Mapping the South Texas Banks

Mapear los Bancos del Sur de Texas]

Cartographier les Rives Sud du Texas

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ABSTRACT

Biodiversity data are critical for marine conservation planning, but biological surveys, particularly in offshore locations, are resource intensive and dependent on favorable conditions at sea. In areas with few biological data, abiotic variables are used as surrogates for marine biodiversity. The South Texas Banks are hard-substrate sites with bathymetric relief on the otherwise flat, soft sediment continental shelf in the northwestern Gulf of Mexico where biological data are sparse. This study focused on 12 outer-shelf South Texas Banks that support ecological connectivity among nearshore and offshore, hard-bottom, natural and artificial sites. High-resolution multibeam echosounder data were used to create maps and a dataset of geomorphic variables to be used via multivariate statistical analyses as an abiotic surrogate for biodiversity patterns. The detailed site maps are important tools to guide future studies, such as identification of reef fish spawning sites and biodiversity trends. The statistical approach produced a ranking tool to guide prioritization of future biological explorations and site selection for design of marine protected areas. A minimum of five of the South Texas Banks is proposed for place-based protection. Similar methodology can be applied to other regions of the Gulf of Mexico to identify sites for inclusion in the International Gulf of Mexico Marine Protected Area Network.

KEY WORDS: South Texas Banks, multibeam bathymetry, International Gulf of Mexico MPA Network

INTRODUCTION

Hard-substrate sites throughout the Gulf of Mexico's continental shelf provide valuable habitat for fish and other marine species. The South Texas Banks are relict barrier islands and Pleistocene coralgal reefs (Rezak et al. 1985, Belopolsky and Droxler 1999). Several of the banks were mapped and surveyed in 2006 and 2008 (Tunnell et al. 2009, Weaver et al. 2009), but data are lacking for most of the banks. A mapping cruise in 2012 enabled collection of more complete bathymetric datasets for additional sites. Fishermen and others have known about the South Texas Banks for many years, but few of the hard-substrate sites have ample biological data for well-informed conservation planning.

The use of abiotic surrogates for biodiversity enables identification of areas that are ecologically important (Zacharias and Roff 2000, Last et al. 2010). With improving technology, high-resolution bathymetric data can be collected using fewer resources than required for intensive biological surveys. Many quantitative variables can be derived from multibeam bathymetric data (Buhl-Mortensen et al. 2009), and these variables can be used as surrogates for biodiversity to guide conservation planning. This paper describes a statistical model that was developed using geomorphic variables from 2012 multibeam data to facilitate prioritization of future expeditions and marine protected area site selection among the South Texas Banks.

METHODS

Methods for this study were based on methods used to create a principal component analysis (PCA) model to predict the number of biotic zones at hard-substrate sites in the salt diapir region of the northwestern Gulf of Mexico (Nash et al. 2013b). For this study on 12 outer-shelf South Texas Banks, the model was designed to predict biodiversity trends among the banks using six geomorphic variables: distance to nearest neighbor, regional depth, shallowest depth, planimetric area, rugosity, and terrace count.

Scientists aboard the Schmidt Ocean Institute's *R/V Falkor* collected high-resolution, multibeam bathymetric data at most South Texas Banks in September 2012. Target sites were identified using locations described in literature throughout the last several decades (Nash et al. 2013a). Processed bathymetric data were georeferenced and analyzed using ArcGIS® to calculate the six geomorphic variables for each of the 12 sites (Table 1). The data were used as input values using Matlab® for three multivariate statistical tests: hierarchical cluster analysis, non-metric multidimensional scaling (MDS), and PCA. Statistical results were interpreted and used to create a ranking tool for prioritizing sites for purposes dedicated to exploration, conservation, and protection.

RESULTS

Similar site groupings resulted from the cluster analysis and MDS. Two small, shallow sites grouped together, several larger, prominent sites grouped together, and two sites were relatively dissimilar to the others (Figures 1, 2). The unique sites (Unnamed Bank and Mysterious Banks) were statistically isolated likely because of an unusual combination of depth, relief, and rugosity. The PCA results (Figure 3) were used for the ranking tool because a predicted biodiversity trend was

Table 1. Geomorphic data for selected South Texas Banks (listed north to south). Source: Nash 2013

Site name	Distance to nearest neighbor (km)	Regional depth (m)	Shallowest depth (m)	Area (km^2)	Rugosity (0 to 1)	Terrace count
Baker Bank	9.22	74	58	1.39	0.00187	3
South Baker Bank	9.22	85	62	0.21	0.00250	4
Aransas Bank	3.08	73	59	0.51	0.00143	4
North Hospital Bank	3.08	71	57	1.42	0.00193	5
Hospital Bank	3.71	77	58	2.41	0.00182	4
Southern Bank	12.16	82	59	1.02	0.00203	5
Dream Bank	14.55	84	68	2.07	0.00129	4
Big Adam Rock	1.61	68	60	0.51	0.00092	3
Small Adam Rock	1.61	65	60	0.07	0.00068	2
Blackfish Ridge	9.26	75	61	1.36	0.00154	3
Mysterious Banks[a]	14.25	80	69	3.64	0.00090	0
Unnamed Bank	17.96	99	83	0.37	0.00324	2

[a] Entire site was not mapped. Data were minima.

detected based on comparison to available biodiversity data. Biodiversity is predicted to increase with increasing value on the y-axis of the PCA plot. The general pattern is similar to the decreasing trend of fish biodiversity moving from north to south (Hicks et al. 2013). Sites were ranked as high, medium, or low priority based on the statistical results for the second principal component (Figure 4). High-priority sites include South Baker, Aransas, North Hospital, Southern, and Unnamed Banks (a newly discovered site with an official name proposed to be Harte Bank). Medium priority sites include Baker Bank, Hospital Bank, Dream Bank, Big Adam Rock, Small Adam Rock, and Blackfish Ridge. The only low priority site is Mysterious Banks.

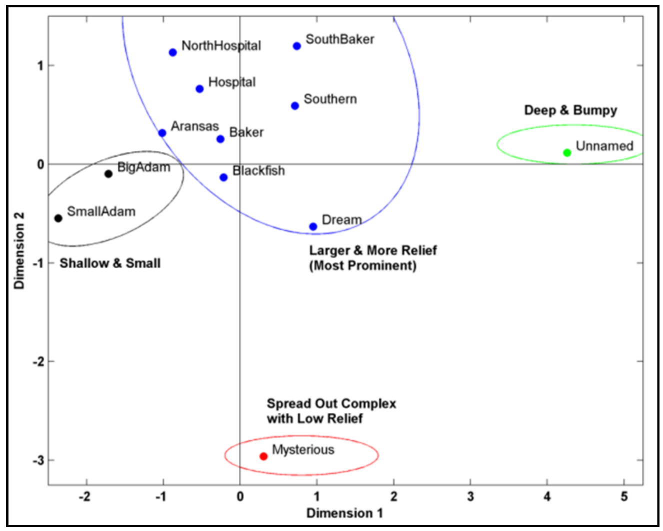

Figure 2. Results of multidimensional scaling. Circled groups corresponded with cluster analysis results. Source: Nash 2013.

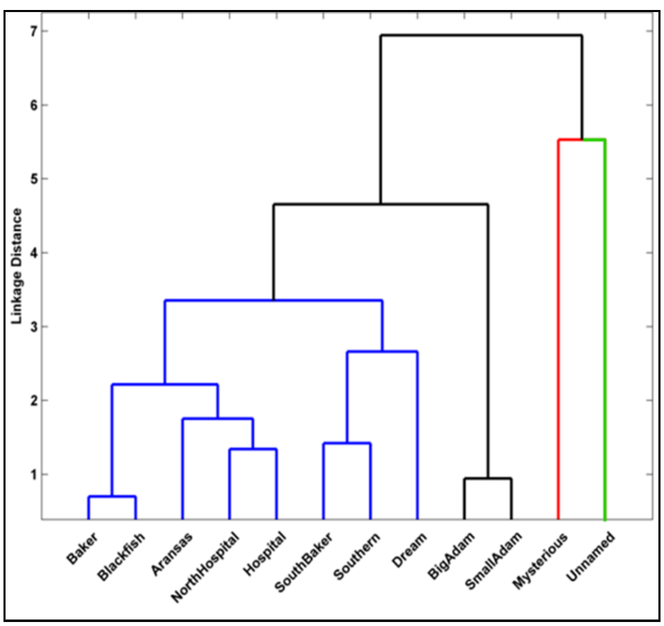

Figure 1. Results of hierarchical cluster analysis. Source: Nash 2013.

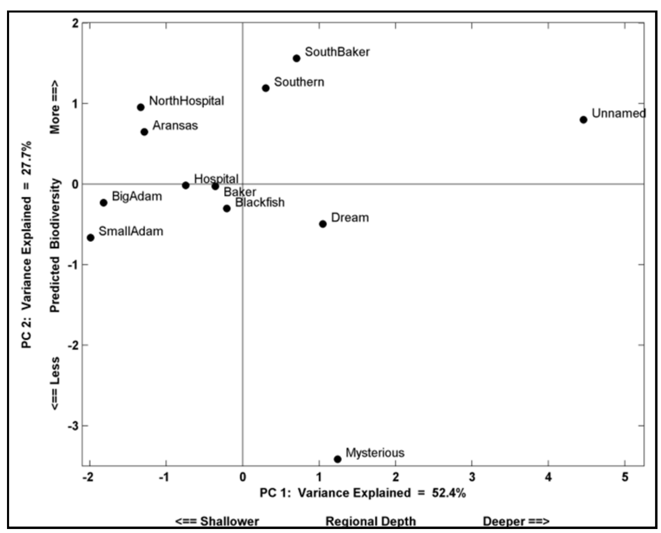

Figure 3. PCA results. Source: Nash 2013.

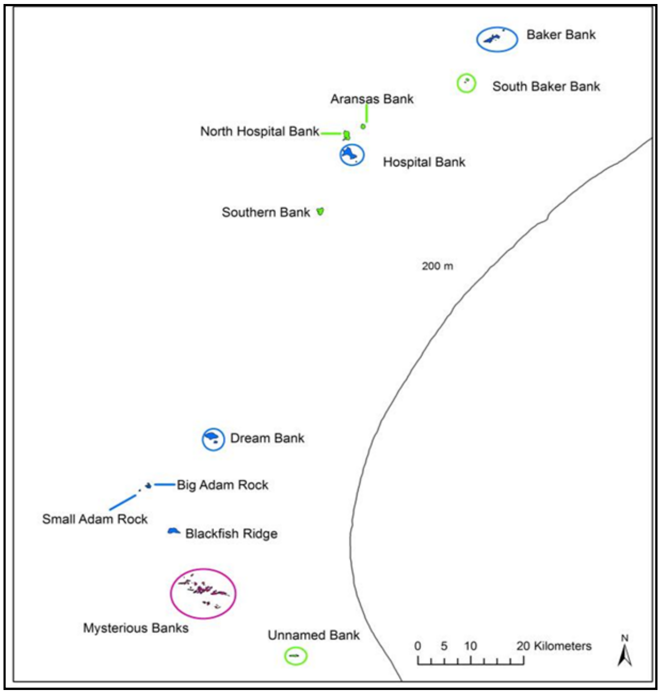

Figure 4. Outer-shelf South Texas Banks ranked by priority as high (green), medium (blue), and low (purple). Source: Nash 2013.

DISCUSSION

Similar results from the three statistical tests confirm that groupings based on geomorphic data are appropriate. The PCA results are supported by ecological principles that rugosity is a good surrogate for biodiversity and that benthic communities increasingly contribute to habitat diversity with increasing depth (Dunn and Halpin 2009, Buhl-Mortensen et al. 2010). The suite of geomorphic variables can be used to predict biodiversity trends for sites with few biological data. Ground-truthing biological surveys should supplement the use of surrogates when resources are available. However, the use of geomorphic surrogates supports ecosystem-based management and is a valuable tool for site-selection processes for creation and design of marine protected areas. At a minimum, the high-priority sites identified in this study should be proposed for inclusion in the International Gulf of Mexico Marine Protected Area Network to protect biodiversity and preserve ecological connectivity throughout the region. Similar statistical approaches could be used to identify additional MPA proposals in the region within the Pinnacles area, Tamaulipas Banks, and Campeche Bank reefs.

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