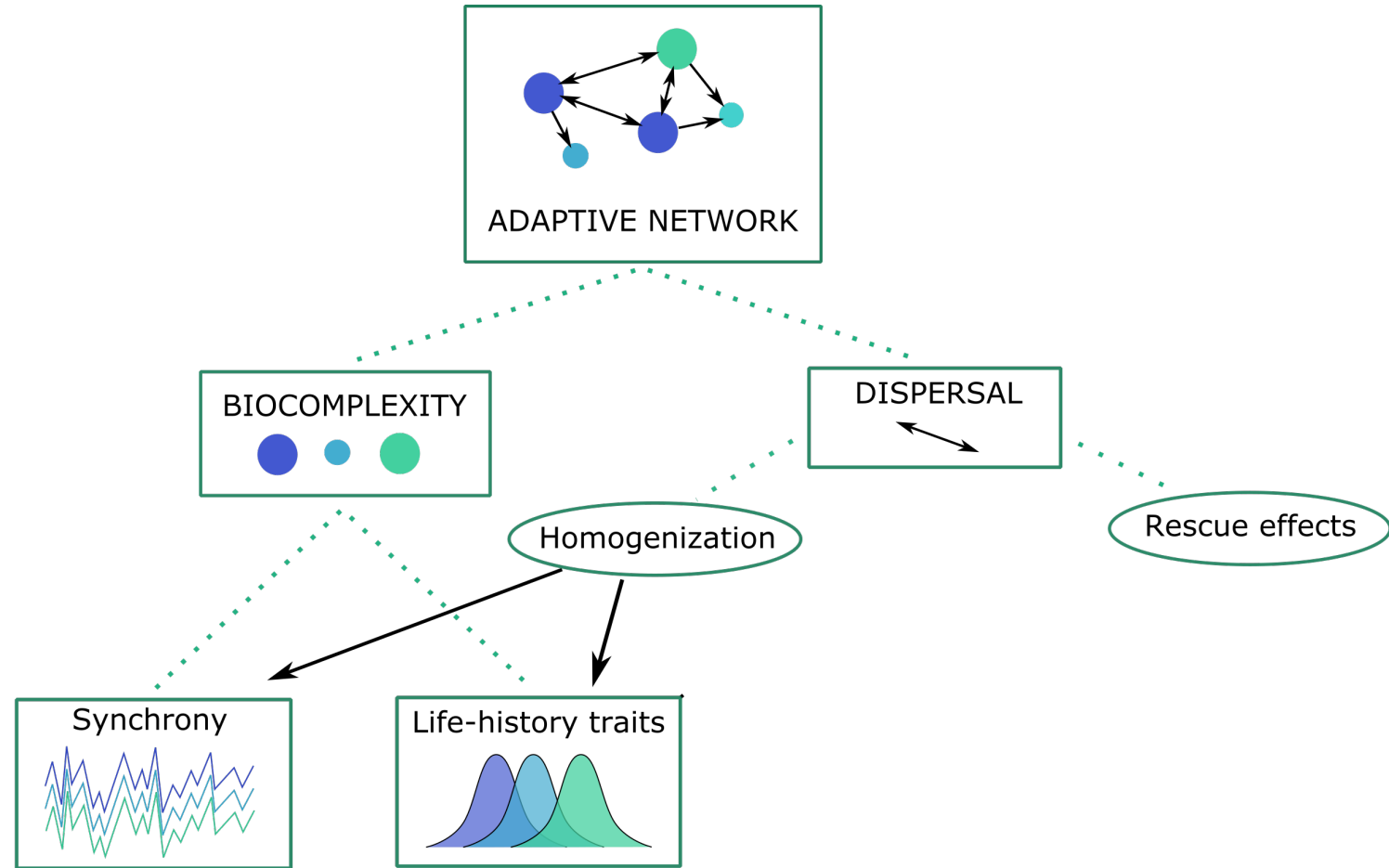




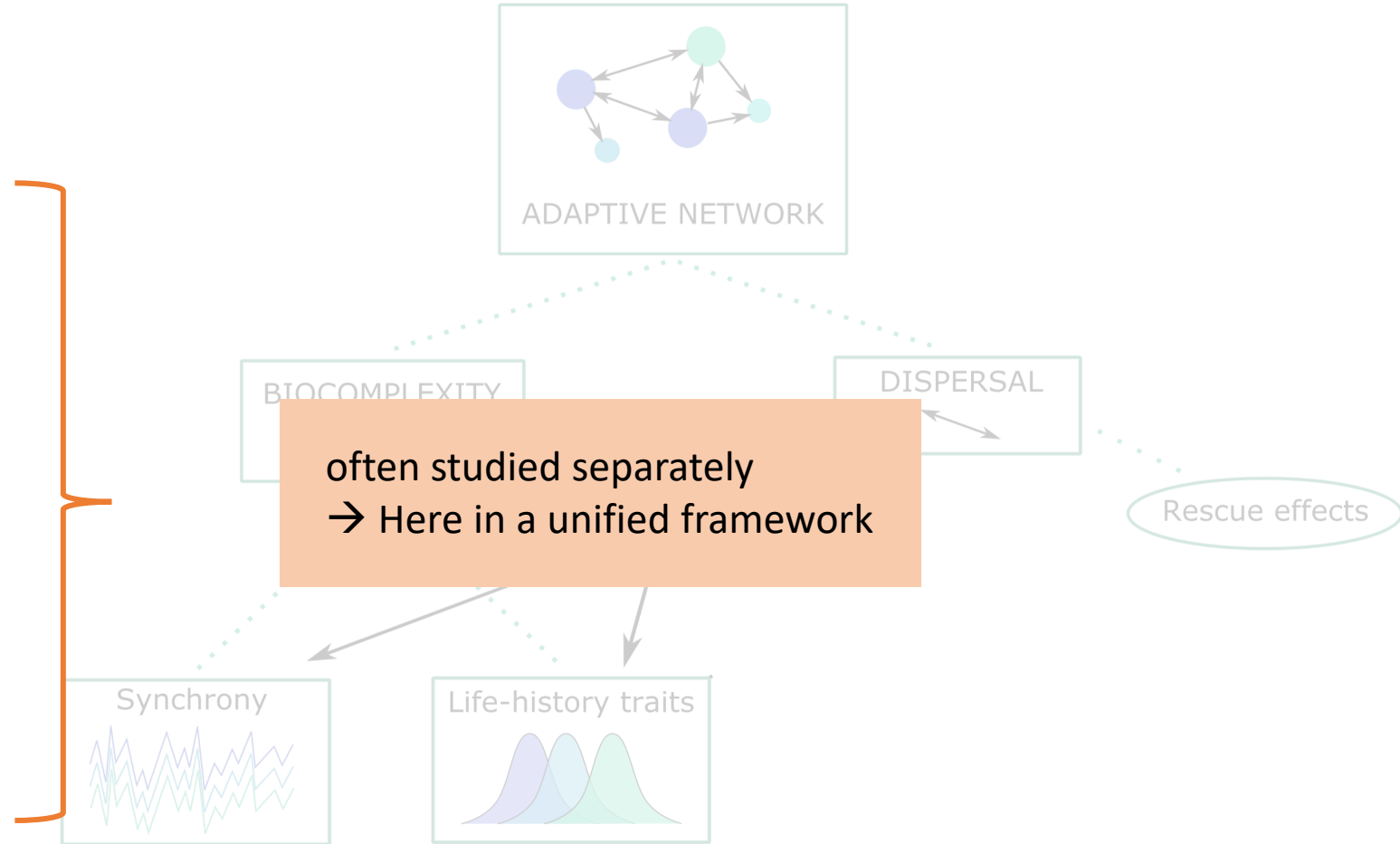
Working hypothesis:

- ① Populations biocomplexity provides network stability through asynchrony and adaptive potential (Portfolio Effect)
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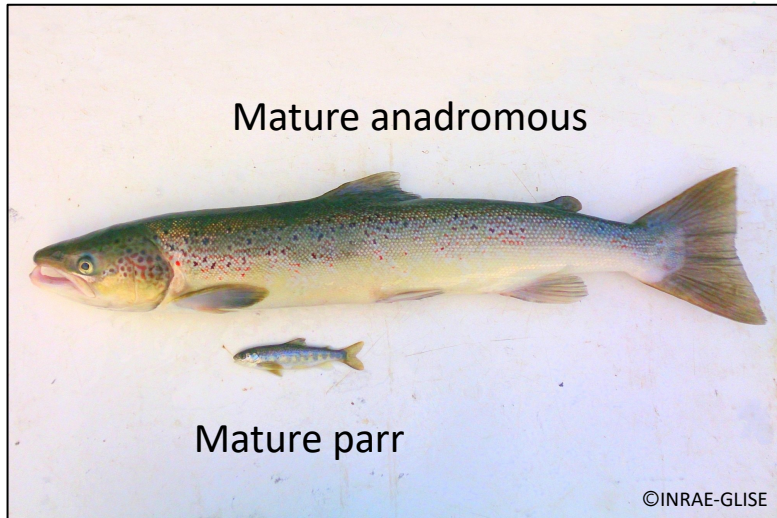




Atlantic salmon (*Salmo salar*)  
→ A good case of study



Homogenization



*Journal of Fish Biology* (2003) **62**, 641–657  
doi:10.1046/j.0022-1112.2003.00053.x, available online at <http://www.blackwell-synergy.com>

**Atlantic salmon straying from the River Imsa**

B. JONSSON\*, N. JONSSON AND L. P. HANSEN  
Norwegian Institute for Nature Research, Dronningensgt. 13, P. O. Box 736 Sentrum,  
N-0105 Oslo, Norway

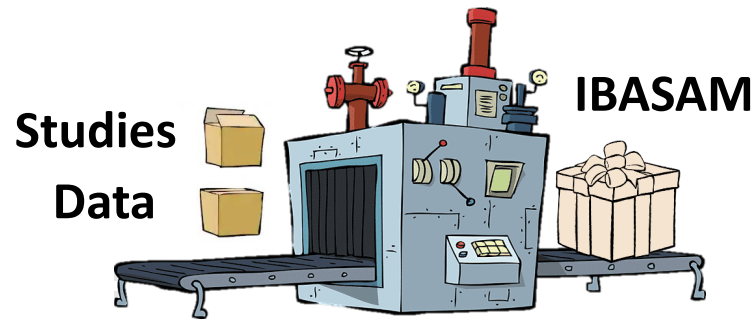
**A metapopulation perspective for salmon and other anadromous fish**

Nicolas Schtickzelle<sup>1,2</sup> & Thomas P. Quinn<sup>2</sup>

<sup>1</sup>Biodiversity Research Centre, Université Catholique de Louvain, 4 Place Croix du Sud, B-1348 Louvain-la-Neuve, Belgium; <sup>2</sup>School of Aquatic and Fishery Sciences, University of Washington, Box 355020, Seattle, WA 98195-5020, USA

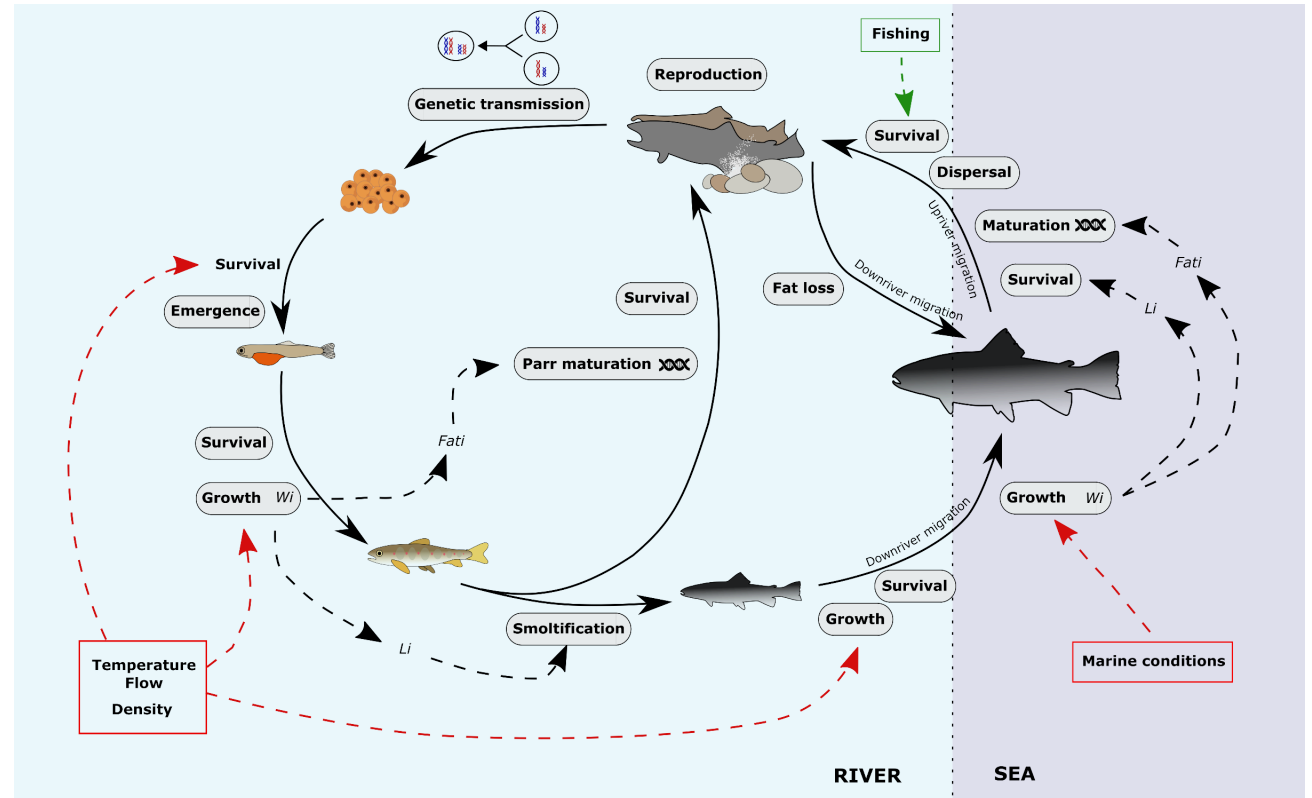
## IBASAM

Individual-Based Atlantic Salmon Model  
: a demo-genetic individual-based model for a single population (Piou & Prévost 2012)



### ■ Eco-evolutionary processes:

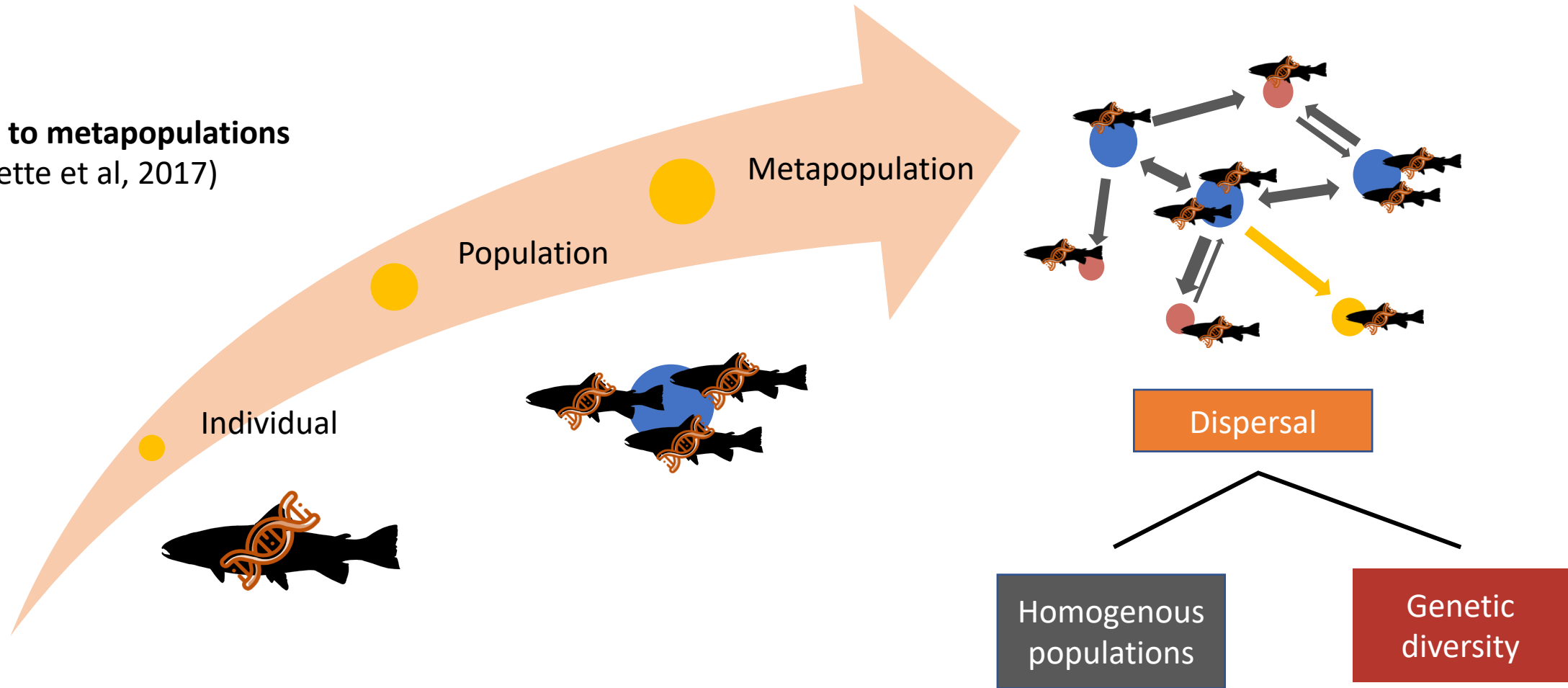
- Environmental effects
- Phenotypic plasticity
- Genetic adaptation
- Dispersal



IBASAM

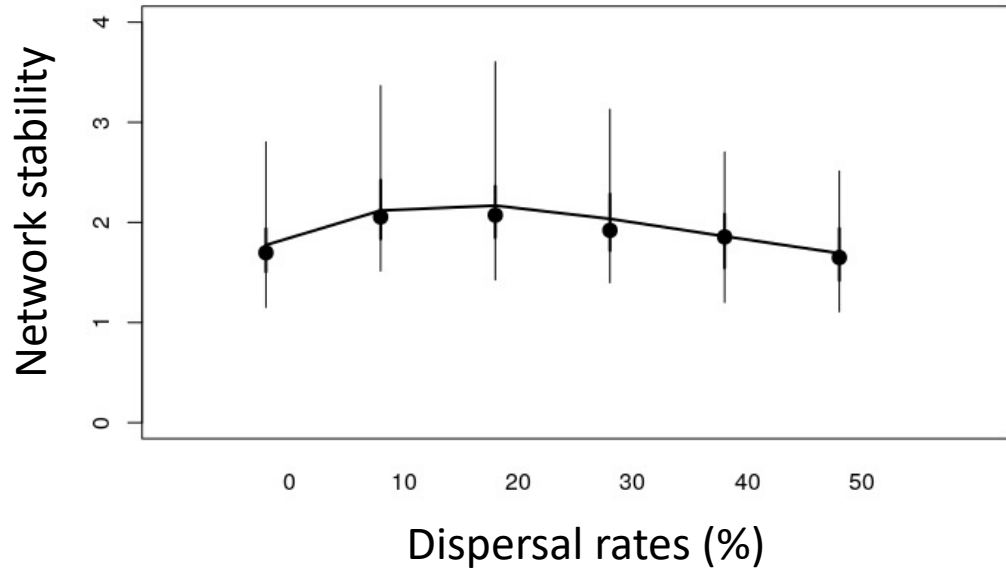
Individual-Based Atlantic Salmon Model  
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From genes to metapopulations  
(Baguette et al, 2017)



# RESULTS

## Populations network stability and Evolutionary rescue

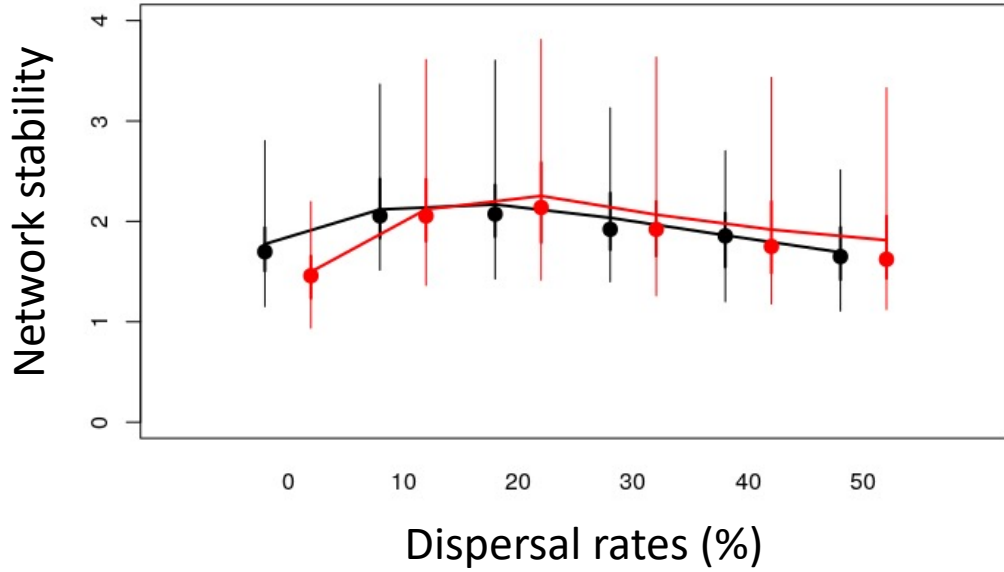


Scenario:

■ Homogenous populations

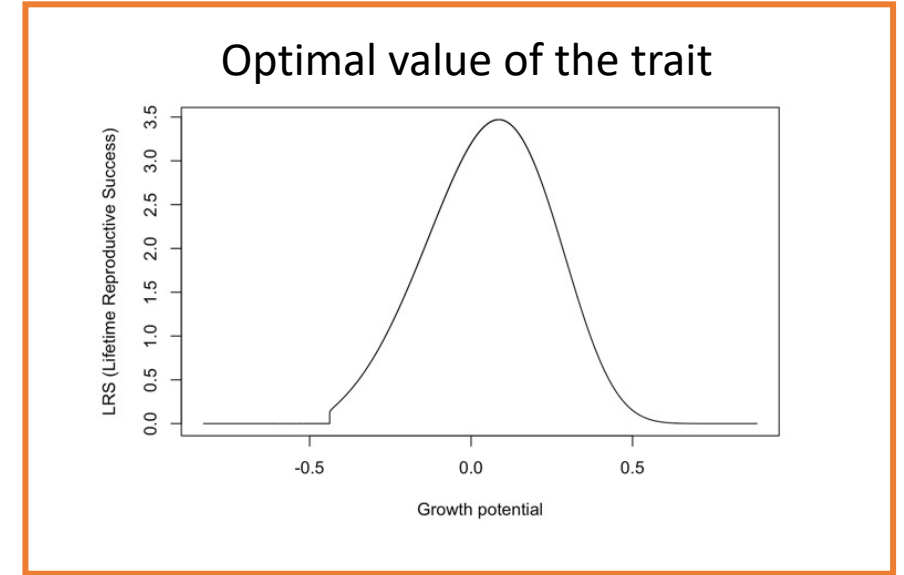
# RESULTS

## Populations network stability and Evolutionary rescue



Scenario:

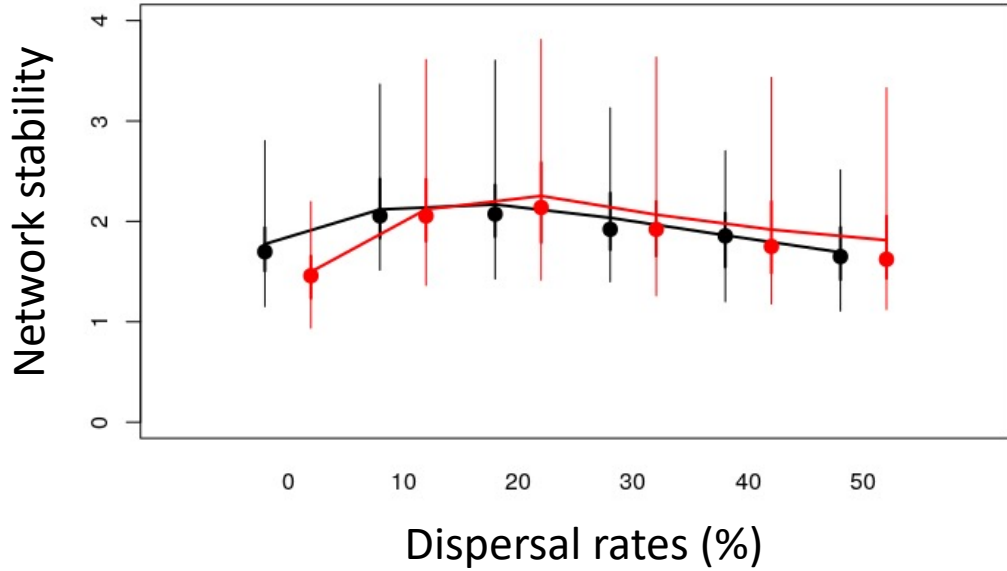
- Homogenous populations
- Genetic diversity (changed trait value)





# RESULTS

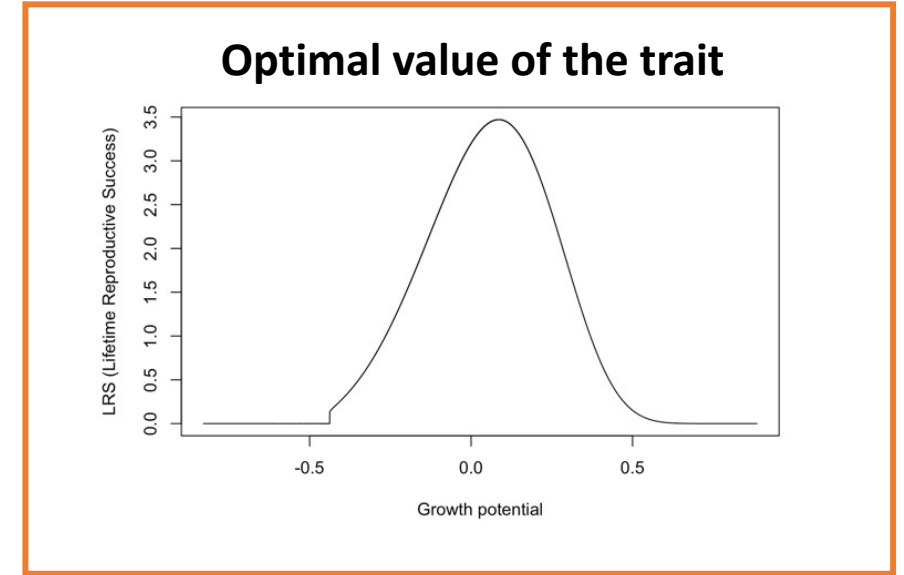
## Populations network stability and Evolutionary rescue



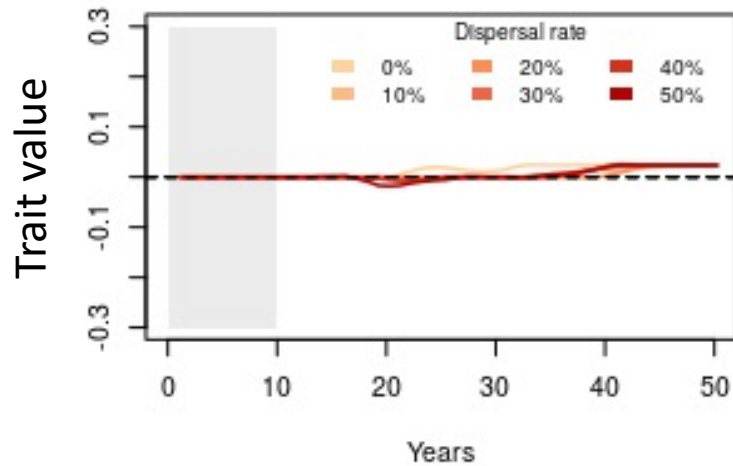
**Scenario:**

■ Homogenous populations

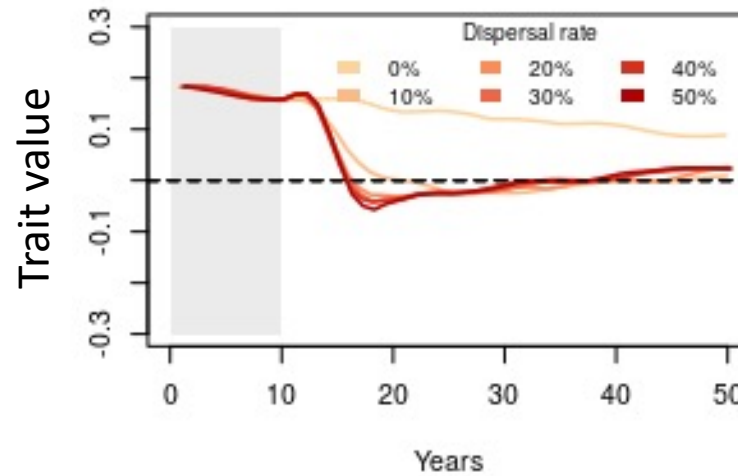
■ Genetic diversity (changed trait value)



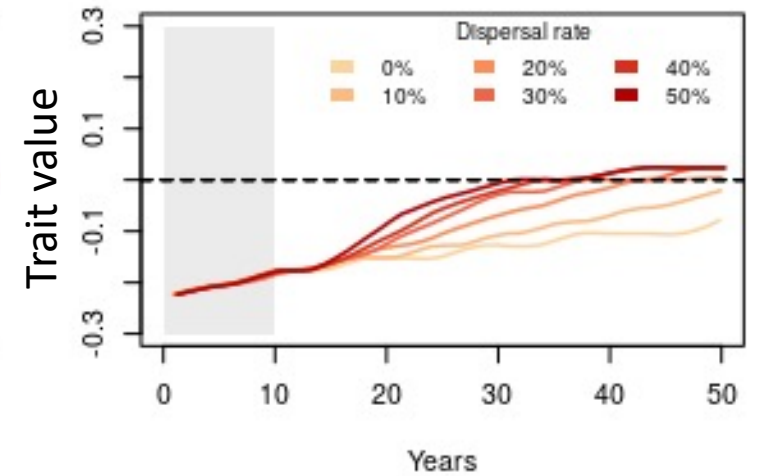
*Douron river*



*Yar river*



*Leguer river*

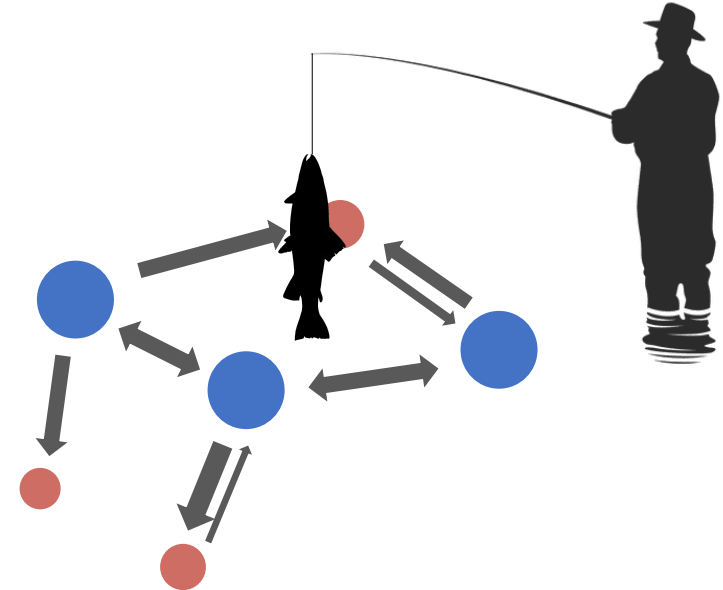
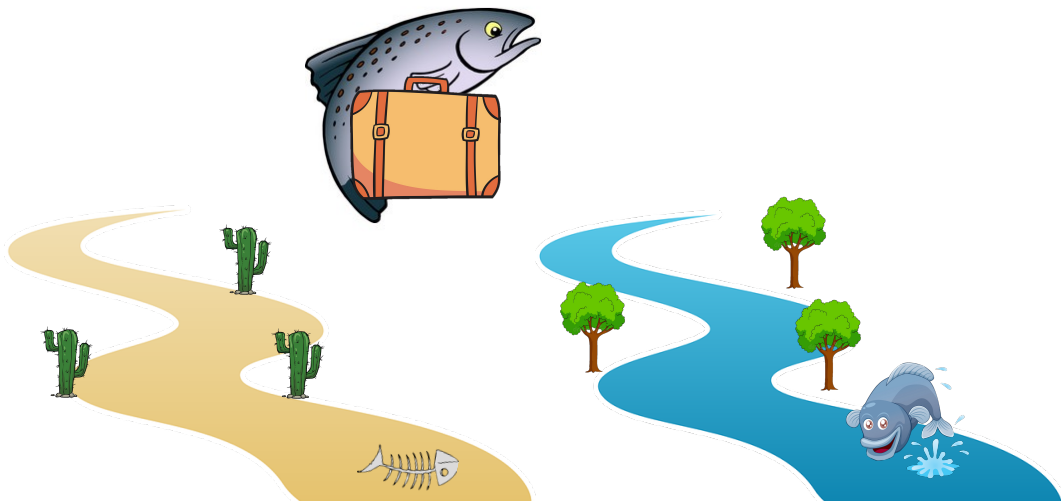


## || CONCLUSION & NEXT STEPS

- Diversity alone does not necessarily promote populations network stability, but can increase populations adaptive ability combined to dispersal

## || CONCLUSION & NEXT STEPS

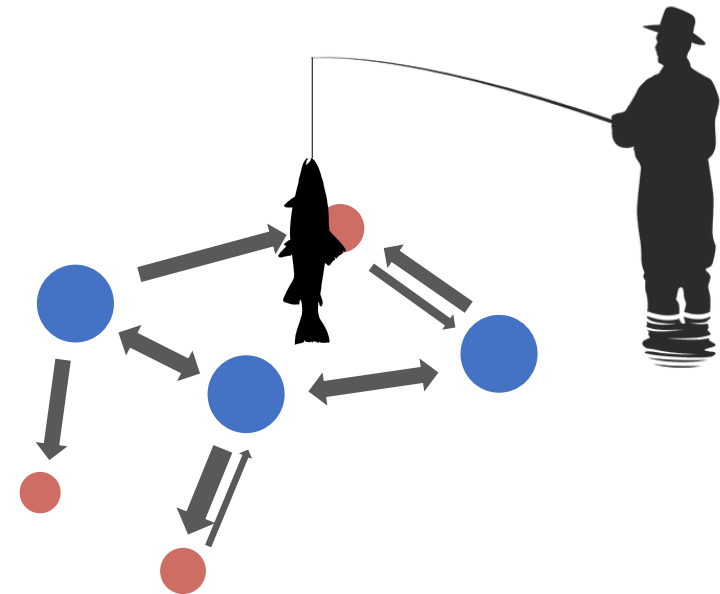
- Diversity alone does not necessarily promote populations network stability, but can increase populations adaptive ability combined to dispersal
- Persistence and adaptive ability facing climate change ?
- Consequences of climate change on synchrony and dispersal?
- Fisheries management in the context of spatially structured populations



## || CONCLUSION & NEXT STEPS

- Diversity alone does not necessarily promote populations network stability, but can increase populations adaptive ability combined to dispersal
- Persistence and adaptive ability facing climate change ?
- Consequences of climate change on dispersal and dispersal?

THANK YOU!



# METHODS

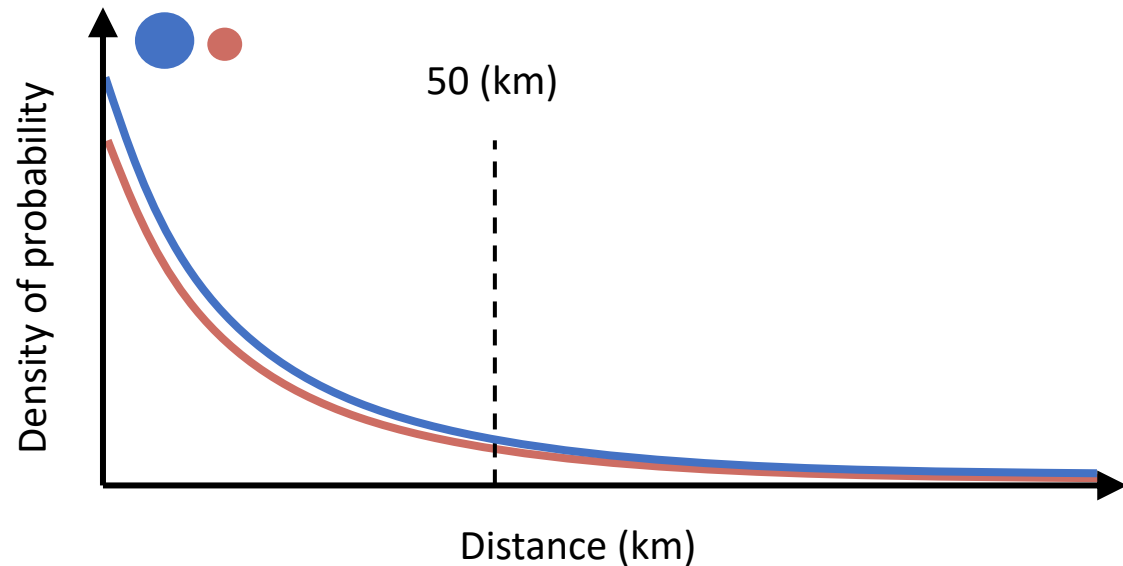
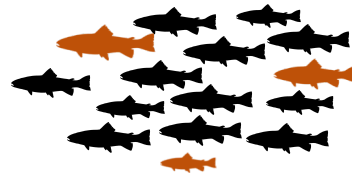
## Salmon metapopulation modeling

MetaIBASAM

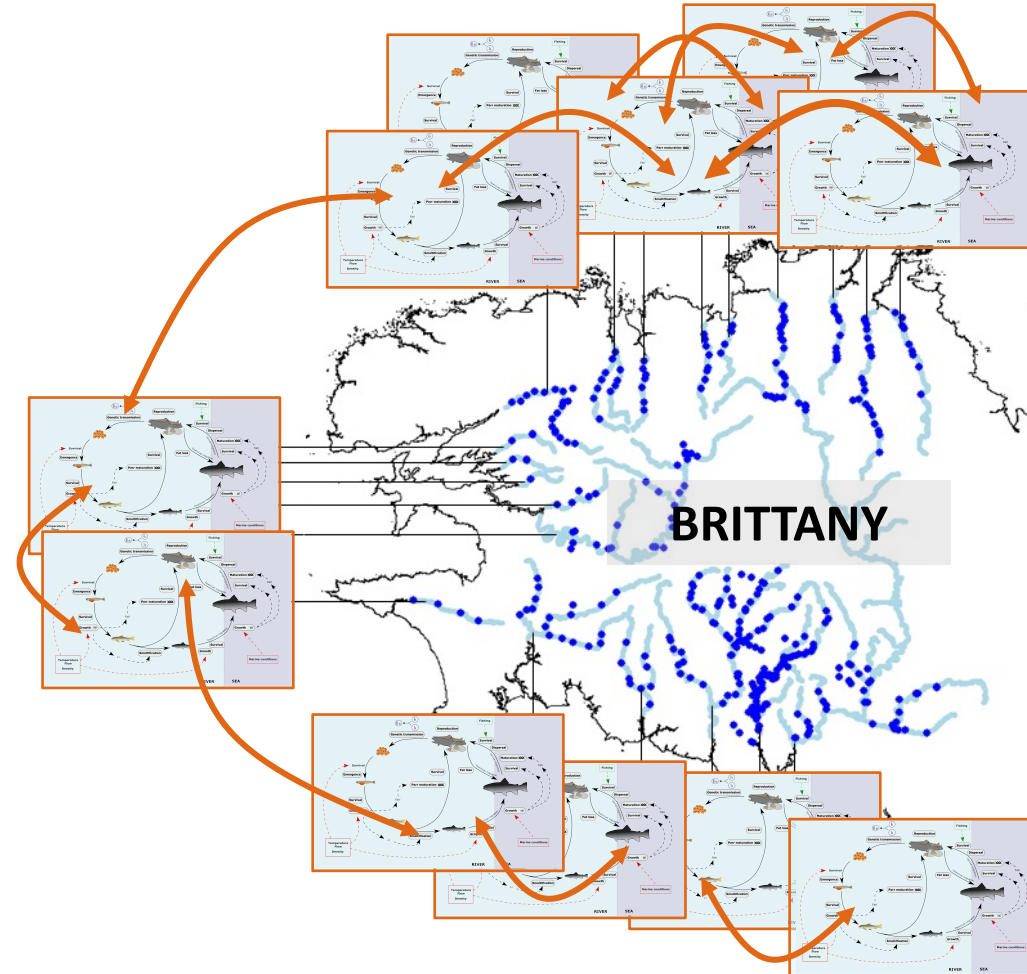
a spatially structured version of IBASAM

### Dispersal modeling assumptions:

- Constant over space (populations) and time
- Not phenotypically or genotypically determined
- Choice of destination population based on distance and attractivity

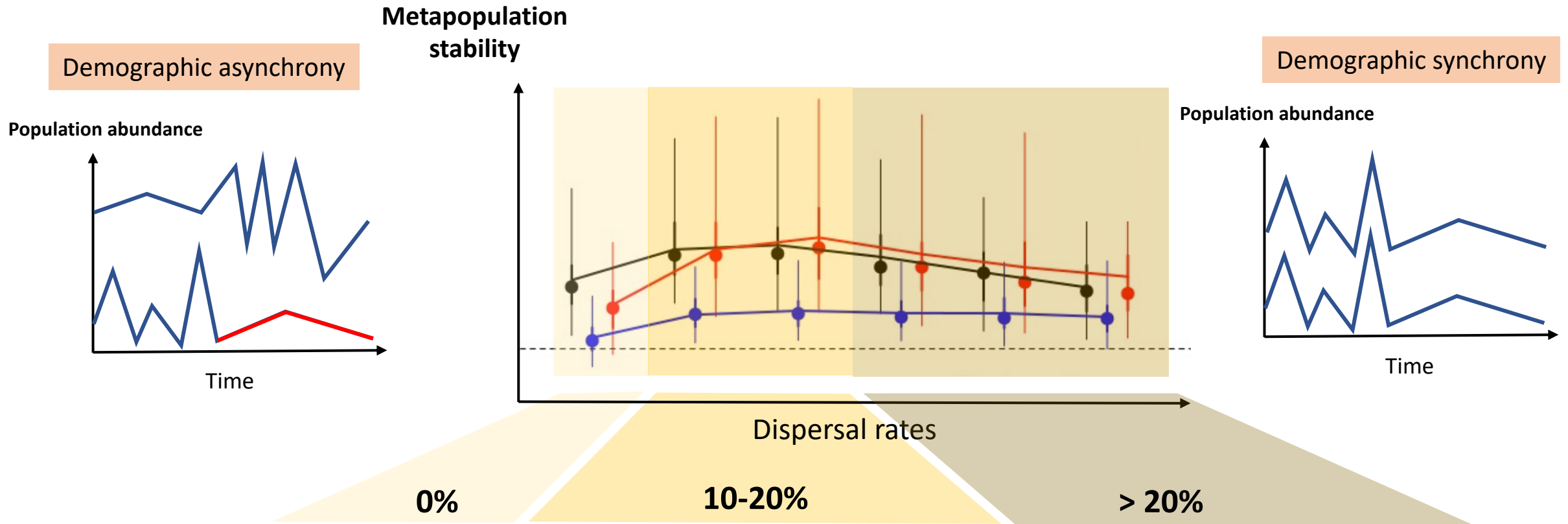


FRANCE



# RESULTS

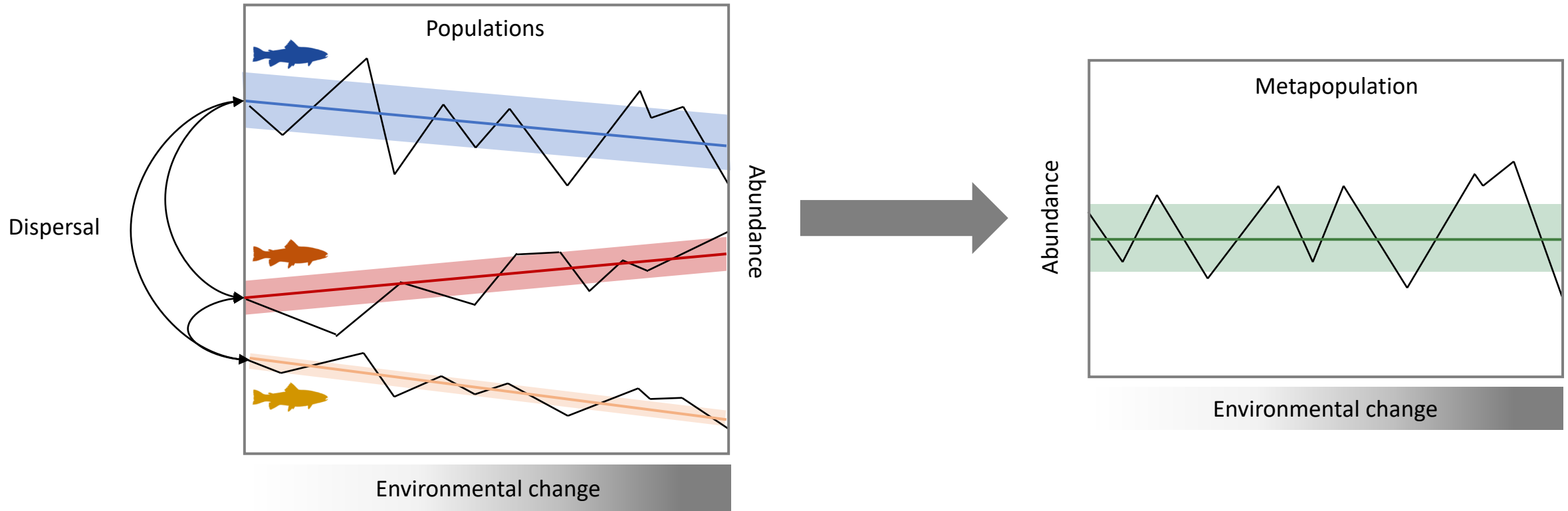
## Effect of dispersal on metapopulation stability



- Asynchrony
- High risk of extinction of small populations

- Demographic rescue of small populations
- Optimum ?

- ↗ ↗ synchrony
- Demographic decline of source populations



Biocomplexity at different levels:

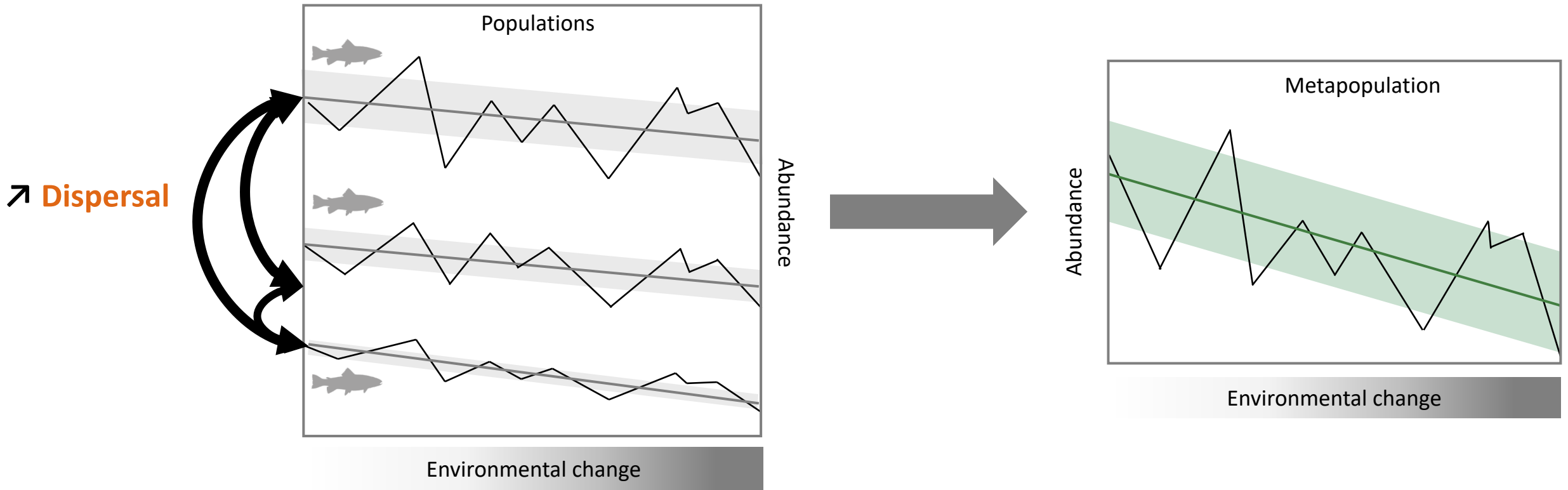
- phenotypes and genotypes
- population dynamics (asynchrony)

↳ Diversity of responses to environmental changes

↗ stability and persistence

= **Portfolio effect (PE)**

(Schindler et al, 2015)



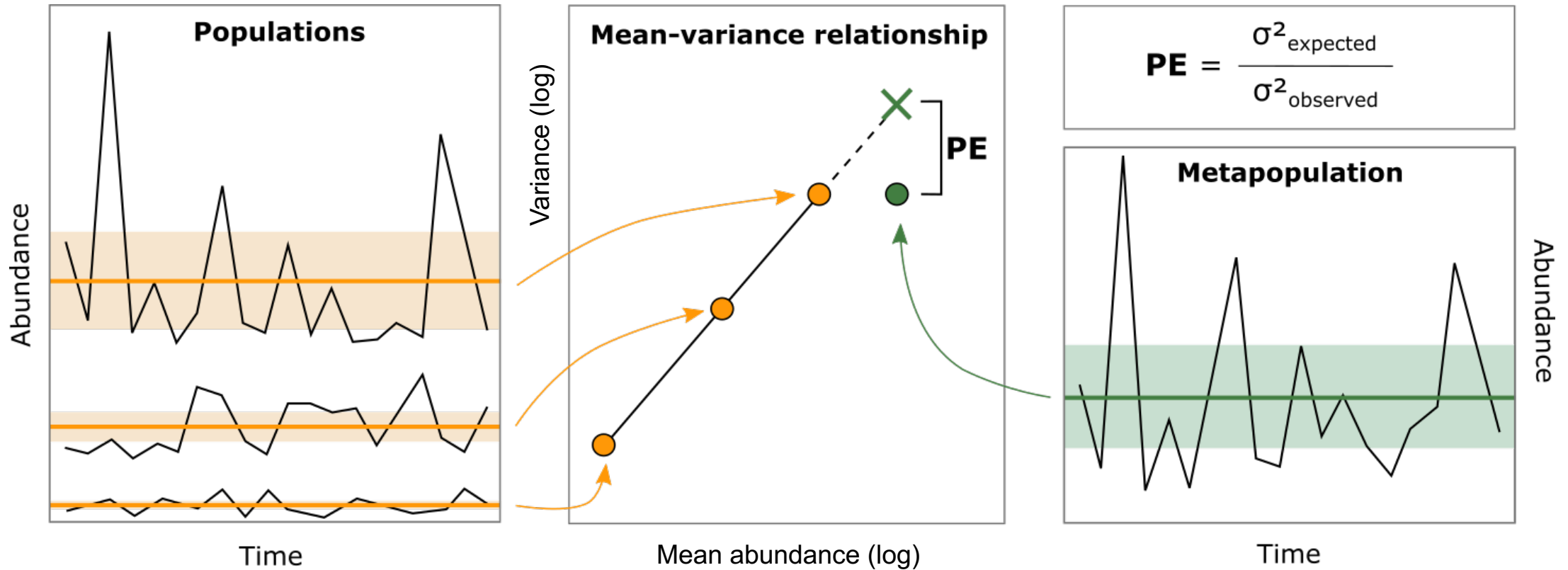
↘ **Biocomplexity** at different levels:

- phenotypes and genotypes homogenization
- synchronyzation of populations dynamics

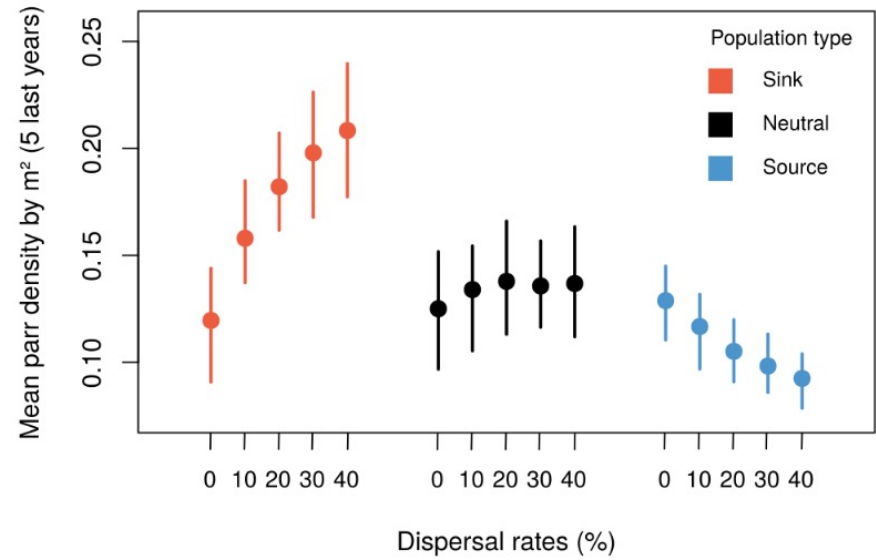
↪ **Homogenization** of responses

↘ stability and persistence  
= **“anti-rescue”** effects  
(Harding and McNamara, 2002)

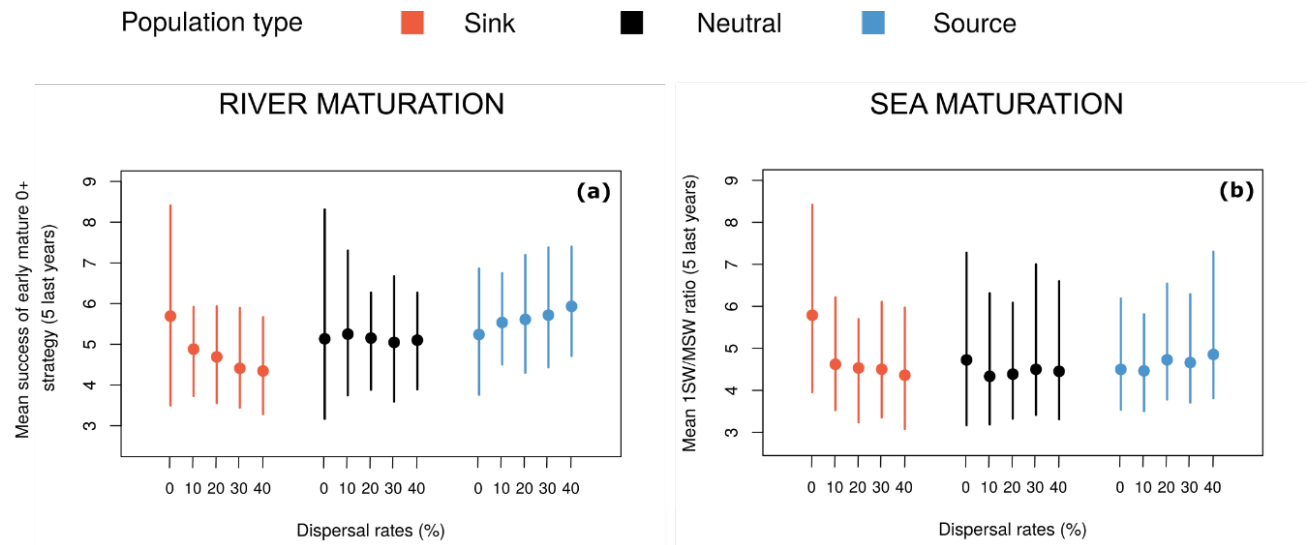




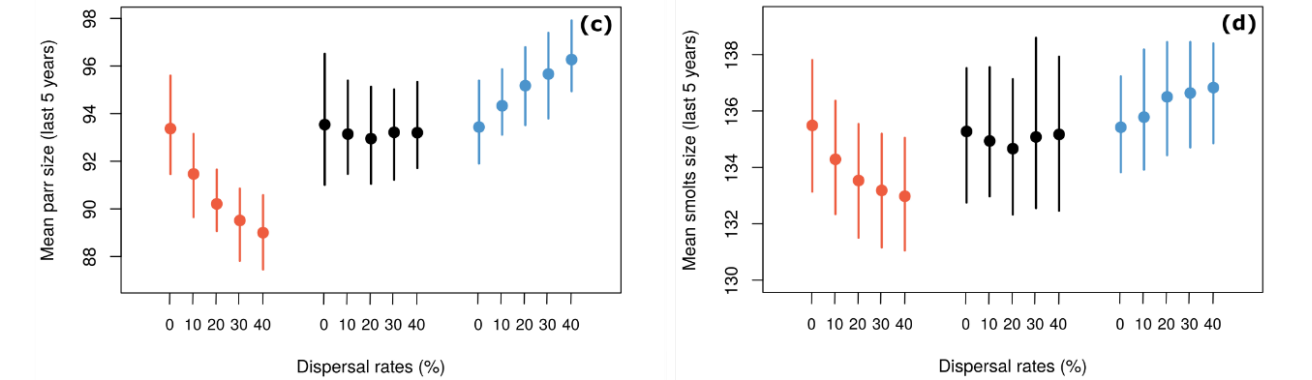
- $PE > 1 \rightarrow$  Metapopulation more stable than expected
- $PE < 1 \rightarrow$  Metapopulation less stable than expected



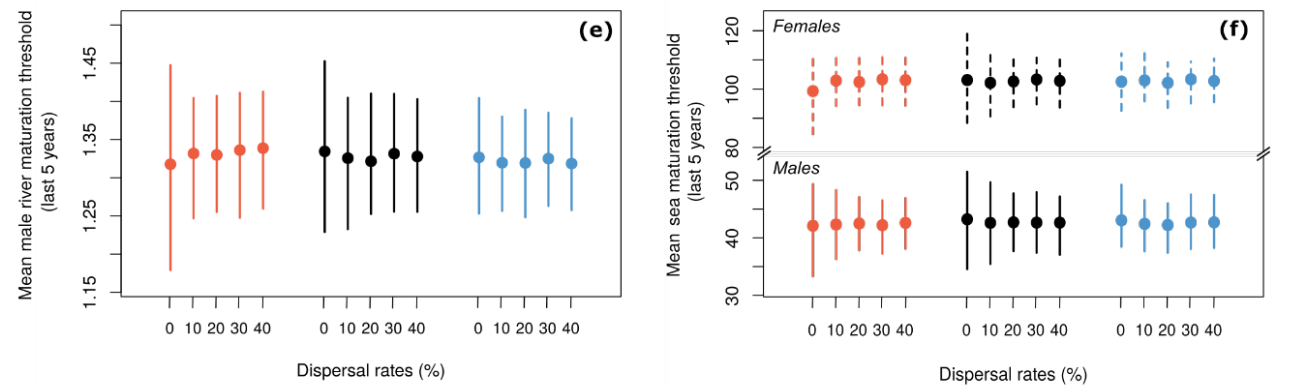
LIFE-HISTORY TRAIT  
(AGE AT MATURATION)



PHENOTYPE  
(JUVENILE SIZE)

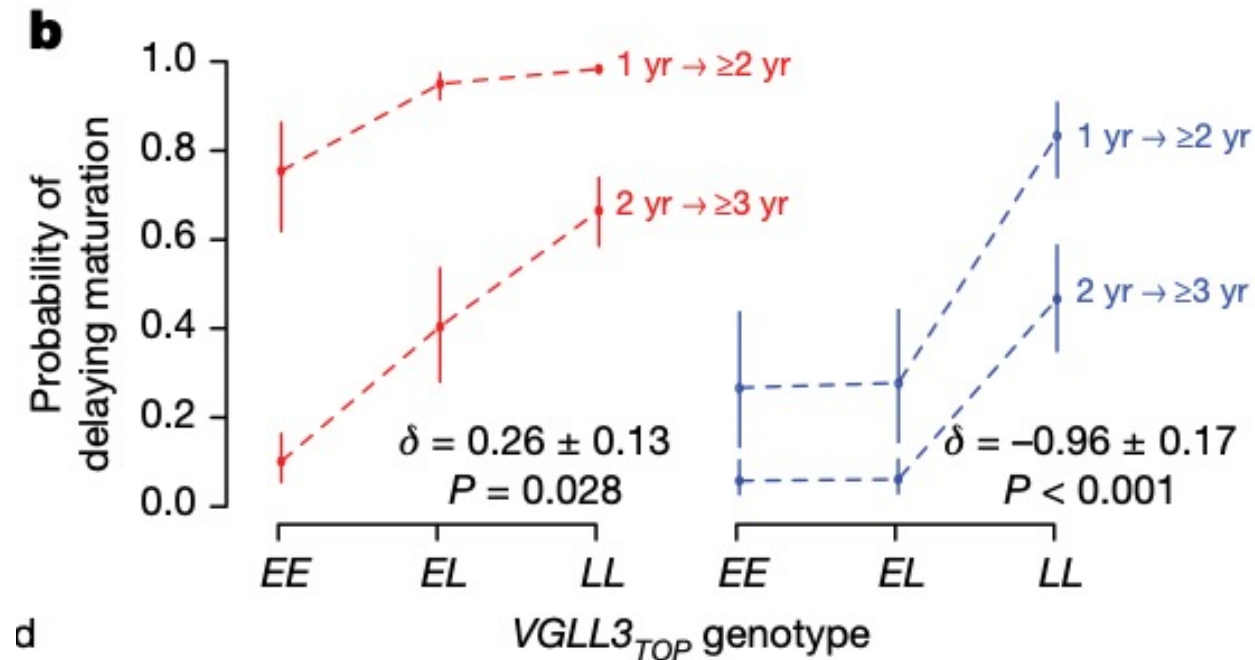


GENOTYPE  
(MATURATION THRESHOLD)



## Sex-dependent dominance at a single locus maintains variation in age at maturity in salmon

Nicola J. Barson<sup>1\*</sup>, Tutku Aykanat<sup>2\*</sup>, Kjetil Hindar<sup>3</sup>, Matthew Baranski<sup>4</sup>, Geir H. Bolstad<sup>3</sup>, Peder Fiske<sup>3</sup>, Céleste Jacq<sup>4</sup>, Arne J. Jensen<sup>3</sup>, Susan E. Johnston<sup>5</sup>, Sten Karlsson<sup>3</sup>, Matthew Kent<sup>1</sup>, Thomas Moen<sup>6</sup>, Eero Niemelä<sup>7</sup>, Torfinn Nome<sup>1</sup>, Tor F. Næsje<sup>3</sup>, Panu Orell<sup>7</sup>, Atso Romakkaniemi<sup>7</sup>, Harald Sægvog<sup>8</sup>, Kurt Urdal<sup>8</sup>, Jaakko Erkinaro<sup>7</sup>, Sigbjørn Lien<sup>1</sup> & Craig R. Primmer<sup>2</sup>



# Axis 1: Role of biocomplexity and dispersal on metapopulation response to CC

How dispersal influences metapopulation **stability** ?

**Synchrony = 1**

- Populations highly synchronous
- Metapopulation size variable

$$\text{Synchrony} = \frac{\sigma_{\text{metapop}}^2}{\left(\sum_{\text{pop}_i} \sigma_{\text{pop}_i}\right)^2}$$

**Synchrony = 0**

- Populations highly asynchronous
- Metapopulation size stable

