Predicting the distribution of seabed biotopes in the southern Irish Sea

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ABSTRACT

Habitat maps are becoming increasingly important for marine management in the United Kingdom, though fully ground-truthed acoustic datasets are only available for a limited number of areas. In order to address this information gap in the short term, the HABMAP (HABitat MAPping for conservation and management of the southern Irish Sea) project was set up to develop a predictive modelling tool that would enable the distribution of benthic biotopes to be mapped in areas of the southern Irish Sea where survey data is currently absent. The project collated physical and biological datasets in a Geographic Information System (GIS), and used these to develop a multi-parameter rule-based model to predict biological community type. Maps were produced for individual biotopes, and a confidence assessment method was developed to highlight areas where predicted distributions were likely to be more or less accurate. The maps were validated using survey data collected both as part of the HABMAP project and by other organisations.

The maps arising from the project are intended to act as a guide for marine scientists, and have the potential to be used in a variety of activities including conservation management and marine spatial planning.

1. Introduction

Seabed habitat maps have a variety of uses in marine management and conservation. However, to date, fully ground truthed seabed mapping surveys have only been carried out in a limited number of areas around the UK, due in part to the expense of running them. In order to address information gaps in the short term, various projects have been undertaken to classify the marine environment into ecologically relevant units (such as "marine landscapes") for the purposes of management at a national level. These include the Irish Sea Pilot (Vincent et al., 2004), UKSeaMap (Connor et al., 2006) and Mapping European Seabed Habitats (MESH) project (http://www.searchmesh.net/). On a regional scale, the HABMAP (HABitat MAPping for conservation and management of the southern Irish Sea) project was set up to improve our knowledge and understanding of benthic habitat distributions in the southern Irish Sea by developing a predictive modelling tool that would enable the distribution of benthic biotopes to be mapped in areas where survey data is currently

sparse or absent. The maps arising from the project will be used to inform future management decisions on a regional level, and will feed into initiatives such as fisheries sensitivity mapping in Welsh waters (Hall et al., 2007).

It is generally acknowledged that the distribution of benthic species and communities is linked closely with physical aspects of the environment (e.g. Galparsoro et al., 2009; Gray, 1974; Rosenberg, 1995; Warwick and Uncles, 1980). However, the complex nature of the links and the interaction between organisms and their environment are often difficult to quantify and incorporate into predictive tools for the purposes of modelling. Methods that use single physical parameters such as sediment type or bed-sheer stress to predict the likely occurrence of species or communities are often inadequate as they fail to account for the combined effects of different parameters on biological processes. However, it has been shown that by incorporating several key physical parameters such as tidal stress, bathymetry, water temperature and sediment type, the effectiveness of benthic prediction and characterisation models can be dramatically improved (Davies, et al., 2008; Freeman and Rogers, 2003; Janekovic et al., 2006).

There are various different statistical and mathematical methods that can be used for predicting the distribution of habitats (Guisan and Zimmermann, 2000), including Discriminate Function Analysis (Degraer et al., 2008) and Ecological Niche Factor Analysis (Davies, et al.; 2008, Skov et al., 2008; Galparsoro

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et al., 2009). A small comparative study of different modelling approaches was therefore undertaken prior to the start of the project for the Tremadog Bay area in North Wales (Fig. 1) in order to investigate the potential of using various statistical tools on the data collated for the HABMAP project (ABPmer, 2007a). This concluded that a rule-based approach was the most suitable for predicting biotope distributions in the current study since it allowed the use of several different parameters as predictors, and was not highly dependent on data quantity in the way that a statistical approach would have been. Similar types of rule-based predictive methods have been used successfully in studies elsewhere in the UK, including within the Bristol Channel (ABPmer, 2004) the Humber Estuary (Frost et al., 2004), and Chichester Harbour (ABPmer, 2006), and are able to accommodate the wide variety of physical datasets considered to be potentially important drivers of biotope distributions, including both discrete and continuous variables. The methods used here were adapted from those developed previously in order to accommodate the prediction of biotopes as opposed to the relative abundance of species within different physical environments (e.g. as used in the Humber Estuary by Frost et al. (2004)).

The main objectives of this study were to:

- develop a modelling method that would enable the distribution of seabed habitats (biotopes) to be predicted in areas where survey data is currently absent,
- produce seabed biotope maps for the southern Irish Sea (project area shown in Fig. 1), with an indication of the degree of confidence in the predictions made.

2. Study area

The study area used during the HABMAP project is shown in Fig. 1, and is known as the southern Irish Sea. The area included both Welsh and Irish territorial waters, and extended from the Celtic Sea in the south towards Liverpool Bay in the north. Previous studies conducted in this part of the Irish Sea have shown the seabed environment to be highly variable, and to contain a diverse range of both physical conditions and biological communities ranging from rocky reefs to deep mud basins (Mackie, 1990; Tappin et al., 1994, Mackie et al. 1995, Wilson et al. 2001, Darbyshire et al., 2002). Much of the seabed morphology is known to have been determined by historic events, particularly the post-glacial marine transgression at the end of the last ice age (Kidson and Tooley, 1977, Devoy, 1989). Evidence of previous glacial action and post-glacial thawing are present in the form of extensive areas of lag deposits, drumlins and scour marks found in areas such as that to the north of Anglesey (Blyth-Skyrme et al., 2008). The diversity of physical environments is complemented by a richness of benthic habitats that have contributed to the designation of several Special Areas of Conservation around the Welsh and Irish coast under the EU Habitats Directive.

3. Methods

The main aim of the HABMAP project was to use a multi-parameter predictive tool to develop seabed biotope maps for the southern Irish Sea. This required the collation of existing
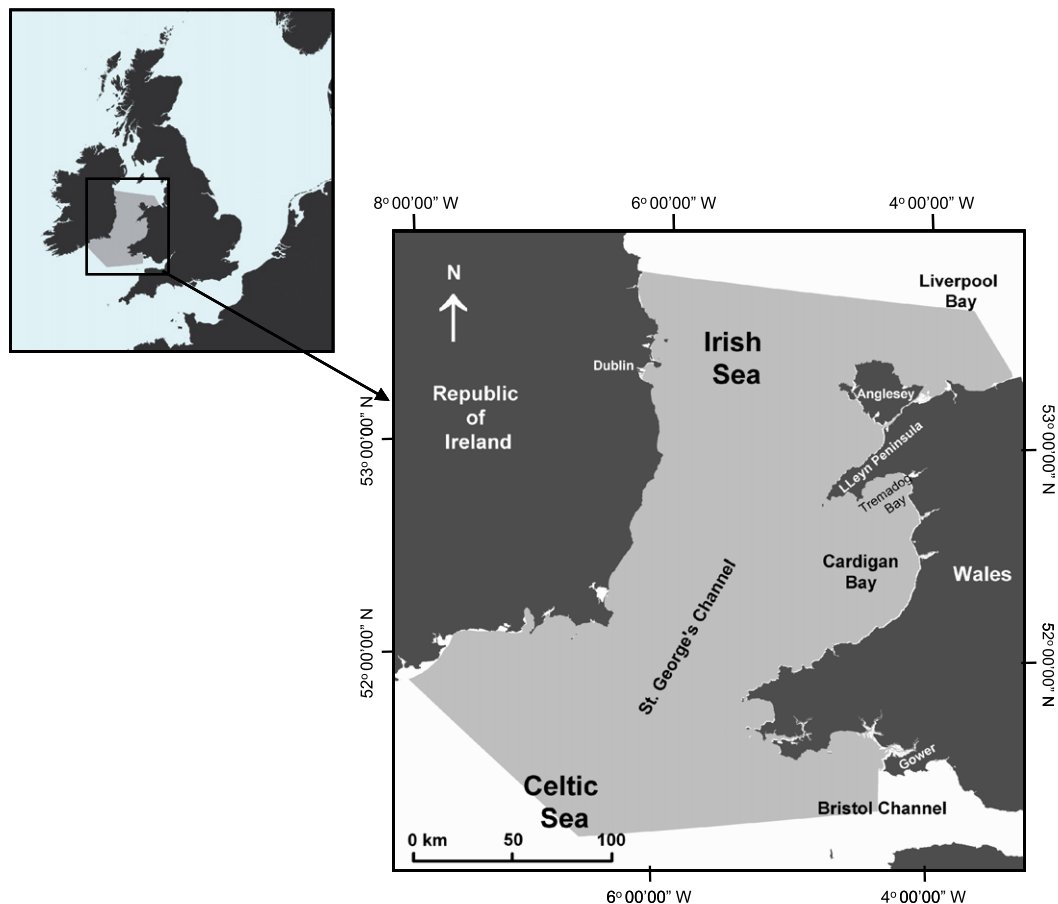

Fig. 1. The HABMAP project area (southern Irish Sea).