# Joint Research Centre

## the European Commission's in-house science service

*Serving society*
*Stimulating innovation*
*Supporting legislation*

# 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**

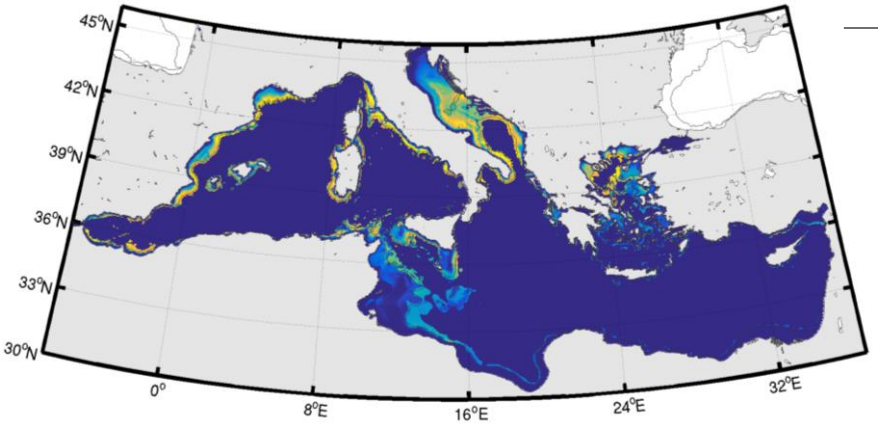
www.ec.europa.eu/jrc

**June 2016**

European Commission

# Acknowledgements

**Hake nurseries**
*Progress in Oceanography (2015)*
Fiorentino F,
Murenu M,
Knittweis L,
Colloca F,
Osio C,
Mérigot B,
Garofalo G,
Mannini A,
Jadaud A,
Sbrana M,
Scarcella G,
Tserpes G,
Peristeraki P,
Carlucci R
Heikkonen J




Progress in Oceanography 130 (2015) 188–204

Contents lists available at ScienceDirect

Progress in Oceanography

journal homepage: www.elsevier.com/locate/pocean

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

Jean-Noël Druon [a,*], Fabio Fiorentino [b], Matteo Murenu [c], Leyla Knittweis [d], Francesco Colloca [b], Chato Osio [a], Bastien Mérigot [e], Germana Garofalo [b], Alessandro Mannini [f], Angélique Jadaud [g], Mario Sbrana [h], Giuseppe Scarcella [i], George Tserpes [j], Panagiota Peristeraki [j], Roberto Carlucci [k], Jukka Heikkonen [l]

[a] European Commission, Joint Research Centre (JRC), Institute for the Protection and Security of the Citizen (IPSC), Maritime Affairs Unit, Via Enrico Fermi 2749, 21027 Ispra, VA, Italy
[b] Institute for Coastal Marine Environment (IAMC), National Research Council (CNR), Via L. Vaccara, 61, 91026 Mazara del Vallo, TP, Italy
[c] Department of Life and Environmental Science, University of Cagliari, Via T. Fiorelli, 1, 09126 Cagliari, Italy
[d] Department of Biology, Faculty of Science, University of Malta, Msida MSD 2080, Malta
[e] Université Montpellier 2, UMR 212 Exploited Marine Ecosystems EME, CRH, Av. Jean Monnet, BP 171, 34203 Sète, France
[f] Department of Science of Earth, Environmental and Life (DISTAV), University of Genoa, Corso Europa, 26, 16132 Genova, Italy
[g] IFREMER, Station de Sète, Avenue Jean Monnet, CS 30171, 34203 Sète Cedex, France
[h] Consorzio per il Centro Interuniversitario di Biologia Marina ed Ecologia Applicata "G. Bacci", 57128 Livorno, Italy
[i] Institute of Marine Science (ISMAR), National Research Council (CNR), L.go Fiera della Pesca, 60125 Ancona, Italy
[j] Hellenic Center for Marine Research, Institute of Marine Biological Resources and Inland Waters, PO Box 2214, 71003 Heraklion, Greece
[k] Department of Biology, University of Bari, via Orabona 4, 70125 Bari, BA, Italy
[l] European Commission, Joint Research Centre (JRC), Institute for the Protection and Security of the Citizen (IPSC), Scientific Support to Financial Analysis, Via Enrico Fermi 2749, 21027 Ispra, VA, Italy

ARTICLE INFO

*Article history:*
Received 22 May 2014
Received in revised form 13 November 2014
Accepted 13 November 2014
Available online 22 November 2014

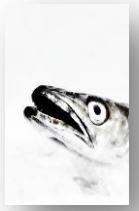
ABSTRACT

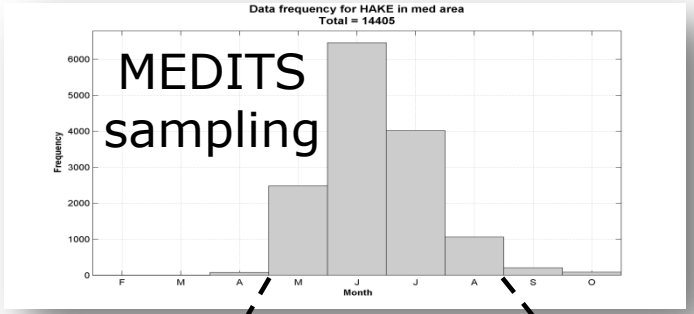
An ecological niche modelling (ENM) approach was developed to model the suitable habitat for the 0-group European hake, *Merluccius merluccius* L., 1758, in the Mediterranean Sea. The ENM was built combining knowledge on biological traits of hake recruits (e.g. growth, settlement, mobility and feeding 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 $s^{-1}$) and a frequent occurrence of productive fronts in low chlorophyll-a areas (0.1–0.9 mg $m^{-3}$) 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.




European Commission

# 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

European Commission

# The Ecological Niche Model approach

1 - Species ecological analysis

↓

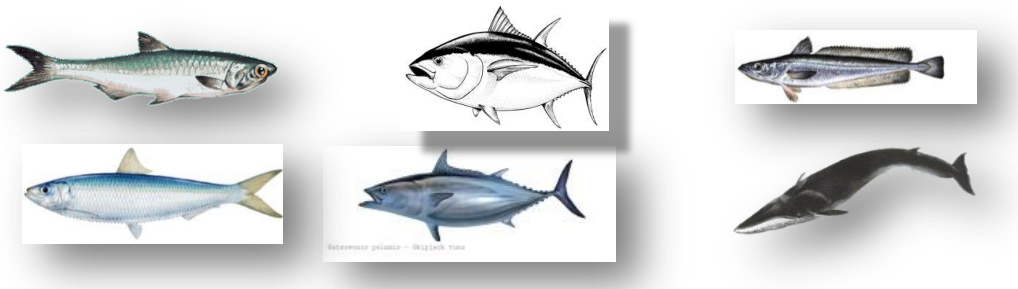
2 - Data collection & processing

↓

3 - Statistical analysis

↓

4 - Ecological Niche Model

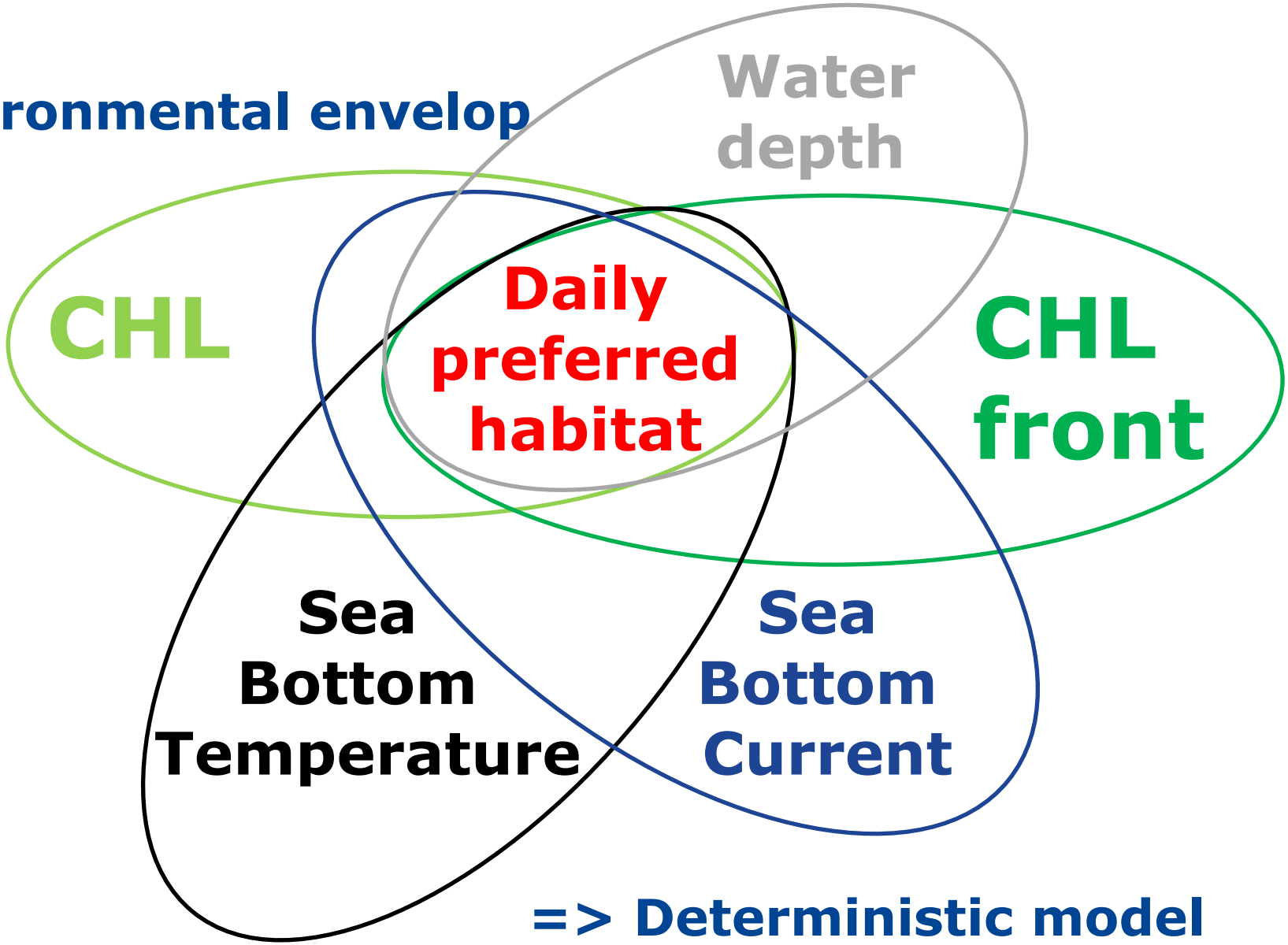


**Environmental envelop**
(relevant thresholds)

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

Nurseries = f(CHL fronts+CHL+SBT+SBC+depth))

## Environmental envelop

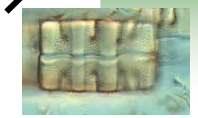


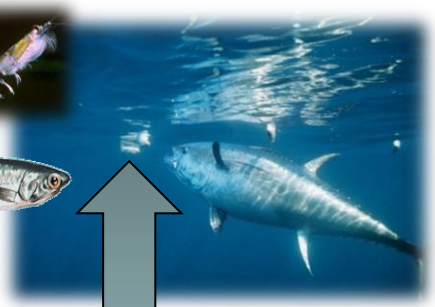

=> Deterministic model

# Chl-a fronts are continuous producers of organic matter

Moving few km/day
**for weeks or months**

**Chl-a front**
**Diatoms**





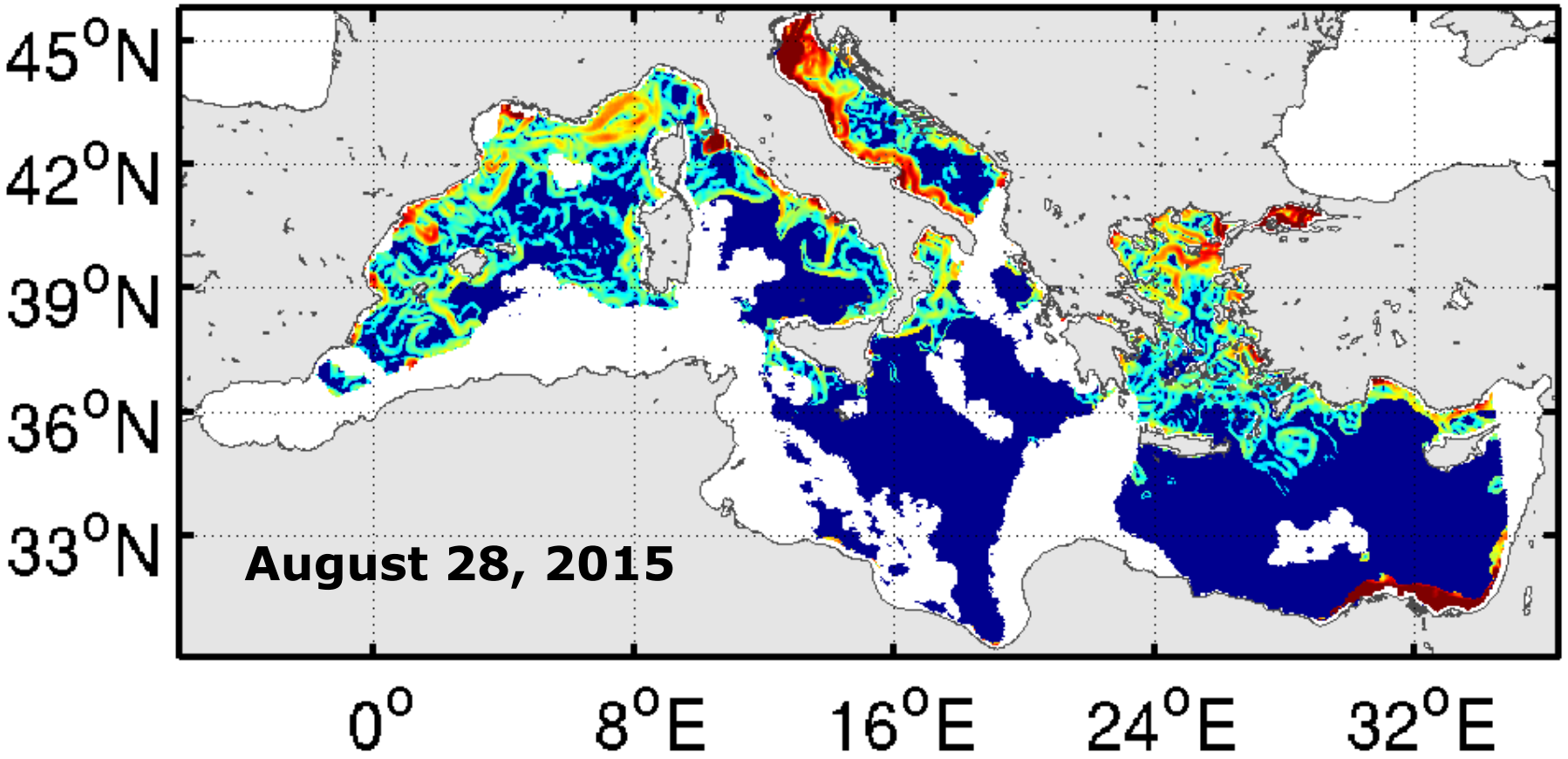
**Particulate organic matter**

**Si, N, P and ratios**

**Deeper ocean or sea bed**

# Small zooplankton

# Productive fronts can be daily tracked by satellite sensors

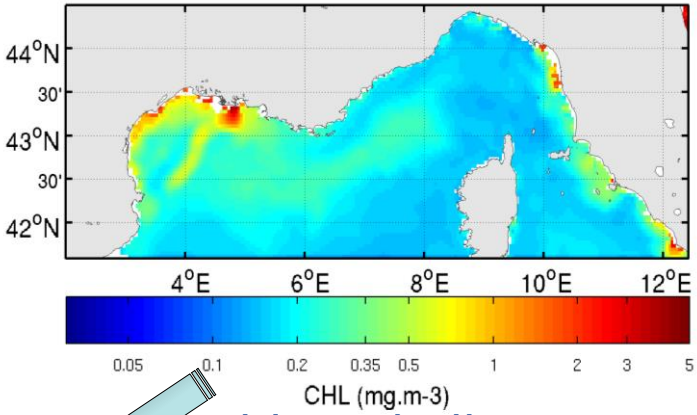




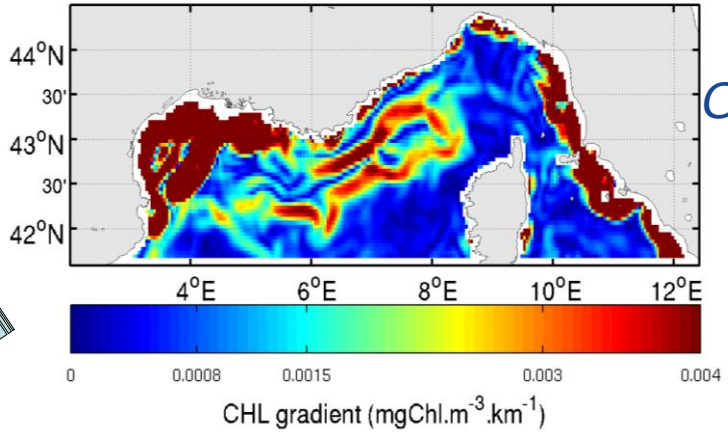

European Commission

# Habitat = biotic+abiotic proxies

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

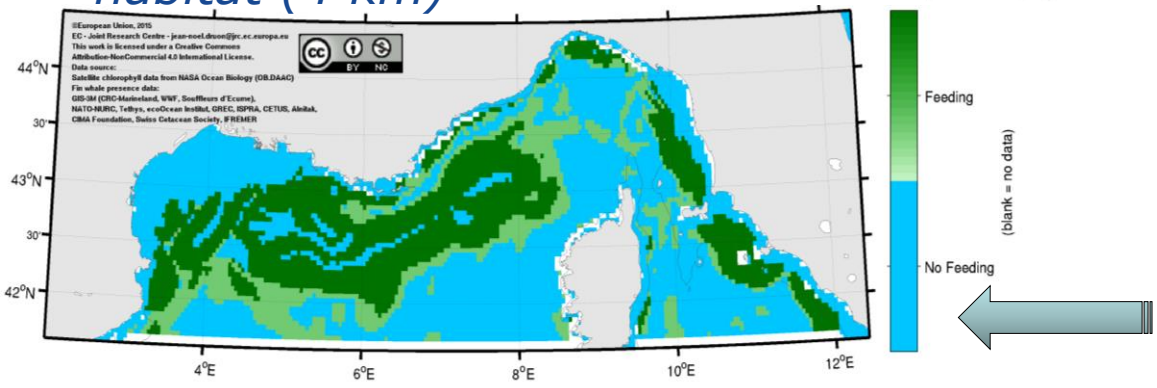



*Chlorophyll-a content*

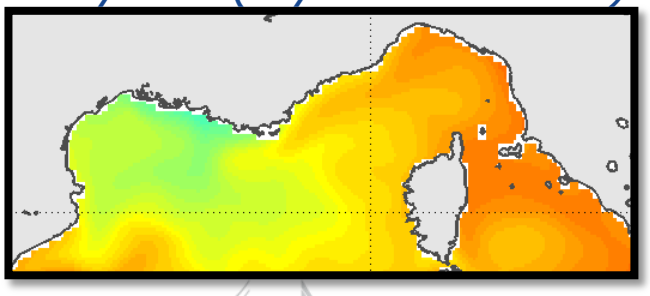



*Chlorophyll-a fronts*

*Daily potential habitat (4 km)*



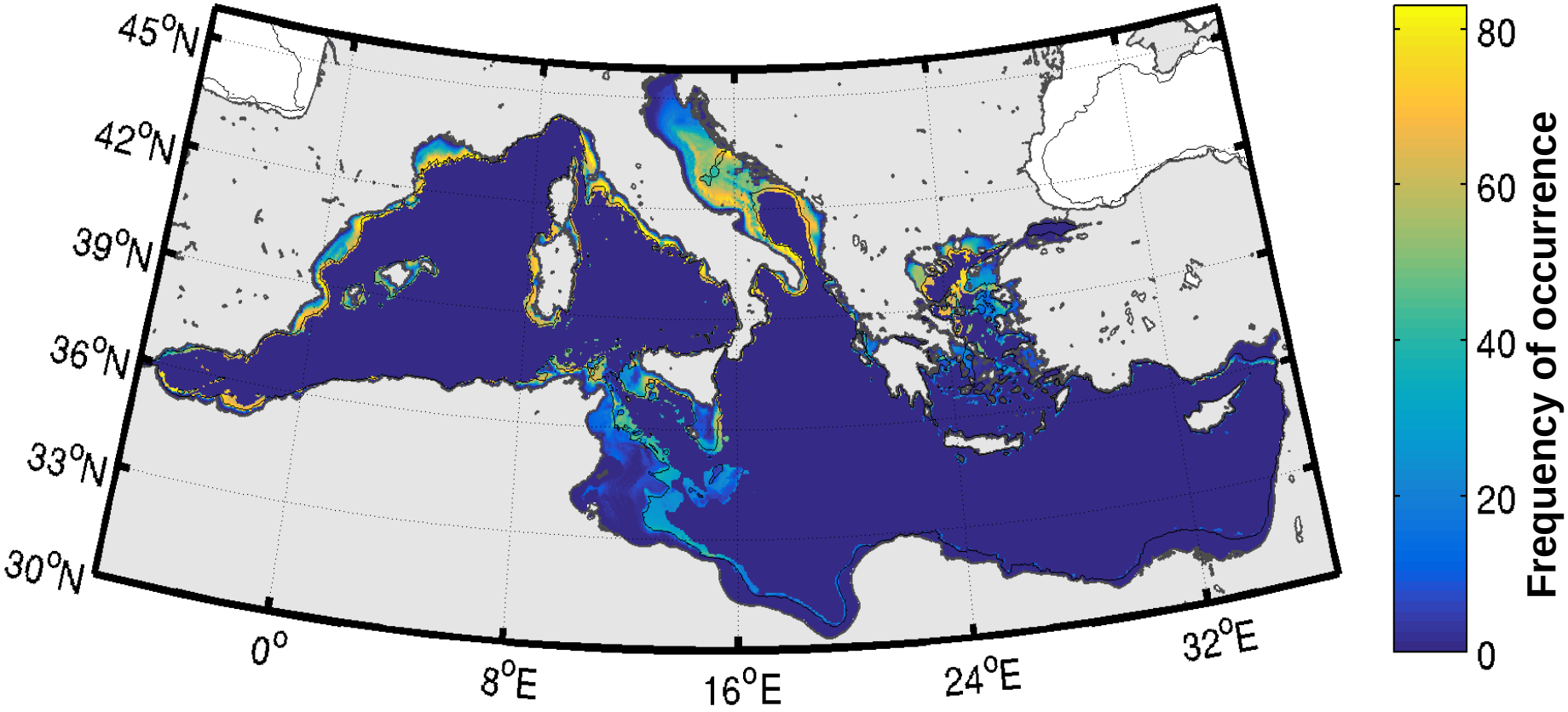

*Physics (MyOcean 7 km)*



European Commission

# Potential habitat of year-0 hake in the Mediterranean:

# (2003-2015)

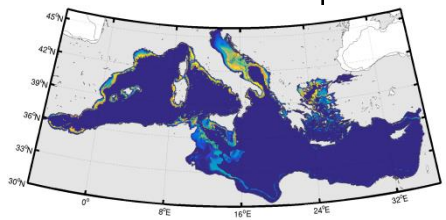


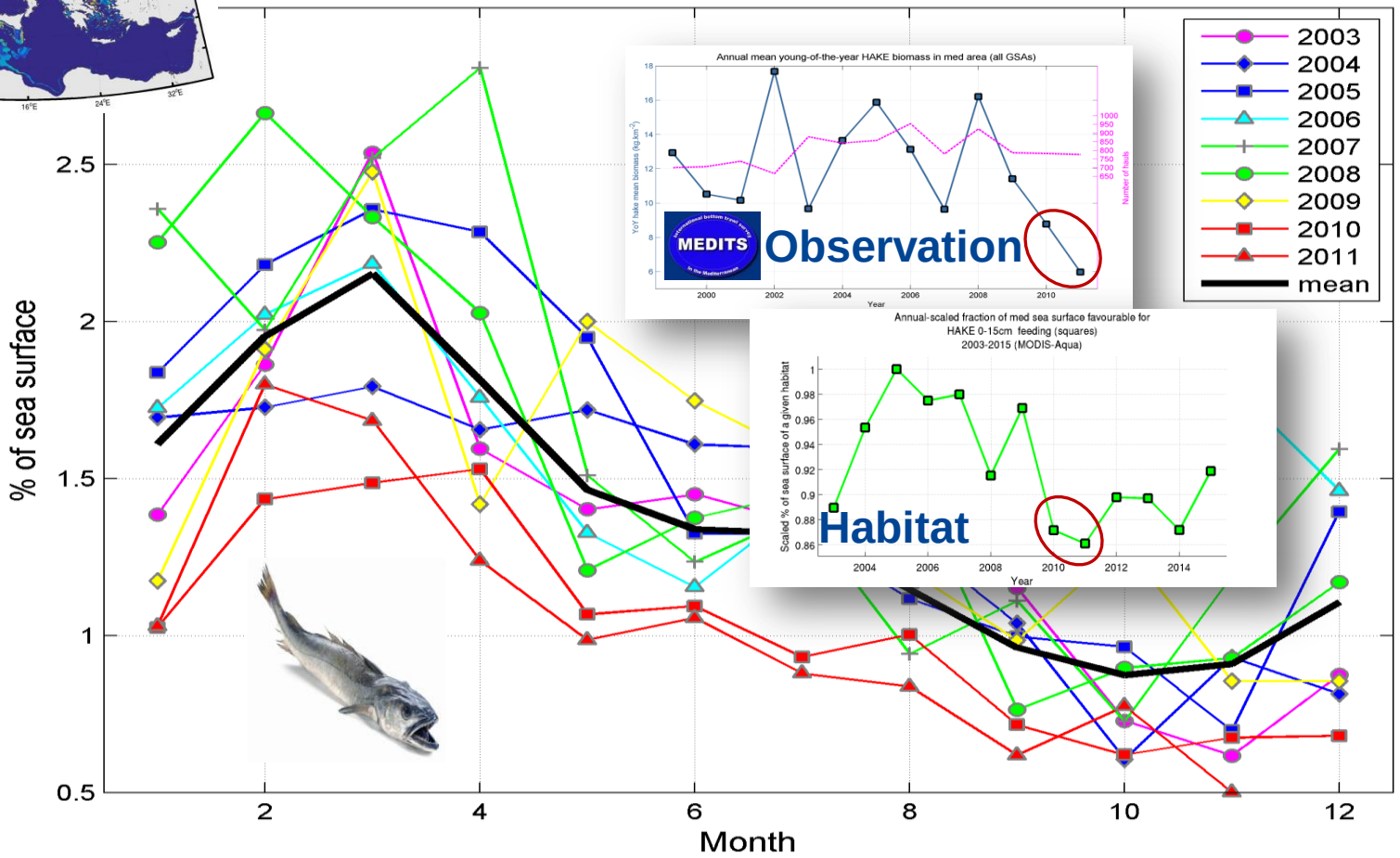

**=>Yellow is where the bottom trawling avoidance index will most frequently show areas to avoid**

European Commission

# Potential habitat of year-0 hake in the Mediterranean:

## Monthly and inter-annual variability (2003-2011)

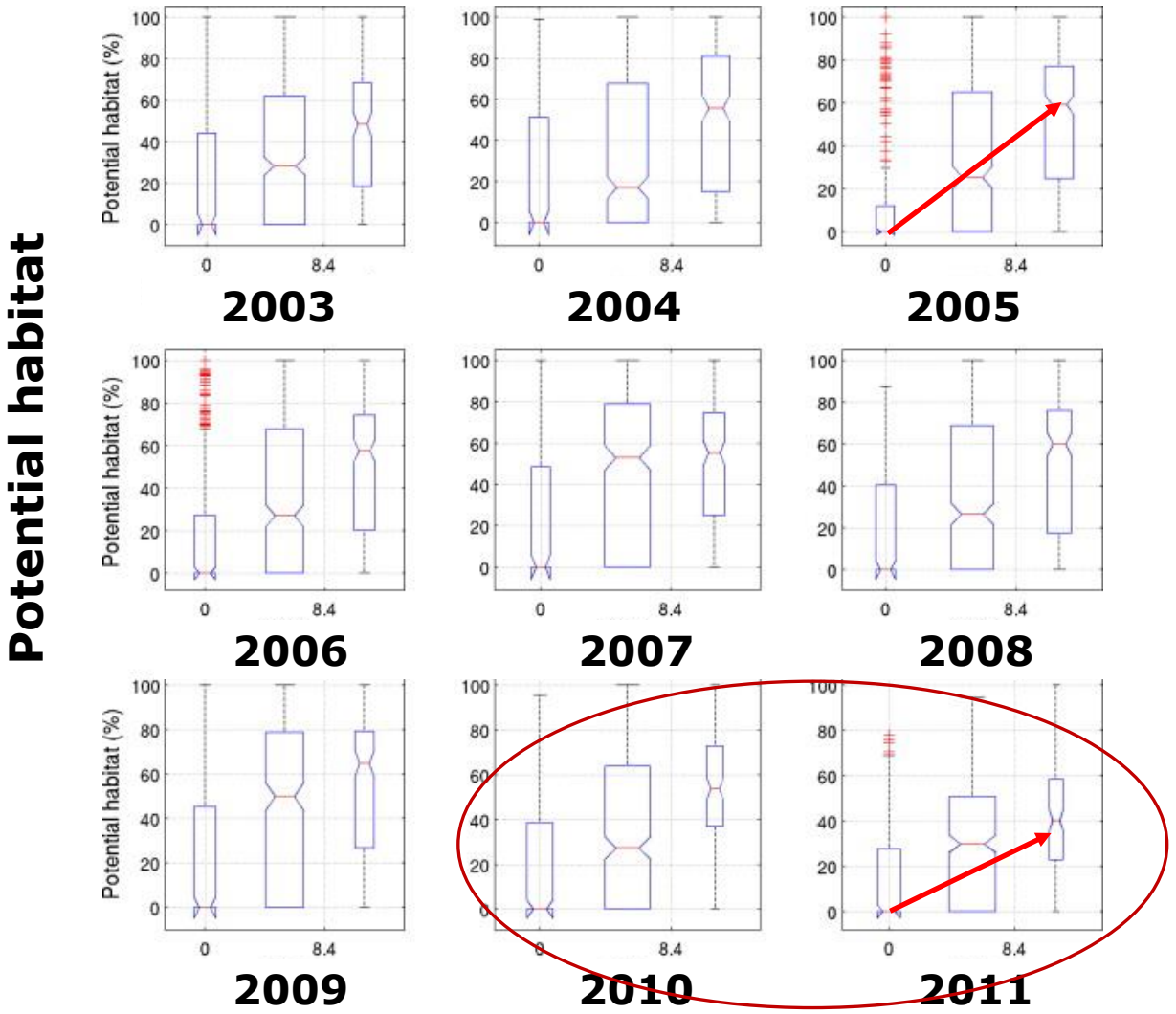





**=>Poor recruitment in 2010 and 2011 likely due to poor environmental conditions (in addition to fishing mortality in nurseries).**

European Commission

# Potential habitat of year-0 hake in the Mediterranean




**Hake recruit biomass (MEDITS)**

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

European Commission

**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.

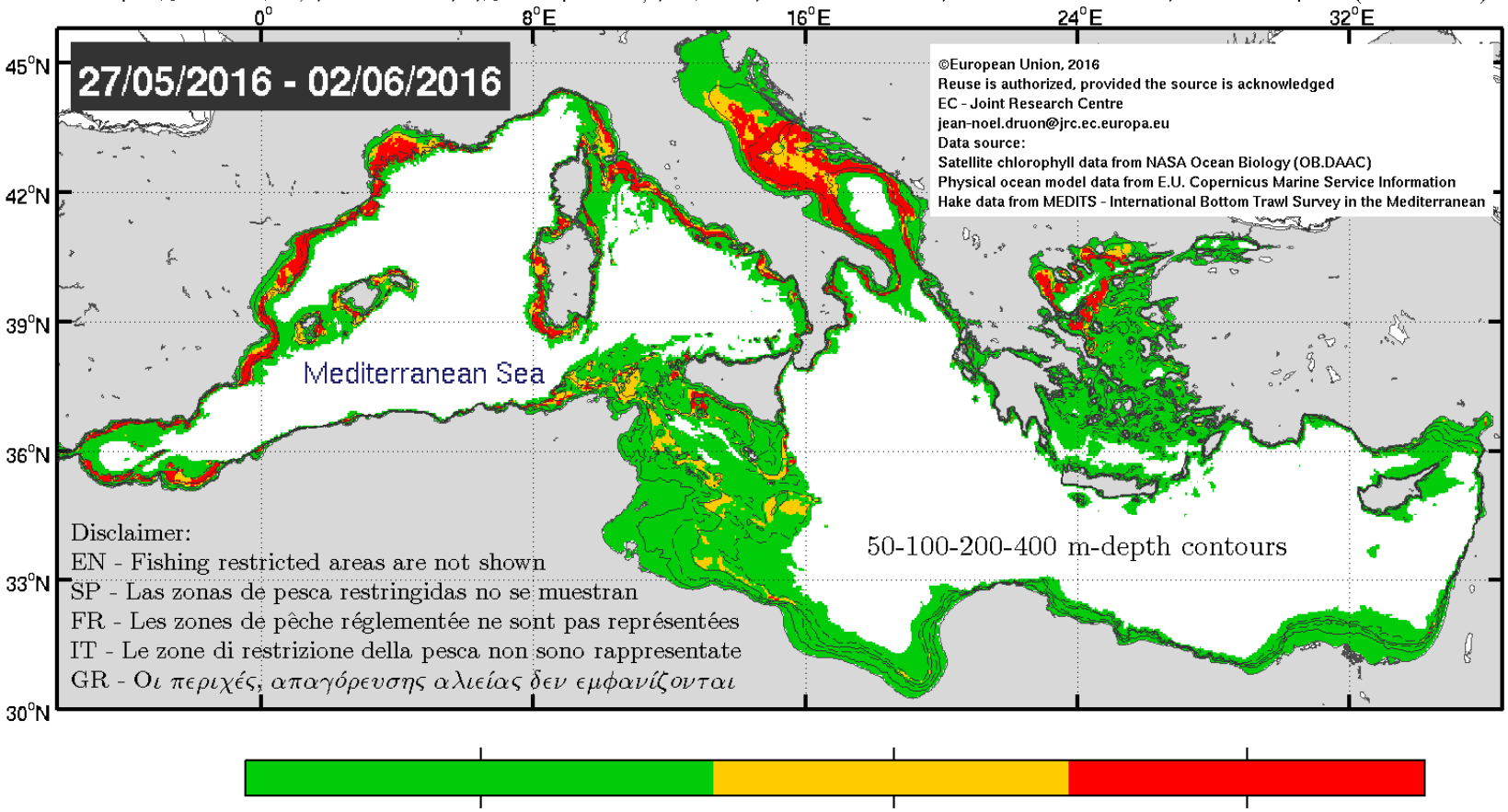
**Persistence index**

**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.

European Commission

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)



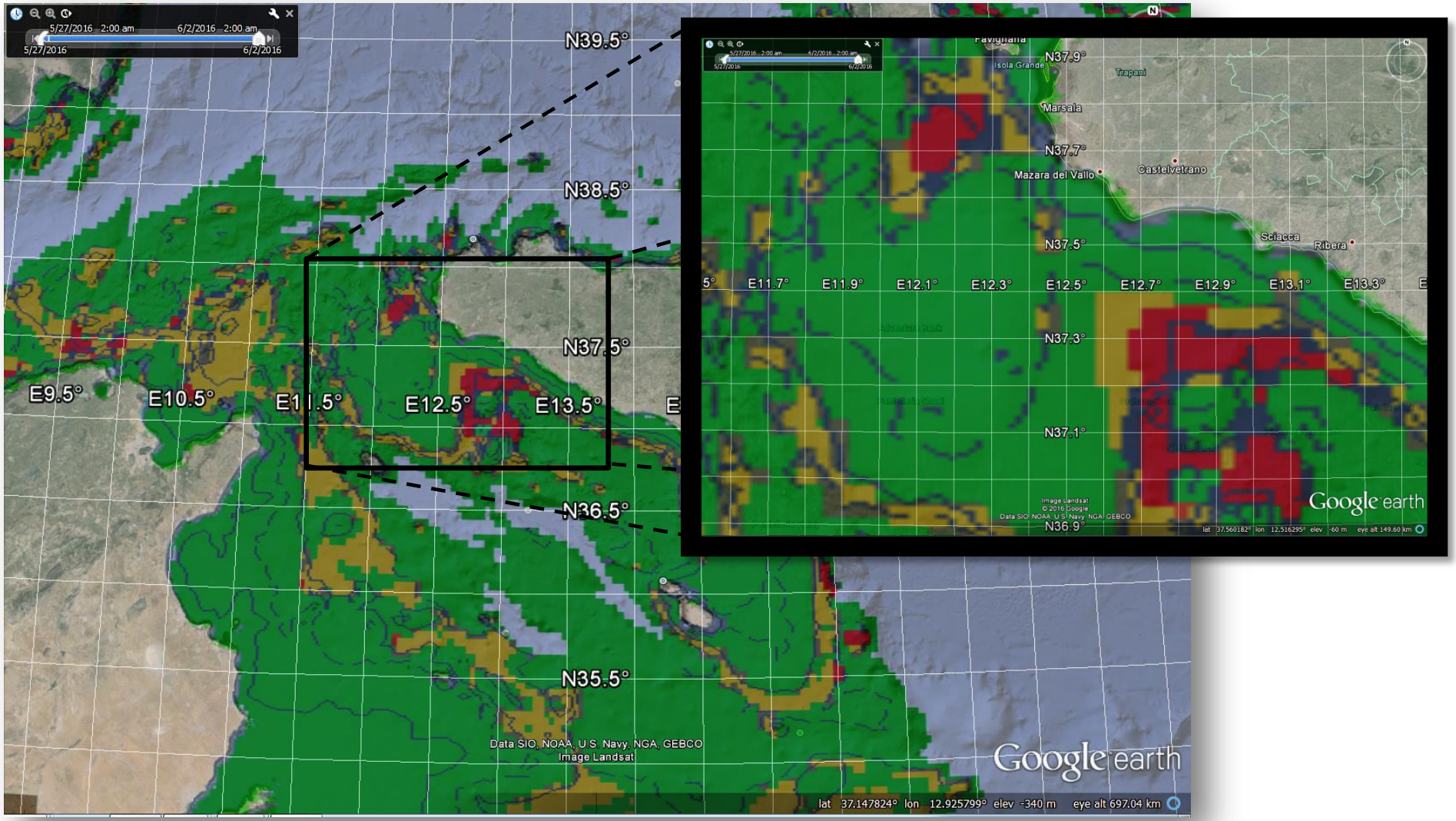

EN - Bottom trawling: Preferable area / Preferable avoidance/ Absolute avoidance
SP - Arrastre de fondo: Zona preferible / A evitar preferiblemente/ A evitar absolutamente
FR - Chalut de fond: Zone préférentielle / A éviter préférablement / A éviter absolument
IT - Strascico a fondo: Zona preferibile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

**REAL TIME AVOIDANCE MAP**

European Commission

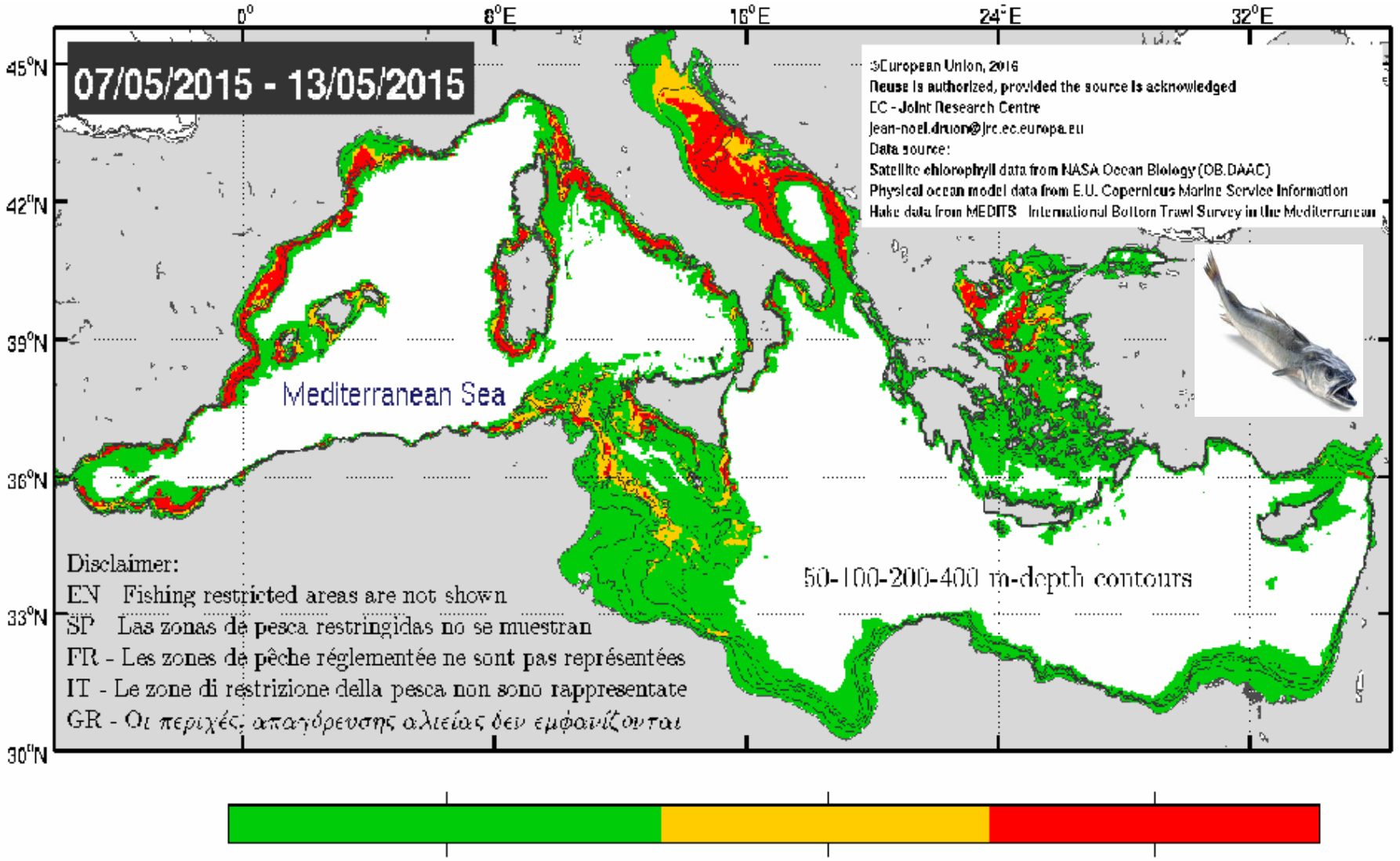
# REAL TIME AVOIDANCE MAP

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



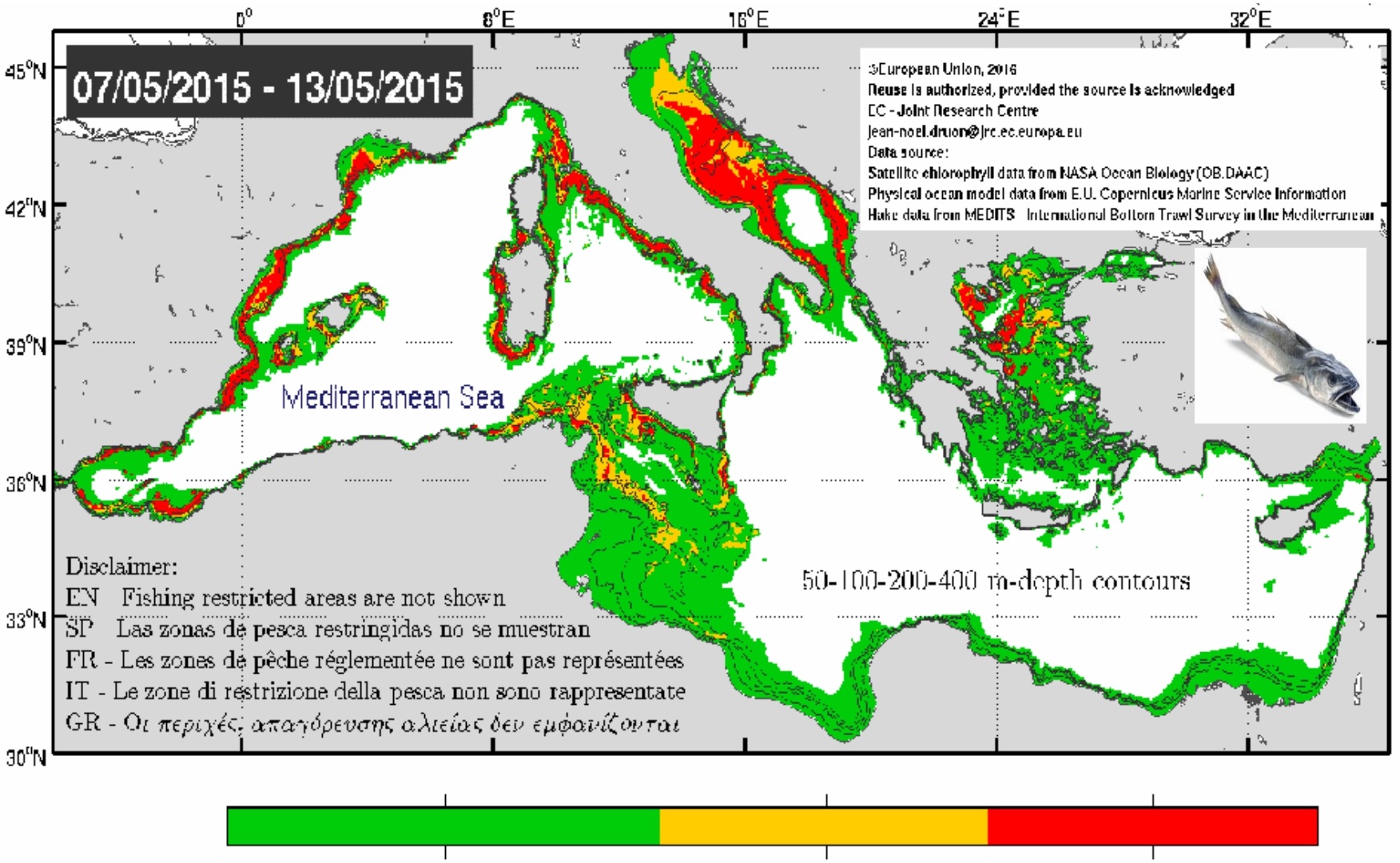

European Commission

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

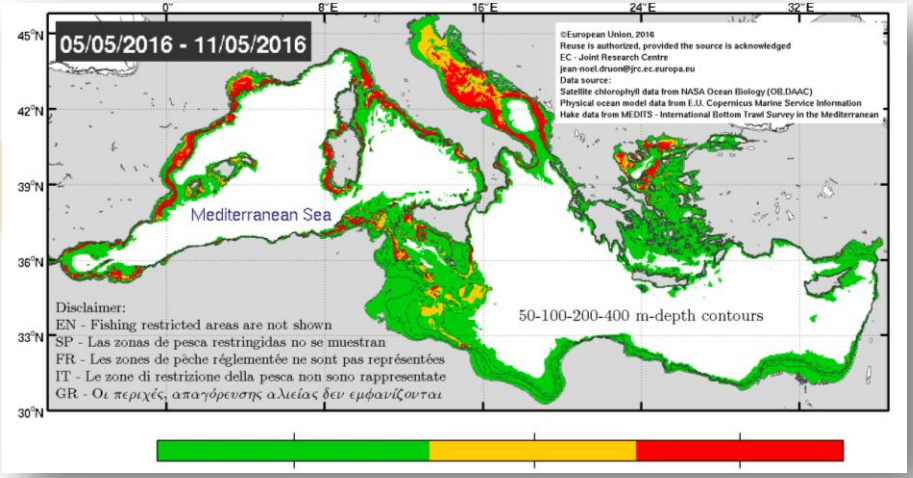



European Commission

# 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**

European Commission