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WHAT IS KNOWN ABOUT SPECIES RICHNESS AND DISTRIBUTION ON THE OUTER—SHELF SOUTH TEXAS BANKS?

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ABSTRACT: The outer—shelf South Texas Banks, also known as the snapper banks, are known by fishermen to be excellent fishing grounds. However, few scientific studies have been conducted to describe the ecology of these uncommon but distinctive habitats. This paper describes results of a literature review and an assessment to determine what is known about the biota of the South Texas Banks and to assist in developing renewed interest and focus on these topographic highs. The outer—shelf South Texas Banks include relict coralgal reefs and relict barrier islands, and we also include data for a nearshore site, which is geographically and geologically separated from the offshore banks. Obtainable scientific literature was reviewed, and biodiversity data were compiled. Results indicate that one of the most studied sites, Southern Bank, could be used as a surrogate to describe potential biodiversity at other, less studied South Texas Banks. Conclusions support the need for more biological studies at all of the South Texas Banks. Results of future studies, when combined with existing results, could be used to identify sites as potential candidates for place—based protection.

KEY WORDS: Gulf of Mexico, hard banks, drowned coralgal reef, relict barrier island

INTRODUCTION

The continental shelf of the northwestern Gulf of Mexico (GOM) is very broad and primarily covered with soft sand or clay sediment. Hard banks and reefs with conspicuous topographic relief occur uncommonly on the otherwise flat outer continental shelf. Such offshore sites have been known for almost 100 years (Carsey 1950, Geodicke 1955), but biological data are scarce for all but West and East Flower Garden Banks and Stetson Bank (Tunnell et al. 1978, Earle 1998, Tunnell et al. 2005). Offshore hard banks are geographically and geologically divided into two broad categories, separated by a line extending seaward from Matagorda Bay to the shelf edge (Figure 1, Rezak et al. 1990, Holcombe et al. 2010). Northeast of this line, bathymetric highs form as a result of salt diapirs on the shelf edge and upper continental slope. Salt diapirs are formed from sheets of allochthonous salt beneath the seafloor when faults or high differential pressure cause the fluid salt to move upward through the seafloor (Roberts 2011). Southwest of the line, allochthonous salt sheets are not present, and seismic signatures reveal dense stratigraphic sediments that indicate the presence of drowned barrier islands and coral reefs on the mid and outer shelf (Berryhill 1986). The drowned coralgal reefs off South Texas have more topographic relief than the relict barrier island ridges and, therefore, provide habitat for many species, which will be the main focus of this paper. Two recent opportunities, in 2006 and 2008, to visit several of these banks, map them with multi—beam imagery, and survey them with a submersible remotely operated vehicle (ROV) have renewed interest in these little—known but important topographic highs (Tunnell et al. 2009, Weaver et al. 2009).

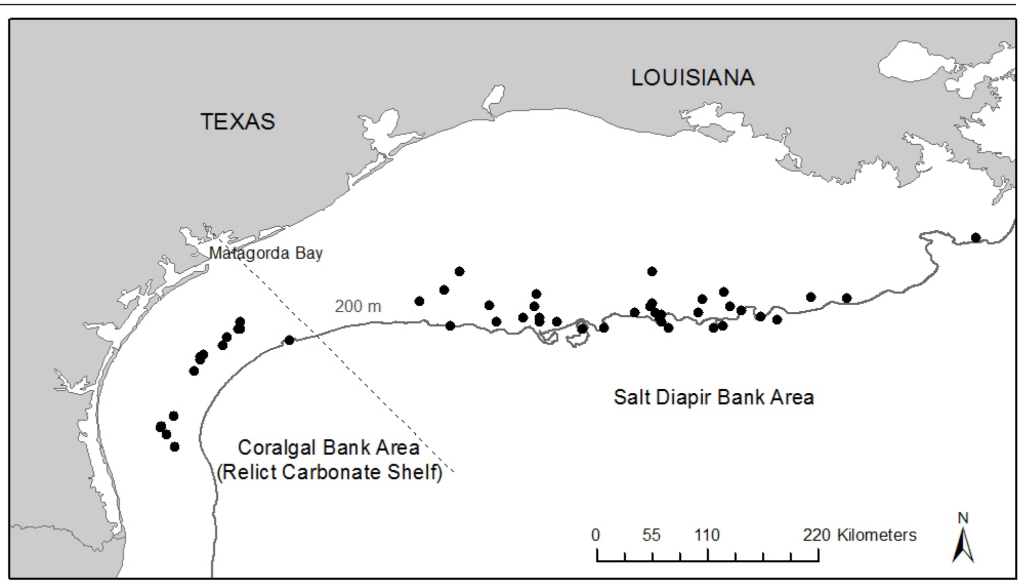

Figure 1. *Locations of selected hard banks and reefs of the northwestern Gulf of Mexico. The dotted line represents estimated geological separation of the types of banks on the continental shelf in the northwestern Gulf of Mexico. The sites southwest of the line are the South Texas Banks according to Rezak et al. (1985).*

The broad, gently sloping continental shelf off South Texas is composed of terrigenous sediments. Across the South Texas shelf, a sea surface temperature gradient exists during winter months, with a low nearshore temperature of 14°C and a minimum outer shelf water temperature of 19—20°C (Flint and Rabalais 1981). In winter, the water temperature is fairly consistent throughout the water column, but thermal stratification is present in summer, particularly in deep waters. Salinity is typically high except when the Mississippi River plume covers the shelf during spring and early summer and lowers salinity in the top 20—30 m of the water column (Flint and Rabalais 1981). Freshwater inflow, from rainfall as well as Texas rivers and the Mississippi River, is a major factor that influences salinity, temperature, and ecological communities in the shallow waters of the inner shelf. Mid—to outer—shelf waters contain over 20 rare hard—substrate features of topographical relief (Berryhill 1986, Belopolsky and Droxler 1999). Many of these hard—bottom habitats are relict carbonate reefs. For purposes of this paper, we collectively refer to the relict reefs and relict barrier islands as the outer—shelf South Texas Banks.

Many technical government reports were published in the 1970s in support of petroleum exploration in the GOM, but since then, few studies have targeted the South Texas Banks. These banks, also referred to as the snapper banks by local fishermen, comprise several topographically distinct features on the continental shelf in the GOM off the coast of Texas south of Matagorda Bay. The vertical relief of the banks provides habitat complexity that attracts a variety of marine fauna and sustains communities that are not typical throughout the majority of the continental shelf, which is mostly bathymetrically planar with sandy or muddy substrate. The purpose of this study is to assess current knowledge and data gaps regarding the biota of the South Texas Banks. The goal is to use the results to guide future studies of the biodiversity and ecological interactions of the cluster of outer—shelf banks that provide rare hard—substrate habitat on the South Texas continental shelf.

Methods

The authors comprehensively reviewed all information that could be obtained related to biota known to occur at the South Texas Banks. Information sources included peer—reviewed publications, government and non—government technical reports, master's theses, doctoral dissertations, unpublished papers, and unpublished data. Next, a taxonomic database was created to link organism occurrences to specific sites or, in some cases, to the collective group of South Texas Banks. Most taxa were identified to the level of genus, but several were identified only to family or, occasionally, only to order. For a more accurate representation of taxonomic diversity at the South Texas Banks, analysts sorted and filtered presence/absence data to determine the number of taxa that could be identified to the level of species. Site—specific taxonomic data, including those identified by this project, are in the process of being added to the Biodiversity of the Gulf of Mexico Database, an online resource available at GulfBase.org (Moretzsohn et al. 2013). Finally, the authors performed a case study of Southern Bank (27°26.5'N, 96°31.5'W; Figure 2) because it is one of the most studied sites of the outer—shelf South Texas Banks and exemplifies the kind and abundance of biota that might be present at

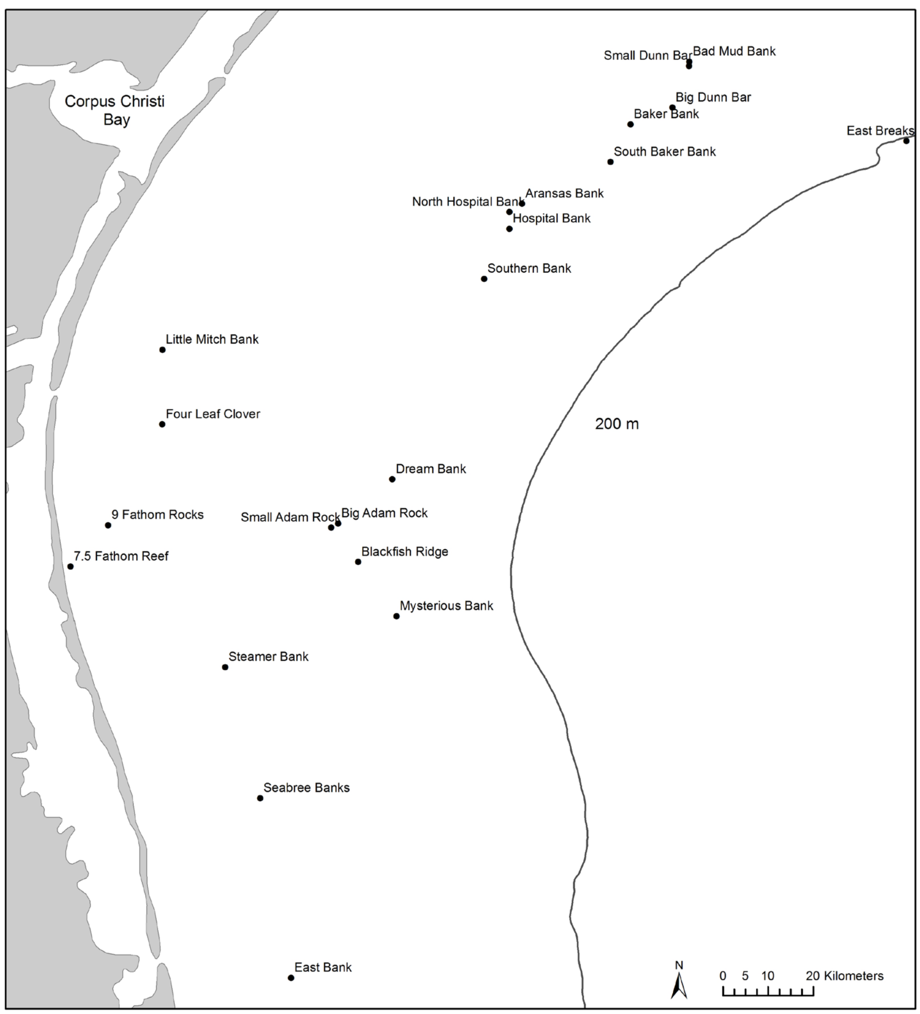

Figure 2. *Locations of selected South Texas Banks.*

less studied sites in the area depending on their biophysical characteristics.

Study Area Description

The South Texas Banks that are closest to the shelf edge consist of hard, carbonate substrate topped with fine sediment and have geologic signatures indicating that they are relict Pleistocene coralgal reefs (Rezak et al. 1985, Berryhill 1986). Such findings are curious because conditions in the GOM were less favorable for corals during the Pleistocene, when the last deglaciation occurred, than they are today. Compared to current conditions in the GOM, Pleistocene sea surface temperatures and salinity were lower, and sea—level rise was much faster (Belopolsky and Droxler 1999). Corals experience stress or even mortality when water temperature and salinity drop below their tolerance ranges or when water depth increases enough to prevent ample light from reaching the coral's symbiotic, photosynthesizing zooxanthellae. Regardless, geological data from the 1970s and 1980s indicate that coralgal reefs flourished on the edge of the continental shelf off South Texas. Holcombe et al. (2010) state that corals settled on bathymetric highs and formed reefs that flourished during the early Holocene when conditions were appropriate (higher water temperatures, lower sea level, and terrigenous sediments that did not flow directly to locations of the South Texas Banks). Conditions changed during the late Holocene resulting in reef die—offs. Seismic profiles indicate that about the lower two thirds of topographic relief of the banks were buried in clay and mud after the drowning of the reefs (Belopolsky and Droxler 1999). However, the shallower portions of the Holocene reefs remain as the South Texas Banks, which continue to provide rare habitat today on an otherwise flat continental shelf of soft substrates.

In addition to the sites about 60—70 km offshore near the shelf edge, several low—relief, flat—topped structures along the 20—30 m contour and about 20—30 km offshore have been interpreted as relict barrier island ridges (e.g., Seabree Banks, Steamer Bank; Berryhill 1976), but little is known of their biota and ecology. Closer to shore, Seven and One—Half Fathom Reef (7.5 Fathom Reef) is one of the most studied. It is located within state waters, while the other South Texas Banks are closer to the shelf edge in Federal waters (Figure 2). Seven and One—Half Fathom Reef is located about 3.2 km from shore almost directly west of Blackfish Ridge and differs geologically from the other South Texas Banks in that it is of lacustrine origin as evidenced by its Pleistocene terrestrial fossils (Tunnell and Causey 1969). Fossils include teeth and bone fragments from terrestrial mammals as well as freshwater and land snails. Analysis of rock samples from 7.5 Fathom Reef identified sediments of old coastal plain formations, thus confirming the lacustrine origin of the ridge (Thayer et al. 1974). Sample features, such as root tubules and soil glaebules, indicative of soil development and calichification, are likely a result of fluctuations in the water table during the Pleistocene (Thayer et al. 1974). The calichified sediments became hardened and were not affected strongly by the Holocene transgression and remained as the topographic prominence now known as 7.5 Fathom Reef.

The number of South Texas Banks is debatable, depending on how a bank is defined (minimum size, relief, etc.), and there are likely many more sites with topographical relief sprinkled throughout the continental shelf off South Texas. Within the Mysterious Banks complex alone, Bright and Rezak (1976) identified 28 distinct reefs through direct observation from a submersible. Seismic studies reveal that there are about 40 outer—shelf banks of coralgal origin and that there were likely other carbonate reefs (possibly oyster banks) during the Wisconsinan period that have since been buried by more recent deposits (Berryhill 1986). Holocene deposits have buried only the edges of many Wisconsinan carbonate reefs, leaving the upper portions exposed as hard—substrate banks (Berryhill 1986), which we focus on in this paper. The existing banks are in about 60—95 m (Rezak et al. 1985, Berryhill 1986) of water with the banks typically cresting at 55—82 m (Rezak et al. 1985, Belopolsky and Droxler 1999) and having an average relief of 10—12 m (Bright and Rezak 1976). Most sites have only minor encrusting populations of coralline algae with a mix of species similar to those of the algal—sponge and drowned reef zones of the Flower Garden Banks, and the epifaunal diversity is minimal below 75 m (Rezak et al. 1985, Dennis and Bright 1988). Although most South Texas Banks have low vertical relief, they are still conspicuous on the vast, flat continental shelf. The banks are located in a mid—to—high—energy environment, thus experiencing high turbidity and substantial sedimentation. The larger South Texas Banks are located roughly on the outer South Texas continental shelf, approximately in the area where freshwater inputs transition from being influenced by Texas rivers to being dominated by the Mississippi River (Flint and Rabalais 1981). Rezak et al. (1985) delineated the specific depth ranges of biotic zones at several sites; biotic zones at the South Texas Banks include an antipatharian transitional zone, a nepheloid layer, and soft bottom. Additionally, Rezak et al. (1985) created profiles of observed biota according to zones at some of the South Texas Banks. The dynamic nepheloid layer is composed of resuspended sediment that is subject to variable, yet chronic, turbidity. The nepheloid layer heavily influences the ecology of the South Texas Banks (Tunnell et al. 2009).

In this analysis species richness at Southern Bank was analyzed specifically because the most data are available for that site, which is likely because of the geological complexity of the site when compared to the other South Texas Banks. Southern Bank is located about 55 km offshore of Corpus Christi on the edge of the outer continental shelf (Belopolsky

TABLE 1. *Known locations and other data for 21 outer–shelf South Texas Banks (ordered from north to south). Sources[1]: Rezak et al. 1985, Berryhill 1986, Bright and Rezak 1976. N/A: Data not available.*

Bank Name	Latitude	Longitude	Depth to Base (m)	Depth to Crest (m)	Relief (m)	Area (km²)
Bad Mud Bank	27°52.50′N	96°07.0′W	58	N/A	N/A	0.65
Small Dunn Bar	27°49.0′N	96°07.6′W	65	N/A	N/A	0.65
Big Dunn Bar	27°49′N	96°08.4′W	65	N/A	N/A	1.20
Baker Bank	27°45.0′N	96°14.0′W	74	58	16	2.09
East Breaks	27°43.0′N	95°41.0′W	100	N/A	N/A	15.5
South Baker Bank	27°40.5′N	96°16.4′W	82	64	18	N/A
Aransas Bank	27°35.5′N	96°27.0′W	70	58	12	0.67
North Hospital Bank	27°34.5′N	96°28.5′W	68	58	10	1.60
Hospital Bank	27°32.5′N	96°28.5′W	78	56	22	5.22
Southern Bank	27°26.5′N	96°31.5′W	80	60	20	1.27
Little Mitch Bank	27°18.0′N	97°10.0′W	30	N/A	N/A	2.5
Four Leaf Clover	27°09.07′N	97°10.01′W	30	N/A	N/A	2.5
Dream Bank	27°02.5′N	96°42.5′W	84	70	14	2.95
9 Fathom Rocks[2]	26°57.5′N	97°18.51′W	20	N/A	N/A	2.5
Big Adam Rock	26°57.2′N	96°49.0′W	66	60	6	0.37
Small Adam Rock	26°56.7′N	96°49.8′W	62	60	2	0.04
Blackfish Ridge	26°52.6′N	96°46.6′W	72	60	12	1.12
Mysterious Bank[3]	26°46.1′N	96°42.0′W	74 – 84	N/A	N/A	N/A
Steamer Bank	26°49.3′N	97°13.50′W	30	N/A	N/A	N/A
Seabree Banks[4]	26°24.3′N	96°58.3′W	36	33	3	130
East Bank	26°02.78′N	96°54.6′W	40	N/A	N/A	155.4

[1]Additional source: Circé, R.C. and J.W. Tunnell, Jr. 1987. Distribution of shelf and shelf–edge banks in the northwestern Gulf of Mexico. Abstract and poster, Fourth Annual Mid–Year SEPM Meeting, Austin, TX, USA.
[2] 9 Fathom Rocks is a complex consisting of at least three sites.
[3] Mysterious Bank is a complex (6.4 km by 2.7 km) of small (100 m) to medium (1250 m) banks.
[4] Seabree (also Sebree) Bank(s) includes four sites.

and Droxler 1999). The formation is about 40—50 m thick but has a maximum relief of 22m above the seafloor (Bright and Rezak 1976, Belopolsky and Droxler 1999). There are three to four levels of reef development or die—offs, which are similar to more defined terraces on sites in the diapiric area in the northwestern GOM, and Southern Bank as it exists today has two distinct peaks that represent the reef crests. These terraces at Southern Bank may represent successive die—offs that occurred during the late Holocene (Holcombe et al. 2010, Belopolsky and Droxler 1999).

Results

Data were reviewed for 21 known outer—shelf South Texas Banks (Table 1). Compared to more northern Gulf sites, such as the East and West Flower Garden Banks that have been well studied over time, few studies have been conducted on the South Texas Banks, and most of those were conducted in the 1970s and 1980s (Table 2). These studies were primarily faunal inventories intended to provide baseline data prior to oil and gas development and often did not include any information of faunal seasonality. No robust dataset quantifies biodiversity at the South Texas Banks comprehensively, but analysis of observational, anecdotal, and scientific data from existing reports, published and unpublished, provides ecological insight regarding community types and possible connectivity throughout the GOM region.

Collectively, 28 references describe observations of about 1,282 unique taxa at the nearshore 7.5 Fathom Reef and 11 of the outer—shelf South Texas Banks (Tables 2 and 3). This total accounts for taxa identified at more than one site. Of the 11 outer—shelf sites, Seabree Bank is the only site that is a relict barrier relief; the remaining 10 sites are relict coralgal reefs. Of all these banks, 7.5 Fathom Reef, Southern Bank, and Hospital Rock each host roughly a third of the total taxa known from the literature. Based on available data describing communities at the South Texas Banks, about 75% of the 454 taxa identified as occurring at 7.5 Fathom Reef were documented exclusively at 7.5 Fathom Reef, which is the site nearest to shore in this study. Therefore, only 115 taxa recorded at 7.5 Fathom Reef have been observed in both nearshore and offshore environments. The outer—shelf South Texas Banks (mostly coralgal banks) collectively provide habitat for about 943 known taxa, based on currently available information. Of these taxa, about 27% do not have occurrences from specific sites mentioned.

Only slightly over half of the identified taxa were identified to species level. Not unexpectedly, outer—shelf banks surveyed more often tend to have the highest species

TABLE 2. *References containing taxonomic data for South Texas Banks ordered by date.*

Citation	Source Type	Site(s)	Taxa
Parker and Curray 1956	Peer–reviewed journal	Baker Bank, Southern Bank	Cnidaria, Mollusca
Hoese 1965	PhD dissertation	Unspecified South Texas Banks	Chordata: Chondrichthyes, Actinopterygii
Causey 1969	Master's thesis	7.5 Fathom Reef	Chordata: Chondrichthyes, Actinopterygii
Tunnell 1969	Master's thesis	7.5 Fathom Reef	Mollusca
Tunnell and Chaney 1970	Peer–reviewed journal	7.5 Fathom Reef	Mollusca
Felder 1971	Master's thesis	7.5 Fathom Reef	Annelida, Arthropoda
Tunnell 1972	Peer–reviewed journal	7.5 Fathom Reef	Brachiopoda
Bright and Pequegnat 1974	Book	Seabree Bank	Granuloreticulosa, Cnidaria, Mollusca, Annelida, Arthropoda, Echinodermata, Chordata
McCarty 1974	Master's thesis	7.5 Fathom Reef	Annelida: Polychaeta
Shirley 1974	Master's thesis	7.5 Fathom Reef	Cnidaria, Sipuncula, Echinodermata
Abbott and Bright 1975	Technical report	Individual species reports from Small Adam Rock, Big Adam Rock, Blackfish Ridge, Mysterious Bank, Southern Bank, Baker Bank, 7.5 Fathom Reef	Porifera, Cnidaria, Mollusca, Bryozoa, Chordata, Annelida, Arthropoda, Brachiopoda, Echinodermata
Bright and Rezak 1975	Technical report	Unspecified South Texas Banks, Southern Bank	Chordata: Perciformes, Anguilliformes, Tetraodontiformes
Davis 1975	Master's thesis	7.5 Fathom Reef	1 species: *Leptogorgia virgulata*
Bright and Rezak 1976	Government report	Baker Bank, Big Adam Rock, Dream Bank, Hospital Rock, North Hospital Rock, Seabree Bank, South Baker Bank, Southern Bank, 7.5 Fathom Reef, unspecified South Texas Banks	Granuloreticulosa, Rhodophyta, Chlorophyta, Ochrophyta, Porifera, Cnidaria, Mollusca, Annelida, Sipuncula, Arthropoda, Chordata, Brachiopoda, Echinodermata
Groover et al. 1977	Government report	Hospital Rock, Southern Bank	Annelida: Polychaeta
Holland 1976	Government report	Hospital Rock, Southern Bank	Mollusca, Annelida, Arthropoda
UTMSI 1976	Government report	Hospital Rock, Southern Bank	Cnidaria; Mollusca; Annelida; Arthropoda: Ostracoda, Malacostraca; Echinodermata
Rezak and Bright 1978	Government report	Unspecified South Texas Banks	Cnidaria, Chordata
Felder and Chaney 1979	Peer–reviewed journal	7.5 Fathom Reef	Annelida, Arthropoda
Tunnell 1982	Symposium proceedings	7.5 Fathom Reef	Brachiopoda
Rezak et al. 1985	Book	Baker Bank, Big Adam Rock, Blackfish Ridge, Mysterious Bank, Seabree Bank, Small Adam Rock, Southern Bank, 7.5 Fathom Reef, unspecified South Texas Banks	Rhodophyta, Chlorophyta, Ochrophyta, Porifera, Cnidaria, Mollusca, Annelida, Arthropoda, Brachiopoda, Bryozoa, Echinodermata, Chordata
Dennis and Bright 1988	Peer–reviewed journal	Big Adam Rock, Blackfish Ridge, Mysterious Bank, Small Adam Rock, Southern Bank, unspecified South Texas Banks	Chordata: Chondrichthyes, Actinopterygii
Rezak et al. 1990	Peer–reviewed journal	Southern Bank	Porifera, Mollusca, Arthropoda, Brachiopoda, Chordata
Dokken et al. 1993	White paper	Seabree Bank	Cnidaria, Mollusca, Annelida, Arthropoda, Echinodermata
Lehman et al. 1996	Government report	7.5 Fathom Reef	Rhodophyta, Chlorophyta, Chordata, Ochrophyta, Cnidaria, Mollusca, Annelida, Arthropoda, Echinodermata
Hyde 2000	Master's thesis	Hospital Rock, 7.5 Fathom Reef	Mollusca: Gastropoda, Bivalvia, Scaphopoda
Weaver et al. 2005	Government report	7.5 Fathom Reef	Chordata: Chondrichthyes, Actinopterygii
Weaver et al. 2009	Symposium proceedings	Southern Bank, North Hospital Bank	Chordata: Actinopterygii

TABLE 3. *Number of taxa at selected South Texas Banks. Sites are listed north to south. No taxonomic data were available for the South Texas Banks not included in this table.*

	Taxa[1]		Species	
Bank Name	**Identified**	**Unique to Bank**	**Identified**	**Unique to Bank**
Baker Bank	48	2	27	0
South Baker Bank	43	5	18	0
North Hospital Bank	44	2	28	0
Hospital Bank	363	125	239	67
Southern Bank	420	96	268	49
Dream Bank	62	13	27	0
Big Adam Rock	14	0	5	0
Small Adam Rock	6	0	3	0
Blackfish Ridge	6	0	3	0
Mysterious Bank	6	0	3	0
Seabree Bank	42	19	34	9
Collective banks (sites unspecified in literature)	389	253	250	157
7.5 Fathom Reef	454	339	417	302
ALL BANKS COMBINED[2]	**1282**		**881**	

[1] Taxa include organisms identified to any level (species or above species level).

[2] These totals account for overlap of counts among banks; each taxon is counted only once in sums.

richness. Southern and Hospital Banks are the most speciose of the studied offshore South Texas Banks, even though fewer studies focused on Hospital Bank than Southern Bank (Figure 3).

The number of taxa listed in each classification category increases as taxonomic level decreases. Taxa representing 14 phyla have been recorded from the South Texas Banks, and most of these taxa are placed in the phyla Annelida (27%), Mollusca (23%), and Chordata (17%) (Figure 4). Within Annelida, all species identified are within Class Polychaeta.

When looking at Southern Bank specifically as a case study, the top three phyla are Annelida, Chordata, and Mollusca, as seen with the South Texas Banks as a group. However, at Southern Bank there are no reports of Bryozoa, Granuloreticulosa, Rhodophyta, or Sipuncula, which occur at one or more of the other South Texas Banks. This may be due to the type of sampling at this location rather than to the absence of these taxa. Of the 269 species reported at Southern Bank, almost 49% are classified within the Phylum Annelida. Sixteen percent of the species at Southern Bank are in the Order Phyllodocida (polychaetes), and 12% are in Perciformes (bony fishes) (Figure 5). The remaining orders individually comprise less than 10% of the species recorded at Southern Bank. There are 17 polychaete species that are not assigned to orders in the Biodiversity of the Gulf of Mexico Database (Moretzsohn et al. 2013) and other online taxonomic databases (World Register of Marine Species, Encyclopedia of Life, Integrated Taxonomic Information System) due to recent phylogenies debunking older classification schemes (Rouse and Fauchald 1997). These unclassified polychaete species make up about 6% of the species listed at Southern Bank.

Discussion

Southern and Hospital Banks show the highest species richness of the outer—shelf South Texas Banks for several reasons. From the biophysical perspective, Hospital and Southern Banks are large sites with the highest vertical relief of the outer—shelf South Texas Banks (see Table 1). Greater topographic relief is conducive to increased ecological zonation, which provides more habitat, not only based on surface area and vertical structure but also on various physical parameters such as depth, turbidity, and light penetration (Rezak et al. 1985). Different species inhabit different biotic zones; therefore, sites with greater vertical relief have higher spe-

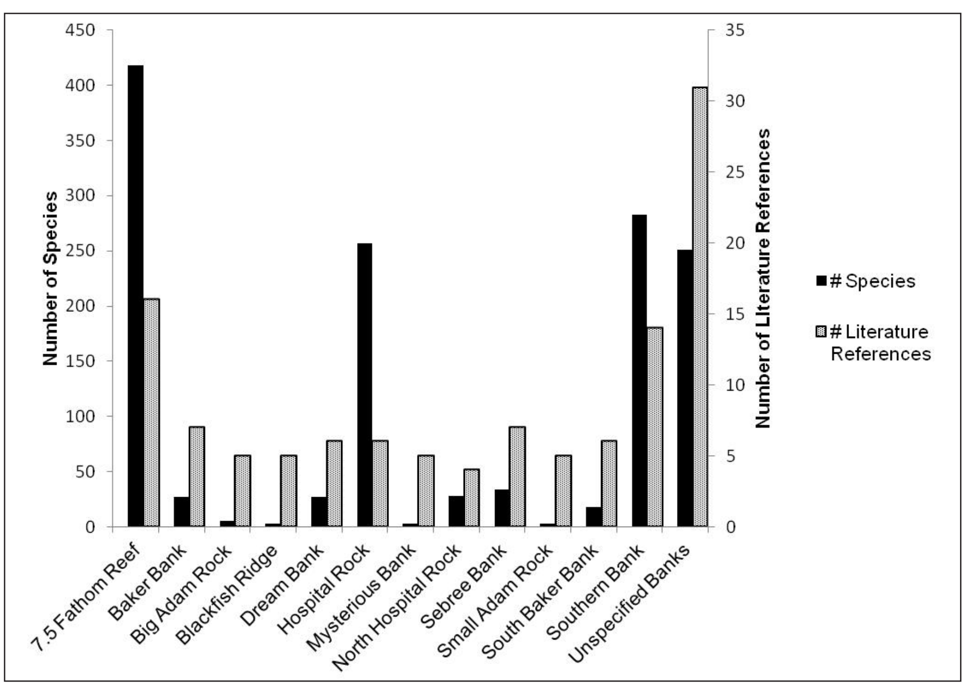

Figure 3. *Number of species and literature references per bank.*

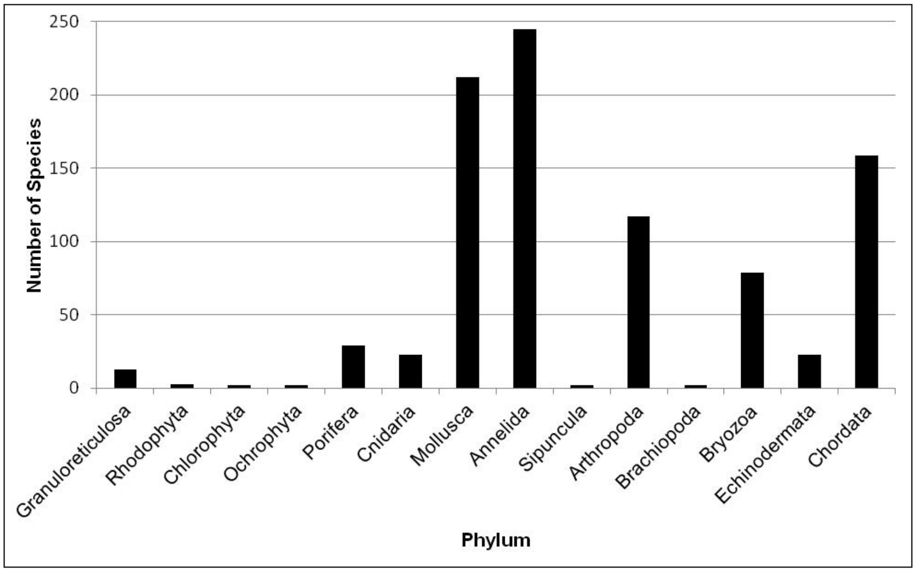

Figure 4. *Number of species per phylum at South Texas Banks.*

cies richness. Also, the spatial and temporal variability of the thickness and density of the nepheloid layer may enhance or impede observations at the time of data collection (Flint and Rabalais 1981). As topographical highs, Southern and Hospital Banks protrude farther above the nepheloid layer than the other banks, enabling different ecological communities to survive (Rezak et al. 1985). The nepheloid layer's coverage of other banks with lower relief is likely a reason they are not as well characterized because the suspended muddy sediment obscures visibility required for biological observations. From the perspective of scientific effort, higher study effort is often correlated with higher species richness because more time has been spent looking for organisms, which increases the probability of finding more species. Higher species richness at several banks could be due to a larger number of studies at such banks (see Figure 3), but this is only a rough measure of sampling effort because of differences in effort among studies. Many studies identified taxa from the South Texas Banks collectively; as expected, such studies revealed relatively high biodiversity as well. In the case of the outer–shelf South Texas Banks, greatest scientific effort at Southern Bank is likely due to accessibility, size, and ease of locating the site. Similar reasons apply to the high species richness identified at the nearshore 7.5 Fathom Reef; more studies occurred at this reef than at any other site discussed herein. Data are no doubt lacking for many of the South Texas Banks because exact locations of sites are not always known, some sites have more than one name causing confusion when trying to match data with sites in literature, atmospheric and sea conditions may make it difficult to locate a site, and the culture of secrecy within the fishing communities makes it difficult for scientists to locate or study sites known to have a high abundance of targeted species.

Although sampling effort biases may exist, Southern Bank appears to have the greatest species richness when compared to other South Texas Banks, therefore allowing further analysis. The pattern of diversity of the higher taxonomic groups remains similar to the combined South Texas Banks, with Annelida, Chordata, and Mollusca being the most speciose phyla. The number of species from Southern Bank, however, does not skew the combined data. When Southern Bank was removed from the combined South Texas Banks data, the percentage of species changed by one percentage point or less for every phylum recorded. This indicates that Southern Bank could be representative of the potential species diversity that may be found at other South Texas Banks.

In previous studies of the submerged banks of the northwestern GOM, mollusks were the most diverse group of organisms (Tunnell et al. 1978). Although results from this study show that polychaetes represent the taxonomic group with the highest species richness, mollusks have the second highest species richness among the South Texas Banks. However, biases in data collection methods and analyses may obfuscate or even invalidate some conclusions. Potential biases include, but are not limited to:

- Taxonomic misidentifications
- Unresolved or inconsistent taxonomic shifts in the last several decades
- Variable sampling methods (consistency, duration, gear type, etc.) and effort among sites
- Reliability of anecdotal and observational data (e.g., from submersibles)
- Differences in data interpretation by different scientists
- Lack of repeatability
- Lack of geographic coordinates in reports and site nomenclature confusion
- Spatiotemporal variability of nepheloid layer.

Comparisons within taxonomic groups (corals, mollusks, fishes, etc.) may provide additional insight into community structure and potential connectivity among the banks. For example, previous qualitative comparisons indicate that the reef fish community of the South Texas Banks resembles that of some banks in the salt diapir area to the north at similar depths (Weaver et al. 2009). Further analyses could focus on numbers of species that are typical of temperate and tropical marine communities to determine the role of the South Texas Banks in providing habitat essential for the GOM to function as a faunal ecotone (Bangma and Haedrich 2008). The overall morphological similarity of the South Texas Banks to the Lobos–Tuxpan Reef System in Mexico (Weaver et al.

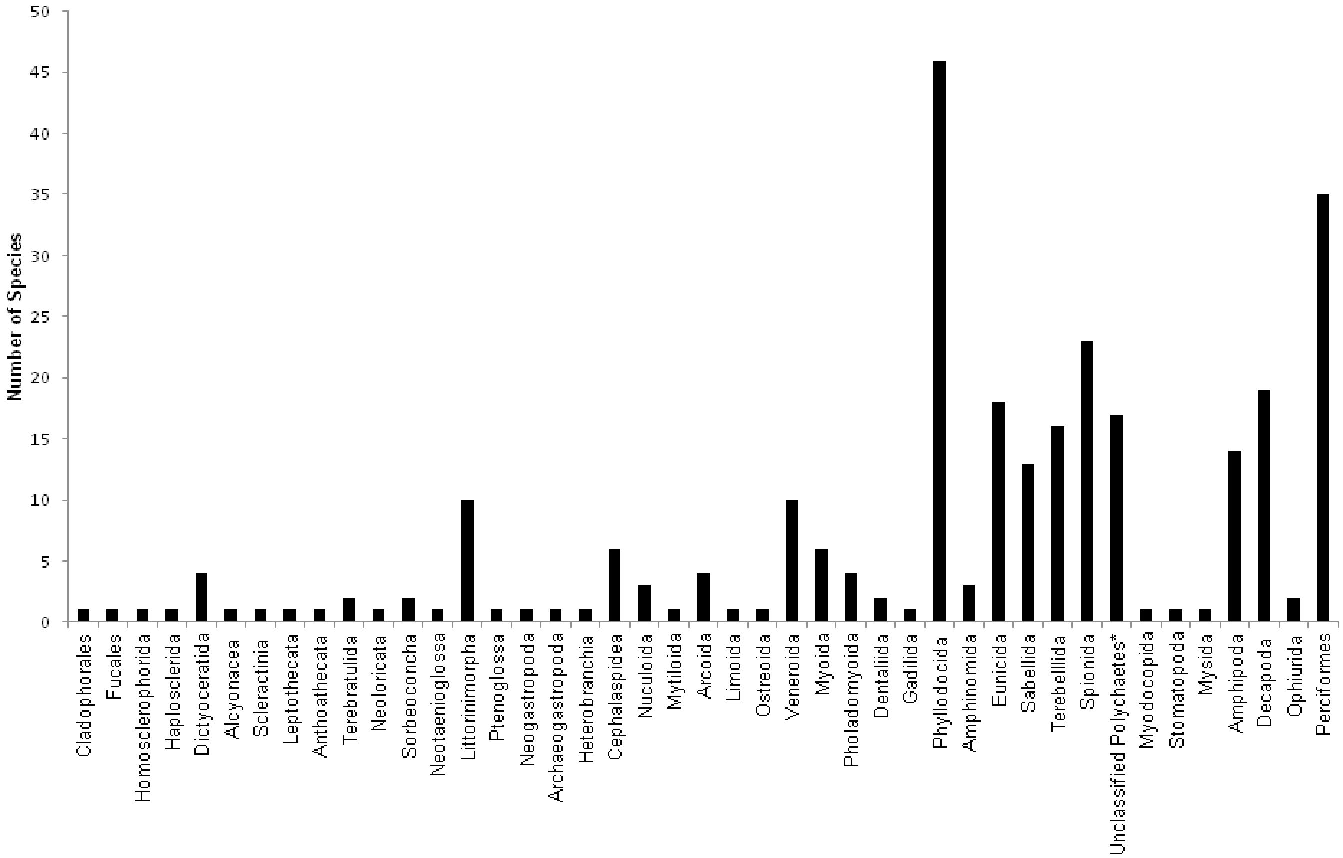

Figure 5. *Number of species per order at Southern Bank. Recent large–scale phylogenies of polychaetes have found that in older classifications some of the orders are not monophyletic (Rouse and Fauchald 1997). Therefore, recent classification schemes have not assigned some polychaete families to any order; these are referred to as unclassified polychaetes.*

2009) may indicate that Tuxpan biological studies (Rigby and McIntire 1966, Chávez et al. 1970, Tunnell 1974, Tunnell et al. 2007, Escobar–Vásquez and Chávez 2012) could serve as good models for future studies at the South Texas Banks given that the two systems likely share ecological connections as a result of their relatively close proximity to each other and to currents. Increases in species richness, rank abundance, and occurrence of tropical fish species since the 1970s (Bright and Rezak 1976, Tunnell et al. 2009) supports the concept of ecological connectivity, perhaps between the Lobos–Tuxpan Reef System and the South Texas Banks, particularly in a changing climate.

Information about the South Texas Banks is dominated by physical and geological data, with relatively little biological data being available. Because there have not been systematic, comprehensive studies conducted on all of the South Texas Banks, little is known about the ecological communities at many of the sites. Suggested next steps include systematic ecological studies using a consistent methodology for describing biota of all South Texas Banks, standardization of specific locations and names of sites (see note in Table 1), and discussion of species richness as functions of survey effort, habitat availability, and environmental conditions. These studies would facilitate design of conservation and protection parameters for rare habitat sites with vertical relief found in some portions of the Gulf's continental shelf. Surveys and observations would likely yield the best results during May to November when water clarity is greatest due to northerly currents moving clear, tropical oceanic water from the south over the banks, thus reducing the visual obscurity of the nepheloid layer (Tunnell et al. 2009). Finally, survey results could be compared to similar studies conducted on hard banks and reefs throughout the rest of the GOM to draw conclusions and propose candidate sites for protection on a regional scale (Nash and McLaughlin 2012). We submit that such studies are particularly important for habitat conservation and sustainability of living marine resources in the face of climate change.

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