Reconciling ocean connectivity and hydroclimate with the management of transboundary metapopulations

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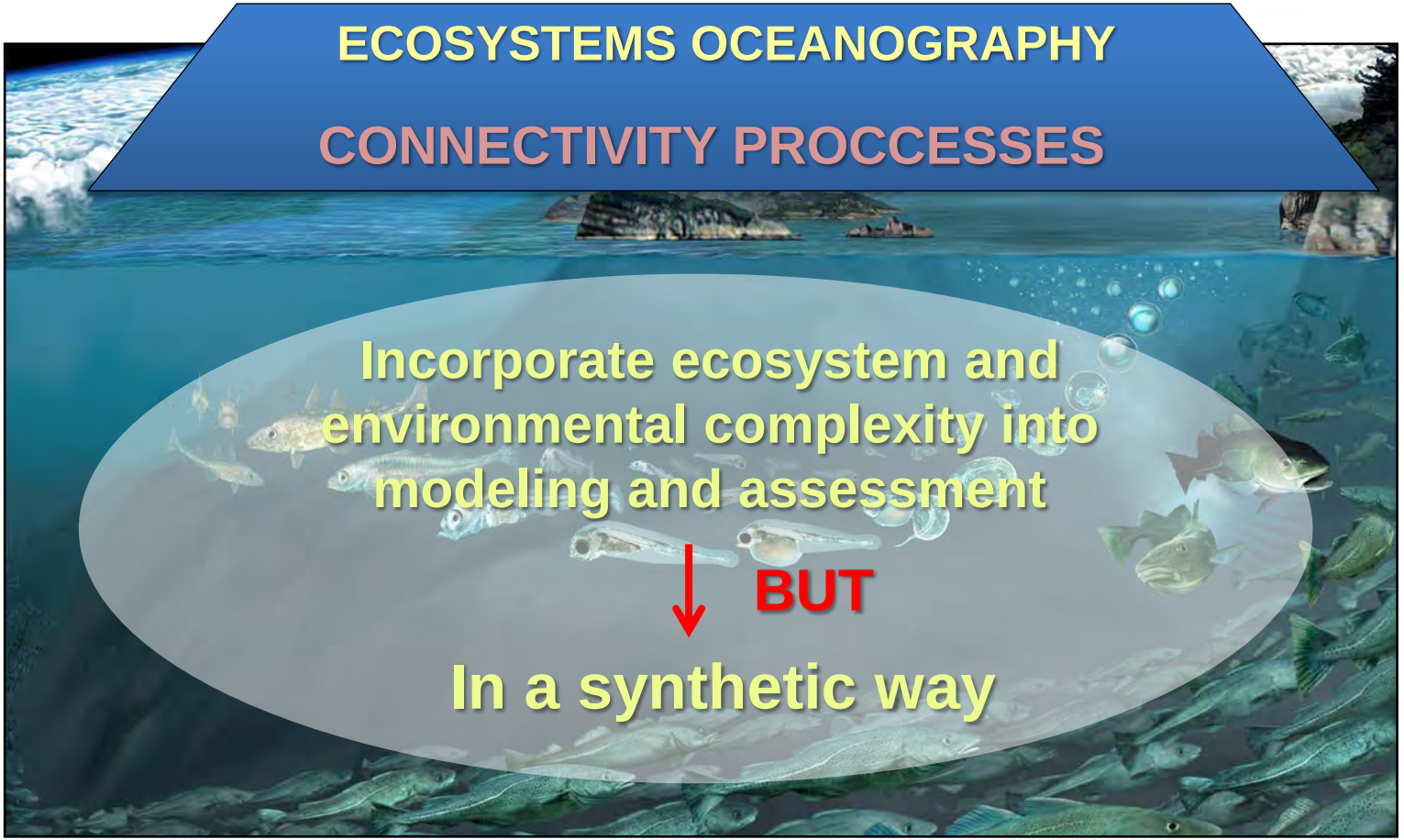
1. BACKGROUND & MOTIVATION

M. Hidalgo



AT FISH STOCK LEVEL

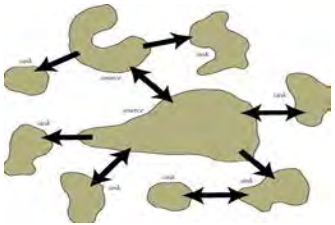
CONNECTIVITY PROCCESSES

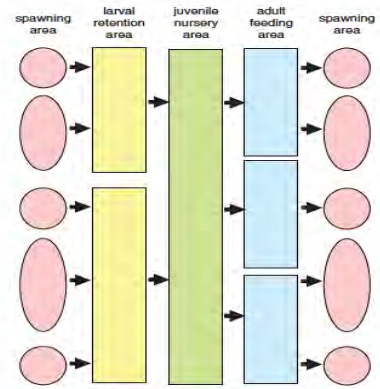
1. **Indirectly investigated** in fisheries science to reveal ***'stock identification/delimitation'*** *(i.e. management units).*

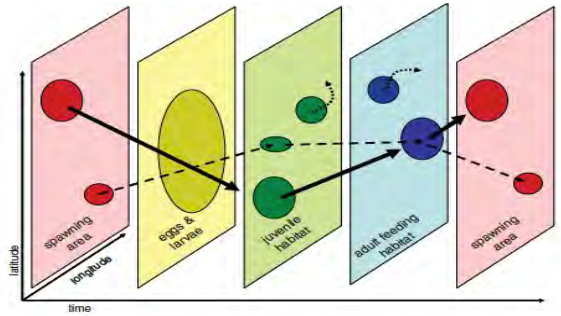
AT FISH STOCK LEVEL

CONNECTIVITY PROCCESSES

2. Mounting research evidences that **demographic and spatial population structure is much more complex** that currently assumed.







Cadrin and Secor 2009

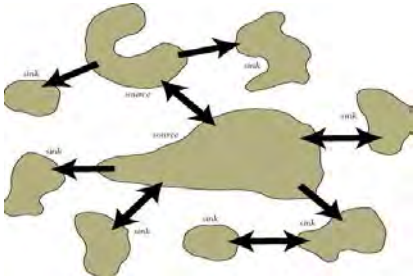
AT FISH STOCK LEVEL

CONNECTIVITY PROCCESSES

Tagging

Stock boundaries

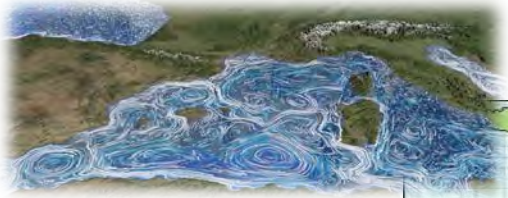
Intra – stock complexity

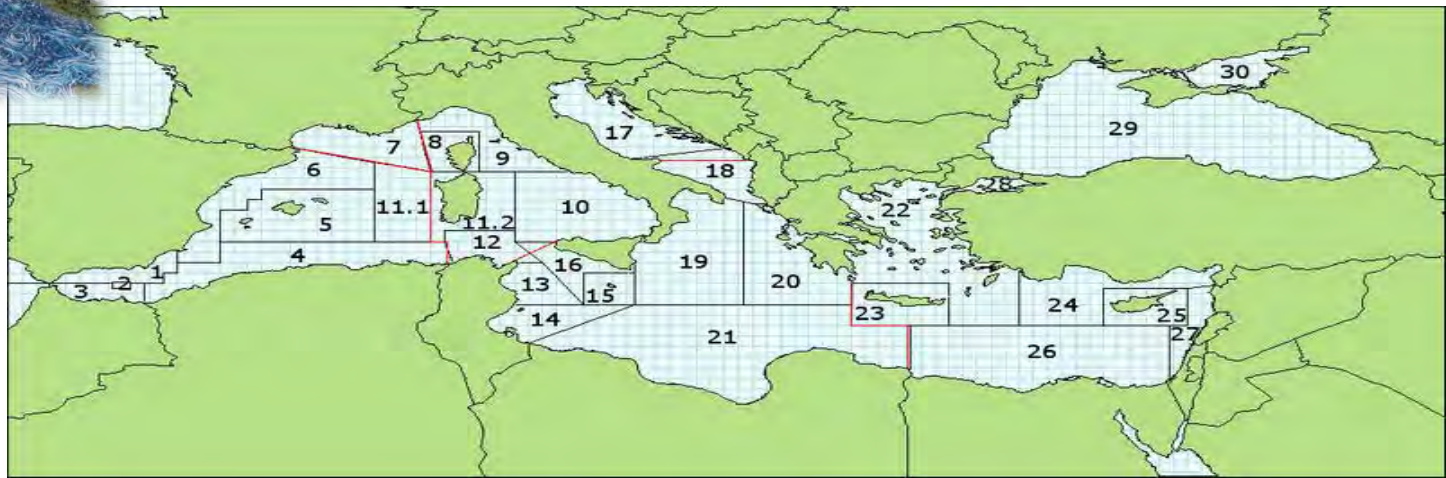


Biophysical modeling

Can populations estimates be (over/under)-estimated?

Can estimates at a given management area be improved by considering a more complex populations structure?

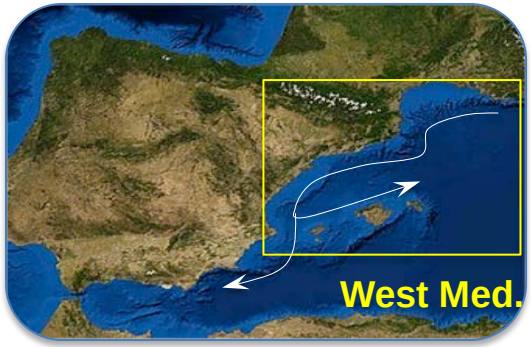




2. OBJECTIVE

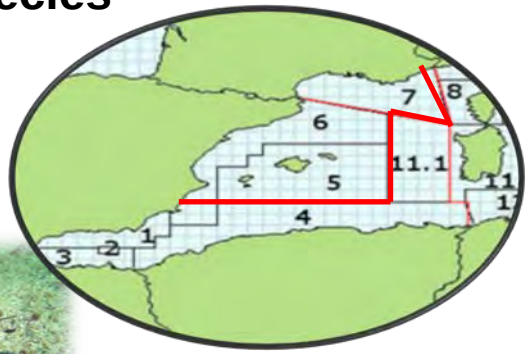
*To elucidate the influence of the inter-annual variability of the connectivity processes (**self-recruitment, export and retention**) and **local climate** variability on the **recruitment dynamics** of the European hake.*

Case Study



Western Mediterranean

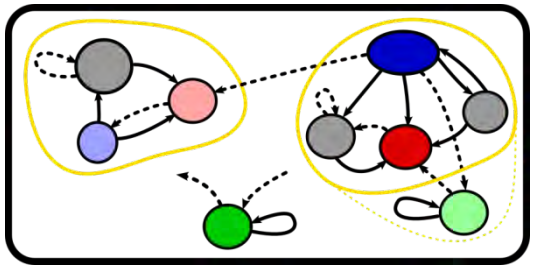
Study species



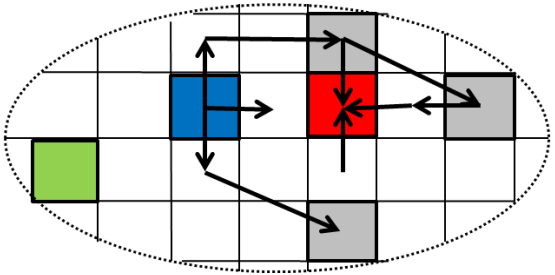
European hake
(*Merluccius merluccius*)

LAGRANGIAN FLOW NETWORK: Lagrangian bio-physical modelling + Graph Theory tools.

Metapopulation



Mediterranean Sea



Ecological Objectives

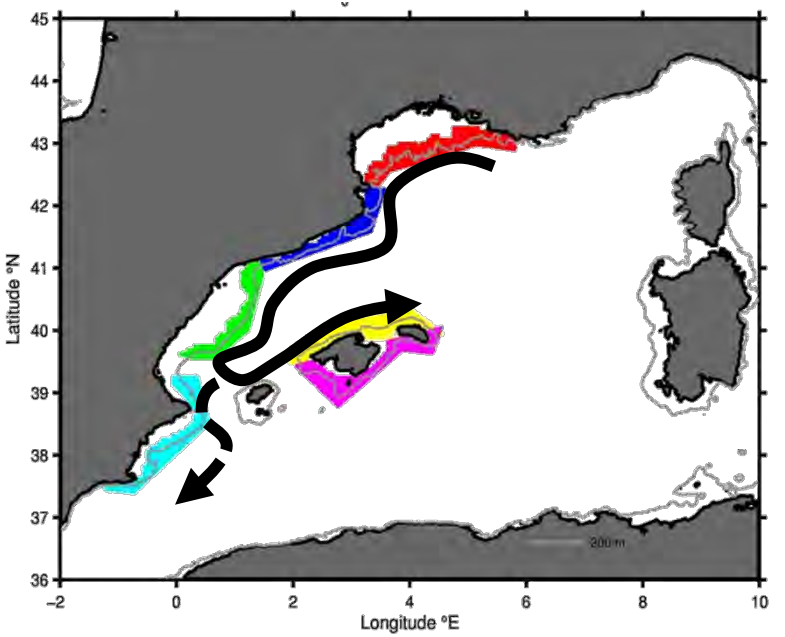
Describe the **direction** and **quantity of larvae** transported between sub-populations (e.g. habitat patches)

Network Theory Equivalent

Describe the **direction** and **strength** of the links existing between all the nodes of our transport network

Ser-Giacomi et al. 2015

PARTICLES DISPERSION EXPERIMENT



- ✓ 6 potential subpopulations (3 management areas)
- ✓ Spawning period: 1st Sept- 30th Nov.
- ✓ Spawning events**: 7 starting dates 15 days apar**t (19 events, 5 days apart).
- ✓ Depth: 60, **90**, 120 m. depth
- ✓ PLD: 30, **40** and 50 days.

Sensitivity analyses

- ✓ No significant differences in all the elements.

CONNECTIVITY / RETENTION INDICATORS AT SUB-POPULATION SCALE

LOCAL RETENTION (LR)

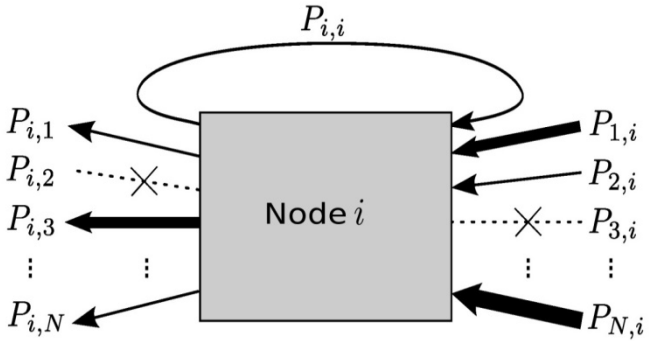
Proportion of locally produced settlement to local larval release

$$LR_i = P_{i,i}$$

SELF-RECRUITEMENT (SR)

Ratio of locally produced settlement to settlement of all origins at a given site

$$SR_i = \frac{P_{i,i}}{\sum_{x=1}^{N} P_{x,i}}$$



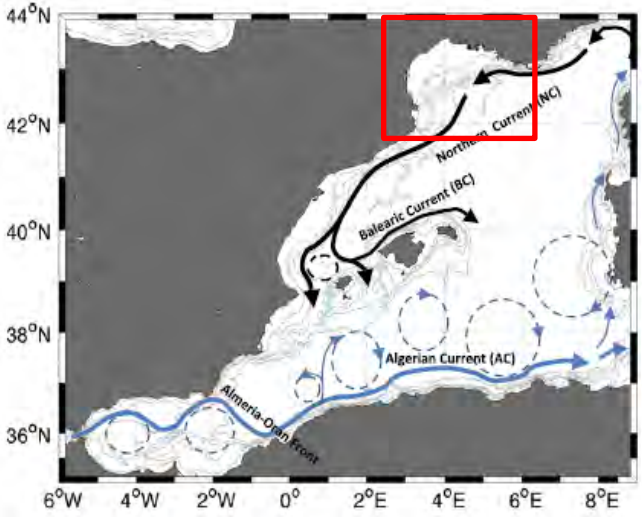
$$OUT_i{}^{flux} = \sum_{x=1}^{N} (P_{i,x}) - P_{i,i}$$

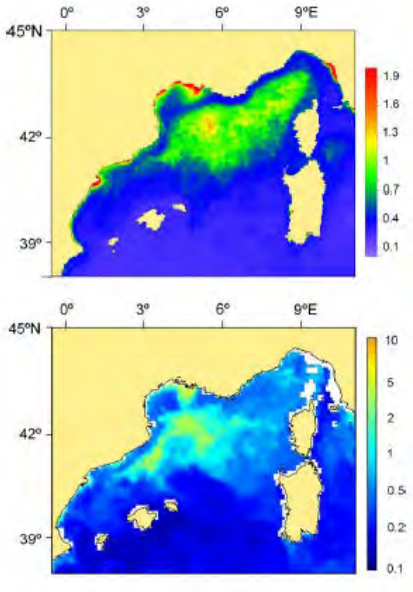
$$IN_i{}^{flux} = \sum_{x=1}^{N} (P_{x,i}) - P_{i,i}$$

IMPORT (IN)

Bostford et al. 2009, Dubois et al. 2016 JBG

REGIONAL CLIMATE INDEX





- Difference of air and sea temperatures.

- Convection processes and Primary Production.

- Thermohaline circulation and Intermediate Water Masses formation.

- Related to the hake recruitment in the Balearic Islands.

- No information in the rest of management areas.

Balbín et al (2014) JMS Martín et al (2016) FO

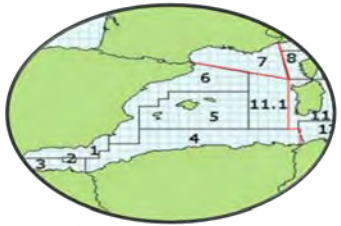
RECRUITMENT DYNAMICS

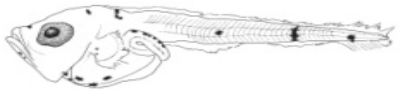
RECRUITMENT

Self-Recruitment

Local Retention + **Regional climate** + **SSB**

Import





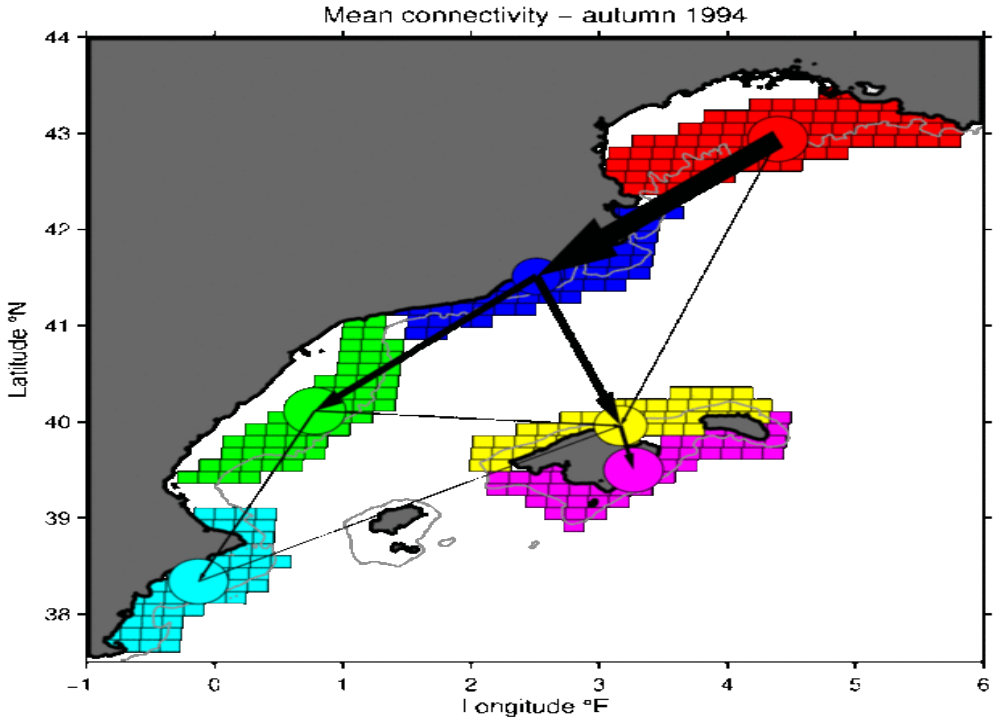
SURVIVAL

Log (Rec/SSB_{t-1})

GLOBAL PATTERN

Gulf of Lions as the a main and strong source.

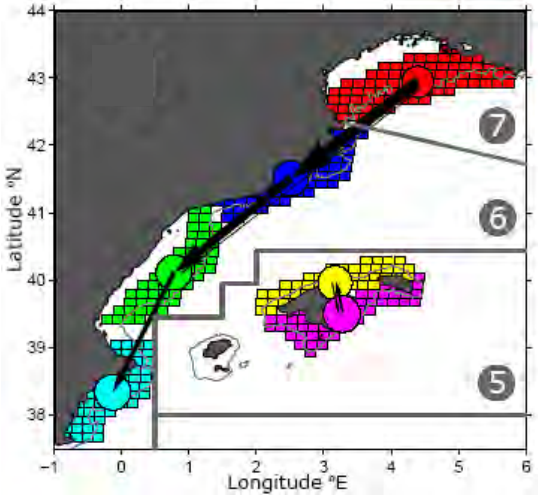
Directional connectivity.



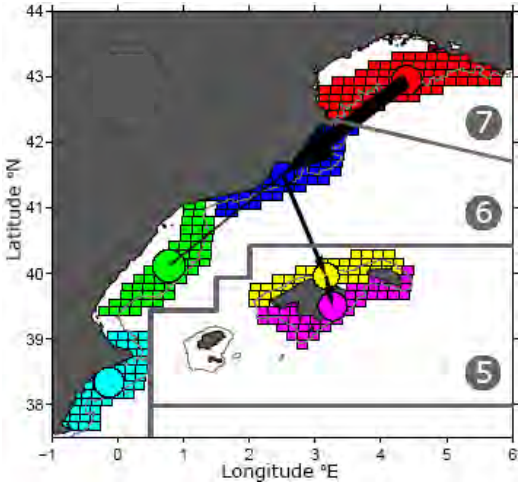
GLOBAL PATTERN

TWO MAIN SCENARIOS

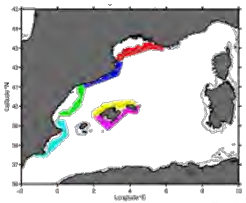
1. Mainland transport with reduced connection to the Islands

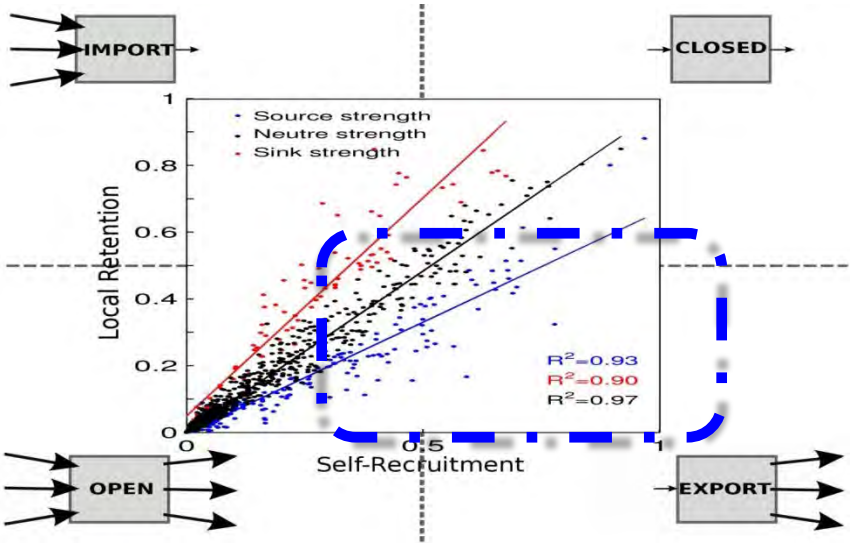


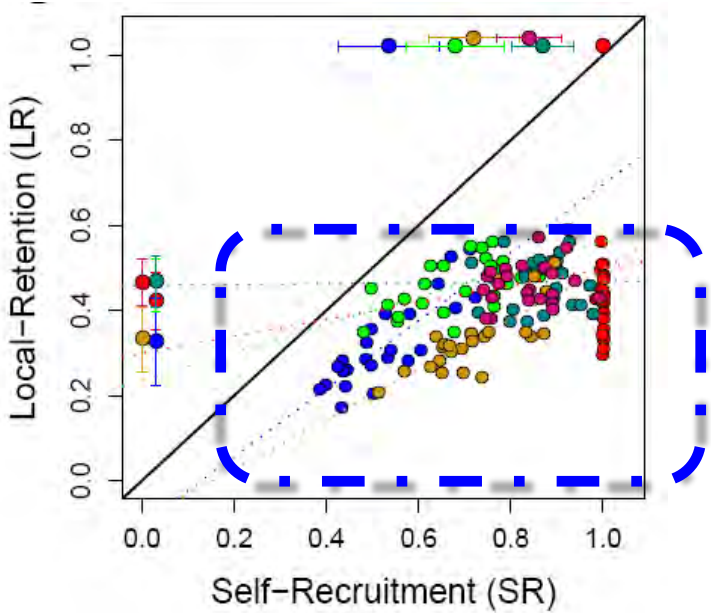
2. Mainland transport reduced with more connection to the archipelago



INTER-ANNUAL VARIABILITY

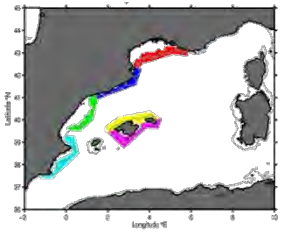


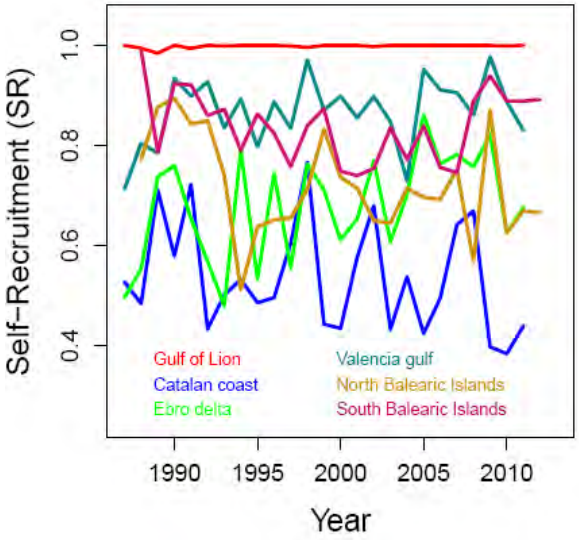


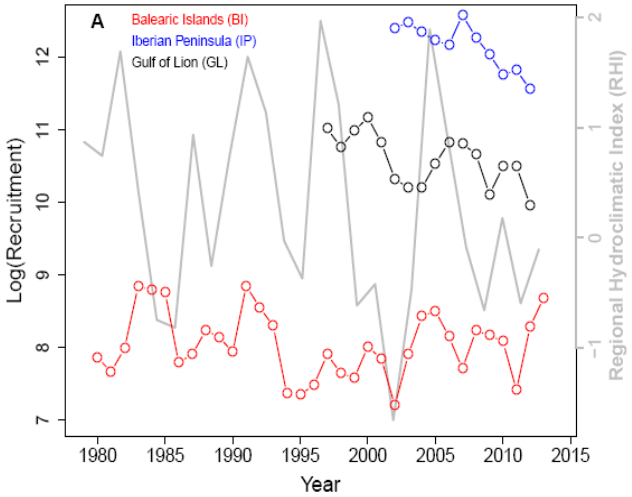


Dubois et al. 2016 JBG

INTER-ANNUAL VARIABILITY



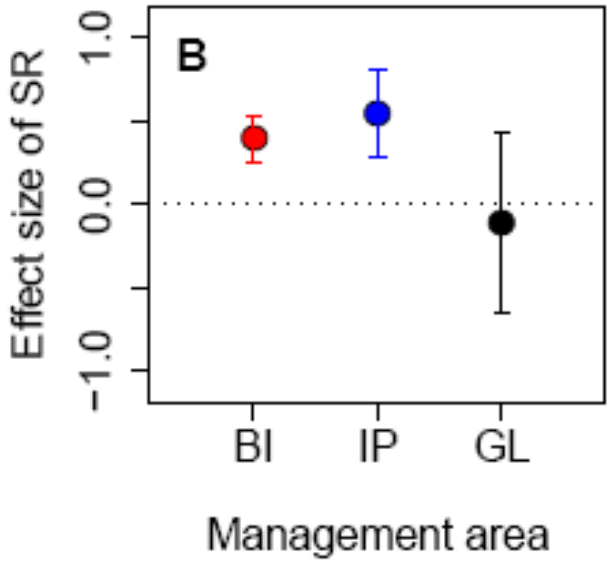


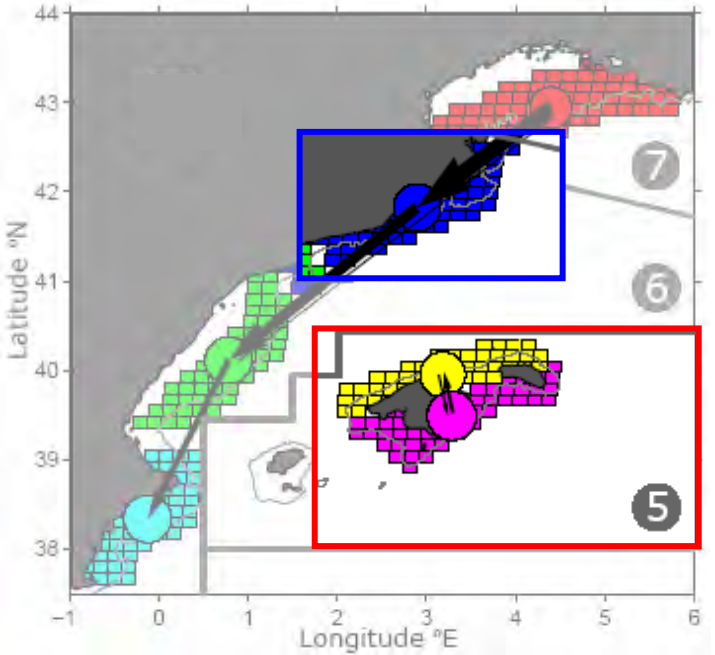


RECRUITMENT DYNAMICS

Self-Recruitment (SR) is the main driver.

SR effect acts at different spatial scale.



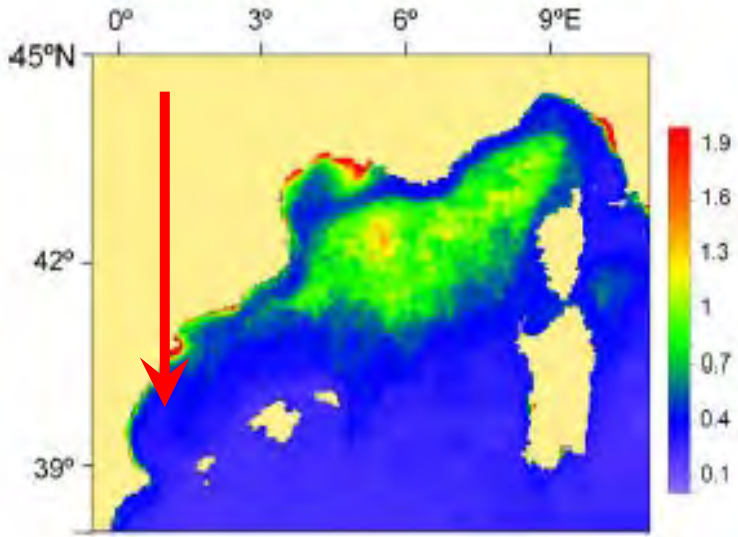


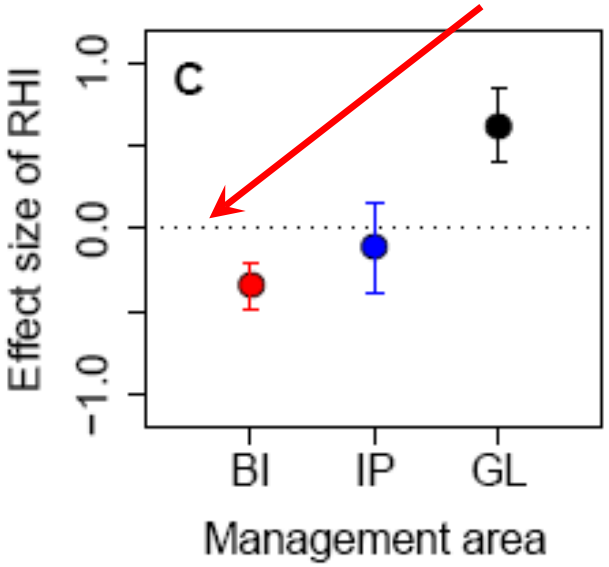
RECRUITMENT DYNAMICS

Gradient in the regional climate effect.

Response to climate spatially-structured within the metapopulation.

High convection: high mortality in the Gulf of Lion and productive scenario in the Islands.





5. IMPLICATIONS

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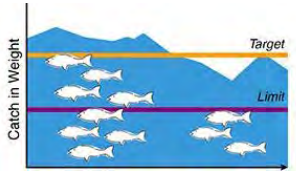
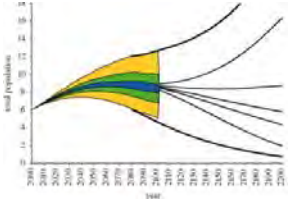
1. Short-term forecast: Measures in winter for the spring recruitment.

Stock assessment models



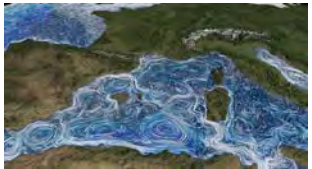
2. Mid- and long-term projections: Regional oceanographic models to test potential scenarios.

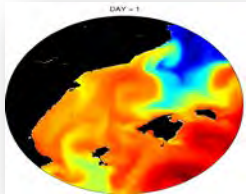
Population projection models



3. Embrace temporal assessment and (operational) **spatial management**





5. CONCLUSIONS

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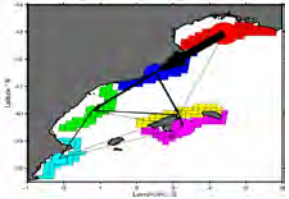
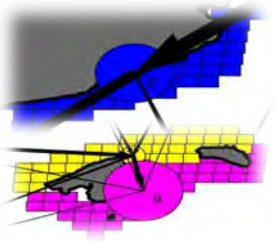
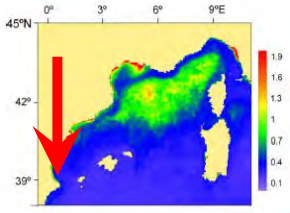
1. There is a **directional** and **fluctuating** pattern of **connectivity** that may drive a meta-population dynamics.



2. There is a **spatial heterogeneity** in the relative influence of Local Retention and Import on Self-Recruitment.

3. Self-Recruitment, at different spatial scales, is the main driver on recruitment dynamics.





4. Response to **regional climate** is spatially-structured associated to contrasting processes affecting survival.

Thank you

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