Understanding pelagic seabird 3D environment from multidisciplinary oceanographic cruises

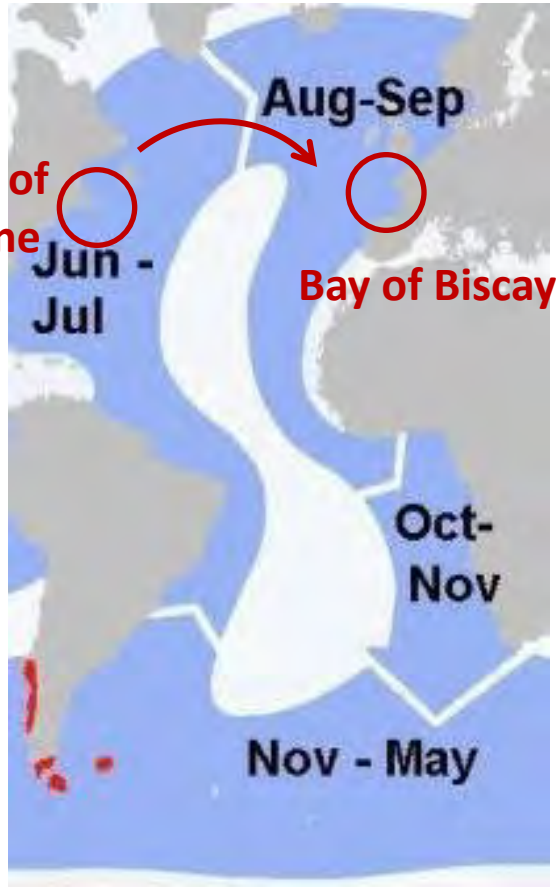
*Maite Louzao, **Guillermo Boyra**, Isabel García-Barón, Anna Rubio, Udane Martínez, José Antonio Vázquez, José Luis Murcia, Iñigo Krug, Iñaki Oyarzabal, Mikel Basterretxea*

Migratory seabirds

Sooty shearwater
Ardenna grisea

Near Threatened

- Migrating seabirds move through different ecosystems ⇒ integrate system variability at different spatial and temporal scales.
- Birds stop at few key locations for increasing refueling opportunities (productive areas), often recurrent areas.
- ✓ For numerous species, the Bay of Biscay (BoB) represents a key feeding area during certain periods of the year (seabirds, tuna, mammals).



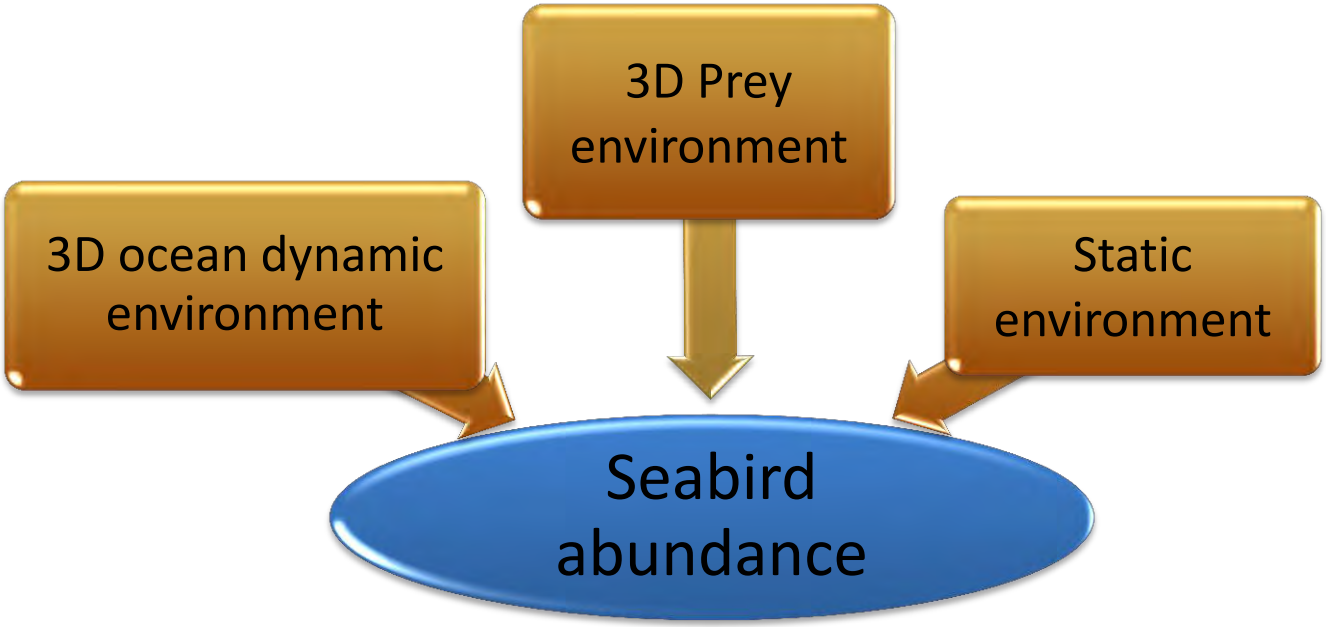
Objectives

- **To explore the effects of environmental conditions and pelagic prey availability in driving abundance patterns of highly migratory seabirds in the Bay of Biscay.**

1. **To assess the importance of prey fields in seabird abundance models.**
2. **To understand the role of mesoescale oceanographic features in seabird abundance patterns.**
3. **To obtain spatial predictions of seabird abundance in the BoB.**

Objectives

- **To explore the effects of environmental conditions and pelagic prey availability in driving abundance patterns of the highly migratory sooty shearwater in the Bay of Biscay.**



3D prey environment allows considering diving capabilities and prey preference

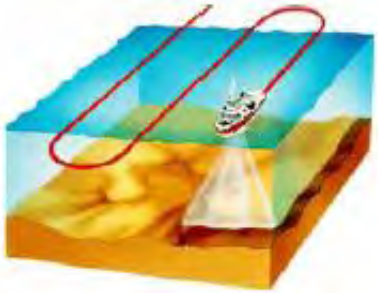
Seabird Observations

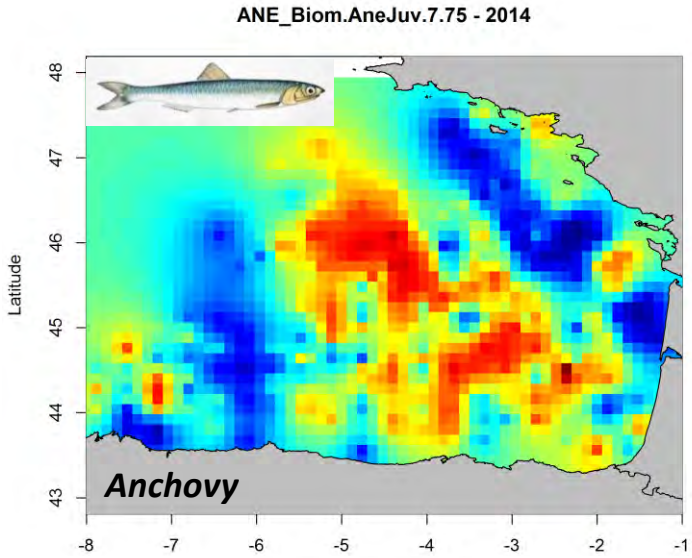
- Team of 3 observers (2 at a time) at 6 m and 10 knots.
- Species sightings and number of individuals (temporal unit = 1 minute).
- Environmental conditions recorded whenever changed.

R/V Ramón Margalef

Linking prey fields with predator preferences

Hydroacoustics

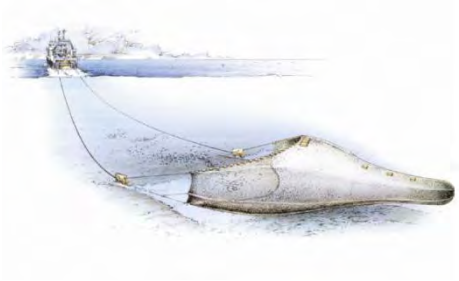


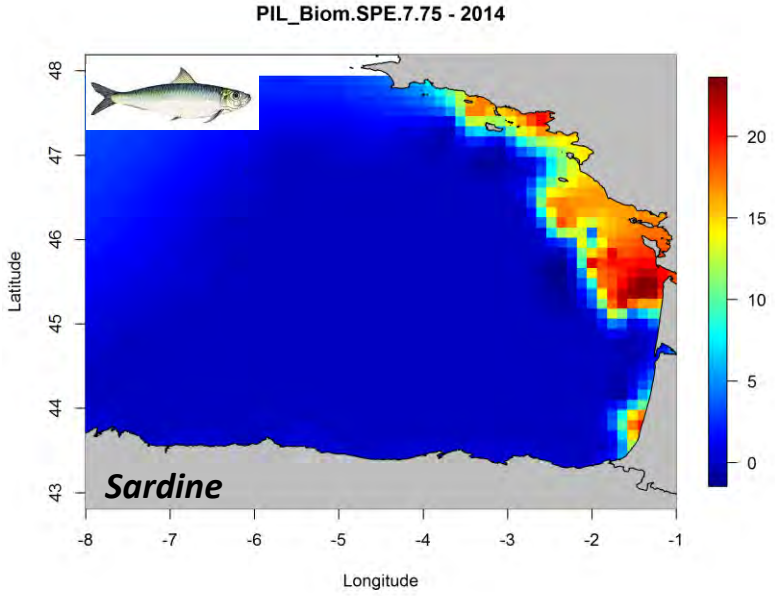


Maximum depth of 70 m

Shaffer et al 2009 Marine Ecology Progress Series

Pelagic trawl





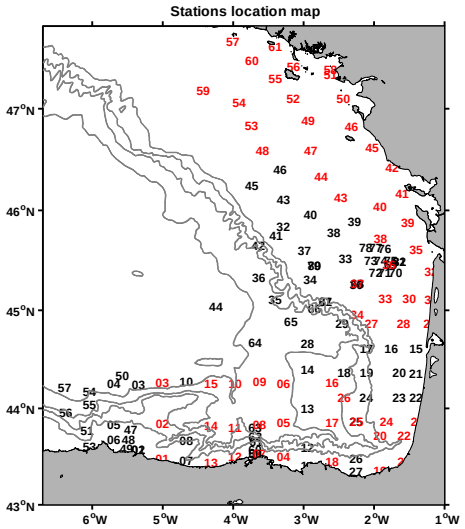
Average diet (2005-2009) non breeding

37% pelagic fish

Ronconi et al. 2009 Marine Ecology Progress Series

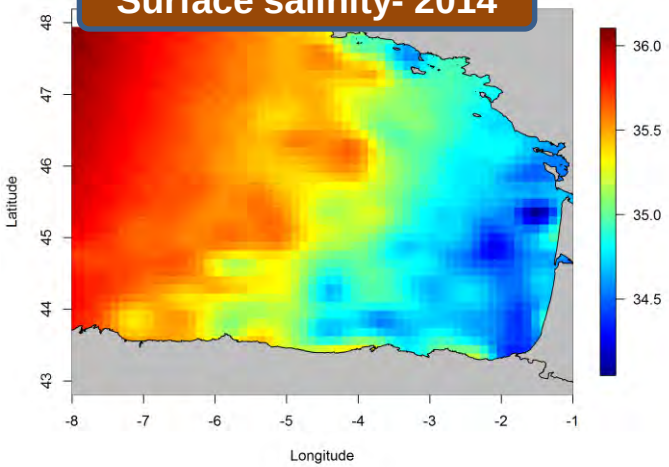
Boyra et al. 2013 ICES J M Sci

3D dynamic environment considering diving capabilities

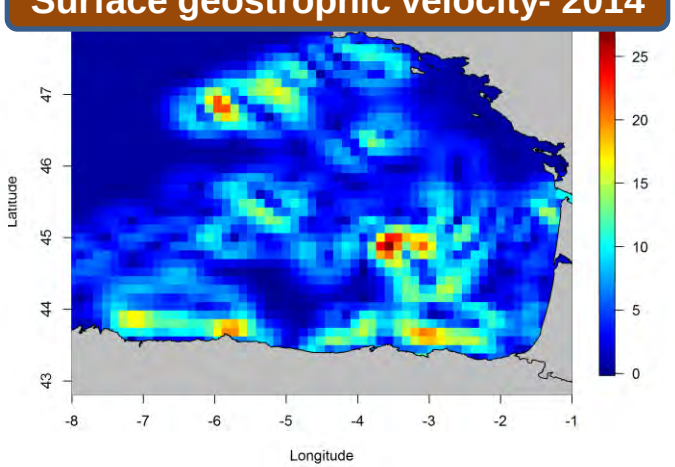


Horizontal fields of temperature, salinity, geostrophic velocities

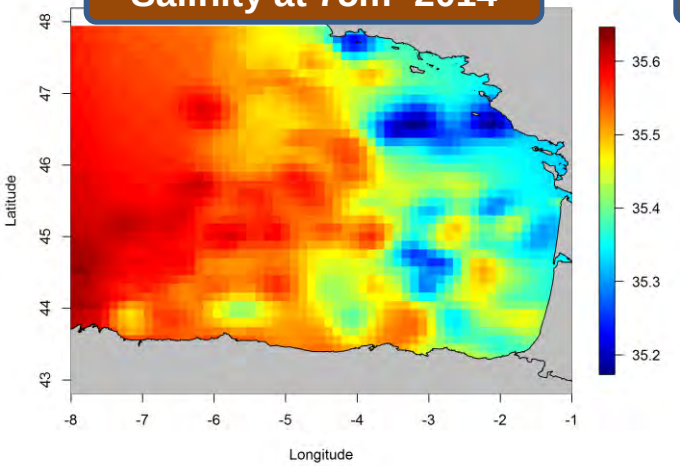
Surface salinity- 2014



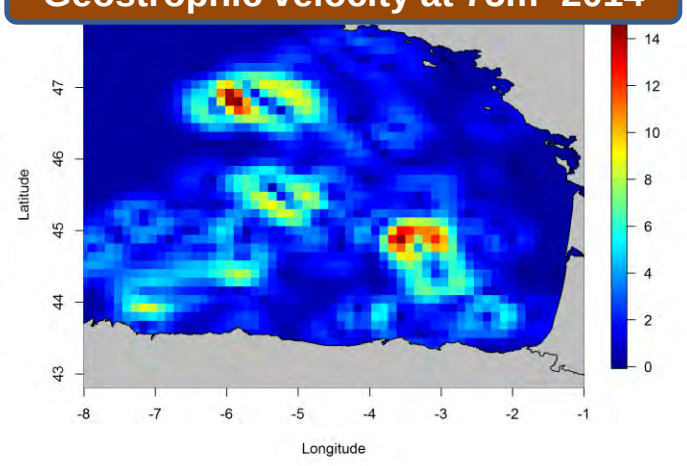
Surface geostrophic velocity- 2014



Salinity at 75m- 2014



Geostrophic velocity at 75m- 2014

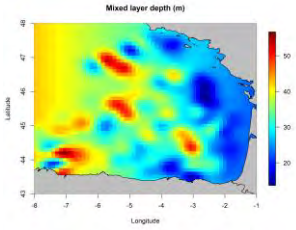


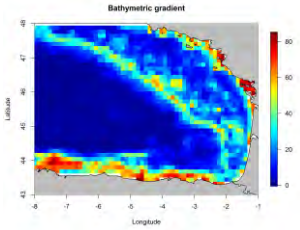
Abundance spatial models

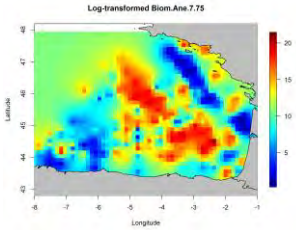
To explore environment and food availability effect on sooty shearwater abundance, A

JUVENA 2013-2015

$$A = \alpha + f(\text{Dynamic}_i) + f(\text{Static}_j) + f(\text{Prey}_k) + \textit{offset}(\textit{log}(\textit{Effort})) + \varepsilon$$







A ~ NB

i **= surface temperature, surface salinity, averaged geostrophic velocity**

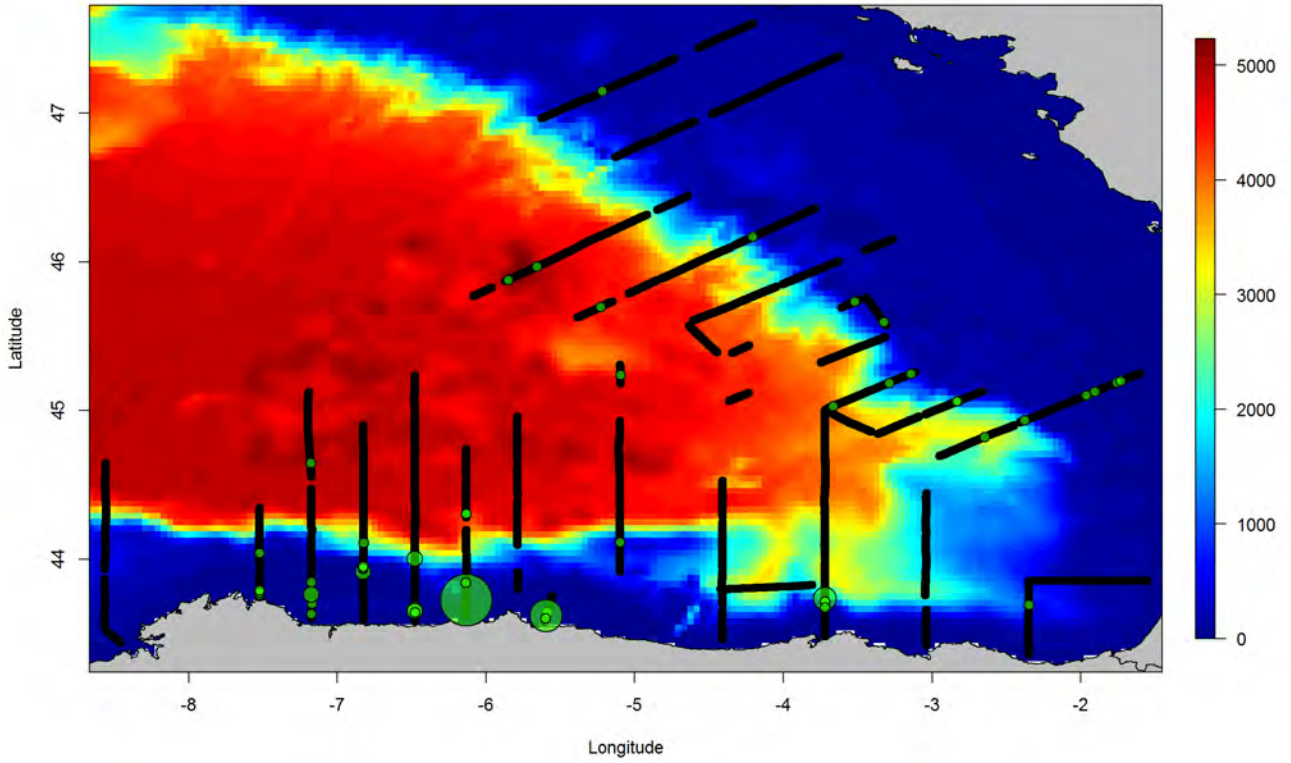
j = bathymetric spatial gradient, distance shelf-break, distance to coast

k = biomass of anchovy juvenile, anchovy adult and sardine integrated 7-75 m

Generalized Additive Models
Information Theoretic Approach

Observations (example of 2014)

- In 2014, travelling a total of 2427.13 km during 144.55 hours of observation.
- In 2013-2015, 359 sooty shearwaters were observed in 213 occasions (mean ± SD group size = 1.68 ± 2.74).

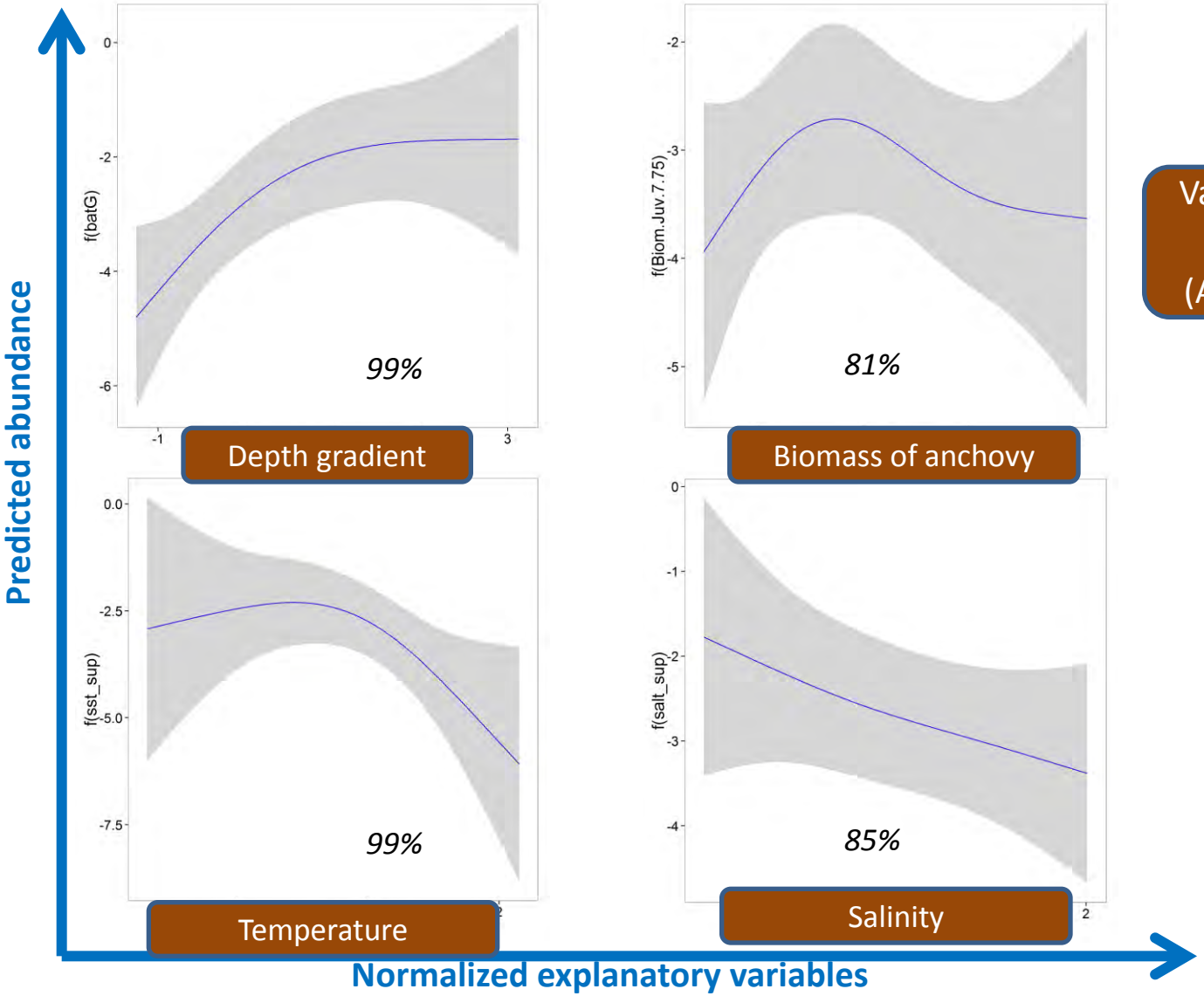


Observation aggregation over standard grid (2013-2015) :

84 presence
667 absence

Variables influencing shearwater abundance

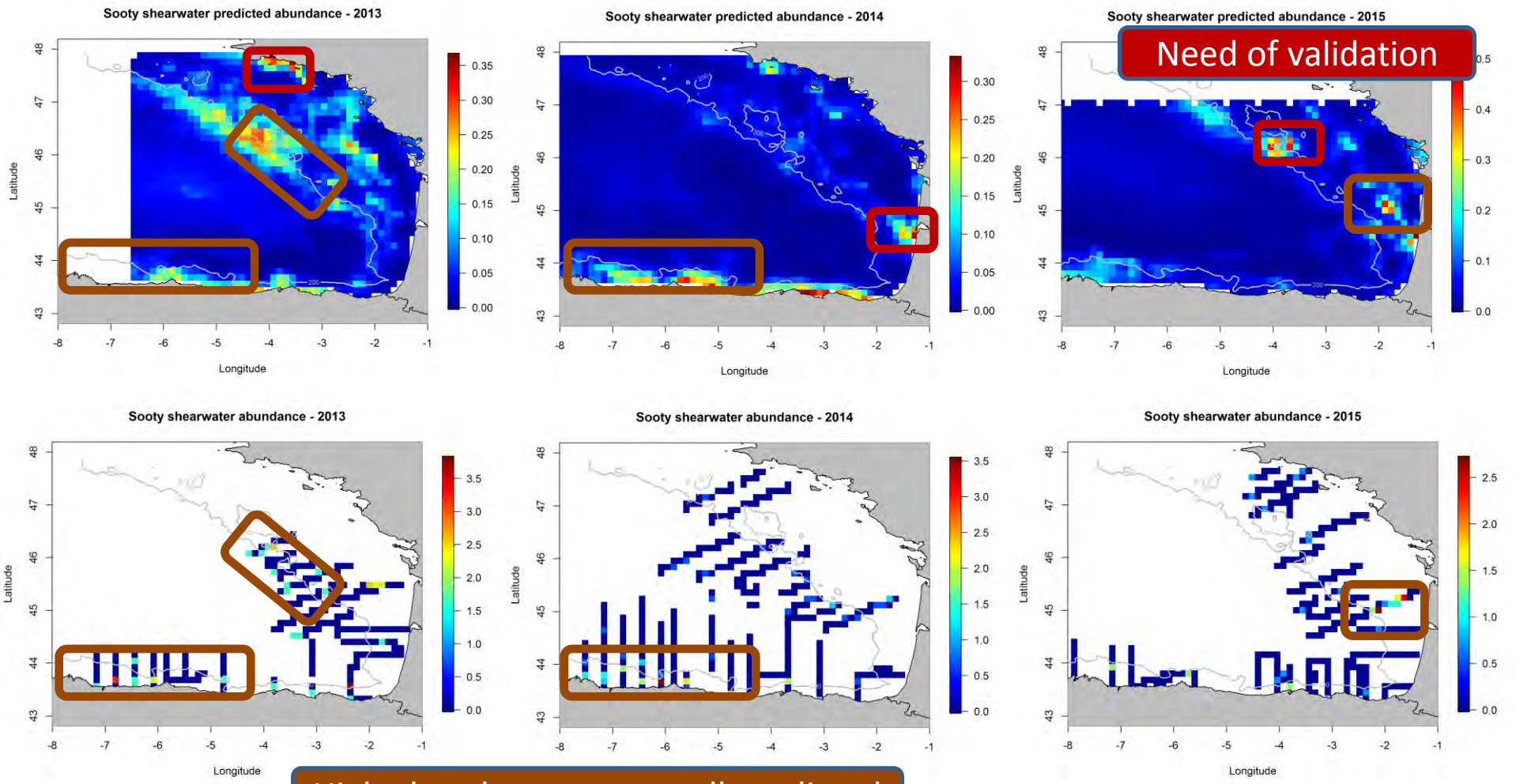
Model with lowest AICc explained the 31% of deviance, overdispersion $\phi \sim 1$



Variable relative importance (Akaike weight)

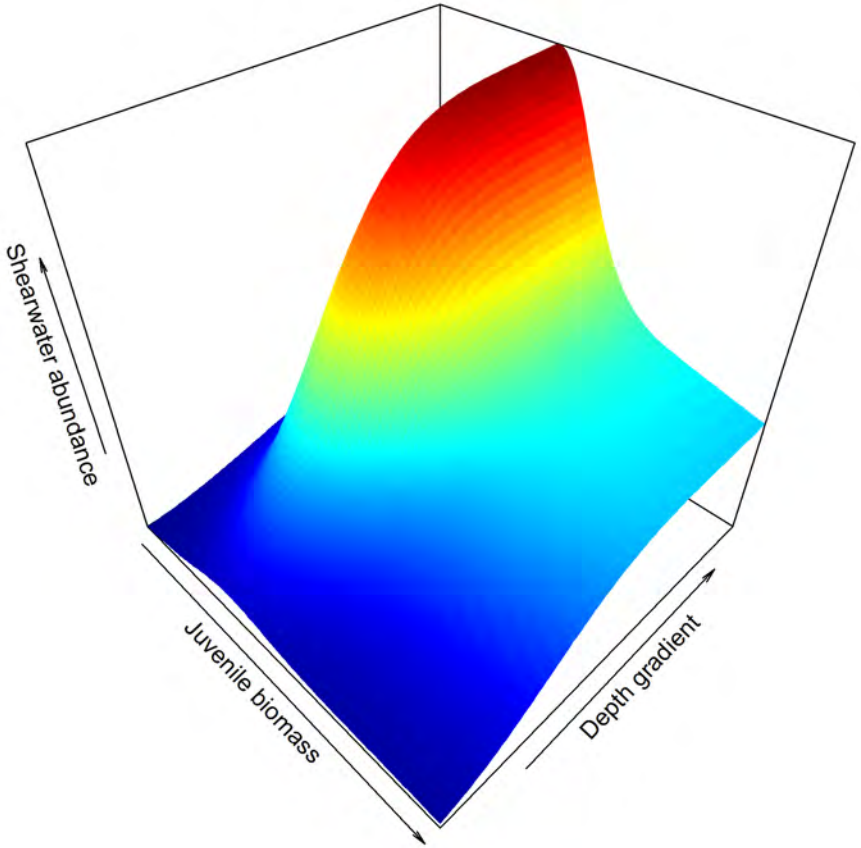
Predicted spatial abundance

Model averaging approach
95% confidence set: 101 models from 512



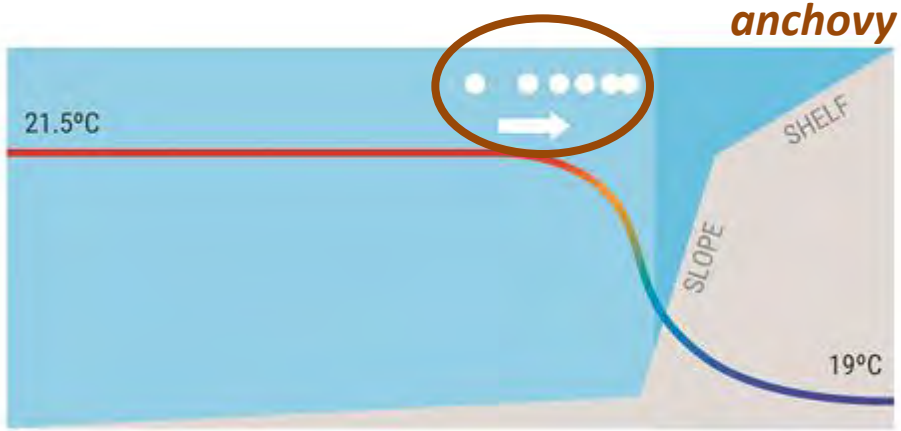
Importance of considering prey fields

- Biomass of juveniles of anchovy was influential on driving distribution patterns of sooty shearwaters, along with depth gradient.



- Juveniles of anchovy aggregated in oceanic areas, close to the shelf-break (high depth gradient values).

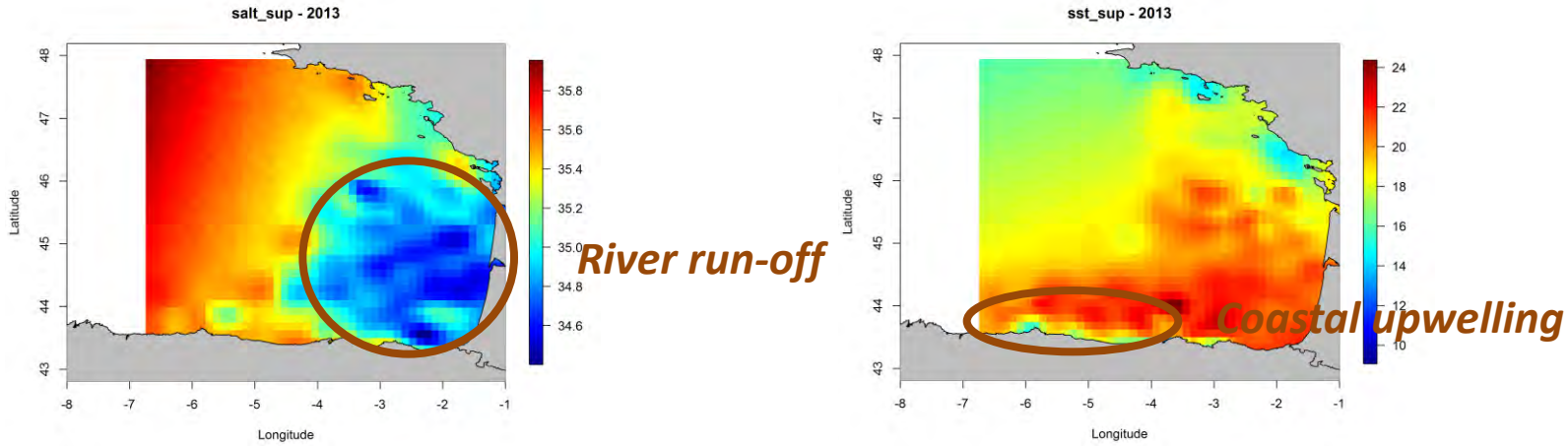
Schools of juveniles of anchovy



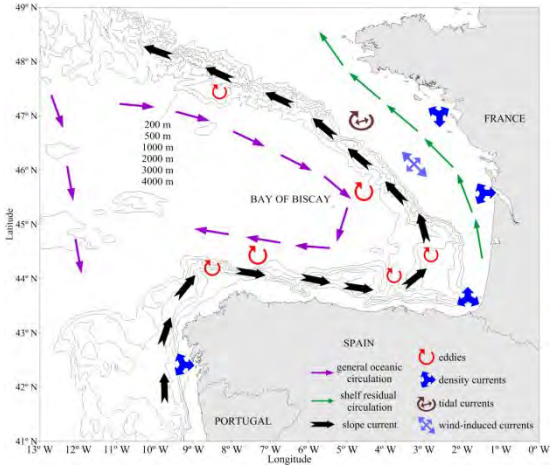
Boyra et al. 2016 Fisheries Oceanography

Oceanographic features

- Surface salinity (low salinity) and temperature (lower values) were the main important variables associated to higher shearwater abundance.

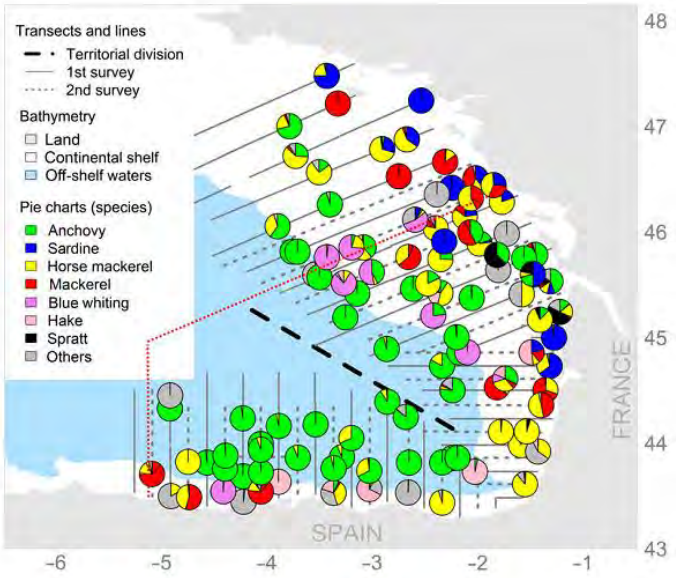


- We did not detect an effect of typical eddies observed during JUVENA period.



Next steps...

- To validate spatial predictions with observations during JUVENA 2016 (cross-validation).
- Integration of additional pelagic prey data, ongoing work .



Boyra et al. 2016
Fisheries Oceanography

- Integrative studies combining predator observations and pelagic prey can provide a comprehensive picture on the importance of refueling areas in determining migratory pathways with important implications in conservation strategies and climate change studies.

Thank you for your attention!

Eskerrik asko zuen arretagatik!

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