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**Would real time maps of highly probable hake nurseries be an incentive for bottom trawlers to reduce discard of juveniles in the Mediterranean Sea?**

**Jean-Noël Druon**



**June 2016**

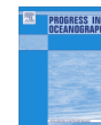
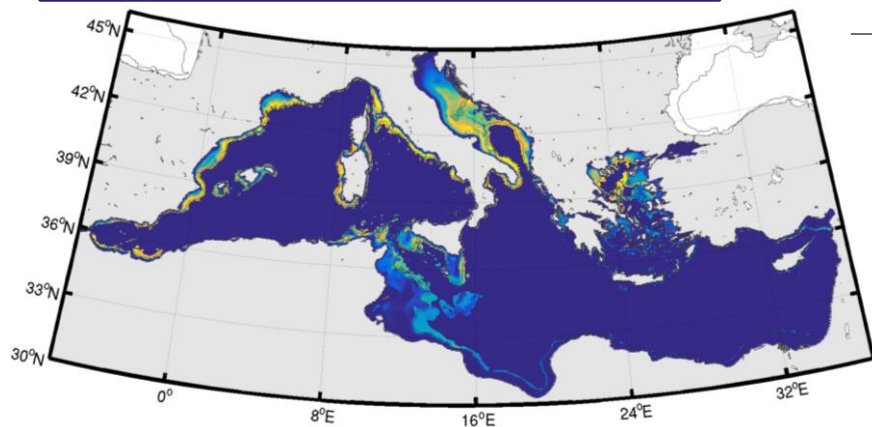
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# Acknowledgements

## Hake nurseries

*Progress in Oceanography* (2015)

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## Modelling of European hake nurseries in the Mediterranean Sea: An ecological niche approach



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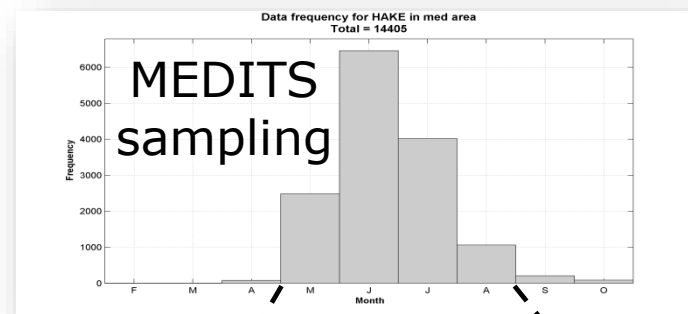
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### ABSTRACT

An ecological niche modelling (ENM) approach was developed to model the suitable habitat for the 0-group European hake, *Merluccius merluccius* L., 1758, in the Mediterranean Sea. The ENM was built combining knowledge on biological traits of hake recruits (e.g. growth, settlement, mobility and feeding strategy) with patterns of selected ecological variables (chlorophyll-*a* fronts and concentration, bottom depth, sea bottom current and temperature) to highlight favourable nursery habitats. The results show that hake nurseries require stable bottom temperature (11.8–15.0 °C), low bottom currents (<0.034 m s<sup>-1</sup>) and a frequent occurrence of productive fronts in low chlorophyll-*a* areas (0.1–0.9 mg m<sup>-3</sup>) to support a successful recruitment. These conditions mostly occur recurrently in outer shelf and shelf break areas. The prediction explains the relative balance between biotic and abiotic drivers of hake recruitment in the Mediterranean Sea and the primary role of unfavourable environmental conditions on low recruitment in specific years (i.e. 2011). The ENM outputs particularly agree spatially with biomass data of recruits, although processes such as fishing and natural mortality are not accounted for. The seasonal mapping of suitable habitats provides information on potential nurseries and recruitment carrying capacity which are relevant for spatial fisheries management of hake in the Mediterranean Sea. © 2014 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/3.0/>).



# Stages of year-0 hake



	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
MEDITS sampling														
Estimated spawning														
Pelagic stage														
Settlement at seabed														
Diurnal migration														

-> most relevant period after settlement

1 - Species ecological analysis



2 - Data collection & processing

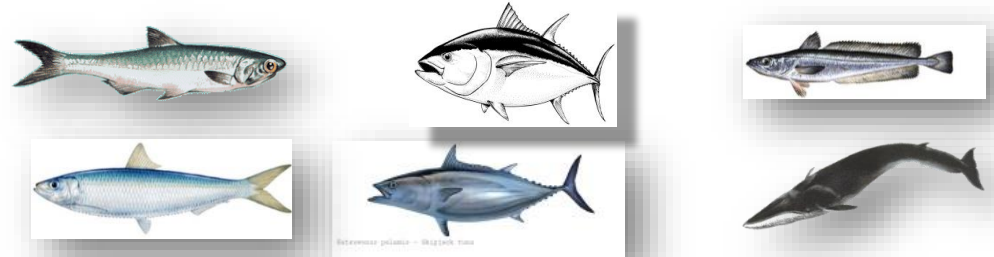


3 - Statistical analysis



4 - Ecological Niche Model

## The Ecological Niche Model approach



**Environmental envelope**  
(relevant thresholds)



**Deterministic model**  
(Back projection of species-environment links)

$$\text{Nurseries} = f(\text{CHL fronts} + \text{CHL} + \text{SBT} + \text{SBC} + \text{depth})$$

**Environmental envelop**

**Water  
depth**

**CHL**

**Daily  
preferred  
habitat**

**CHL  
front**

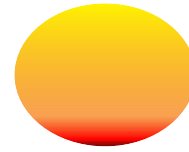
**Sea  
Bottom  
Temperature**

**Sea  
Bottom  
Current**

**=> Deterministic model**

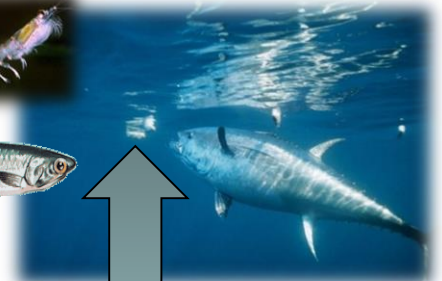
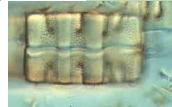
5

**Chl-a fronts are continuous producers of organic matter**



Moving few km/day for weeks or months

**Chl-a front  
Diatoms**



**Particulate organic matter**

**Si, N, P  
and ratios**

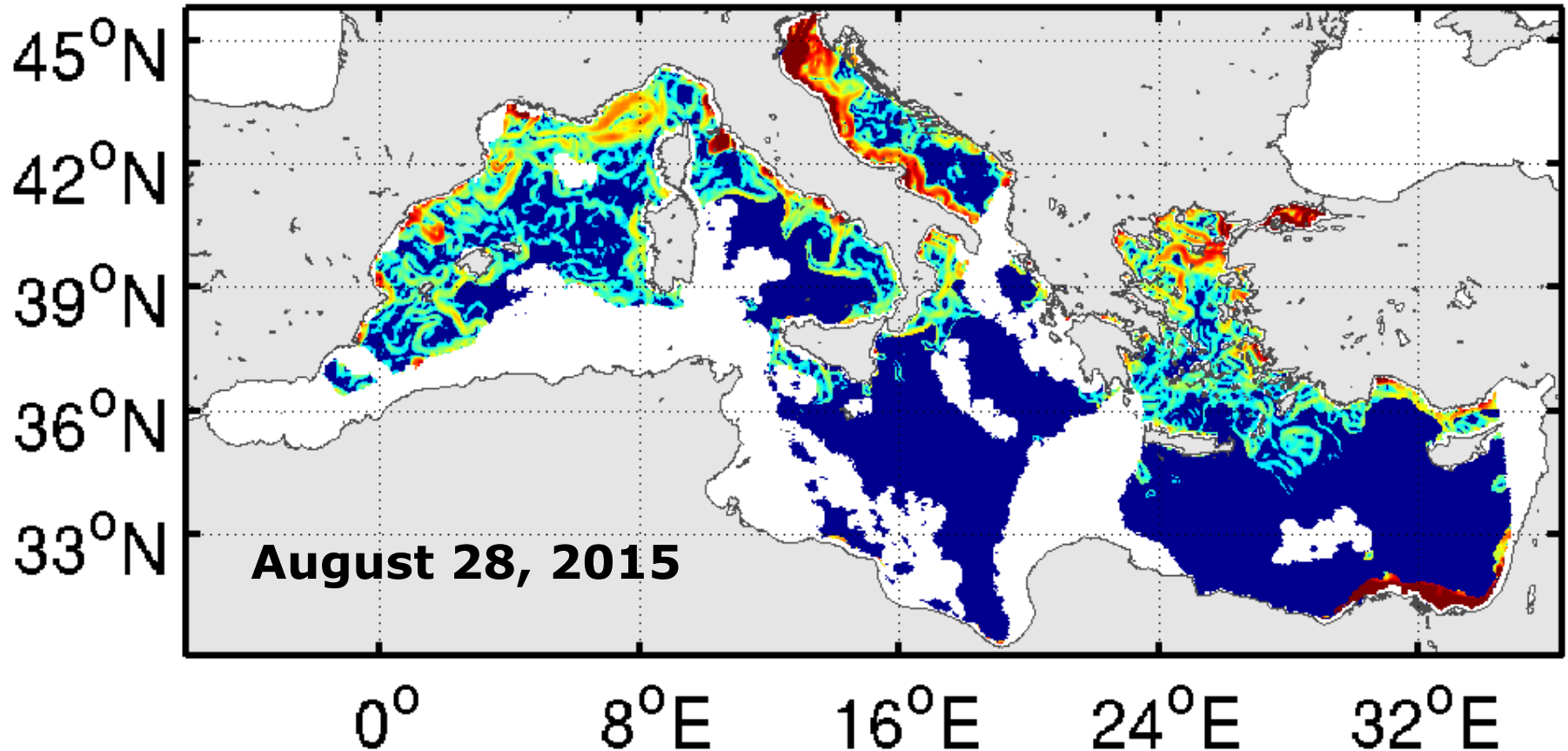
**Deeper ocean  
or sea bed**



# Small zooplankton

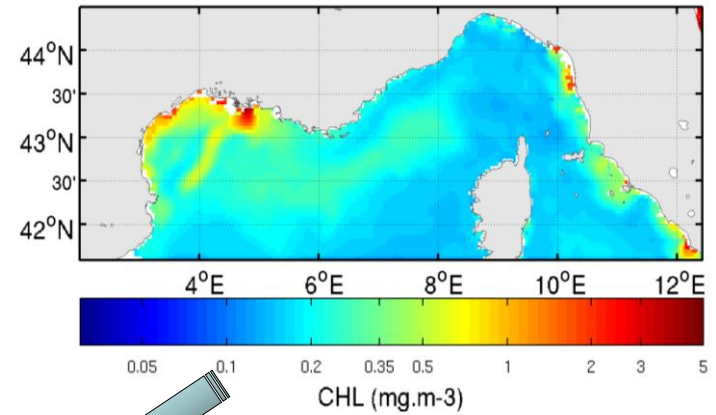
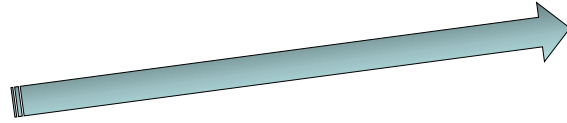


## Productive fronts can be daily tracked by satellite sensors



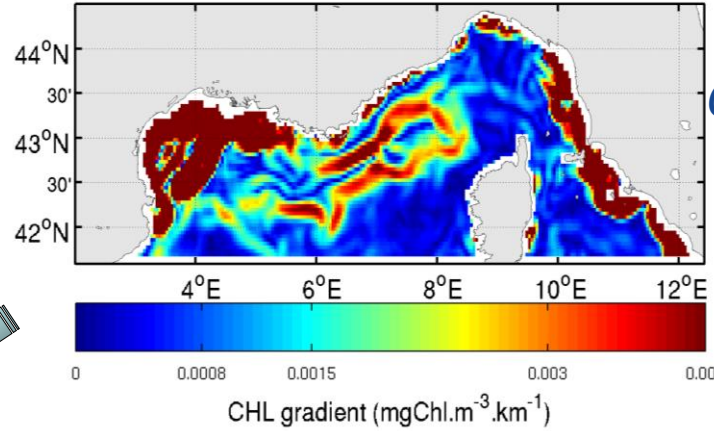


# Daily satellite ocean colour MODIS-Aqua (4 km)



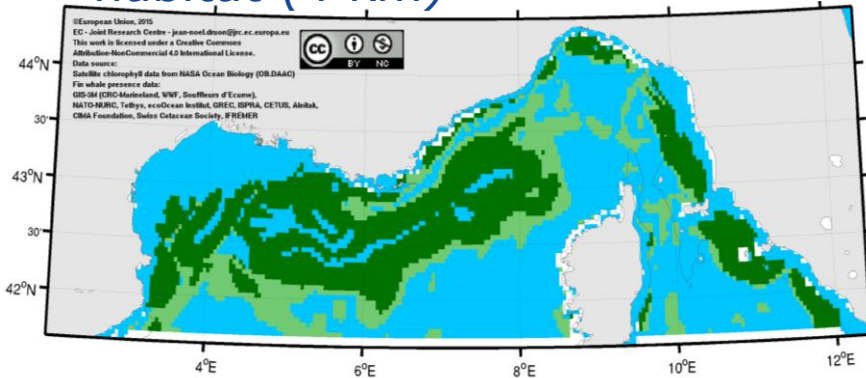
Chlorophyll-a content

## Habitat = biotic+ abiotic proxies

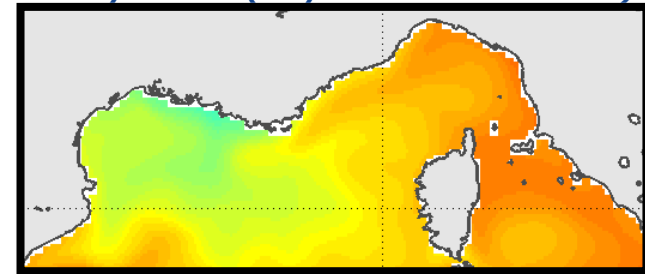


Chlorophyll-a fronts

## Daily potential habitat (4 km)

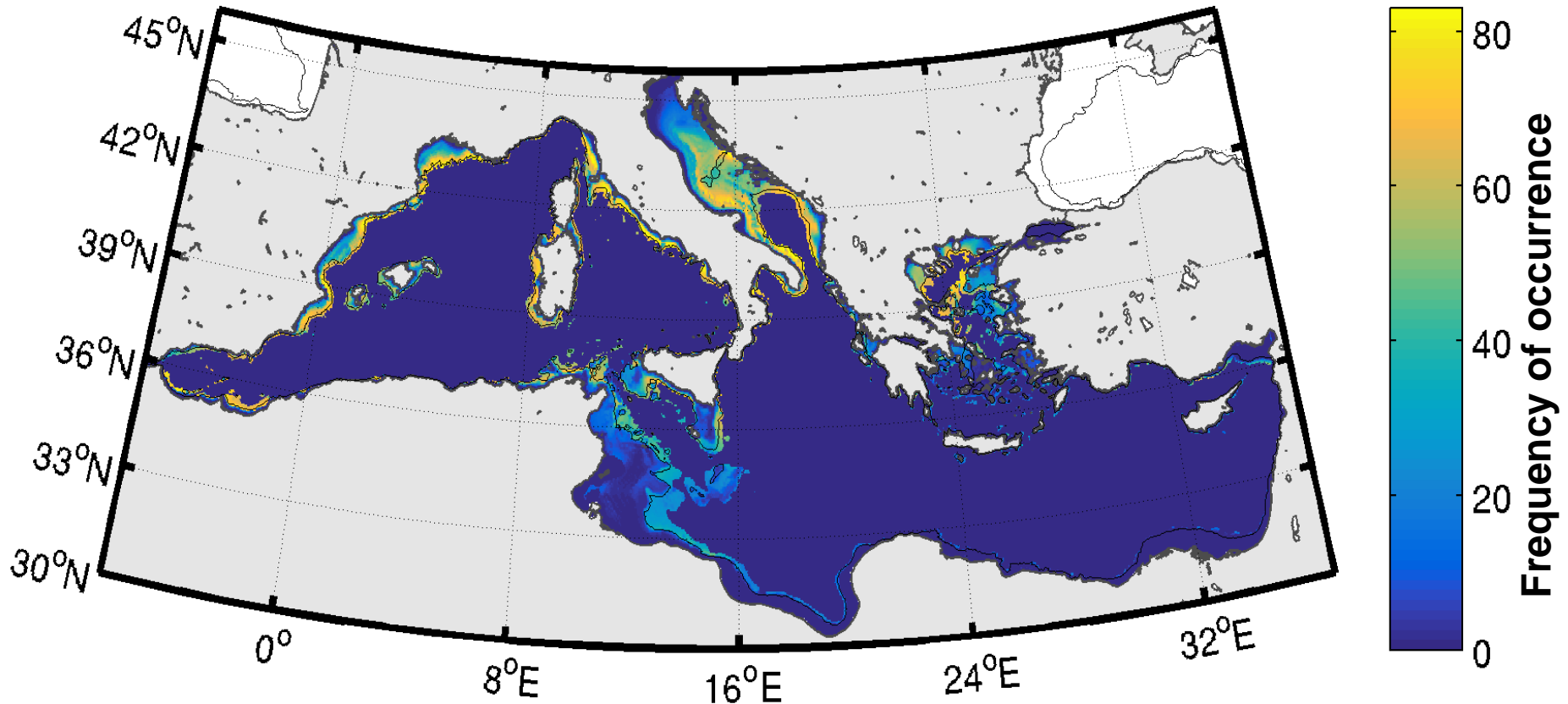


## Physics (MyOcean 7 km)



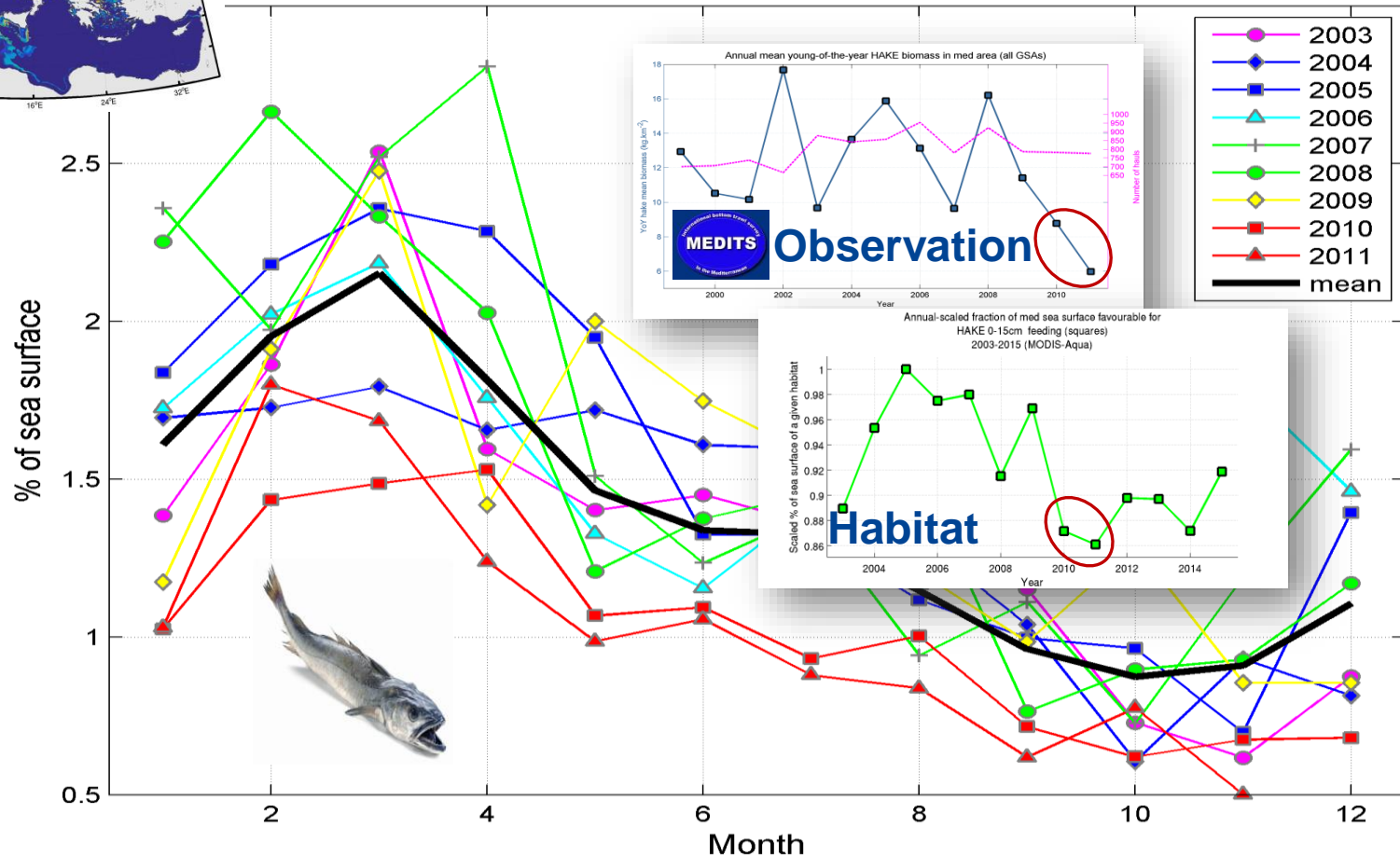
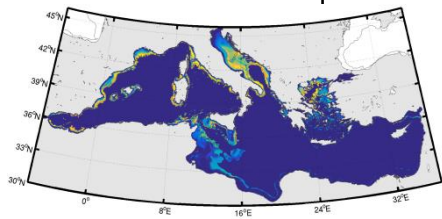


## Potential habitat of year-0 hake in the Mediterranean: (2003-2015)



**=> Yellow is where the bottom trawling avoidance index will most frequently show areas to avoid**

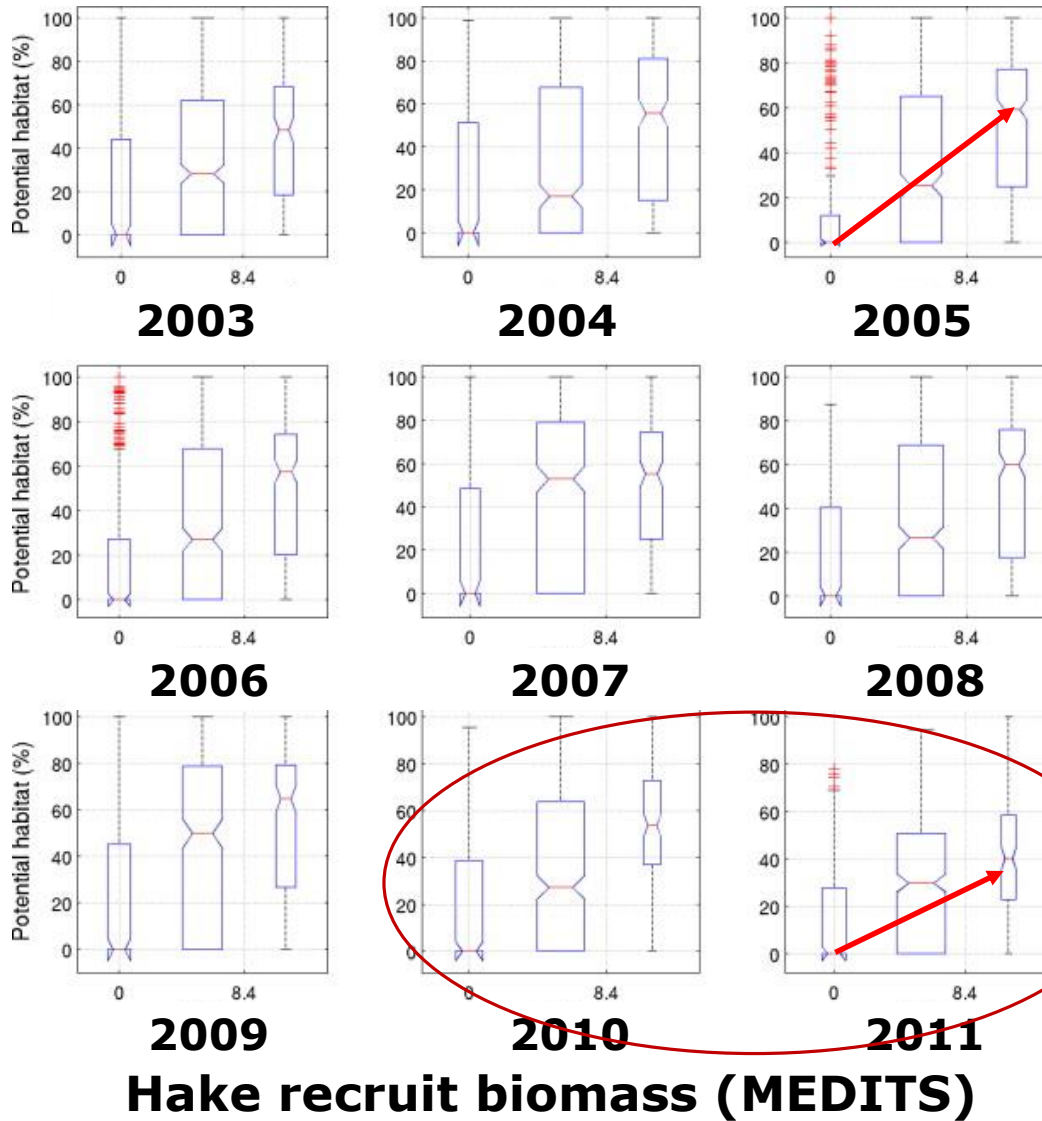
# Potential habitat of year-0 hake in the Mediterranean: Monthly and inter-annual variability (2003-2011)



**=> Poor recruitment in 2010 and 2011 likely due to poor environmental conditions (in addition to fishing mortality in nurseries).**

# Potential habitat of year-0 hake in the Mediterranean

Potential habitat



=>The more potential habitat, the more recruit biomass.

## Stability and robustness of the bottom trawling avoidance index

### 7-day floating composite of hake nursery in NRT

- Few weeks nurseries are not viable,
- A minimum of 3-4 months continuous favorable conditions are necessary.

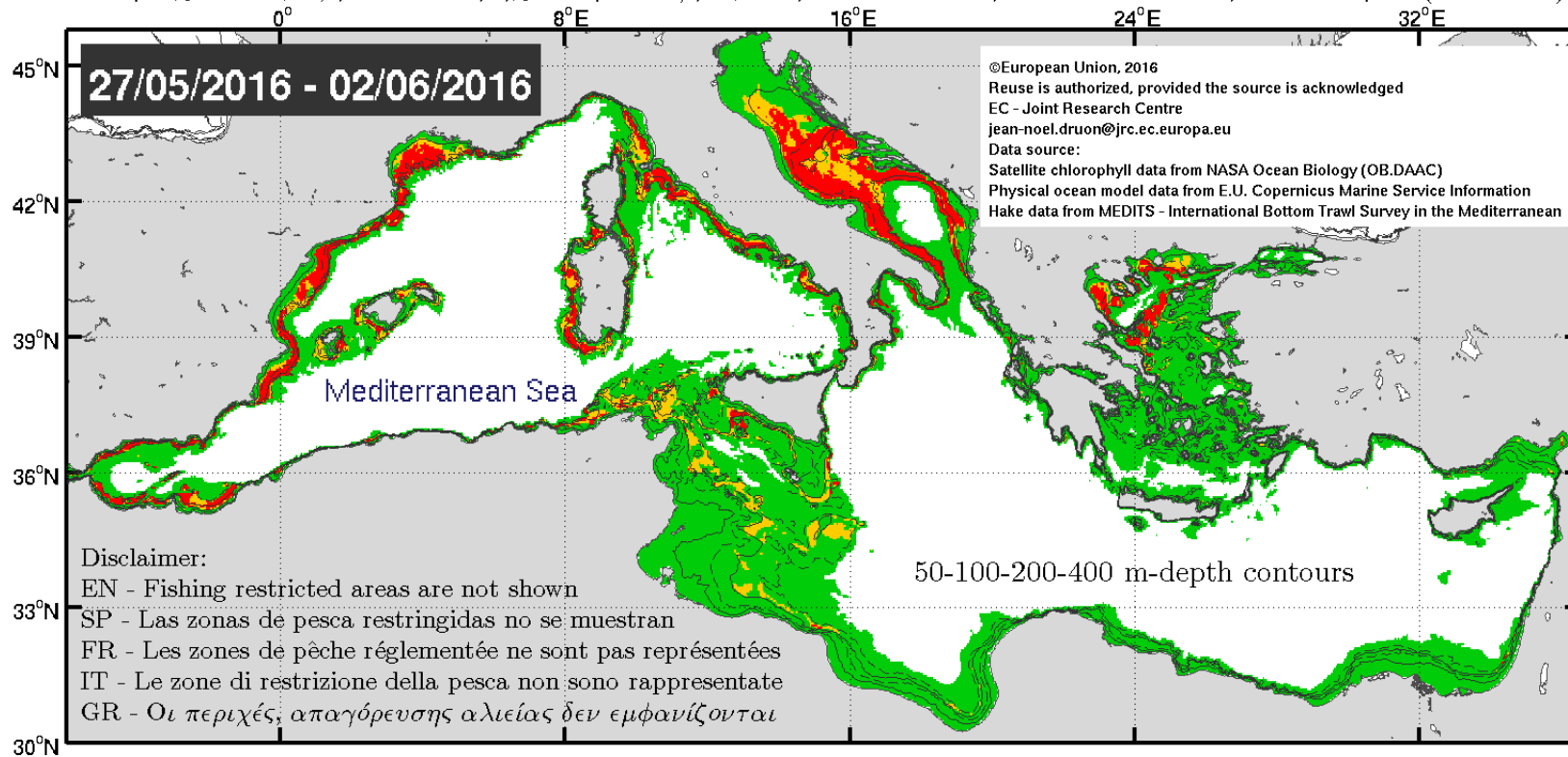
### Persistence index

### Mean of the last 4-years of nursery habitat

- Sufficiently long to represent the main nurseries,
- Sufficiently recent to take into account the influence of climate change.



EN - Bottom trawling avoidance areas derived from hake nurseries potential distribution (0-1000 m)  
 SP - Zonas de arrastre de fondo a evitar derivadas de la distribución potencial de las áreas de cría de merluza (0-1000 m)  
 FR - Zones de chalutage de fond à éviter établies depuis la distribution potentielle des nourriceries de merlu (0-1000 m)  
 IT - Zone a strascico di fondo da evitare stabilite dalla distribuzione potenziale dei giovanili di nasello (0-1000 m)  
 GR - Περιοχές αποφυγής αλιείας μηχανότρατας, με βάση τα πιθανά νηπιακά πεδία του μπακαλιάρου (0-1000 m)



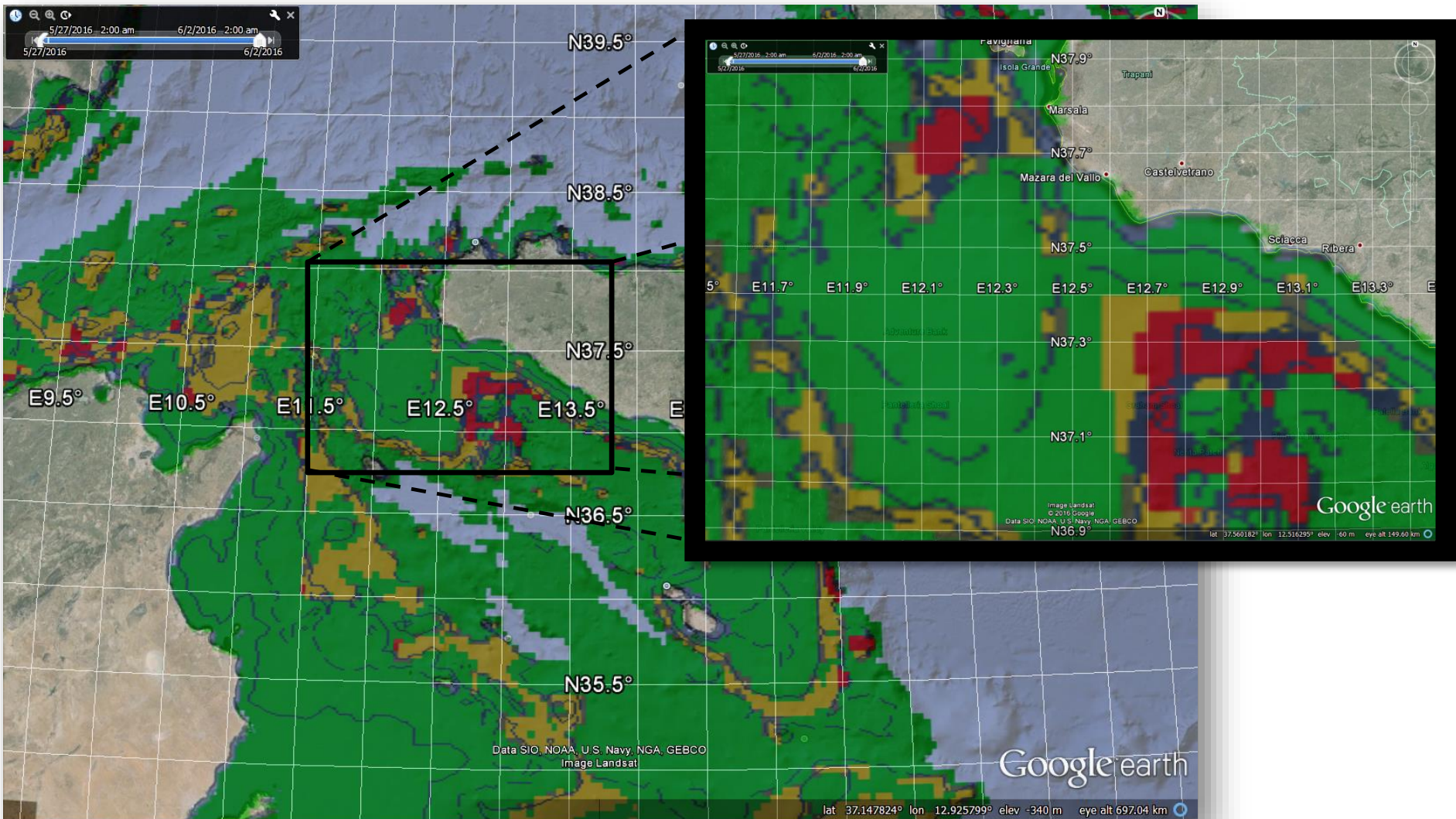
EN - Bottom trawling: Preferable area / Preferable avoidance/ Absolute avoidance  
 SP - Arrastre de fondo: Zona preferible / A evitar preferiblemente/ A evitar absolutamente  
 FR - Chalut de fond: Zone préférentielle / A éviter préférentiellement / A éviter absolument  
 IT - Strascico a fondo: Zona preferibile / Da evitare preferibilmente / Da evitare assolutamente  
 GR - Μηχανότρατα: Επιθυμητή περιοχή / Επιθυμητό να αποφεύγεται / Να αποφεύγεται παντελώς

**REAL TIME AVOIDANCE MAP**

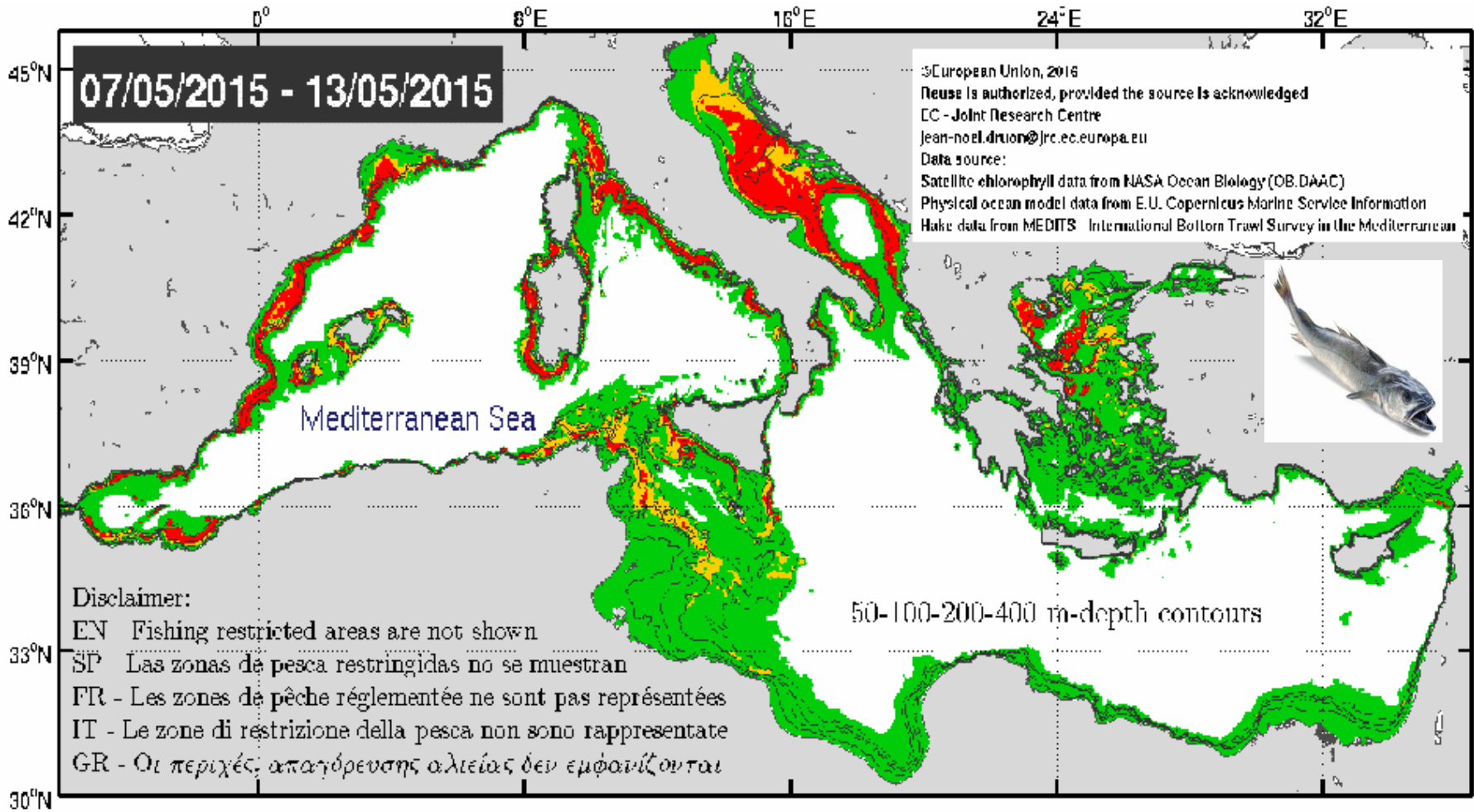


# REAL TIME AVOIDANCE MAP

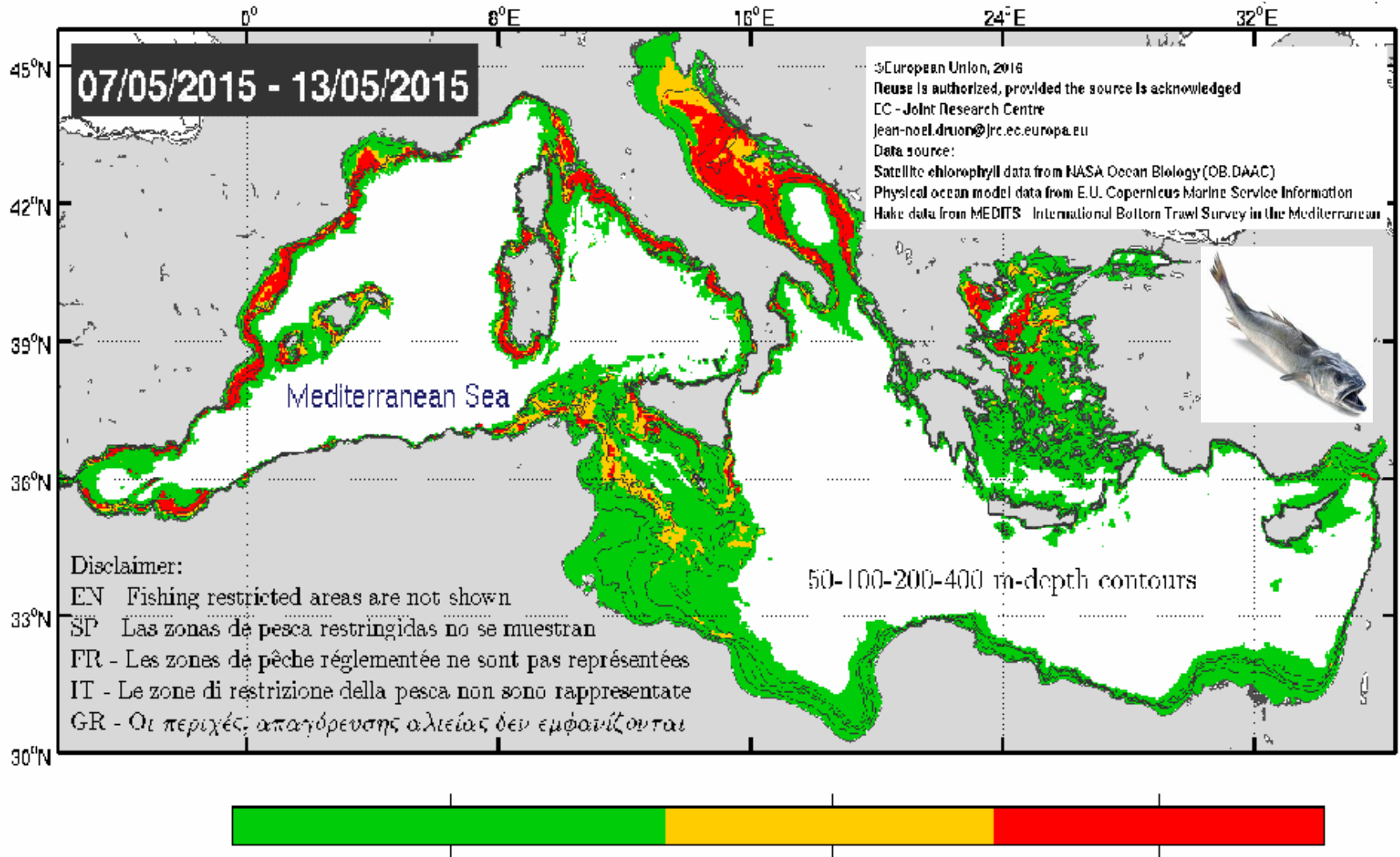
## Zoom in your area of interest (Google Earth)



# AVOIDANCE MAP – slow animation 2015-2016 (daily change)



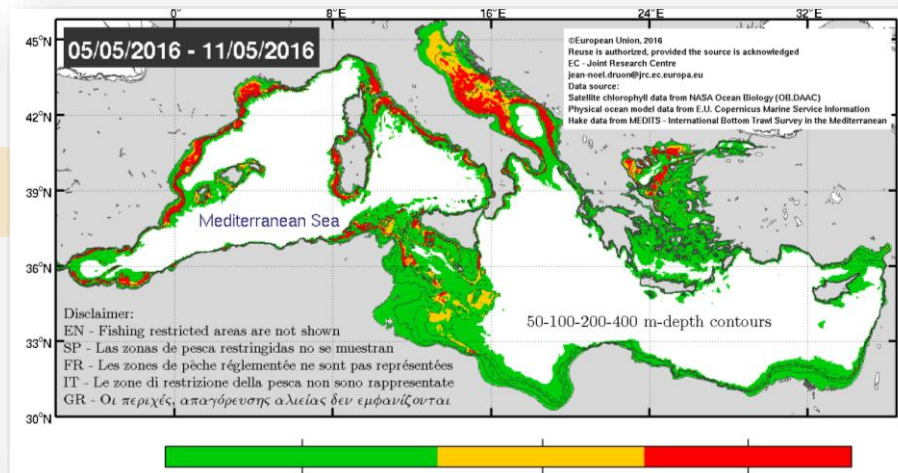
# AVOIDANCE MAP – fast animation 2015-2016 (seasonal change)





## Perspectives for management:

### Use of real time habitat mapping:



- To inform fishers on where to limit mortality of juveniles as an incentive,
- To raise fishers' awareness on the seasonal and inter-annual variability of nurseries,
- To favour fishers-scientists collaboration and mutual trust,
- To promote the dynamic and responsible management of fisheries,

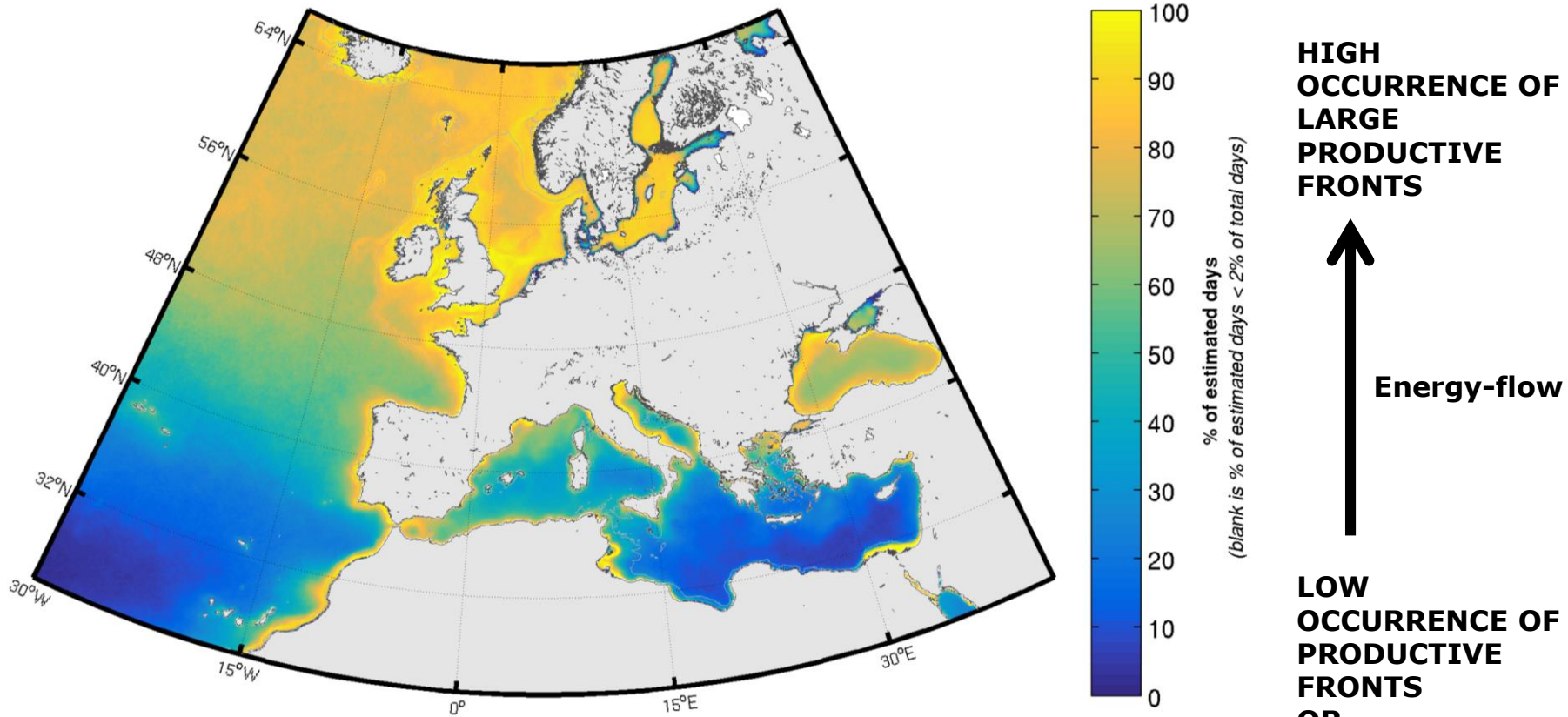
What are the interactions with the other species' nurseries?

**YOUR FEEDBACK IS ESSENTIAL!**

More information: <http://fishreg.jrc.ec.europa.eu/fish-habitat>  
[jean-noel.druon@jrc.ec.europa.eu](mailto:jean-noel.druon@jrc.ec.europa.eu)

# Ocean Productivity index (2003-2015)

- **CHL fronts intensity and frequency**
- **CHL < 10 mg/m<sup>3</sup>**  
(excludes potentially eutrophicated areas)



**D3 Fish stocks**  
**D4 Food webs**  
**D5 Eutrophication**

- Shelves are productive all-year.
- Med and off-shelf Atlantic are less productive,