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Hard-bottom bathyal habitats and keystone epibenthic species on Le Danois Bank (Cantabrian Sea)

F. Sánchez[a,*], A. Rodríguez Basalo[a], A. García-Alegre[b], M. Gómez-Ballesteros[c]

[a] Instituto Español de Oceanografía, P.Box 240, 39080 Santander, Spain
[b] Tecnologías y Servicios Agrarios S.A. (Tragsatec), Avenida de los Castros 55, 39005 Santander, Spain
[c] Instituto Español de Oceanografía, Corazón de María 8, 28002 Madrid, Spain

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ABSTRACT

"El Cachucho" Marine Protected Area (MPA), which comprises Le Danois Bank and its intraslope basin, was included during 2008 in the Nature 2000 network mainly because of the presence of the habitat "1170 Reefs" according to the EU Habitat Directive. To review the effectiveness of existing management measures, several activities aimed at characterizing the most structurally complex hard-bottom habitats were planned and carried out during the ESMAREC 0514 survey. For identification of these habitats, several transects using the photogrammetric towed sled *Politolana* were carried out on Le Danois Bank, in the depth range between 427 and 1379 m, searching for the sea beds with higher values of slope and backscatter. Photogrammetric techniques were used for image scaling, so we could determine the surface areas of different substrata types (facies) and their species densities. A total area of 28,762 m^2 was analyzed in the still images of 23 transects, verifying that 85% of the substrata of our study area are occupied by 4 different facies: Bedrock, bedrock with mixed sediments, mixed sediments with pebbles and boulders, and mixed sediments. Acoustic data and ground-truth visual data were combined to evaluate distinctive benthic scenarios. The relative abundances of the 123 epibenthic species identified by image analyses show that the most abundant are sponges (29%), cnidarians (26%), crustaceans (26%) and echinoderms (14%), i.e. mostly sessile species or those with low mobility. The keystone species of the "1170 Reefs" habitat are 3 cnidarians: *Callogorgia verticillata*, *Paramuricea* cf. *placomus* and *Dendrophyllia cornigera,* and 3 sponges, *Asconema setubalense*, *Geodia* msp.1 and *Phakellia robusta*. Eight new habitats (biotopes) have been identified on Le Danois Bank, six of which occur on the hard bottoms, with depth, substratum, BPI (Bathymetric Position Index) and slope as determining environmental variables that explain their spatial distributions.

1. Introduction

Current knowledge of the geographical range and ecological functioning of deep-sea benthic habitats of the Cantabrian Sea (southern Bay of Biscay) is still extremely poor due to the limitations of conventional seabed sampling methods (Sánchez et al., 2009; García-Alegre et al., 2014). Particularly, the vulnerable habitats located on bathyal hard bottoms are difficult to study using classical extractive methods such as dredges or trawls. Consequently, it is not easy to manage their resources effectively, protect ecologically important areas or set legislation to safeguard the biodiversity.

Spain is one of the richest European countries in terms of marine biodiversity. In the last few years great advances and efforts have been made to consolidate a significant number of Marine Protected Areas (MPAs), following the principles established by the European Union that are articulated in the Natura 2000 network. Currently, and as a result of the studies included in the European Project LIFE + INDEMARES, ten large deep-sea areas have been identified as *Sites of Community Importance* (SCIs). That has started a long process of consoliding them as MPAs, with management plans to ensure the necessary protection of their biodiversity. At the same time, fishing has always been an important social and economic activity for Spanish coastal villages, due to the high demand for fish as food by a large proportion of our society (Piquero and López, 2005). Thus, the entire process of creating a network of MPAs must be accompanied by adequate and reasonable management measures based on scientific studies and by the recognition and approval of all the sectors involved. Initially, in 2008, the first large off-shore MPA in Spain, "El Cachucho", was created and it serves as a starting point or model for developing the research, the process of MPA declaration and the monitoring of MPAs located in

* Corresponding author.
E-mail address: f.sanchez@ieo.es (F. Sánchez).

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deep-sea ecosystems.

Le Danois Bank (Le Danois, 1948) and its intraslope basin (a sedimentary area between the bank and the Cantabrian Sea continental shelf) have been declared by the Spanish Ministry of Environment as "El Cachucho" MPA (Heredia et al., 2008). El Cachucho is integrated into the Natura 2000 network in the category *Special Area of Conservation* (SAC). The main reason for the declaration is the presence in the area of "1170 Reef" habitats, that are included in Annex I of the Habitats Directive of the European Union (Council Directive 92/43/EEC). Under the definition of "1170 Reefs", a whole set of complex and diverse hard-bottom habitats are included, which can be either biogenic concretions or of geogenic origin. The characteristics of this set of habitats can differ depending on the biogeographical area, the topography and nature of the substratum, and physical and chemical characteristics of the water column. In the case of Atlantic bathyal ecosystems, these habitats are usually occupied by gorgonian communities, deep-sea sponge aggregations or cold-water coral reefs (EC, 2013).

During 2003–2009, Le Danois Bank was studied by the ECOMARG project, mainly focused on the benthic-demersal ecosystem (http://www.ecomarg.com). In its initial stage, the project addressed the morpho-sedimentary and bathymetric characteristics (Ballesteros et al., 2006; Van Rooij et al., 2010; Gómez-Ballesteros et al., 2015) and the characterization and dynamics of the water masses (González-Pola et al., 2012). In a second phase, it focused on the fauna, accomplishing an integrated study of three benthic compartments: endobenthos, epibenthos and suprabenthos (Cartes et al., 2007a; Sánchez et al., 2008). The trophic ecology of the dominant species of fish and crustaceans was used to estimate the energy flows, the consumption and the niche overlaps among high-level trophic groups (Cartes et al., 2007b; Preciado et al., 2009). This information, together with studies of the impact of fisheries working in the area, was integrated in a trophodynamic mass-balance model to provide an efficient tool for management of the MPA (Sánchez et al., 2010). This multi-methodological approach offered a holistic view of the ecosystem's variability, its communities and the distribution of fishing resources. However, the majority of the biological studies were based on surveys conducted on sedimentary seabeds. Thus, knowledge of the habitats and communities of hard bottoms, existence of which justified the declaration of this area as an MPA, was scarce. However, some previous studies and methodological approaches had been carried out on Le Danois Bank aimed at identifying the hard-bottom communities using a photogrammetric towed sled (Sánchez et al., 2009). There had also been mapping of some representative benthic species using a habitat modelling analysis (García-Alegre et al., 2014).

The exceptional characteristics of Le Danois Bank, a big seamount under strong continental influence and located in the productive, large ecosystem of the Bay of Biscay (Lavin et al., 2006), are the main reason for the high biodiversity found in this area (Sánchez et al., 2008; Cristobo et al., 2009; Altuna, 2013). A remarkably large number of species has been recently discovered there as new to science, and more are in the process of description (Guerra-García et al., 2008; Frutos and Sorbe, 2010; Frutos et al., 2011). Beside the ECOMARG project, other studies have been performed in this area, like the DEEPCON project studying the connectivities among deep-water ecosystems, which was based on elasmobranch populations and used both electronic pop-up (PSAT) and conventional tags (Rodríguez-Cabello et al., 2012; Rodríguez-Cabello and Sánchez, 2014; Rodríguez-Cabello et al., 2016).

The management plan for "El Cachucho" MPA included measures to prohibit the use of bottom-fishing gear (trawls, long-lines and gillnets) on Le Danois Bank, but did authorize a few longline vessels (a closed list) that could fish, but only away from the top of the bank in the intraslope basin that acts as a buffer area. A recent study on the spatial distribution of fishing effort showed good compliance by vessels required to carry satellite tracking systems (Punzón et al., 2016). The main target species of the artisanal fleet that operated on the bank prior to implementation of fishing regulations were the monkfish (*Lophius piscatorius*), the alfonsino (*Beryx decadactylus*), the conger eel (*Conger conger*) and the greather forkbeard (*Phycis blennoides*), all benthic/demersal species usually caught with gillnets and long-lines. Pelagic fisheries, such as for tuna, have not been affected by the new management plans. Previous studies regarding this fishery in the MPA indicate that the mechanisms of production associated with the bank may enhance the surface fisheries (Rodríguez-Cabello et al., 2009).

Non-invasive methods, such as acoustic and visual surveys, are mandatory for the assessment and monitoring of MPAs. It is necessary to test whether these approaches provide the high-resolution habitat mapping requested in the Natura 2000 context and to estimate the descriptors of habitat health status contemplated in the Marine Strategy Framework Directive (MSFD, 2008/56/EC). Using technologies such as ship-borne multibeam echosounders, it is possible to acquire high-resolution, full-coverage imagery of the seafloor over extensive areas. The resulting topographic data and geophysical attributes of the terrain derived from its acoustic properties constitute an excellent basis for geomorphological classifications of the sea floor, particularly when they are interpreted together with supporting data from video or bottom samples (Kostylev et al., 2001; Conway et al., 2005; Harris and Baker, 2012). Also, visual inspection using underwater cameras not only provides detailed information on the general features visible in multibeam data, but is an excellent basis for biological investigations across a range of bottom types (Sánchez et al., 2009; Howell et al., 2010; Neves et al., 2014; Buhl-Mortensen et al., 2015). Sessile benthic organisms are useful for habitat characterization because substratum is critical in determining their status. Since they are static, these organisms are the most accessible indicators of environmental conditions on the seafloor they occupy (Kostylev et al., 2001).

In the context of the biannual monitoring of "El Cachucho" MPA, the Spanish Oceanographic Institute (IEO) has worked to describe the various vulnerable habitats, with the objective of making high-resolution maps that identify the adequacy of the currently implemented management measures. Consequently, the main objectives in this study have been:

- Identify, characterize and map the hard-bottom habitats of Le Danois Bank for patterns in the environmental data.
- Identify the dominant (keystone) epibenthic species in vulnerable habitats and know their states of conservation.
- Produce high-resolution maps for management purposes of the "1170 Reefs" typology from the European Habitats Directive.
- Evaluate the feasibility of applying the criteria from the Marine Strategy Framework Directive (MSFD, 2008/56/EC) for monitoring some of the descriptors of environmental status in respect to deep-sea ecosystems.

2. Material and methods

2.1. Study area

The bathymetric and high resolution seismic profile data and the oceanographic studies carried out during the ECOMARG and ESMAREC projects allowed us to identify the morpho-sedimentary features and the hydrodynamics of the study area, parts of the determinant factors of the environmental scenario (Van Rooij et al., 2010; González-Pola et al., 2012; Gómez-Ballesteros et al., 2015). Le Danois Bank, locally known by fishermen as 'El Cachucho' (that is also the local name of the alfonsino, *Beryx decadactylus*) fishing ground, is located on a marginal shelf in the Cantabrian Sea (southern Bay of Biscay) at 5°W longitude and 44°N latitude (Fig. 1). In plan view the Bank presents an elongated form about 72 km long in an *E*-W direction and about 15 km wide from north to south; it has an almost flat surface with a minimum depth of 424 m, and is separated at 25 km from the Spanish continental shelf by a deeper intraslope basin (Ballesteros et al., 2006; Van Rooij et al., 2010). This structure is a "horst" type, presenting a dissymmetry