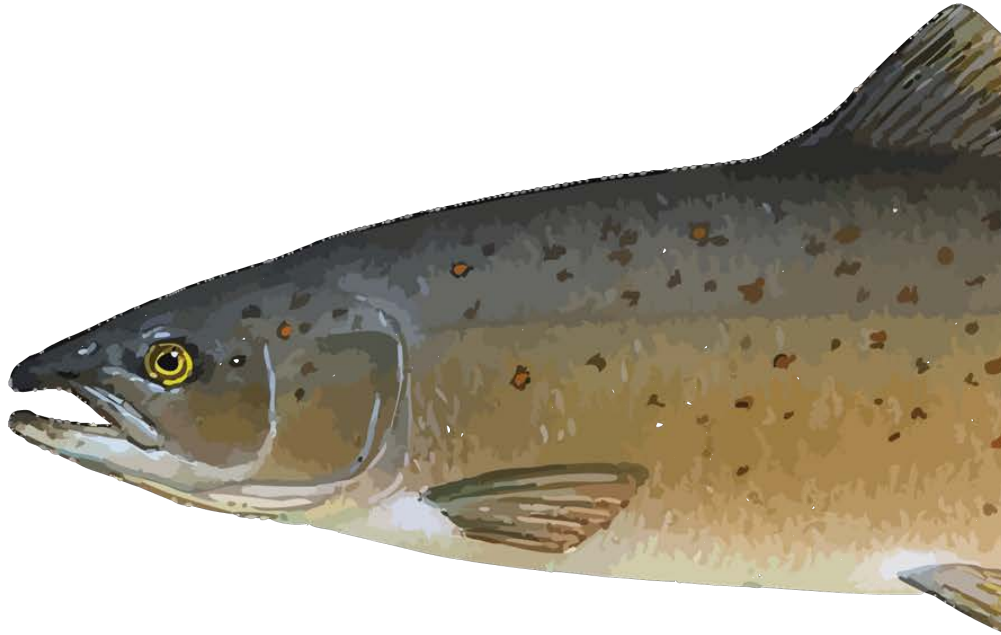
Can we predict the fate of Atlantic salmon populations in the face of climate change?



Mathieu BUORO
UMR 1224 ECOBIOP, St Pée s/ Nivelle

RÉPUBLIQUE FRANÇAISE
Liberté Égalité Fraternité

INRAE

UNIVERSITÉ DE PAU ET DES PAYS DE L'ADOUR

Atlantic salmon threats

Emblematic and threatened species
Poikilotherm and cold water species
→ France: southern edge of species distribution

Atlantic salmon threats

Emblematic and threatened species
Poikilotherm and cold water species
→ France: southern edge of species distribution
→ Strongly impacted by dams

Nivelle, France

Atlantic salmon threats

Emblematic and threatened species
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→ Selective exploitation

Atlantic salmon threats

Emblematic and threatened species
Poikilotherm and cold water species
→ France: southern edge of species distribution
→ Strongly impacted by dams
→ Selective exploitation
→ Climate Change

Original pic from http://www.wiseass.org/

Atlantic salmon threats

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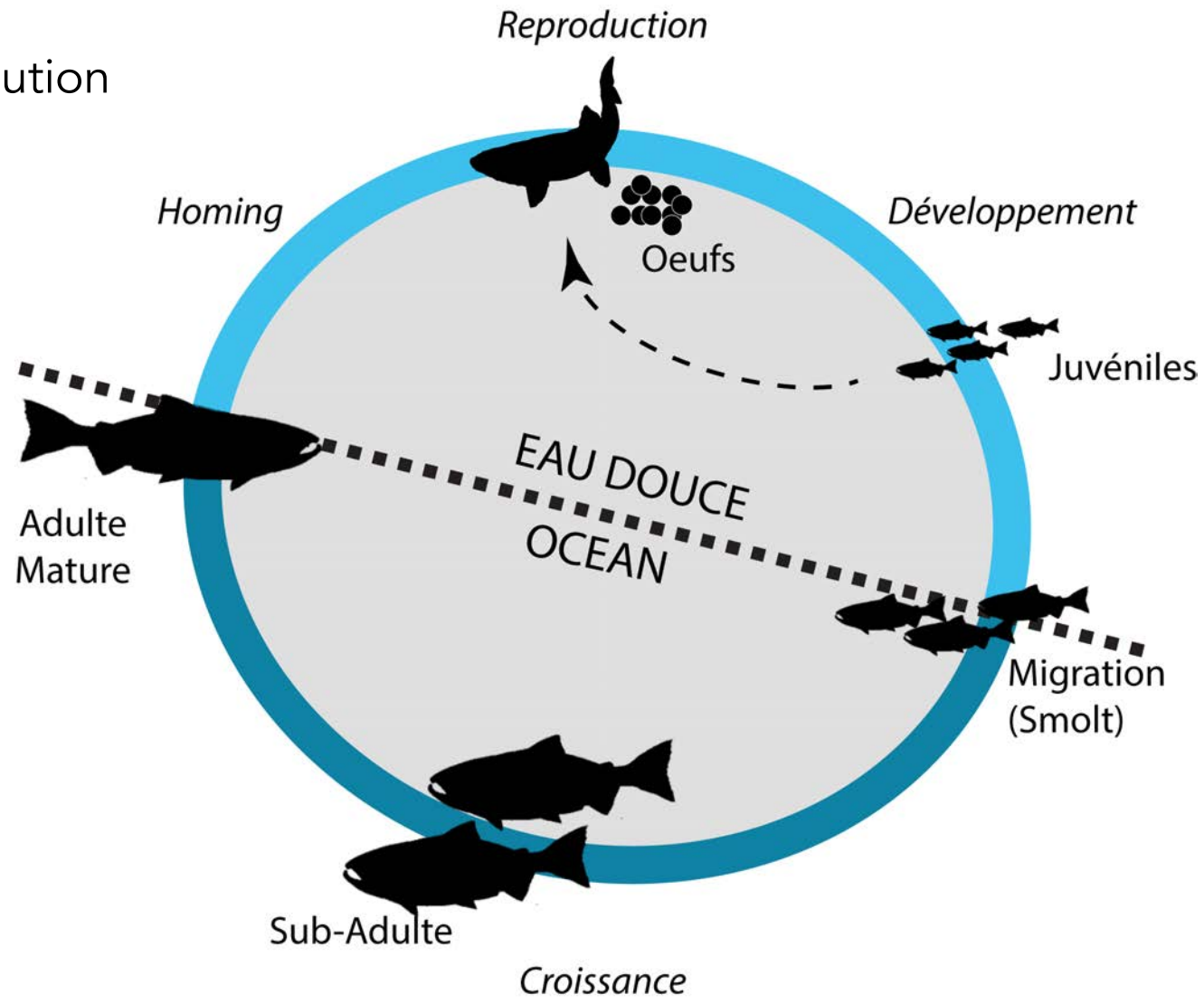
→ Climate Change

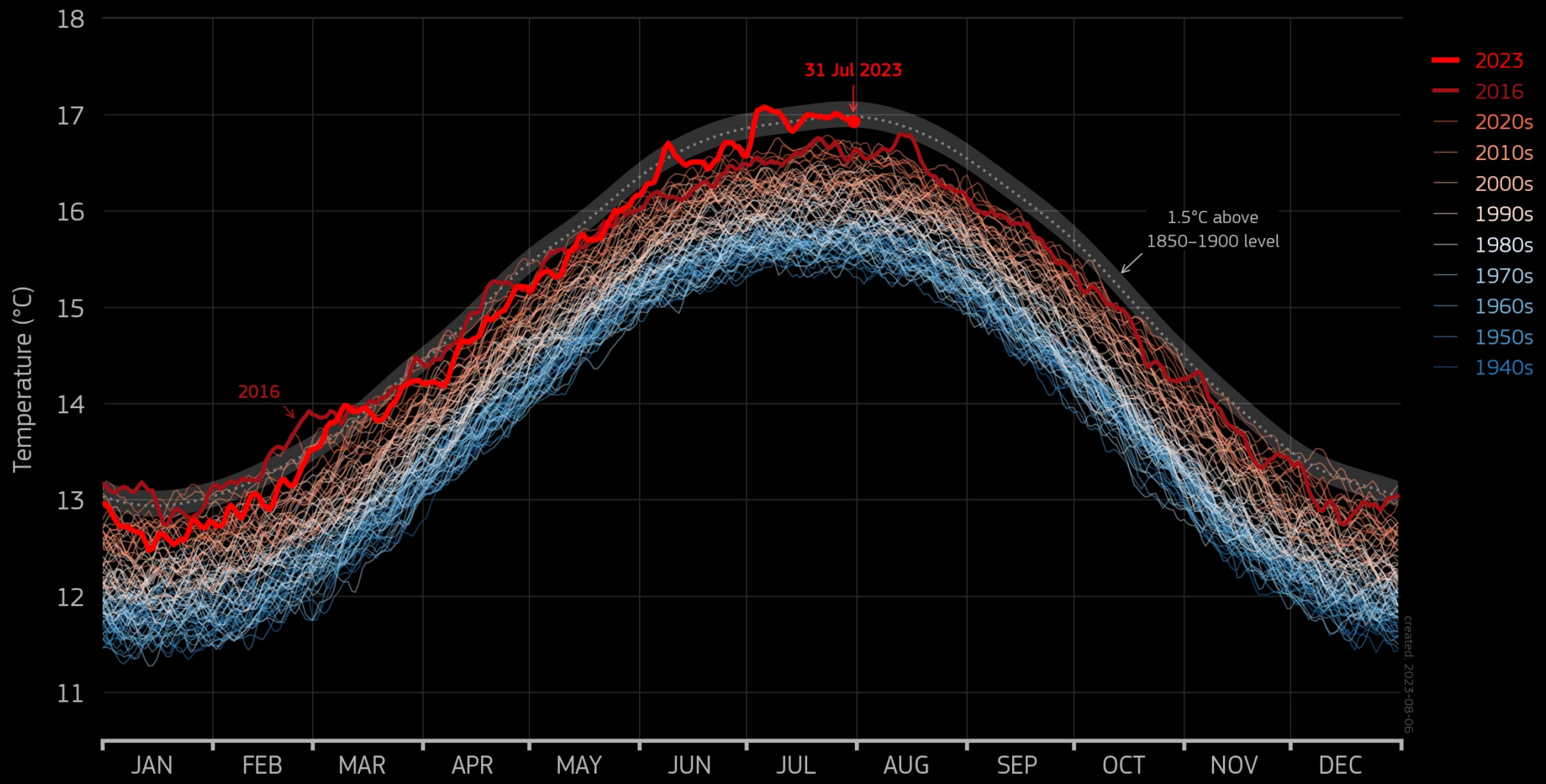


DAILY SURFACE AIR TEMPERATURE

Data: ERA5 1940–2023 • Credit: C3S/ECMWF

Climate Change Service

climate.copernicus.eu



PROGRAMME OF THE EUROPEAN UNION

Copernicus Europe's eyes on Earth

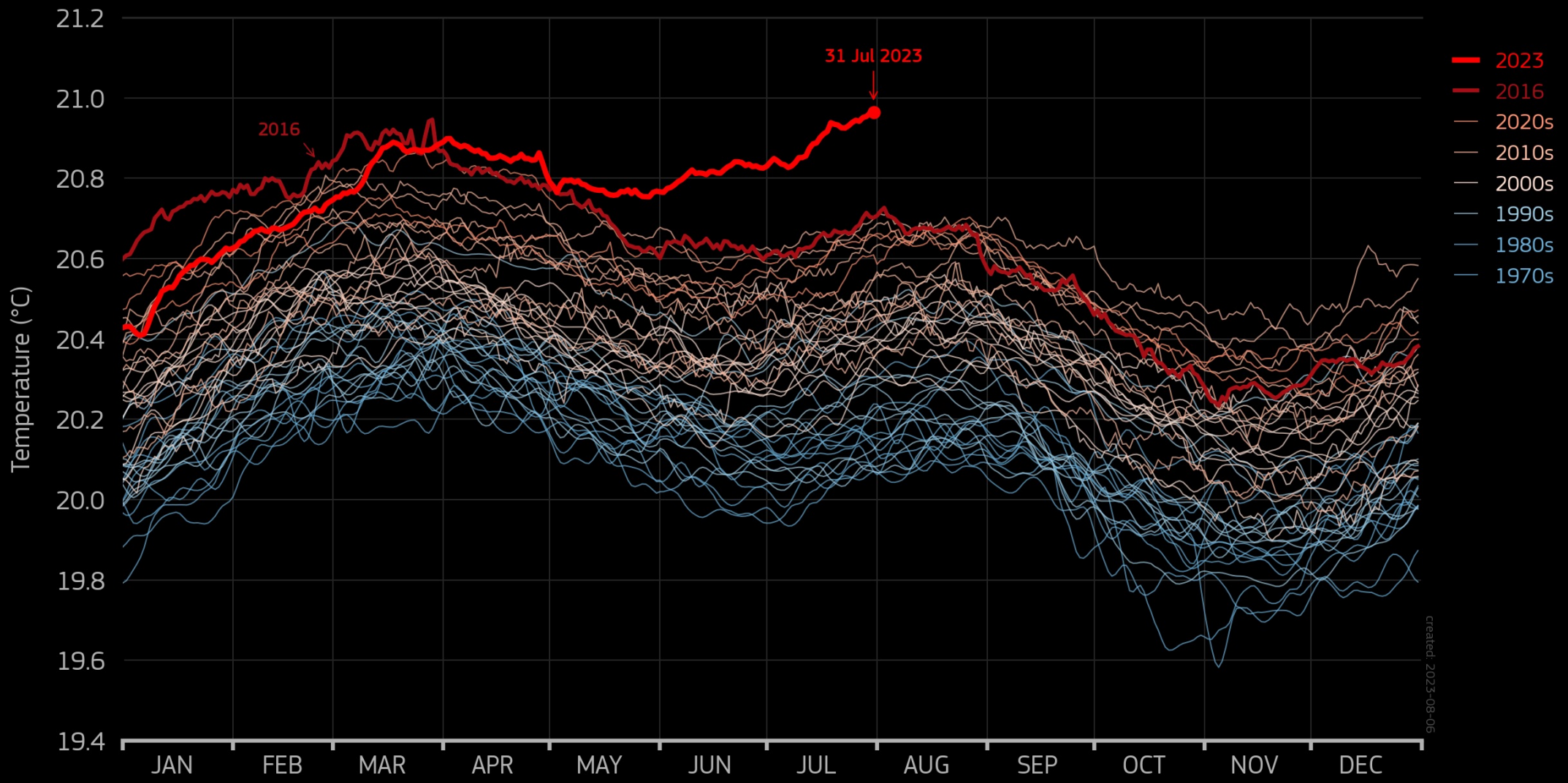
IMPLEMENTED BY ECMWF

DAILY SEA SURFACE TEMPERATURE 60°S–60°N

Data: ERA5 1979–2023 • Credit: C3S/ECMWF

Climate Change Service

climate.copernicus.eu



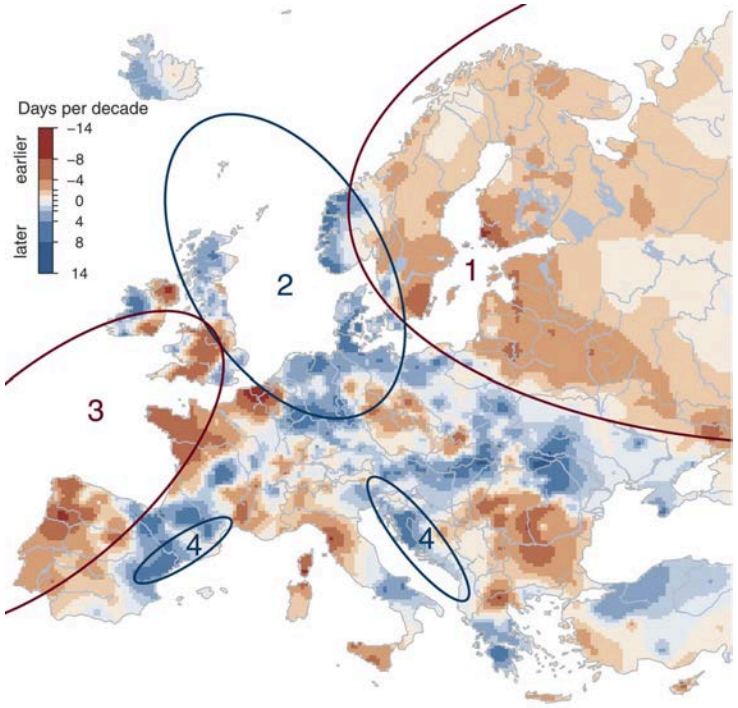
PROGRAMME OF THE EUROPEAN UNION

Copernicus Europe's eyes on Earth

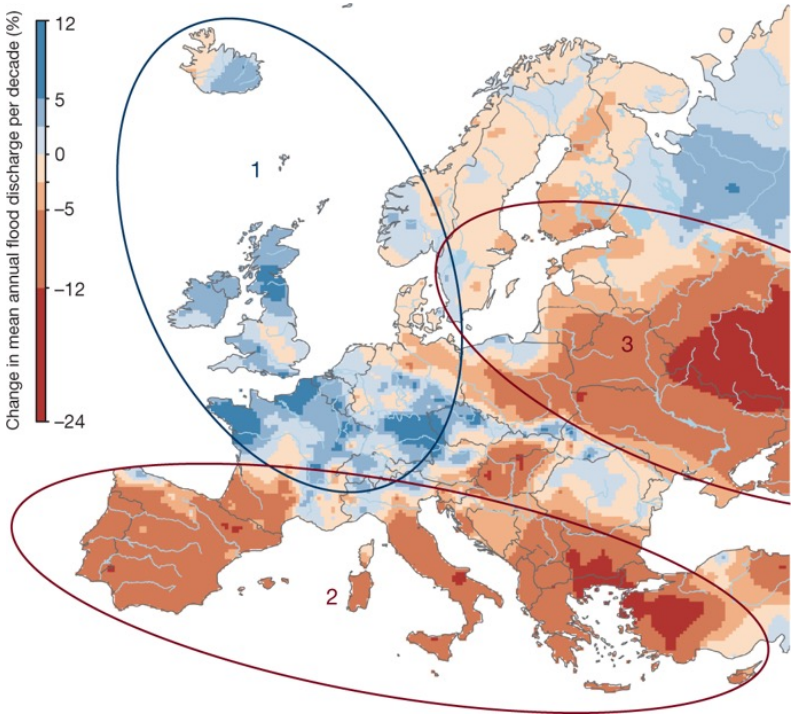
IMPLEMENTED BY ECMWF

Atlantic salmon threats

Emblematic and threatened species
Poikilotherm and cold water species
→ France: southern edge of species distribution
→ Strongly impacted by dams
→ Selective exploitation
→ Climate Change & Extreme climatic events



Blöschl et al *Science* 2017

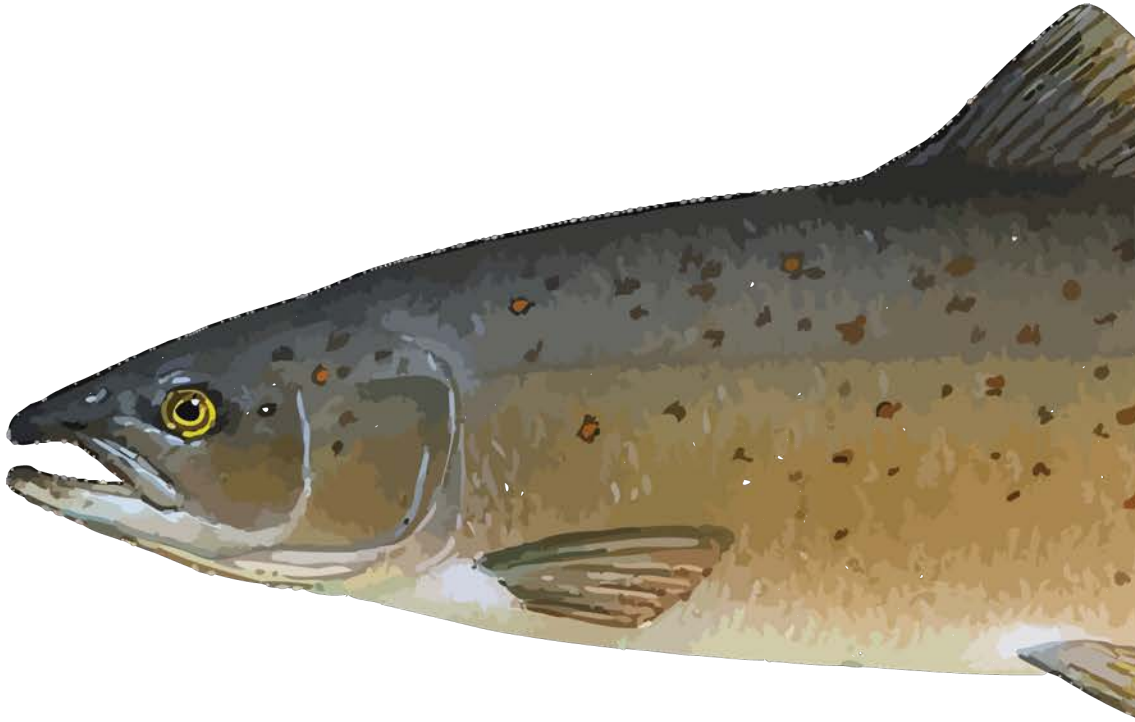


Blöschl et al *Nature* 2019

Objectives

How Atlantic salmon populations will cope with climate change?

Evaluate adaptation capacity to climate change and management practices to foster stability and resilience of populations



How to cope with environmental changes?

Its **vulnerability** will depend on :

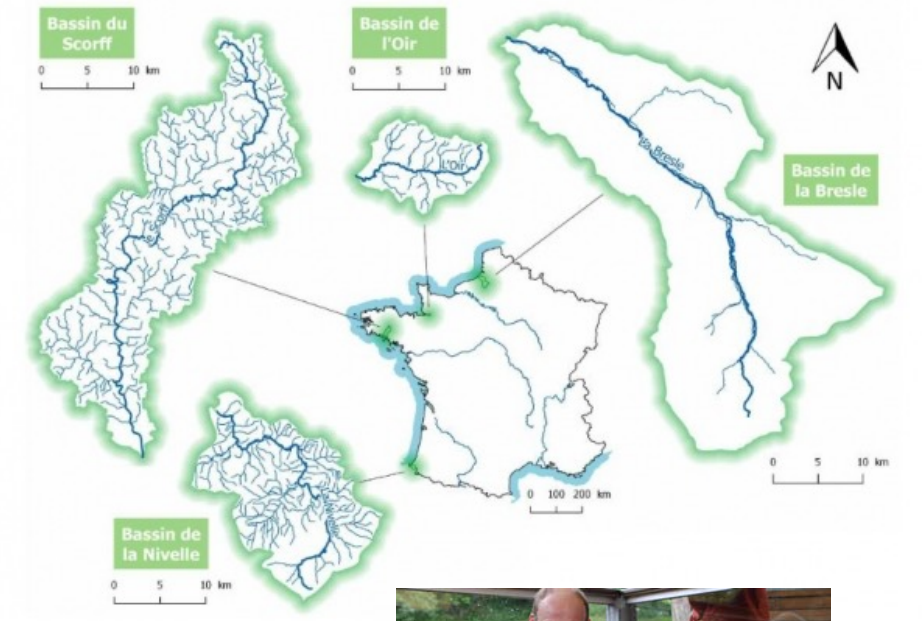
1) **SENSITIVITY** : the species' ability to **adapt**
   - Phenotypic plasticity (e.g. timing of migration, thermal refugee,…)
   - Genetic adaptation
   - Dispersal

Assessing ecological & evolutionary processes and mechanisms!!!

Understanding how populations work

Diadromous Fish in Coastal Rivers Observatory

https://diapfc.hub.inrae.fr



Long-term monitoring and marking

“Le saumon aux 4 saisons”

changement clim YouTube

Understanding how populations work

Diadromous Fish in Coastal Rivers Observatory

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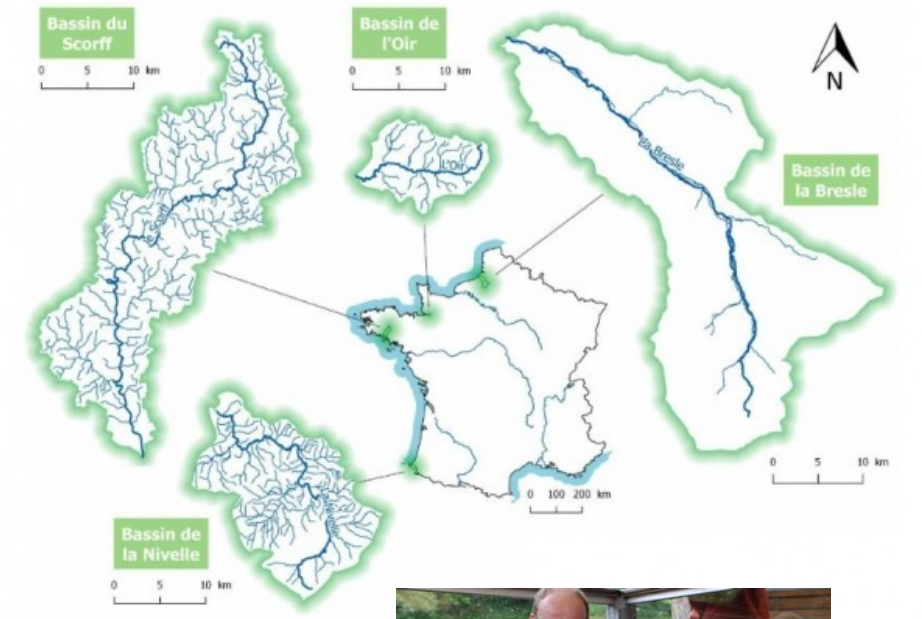


Experimental channel

Metabolism & Energy

Long-term monitoring and marking

“Le saumon aux 4 saisons”

changement clim

YouTube

Inheritance

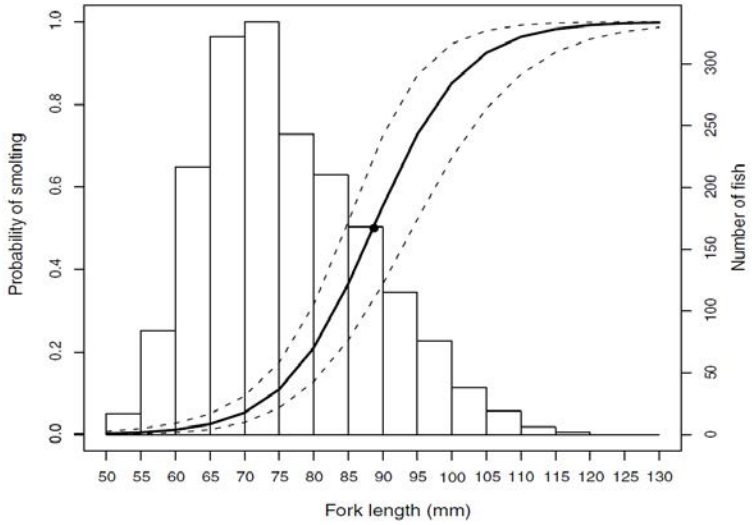
Understanding how populations work

ORIGINAL ARTICLE

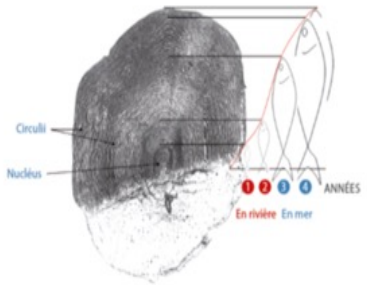
INVESTIGATING EVOLUTIONARY TRADE-OFFS IN WILD POPULATIONS OF ATLANTIC SALMON (*SALMO SALAR*): INCORPORATING DETECTION PROBABILITIES AND INDIVIDUAL HETEROGENEITY

Mathieu Buoro, Etienne Prévost and Olivier Gimenez

Buoro et al. 2010



River and sea ages depend on growth at sea



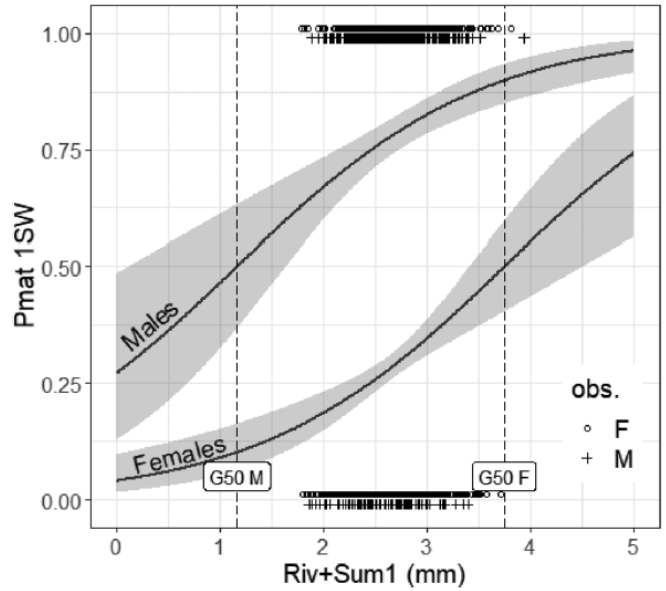
NRC Research Press

ARTICLE

Growth during the first summer at sea modulates sex-specific maturation schedule in Atlantic salmon

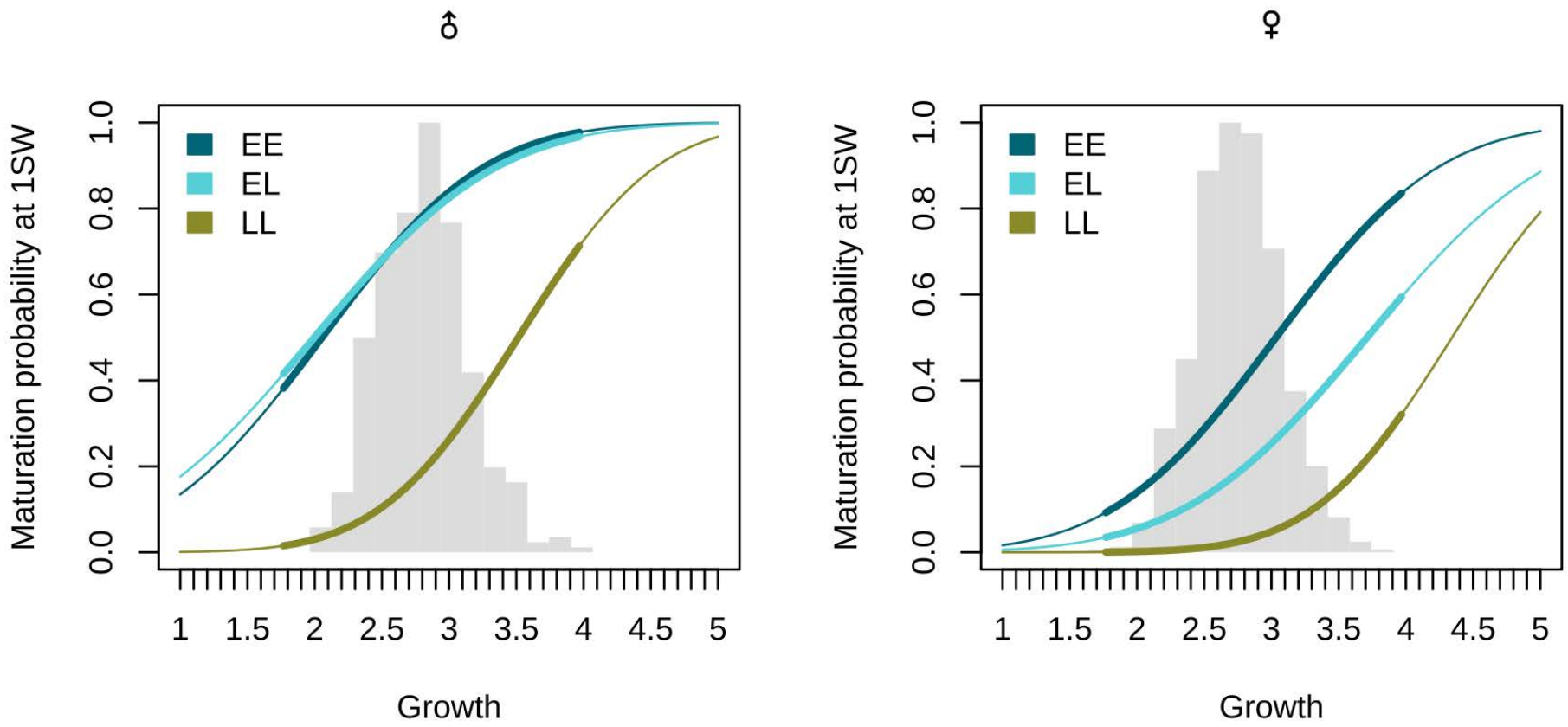
Cécile Tréhin, Etienne Rivot, Ludivine Lamireau, Lisa Meslier, Anne-Laure Besnard, Stephen D. Gregory, and Marie Nevoux

Trehin et al. 2020



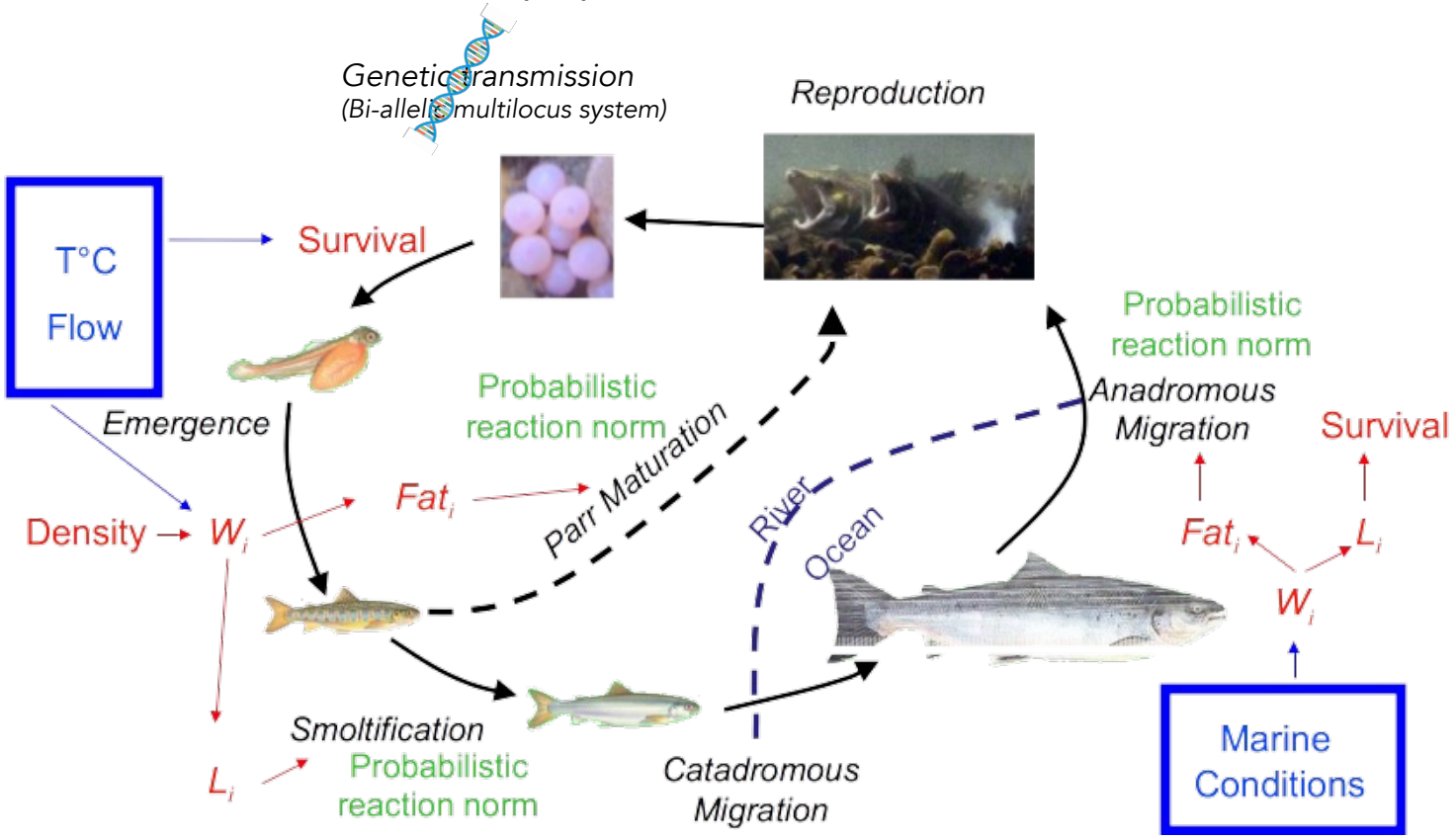
Understanding how populations work

Influence of genes on age at maturation (VGLL3)



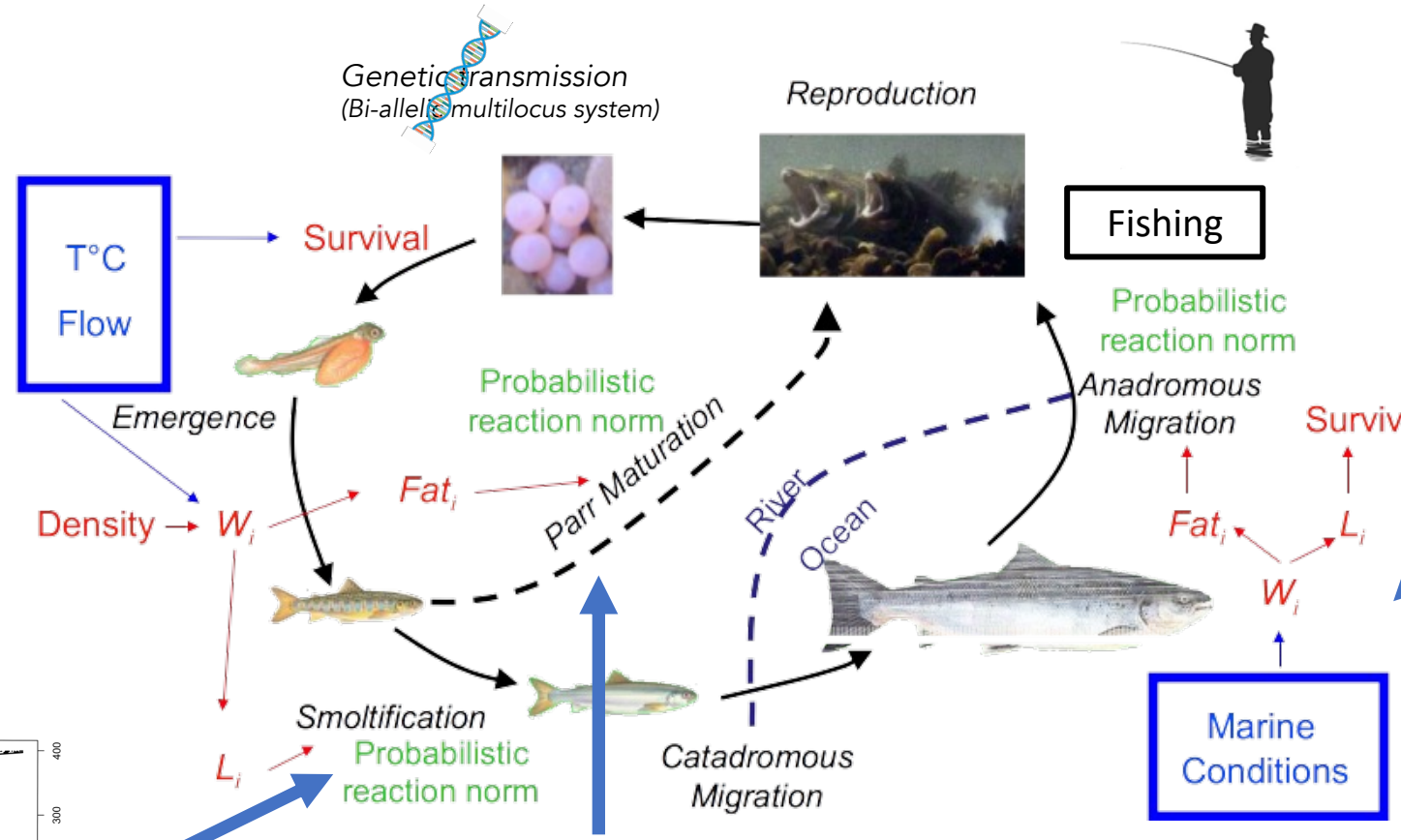
Understanding how populations work

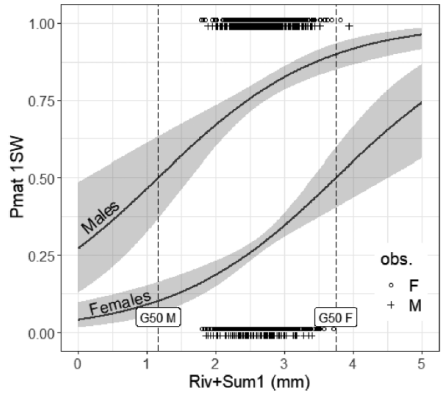
Individual Based SAlmon Model (IBASAM): virtual population to connect demo-genetic dynamics with biotic & abiotic factors (from genes to metapopulations)

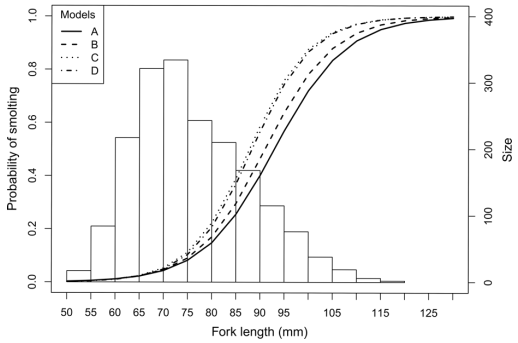


Understanding how populations work

Individual Based SAlmon Model (IBASAM): Incorporates the knowledge available to date







SCIENTIFIC REPORTS

OPEN

Genetic architecture of threshold reaction norms for male alternative reproductive tactics in Atlantic salmon (*Salmo salar* L.)

Received: 23 September 2016
Accepted: 25 January 2017
Published: 10 March 2017

Olivier Lepais, Aurélie Manicki, Stéphane Glise, Mathieu Buoro & Agnès Bardonnet

How to cope with environmental changes?

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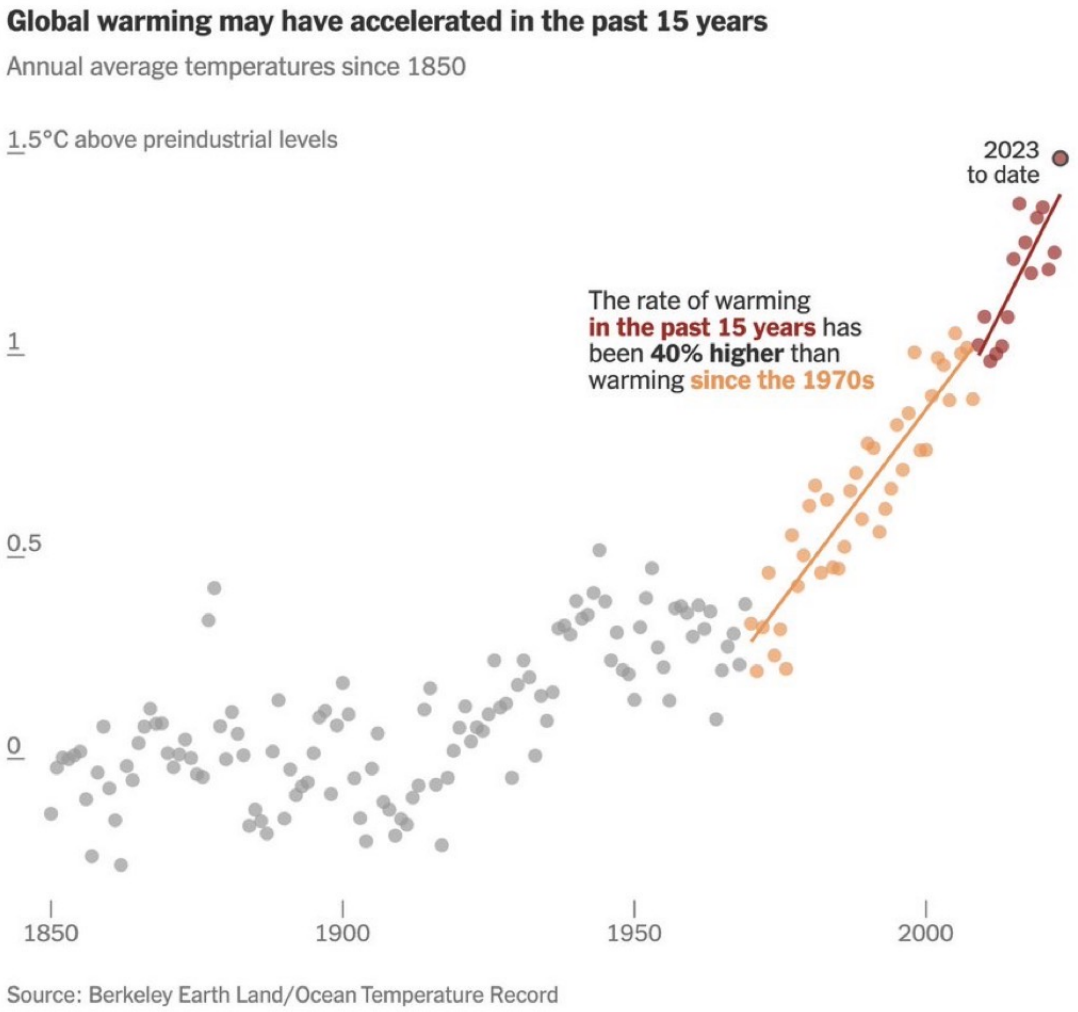
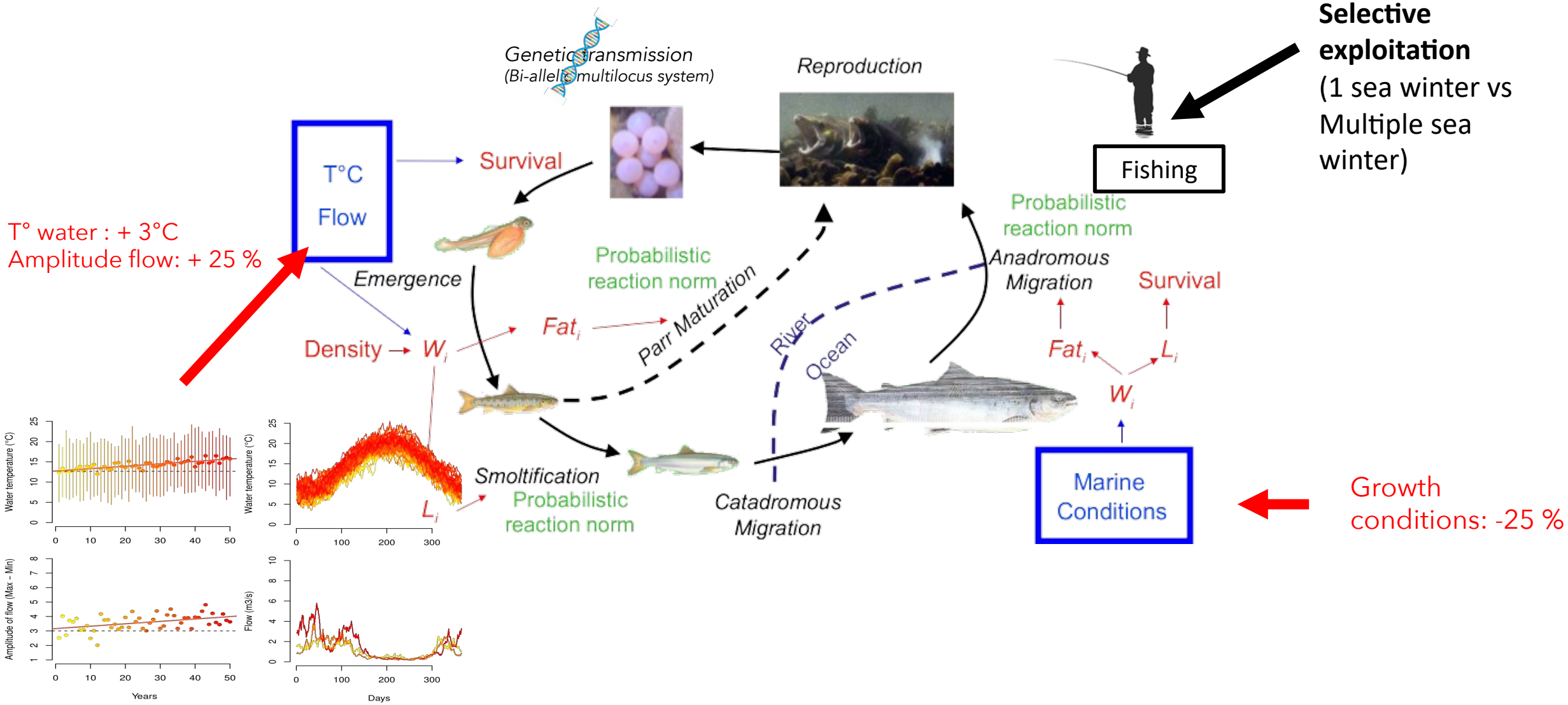
1) **SENSITIVITY** : the species' ability to **adapt**
   - Phenotypic plasticity (e.g. timing of migration, thermal refugee,…)
   - Genetic adaptation
   - Dispersal

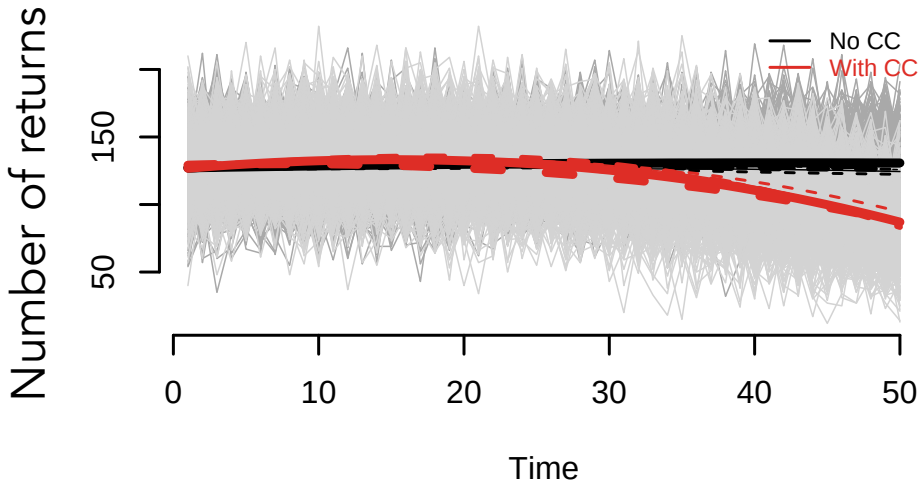
2) **EXPOSURE**: the intensity and speed of environmental change.

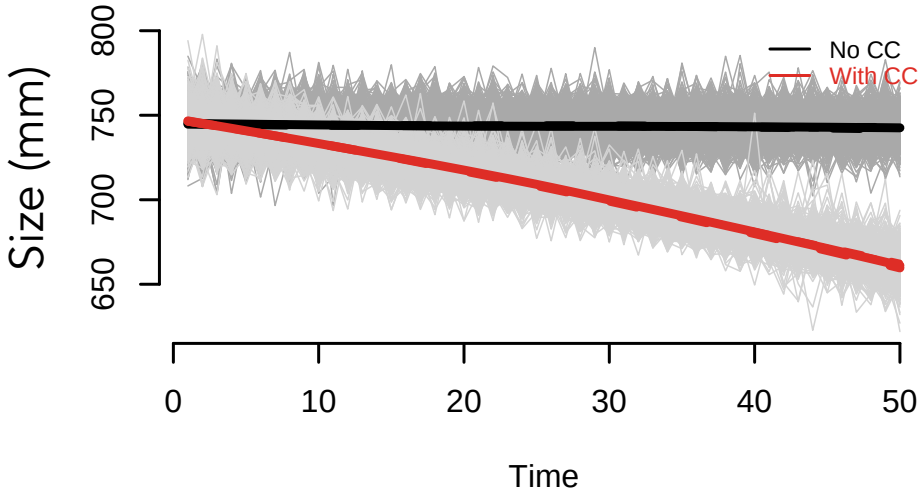


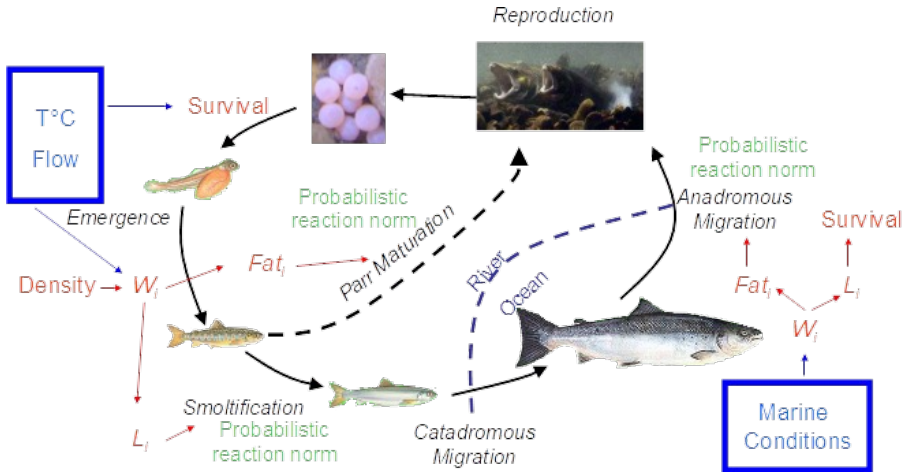
Prospective : Impacts of CC and selective fisheries



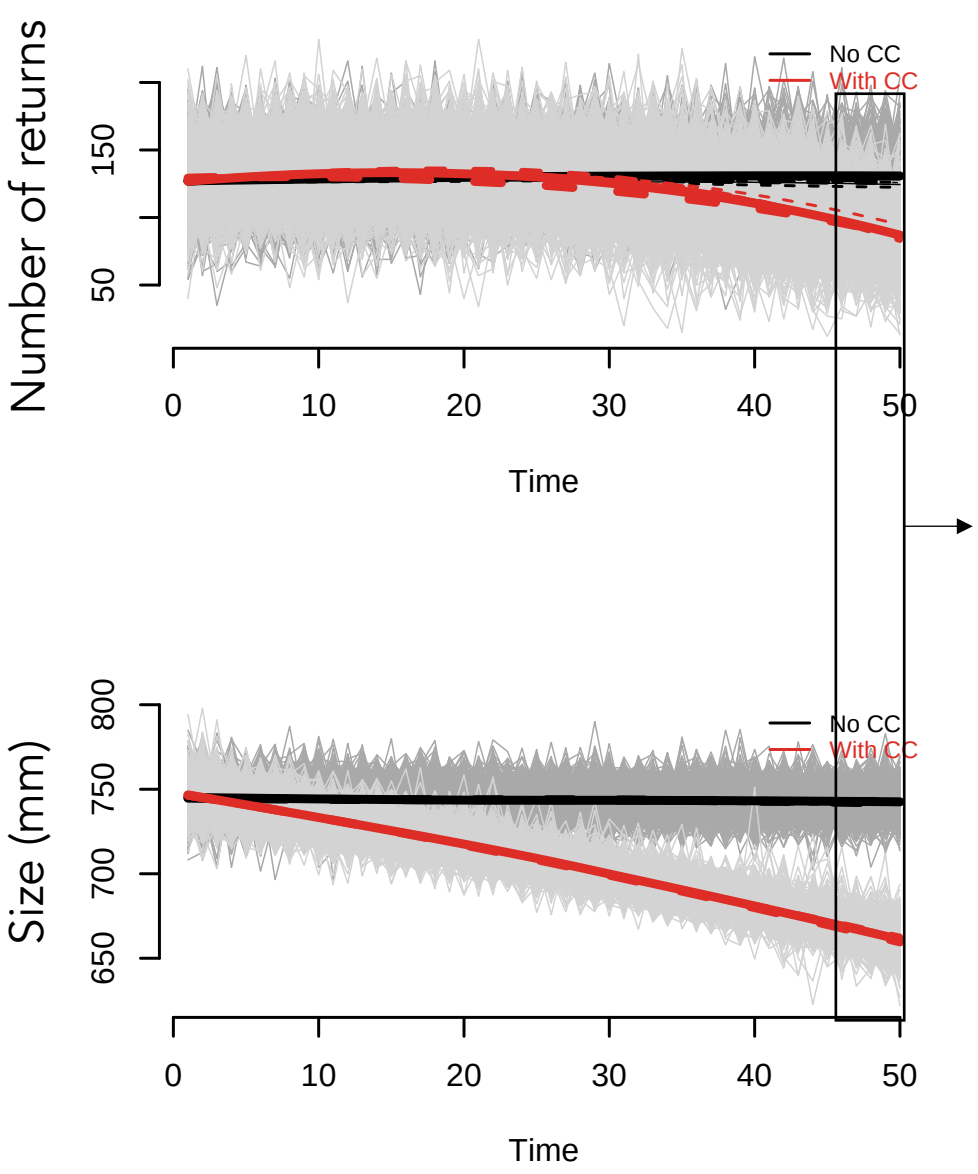
Prospective : Impacts of CC and selective fisheries

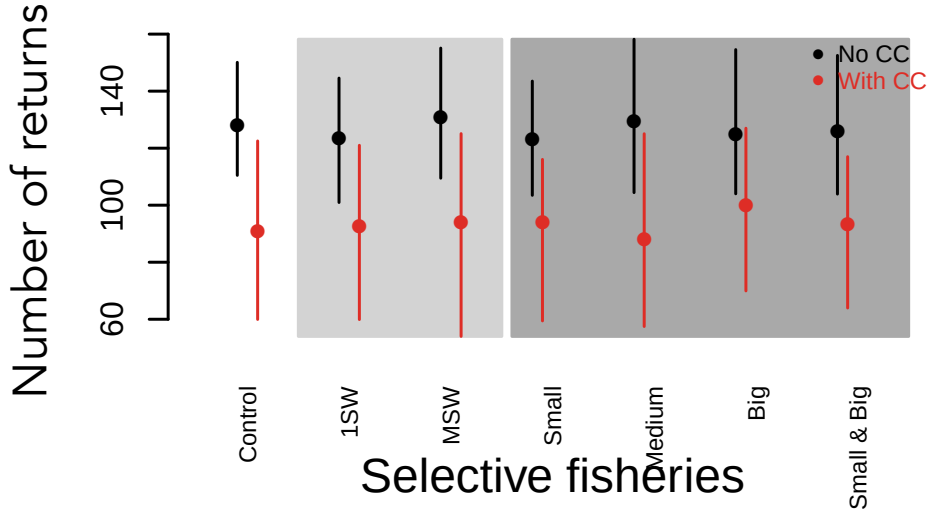




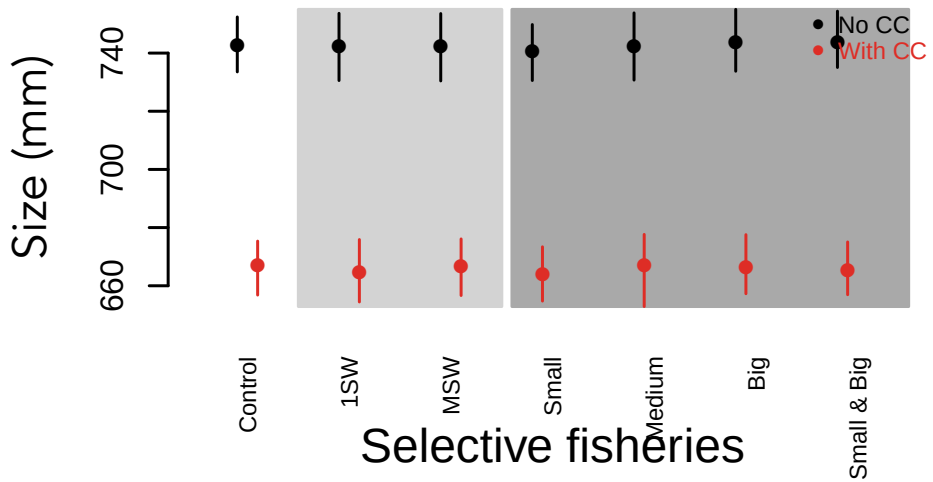


Prospective : Impacts of CC and selective fisheries





Decrease of abundance under CC



Decrease of body size (anadromous) under CC

Prospective : Impacts of CC

Global Change Biology

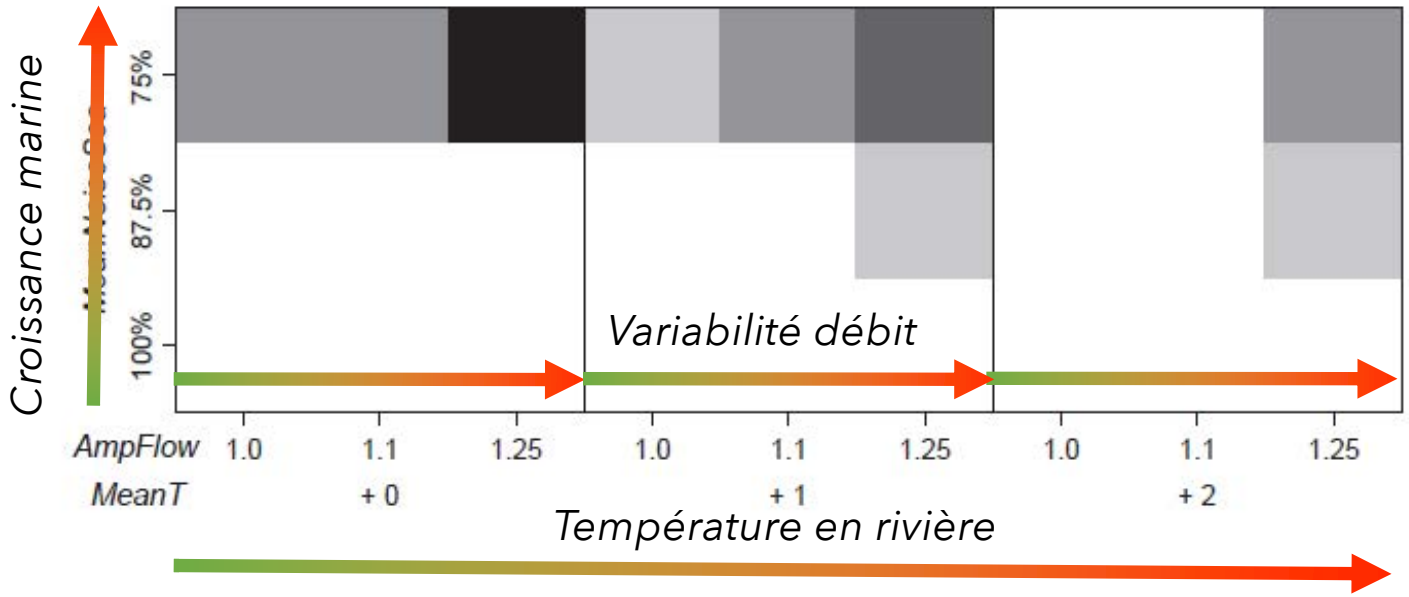
Global Change Biology (2013) 19, 711–723, doi: 10.1111/gcb.12085

Contrasting effects of climate change in continental vs. oceanic environments on population persistence and microevolution of Atlantic salmon

CYRIL PIOU*†‡ and ETIENNE PRÉVOST*†

*INRA, UMR 1224 ECOBIOP, Aquapôle, Quartier Ilarron, Saint-Pée sur Nivelle 64310, France, †Pau and Pays Adour University, UFR Sciences et Techniques Côte Basque, Campus Montaury, Anglet 64600, France, ‡CIRAD, UPR Bioagresseurs analyse et maitrise du risque, Montpellier F-34398, France

Risque d'extinction à 50 ans



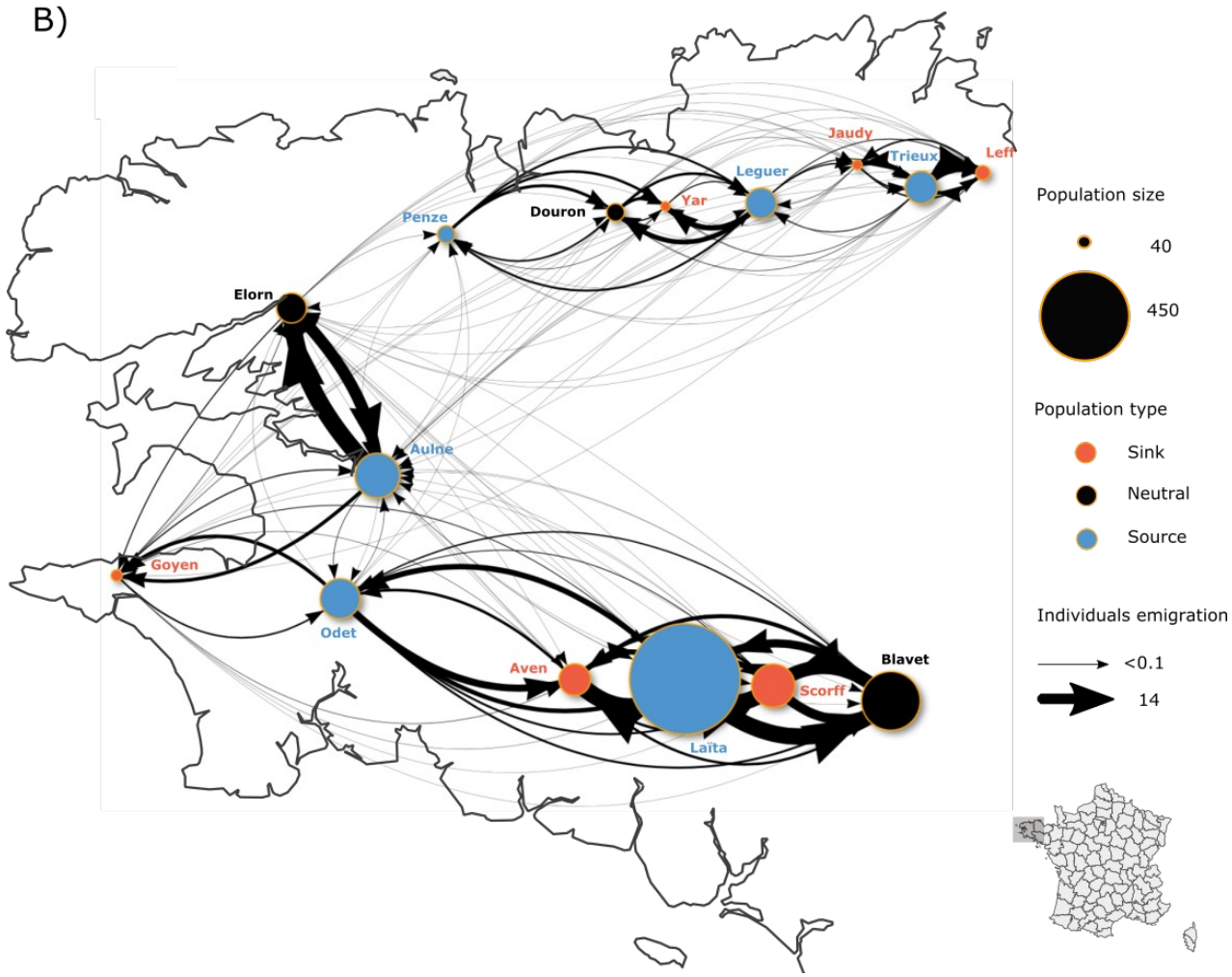
Adaptation network to face CC

Salmon populations **are not isolated**
– *Dispersal*

The dangers of ignoring metapopulation structure for the conservation of salmonids

Andrew B. Cooper
Quantitative Ecology and Resource Management
University of Washington
Box 357980
Seattle, Washington 98195-7980
E-mail address: andy@cqs.washington.edu

Marc Mangel
Department of Environmental Studies
and
Institute of Marine Sciences
University of California
Santa Cruz, California 95064



Lamarins et al. 2022, 2023

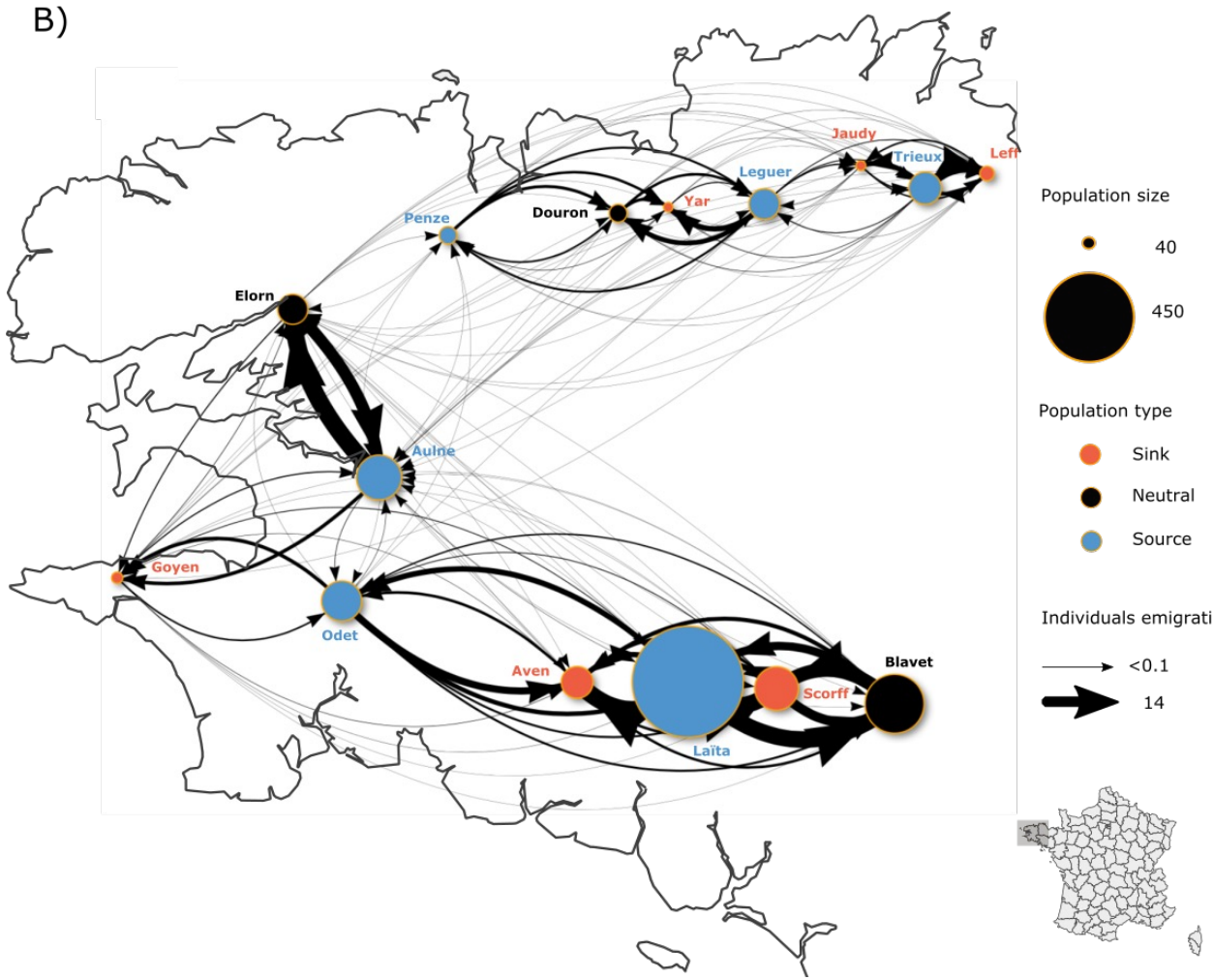
Adaptation network to face CC

Salmon populations **are not isolated** – *Dispersal*

Importance of diversity **within** and **between** populations – *Biocomplexity*

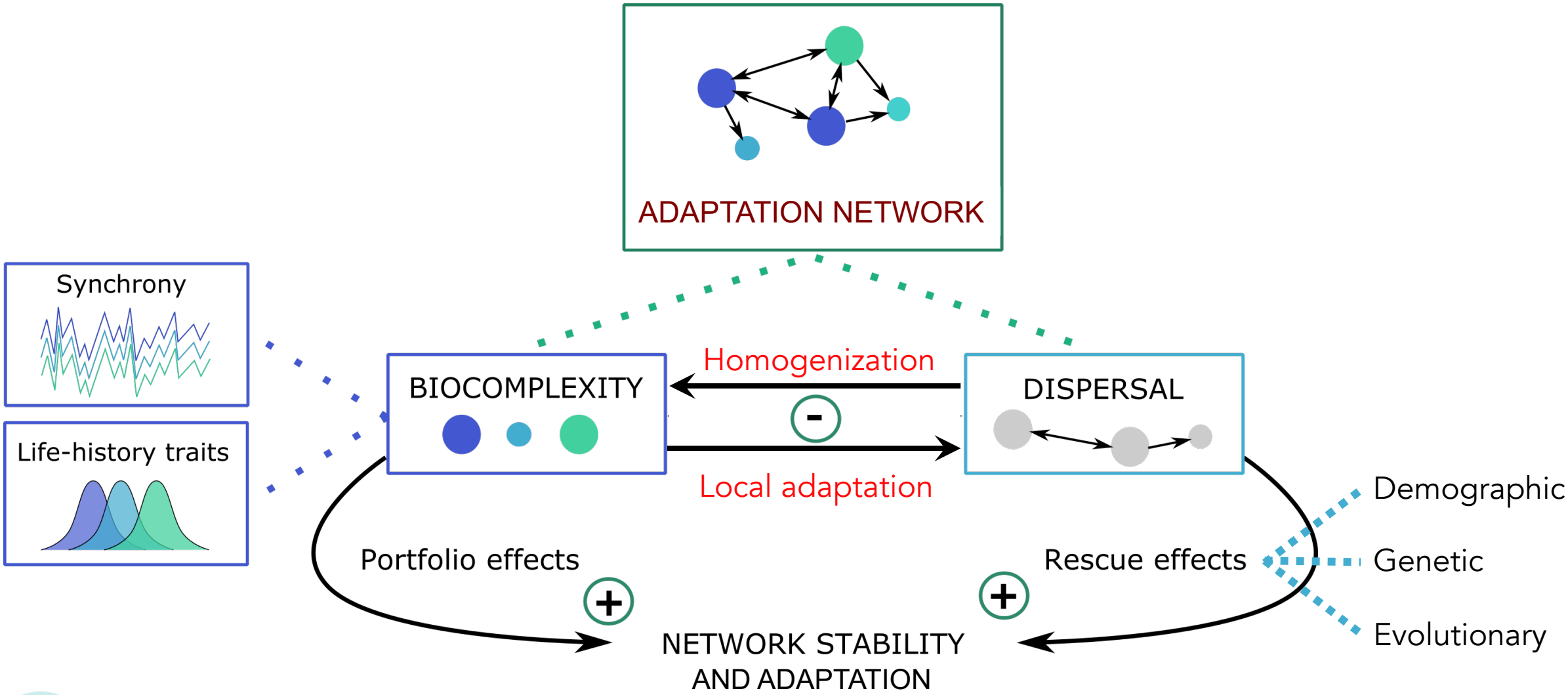
ADAPTATION NETWORK

Foster stability, persistence and adaption to environmental changes



Lamarins et al. 2022, 2023

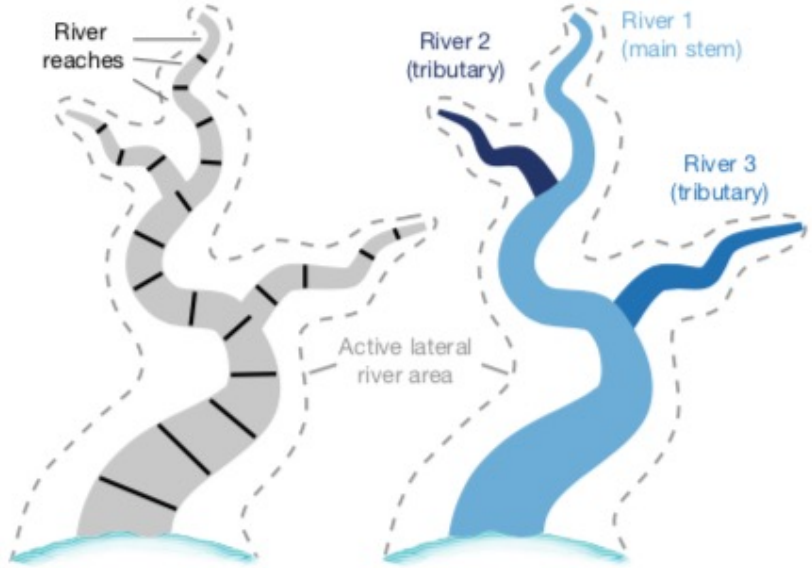
Adaptation network facing CC



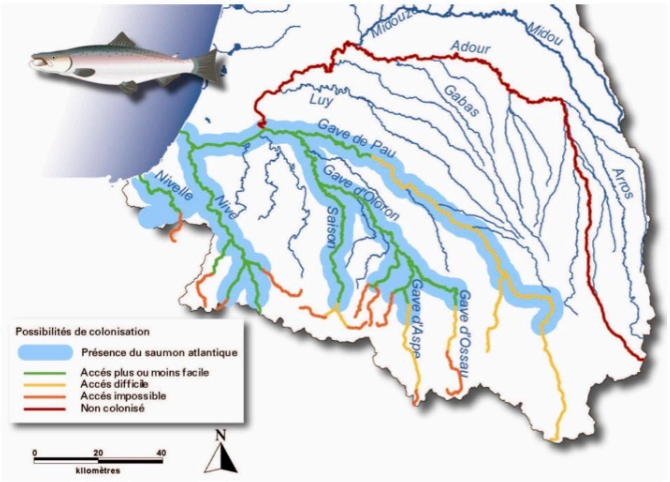
Lamarins et al. 2022, 2023

Ongoing & Future projects

IBASAM v2



Salmon Adaptation to Climate Change in the ADour and Basque coastal streams (SACCAD: 2024-2027)




Scorff river, Brittany, France

Thank you for your attention!

Acknowledgment
Amaïa Lamarins
Florèn Hugon
Clément Lebot
Cyril Piou
Etienne Prévost
Julien Papaïx
Stephanie Carlson

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