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Deep-sea benthic habitats modeling and mapping in a NE Atlantic seamount (Galicia Bank)

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ABSTRACT

This study presents the results of seafloor habitat identification and mapping of a NE Atlantic deep seamount. An "assemble first, predict later" approach has been followed to identify and map the benthic habitats of the Galicia Bank (NW Iberian). Biotic patterns inferred from the survey data have been used to drive the definition of benthic assemblages using multivariate tools. Eight assemblages, four hard substrates and four sedimentary ones, have been described from a matrix of structural species. Distribution of these assemblages was correlated with environmental factors (multibeam and backscatter data) using binomial GAMs. Finally, the distribution model of each assemblage was applied to produce continuous maps and pooled in a final map with the distribution of the main benthic habitats. Depth and substrate type are key factors when determining soft bottom communities, whereas rocky habitat distribution is mainly explained by rock slope and orientation. Enrichment by northern water masses (LSW) arriving to GB and possible zooplankton biomass increase at vertical-steep walls by "bottom trapping" can explain the higher diversity of habitat providing filter-feeders at slope rocky breaks. These results concerning vulnerable species and habitats, such as *Lophelia* and *Madrepora* communities and black and bamboo coral aggregations were the basis of the Spanish proposal of inclusion within the Natura 2000 network. The aim of the present study was to establish the scientific criteria needed for managing and protecting those environmental values.

1. Introduction

There is a global call to protect marine species and ecosystems and to develop coherent and connected networks of Marine Protected Areas (MPAs) in national and international waters (Bullimore et al., 2013; Edgar et al., 2014). The last Convention on Biological Diversity (CBD) established in 1992, states the necessity of conserving 10% of the coastal and marine areas through effective and equitably managed, ecologically representative, and well-connected systems of protected areas and other effective area-based conservation measures. Similar calls have been made by regional organisations, such as the Oslo-Paris (OSPAR) Convention and several countries around the world which are contributing to this global effort by developing their own MPA networks (IUCN and UNEP-WCMC, 2013). In Europe, the Marine Strategy Framework Directive (MSFD) includes a requirement to establish an ecologically coherent network of MPAs to help protect vulnerable species and habitats. Despite the remarkable expansion of the number of MPAs and the amount of marine areas protected in recent years, MPAs still cover only 2.8% of the world's seas and oceans (IUCN and UNEP-WCMC, 2013), far from the 10% target for 2020. As part of the necessary effort to conserve marine ecosystems, the Spanish government has proposed eleven off-shore areas as Special Areas of Conservation (SACs) under the Habitat Directive (Council Directive 92/43/EEC). These areas were shortlisted based on previous knowledge and their priority features studied within the research project INDEMARES (EC contract LIFE 07/ NAT /E/000732). The main objective of this project was to provide the necessary information to establish a network of representative MPAs in Spanish waters.

Habitat identification and mapping are fundamental in determining the locations for potential protected areas although both requirements are challenging, especially in the deep sea (Bryan and Metaxas, 2007; Howell, 2010; Howell et al., 2010; González-Mirelis et al., 2012;

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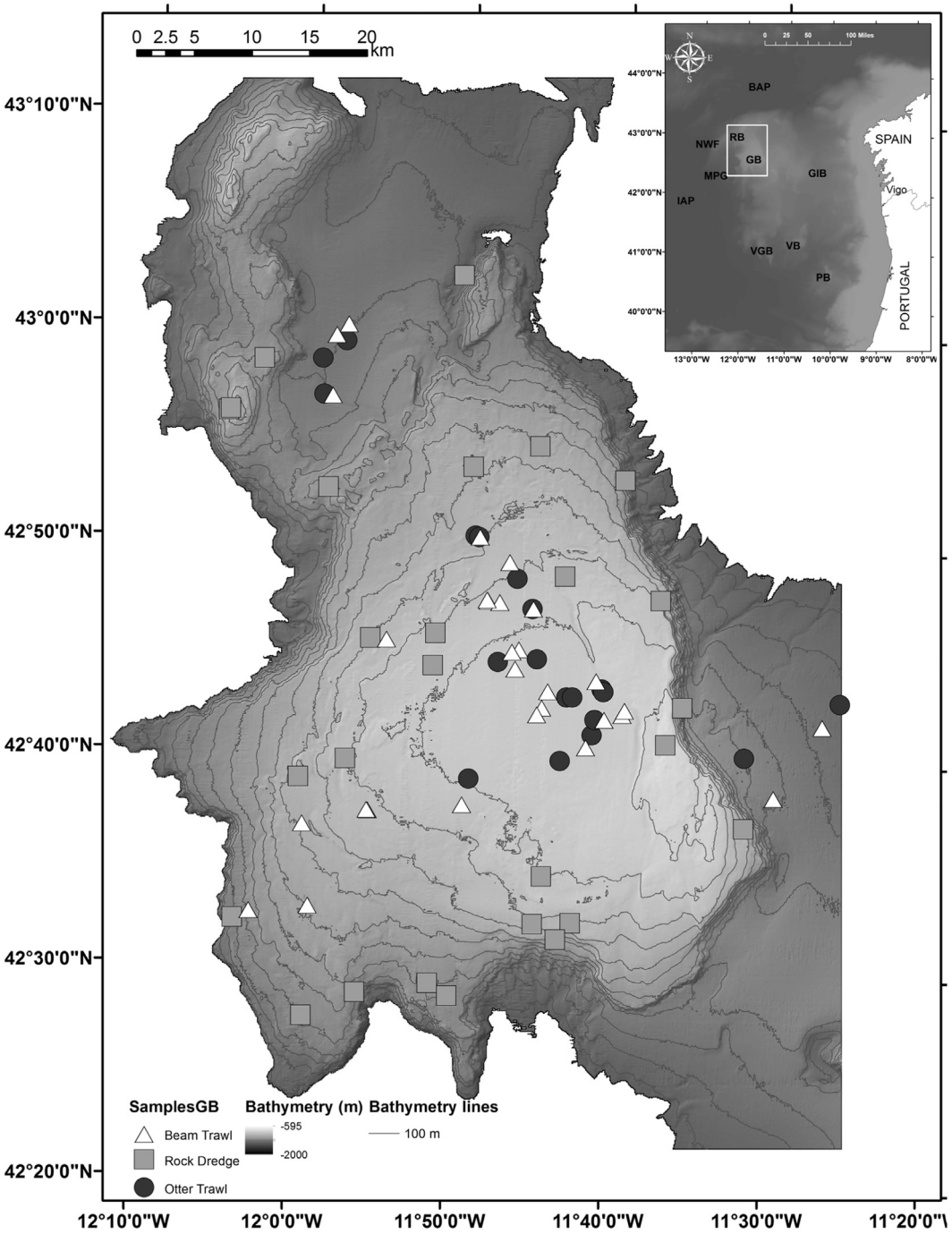

Fig. 1. Study area and sampling stations. Bathymetric contours each 100 m. Inset: Location of the study area on the west Iberia continental margin. GB, Galicia Bank; RB, Rucabado Bank, VGB, Vasco da Gama bank; VB, Vigo bank; PB, Porto bank; GIB, Galicia Interior Basin; TZ, Transition Zone; NWF, Northwestern flank; DGM, Deep Galicia Margin; BAP, Biscay abyssal plain; IAP, Iberia abyssal plain. Bathymetry from the Spanish EEZ Project (multibeam bathymetry) and the GEBCO Digital Atlas.

Bullimore et al., 2013; Davies et al., 2015; González-Irusta et al., 2015). Deep-sea ecosystems are usually characterised by their remoteness and challenging accessibility. Great depths mean expensive costs in time and budget. Moreover, whereas in the shallow-water ecosystems the benthic assemblages are relatively well known, the description of these communities in the deep sea is still poor (Bullimore et al., 2013). Furthermore, hard-bottom living communities (typified mainly by corals and sponges), due to their patchy, irregular distribution linked to remote bottom accidents such as canyons, seamounts, steep reliefs, etc., are even more inaccessible than soft-bottom communities in the deep sea, and consequently information on their distribution and zonation is comparatively scarce. Therefore, it is necessary to describe these assemblages, especially hard-bottom ones, and the underlying environmental conditions which structure them in order to identify the habitats to protect (Howell, 2010; Howell et al., 2010). Only after properly describing the habitats it is possible to include them in the different habitat classification systems, a required step to protect them through directives (Habitats Directive- HD, Marine Strategy Framework Directive- MSFD) and conventions (OSPAR). EUNIS habitat classification (Davies and Moss, 2002) was used to classify benthic habitats and to extend crosswalks to the above cited directives and conventions and in order to supply information that can be used in the SAC management plan.

Once the different habitats have been identified, it is necessary to