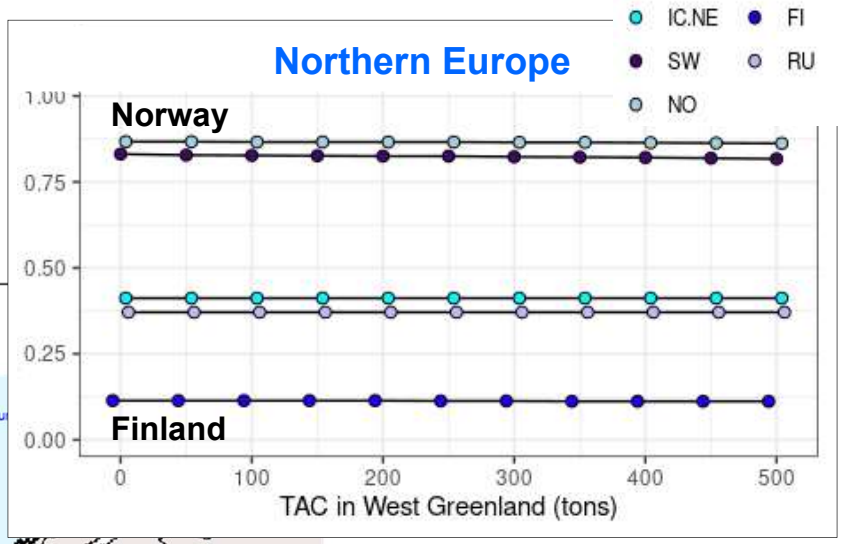
West Greenland fishery
6 years projection 2022 → 2027

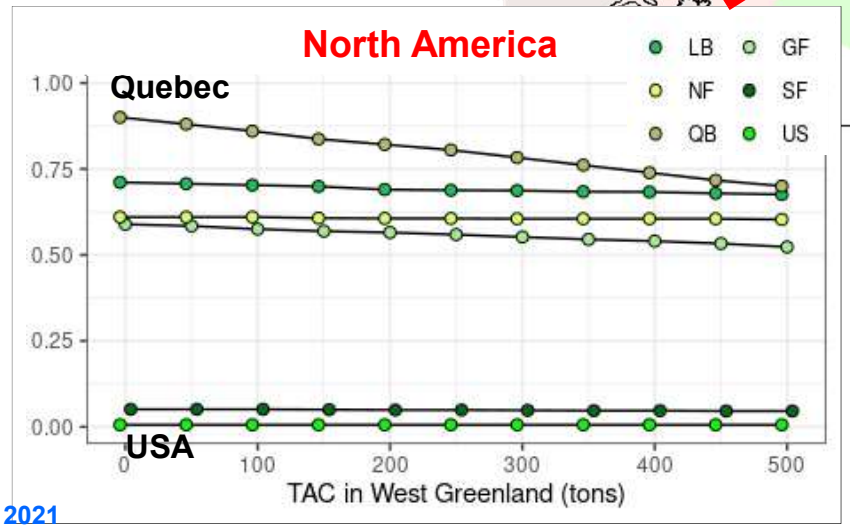
P(eggs deposition > CL)

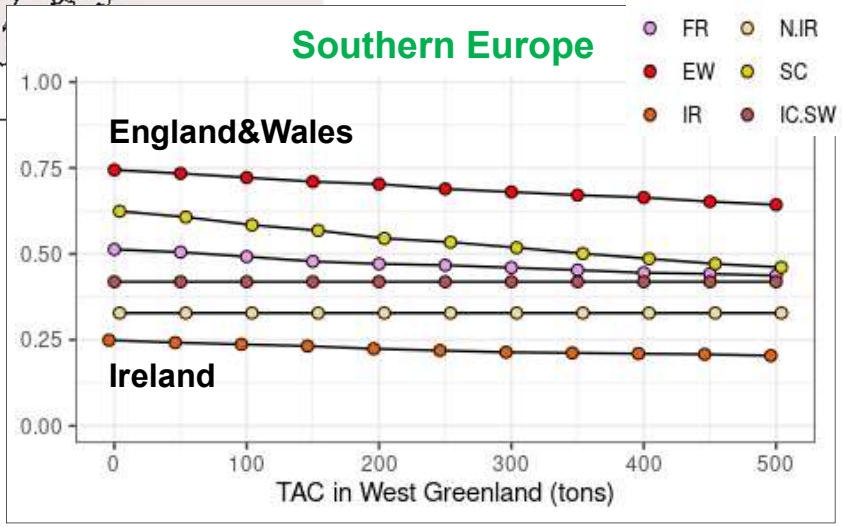
➔ ICES recommend 0 catches quotas at WG Greenland

(only subsistence fishery allowed)









Rivot, Patin et al., 2021

A stage-based population model
for population dynamics and stock assessment
in the North Atlantic Bassin

We need data and models at the scale of index rivers to improve mechanisms

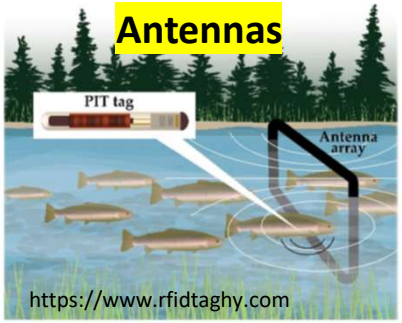
Population survey & individual data on index rivers

- 5 Index rivers

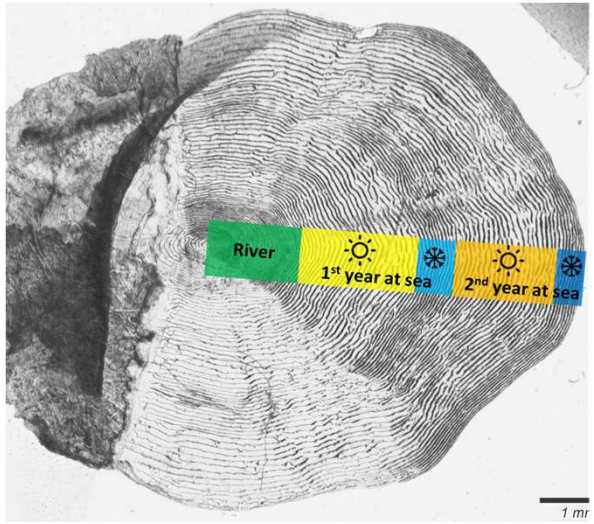
- Population survey
  Abundance smolts, & adults (returns)

Mark-Recapture

Antennas



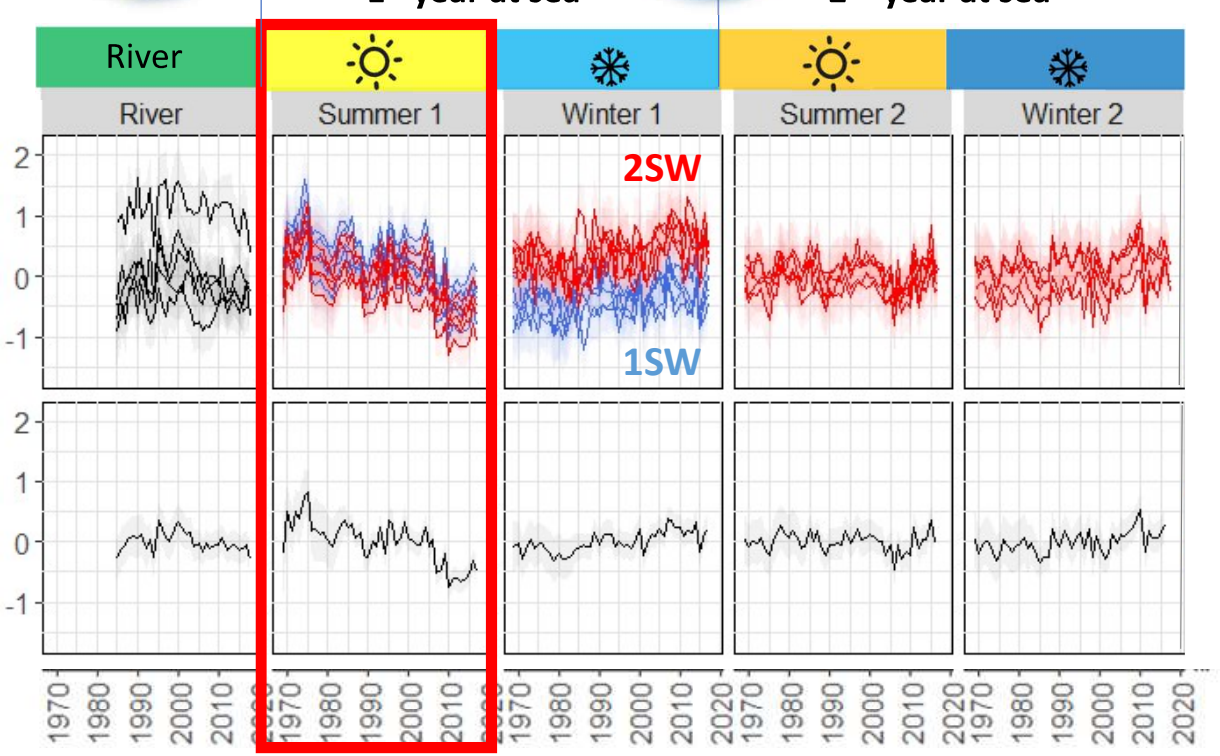
- Scales collection (> 9000 fish)
- Scale reading (growth)



Molecular sexing

Gregory et al., 2019
Simmons et al., in prep.
Tréhin et al., in prep.

Growth at sea reveals major ecosystem changes



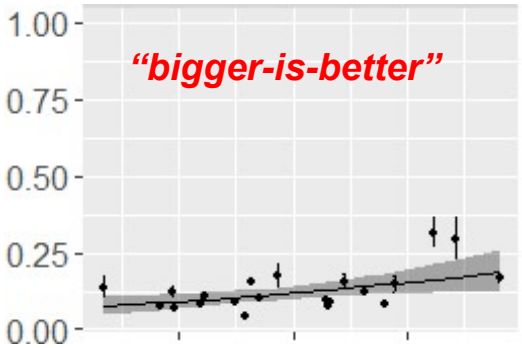
Tréhin *et al*, in prep.

- Growth during the first summer at sea has significantly declined (1970-2020)
- Decline is synchronous among the 5 rivers
- Consistent with other pop. in Europe
  - Scotland (Todd et al. 2021)
  - Norway (Vollset et al., 2022)
- Reinforces the hypothesis of a response to major changes in the Norvegian Sea ecosystem

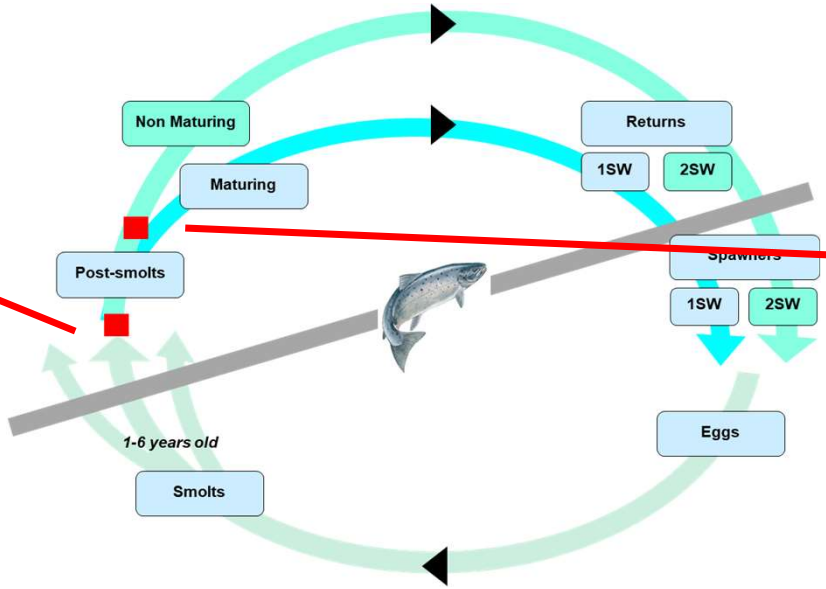
Survival and maturation controlled by size/growth

Tréhin *et al*, in prep.

Post-smolt survival increases with the size at smolt migration

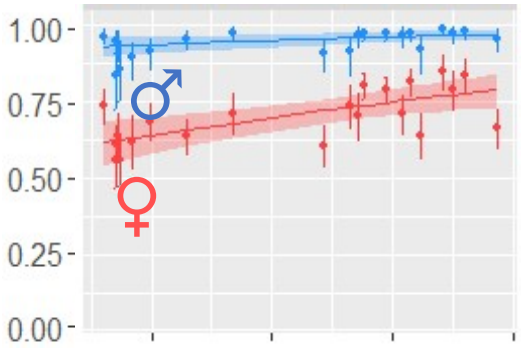


Size of smolt at migration



Tréhin et al., in prep
Gregory et al., 2019
Simmons et al., in prep.

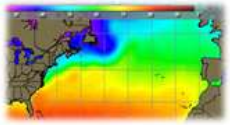
Probability to mature as 1SW increases with body size after the first summer at sea



Body size at the end of first summer at sea

Take home messages

Towards a better understanding of the marine phase



- **Stage-based population models: a framework to improve on understanding of the mechanisms that shape population dynamics and productivity**
  - Testing hypotheses on the role of environmental factors along the marine migration routes
  - Foster transfer of knowledge across scales (Pop → Complex of pop)
- **Combination of marine survival & maturation is critical to understand population dynamics and the influence of environmental variations**
- **Growth is one of the key**
  - "*Bigger is better*" - Marine survival (1st year at sea) depends upon smolts size
  - ↘ in growth at sea as a response to ↘ in quantity and quality of preys
  - ↘ in growth at sea delays sexual maturation

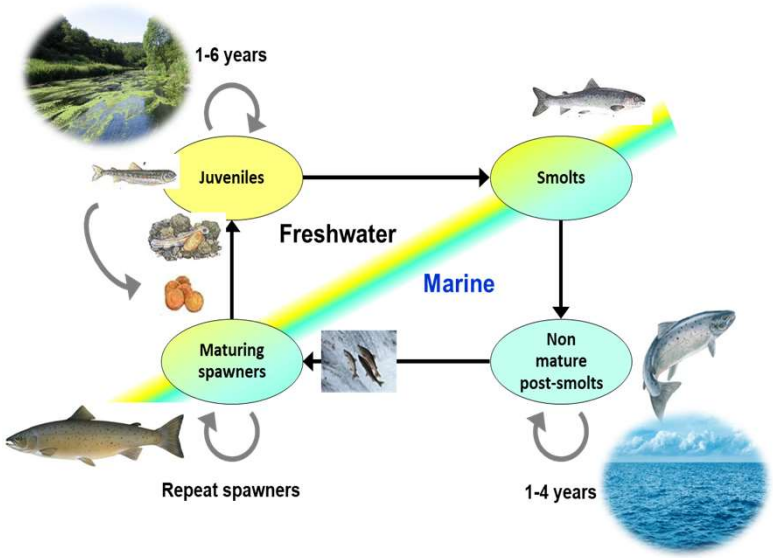
A benchmark for Atlantic salmon stock assessment

A life cycle model for population dynamics at the scale of the N. Atlantic Basin

- **A route toward embedding stock assessment and management within an ecosystemic approach** (Olmos et al. 2019,2020; Colin et al. in press)
- **An expandable framework that allows additional information to be assimilated**
  - Fosters improvement of the data mobilization and collection in every jurisdictions

➔ ICES WGNAS Benchmark process initiated in 2022

Help prioritize future research



- Improve understanding of the **marine migration** from natal rivers to feeding ground and back **to support future spatiotemporal-explicit hypothesis testing**
- Improve understanding of the **energy flow** through the North Atlantic ecosystem and how **changing energy densities of preys may be altering salmon growth, survival and maturation**
- Investigating on the **interactions between freshwater and marine phase**
- Investigating the role of **genetic adaptation**

Thank you !