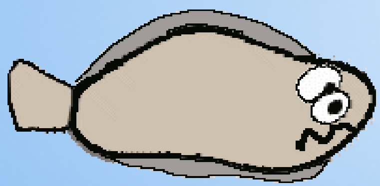
Ifremer

VECTORS

AGRO CAMPUS OUEST



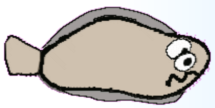
A Bayesian state-space model to merge larval drifting and habitat suitability models with spatially – explicit age-structured fish population dynamics model

The common sole (Solea solea) in the eastern Channel

Chapitre de thèse de S. Rochette à Agrocampus Ouest.
Travail poursuivi par la thèse de B. Archambault.

Rochette S., Le Pape O., Vigneau J., Rivot E. (2013). A hierarchical Bayesian model for embedding larval drift and habitat models in integrated life cycles for exploited fish. Ecological Applications, 23(7), 1659-1676.

Archambault B., Le Pape O., Baulier L., Vermard Y., Rivot E. (sub.) Adults mediated connectivity affects inferences on population dynamics and stock assessment.



Outline

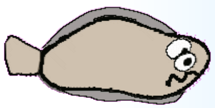
1. Introduction

2. Assessing the quality of nursery habitats

3. Quantifying larval dispersal and survival

4. Modelling an integrated life cycle

5. Conclusion & perspectives



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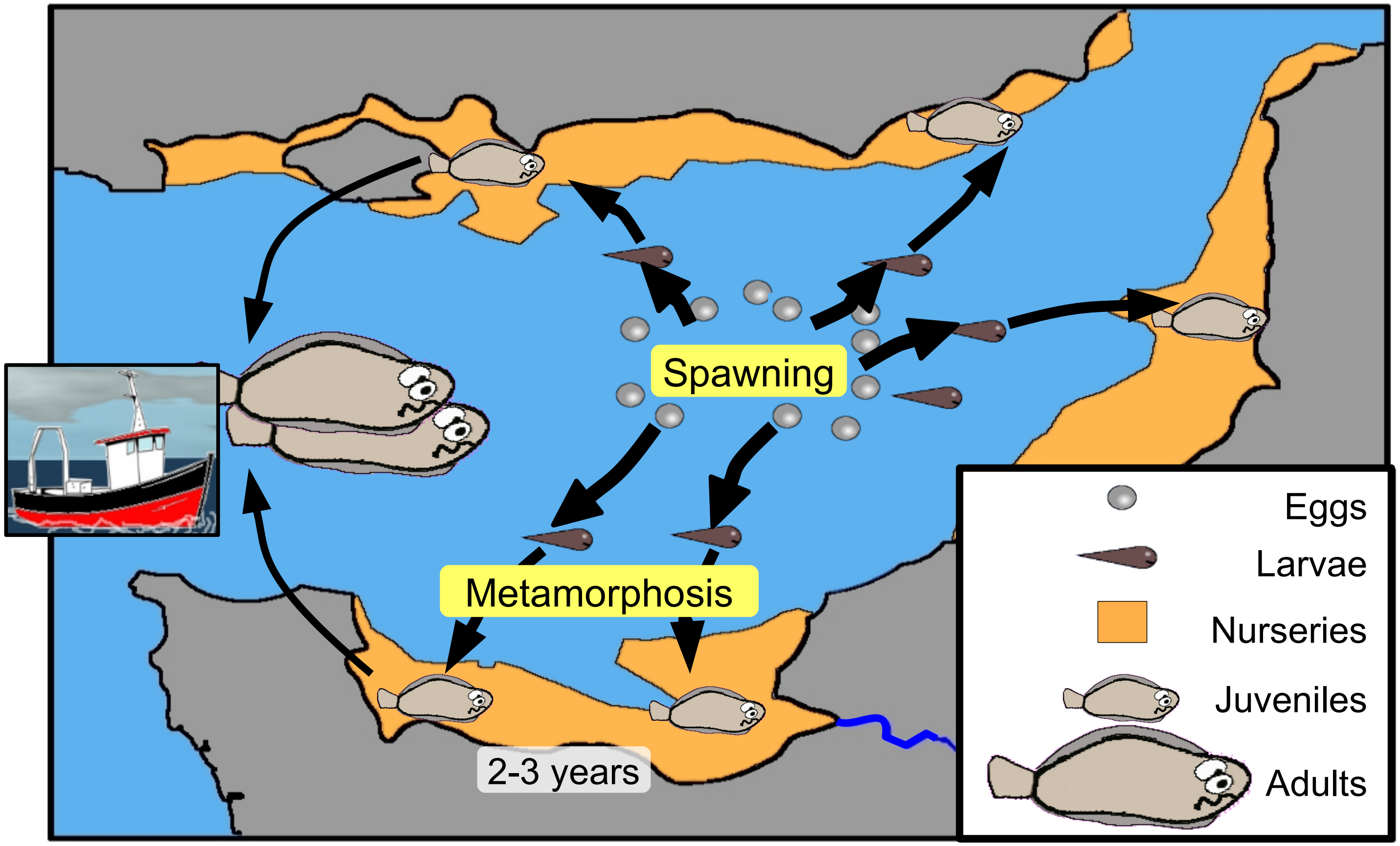
1. Introduction

- The sole population life cycle in the eastern Channel

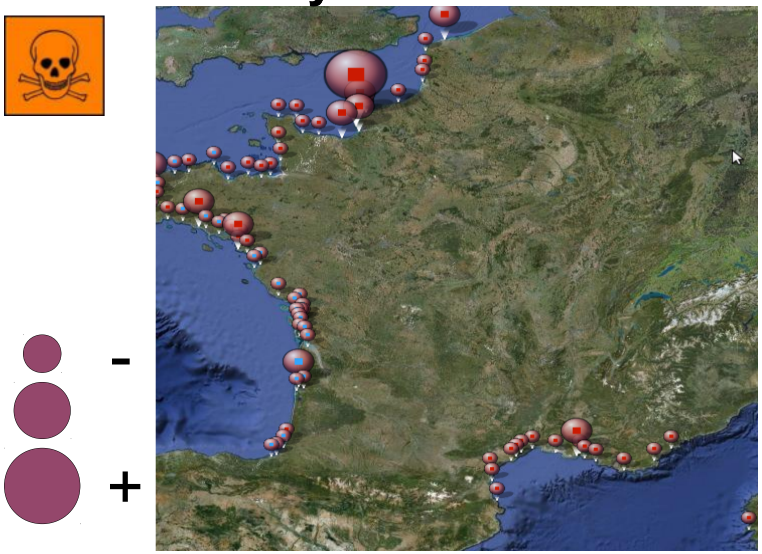


1. Introduction

- Pressures over nurseries of the eastern Channel
  - Habitat modifications (-75% of muddy grounds)
  - Chemical contamination (×10)

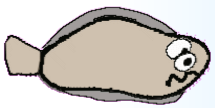
The Seine estuary

Polycyclic Aromatic Hydrocarbons



1. Introduction

- How human pressures impact marine fish life cycle?
  - Habitat degradation over nurseries
  - Influence of larval supply
  - Combination at the scale of the population



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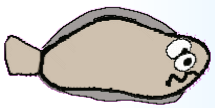
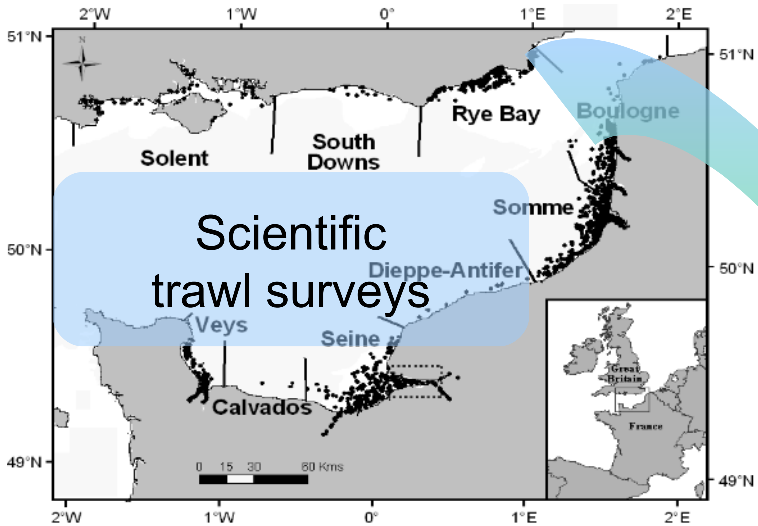
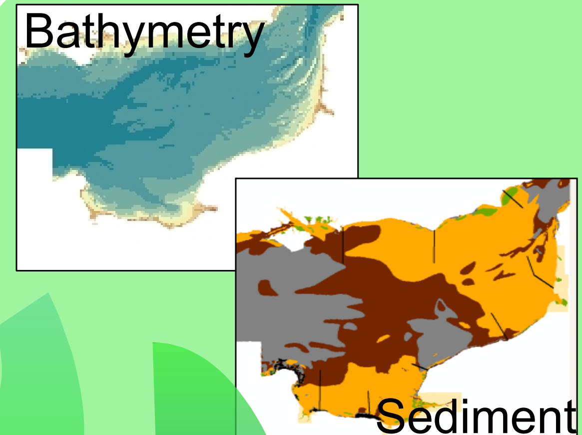


2. Quality of nursery habitats

Method: Habitat suitability model



Scientific trawl surveys



Statistical model (Zero-inflated data: Delta model)

Juveniles densities ~

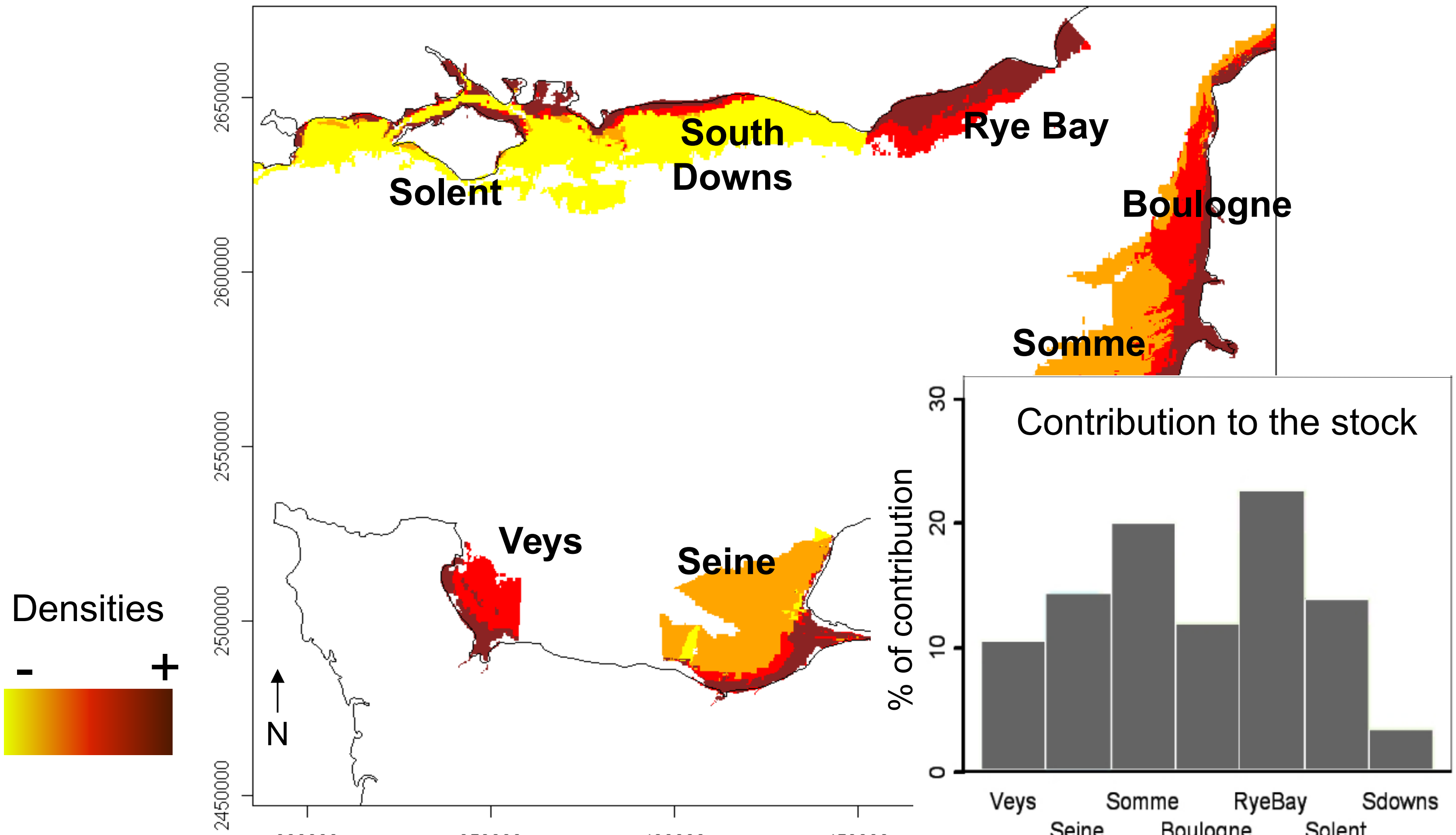
Sector + Bathymetry + Sediment

Mapping of juveniles densities

Rochette S., Rivot E., Morin J., Riou P., and Le Pape O.. 2010.
Effect of nursery habitat degradation on flatfish population: Application to Solea solea in the Eastern Channel (Western Europe).
Journal of Sea Research 64:34-44.

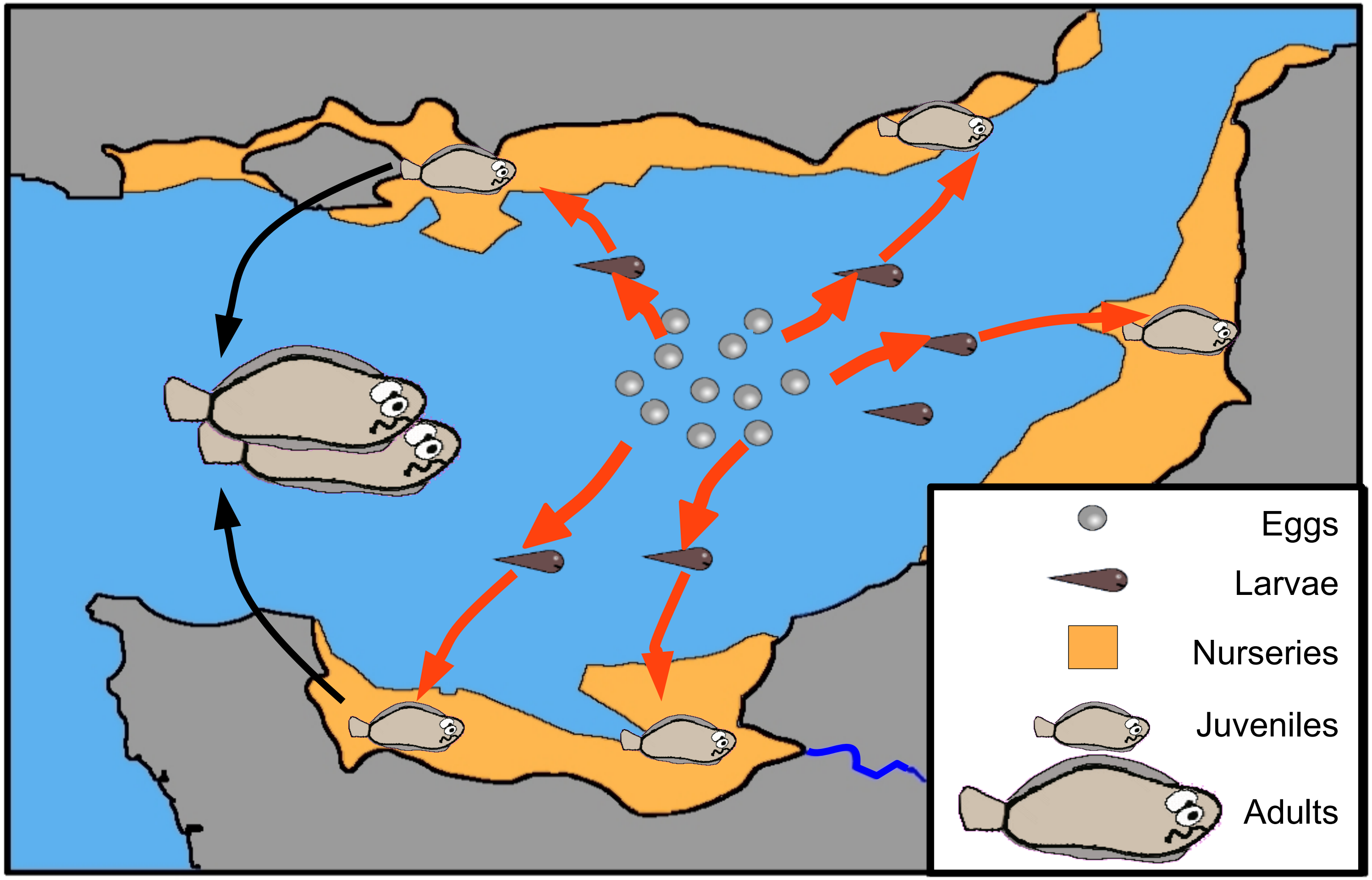
2. Quality of nursery habitats
Results: juvenile production

- Map of juveniles densities



2. Quality of nursery habitats

Discussion



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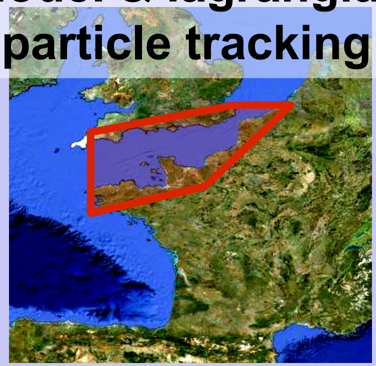
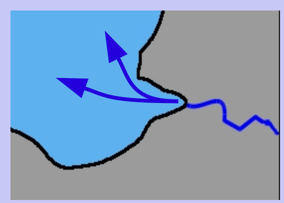
3. Larval dispersal and survival

Material & Methods

Ocean circulation model & lagrangian particle tracking



(Lazure and Dumas, 2008)



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Mars3D

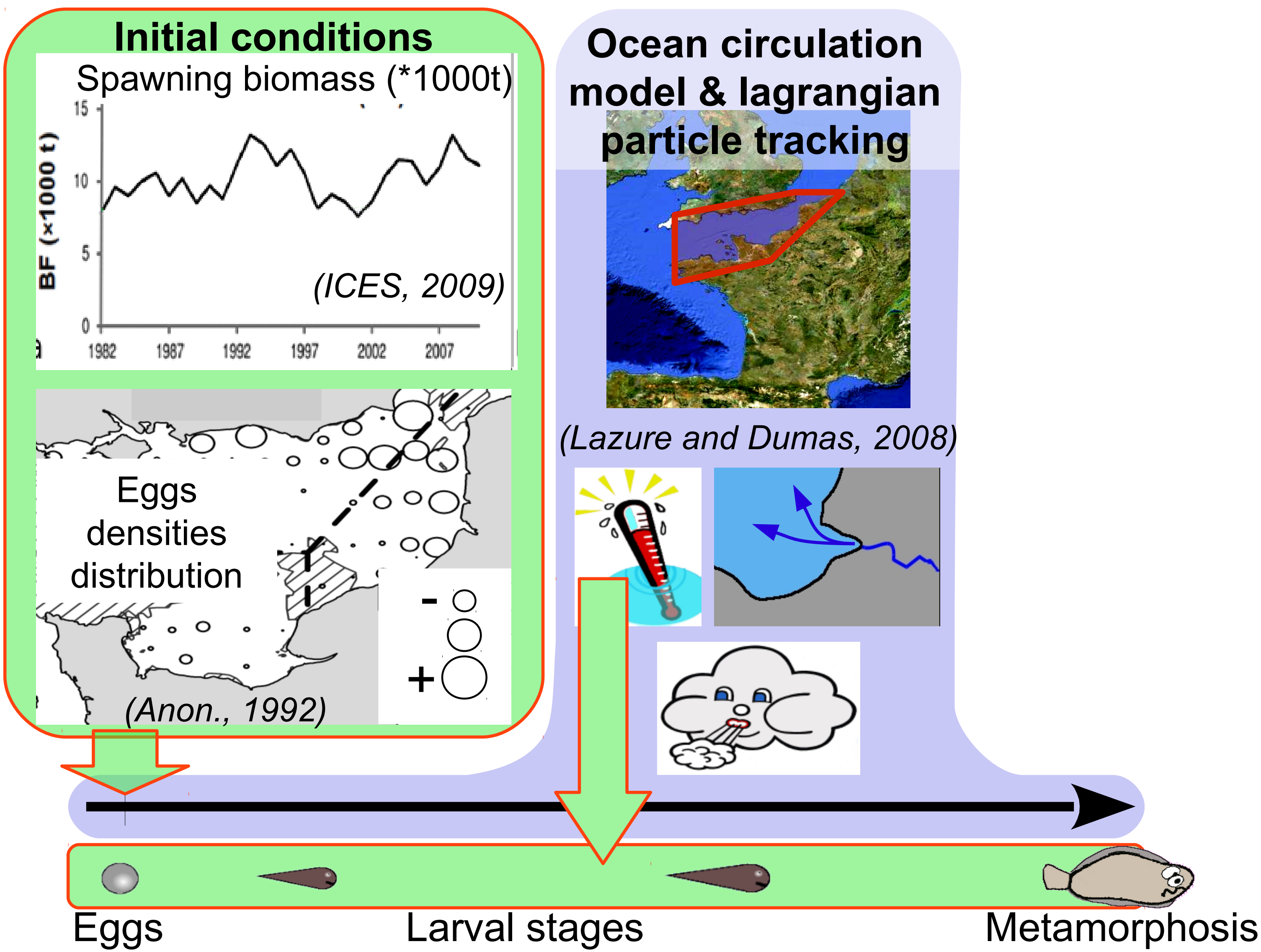
Rochette, S., Huret, M., Rivot, E., Le Pape, O. (in prep.)
A biophysical model to analyse the influence of larval supply on fish recruitment: Application to a coastal and estuarine nursery dependent flatfish population.
Fisheries Oceanography.

Eggs

Metamorphosis

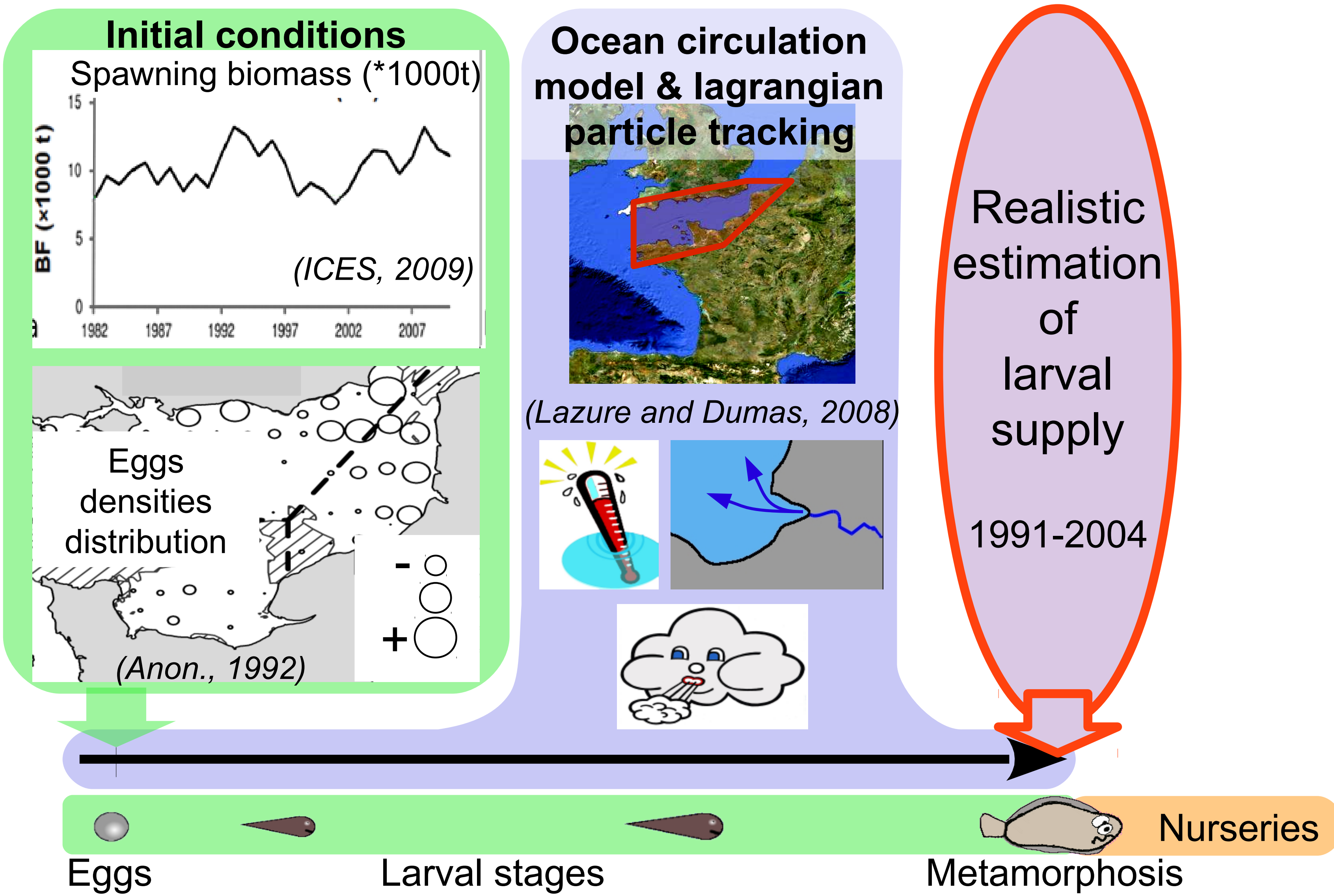
3. Larval dispersal and survival

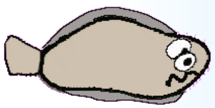
Material & Methods



3. Larval dispersal and survival

Material & Methods



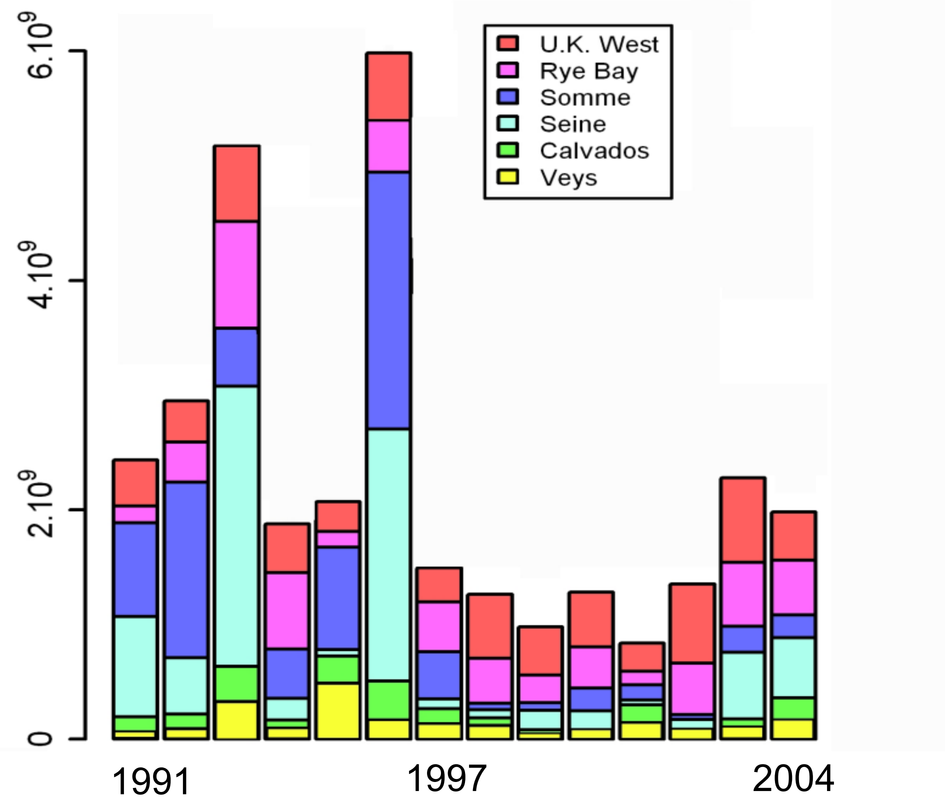


3. Larval dispersal and survival

Results: interannual variability

- Yearly larval supply
- Larval allocation among nurseries

Interannual variability of larval supply



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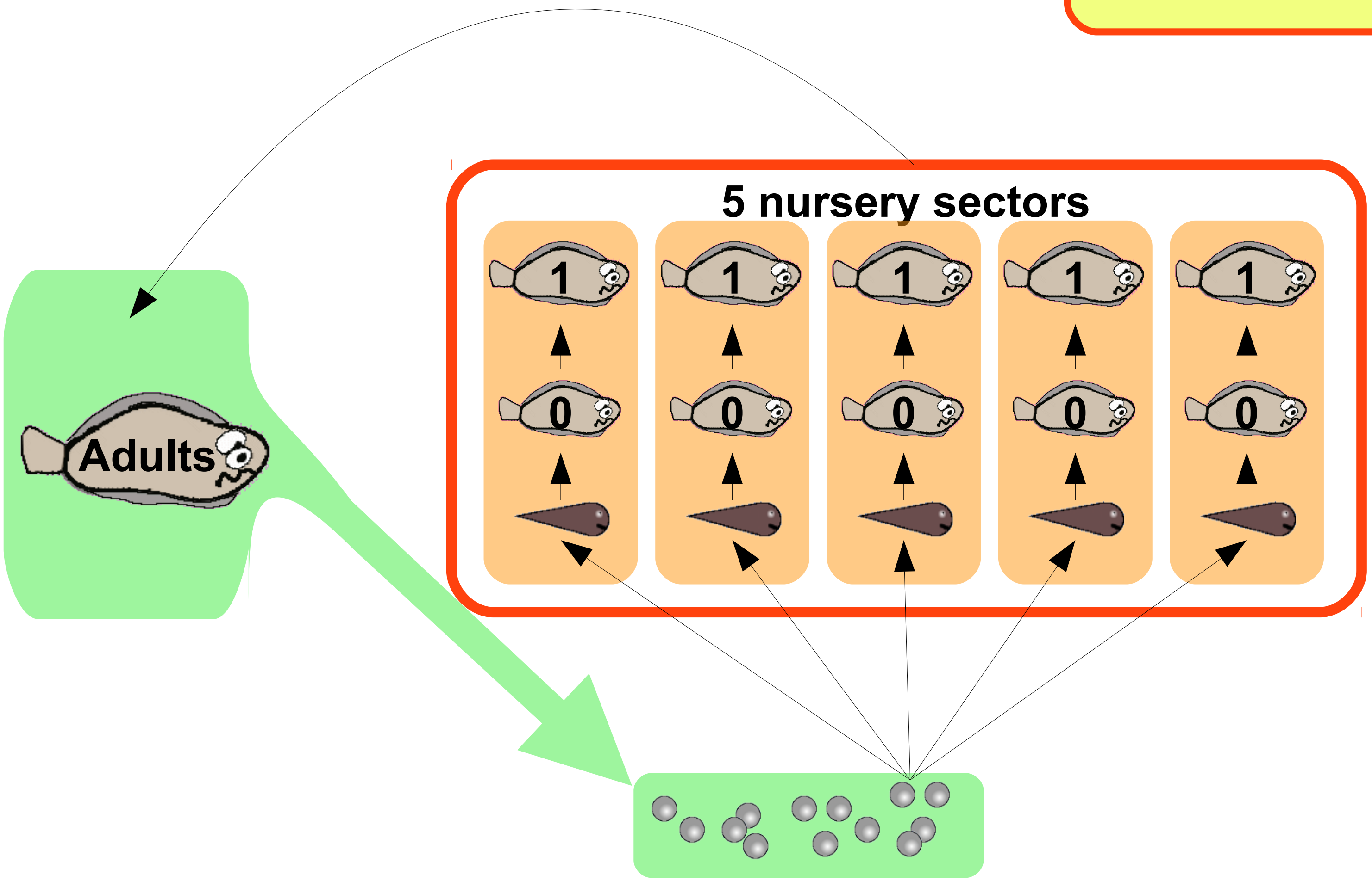
4. The integrated life cycle

Material & Methods: the sole population life cycle

- Spatially-explicit structure

Spatialized recruitment



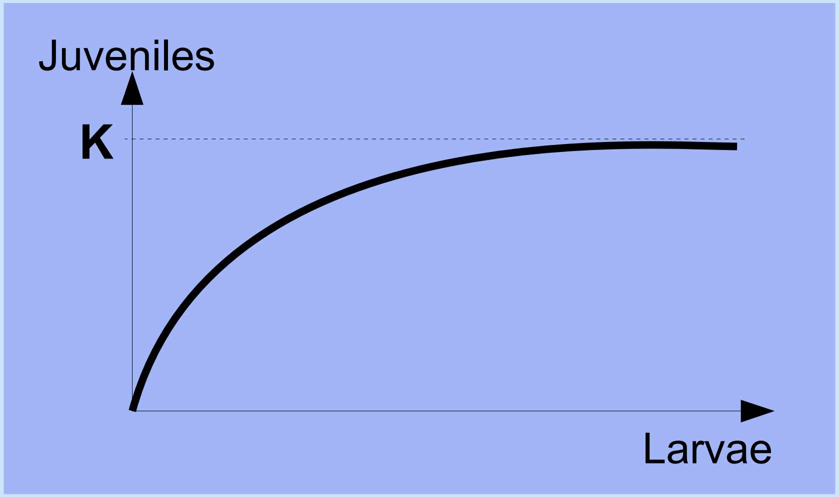
4. The integrated life cycle

Material & Methods: the sole population life cycle

- Spatially-explicit structure

Spatialized recruitment

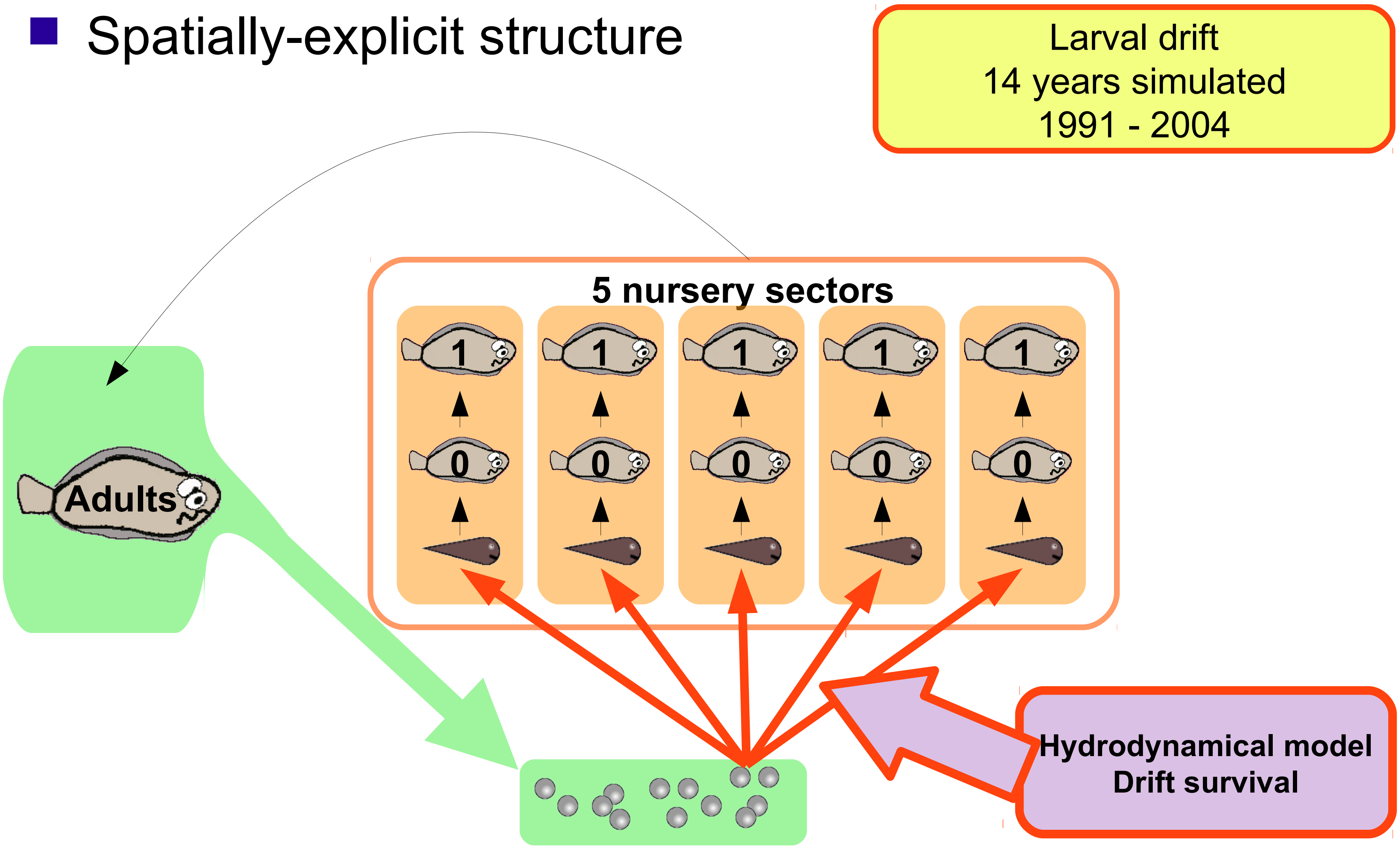
⇒ Density – dependent mortality specific to each nursery



4. The integrated life cycle

Material & Methods: the sole population life cycle

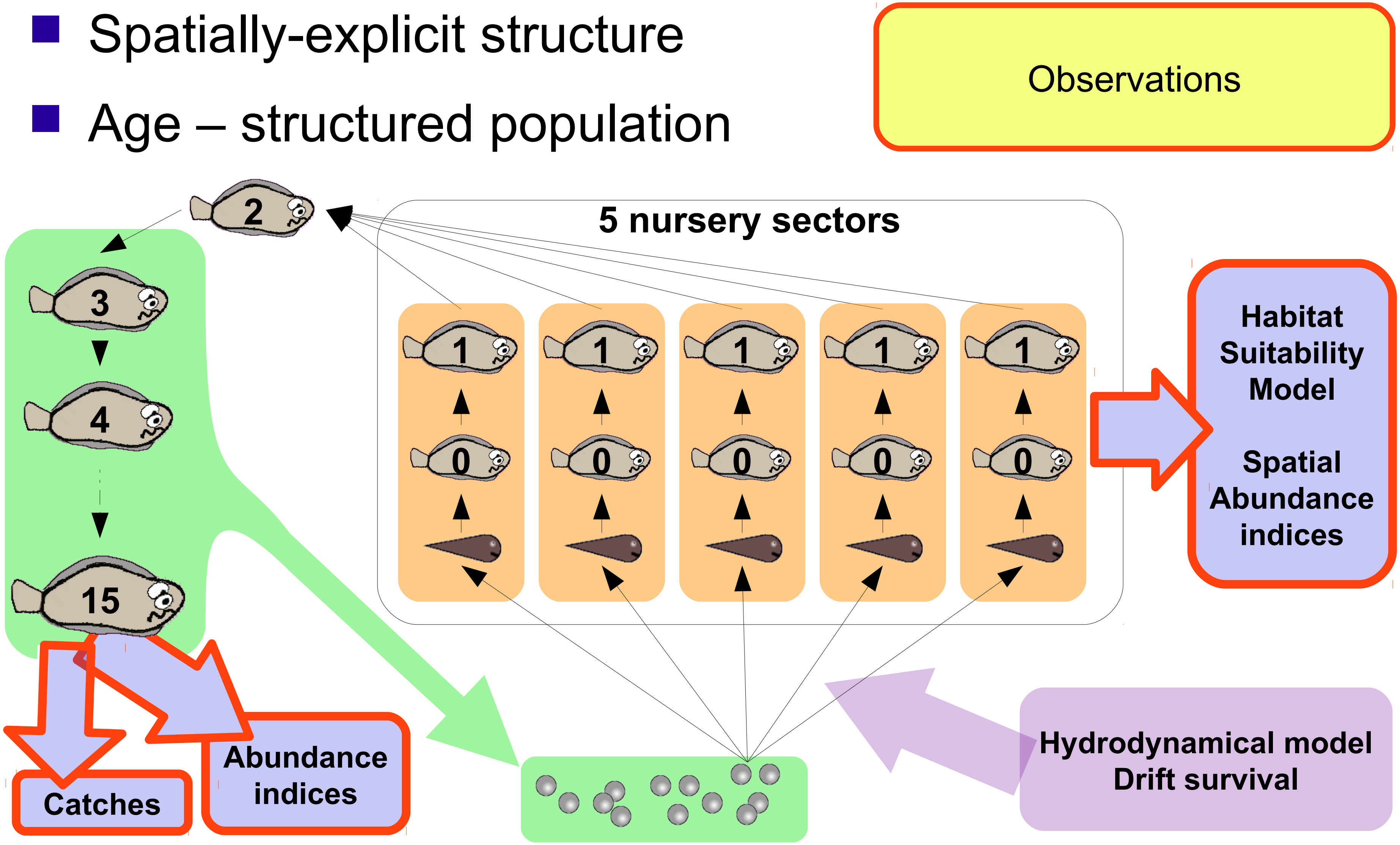
- Spatially-explicit structure



4. The integrated life cycle

Material & Methods: the sole population life cycle

- Spatially-explicit structure
- Age – structured population



4. The integrated life cycle
Material & Methods: the sole population life cycle

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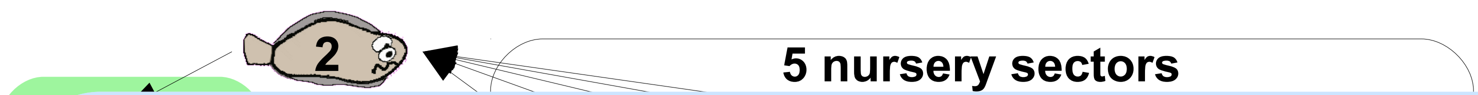
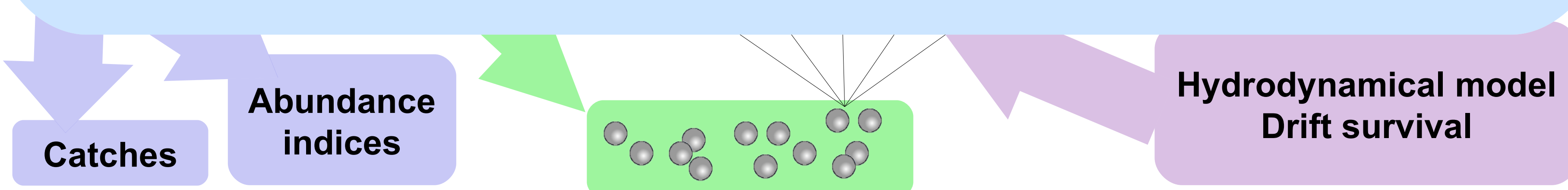


⇒ Bayesian state-space model

- ⇒ Non-observed processes ↔ observations processes
- ⇒ Inferences on hidden states variables and parameters
  - ⇒ Population dynamics and density-dependent mortalities
- ⇒ A fair quantification of uncertainties

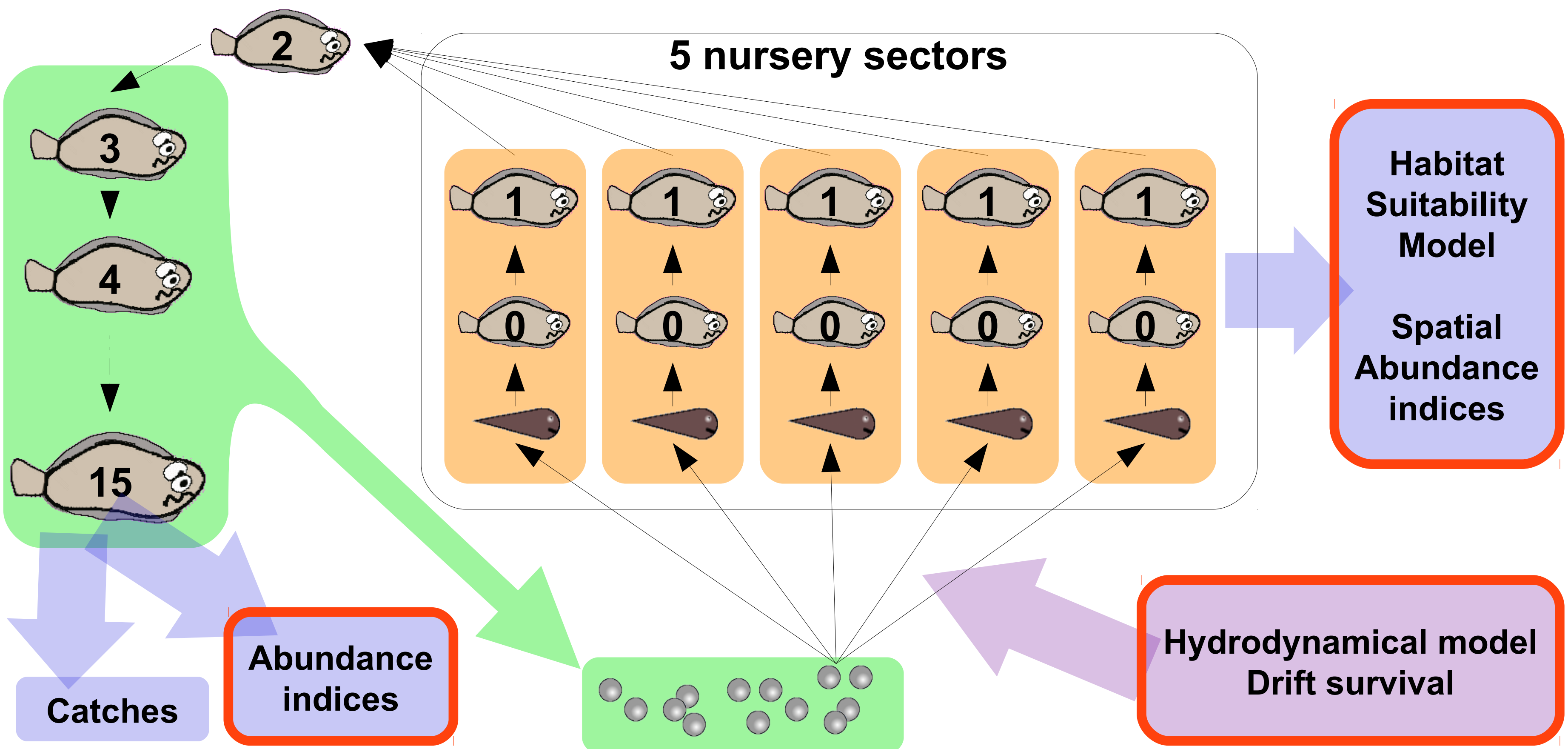


4. The integrated life cycle

Material & Methods: the sole population life cycle

- Spatially-explicit structure
- Age – structured population

Data poor context



4. The integrated life cycle

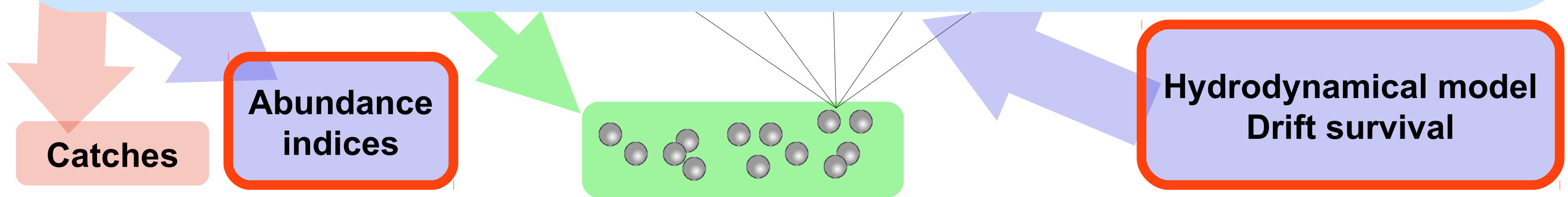
Material & Methods: the sole population life cycle

- Spatially-explicit structure
- Age – structured population

Data poor context

⇒ Assessing the ability of the model to estimate parameters with incomplete time series of data

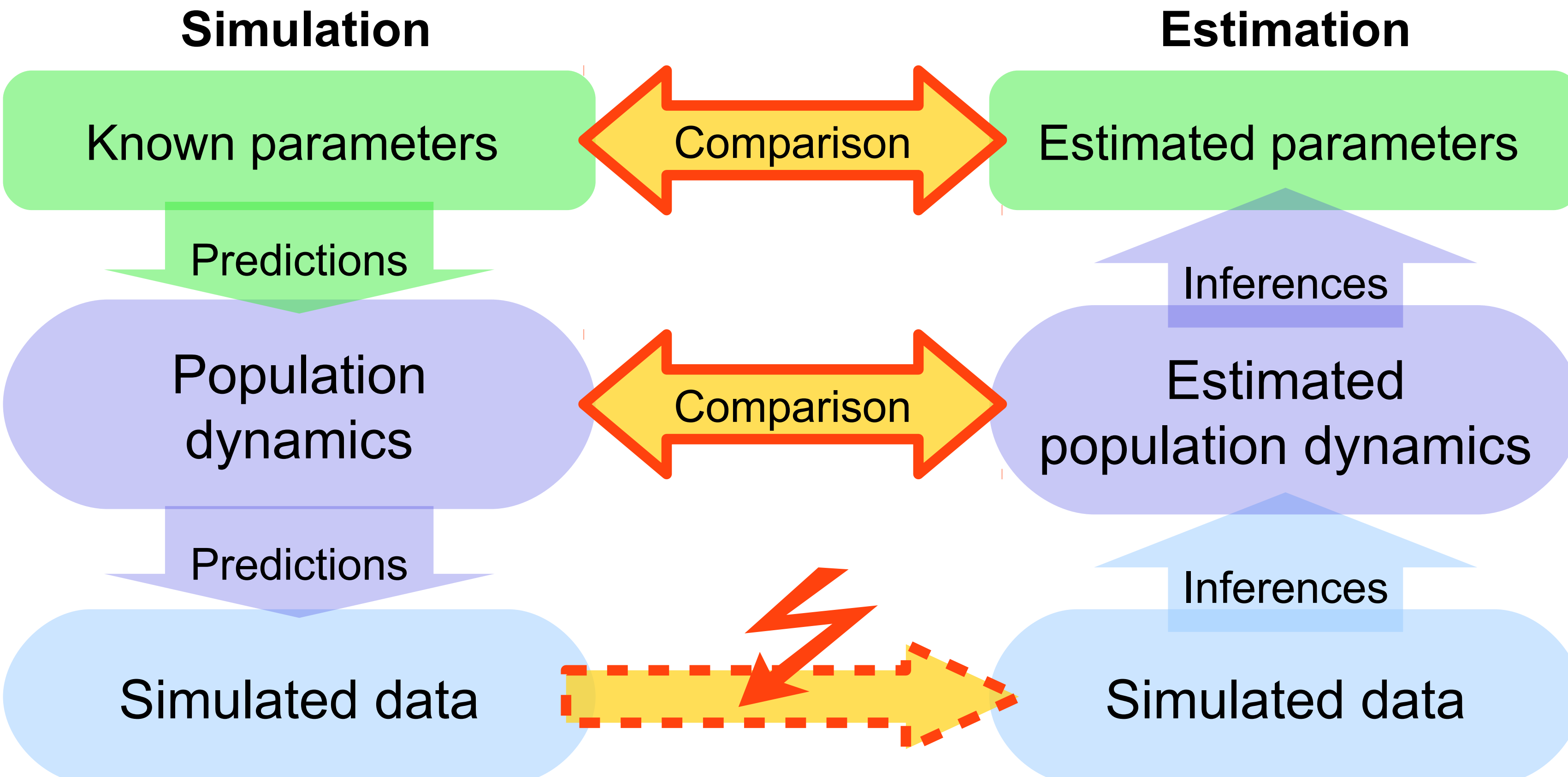
⇒ Simulation – estimation approach

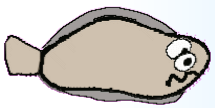


4. The integrated life cycle

Material & Methods: simulation - estimation

- Assessing the ability of the model to estimate parameters with incomplete time series of data

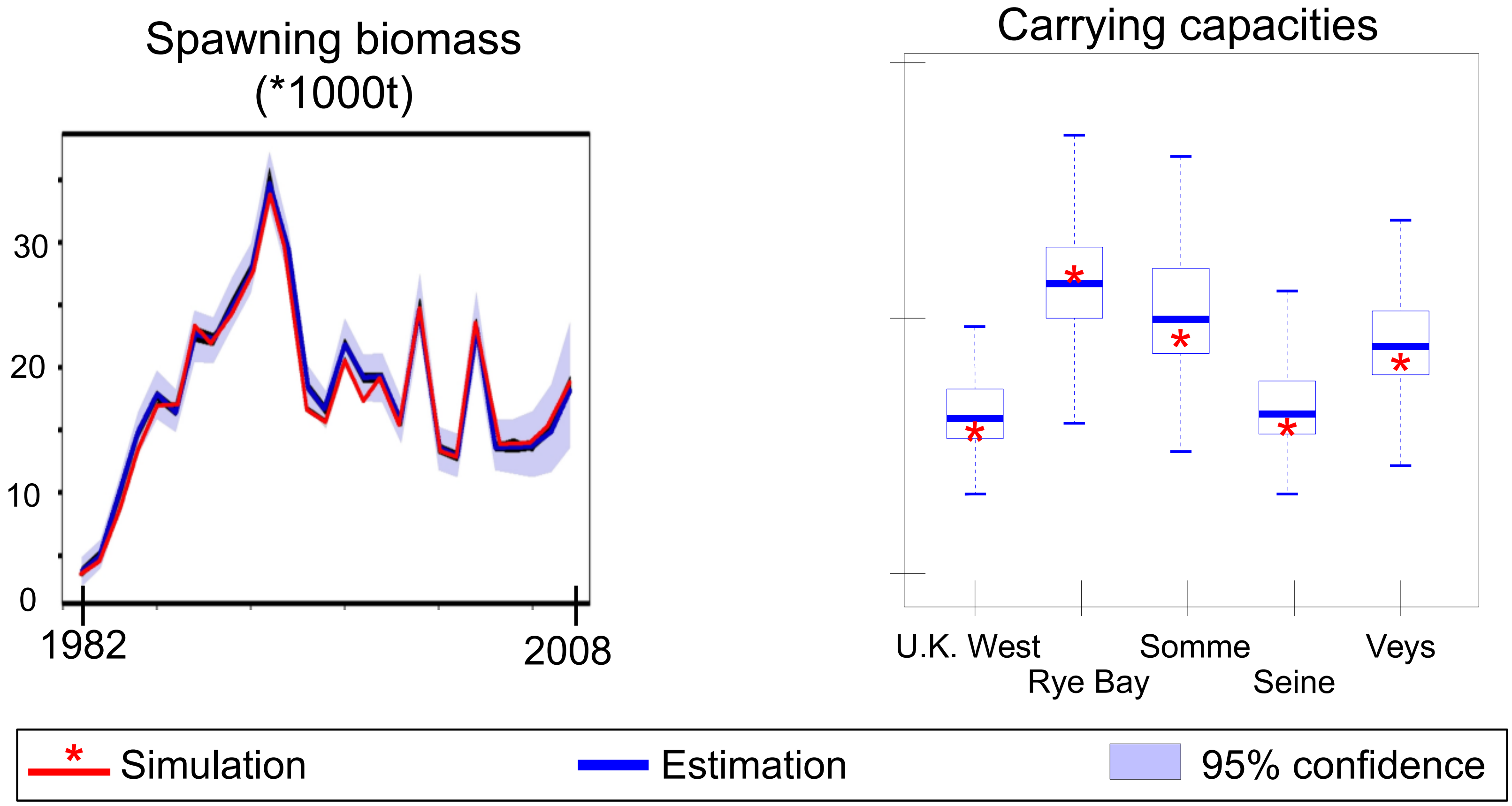


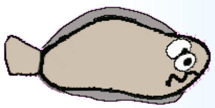


4. The integrated life cycle

Results: simulation - estimation

- Time series of states variables
- Site specific parameters





4. The integrated life cycle
Results: simulation - estimation

- Time series of states variables
- Site specific parameters

Spawning biomass
(*1000t)

Carrying capacities

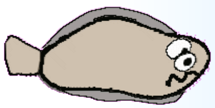
⇒ All parameters and state variables are identifiable
⇒ No bias and low uncertainty

⇒ Application to the real case

0
1982
2008

U.K. West
Rye Bay
Somme
Seine
Veys

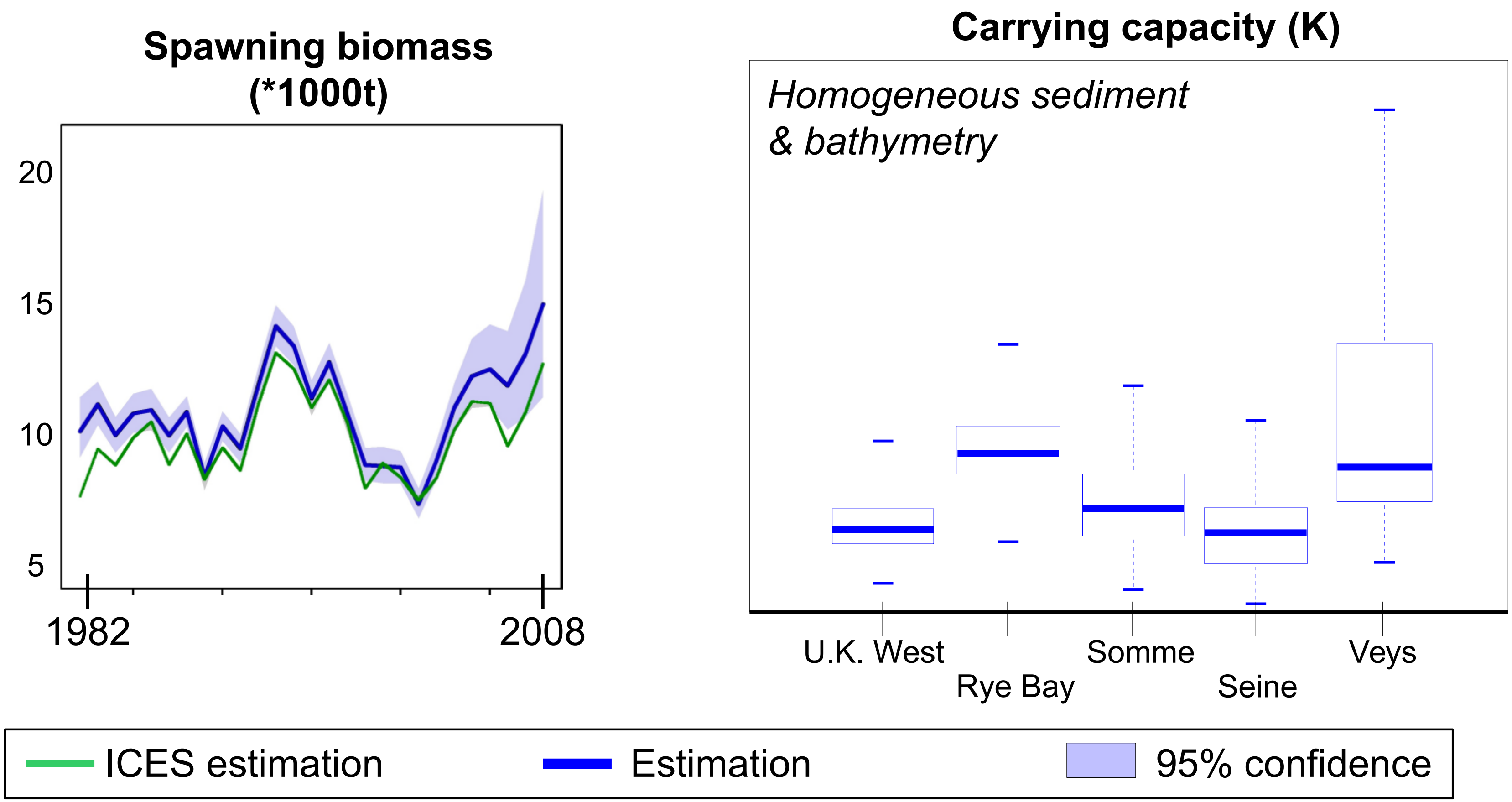
Simulation
Estimation
95% confidence

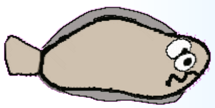


4. The integrated life cycle

Results: application to the real case

- Consistent with ICES estimations
- Spatially-explicit recruitment process





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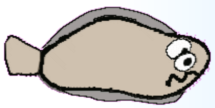


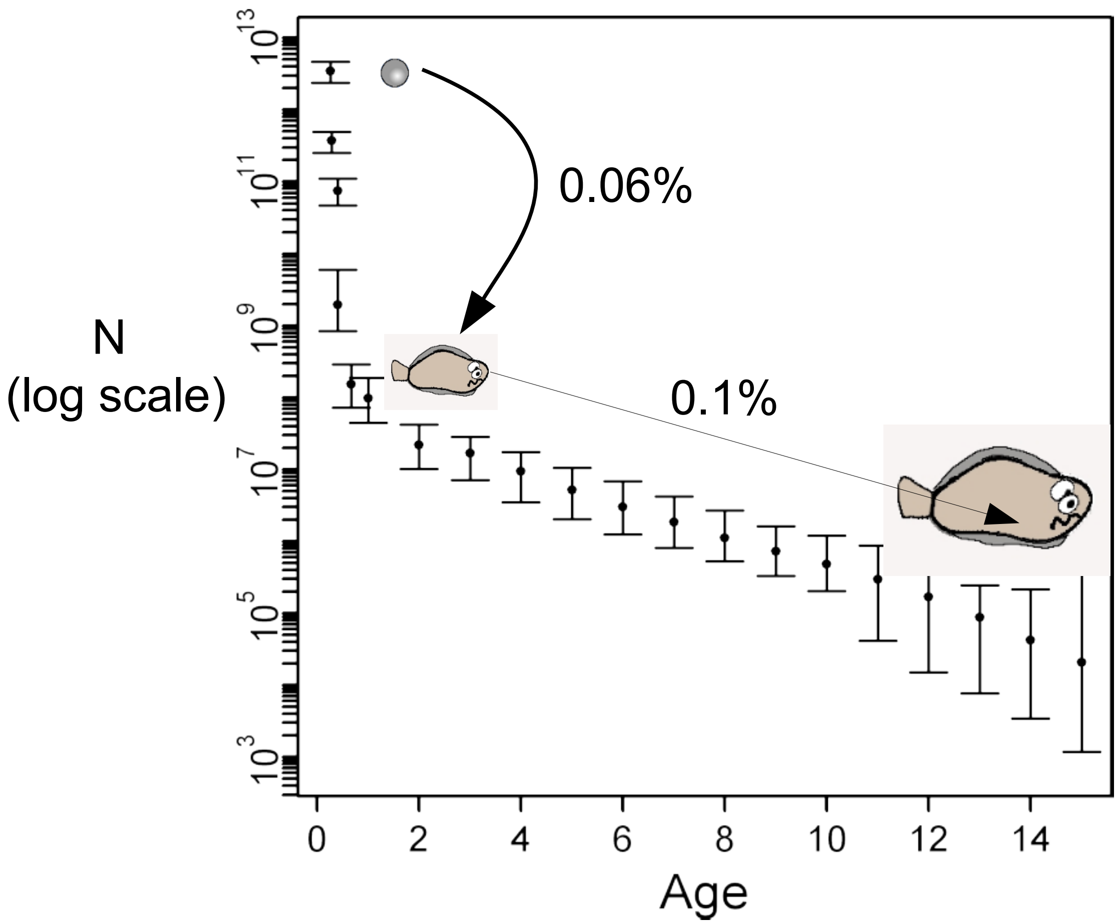
5. Conclusion & perspectives

- A framework allowing for integrated life cycle modelling
  - Prior information of processes
  - Biological knowledge
  - Observations

- Layout foundations
  - Estimate hidden population dynamics under pressures
  - Detail effects of pressures on the recruitment process

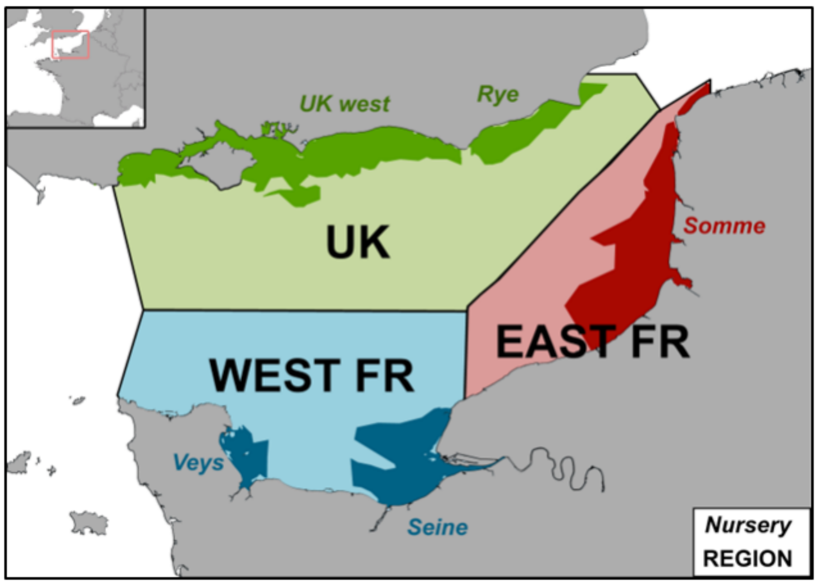
5. Conclusion & perspectives

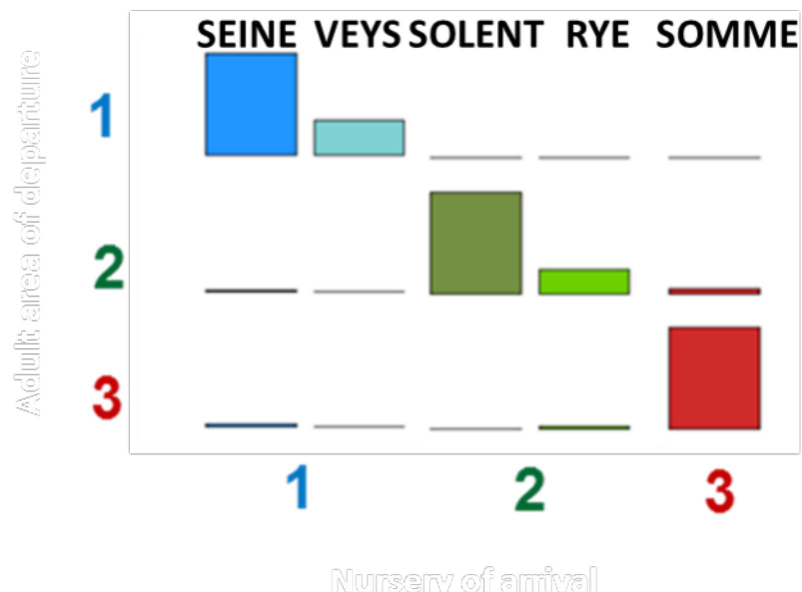
Importance of first life stages

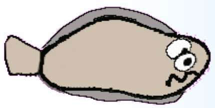


5. Conclusion & perspectives

- Effect of connectivity on larval stage
  - Larval dispersal model suggest low young stage connectivity



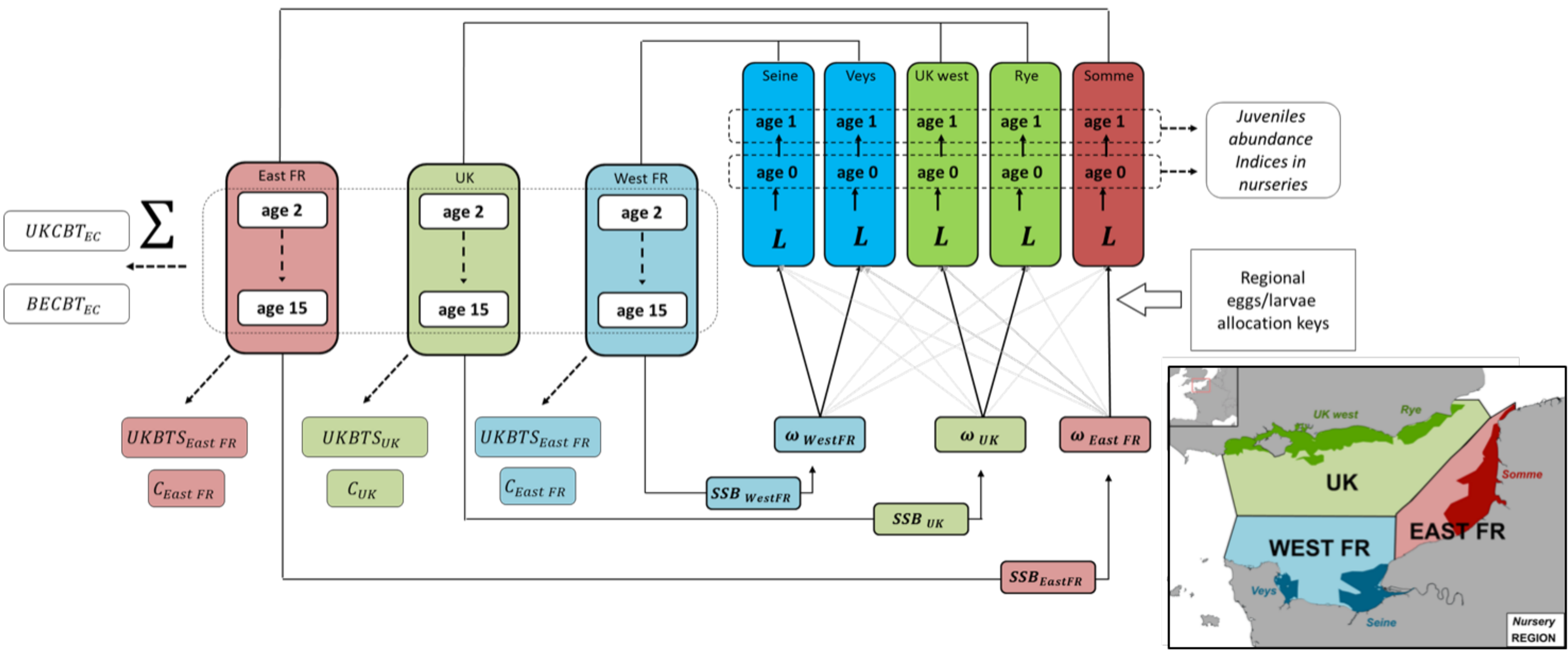




5. Conclusion & perspectives

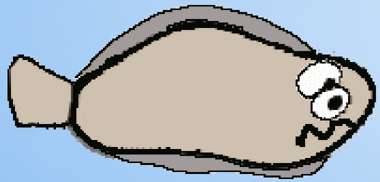
- Effect of connectivity on larval stage
  - Larval dispersal model suggest low young stage connectivity
  - What about the connectivity of the adult population ?

REGIONAL MODEL WITH THREE SUBPOPULATIONS



5. Conclusion & perspectives

- The life cycle modelling framework offers interesting simulation perspectives
  - Past scenarios
    - Impact of fishing vs habitat degradation
  - Future scenarios
    - Stock assessment with reliable recruitment estimation
    - Effect of management scenarios (spatially-structured)



Thanks you for your attention

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Data sources