Use of stable carbon and nitrogen isotopes for trophic levels evaluation and food webs reconstruction:
the Bay of Biscay case study
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Introduction
The Bay of Biscay is a very large bay opened on the North-East Atlantic Ocean (Fig. 1). The continental shelf covers over 220 000 km². The hydrological structure is influenced by 2 main rivers plumes (Loire and Gironde) and a continental slope indented by numerous canyons. The Bay of Biscay supports both numerous important fisheries and a rich fauna including many protected species (e.g., marine mammals). The management of this ecosystem subjected to numerous anthropogenic impacts notably depends on the good understanding of its food webs' structure.

Methods
In trophic ecology, stable isotope ratios (SIR) of carbon (C) and nitrogen (N) are generally used as proxies of:
• the feeding zone or habitat (δ13C)
• trophic position (δ15N).

Here, were analysed C and N SIR in the muscle of 1520 individuals belonging to 129 species from various taxa.
Species were grouped following:
• taxonomic criteria
• general spatial distribution (i.e., pelagic vs. demersal/benthic species, and from coastline to oceanic area).

Results & Discussion
Within each major group of taxa, spatial groups displayed significantly different δ13C and δ15N values (KW tests, all p < 0.0001). A gradient in stable C and N ratios was evidenced. As expected from literature, δ13C and δ15N values decreased from near-shore organisms to deep-sea or oceanic organisms (Fig. 2). These results highlighted the existence of several food webs with distinct baseline signatures in the Bay of Biscay.

Differences in δ15N values in particular are linked to processes occurring at the Dissolved Inorganic Nitrogen (DIN) level (not detailed here), and to nutrients and particulate organic matter available for primary production in general.

Therefore, the contrasted hydrological landscapes from the Bay of Biscay probably impact signatures of the primary producers in the different areas of the Bay.

Fig. 1: Map of the study area. The grey line indicates the 200 m isobath.

Fig. 2: Muscle δ13C and δ15N values (‰) for various taxa from the Bay of Biscay. Values are means ± SD. For Fish, the biggest triangles correspond to larger species, the smallest triangles to smaller species (50 cm total length in mean vs. 21 ± 11 cm). For marine mammals, species are not regrouped. Bph = Balaenoptera physalus; Bac = Balaenoptera acutadrus; Dke = Delphinus delphis; Fph = Phocoena phocoena; Ttr = Tursiops truncatus.

Fig. 3: Map of the different environments in the Bay of Biscay, as revealed by SIR of C and N.

Conclusions
• Near-shore, upper-slope, and deep-sea or oceanic environments must be distinguished in the Bay of Biscay, notably when calculating trophic levels from δ15N values.
• The results encourage further study on trophic relationships in the different environments.
• Finally, spatial variations in δ13C and δ15N values between areas is promising for the study of particularly poor-known species, and those difficult to sample and/or to observe (e.g., deep-sea species, marine mammals).

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