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Mapping coral and sponge habitats on a shelf-depth environment using multibeam sonar and ROV video observations: Learmonth Bank, northern British Columbia, Canada

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ABSTRACT

Efforts to locate and map deep-water coral and sponge habitats are essential for the effective management and conservation of these vulnerable marine ecosystems. Here we test the applicability of a simple multibeam sonar classification method developed for fjord environments to map the distribution of shelf-depth substrates and gorgonian coral- and sponge-dominated biotopes. The studied area is a shelf-depth feature Learmonth Bank, northern British Columbia, Canada and the method was applied aiming to map primarily non-reef forming coral and sponge biotopes. Aside from producing high-resolution maps (5 m^2 raster grid), biotope-substrate associations were also investigated. A multibeam sonar survey yielded bathymetry, acoustic backscatter strength and slope. From benthic video transects recorded by remotely operated vehicles (ROVs) six primary substrate types and twelve biotope categories were identified, defined by the primary sediment and dominant biological structure, respectively. Substrate and biotope maps were produced using a supervised classification mostly based on the inter-quartile range of the acoustic variables for each substrate type and biotope. Twenty-five percent of the video observations were randomly reserved for testing the classification accuracy. The dominant biotope-defining corals were red tree coral *Primnoa pacifica* and small styasterids, of which *Stylaster parageus* was common. Demosponges and hexactinellid sponges were frequently observed but no sponge reefs were observed. The substrate classification readily distinguished fine sediment, Sand and Bedrock from the other substrate types, but had greater difficulty distinguishing Bedrock from Boulders and Cobble. The biotope classification accurately identified Gardens (dense aggregations of sponges and corals) and *Primnoa*-dominated biotopes (67% accuracy), but most other biotopes had lower accuracies. There was a significant correspondence between Learmonth's biotopes and substrate types, with many biotopes strongly associated with only a single substrate type. This strong correspondence allowed substrate types to function as a surrogate for helping to map biotope distributions. Our results add new information on the distribution of corals and sponges at Learmonth Bank, which can be used to guide management at this location.

1. Introduction

Deep-water coral and sponge habitats have received more attention in recent decades as their vulnerability to human activities has been recognized. The fragility and importance of these organisms have been made evident: they are highly vulnerable to physical contact (Heifetz et al., 2009), some species have great longevity and extremely slow growth rates in the scale of millimeters per year (e.g. Andrews et al., 2002; Fallon et al., 2010; Roark et al., 2009; Sherwood and Edinger, 2009), many provide habitat for other species (Auster, 2005; Costello et al., 2005; Du Preez and Tunnicliffe, 2011; Hogg et al., 2010), they can act as paleoceanographic monitors (Aranha et al., 2014; Sherwood et al., 2005, Sherwood et al., 2011) and some are promising in the biotechnological industry (Ehrlich, 2010; Hogg et al., 2010; Sundar et al., 2003). Of the numerous anthropogenic impacts affecting these habitats, commercial fisheries (e.g. bottom trawling) stand out as creating long-lasting impacts that have the potential to be irreversible (Althaus et al., 2009; Hall-Spencer et al., 2002; Jones, 1992; Wassenberg et al., 2002). The loss of coral and sponge habitat is comparable to terrestrial deforestation (Watling and Norse, 1998), with potential consequences for biodiversity and fisheries (Danovaro et al., 2008).

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The recognition that vulnerable marine habitats have been destroyed faster than we are able to discover them has been raising world concerns. With its advent and continued improvement, marine habitat mapping has quickly become an essential instrument in marine conservation (Brown et al., 2011; Cogan et al., 2009; Copeland et al., 2011; Gonzalez-Mirelis and Lindegarth, 2012; Pickrill and Todd, 2003). Sonar technologies together with photography and video have proven to be particularly useful data sampling tools in the context of deep-water habitat mapping (Brown et al., 2011; Kenny et al., 2003; Kostylev et al., 2001). Multibeam echosounders (MBES) generate continuous swaths of bathymetry and backscatter (acoustic return strength) data simultaneously (e.g. Courtney and Shaw, 2000) providing information on both seafloor topography and substrate type (Harris and Baker, 2012). Because surficial geology is an important determinant of the distribution of benthic organisms, especially deep-sea corals and sponges (Leys et al., 2004; Edinger et al., 2011; Baker et al., 2012), MBES plays an important role in this context (e.g. Whitmire et al., 2007; Wilson et al., 2007).

Benthic habitat maps have been produced through the use of environmental variables as proxies for habitats, which in general can be oceanographic and/or geomorphologic (Brown et al., 2011). While successfully applied in global (Davies and Guinotte, 2011; Tittensor et al., 2009; Yesson et al., 2012) and regional contexts (e.g. Bryan and Metaxas, 2007; Gonzalez-Mirelis and Lindegarth, 2012; Guinan et al., 2009; Buhl-Mortensen et al., 2009; Ross and Howell, 2012; Tong et al., 2012; Tracey et al., 2011) variation in oceanographic variables is more difficult to measure at local scales (Brown et al., 2011; Dolan et al., 2008). Some studies have included only terrain variables as proxies for biotope or taxa distribution (e.g. Anderson et al., 2011; Conway et al., 2005; Dolan et al., 2008; Huang et al., 2011). Copeland et al. (2011) presented a method for supervised classification of multibeam to map substrates and habitats in a fjord environment (Gilbert Bay, Eastern Canada) based on the inter-quartile ranges (IQR) of bathymetry, backscatter and slope values, ground-truthed with underwater video and bottom sediment samples. Those authors were able to distinguish eight substrates and five statistically distinct habitats.

Here, we test the applicability of the IQR method to map substrate types and coral- and sponge-dominated biotopes on a shelf-depth feature, Learmonth Bank (Dixon Entrance, British Columbia, Canada). Learmonth Bank has abundant corals and sponges, based on reports of high by-catch density in this location (Ardron et al., 2007). Between the years 1996 and 2002, observed bottom trawls (representing 2.62% of all bottom trawling activity in British Columbia) recovered, approximately 2400 kg of gorgonian corals in by-catch at Learmonth Bank (Ardron et al., 2007). Detailed data on coral and sponge by-catch at this location are not available for publication (pers. comm. Greg Workman). Learmonth Bank is considered a hotspot for demersal fish trawling activity (Sinclair et al., 2005), but due to an unresolved maritime boundary dispute between Canada and the USA (Gray, 1997), the area under dispute receives almost no fishing pressure. The entire area under dispute in Dixon Entrance is 2764 km^2 (806 M^2) (Gray, 1997), 21% (approximately 216 km^2) of the bank receives almost no fishing pressure. Du Preez and Tunnicliffe (2011) found corals and sponges to be significantly more abundant in untrawled than in trawled areas of the bank, and Ardron et al. (2007) suggested the entire bank should be a coral–sponge protected area. No formal protection measures have yet been implemented for Learmonth Bank, or Dixon Entrance.

In this study we used backscatter, bathymetry and slope, ground-truthed with video data, to map substrates and coral- and sponge-dominated biotopes on Learmonth Bank. Four specific objectives were recognized: (1) to investigate the applicability of a simple supervised classification method described for fjords in a continental shelf setting; (2) to determine the degree of association between biotopes and substrate types and to assess substrate as a surrogate for biotope using video data; (3) to investigate the applicability of using backscatter, bathymetry and

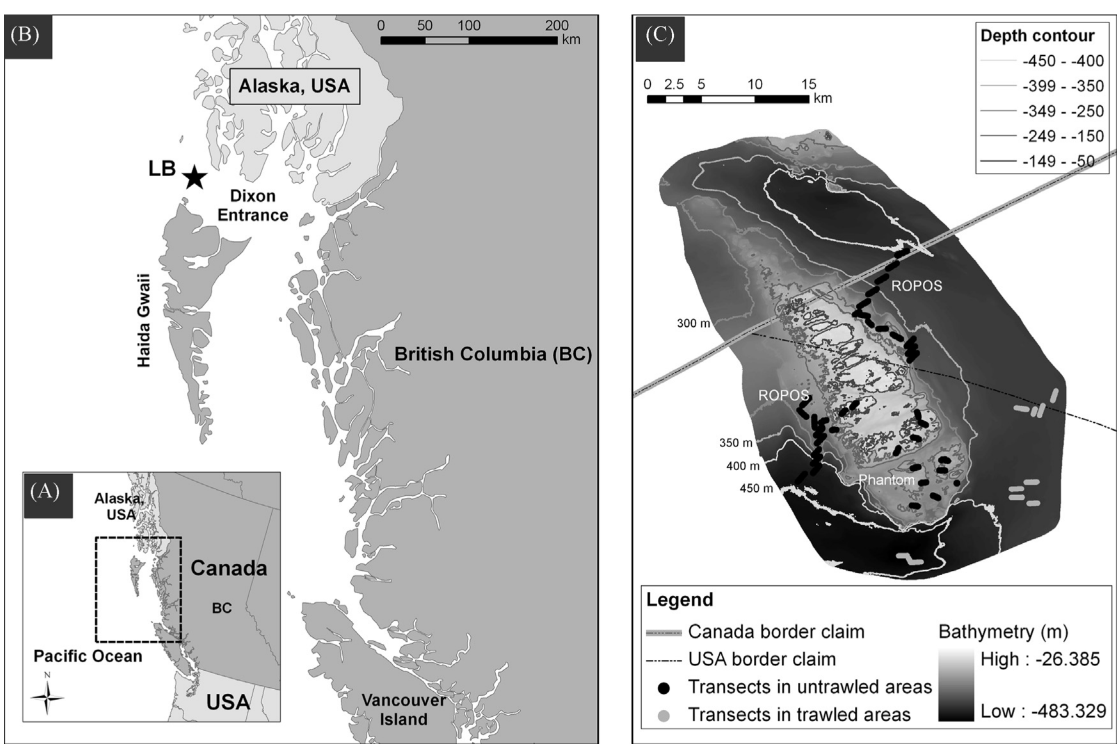

Fig. 1. Location of Learmonth Bank (LB) (A–B). (C) Bathymetry of Learmonth Bank showing transects and boundaries as claimed by Canada and the USA. Canadian boundary layer from GeoBase (www.geobase.ca) and USA boundary layer from NOAA's Office of Coast Survey (http://www.nauticalcharts.noaa.gov/csdl/mbound.htm#data).