

The effect of fishing pressure on *Sardinella aurita*'s migrations off North-West Africa investigated with an individual based biophysical model

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Summary

1. Introduction

Sardinella in West African Waters

2. Methods

The biophysical model

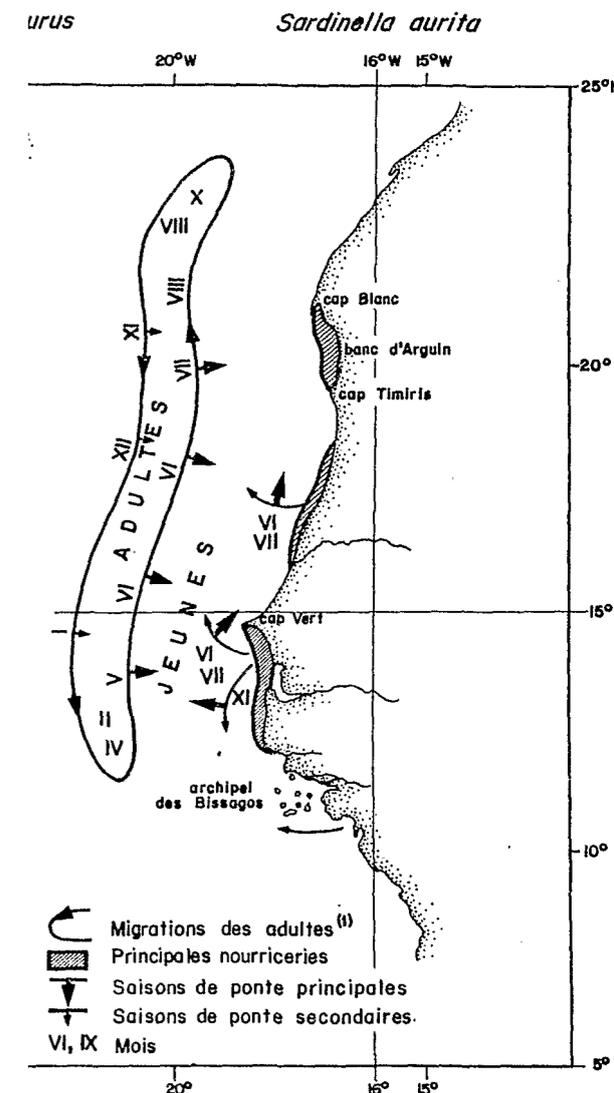
3. Results

Seasonal migrations sensibility to fishing intensity

4. Conclusion & perspectives

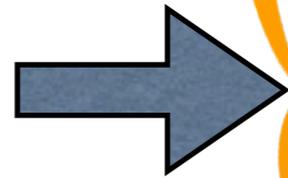
Introduction

- West Africa : **Coastal Upwelling System**
- **Round sardinella** (= *Sardinella aurita*): key species for local economy, food security and ecosystem
- **Seasonal migrations:** between Morocco and Guinea
- ➔ This complicate the fishing management policies

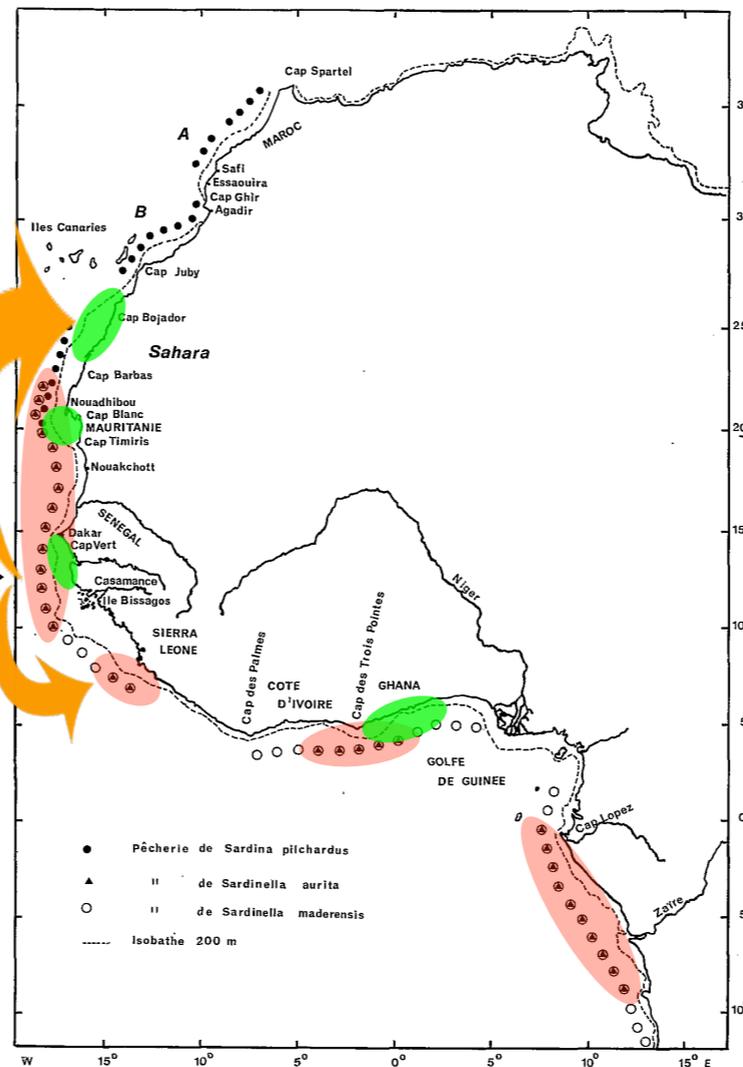


Introduction

Over-fishing



Impact on the overall distribution?



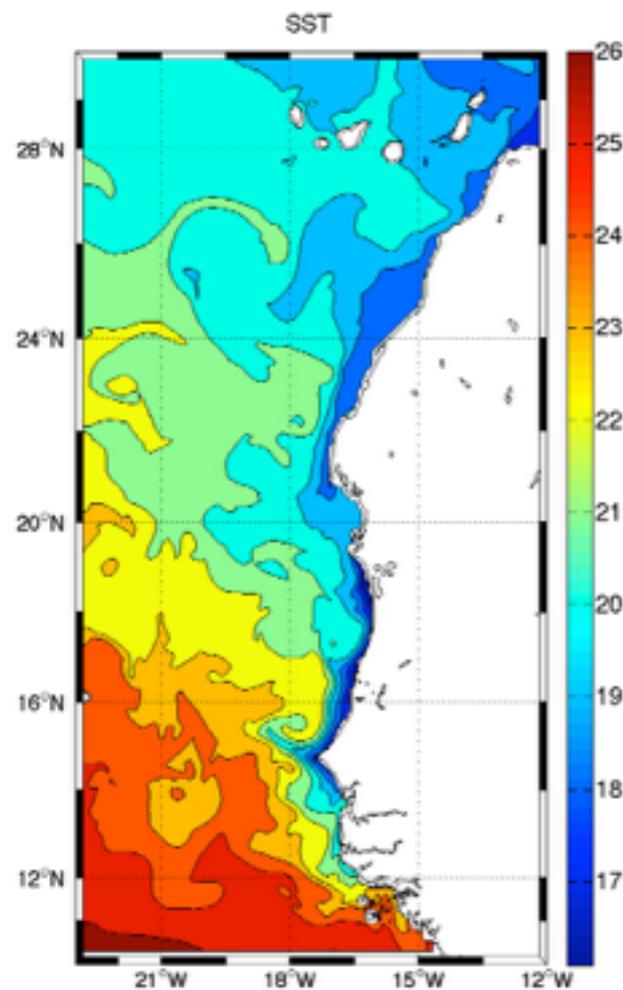
-  *S. aurita* fisheries (Binet, 1988)
-  *S. aurita* main spawning areas

Methods : biophysical modeling

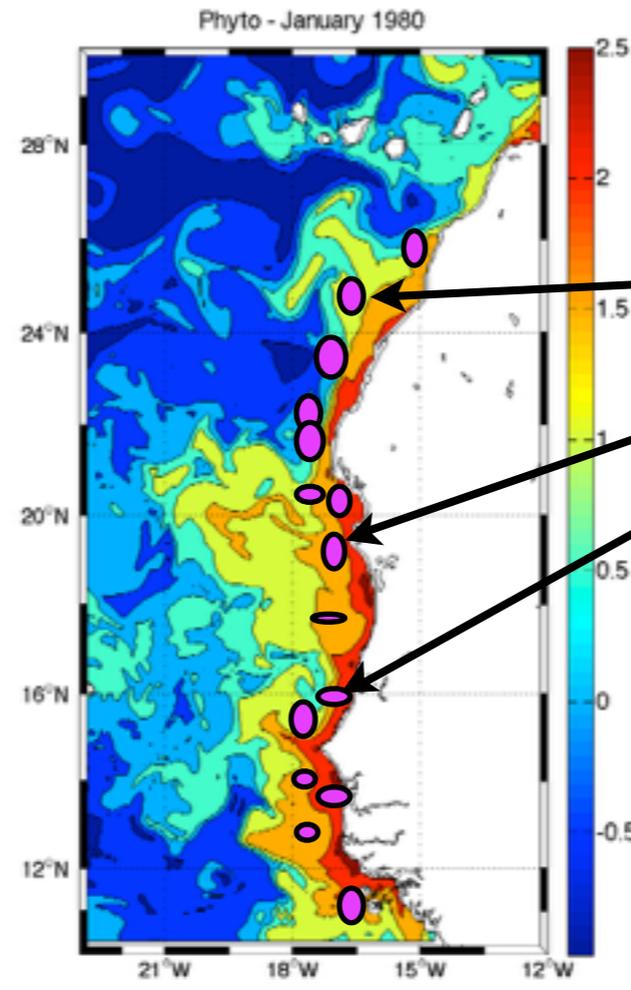
3D Environment from 1980 to 2009

+

Individual Based Model for Sardinelle :



Hydrodynamic
(ROMS)



Bio-geochemical
(ROMS-PISCES)

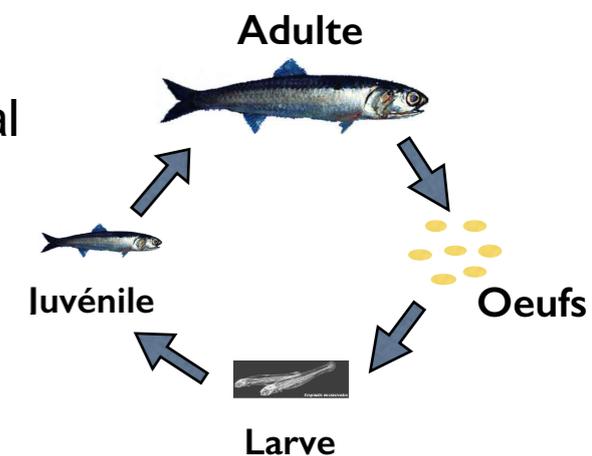


● = Schools

➔ *Monospecific,
Full life cycle model*

Processus :

- Larval dispersal
- Energy budget
- Swimming
- Spawning

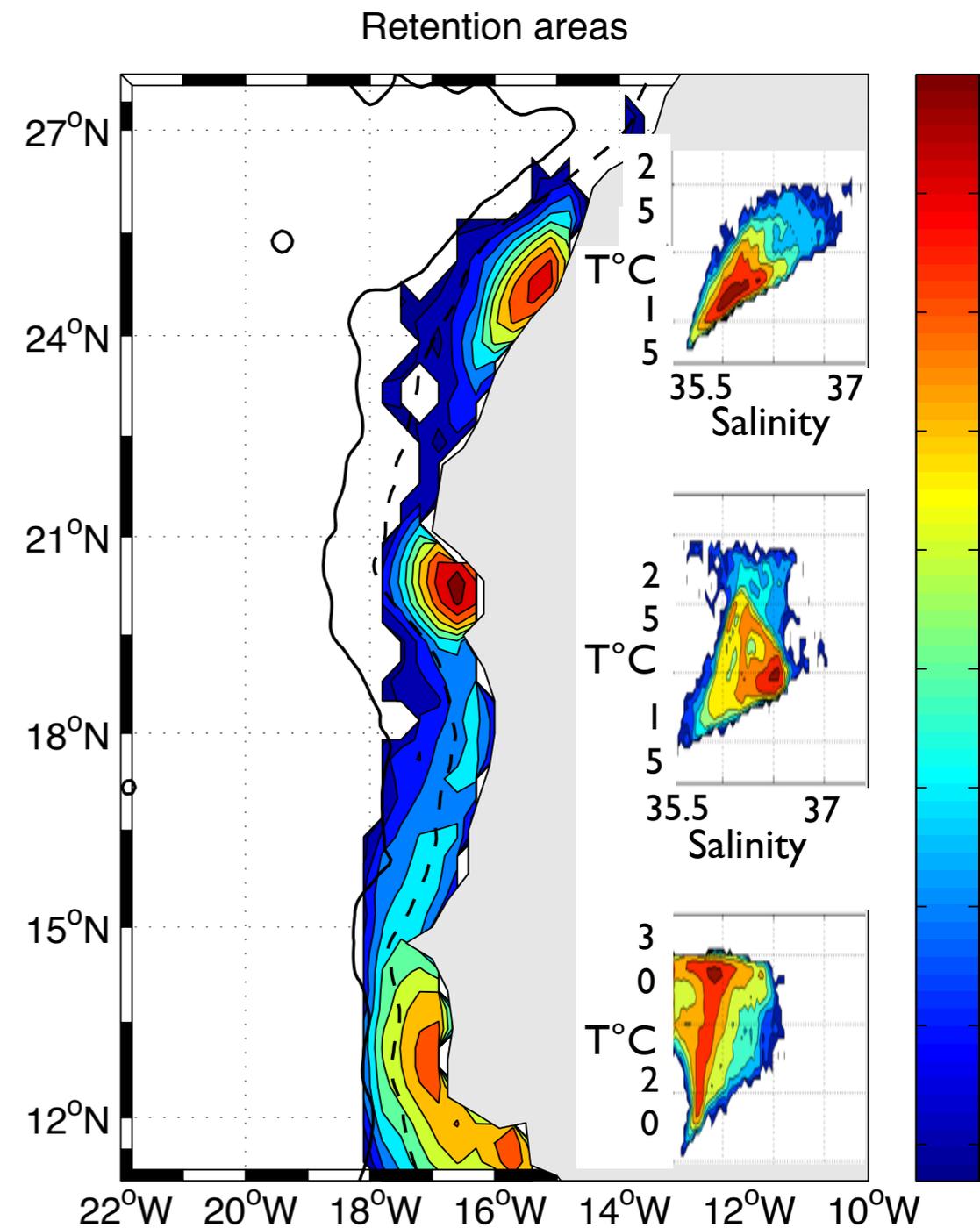
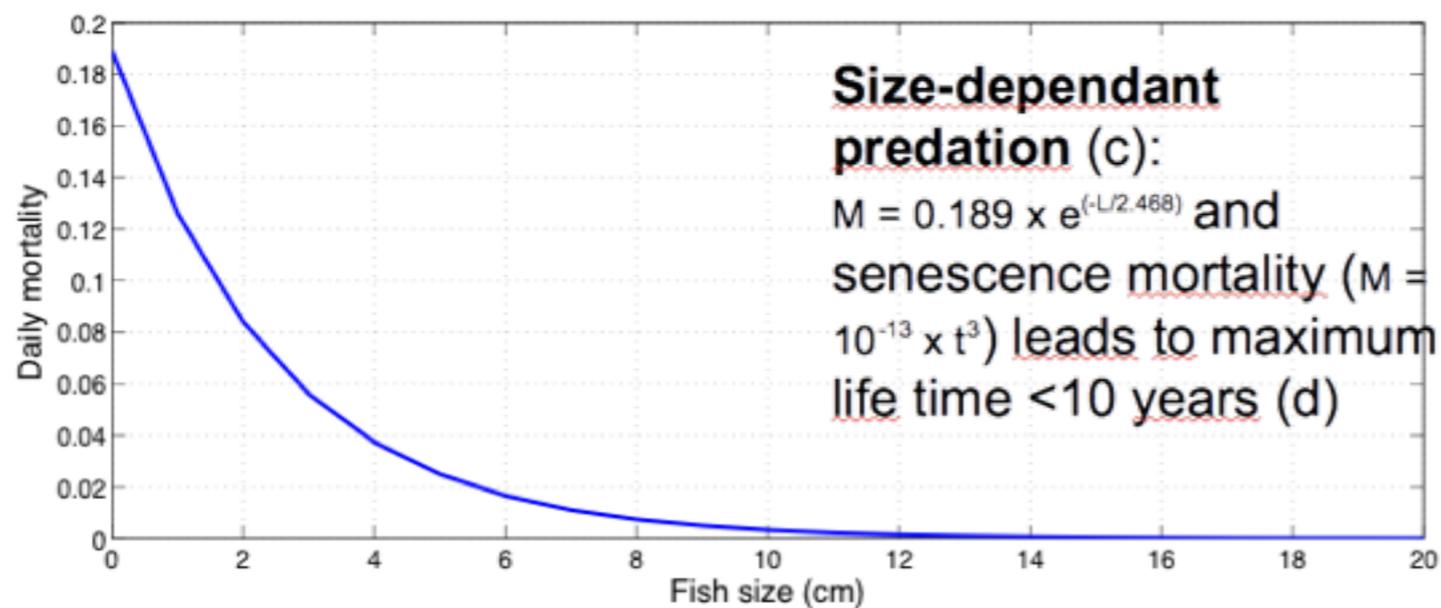


ROMS-PISCES 3D simulation of the upwelling system
(AGRIF-2 ways, 1980-2009)

Auger P.A., Machu E., Gorgues T. (IRD, Brest)

Methods : larval survival

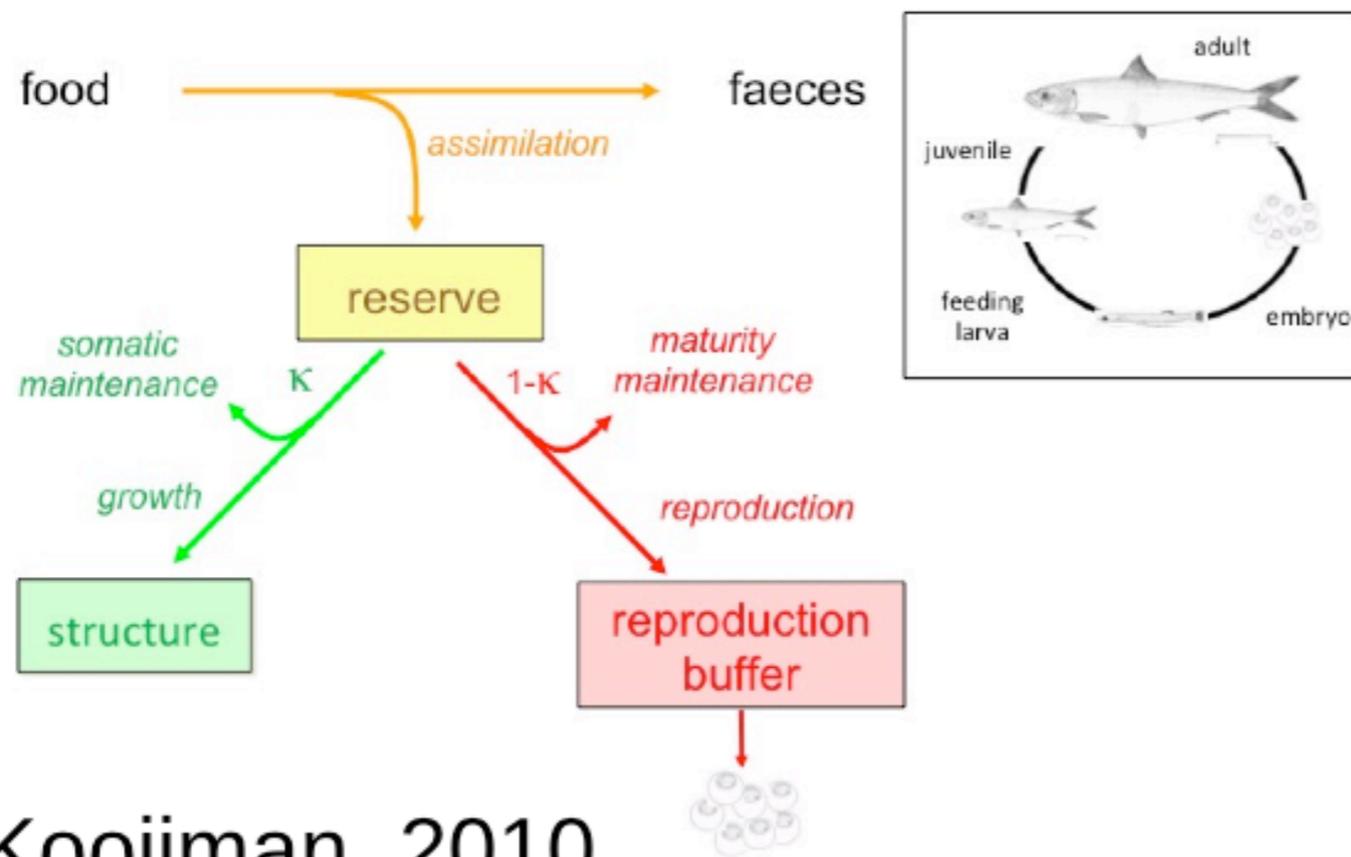
- Retention in coastal area
- Rapid growth to limit predation



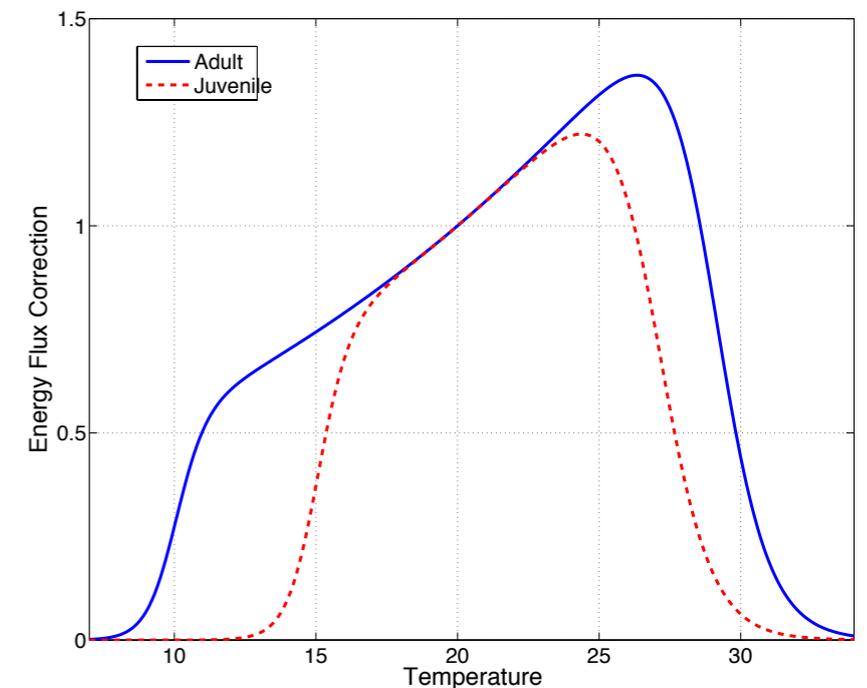
Methods: bioenergetics

Dynamic Energy Budget (DEB)

Input : Food and Temperature



Kooijman, 2010



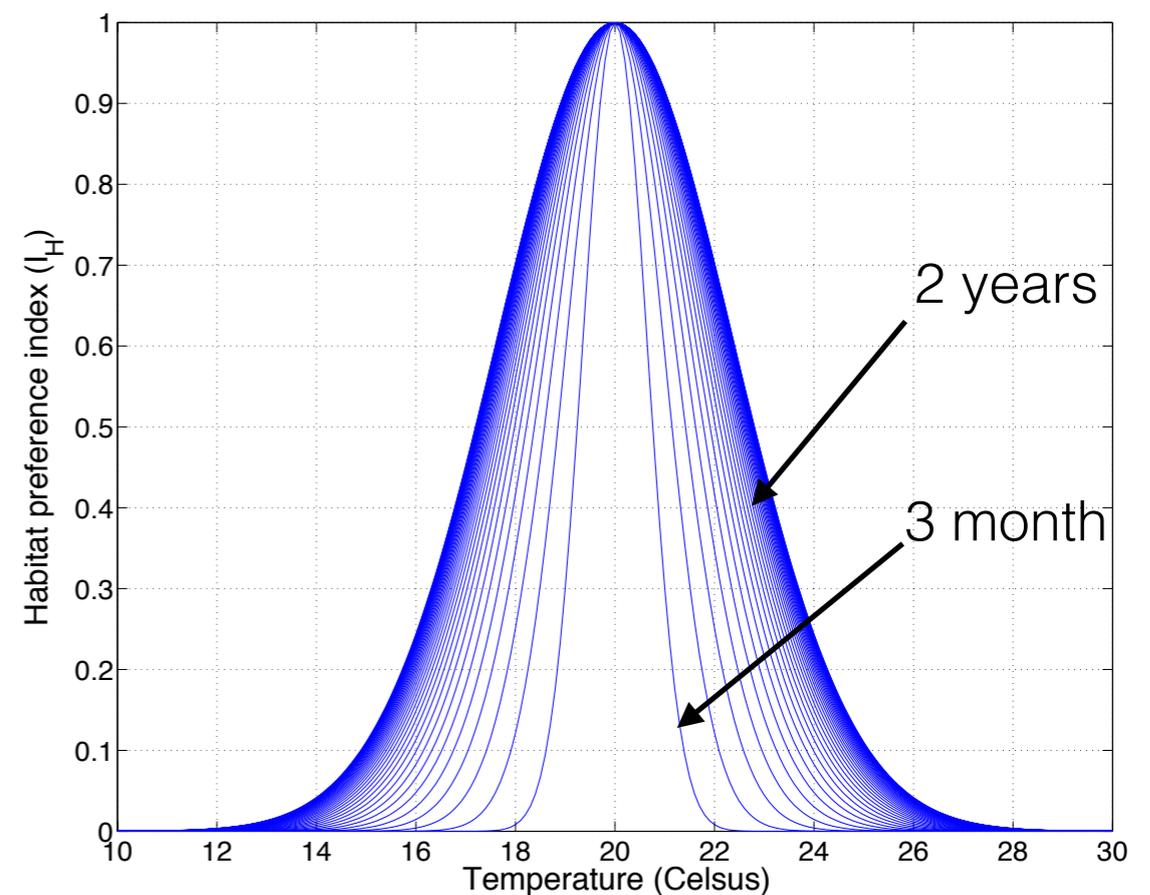
Temperature flux corrections for the bio-energetic model

Methods: swimming

- **Kinesis:** random + inertial component
- **Habitat quality index:** Temperature x Food - Mortality

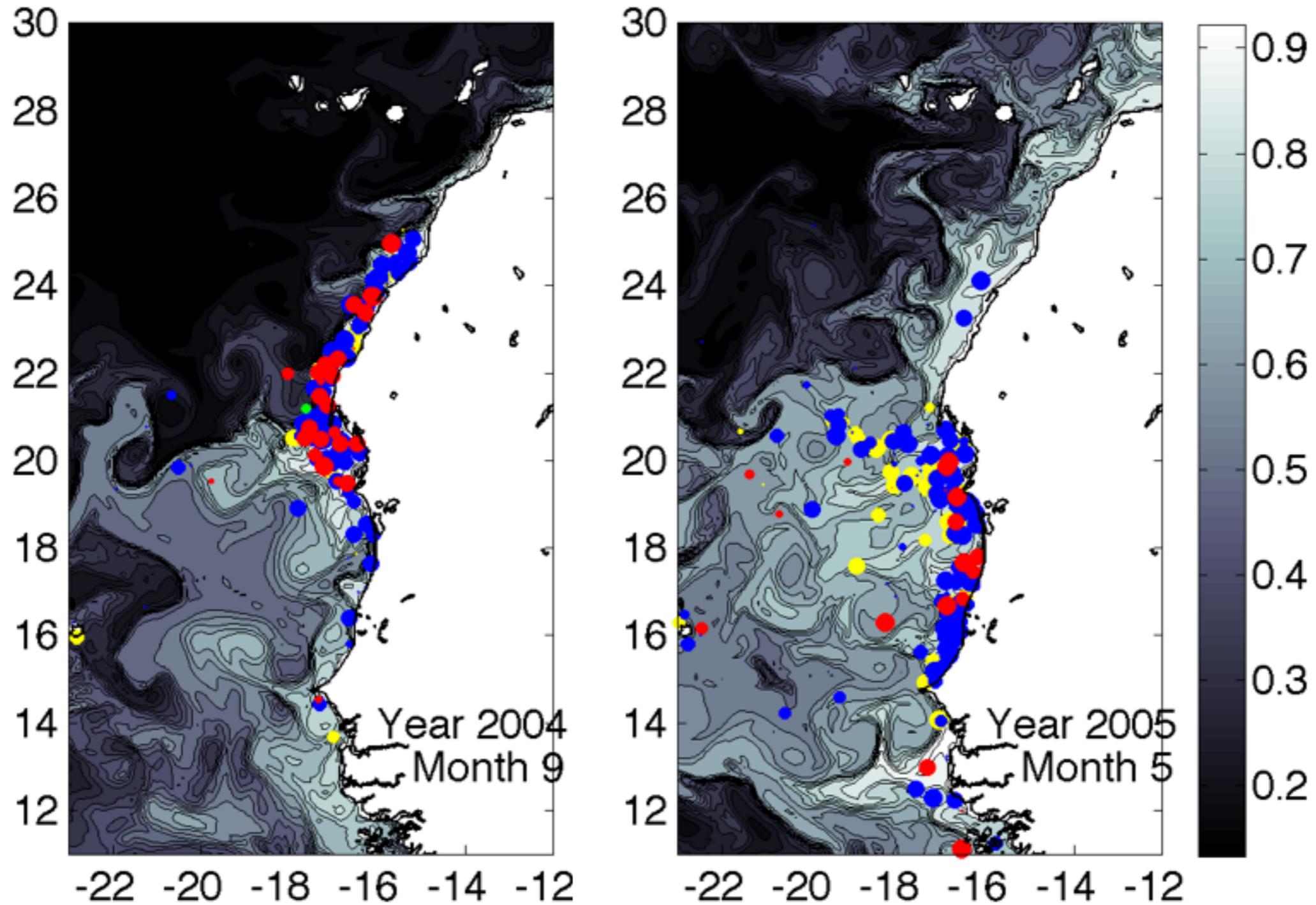
- **Food :** functional response
- **Mortality :** offshore predation
- **Temperature :** imprinting (natal temperature)

- ➔ ● **Natural selection**

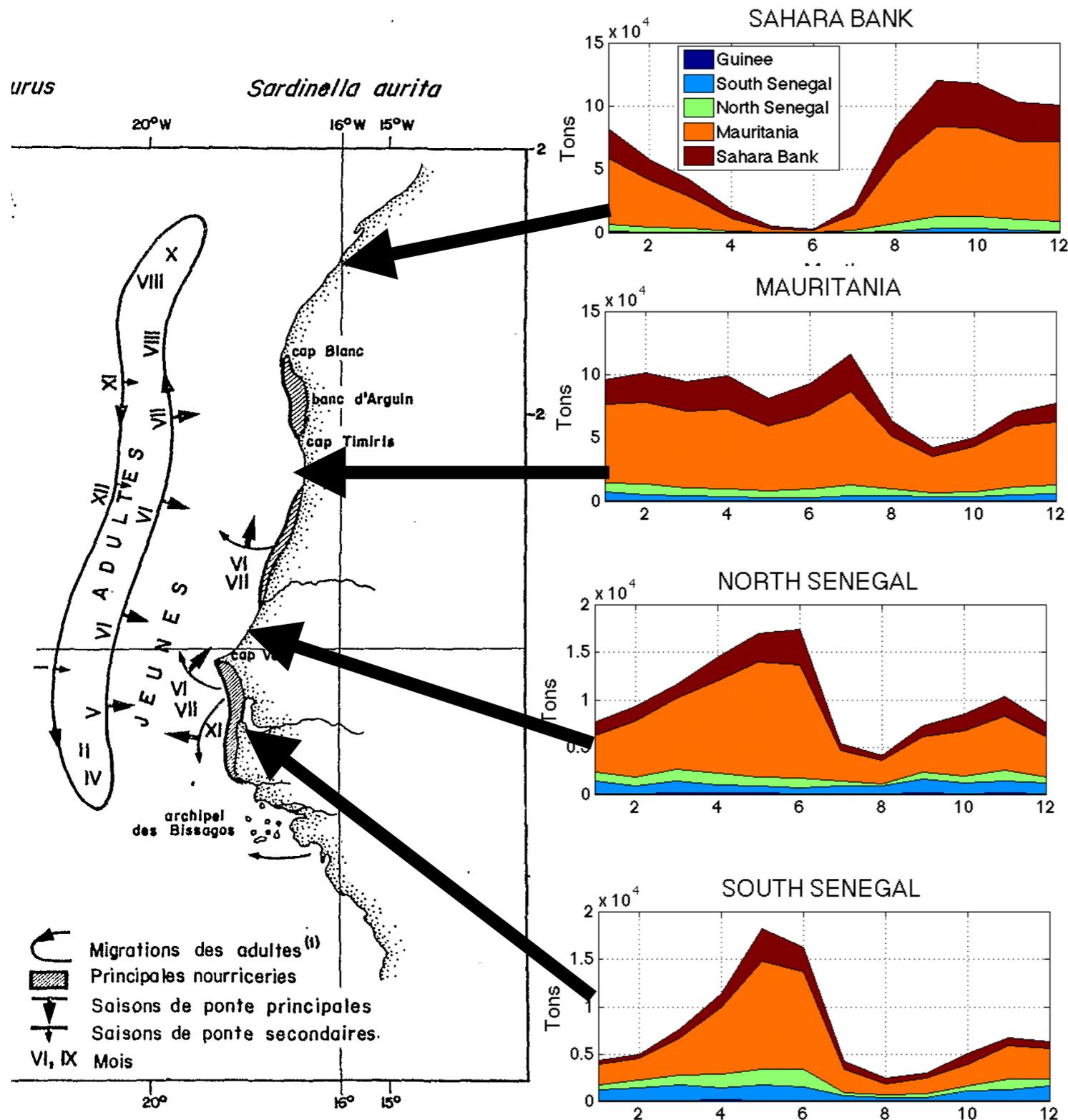


Temperature tolerance depending on age for a fish born in 20 degree water

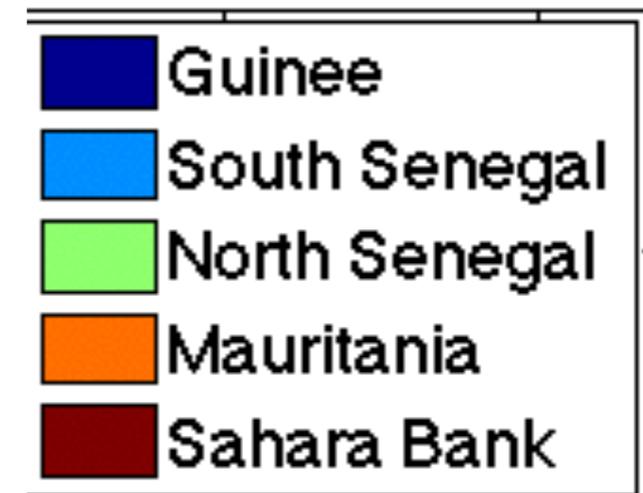
Example of fish distribution



Results : seasonality



Fish born in



—> No fishing mortality

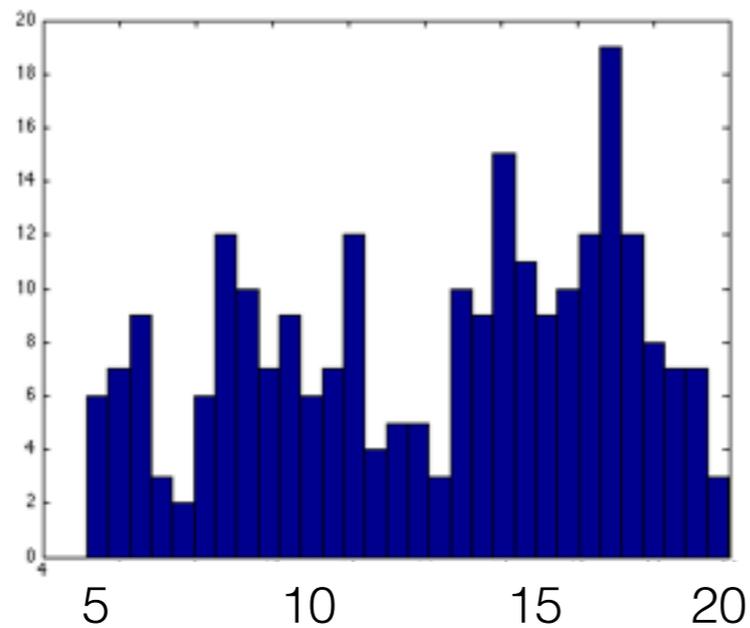
—> Fits with migratory scheme described in 1979 from landings data

S. aurita migrations
(Boely and Fréon, 1979)

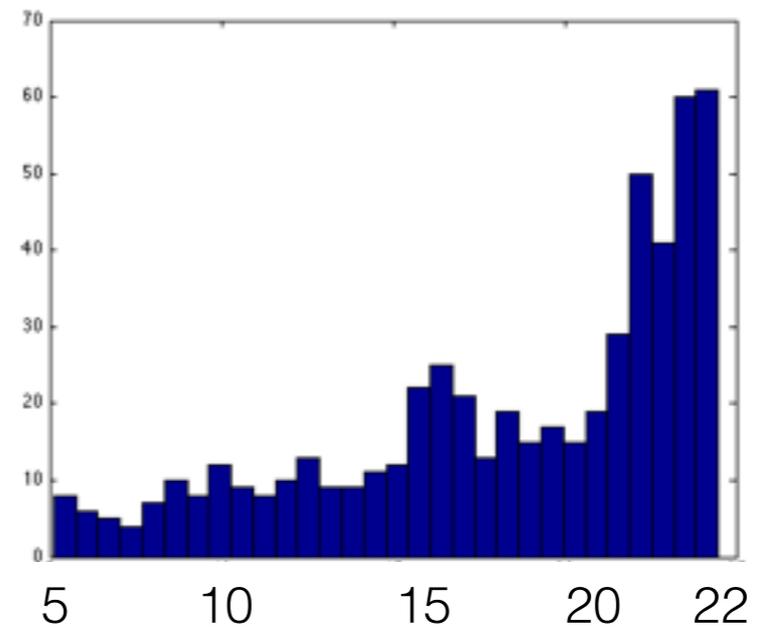
Results : effect of fishing mortality

Change in size spectrum :

Biophysical model
with strong fishing



Biophysical model
without fishing

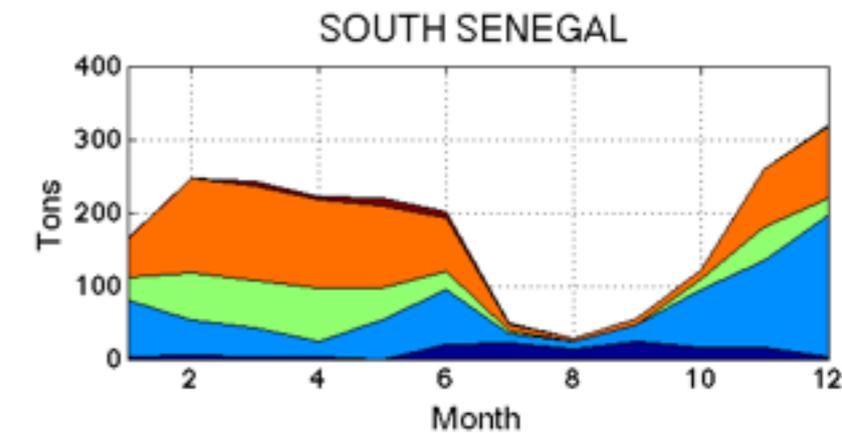
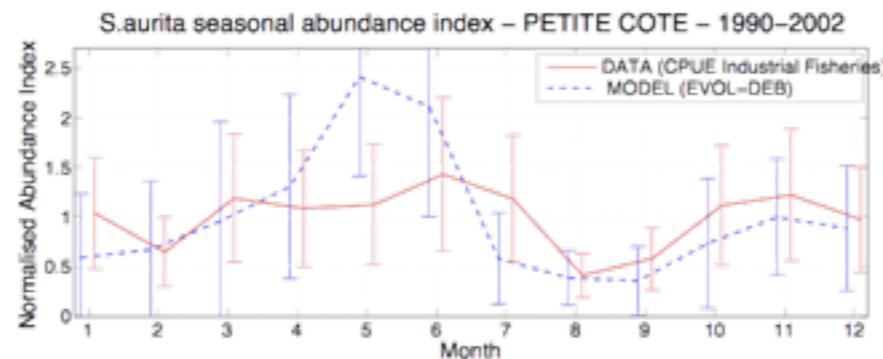
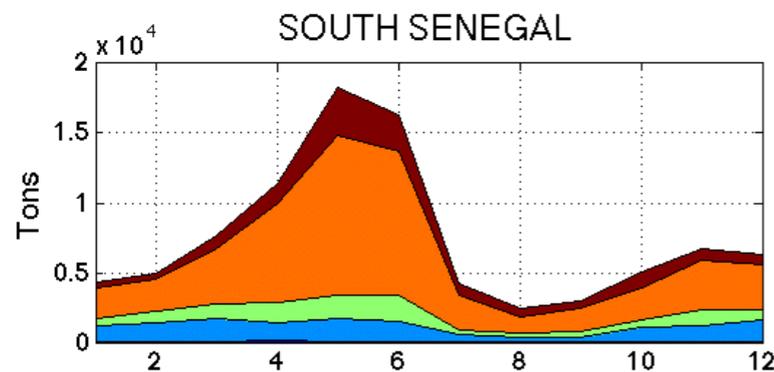
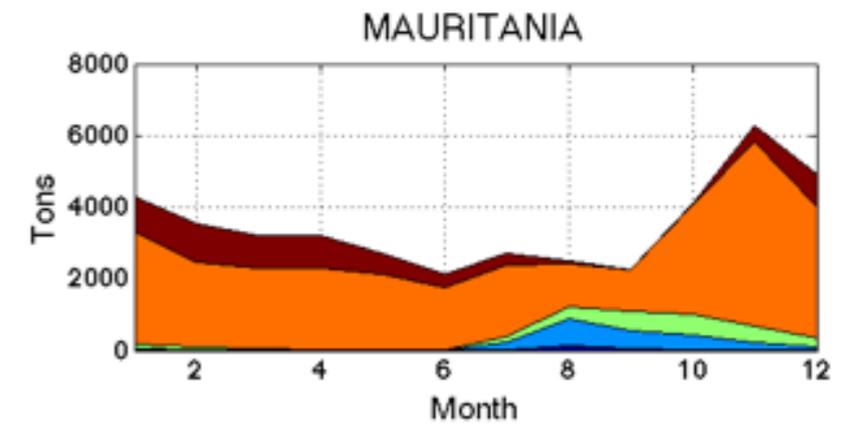
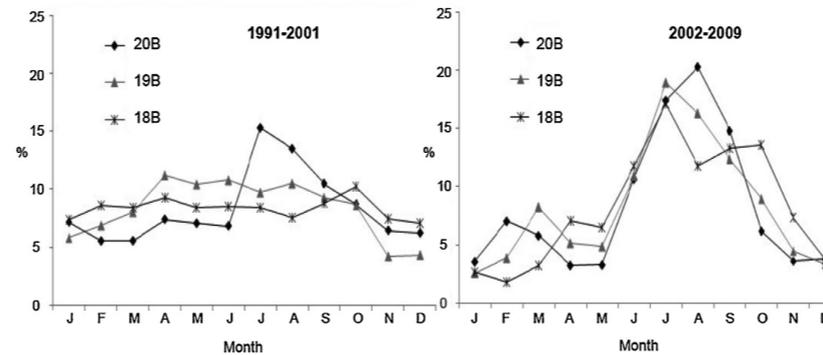
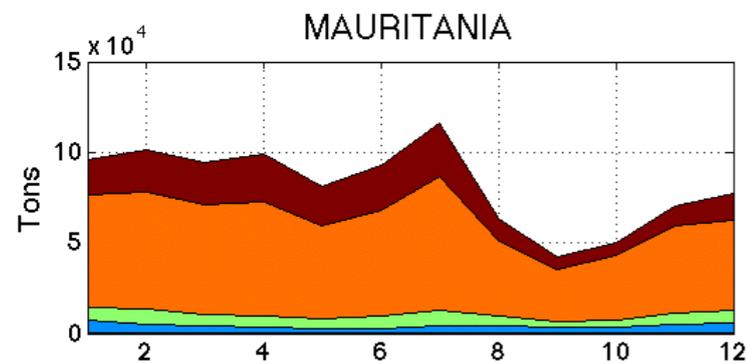


Results : effect of fishing mortality

Biophysical model
without fishing
(1991-2008)

CPUE (from local
fishery institute)

Biophysical model
with strong fishing
(1991-2008)

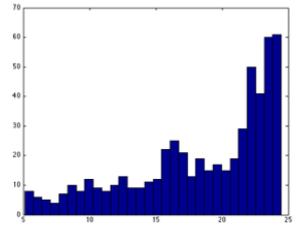


Conclusion

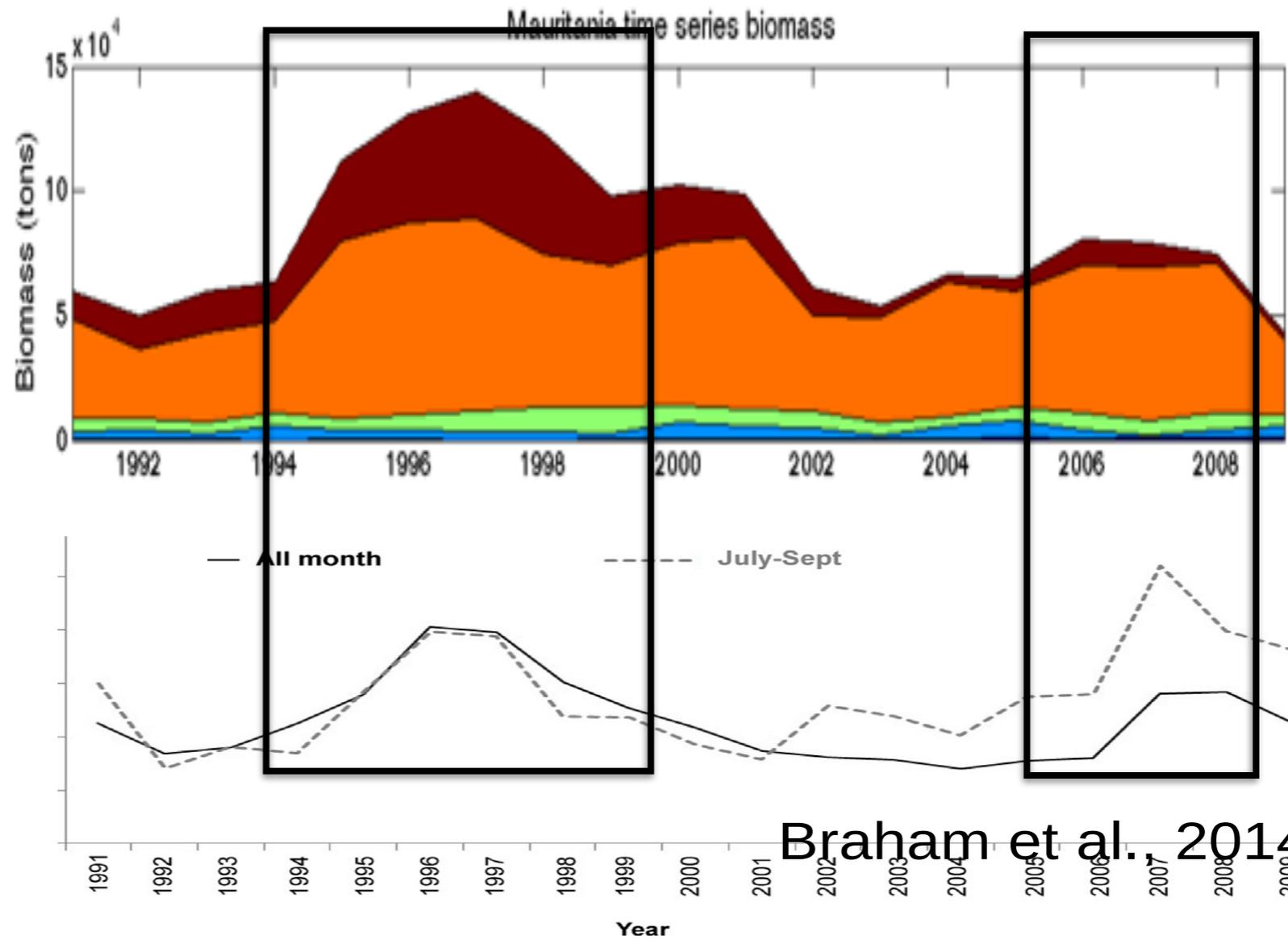
- The simulated migrations are consistent with CPUE seasonality in Senegal
- Increasing the fishing mortality reduce the massive migration from Mauritania to Senegal in May-June
- ➔ Perspectives
 - Otoliths life history validation
 - Mauritanian waters = major nursery area : check how this could change by taking into account the natural predation (which is probably higher in Mauritania)

Results : time series

Mauritania



Predicted
abundance
Without Fishing



Braham et al. 2014

Results : time series

Senegal

