Cetaceans ecological preferences in response to ocean seasonality

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Cetaceans ecological preferences in response to ocean seasonality

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Introduction

Ocean is characterized by strong spatio-temporal heterogeneity inducing patchy and variable resources for predators. Spatial and temporal scales are inter-related, with large scale processes occurring at the long-term scale. The season is an intermediate temporal scale, occurring from fine to large spatial scales.

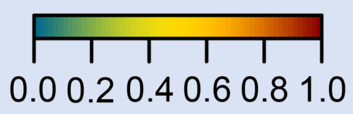
We expect cetaceans to anticipate the recurrent variability of their environment and to adjust their preferences to find the best compromise between ocean conditions and their own constraints.

How do cetaceans tune their ecological preferences to respond to ocean seasonality ?

Methods

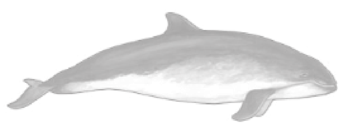
Aerial surveys (SAMM) conducted during winter 2011-2012 and summer 2012 in Bay of Biscay (BoB), English Channel (EC) and Mediterranean Sea, following line transect method.

Habitat modelling was performed for BoB & EC at one hand, Mediterranean at the other hand, with Generalized Additive Models using physiographic (depth, slope) and dynamic variables (SST, SSH in both areas; currents in BoB/EC only; Chlorophyll a, NPP and euphotic depth in Mediterranean only). Daily predictions were then averaged over each season (in relative abundance standardised by groups and seasons, see scalebar below).



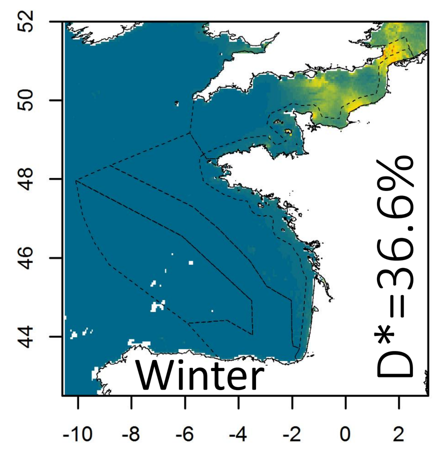
Results & Discussion

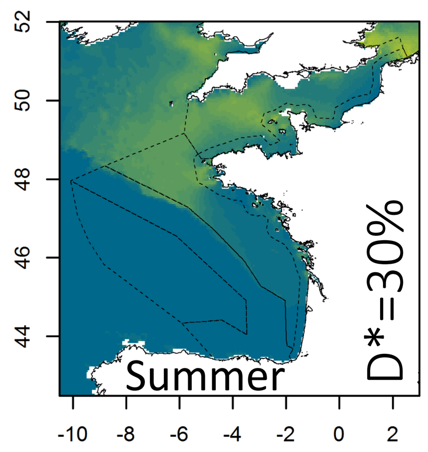
Harbour porpoise



In winter: preference for shallow waters coupled with high SSH and high tidal currents

In summer: preference null SSH waters, with important hydrological activity during last month

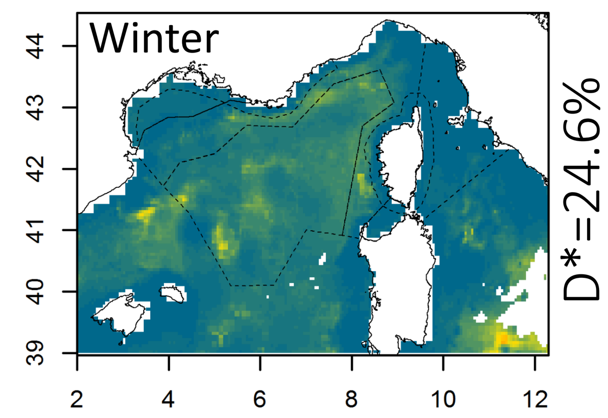


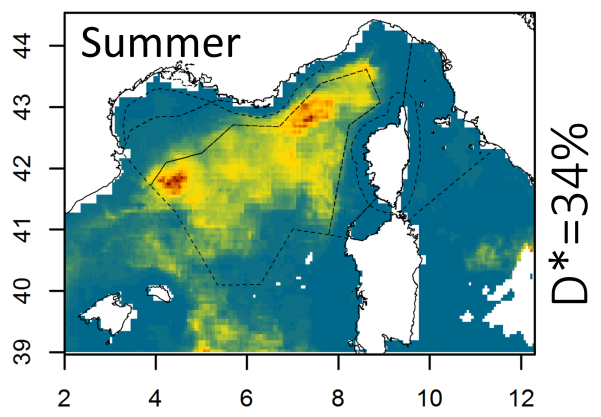


In winter, target highly predictable prey aggregation structures, then shift to calm waters, previously enriched through vertical mixing during calving period

Fin whales

Winter & summer same preference for the Liguro-Provençal current anti-clockwise gyre → highly predictable krill habitat, Lower densities in winter



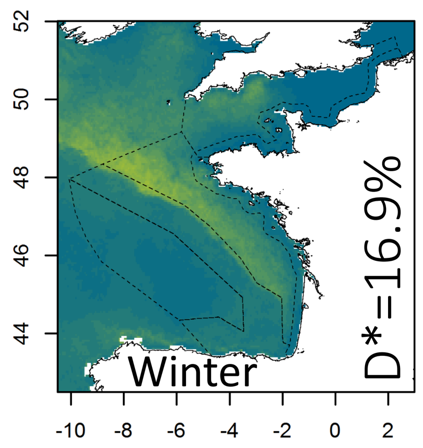


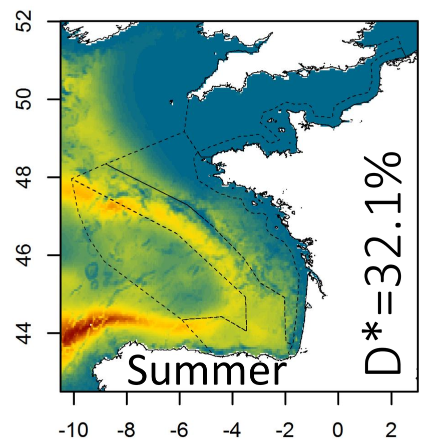
Population aggregate over krill in summer. In winter (↘ productivity), part of the population disperse, the remaining staying over the krill patch.

Common & Stripped dolphins

In winter: preference for calm waters around 14°C (reduced hydrological dynamism and thermal gradients)

In summer: preference for calm waters around 16°C associated to important thermal gradients

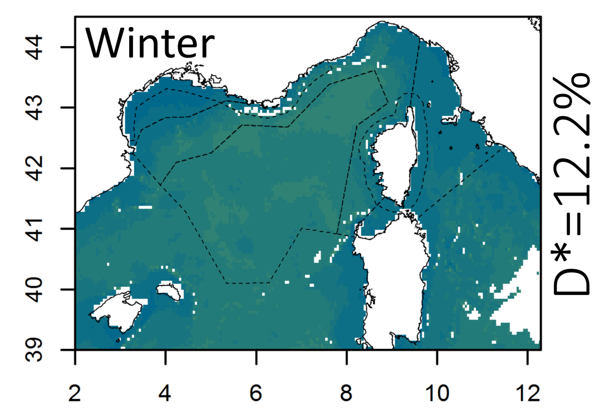


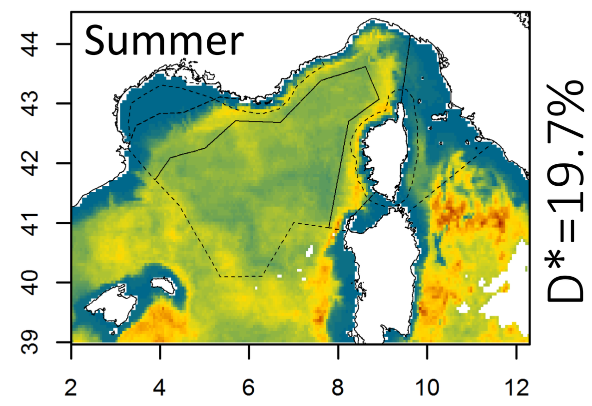


Large-scale seasonal movement from inshore in winter to offshore in summer potentially linked to prey migration

Strong preference for deep oligotrophic waters in both winter and summer

In winter: contrasted by preference for low eddy dynamism and steep slope.



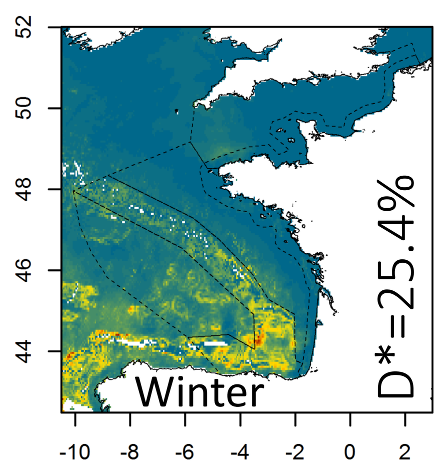


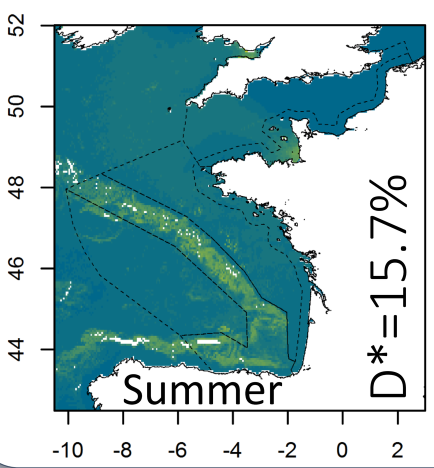
In summer: contrasted by preference for SST around 21°C and moderate thermal variations.

Bottlenose dolphins

In winter: preference for warm waters (>15°C) and long-term predictable mesoscale features associated to shelf edge (eddies/fronts)

In summer: preference for negative SSH and high slopes

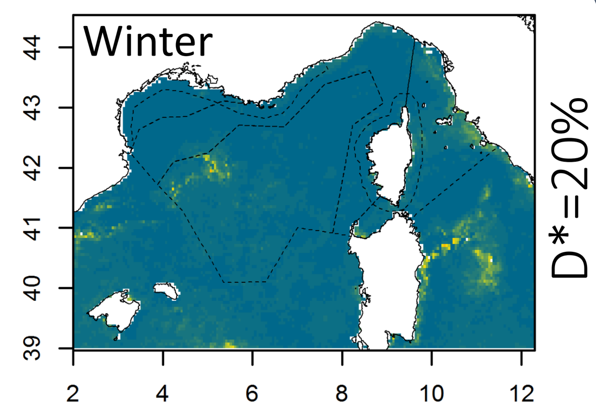


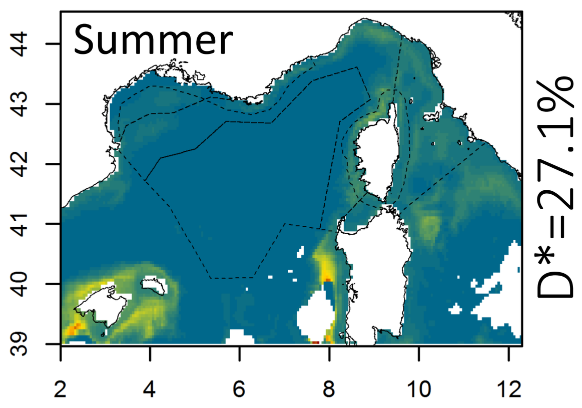


During winter, exploit predictable features of shelf edge and beyond, then part of pop° shift to neritic areas during calving periods, while the rest still exploit shelf edge

In winter: oceanic, aggregating over long-term and predictable Balearic and Tyrrhenian fronts

In summer: shallow (< 1,000 m) calm and warm waters (22°C)





Seasonal shift linked to phenological reasons ? During winter, forage over predictable offshore fronts, then shift to neritic areas during calving periods (protection)

Conclusion

Three strategies in response to ocean seasonality

No shift in ecological preferences, but part of population disperse during unfavourable season

(fin whales, small-sized delphinids in Med. Sea)

Shift in ecological preferences to optimise compromise between phenological and foraging constraints

(harbour porpoises, bottlenose dolphins, small-sized delphinids in Atlantic)

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