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EUNIS habitat's thresholds for the Western coast of the Iberian Peninsula — A Portuguese case study

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A B S T R A C T

The European Nature Information System (EUNIS) has been implemented for the establishment of a marine European habitats inventory. Its hierarchical classification is defined and relies on environmental variables which primarily constrain biological communities (e.g. substrate types, sea energy level, depth and light penetration). The EUNIS habitat classification scheme relies on thresholds (e.g. fraction of light and energy) which are based on expert judgment or on the empirical analysis of the above environmental data. The present paper proposes to establish and validate an appropriate threshold for energy classes (high, moderate and low) and for subtidal biological zonation (infralittoral and circalittoral) suitable for EUNIS habitat classification of the Western Iberian coast. Kinetic wave-induced energy and the fraction of photosynthetically available light exerted on the marine bottom were respectively assigned to the presence of kelp (*Saccorhiza polyschides*, *Laminaria hyperborea* and *Laminaria ochroleuca*) and seaweed species in general. Both data were statistically described, ordered from the largest to the smallest and percentile analyses were independently performed. The threshold between infralittoral and circalittoral was based on the first quartile while the 'moderate energy' class was established between the 12.5 and 87.5 percentiles. To avoid data dependence on sampling locations and assess the confidence interval a bootstrap technique was applied. According to this analysis, more than 75% of seaweeds are present at locations where more than 3.65% of the surface light reaches the sea bottom. The range of energy levels estimated using *S. polyschides* data, indicate that on the Iberian West coast the 'moderate energy' areas are between 0.00303 and 0.04385 N/m^2 of wave-induced energy. The lack of agreement between different studies in different regions of Europe suggests the need for more standardization in the future. However, the obtained thresholds in the present study will be very useful in the near future to implement and establish the Iberian EUNIS habitats inventory.

1. Introduction

The effects of human activities on the marine environment are increasingly evident and impossible to be ignored. Industrial fishing and pollution as well as several other anthropogenic impacts have been causing damage to marine species and their habitats. An ecosystem-based management approach within marine spatial planning requires standardized classifications and terminology across all possible habitats (Costello, 2009; Hiscock and Connor, 1991). There have been progresses into the development of habitat classifications and different schemes have been implemented, such as in Europe (Connor et al., 1995, 1997a, 1997b, 2003, 2004; Davies et al., 2004; Devillers and Devillers-Terschuren, 1996; Devillers et al., 1991), Canada (Zacharias et al., 1998), Australia (Butler et al., 2001), United States (Allee et al., 2000), New Zealand (Snelder et al., 2006) and in South Africa (SANBI, 2009).

The system by which European habitats have been classified is called the European Nature Information System (EUNIS) (Connor et al., 2003, 2004; Davies et al., 2004; Evans, 2012). The marine section of the EUNIS classification was originally based on the UK BioMar classification (Connor et al., 1995, 1997a, 1997b). It was developed in collaboration with experts from all over Europe and managed by the European Topic Centre for Nature Protection and Biodiversity (ETC/NPB) for the European Environment Agency (EEA) and the European Environmental Information Observation Network (EIONET) (Davies et al., 2004). This system covers all types of natural and artificial habitats and is theoretically under development as new information becomes available (Howell, 2010).

A habitat is the area where an organism, or population or communities of species occur (e.g. mussel beds on circalittoral rock) i.e. the type of environment where a species could potentially establish itself (Olenin and Ducrotoy, 2006). For the purposes of EUNIS habitat classification the term is used as the place where a biological community normally lives, characterized by its physical features and by the communities or assemblages of species that live there (Davies et al., 2004). Thus it is defined by the combination of several key environmental variables

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(e.g. substrate types, exposure to wave action, strength of tidal currents, salinity, temperature, hydrographic regime), referred to as the 'habitat envelope', together with its associated biological community, operating at particular spatial and temporal scales (ICES, 2001).

Hierarchical segmentation within the upper marine division of the EUNIS classification systems is defined by a few environmental variables which primarily drive/structure the distribution of biological communities such as substrate types, energy level (wave action and tidal current), depth and light penetration (Connor et al., 1995, 1997a, 1997b, 2003, 2004; Davies et al., 2004). The EUNIS marine classification scheme is initially divided up on the basis of biological zones (e.g. infralittoral and circalittoral) and substrate types (e.g. sand, rock) as well as on the depth range (level 2). At level 3 the segmentation is broadly based on ecological region (Atlantic, Baltic, Mediterranean and Black Sea) and three energy levels of the coast (low, moderate and high), while associated biological communities begin to appear on lower levels (Davies et al., 2004). Referred to as a 'top-down' approach, this classification scheme relies on thresholds (e.g. biological zonation and sea energy) that can be based on the literature, expert judgment or on the empirical analysis of the above environmental data variables (Cameron and Askew, 2011).

The biological zones are classically obtained through the characterization of the vertical distribution of certain indicator species, such as macrophytes and algae, or sessile fauna such as sponges and ascidians which are less tolerant to light (Logan et al., 1984; Pérès, 1967; Pérès and Picard, 1964). The presence of macrophytes and algae (sea grasses, kelp and other seaweeds) is directly correlated to the fraction of light reaching the seabed (Birkett et al., 1998). Studies have stated that kelp species and seagrass (e.g. *Posidonia oceanica*) require a minimum of 1% of surface light to be able to develop (Ballesta et al., 2000; McBreen and Askew, 2011; McBreen et al., 2011b). This threshold value has been tested for different European regions by several marine mapping projects (e.g. 2.36% for the North Sea and Celtic Sea in MESH and 4.5% for the North and Celtic Sea and 1% for the West Mediterranean Sea in EUSeaMap) (Cameron and Askew, 2011; Coltman et al., 2008). McBreen and Askew (2011) in the UKSeaMap 2010 defined the hard threshold to be the value above which 75% of kelp biotopes were classed as infralittoral and obtained 1%.

On the other hand, the concept of what constitutes 'low' or 'high energy' on the sea bottom is far from being easily established (Galparsoro et al., 2012). Energy can be characterized in a variety of ways that account for effects due to tidal currents and waves (McBreen et al., 2011a). In previous European mapping projects, sea energy expressed as Newton per square meter (N/m^2) has been divided in three range classes based on wave and/or current. 'Moderate energy' was characterized using a tidal effect between 1.8 and 4.0 N/m^2 in the MESH project for the Atlantic North (Coltman et al., 2008). The UKSeaMap project, combining the tidal and wave effects, computed respectively 0.13–1.16 N/m^2 and 0.21–1.2 N/m^2 for 'Moderate energy' class (McBreen et al., 2011a).

Due to regional specificity and a low level of agreement between studies across Europe (Galparsoro et al., 2012) it is not adequate to use thresholds from one region to another one. Validated thresholds which could provide confidence in output maps for the Iberian coast are therefore desirable. The aim of the present paper is to validate and establish appropriate thresholds on sea energy and biological zonation to fit the EUNIS classification system for the Western Atlantic Iberian coast, using environmental (fraction of photosynthetically available light and kinetic wave energy) and biological data (presence of seaweeds species).

2. Material and methods

2.1. Study area and biological data

This study was carried out within the framework of the MeshAtlantic project (www.meshatlantic.eu/) which was built on the approach of the MESH (Coltman et al., 2008) and EUSeaMap European projects (Cameron and Askew, 2011). Using the EUNIS classification system of habitats (version 2007-11), the MeshAtlantic project (2010–2013) proposed to collate and provide harmonized habitat maps for the Atlantic area, including the Iberian coast.

Biological and depth data used to establish thresholds between biological zones were collected from a previous regional project (Rensub) carried out seasonally over 7 years (2003–2010) in the South coast of Portugal (Gonçalves et al., 2004, 2007, 2008, 2010). The Rensub project mapped marine habitat/biotopes off the Algarve coast between the localities of 'Faro' and 'Lagos' (340 km^2) from 0 to 30 m depth (Algarve study area) (Fig. 1). Seaweed percentage cover (Chlorophyta — green algae, Heterokontophyta — brown algae and Rhodophyta

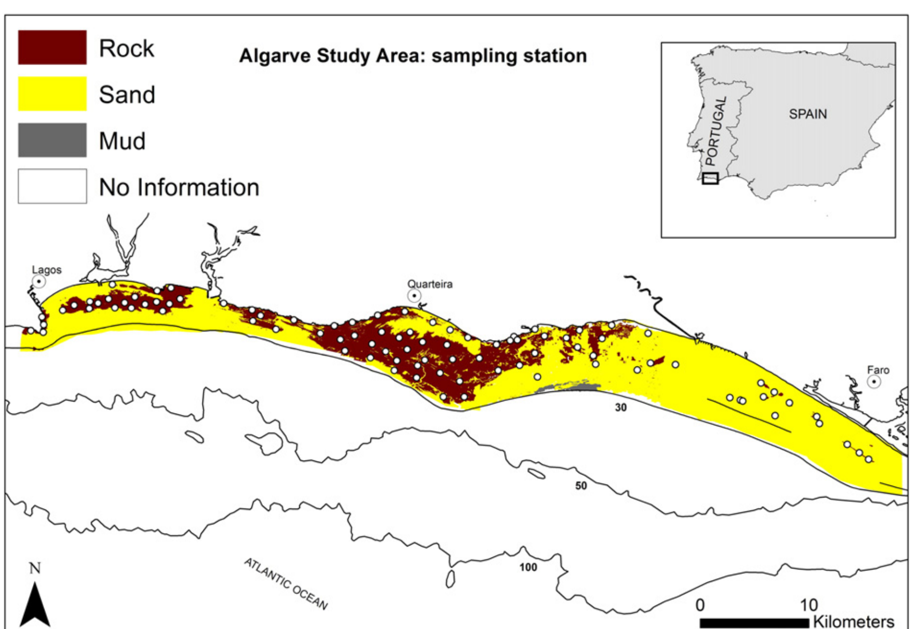

Fig. 1. Sampling station from the Rensub data base project (2003–2010) used for computing light threshold.