A benign technique for mapping coral distribution in the closed areas of the Rockall Plateau

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Summary

Cold-water corals (*Lophelia* spp.) occur throughout the north east Atlantic and have been identified in bottom trawl records occurring in abundant patches on the Rockall Plateau. As a result, several large areas have been closed to bottom trawling to protect this habitat. However, our understanding of the distribution of deep-water coral remains poor. A non-destructive visual survey method using a deep towed camera system was deployed to collect data on the occurrence of *Lophelia* spp. around the closed areas at Rockall. The species distribution model (SDM) Random Forest was used to predict the potential spatial distribution of *Lophelia* spp. and infer the environmental requirements of the species. The model used coral presence-absence data from the towed camera survey and the trawl record data. Performance was evaluated by partitioning the data into 'training' and 'testing' data. The model showed good performance based on Cohen's Kappa and the area under the curve of the receiver operator characteristic curve. Depth, aspect, and slope were the most important environmental variables for predicting the presence of *Lophelia* spp. The predictive map suggests that potential *Lophelia* habitat occurs most abundantly along the west of the plateau in a depth range of 200 – 400 m.

Introduction

Lophelia spp. are reef forming corals which grow in distinct colonies over thousands of years and are known to support high biodiversity. Much of our knowledge of coral distribution on the Rockall Plateau is from historic trawl records and our current knowledge of its distribution in this area is still rather limited. Additionally, many characteristics of *Lophelia* spp. make them vulnerable to damage by bottom trawls; cold water corals have a slow growth rate, and considerable longevity (Hall-Spencer et al. 2002). As a result several large areas at Rockall have been closed to bottom trawling to protect *Lophelia* spp (NEAFC). Non-destructive survey methods are therefore required to document the distribution of *Lophelia* spp. within the closed areas and around the Rockall Plateau both rapidly and effectively to ensure the continued protection of this fragile benthic habitat. A towed camera system was developed to enable visual surveying in deep waters with surveys being conducted annually since 2008. The towed camera survey provides presence and absence data for *Lophelia* at a high resolution and spatial accuracy. This data can be used to construct maps on the distribution of coral at Rockall through predictive species distribution modelling (SDM). The modelling process correlates species occurrence data (presence and/or absence) with environmental data in geographic space to describe and predict the species distribution (Elith and Graham 2009) and has proved particularly useful in marine conservation management (Robinson et al. 2011). In this study we use a Random Forest (RF) model of presence-absence data to predict the distribution of *Lophelia* spp. at Rockall and improve our understanding of the environmental conditions under which *Lophelia* forms.

Materials and Methods

Camera tows were conducted across a range of depths from 200 – 1000 m in and around the closed areas of the Rockall Plateau on-board the *MRV* Scotia from 2008 – 2013. Since the survey has begun over 600 km of visual transects have been conducted. Presence of *Lophelia* was recorded as the camera moved along transect. Using the navigational, sensor files and the timestamp from the video non-overlapping image frames were selected. Presence and absence positions of *Lophelia* were then obtained for each individual non-overlapping frame. Trawl presence data was obtained from ICES and presence-absence data from the anglerfish trawl survey conducted by Marine Scotland.

Environmental data layers were constructed in ArcGIS 10.0 for depth, aspect (measured by indices of northness and eastness), slope, and bathymetric position index (BPI). All layers were re-sampled to the resolution of the depth layer at 762 m (30 seconds) using the resampling algorithm tool in ArcGIS.

A RF model was used to predict *Lophelia* distribution using presence-absence data from the towed camera survey. RF is a machine learning technique that predicts the value of a single response variable from the values of multiple predictors. A RF model is composed of multiple regression trees, where splits at each node in each tree are based on a random subset of the available predictors (Cutler et al. 2007). The presence-absence data of *Lophelia* was randomly divided into a 'training' subsample (70% of total points) and 'test' subsample (30%) by *k-fold* partitioning. The ability of the RF model using the 'training' subsample to predict the probability of presence was tested using the 'test 'subsample. Performance of the models was estimated using Cohen's Kappa statistic and area under the curve (AUC) of the receiver operating statistic (ROC). The value of the AUC is between 0.5 and 1, values higher than 0.7 indicate good prediction. The ranges for model agreement based on the kappa statistic are: poor $K < 0.4$; good $0.4 < K < 0.75$; excellent $K > 0.75$.

Results and Discussion

The probability of presence of *Lophelia* for the Rockall Bank based on the RF is shown in Figure 1. The distribution map shows the highest probabilities of presence occurring along the north-west side of the Rockall Bank. The performance of RF was classified as good based on the AUC value, which was greater than 0.7 (AUC = 0.767) and the kappa statistic which was higher than 0.4 ($k = 0.48$).

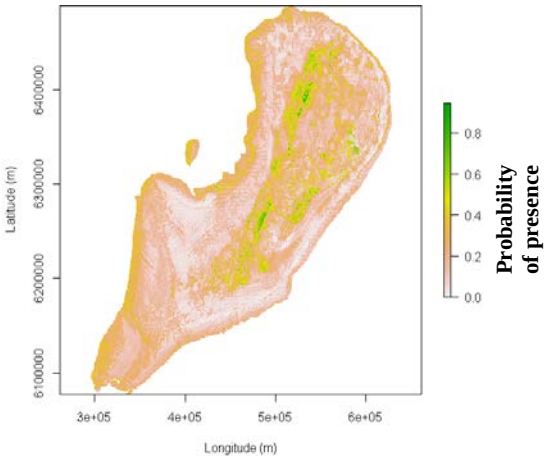

Figure 1. Probability of presence of *Lophelia* spp. on the Rockall Plateau based on the RF model using presence-absence data from the towed camera survey.

Depth was the most important explained environmental variable in the model with the highest probability of presence occurring within the depth range 200 – 400 m, followed by the variables aspect (index of eastness) and slope. Depth serves as a proxy to several other environmental factors such as temperature, pressure, and food availablilty that influence the presence of benthic species. The measure of aspect indicated a higher probability of presence of *Lophelia* along western facing slopes, which may be linked to the hydrography of the area. Interactions between the currents and topography generate increased flow velocities which have been shown to be of importance in the distribution of *Lophelia* spp. (Freiwald et al. 1999, Masson 2003) The model presented here could be therefore be improved by including an environmental layer of modelled bottom current velocities for Rockall. The predicted map of the presence of *Lophelia* spp. can be used to assess the appropriateness of marine conservation management efforts in the area.

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