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Publication date:
2015

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Summary

High intensity, localised, and targeted surveys using multibeam and drop down video have been carried out around Shetland aiming to map nationally and internationally important habitats of maerl and horse mussel (*Modiolus modiolus*) beds. These surveys have resulted in targeted closures to mobile dredging gear in order to conserve these habitats. However, the surveys were based on historical information and there is a growing requirement to identify additional suitable habitats which could be considered for protection. In order to achieve this, predictive habitat maps, using the MaxEnt species distribution model (SDM), were run and analysed at different spatial scales and data resolutions. Tide, bathymetry, and bathymetric associations such as slope and aspect were used as variables in the model. Comparisons were made at a large- (regional level) and small-spatial scale (site-specific) and between different bathymetry resolutions (e.g. localised high resolution versus broad scale lower resolution) to assess the impact of modelling resolution. Depth and tide had the greatest influence in the SDM outputs for both habitats. Access to high resolution data, in this case bathymetry, greatly increased the confidence of the SDMs.

Introduction

During 2011, the NAFC Marine Centre undertook a series of intense, localised and targeted acoustic multibeam surveys around Shetland aiming to map nationally and internationally protected species habitats, namely horse mussel (*Modiolus modiolus*) and maerl beds (Shelmerdine, *et al.*, 2014). Surveys were targeted based on information held within the Shetland Islands' Marine Spatial Plan (NAFC Marine Centre, 2014) and resulted in targeted areas being closed to scallop dredgers. Since the 2011 surveys ended, Marine Protected Areas (MPAs) were established which led to additional survey information from third party sources, particularly in the Fetlar-Haroldswick MPA in the northeast of the Isles (Hirst, *et al.*, 2013) but also several high-resolution multibeam surveys targeting potential regions for marine renewable energy. This additional survey information enabled the use of species distribution modelling, namely MaxEnt, to be utilised over a regional scale with greater accuracy. MaxEnt is a species distribution model utilising presence only data in relation to environmental variables and based on maximum entropy (Phillips, *et al.*, 2006; Phillips and Dudik, 2008). In the marine environment it is widely regarded as providing reliable outputs for estimating species distributions (e.g. Monk, *et al.*, 2010; Reiss, *et al.*, 2011; Gormley, *et al.*, 2013).

The aim of the study was to understand the importance of data resolution of the environmental data available within 12 nautical miles around Shetland in order to produce species distribution models (SDM) which were considered appropriate for guiding future acoustic multibeam surveys in order to better protect habitats of national and international interest.

Materials and Methods

High resolution multibeam bathymetry data were obtained from two sources, UK Hydrographic Office using their online data download portal and surveys carried out by NAFC Marine Centre. The resulting point clouds were combined and interpolated in ArcGIS along with the associated bathymetric surfaces such as aspect, curvature, and slope. Interpolations were carried out at varying resolutions and converted to an asc file type. Interpolations at varying resolutions were also carried out for tidal information, obtained through the Shetland Islands' Marine Spatial Plan. Backscatter was only available for the NAFC Marine Centre data. Species information was extracted from drop down video footage reported in Hirst, *et al.* (2013) and Shelmerdine, *et al.* (2014). This information was inputted into the MaxEnt species distribution model using the default settings and a 25% random test percentage. Results were analysed using area under the curve (AUC) and jacknife analysis.

Results and Discussion

Test AUC was found to vary with spatial scale and data resolution. At a small geographic spatial scale (site-specific), test AUC decreased with decreasing resolution in environmental data for both species under investigation. At a larger geographic spatial scale (regional), no obvious decrease was recorded, with test AUC values all exceeding 0.9 for both species. Depth was found to be the greatest contributing factor for maerl in all scenarios followed by tidal strength and slope. Contributing factors related with *M. modiolus* varied depending on spatial scale. Larger spatial scales had a greater influence from depth followed by slope and tide. At a smaller geographic spatial scale, tidal strength was found to be more important followed by depth, slope, and aspect, depending on the resolution of the environmental data. Distributions produced from low resolution environmental data over a small spatial scale were not considered to be a good representation due to the low confidence of the data at a site-specific level.

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