

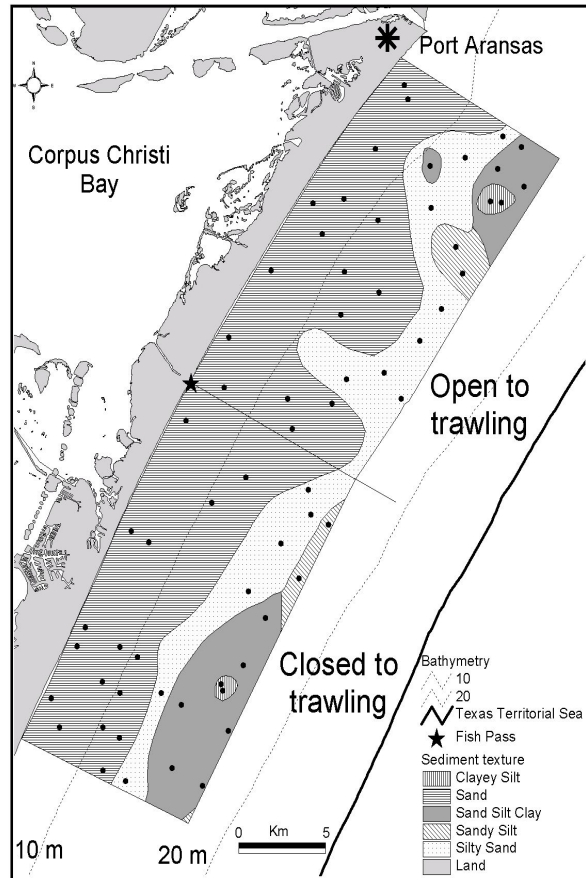


# NOAA Technical Memorandum NMFS-SEFSC-483

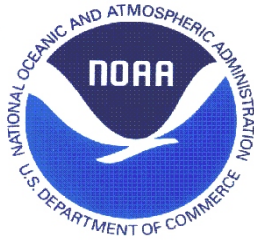
## Compilation of Data Sets Relevant to the Identification of Essential Fish Habitat on the Gulf of Mexico Continental Shelf and for the Estimation of the Effects of Shrimp Trawling Gear on Habitat

by

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**Introduction**

The alteration of essential fish habitat (structural components, benthic community structure, and ecosystem level processes) by fishing activities is not well understood, yet it is generally acknowledged that fishing can influence species composition and diversity of non-target organisms and reduce habitat complexity. Little research has been conducted on fishing gear impacts in the Gulf of Mexico, and information to predict the magnitude of these effects and to determine whether habitat alterations are short- or long-term is generally lacking. The environmental, ecological, and physiological processes that regulate recruitment and abundance of organisms in essential fish habitat (EFH) are complex and not well understood. Thus, impacts of habitat disturbance by fishing gear are difficult to estimate. However, fishing has been shown to affect the structural components of habitat. Numerous studies outside the Gulf of Mexico indicate that mobile fishing gear reduces habitat complexity by: 1) directly removing epifauna or damaging epifauna leading to mortality, 2) smoothing sedimentary bedforms and reducing bottom roughness, and 3) removing taxa which produce structure (i.e., colonies, tubes, mounds, burrows, and pits) (Auster and Langton 1999). Overall, the recovery of habitat structure is difficult to predict as timing, duration, severity, seasonality, and frequency of impacts all interact and influence processes that lead to recovery.

Most studies of the effects of fishing gear on habitat have been conducted on small spatial scales, hence it is difficult to apply this information for management on an ecosystem level. Simply, we do not have the knowledge to understand how communities respond to large-scale and long-term disturbances. Such knowledge is necessary to compartmentalize natural versus man-induced disturbances. Models developed from ecological studies of disturbance could be useful in understanding successional patterns and may allow managers to predict future community stages to directly manage EFH.

The National Marine Fisheries Service Southeast Fisheries Science Center (SEFSC) has determined that trawls are among the fishing gears most likely to impact EFH in the Gulf of Mexico (Hamilton<sup>1</sup>). The Gulf of Mexico shrimp trawl fishery is the largest, most geographically widespread fishery of any in the southeastern United States. It is also one of the most carefully and consistently documented in terms of catch, effort, and location. The shrimp fleet is the most likely fishery to exert short- and long-term effects, if any, on fish and shellfish habitat on the continental shelf.

Even though human and natural disturbances might change substrate characteristics or benthic community compositions, these disturbances are likely to be localized or short-lived. For example, fine sediments might be re-suspended after storm passage but, in most areas of the continental shelf, the long-term proportions of sand, silt, and clay probably only change on a geological time scale. Likewise, benthic community composition may change seasonally but the suite of benthic organisms likely to be found in any given location is stable and repeatable over long time periods (if unimpacted by disturbance).

Any examination of fishing gear impacts requires information on habitat distribution, animal abundance, and intensity of disturbances. The objectives of this project were to 1)

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<sup>1</sup> Hamilton, A. N., Jr. 2000. Gear impacts on essential fish habitat in the Southeastern Region. Unpublished report. National Marine Fisheries Service, Pascagoula MS. 41 p.

identify and obtain data bases describing continental shelf habitats, trawl fishery activities, and other human activities, 2) to incorporate these data sets into a geographical information system (GIS) format, and 3) to provide preliminary experimental designs for the assessment of the effects of shrimp trawling to EFH on the Gulf of Mexico continental shelf. The habitat data can also be used in the future to frame studies of other fishing gears, since traps, longlines, dredges, and recreational fishing have also been identified as fishing methods with high potential for impact (Hamilton<sup>1</sup>). In general, the term habitat is defined as “the structural component of the environment that attracts organisms and serves as a center of biological activity” (Peters and Cross 1992). Habitat types then include both substrates and benthic fauna that are utilized by bottom-dwelling organisms such as fishes, shrimps, and crabs for refuge, growth, feeding, or reproduction.

## Materials

We reviewed over 50 publications (see Annotated Bibliography) and numerous data sources (such as web sites or resource agency files) and developed 57 data layers with information relevant to studying the effects of shrimp trawling on the Gulf of Mexico continental shelf (see Brief Description of Data Layers). We did not include water quality data (except for hypoxia, when dissolved oxygen  $\leq 2$  ppm) since changes in factors such as ambient salinity, temperature, or currents all vary over short to long time scales but do not typically impact sediments or benthic organisms adapted to such variations. Hypoxia, however, can defaunate benthic communities and influence habitat use by penaeid shrimps either directly by killing or incapacitating them or indirectly by causing avoidance reactions and thus preventing shrimp use of an area (Renaud 1985, 1986a, b).

The data layers for the project, as well as this publication, are available on CD from the authors. The project was designed for use with ArcView 3.2 software from Environmental Systems Research Incorporated (ESRI). *The project will not run without ArcView software.* There are several text files included in the CD that are separate from, but are called by, the main ArcView files, including 1) text describing underwater photography by Woodward-Clyde Consultants (see Annotated Bibliography), 2) text describing point data, biological communities, transect data, and their codes, and 3) a shelf habitats annotated bibliography. In addition, the bibliography is included as an EndNote (.enl) file for importing with EndNote software (the EndNote file is not used by the ArcView software). This Technical Memorandum is also included on the CD as Word (.doc) and Word Perfect (.wpd) files.

All of the data layers were prepared with ArcView 3.2 in a non-projected format using decimal degrees for latitude and longitude. The purpose of this project was to help identify data available to describe the continental shelf of the Gulf of Mexico in order to delimit future research activities, not to quantify previous research. The data layers were gathered from separate sources using various means of mapping and having variable quality control. As a result, some of the layers may not display exactly at larger scales. Since this project encompassed a Gulf-wide scale, many of the layers contain neither perimeter nor area values. *Attempting to project these layers into an appropriate projection and then calculating “accurate” area values is not recommended.* Most of these data layers were not designed for that purpose. Any calculations of this nature should be considered only rough estimates. Users

are advised to consult original publications and data sources for exact data.

The last theme in the Offshore Data view (“Text Links”) contains no geographic data. This layer contains “ArcView Hotlinks” that display information and codes used in various themes. The hotlinks are associated with grey information boxes at the bottom of the map display. *This file should not be re-projected, as the labels will not display properly.* For a correct display, remove then add labels after reproduction. Legends for most themes have been created and stored in the “Legends” folder. Metadata have been created for the complete project and are available on the CD. Metadata for individual themes are not available at present. Users are advised to contact the original data owners for metadata if needed.

The “Hypoxia” layer is neither an extrapolation of available data nor an exact display of actual measurements. Rough estimates of the hypoxic bottom water zone were taken from text documents and incorporated into a GIS format. Area values were not calculated. Users are advised to contact the data owner (Dr. Nancy Rabalais, Louisiana Universities Marine Consortium, Chauvin LA) for exact information.

## Results

Habitat information is comprised of 15 data layers including actual benthos and sediment point data (numbers of individuals per m<sup>2</sup> or percentages of sand, silt, and clay at a given latitude and longitude; Layer 1), digitized sediment maps (Layers 45-46), and digitized maps of biotic communities including seagrasses, corals, and live-bottom areas (Layers 2, 26-35, and 44). Descriptive area information is contained in 18 layers including base maps of the U. S. Gulf of Mexico and its bathymetry (Layers 56 and 43), demarcations of State and Federal waters (Layers 47 and 50-51), locations of navigation safety fairways (Layer 52), various data sets concerning oil and gas platforms and pipelines (Layers 48-49, 53-55), locations of artificial reefs (Layers 36-40), and locations of bottom obstructions (Layers 41-42). Data concerning the shrimp fishery itself comprise 22 layers including National Marine Fisheries Service statistical subareas (Layer 12), general patterns of shrimp fishing effort (Layers 10-11), locations of SEAMAP trawl stations and catches (Layers 7-9), starting locations for several National Marine Fisheries Service trawl surveys (Layers 4-6), and waters that are (or may be) closed to trawling around the Gulf of Mexico (Layers 13-25). We only present selected combinations of data layers in support of our objectives, therefore the end users of this report may want to delve deeper into the data base.

An examination of trawling impacts on bottom sediments requires information on baseline sediment characteristics. While many human activities continue to affect shallow Gulf of Mexico continental shelf habitats to an unknown degree (trawling, oil and gas extraction, dredging, etc.), there seems to have been little or no attempt at characterization of shelf sediments and benthos. These two components are expected to be the primary descriptors of Essential Fish Habitat for managed fishery species because animal-sediment relations and the food web on the continental shelf likely determine the distributions of demersal fishes and decapod crustaceans. Most continental shelf studies of sediments or benthos have centered around a potential impact site (e.g., brine diffusers off Texas, oil platforms off Louisiana, or sand mining off Alabama) and have not conducted shelf-wide studies. To our knowledge, there has been only one: the Minerals Management Service assembled available gulf-wide sediment data

from the 1960's and 1970's into a picture of shelf sediments (U. S. Department of the Interior 1983). Thus, background information concerning sediments and benthos that is relevant to assigning experimental trawling sites is likely to be general in nature, unless experiments are conducted in the vicinity of previous studies. This lack of data suggests that the best way of proceeding is to conduct comprehensive tests on the effects of trawling gear on sediments and benthos at a number of sites throughout the depth range fished by the Gulf of Mexico shrimp fleet. These tests could be conducted in areas closed to trawling or in open fished areas.

Possible Trawling Experiments in Closed Areas: There are few permanently closed areas within the depth range typically fished by the shrimp fleet where experiments on the effects of trawling or gear modification might be conducted (Figure 1). Gulf Islands National Seashore, which spans barrier islands in Mississippi, Alabama, and Florida, does not permit trawling within 1.85 km (1 nautical mile) of shore. The Florida Big Bend Region closed area encompasses shallow waters of Wakulla, Jefferson, Taylor, Dixie, Levy, Citrus, Hernando, and Pasco Counties (shoreline to depths of 1.8 m or 6 feet). In addition, Taylor County prevents shrimp trawling in a more extensive area within state waters (shoreline to 17 km or 9 nmi), and the Citrus-Hernando county line has an area of seasonally alternating shrimp and stone crab closures. These areas provide limited depths, times, and habitats for experimentation. The Florida Keys National Marine Sanctuary and adjoining Tortugas Ecological Reserve do not permit trawling, but much of their areas are coral, live bottom, and seagrass habitats that are not usually trawled. It may be possible to conduct limited experiments in these areas if trawlable bottom can be located.

The best opportunities for experimental trawling studies lie in southern Florida (Tortugas Shrimp Sanctuary), northwest Florida (Madison-Swanson and Steamboat Lumps marine protected areas [MPAs]), and in Texas (Texas Closure and Southern Shrimp Zone). Florida sites offer the opportunity to address gear effects in habitats inside versus outside of permanently closed areas. The Tortugas Shrimp Sanctuary was established in 1981 by the Gulf of Mexico Fishery Management Council and restricts trawling generally to areas west of a north-south line between Key West and Cape Romano, FL. There is a relatively large area with depths of 9-18 m (5-10 fm) both inside and outside the closure line where experiments could be replicated (Figure 2). There is information available concerning sediments, but benthic communities are not well-known in this area. In addition, there are several seagrass zones inside and outside the sanctuary line that could be included in the experimental design. At the Florida MPAs, which were established in 2000, there are deep water sites that have been mapped by side-scan and multibeam telemetry where there has traditionally been little or no shrimp trawling (Figure 3). Sediment and benthic community information are available from the general area, and there are several NOAA and USGS projects on-going in the area that may supply more information in the future. There are limitations due to the relatively narrow depth ranges available in either case.

In Texas, the best opportunities result from either the summer closure of all Texas waters (45-60 days during May 15 - July 15) or the Southern Shrimp Zone closure (December 1 - ending of Texas Closure). The Texas Closure, in place since 1981, presents an opportunity to compare gear impacts in Texas waters (closed) versus adjacent Louisiana waters (open; Figure 4). A gradation of trawling effort could be applied to experimental sites over a short period with no interference from the fishery itself. There are several depth zones and several sediment types that can be compared. Some sediment and benthos data are available from the area, but most data

are from either shallow ( $\leq 20$  m) or deep ( $\geq 80$  m) waters. Experiments should be limited to near the closure line since sediments become progressively finer and hypoxic bottom waters become more likely east of the line. We note, however, that the time frame for studying this area is only 45-60 days in summer, so Gulf-wide applicability of results would be limited. In addition, the Texas Closure may be temporarily suspended or even eliminated (this nearly happened in 2002).

In the Texas Southern Shrimp Zone (enacted in December 2000), trawling is prohibited from shoreline out to 9.3 km (5 nmi) for approximately 7 months (Figure 5). Sediments are most variable and depths are least variable in the upper SSZ and least variable in the lower SSZ. Depths are restricted to  $\leq 20$  m throughout. Sediments have been relatively well-described, but benthic communities are poorly documented in these shallow areas. Here again, a gradation of trawling effort could be applied to experimental sites throughout the SSZ and monitored over a short period with no interference from the fishery itself. Alternatively, assessment of sediments and benthos inside (protected) and outside (trawled) the upper SSZ under ambient trawling pressure could be conducted. National Marine Fisheries Service Galveston began preliminary work on the latter option during 2001 (see Experimental Design section below).

Other options for research sites include: 1) multi-platform oil or gas installations that might prevent trawlers from approaching too close (upper Texas and western Louisiana coasts), 2) large areas of artificial reefs that preclude trawling (particularly off Mississippi-Alabama), and 3) large areas of known and unknown bottom obstructions. There are seven 3-structure petroleum complexes off Texas and 17 5- to 14-structure complexes off Louisiana (Figure 6). Shrimp trawlers might be expected to keep clear of these areas to avoid hangs and obstructions. The Texas complexes offer a variety of substrates and depths, but almost all of the Louisiana complexes are located in shallow, regularly-hypoxic waters. There are sediment and benthos data from nearby platforms, if not from the target platforms themselves. There are other limitations to using the platforms as research sites: a) these are reef environments that do not resemble the vast majority of the continental shelf substrates trawled by shrimpers, b) sediments and benthic communities at platforms are typically disturbed or contaminated by drilling muds out to at least 500 m (see Kennicutt 1995 and Montagna and Harper 1996 in Annotated Bibliography), and c) shrimp trawling actually does take place within the 500-m perimeter (NMFS trawl tows [Layers 4-6] indicate at least one tow near the easternmost Louisiana complex). Artificial reefs are scattered across the Gulf of Mexico, but an area south of Mobile Bay harbors a large number of reefs in a restricted area (Figure 6). This area might be too shallow and hazardous for trawling, but good navigational capabilities might be a solution. Clusters of obstructions could provide relatively protected habitat, but the exact locations and types of these obstructions are not well known. Previous comments concerning platforms as reefs apply to artificial reefs and obstructions as well. However, no area can really be ruled out and it remains possible that useful experiments could be designed for each area if necessary.

Possible Trawling Experiments on the Open Continental Shelf: There exist ample opportunities for research on the open continental shelf, as long as closures, ambient fishing effort, and variations in sediments and their associated benthic communities are factored into experiments. Cross-gulf replication is a major necessity - experiments should be conducted in as many apparently-similar locales as possible in order to provide a fishery-wide assessment of gear impacts. Toward this end, we have examined fishing effort, sediment, and depth combinations to



identify potential replicate experimental sites at several depth ranges across the Gulf (Figures 7-11).

The most opportunities for replication exist at depths of 18-27 m (10-15 fm) for both sand and mud (= silt + clay) habitats. The 18-27 m sand habitat (Figure 7) supports: a) five areas with relatively high fishing effort (southern Texas, central Louisiana [although in the hypoxic zone], eastern Louisiana, south of Mobile Bay, and north of the Dry Tortugas); b) three areas with low to moderate fishing effort (northern Texas and northwest and west-central Florida); and c) two areas with very low effort (northwest and southwest Florida). The 18-27 m mud habitat is limited to the central and western Gulf (Figure 8) and thus replication is limited as well: a) very high effort at two close areas off the Mississippi Delta; b) moderately high effort in three areas (southern Texas, central Louisiana, and east of the Chandeleur Islands); c) moderate effort only off the central Texas coast; and d) moderately low effort off northern Texas and western Louisiana. Three of these potential research areas are regularly impacted by hypoxia.

Moving to deeper waters and potentially to different benthic communities, opportunities in the 46-55 m (25-30 fm) depth range become more regional and less Gulf-wide in nature. The 46-55 m sand habitat (Figure 9) presents two moderately high effort areas off Texas, two moderate effort areas off west Louisiana, two moderately low effort areas (west Louisiana and northern Texas), and three very low effort areas (Mobile Bay, Florida Panhandle, Dry Tortugas). The 46-55 m mud habitat (Figure 10) is restricted to the central and western Gulf, with two moderately high effort areas off Texas, two moderate effort areas off central Louisiana, and two moderately low effort areas off central and west Louisiana, and a single very low effort area east of the Mississippi Delta.

A final depth related example is drawn from the outer edge of the Gulf shrimp fishery. The 82-91 m (45-50 fm) depth stratum is generally a very low fishing effort zone (Figure 11). There are four sand habitat areas (west Louisiana, Mobile Bay, and northwest and central Florida) and three silty-clay habitat areas (southern Texas and central Louisiana) in which experimental habitats could be replicated. We also note that this depth zone is characterized by hard bottom in certain areas where gear impacts to coral or live bottom habitats could be investigated.

For all of the above areas, there is some background information on benthic communities. However, available data are most dense off southern Texas and off Mobile Bay, less dense off Florida, and are largely absent off west Louisiana and northern Texas (Figure 12). In addition, there is a relevant data set that documented live bottom communities off southwest Florida (Figure 12). We have not presented maps of the extensive seagrass beds off Florida, but these data are available and need to be integrated into experimental designs.

In assessing the value of the available National Marine Fisheries Service SEAMAP trawl data sets, we noted that there are records of live bottom community organisms, such as hard and soft coral, gorgonians, etc., as well as federally managed fishery species that are occasionally noted in the catch. Live bottom communities might be of special interest to gear impact researchers since there is a national NOAA Coral Reef Initiative to conserve and maintain these communities. Live bottom organisms seem to be scattered across the shelf and not in any particular association with known rock or coral reefs (Figure 13). These areas perhaps need to be investigated further in preparation for gear impacts studies on these special bottom habitats. Plotting the occurrence of fishery species in trawl catches might be useful in designating other

special research sites or in selecting general research areas. However, we could determine no trends in the catch records, probably because these species are mobile water-column or reef residents (Figure 14).

The Gulf of Mexico Shrimp Fishery: The shrimp fishery developed in the late 1940's and expanded rapidly through the 1950's. By 1960, the shrimp fishery was geographically widespread, operating not only in bays and estuaries but also from the shoreline to greater than 100 m depths on the continental shelf. National Marine Fisheries Service has tracked this large and valuable fishery with standard methods since 1960. The 1990-1999 average annual effort on the Gulf of Mexico continental shelf was 203,937 24-hr days or 4.89 million hours. Spread over the estimated 263,657 km<sup>2</sup> of primary shrimping grounds at depths of 0-91 m (0-50 fm; Patella 1975), this effort translates into 18.6 hr for every km<sup>2</sup> over the entire fishing area each year. There is some variation in the amount and location of fishing effort among years, but typically the highest effort is expended in shallow waters off Texas, Louisiana, and Mississippi and in moderate depths off southwest Florida (Figure 15). Lowest effort is expended in deeper waters and over much of the Florida and Alabama shelf. A better picture of the distribution of fishing effort is gained after standardizing effort by the area within each depth stratum and statistical subarea (Figure 16). The regions with highest effort per unit area are the shallowest waters of Louisiana. Compared to these regions, effort per unit area is moderate to low elsewhere.

National Marine Fisheries Service conducted several studies of shrimp trawling bycatch during the 1990's. Starting and stopping positions for each trawl tow were recorded. We used the starting latitude and longitude of these tows as a proxy for the finer scale distribution of fishing effort around the Gulf of Mexico (Figure 17). In general, trawl tows seemed to be positioned haphazardly although several trends were noted. There were few to no deeper water tows (> 50 m) off Florida or at any depth between Apalachicola Bay, Florida and Mobile Bay, Alabama. There is a band of relatively shallow water that was not exploited along the central and western Louisiana coasts that we believe is congruent with the hypoxia zone. There is a relatively large area between the Sabine River and Galveston Bay that received little effort, probably due to shipping lanes and safety fairways in the area. Finally, there were some low to no effort areas in otherwise towed zones that were not explained by the presence of human or natural obstructions or disturbances. Interpretation of these patterns is subject to patterns caused by sampling a relatively small proportion of the available vessel captains and trawl tows made during the time periods sampled. Any number of conditions could have influenced the patterns, including favored trawling areas and lack of participation in the NOAA study from some ports.

Benthos data sets: We were able to locate site-specific data (i.e., linked to latitude and longitude) for approximately 1500 sediment samples and 2200 benthos samples (Figure 12). These data were compiled from 25 studies across the Gulf of Mexico. The southern Texas shelf was perhaps the most intensively studied, although the Mississippi - Alabama - Florida shelf did have a variety of stations scattered across it. Most studies were of relatively small sites and show up as clusters of data points. We note that there are few data points for the western Louisiana - northern Texas area.

Proposed Experimental Designs: The general structure of these experiments would be to apply variations in effort (for example, ambient and 2X, 5X, and 10X ambient) to replicate plots in replicate areas of the continental shelf and search for changes in substrate characteristics and benthic community density and composition. Subsequent experiments could be conducted as

needed to address food web changes (e.g., growth of caged shrimps) and ecosystem ramifications of those changes, but these should wait until gear effects are documented. Experimental plots could be trawled repeatedly, periodically, or only once during a several-year study period. Plots could be monitored by a combination of underwater video, sidescan or multibeam telemetry, quantitative bottom samplers, and divers before, during, and after trawl pressure is applied. As an example, we conducted a preliminary mensurative experiment to compare sediment characteristics and benthic communities on either side of a line marking a seasonal trawling closure off Port Aransas, Texas. The Texas Southern Shrimp Zone (SSZ) closed state waters from shoreline out 9.3 km (5 nmi) to shrimp trawling on 1 December 2000 and re-opened those waters on 8 July 2001. During 18-22 June 2001, we collected benthos and sediment samples from two areas adjacent on the dividing line at Corpus Christi Fish Pass (27.675° N, 97.000° W): a “closed” northern edge SSZ block 18.5 km (10 nmi) long and 9.3 km (5 nmi) wide, and a complimentary northern “open” block. We used our GIS database to develop a random stratified sampling program based on sediment characteristics of each block (Figure 18). Using divers and GPS units, we collected benthos and sediment cores from 64 sites. Data from this study will be available in the future.

Establishment of No-Take Marine Reserves: As noted previously, there are few areas where shrimping is prevented either by legislative mandate or by obstructions. Every area that can be trawled is trawled and has been trawled for decades. It is not possible for us to know what shelf habitats were like prior to the fishery since few data were collected beyond scattered trawl or dredge samples. Few (if any) underwater photographs, diver or submersible observations, sidescan or multibeam telemetry studies, or other technological applications were available to collect such information. However, there is a way to estimate what might have been, and that is through the use of non-extractive marine reserves. There should be a system of non-extractive or no-take marine reserves spanning the suite of habitats in the Gulf of Mexico. Each reserve should be relatively large and span the entire shelf from shoreline to the 200 mile limit (this would make it easy to avoid and to enforce). Marine reserves could be used to study the effects of complete cessation of trawling on substrates, benthos, shrimps, and other marine fauna. These data could be used to estimate recovery rates of various ecosystem components and to conduct experimental, fishery-free gear impact studies. The reserves themselves may provide such ancillary benefits as protection of spawning stocks of target and non-target species as well as enhancement or conservation of biodiversity (Bohnsack 1993). Further reserve planning is beyond the scope of this project, but the benefits of a reserve system need to be investigated.

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## **Brief Description of Data Layers (see following Annotated Bibliography for references)**

### **Layer 1. Benthos and sediments**

These data were derived from various publications cited in the Annotated Bibliography. They are point data - each sediment characteristic or organism density value is associated with latitude and longitude. Benthos data are given as numbers of organisms per m<sup>2</sup> to be able to compare densities among studies or time periods (most studies reported numbers per sample, and sampling areas varied). We present whatever data were available from the references. In general this includes: 1) author and year published, 2) year and month collected (may be combined over several months or as a season if that is all that was given), 3) original sample or station identification numbers, 4) depth in meters, 5) % gravel, sand, silt, clay, and mud (= silt + clay), 6) sediment texture according to the Shepard pyramid (combinations of sand, silt, and clay, e.g. clayey sand; or gravel, sand, mud, e.g. slightly gravelly muddy sand), 7) % organic matter, 8) total benthos and categories including annelids, crustaceans, molluscs, and others, 9) total epibiota density over hard substrates and categories including various types of corals, sponges, crinoids, and algae.

### **Layer 2. Southwest Florida biological communities 1987**

These data were derived from a habitat mapping project conducted by Continental Shelf Associates, Inc. (1987). Underwater television and still cameras were employed along a series of transects perpendicular and parallel to shore between Charlotte Harbor and Key West, Florida. We reconstructed the distribution of substrate types and geologic features from their figures and descriptions.

### **Layer 3. Hypoxia 1984-2001**

These are maps of the summer distribution of hypoxic bottom water (< 2 ppm) along the western Louisiana shelf. They were prepared by Dr. Nancy Rabalais, Louisiana Universities Marine Consortium, Chauvin, LA, and are used with her permission.

### **Layer 4. NMFS Bycatch 1**

### **Layer 5. NMFS Bycatch 2**

### **Layer 6. NMFS BRD observer data**

These data sets contain starting locations (latitude and longitude) for shrimp trawl tows collected in three separate studies conducted by the National Marine Fisheries Service Galveston Laboratory. Observers collected data on shrimp and bycatch landings or performance of bycatch reduction devices (BRDs) from North Carolina through Texas. Bycatch 1 represents approximately 12,900 locations, Bycatch 2 is approximately 300 locations, and BRD holds approximately 1,900 locations. Approximately 10,800 starting locations were in the Gulf of Mexico. Starting locations were chosen to indicate the distribution of trawling effort across the continental shelf. Ending locations were available, but we made no attempt to illustrate tow

tracks because trawlers do not necessarily tow in straight lines. Data were extracted from data files that had not been proofed for accuracy, so location data are not exact. Data were provided by Dr. James Nance, National Marine Fisheries Service, Galveston, TX.

**Layer 7. SEAMAP trawl sites 1982-1999**

**Layer 8. SEAMAP data live bottom 1982-1999**

**Layer 9. SEAMAP data fishery species 1982-1999**

These data sets were collected by trawling on the continental shelf by the Southeast Area Monitoring and Assessment Program (SEAMAP), a joint effort of the National Marine Fisheries Service and the Gulf states. The trawl sites data base represents approximately 12,800 trawl start locations (latitude and longitude) in the Gulf of Mexico during 1982-1999. The live bottom data base represents the subset of start locations where live bottom organisms were recorded. Live bottom organisms were defined as those that are attached to the bottom (sessile) and project into the water column, thus providing structure to an potentially otherwise unstructured sand, mud, or rock bottom. Live bottom organisms included sponges, corals, sea fans, sea pansies, gorgonians, sea pens, bryozoans, endoprocts, and crinoids. The fishery species data base represents the subset of start locations where fishes and invertebrates managed by the Gulf of Mexico Fishery Management Council were recorded. Managed fisheries include 37 fish species and 2 invertebrate species. Data are maintained by the National Marine Fisheries Service and were provided by Mark McDuff, National Marine Fisheries Service, Pascagoula, MS.

**Layer 10. Shrimping effort 1990-1999**

**Layer 11. Shrimping effort per 100 hectares 1990-1999**

These data sets reference catch and effort data collected from the Gulf of Mexico shrimp fleet by the National Marine Fisheries Service. The objective was to present information on the average spatial and temporal distribution of trawl fishing effort on the Gulf of Mexico continental shelf (data for bays and estuaries are not included). Data are collected monthly by 5-fathom depth zones in the 21 statistical subareas of the U.S. Gulf of Mexico (see Patella 1975 for descriptions of the statistical subareas and for areas calculated for each depth zone in each subarea). Data are presented as the grand averages of the total number of 24-hr days fished in each depth zone and subarea during 1990-1999. In addition, acreage in each depth zone (as calculated by Patella 1975) was used to standardize effort by area within each depth zone, thus tables of effort per 100 hectares are given. Catch and effort data are collected and maintained by the National Marine Fisheries Service and were provided by Dr. James Nance, National Marine Fisheries Service, Galveston, TX.

**Layer 12. NMFS statistical subareas**

Patella (1975) describes statistical subareas and depth zones in each subarea in the Gulf of Mexico that are used to monitor various fisheries by the National Marine Fisheries Service. Original tracings of depth strata from NOS charts used by Patella (1975) were digitized with ArcView 3.2a software and a ClaComp DrawingBoard III.

### **Layer 13. West Florida Crab and Shrimp Zones**

The coverage includes an area on the west coast of Florida from the Citrus / Hernando County boundary northward to the Florida Barge Canal, including Homosassa Bay and Crystal Bay. The area extends westward into the Gulf of Mexico beyond the state resources boundary. The area includes zones in which shrimping and stone crabbing alternate during the year. The zones are never closed to all types of fishing. The area is under the jurisdiction of the Florida Fish and Game Conservation Commission, Division of Marine Fisheries. The coverage is available from the Florida Marine Research Institute, St. Petersburg, FL.

### **Layer 14. Tortugas Shrimp Sanctuary**

The coverage defines the shrimp harvesting closure zone known as the Tortugas Shrimp Sanctuary that was established in 1981. The sanctuary is bounded by Rebecca Shoal on the west, the Florida Keys on the south, and Cape Romano on the north. All of Florida Bay east to the Florida Keys is included. Shrimp trawling is prohibited east and south of the line, although there are some sections in the south that are occasionally opened to trawling. The area is under the jurisdiction of the Florida Fish and Game Conservation Commission, Division of Marine Fisheries and the Gulf of Mexico Fishery Management Council. These data are available from the Florida Marine Research Institute, St. Petersburg, FL.

### **Layer 15. Texas Parks and Wildlife Southern Shrimp Zone Closure**

The coverage defines an area within Texas territorial waters seaward of Padre Island, Texas, extending from the coastline 5 nautical miles into the Gulf of Mexico. The area begins in the north at Fish Pass (27.675° N, 97.000° W) and ends in the south at the extent of state jurisdiction on the boundary with Mexico. The area defines the zone closed to shrimping activities during prescribed times (December 1 until the opening of the shrimping season around July 1 of the following year). Exact location of the boundaries is available from Texas Parks and Wildlife Department, Austin, TX.

### **Layer 16. Florida Offshore Closed Areas**

The coverage includes the Steam Boat Lumps and Madison-Swanson Marine Protected Areas (MPAs), as well as the Florida Middle Grounds, located in the eastern Gulf of Mexico. Trawling is not permitted in the MPAs, whereas there are no restrictions at the Middle Grounds although surface topography likely prevents trawling. This map should not be used as a legal delineation but only as a general display of the areas involved. Data should not be used for detailed, site-specific analysis but can be used for general regional or Gulf-wide analysis. These data are available from the Florida Marine Research Institute, St. Petersburg, FL.

### **Layer 17. Tortugas Ecological Reserve**

The coverage includes protected coral reefs of the Tortugas Ecological Reserve, which became effective in July 2001 in the westernmost waters of the Florida Keys National Marine Sanctuary. The Tortugas Ecological Reserve is broken into two sections. Tortugas North is located to the west of Dry Tortugas National Park, whereas Tortugas South is located to the southwest of Dry Tortugas National Park. Data are available from the Florida Keys National Marine Sanctuary, Marathon, FL (<http://www.fknms.nos.noaa.gov/tortugas/>).

#### **Layer 18. Florida Keys National Marine Sanctuary**

The coverage represents the Florida Keys National Marine Sanctuary boundaries, including the Dry Tortugas and Biscayne Bay. These data are available from the Florida Marine Research Institute, St. Petersburg, FL.

#### **Layer 19. Taylor County Florida Shrimping Closure**

The coverage defines the boundaries of closure zones for the harvesting of food shrimp in Taylor County, Florida. The closure is year-round, however bait shrimping and other types of fishing are allowed. The area is in the Gulf of Mexico adjacent to the coast of Taylor County in the Big Bend region of Florida. The area was designated by the Florida Fish and Wildlife Conservation Commission, Division of Marine Fisheries. These data are available from the Florida Marine Research Institute, St. Petersburg, FL.

#### **Layer 20. Apalachicola Bay Shrimping Closure**

The coverage includes the shrimp harvesting closure zones for Apalachicola Bay in the Panhandle Region of Florida. The closed areas do not extend into the Gulf of Mexico. The area was designated by the Florida Fish and Wildlife Conservation Commission, Division of Marine Fisheries. These data are available from the Florida Marine Research Institute, St. Petersburg, FL.

#### **Layer 21. Florida Sanctuaries 1998**

The coverage includes ecological reserves and special preservation areas created within the Florida Keys National Marine Sanctuary. These data are available from the Florida Marine Research Institute, St. Petersburg, FL and the Florida Keys National Marine Sanctuary, Marathon, FL.

#### **Layer 22. National Estuarine Research Reserves**

The coverage delineates three research reserves in Florida: Apalachicola, Rookery Bay, and Guana - Tolomato - Matanzas National Estuarine Research Reserves. Apalachicola Bay and Rookery Bay are located on the margins of the Gulf of Mexico but do not extend offshore. The original data are official boundaries for reference purposes only, and they are not suitable for



large scale, survey level analysis. These data are available from the Florida Marine Research Institute, St. Petersburg, FL.

### **Layer 23. Florida Aquatic Preserves**

The coverage includes the boundaries of 42 statewide aquatic preserves in Florida. Some of the areas extend into the Gulf of Mexico. These areas are managed by the Florida Department of Environmental Protection, Office of Coastal and Aquatic Managed Areas. Fishing and boating are allowed in the preserves whereas shoreline development is restricted. These data are available from the Florida Marine Research Institute, St. Petersburg, FL.

### **Layer 24. Florida Ecosystem Management Areas**

The coverage includes Marine Ecosystem Management Areas in Florida managed by the Florida Department of Environmental Protection. The layer depicts rough boundaries based on physical characteristics of the coastline. The areas are for general coastal management and not for fishing gear regulation. The areas extend seaward to the state water boundary. These data are available from the Florida Marine Research Institute, St. Petersburg, FL.

### **Layer 25. Texas Closure**

The coverage for the Texas Closure is a layer displaying the area of federal waters offshore from the Texas coastline that is closed to shrimping for part of the year (45-60 days between May 15 and July 15 each year). These data are available from the Gulf of Mexico Fishery Management Council, Tampa, FL.

### **Layer 26. Florida Keys Coral Cover 1996**

The coverage includes coral cover in the Florida Keys. The original layers were created in 1996 from data collected by the Coral Reef Monitoring Project. These data are available from the Florida Marine Research Institute, St. Petersburg, FL.

### **Layer 27. West Florida Seagrass 1996**

The coverage includes submerged aquatic vegetation mapping of Tampa Bay, Charlotte Harbor, Sarasota Bay, and the Intracoastal Waterway in 1994 and 1996. These data are available from the Florida Marine Research Institute, St. Petersburg, FL.

### **Layer 28. Tampa Bay Seagrass 1996**

The coverage includes the west side of Pinellas County. The area covers a small section not included in the original mapping effort of the West Florida Seagrass 1996 data. These data are available from the Florida Marine Research Institute, St. Petersburg, FL.

### **Layer 29. Florida Bay 1992 - 1995 (CCAP)**

The coverage includes some of the mapping effort done by the NOAA Coastwatch Change Analysis Program (CCAP) in Florida Bay. These data are available from the Florida Marine Research Institute, St. Petersburg, FL.

### **Layer 30. Northwest Florida Seagrass 1992**

The coverage represents density of seagrass beds in the Florida Panhandle and Big Bend Region during the winter of 1992. The seagrass beds were classified according to a National Wetlands Research Center derived classification scheme based on the NOAA Coastwatch Change Analysis Program (CCAP) Coastal Land Cover Classification System. These data are available from the Florida Marine Research Institute, St. Petersburg, FL.

### **Layer 31. Southwest Florida Benthic Habitat 1992**

The coverage maps the spatial distribution of seagrass, according to CCAP protocol, in the winter of 1991/1992. The areas included are Florida Keys National Marine Sanctuary and Florida Bay. These data are available from the Florida Marine Research Institute, St. Petersburg, FL.

### **Layer 32. Southwest Florida Benthic Habitat 1991**

The Southwest Florida Nearshore Benthic Habitat Study was designed to provide information on habitats and sessile biota in shallow water along the southwest Florida coast (Continental Shelf Associates, Inc. 1989). Seagrass and corals were mapped from the Florida Keys north to the Charlotte Harbor region, including parts of Florida Bay. This layer was digitized with ArcView 3.2a software and a ClaComp DrawingBoard III from the hard copy map supplied with the report. The map was modified to a non-projected format with coordinates in decimal degrees.

### **Layer 33. South Florida Seagrass 1987**

The coverage includes seagrass mapping contracted by the Minerals Management Service in the area between Cape Romano and western Florida Bay. The layer was modified from a larger statewide data set and is probably derived from Continental Shelf Associates, Inc. (1987). These data are available from the Florida Marine Research Institute, St. Petersburg, FL.

### **Layer 34. Florida Big Bend Seagrass Habitat**

The Florida Big Bend Seagrass Habitat Study mapped seagrass distribution patterns in both nearshore and offshore portions of the Florida Big Bend Region (Continental Shelf Associates, Inc. and Martel Laboratories, Inc. 1985). The area covers waters from Tarpon Springs to Ochlockonee Bay including state and federal waters. This layer was digitized with

ArcView 3.2a software and a ClaComp DrawingBoard III from the hard copy map supplied with the report. The map was modified to a non-projected format with coordinates in decimal degrees.

### **Layer 35. Pinnacles (images)**

An extensive, deep (~100 m) reef tract occurs on the Mississippi-Alabama outer continental shelf. The tract, known as "The Pinnacles", is apparently part of a sequence of drowned reef complexes along the "40-fathom" shelf edge of the northern Gulf of Mexico. In May-June 2000, the U. S. Geological Survey mapped the Pinnacles region using a multibeam sonar system. These base maps will be the foundation for studies of the abundance and distribution of the deep-water reefs and associated benthic habitats. This GIS layer contains links to images of the Pinnacles region (<http://walrus.wr.usgs.gov/pacmaps/pn-persp.html>).

### **Layer 36. Texas Artificial Reefs**

This layer gives locations of artificial reefs in the state and federal waters of the Gulf of Mexico off the Texas coast. The Texas Artificial Reefs layer was compiled from information on the Texas Parks and Wildlife Department website. The layer has been modified to a non-projected format with coordinates in decimal degrees. (<http://www.tpwd.state.tx.us/fish/reef/artreef.htm>)

### **Layer 37. Florida Artificial Reefs**

This layer gives locations of artificial reefs in the state and federal waters of the Gulf of Mexico and South Atlantic off the Florida coastline. The Florida Artificial Reefs layer was modified from data obtained from Florida Marine Research Institute (FMRI) that is maintained and updated by the Florida Department of Environmental Protection, Office of Fisheries Management and Assistance Services. The layer is in a non-projected format with coordinates in decimal degrees.

### **Layer 38. Louisiana Artificial Reefs**

This layer gives locations of artificial reefs in the state and federal waters of the Gulf of Mexico off the Louisiana coastline. The Louisiana Artificial Reefs layer was constructed from coordinates supplied by the Louisiana Department of Wildlife and Fisheries, Marine Fisheries Artificial Reef Program. The layer was modified to a non-projected format with coordinates in decimal degrees. (<http://www.wlf.state.la.us>)

### **Layer 39. Alabama Artificial Reefs**

This layer gives locations of artificial reefs in the state and federal waters of the Gulf of Mexico off the Alabama coastline. The Alabama Artificial Reefs layer was compiled from coordinates listed on the Alabama Department of Conservation and Natural Resources website

The layer has been modified to a non-projected format with coordinates in decimal degrees. ([http://www.dcnr.state.al.us/mr/loran\\_gps.htm](http://www.dcnr.state.al.us/mr/loran_gps.htm)).

#### **Layer 40. Mississippi Artificial Reefs**

This layer gives locations of artificial reefs in the state and federal waters of the Gulf of Mexico off the Mississippi coastline. The Mississippi Artificial Reefs layer was constructed from information listed on the Mississippi Department of Marine Resources website. The layer has been modified to a non-projected format with coordinates in decimal degrees. (<http://www.dmr.state.ms.us/Fisheries/Reefs/outer.htm>)

#### **Layer 41. Hang Data (Sea Grant)**

This data set is an electronic version of a guide to locations where Texas and Louisiana fishermen have recorded obstructions (Graham 1988). These data can be used to delimit areas where obstructions could impact experimental study sites or, conversely, it could be used to target potential relief areas, whether they be wrecks, reefs, rocks, or human structures. Texas A&M Sea Grant College Program compiled the data, and LGL Ecological Associates, Inc. of Bryan, Texas converted the Loran C data into latitude and longitude. However, there has been no verification of the translation process, and these data are not to be used for navigation or legal purposes. These data are presented with permission of the Texas A&M Sea Grant College Program, College Station, TX.

#### **Layer 42. Automated Wreck and Obstruction Data**

These data were supplied by the NOAA National Ocean Service, Automated Wreck and Obstruction Information System (AWOIS). Data were extracted from two of the standard AWOIS areas: eastern Gulf Coast and Caribbean Sea, and western Gulf Coast. The data are modified to a non-projected format with coordinates in decimal degrees. (<http://anchor.ncd.noaa.gov/awois/search.cfm>)

#### **Layer 43. Bathymetry**

The bathymetry layer was modified from files acquired from National Marine Fisheries Service, Pascagoula MS. No metadata were available for these files, and contouring methods are not presently available. The data show 10-meter contours from 10 meters to 200 meters in the Gulf of Mexico from the Florida Keys to the Texas / Mexico border. The layers are non-projected with coordinates in decimal degrees.

#### **Layer 44. Woodward and Clyde 1978**

This data set was digitized from maps of 10 potential petroleum lease block areas between Pensacola and Charlotte Harbor, FL prepared by Woodward-Clyde Consultants (1979). Side-scan sonar, underwater television, and still photography were used to develop these maps.

This layer was digitized with ArcView 3.2a software and a ClaComp DrawingBoard III from the hard copy map supplied with the report. The map was modified to a non-projected format with coordinates in decimal degrees.

#### **Layer 45. Texas sediments (BEG)**

The coverage contains bottom sediment type polygons distributed in state and federal waters adjacent to the coastline of Texas (shoreline to 11 nautical miles). This data set was digitized from a series of 7 maps of nearshore Texas sediment types prepared by the University of Texas Bureau of Economic Geology (BEG). State waters were sampled on a 1-mile grid to obtain these data (White et al. 1983, 1985, 1986, 1987, 1988, 1989a, 1989b). This layer was digitized with ArcView 3.2a software and a ClaComp DrawingBoard III from the hard copy maps supplied with the reports. The map was modified to a non-projected format with coordinates in decimal degrees.

#### **Layer 46. Gulf Sediments (MMS)**

This layer depicts shelf sediment textures, hard banks, and gravel deposits on the continental shelf of the U. S. Gulf of Mexico as a map and is summarized from 16 different sources (U. S. Department of the Interior 1983, Visual No. 3). The visual was prepared from existing sources to accompany an Environmental Impact Statement. The visual displays general classification of bottom sediments (using the Shepard pyramid) throughout the Gulf of Mexico. The U. S. Department of the Interior does not guarantee the accuracy of the map to the extent of responsibility of liability for reliance thereon. This visual is not to be used for navigation purposes, nor is it a legal document for federal leasing purposes. Polygons delineating sediment types in the Gulf of Mexico were digitized with ArcView 3.2a software and a CalComp Drawing Board III. The layer was modified from the map and stored in a non-projected format with coordinates in decimal degrees.

#### **Layer 47. Florida Federal Lands**

The coverage displays statewide federally owned lands in Florida, excluding military installations, wild and scenic rivers, and wildlife management areas. Areas included are wildlife refuges, marine sanctuaries, seashores, parks, forests, and preserves. These data are available from the Florida Marine Research Institute, St. Petersburg, FL.

#### **Layer 48. Multi-Platform Installations Texas**

#### **Layer 49. Multi-Platform Installations Louisiana**

This layer gives locations of oil or gas installations with multiple platforms at one location in federal waters of the Gulf of Mexico off the Texas and Louisiana coastlines. These complexes might serve as research localities where commercial fishing such as trawling is minimized due to the structures. This layer was modified from GIS data acquired from the U. S. Department of the Interior Minerals Management Service (MMS) website. Although file

description reports are available, no FGDC-compliant metadata are available for the original files from MMS. The current layers are non-projected with coordinates in decimal degrees. ([www.mms.gov](http://www.mms.gov))

#### **Layer 50. State and Federal Jurisdiction Line**

A line file was constructed to depict the boundary between state and federal jurisdictions in the Gulf of Mexico. These layers were modified from GIS data acquired from the U. S. Department of the Interior Minerals Management Service (MMS) website. Although file description reports are available, no FGDC-compliant metadata are available for the original files from MMS. The current layers are non-projected with coordinates in decimal degrees. ([www.mms.gov](http://www.mms.gov))

#### **Layer 51. Exclusive Economic Zone**

A line file was constructed to depict the seaward extent of the 200-mile boundary of the U. S. Exclusive Economic Zone. These layers were modified from GIS data acquired from the U. S. Department of the Interior Minerals Management Service (MMS) website. Although file description reports are available, no FGDC-compliant metadata are available for the original files from MMS. The current layers are non-projected with coordinates in decimal degrees. ([www.mms.gov](http://www.mms.gov))

#### **Layer 52. Shipping Fairways**

Polygon data for all major shipping lanes associated with all ports in the Gulf of Mexico are presented. These layers were modified from GIS data acquired from the U. S. Department of the Interior Minerals Management Service (MMS) website. Although file description reports are available, no FGDC-compliant metadata are available for the original files from MMS. The current layers are non-projected with coordinates in decimal degrees. ([www.mms.gov](http://www.mms.gov))

#### **Layer 53. Oil and Gas Platforms**

Point location for oil and gas installations in federal waters of the Gulf of Mexico are presented. These layers were modified from GIS data acquired from the U. S. Department of the Interior Minerals Management Service (MMS) website. We note that platforms are being added and removed continuously, thus regular updates of this data base are required to know the true distribution of platforms. Although file description reports are available, no FGDC-compliant metadata are available for the original files from MMS. The current layers are non-projected with coordinates in decimal degrees. ([www.mms.gov](http://www.mms.gov))

#### **Layer 54. Oil and Gas Pipelines**

A line file representing locations of the pipeline infrastructure in the Gulf of Mexico associated with the oil and gas industry is presented. These layers were modified from GIS data

acquired from the U. S. Department of the Interior Minerals Management Service (MMS) website. We note that pipelines are being added or modified continuously, thus regular updates of this data base are required to know the true distribution of pipelines. Although file description reports are available, no FGDC-compliant metadata are available for the original files from MMS. The current layers are non-projected with coordinates in decimal degrees. ([www.mms.gov](http://www.mms.gov))

#### **Layer 55. Oil and Gas Lease Blocks**

Polygon data delineating the units of area (lease blocks) used for management of oil and gas mineral leasing in the Gulf of Mexico are presented. These layers were modified from GIS data acquired from the U. S. Department of the Interior Minerals Management Service (MMS) website. Although file description reports are available, no FGDC-compliant metadata are available for the original files from MMS. The current layers are non-projected with coordinates in decimal degrees. ([www.mms.gov](http://www.mms.gov))

#### **Layer 56. Gulf of Mexico**

This coverage is the base map for the project. The area covered includes the coastlines and bays of the five states adjacent to the Gulf of Mexico as well as state and federal waters of the Gulf of Mexico. These files are modifications of original files which were acquired from National Marine Fisheries Service, Pascagoula MS. No metadata were available for the original files. The layers are non-projected with coordinates in decimal degrees.

#### **Layer 57. Links to Text**

This layer contains no geographic data. It is designed to allow for an easy method of referencing text files associated with this project. In ArcView, use the “Hot Link” tool for this “Theme”.

## **Annotated Bibliography for Shelf Habitats**

**Berryhill, H. L., Jr. 1976. Environmental studies, south Texas outer continental shelf. 1976. Geology. U. S. Department of the Interior, Bureau of Land Management, Washington, DC. Contract AA-550-MU6-24. 620 p.**

Scope: Year 2 (1976) geological data from four cross-shelf transects between Port O'Connor and South Padre Island, Texas, 1975 - 1976, and shelf-wide benthic data collected during a preliminary survey during 25 October 1974 - 22 December 1974. Sampling conducted on 4 transects x 3 or 6 stations each. Shelf-wide survey had 264 separate stations.

Gear: Smith-McIntyre grab (0.1088 sq. m, 0.0125 cu. m), 1 grab per station, 0.5 mm sieve.

Notes: Has list of top 35 species by number and station. Has data printout with all latitude / longitude, station, environmental, and catch data by species code (code translator list also given).

For this project, all decapods were removed from tabulated 1974 data. Also, some stations for the 1974 shelf-wide survey had no biological data - it is not clear whether this meant no organisms were captured or data were lost or left out, so these stations were ignored leaving a total of 246 stations with benthos data. See Parker (1976) and Groover (1977) for complementary data. See Hill et al. (1982) for publication of the 1974 data.

Status: Useful data extracted.

**Blake, N. J., Doyle, L. J., and Culter, J. J. 1996. Impacts and direct effects of sand dredging for beach renourishment on the benthic organisms and geology of the west Florida shelf. U.S. Department of the Interior, Minerals Management Service, Office of International Activities and Marine Minerals, Herndon, VA. OCS Report MMS 95-0005. 109 p.**

Scope: Environmental and biological survey of four proposed sand mining sites off Tampa, Florida, 5-15 m depths, pre- and post-dredging data, 1992-1994. Two samples inside each site and 1 sample outside each site.

Gear: Seismic and side-scan sonar data, ROV with underwater video, trawl, box core (21.3 x 30.5 cm = 0.065 sq. m, to 15 cm depth), 9 replicates per site (replicates labeled A-I).

Notes: Has data on other non-core benthos such as urchins, holothurians, sea stars, and sand dollars recorded from trawls. Sites I and IV were dredged, Sites II and III were never dredged.

Collection dates were: Site I: 7/92 (pre), 1/93, 9/93, 5/94 (post); Site IV: 9/93 (post only); Site II: 7/92, 2/93, 5/94 (pre); Site III: 7/92 (pre).

Status: Pre-dredging data only was extracted.

**Bright, T. J. and Rezak, R. 1976. A biological and geological reconnaissance of selected topographic features on the Texas continental shelf. Final report. U. S. Department of the Interior, Bureau of Land Management, OCS Office, New Orleans, LA. Contract No. AA 08550-CT5-4. 377 p.**

Scope: Biology, geology, hydrography, and bathymetry at the East and West Flower Garden Banks plus 17 other banks off Texas, 1974-1975 (actual survey dates for each site not stated).

Gear: Side-scan sonar, bathymetry, dredge, corers, submersible, photographic census.



Notes: 15 banks  $\leq$  100 m depths, 4 banks 100-200 m depths. Has topographic maps of all sites: most banks are small and steep-sided, and all but Hospital and East and West Flower Gardens were immersed in nepheloid layers at the time of survey. Few have extensive flat-top features (mesa-like), and most are topographically complex. All banks have zones that are characterized by algal / sponge mixes or other anthozoans (soft corals, sea whips, sea pens, sea fans, gorgonians, etc.) and crinoids. Lots of species distribution data, photographs, and other information, but no organism density data. Related to McGrail et al. (1982) and Rezak and Bright (1981).

Status: Useful sediment data extracted.

**Brooks, J. M. 1991. Mississippi-Alabama continental shelf ecosystem study: Data summary and synthesis. Vol. II. Technical narrative (Final report). U. S. Department of the Interior, Minerals Management Service, Gulf of Mexico Outer Continental Shelf Regional Office, New Orleans, LA. OCS Study MMS 91-0063. 862 p.**

Scope: Geological and biological survey of the Mississippi - Alabama coast, 20-200 m depths, 3 transects x 4 stations (approximately 20, 60, 100, and 200 m depths) x 5 cruises during 1987-1989. Also topographic features study of the Pinnacles area using side-scan sonar and ROV.

Gear: Box core (0.1 sq. m) or Smith-McIntyre grab (0.1 sq. m), depending upon sediment type.

Notes: Stations are D1-4 (east Desoto Canyon transect), M1-4 (middle Mobile transect), and C1-4 (west Chandeleur transect). Numbers refers to depths, where 1 = shallow and 4 = deep. Vol. II has a topographic features section (Section 13). See Brooks and Wolff (1991). Vol. I is of little value and is not cited.

Status: No data extracted.

**Brooks, J. M. and Wolff, G. A. 1991. Mississippi-Alabama continental shelf ecosystem study: Data summary and synthesis. Vol. III. Appendices, Part 1 (Appendices A-D). U. S. Department of the Interior, Minerals Management Service, Gulf of Mexico Outer Continental Shelf Regional Office, New Orleans, LA. OCS Study MMS 91-0064. 1001 p.**

Scope: Geological and biological survey of the Mississippi - Alabama coast, 20-200 m, 3 transects x 4 stations (20, 60, 100, 200 m) x 5 cruises 1987-1989. Also topographic features study of the Pinnacles area using side-scan sonar and ROV.

Gear: Box core (0.1 sq. m) or Smith-McIntyre grab (0.1 sq. m), depending upon sediment type.

Notes: Stations are D1-4 (east Desoto Canyon transect), M1-4 (middle Mobile transect), and C1-4 (west Chandeleur transect), and 1=shallow, 4=deep. Has sand / silt / clay data by station x sample x cruise (pages A55-66), benthos data by station x cruise (apparently only 1 sample per site; pages B5-83), and latitude / longitude data and maps. Note that station C3 and C4 had "enormous numbers of heart urchins *Brissopsis* sp.". See Brooks (1991) for fish food habits (section 9-1 to 9-76) and topographic features (section 13). Vol. I is of little value and is not cited.

Status: Sediment and benthos data extracted.

**Byrnes, M. R., Hammer, R. M., Vittor, B. A., Ramsey, J. S., Snyder, D. B., Bosma, K. F., Wood, J. D., Thibault, T. D., and Phillips, N. W. 1999. Environmental survey of identified sand resource areas offshore Alabama. Vol. I: Main text. Vol. II: Appendices. U. S. Department of the Interior, Minerals Management Service, International Activities and Marine Minerals Division (INTERMAR), Herndon, VA. OCS Report MMS 99-0052. 326 p. and 132 p.**

Scope: Environmental and biological survey inside and outside of proposed sand mining sites off Alabama, May and December 1997.

Gear: Grab (unspecified size), probably Smith-McIntyre grab (0.1 sq. m, as specified in Table 6-3, pg. 207).

Notes: Sampling design was (16 samples inside + 4 samples outside as controls) x 5 sites x 2 dates. Sediments and benthos, also has trawl survey data. Has maps of sampling sites in each of 5 areas but does not give actual station data (pg. 195-199). Sediments in Appendix D3, benthos in D4. Also has benthos taxonomy list.

Status: Sediment and benthos data extracted.

**Continental Shelf Associates, Inc. 1987. Southwest Florida shelf regional biological communities survey. Vol. I. Executive summary. Vol. II. Technical report. Vol. III. Appendices. U. S. Department of the Interior, Minerals Management Service, Gulf of Mexico Outer Continental Shelf Regional Office, New Orleans, LA. OCS Study MMS 86-0108 (41 p.), 86-0109 (401 p.), 86-0110 (610 p.).**

Scope: Year 3 of 3 report on physical, chemical, geological, and biological characteristics of the continental shelf off Florida between Ft. Myers and Dry Tortugas. Only has Year 3 data, and does not cite any Year 1 or Year 2 reports. Limited number of stations. October and December 1982, May-June 1983. Ten single site stations (numbered 40, 41, 42, 43, 46, 48, 49, 50, 53, 54) and one multi-site station (number 52). All stations < 20 m deep.

Gear: Benthos core (0.0156 sq. m) x 8 replicates per station.

Notes: Appendix I has benthos tabulated but not totaled and has samples from 1 live-bottom station and at several distances away. Pg. I-134 has grand total densities by station and cruise.

Appendix J has sediment grain size data but does not give sand / silt / clay and there is no summary. Live bottom area data presented. See also Danek and Lewbel (1986) and Environmental Science and Engineering, Inc. et al. (1987) for related studies.

Status: Sediment and benthos data extracted.

**Continental Shelf Associates, Inc. 1989. Southwest Florida nearshore benthic habitat study, narrative report. U. S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Regional Office, New Orleans, LA. OCS Study MMS 89-0080. 55 p.**

Scope: Habitat distributions (corals and seagrasses) based on aerial surveys in 1987 and ground truthing in 1988, Florida Coast, Sanibel Island to the Dry Tortugas and Key West, shoreline to 120-ft depths.

Gear: Aerial photography (< 50-ft depths), divers, underwater television, still camera.

Notes: Latitude / longitude and habitat / depth descriptions for 85 stations visited by divers; also has data on seagrass biomass and growth measurements.

Status: Habitat map digitized.

**Continental Shelf Associates, Inc. 1990. A comparison of marine productivity among outer continental shelf planning areas. U. S. Department of the Interior, Minerals Management Service, Herndon, VA. OCS Study MMS 90-0070. 243 p. + appendices.**

Scope: Data synthesis for Gulf of Mexico and other shelf areas.

Gear: None.

Notes: General review, no real habitat information. References to many studies are provided.

Status: No data.

**Continental Shelf Associates, Inc. and Martel Laboratories, Inc. 1985. Florida Big Bend Seagrass Habitat Study Narrative Report. U. S. Department of the Interior, Minerals Management Service, Metairie, LA. Contract No. 14-12-0001-30188. 93 p.**

Scope: Habitat distributions (corals and seagrasses) based on underwater television and aerial surveys in 1984 and ground truthing in 1985, Florida Coast, Ochlockonee Bay south to Tarpon Springs, shoreline to 20-m depths.

Gear: Aerial photography, divers, underwater television, still camera.

Notes: Has data on seagrass and algal blade densities, and some information on live-bottom habitats (corals etc). Also has latitude / longitude with habitat descriptions for several hundred diver and TV sites.

Status: Habitat map digitized.

**Continental Shelf Associates, Inc. and Texas A&M University Geochemical and Environmental Research Group. 1999. Northeastern Gulf of Mexico coastal and marine ecosystem program: ecosystem monitoring, Mississippi/Alabama shelf. Third annual interim report. U. S. Department of the Interior, U. S. Geological Survey, Biological Resources Division, Kearneysville, WV, USGS/BRD/CR-1999-0005, and U. S. Department of the Interior, Minerals Management Service, Gulf of Mexico Outer Continental Shelf Regional Office, New Orleans, LA. OCS Study MMS 99-0005. 211 p.**

Scope: Year 3 of 4 report to characterize and monitor biological communities and environmental conditions at carbonate mounds off Mississippi and Alabama. Nine sites (east, central, and west locations each with low, medium, high relief in 60-100 m depths. Survey of hard bottom communities (epifauna and fish) during 1997-1999.

Gear: Sonar, grab (size not specified), ROV, underwater video, still photography, moored instrument arrays.

Notes: No infaunal benthos data, just epifauna. Year 2 report is available, but contains no data.

Status: Sediment and epibenthos data extracted.

**Dames & Moore. 1979. The Mississippi, Alabama, Florida outer continental shelf baseline environmental survey, 1977/1978. Vol. I-A. Program synthesis report. Vol. I-B. Executive summary report. Vol. II-A, B. Compendium of work element reports. U. S. Department of the Interior, Bureau of Land Management, Washington, DC. Contract AA550-CT7-34. 275 p., 27 p., and 1379 p.**

Scope: Four year physical, chemical, geological, and biological characterization study of up to 50 stations in 20-200 m depths from Mississippi to south of Ft. Myers, FL, 1975-1978.

Gear: Box core (21.3 x 30.5 cm x 15 cm for benthos, x 10 cm for sediments), 0.5 mm mesh sieve, 9 replicates x station x month, except some stations only 1 replicate per month.

Notes: Four years of mean data. No actual data for sediments, just maps with isolines. Has meiofauna data. Crustacean benthos includes small infaunal and epifaunal decapods captured by box core - no apparent way to eliminate them, and decapods average 15% of all crustaceans over all data.

Status: Sediment and benthos data extracted.

**Danek, L. J. and Lewbel, G. S. 1986. Southwest Florida shelf benthic communities study year 5 annual report. Vol. I. Executive summary. Vol. II. Technical discussion. Vol.III. Appendices. U. S. Department of the Interior, Minerals Management Service, Gulf of Mexico Outer Continental Shelf Regional Office, New Orleans, LA. OCS Study MMS 86-0074 (47 p.), 86-0075 (561 p.), 86-0076 (516 p.).**

Scope: A subset of the data covered in Years 1-3 report on physical, chemical, geological, and biological characteristics of the continental shelf off Florida between Ft. Myers and Dry Tortugas. 12 sites, 6 cruises, 1980-1982. Live bottom versus soft bottom contrasts.

Gear: Underwater video, dredge, trawl, settling plates, time-lapse camera, high-resolution benthic photography.

Notes: Limited number of inshore sites with lots of underwater video data and information. Linked with Continental Shelf Associates Inc. (1987) and Environmental Science and Engineering, Inc. et al. (1987).

Status: Sediment data extracted.

**Environmental Consultants, Inc. 1975. Environmental and socioeconomic baseline on the Gulf of Mexico costal [sic] zone and outer continental shelf. Vol. 1-3. U. S. Department of the Interior, Bureau of Land Management, Washington, DC. Contract No. 08550-CT3-10. 778 p., 525 p., and 256 p. + maps.**

Scope: Review of known data up to 1974, with semi-annotated bibliography.

Gear: None.

Notes: Bibliography had few useful references since it preceded the major shelf surveys.

Status: No data.

**Environmental Science and Engineering, Inc., LGL Ecological Research Associates, Inc., and Continental Shelf Associates, Inc. 1987. Southwest Florida shelf ecosystems study. Vol.**

**I. Executive summary. Vol. II. Data synthesis report. Vol. III. Annotated bibliography, Part A (A-K) and Part B (L-Z). U. S. Department of the Interior, Minerals Management Service, Gulf of Mexico Outer Continental Shelf Regional Office, New Orleans, LA. Contract No. 14-12-0001-30276, OCS Study MMS/GM-87/0022 (72 p.), MMS/GM-87/0023 (384 p.), MMS/GM-87/0031 (682 p. and 726 p.).**

Scope: Year 5 of 5 report on physical, chemical, geological, and biological characteristics of the continental shelf off Florida between Ft. Myers and Dry Tortugas. Thirteen cruises: Year 1 = Oct-Nov 1980, Apr-May 1981; Year 2 = Jul-Aug 1981, Jan-Feb 1982; Year 3 = Oct 1982, Dec 1982; Year 4 = Dec 1983, May 1984; Year 5 = Dec 1984, Mar, Jun, Sep, Dec 1985.

Gear: Bathymetry, seismic, side scan sonar, underwater video, water samplers, benthos by diver-operated core (Years 3-4: 0.016 sq. m x 15 cm depth x 8 replicates in Year 3 or 10 replicates in Year 4) or by modified Reineck box corer (Years 1-2: 0.057 sq. m x 40 cm depth x 5 replicates), 0.5 mm mesh sieve, sediments by Smith-McIntyre grab (0.1 sq. m).

Notes: Benthos and sediment data as well as underwater video; sessile epifauna section, as well as mobile vertebrates and invertebrates (starfish, urchins, holothurians, ophiuroids, decapods, fishes). Some data are in graphs (summaries) so values are estimates. Some fish foods and gonadal development data. Vol. II, pg. 98 says benthos is 64% polychaetes, 17% crustaceans, 10% molluscs over all. Not all cruises collected all types of data. Linked with Danek and Lewbel (1986) and Continental Shelf Associates, Inc. (1987).

Status: Sediment and benthos data extracted.

**Flint, R. W. and Rabalais, N. N. 1980. Environmental studies, south Texas outer continental shelf, 1975-1977. Vol. I. Ecosystem description. Vol. III. Study area final reports. U. S. Department of the Interior, Bureau of Land Management, Washington, DC. Contract No. AA 551-CT8-51. 329 p. and 648 p.**

Scope: Environmental and biological characterization of south Texas shelf between Port O'Connor and South Padre Island, 1975-1977, quarterly sampling, four transects of 6-7 stations each.

Gear: Smith-McIntyre grab (0.1 sq. m, 0.0125 cu m), 0.5 mm sieve.

Notes: Has lists of dominant species. Benthos only for Winter-Spring-Fall 1976-1977, only provides summary data over grouped stations, no individual station data, no latitude / longitude. Unclear whether benthos data is total number per 0.6 sq. m or mean number per 0.1 sq. m - need to check against Hill et al. (1982) or original reports cited as Holland et al. (1976, 1977, 1979) on pages 586-587. Actual data retrieved from Berryhill et al. (1976) and Groover (1977).

Status: No useful data, but does provide overall biological assessments.

**Franks, J. S., Christmas, J. Y., Siler, W. L., Combs, R., Waller, R., and Burns, C. 1972. A study of nektonic and benthic faunas of the shallow Gulf of Mexico off the state of Mississippi. Gulf Res. Rep. 4(1): 1-148.**

Scope: Six station transect off Mississippi (5-50 fm) sampled monthly for 3 years (1967-1969); data on water, plankton, and nekton; sediments were done 4 times per station over the project duration.

Gear: Foerst grab (area and depth not stated).

Notes: Data on pages 5-8, 21.

Status: Sediment data extracted.

**Graham, G. L. 1988. "Hangs" and bottom obstructions of the Texas/Louisiana coast. Loran C. Texas A&M University Sea Grant College Program, College Station, TX. TAMU-SG-88-508. No pagination.**

Scope: Loran C coordinates of locations where fishermen snagged or lost fishing gear along the Texas and Louisiana coasts.

Gear: None.

Notes: Includes depths and types of obstructions such as broken bottom, holes, wrecks, pipelines, rocks, coral, well heads, and buoys.

Status: Data are presented in tabular format. The data were converted from Loran C to latitude and longitude by LGL Ecological Associates, Inc. of Bryan, TX.

**Grady, J. R. 1971. The distribution of sediment properties and shrimp catch on two shrimping grounds on the continental shelf of the Gulf of Mexico. Proc. Gulf Carib. Fish. Inst. 23: 139-148.**

Scope: Survey of sediments off Galveston, TX, and Dry Tortugas, FL (sand / silt / clay and total organic carbon) during 1966-1968.

Gear: Van Veen grab (no area given), top 1-2 cm of sediments only.

Notes: No actual station data, just maps. These data were incorporated into a shelf sediment map (see U. S. Department of the Interior, 1983).

Status: No data.

**Groover, R. D. 1977. Environmental studies, south Texas outer continental shelf, biology and chemistry. Vol. IV, Appendices E, F, G, H, I, J, K. U. S. Department of the Interior, Bureau of Land Management, Washington, DC. Contract AA-550-CT6-17. 1023 p.**

Scope: Year 2 data from an expanded series of cross-shelf transects between Port O'Connor and South Padre Island, Texas, 1976 data only, all stations seasonally (Winter = Jan-Feb, Spring = May-Jun, Fall = Sep-Oct) and Transect II stations monthly (Mar, Apr, Jul, Aug, Nov, Dec 1976). 4 transects x 6 stations each (7 stations on transect IV). Also "transects" of 4 stations at Southern Bank and Hospital Rock.

Gear: Smith-McIntyre grab (0.1088 sq. m, 0.0125 cu. m) x 6 replicates per station (= 0.6528 sq m). Although replicate grabs are listed individually by station, they are really pseudoreplicates and thus were combined and multiplied by 1.532 (= 1 / 0.6528) to obtain # per sq. m.

Notes: All benthos data are from Appendix G, Invertebrate Epifauna and Macroinfauna, Tables 3 and 4 (pages G-144 to G-598; all species were listed, then summed to yield total benthos; but

there were no summaries above species level and all species were mixed in lists - these data could be further summed by annelids, molluscs, crustaceans, etc. with extra effort). All sediment data are from Appendix J, Sediment Texture, Table 5 (pages J-118 to J-130; data are means of the seven grab samples per station, which data are given in Tables 1-4). See Parker (1976) for Year 1 data.

Status: Total benthos and mean sediment data extracted.

**Hann, R. W., Giammona, C. P., and Randall, R. E. 1984. Offshore oceanographic and environmental monitoring services for the Strategic Petroleum Reserve: Eighteen month report for the West Hackberry site from May 1982 through November 1983. Vol. I. U. S. Department of Energy, Washington, DC. Contract No. DE-AC96-83P010850. 744 p.**

Scope: Environmental and biological monitoring of western Louisiana shelf, May 1982 - November 1983 (brine disposal from solution-mining of an onshore salt dome began in May 1981).

Gear: Smith-McIntyre grab (0.1 sq. m), 6 replicates per station x 6 stations.

Notes: Sediment sand / silt / clay and total organic carbon data; some latitude / longitude indicators; has dominant species list; hypoxia observed in the area June 1982 and June-Aug 1983. See Parker et al. (1980) and Hausknecht (1980) for pre-disposal data.

Status: Sediment and total benthos data extracted.

**Hann, R. W. and Randall, R. E. 1980. Evaluation of brine disposal from the Bryan Mound site of the Strategic Petroleum Reserve program. Final report of predisposal studies. Vol. I. U. S. Department of Energy, Washington, DC. Contract No. DE-FC96-79P010114. 417 p.**

Scope: Environmental and biological characterization of the Texas coast off Freeport during September 1977 - February 1980 prior to brine discharge from solution mining of salt dome onshore. Two sites, nearshore = 5 mi off, offshore = 10 mi off, 15 stations per site, monthly sampling. Discharge began March 1980.

Gear: Ekman grab (15.2 x 15.2 cm = 0.0232 sq. m) x 3 replicates (combined) per site, 0.500 mm sieve.

Notes: Hypoxia recorded Jun-Jul 1979. All samples at each site within 10 km of each other. Data extracted from computer printouts held by Dr. Donald Harper, Texas A&M University at Galveston, Box 1650, Galveston TX 77553.

Status: Total benthos data extracted

**Harper, D. E., Jr., Potts, D. L., Salzer, R. R., Case, R. J., Jaschek, R. L., and Walker, C. M. 1981. Distribution and abundance of macrobenthic and meiobenthic organisms. Pages 133-177 in B. S. Middleditch (editor), Environmental effects of offshore oil production. The Buccaneer Gas and Oil Field study. Plenum Press, New York, NY. 446 p.**

Scope: Benthos and sediments around two oil production platforms off Galveston, TX, sampled quarterly (July and Oct-Nov 1976, Jan-Feb and Apr 1977).

Gear: Ekman grab (15.2 x 15.2 cm = 0.0232 sq. m) x 3 per station.

Notes: Only used stations > 1000 m away from platforms to avoid platform effects (see Kennicutt 1995).

Status: Sediment and total benthos data extracted.

**Hausknecht, K. A. 1980. Describe surficial sediments and suspended particulate matter. Vol. V. in W. B. Jackson and G. M. Faw (editors). Biological / chemical survey of Texoma and Capline sector salt dome brine disposal sites off Louisiana, 1978-1979. U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Galveston, TX. NOAA Tech. Memo. NMFS-SEFC-29. 56 p.**

Scope: Sediments at two proposed brine disposal sites off West Hackberry and Weeks Island, Louisiana. Jun and Oct-Nov 1978, Jan and Apr-May 1979. Sand / silt / clay and total organic carbon.

Gear: Van Veen grab (size not specified).

Notes: See Parker et al. (1980) for benthos and Hann et al. (1984) for 1981-1983 data at West Hackberry.

Status: Sediment data extracted.

**Hill, G. W., Roberts, K. A., Kindinger, J. L., and Wiley, G. D. 1982. Geobiologic study of the south Texas outer continental shelf. U. S. Department of the Interior, U. S. Geological Survey, Alexandria, VA. Professional Paper 1238. 36 p. + 22 maps.**

Notes: This research is also contained in Berryhill (1976). Personal communication in 2000 with the authors (Hill and Kindinger) indicated that all data were lost in a fire, so this is their only record.

**Jones, J. I., Ring, R. E., Rinkel, M. O., and Smith, R. E. 1973. A summary of knowledge of the eastern Gulf of Mexico 1973. State University System of Florida Institute of Oceanography, St. Petersburg, FL. 604 p.**

Scope: Synthesis of biological, chemical, physical, and geological data for Mississippi, Alabama, and Florida.

Gear: None.

Notes: General review, no real habitat data.

Status: No data.

**Joyce, E. A., Jr. and Williams, J. 1969. Rationale and pertinent data. Vol. I. Part I. Memoires of the Hourglass Cruises. Florida Department of Natural Resources, Marine Research Laboratory, St. Petersburg, FL. 50 p.**

Scope: Characterization of the west Florida shelf, monthly 1965-1967, 10 stations, Tampa to Ft. Myers.

Gear: Divers, dredge / scrape, trawl, water bottles.



Notes: Some sediment data, 1 time only, 6 of 10 stations, gear not mentioned although divers collected samples. Other reports in this series detail several groups of benthos but no density data are given, apparently due to the type of gear used [only depth x distribution data].

Status: Sediment data extracted.

**Kennedy, E. A., Pequegnat, W. E., Hubbard, G. F., James, B. M., Potter, C. M., Comiskey, C. E., Brandt, C. C., and Farmer, T. A. 1983. Ecological effects of energy development on reef fish, ichthyo-plankton and benthos populations in the Flower Gardens Banks of the northwestern Gulf of Mexico, 1980-1982. Vol. I. Ecological survey of the macroinfaunal community near the Flower Gardens Banks. U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Galveston, TX. NOAA/NMFS Administrative Report to the Environmental Protection Agency, Interagency Agreement EPA-79-D-X0514. 312 p.**

Scope: Benthos and sediment collections on Texas continental shelf during Oct 1980, Jan, Apr, Jul, Nov, 1981, and May, Sep, Oct 1982 around two banks and two proposed oil platform areas nearby. Some types of data were not collected at all stations each month.

Gear: Box corer (0.09 sq m), 5 replicates per station (note 2 exceptions, see pg 24).

Notes: Sand / silt / clay and total organic content data. Has benthos species lists. Data from Tables A-24 and A-25, but not all data are listed. No data for benthos in Nov 81, or May, Sep, Oct 1982. Data collected around platforms not included [too close - may have affected benthos - see Kennicutt (1995)].

Status: Sediment and benthos data extracted.

**Kennicutt, M. C., II. 1995. Gulf of Mexico offshore operations monitoring experiment, final report. Phase I: Sublethal responses to contaminant exposure. U. S. Department of the Interior, Minerals Management Service, Gulf of Mexico Outer Continental Shelf Regional Office, New Orleans, LA. MMS Contract 14-35-0001-30582. 709 p.**

Scope: Sediment characterization around three oil platforms off Texas, winter and summer 1993-1994, at distances of <100, 100, 200, 500, and 3000 m.

Gear: Box corer (0.25 sq. m) divided into 25 100 sq. cm compartments, so each sample was 100 sq. cm x 3 replicates from each box x 10 cm depth.

Notes: Drilling sands and contaminants affect surface sediments out to 500 m away from platforms. See also publications by Kennicutt et al. (1996) and Montagna and Harper (1996).

Status: Extracted sediment data for sites 3000 m away only (data were given as an average over 5 stations, so all stations have same data but differing latitude / longitude).

**Kennicutt, M. C., II, Boothe, P. N., Wade, T. L., Sweet, S. T., Rezak, R., Kelly, F. J., Brooks, J. M., Presley, B. J., and Wiesenburg, D. A. 1996. Geochemical patterns in sediments near offshore production platforms. *Can. J. Fish. Aquat. Sci.* 53: 2554-2566.**

Notes: This is the refereed publication resulting from Kennicutt (1995) and does not provide data.

**McGrail, D. W., Rezak, R., and Bright, T. J. 1982. Environmental studies of the Flower Gardens and selected banks: northwestern Gulf of Mexico, 1979-1981. Final Report. Northern Gulf of Mexico topographic features study. U. S. Department of the Interior, Minerals Management Service, OCS Office, New Orleans, LA. Contract No. AA 851-CT0-25. 315 p.**

Scope: Biology, geology, hydrography, and bathymetry at Flower Gardens Banks and 7 other bank sites.

Gear: Side-scan sonar, bottom profiler, divers, submersible, underwater video.

Notes: Figures III-2, 3 on pg. 44-45 show areas of various live bottom habitats.

Status: Sediment data extracted.

**Montagna, P. A. and Harper, D. E., Jr. 1996. Benthic infaunal long-term response to offshore production platforms in the Gulf of Mexico. Can. J. Fish. Aquat. Sci. 53: 2567-2588.**

Scope: Benthos characterization around three oil platforms off Texas, winter and summer 1993-1994, at distances of <100, 100, 200, 500, and 3000 m.

Gear: Box corer (0.25 sq. m) divided into 25 100 sq. cm compartments, so each benthic sample was 100 sq. cm x 3 replicates from each box core x 10 cm depth.

Notes: Drilling sands and contaminants affect surface sediments out to 500 m away from platforms. See also publications by Kennicutt et al. (1996) and Kennicutt (1995).

Status: Extracted benthic data for sites 3000 m away only (data were given as an average over 5 stations, so all stations have same data but differing latitude / longitude).

**Parker, P. L. 1976. Environmental studies, south Texas outer continental shelf, 1975, biology and chemistry. U. S. Department of the Interior, Bureau of Land Management, New Orleans, LA. Contract 08550-CT6517. 598 p. + Appendices.**

Scope: Year 1 data from a series of cross-shelf transects between Port O'Connor and South Padre Island, Texas, 1975 data only (Dec 1974 - Jan 1975, Apr-May 1975, Aug-Sep 1975). 4 transects x 3 stations each.

Gear: Smith-McIntyre grab (0.1088 sq. m, 0.0125 cu. m) x 4 replicates per station (= 0.4352 sq. m total). Although replicate grabs are listed individually by station, they are really pseudoreplicates and thus were combined and multiplied by 2.298 (= 1 / 0.4352) to get number per sq. m.

Notes: Benthos data only has species data for selected species per date / transect / station and an overall species list. Sediment textures given in sand / silt / clay diagrams. See Groover (1977) for Year 2 data.

Status: Total benthos and sediment texture data extracted.

**Parker, R. H., Crowe, A. L., and Bohme, L. S. 1980. Describe living and dead benthic (macro-, meio-) communities. Vol. I. in W. B. Jackson and G. M. Faw (editors), Biological / chemical survey of Texoma and Capline sector salt dome brine disposal sites off Louisiana,**

**1978-1979. U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Galveston, TX. NOAA Tech. Memo. NMFS-SEFC-25. 103 p.**

Scope: Sediments at two proposed brine disposal sites off West Hackberry and Weeks Island, Louisiana. Jun and Oct-Nov 1978, Jan and Apr-May 1979.

Gear: Van Veen grab (0.05 or 0.0526 sq. m [1/20 or 1/19 sq. m])) to ~10 cm depth.

Notes: See Hausknecht (1980) for sediments. Lists of species provided.

Status: Benthos data extracted.

**Patella, F. J. 1975. Water surface area within statistical subareas used in reporting Gulf coast shrimp data. Mar. Fish. Rev. 37(12): 22-24.**

Scope: Gulf of Mexico from Florida Keys to Texas-Mexico border.

Gear: None.

Notes: Indicates latitude and longitude lines forming National Marine Fisheries Service statistical subareas. Also gives acreage in each 5-fathom depth zone for each subarea.

Status: Data extracted.

**Pequegnat, W. E. 1983. The ecological communities of the continental slope and adjacent regimes of the northern Gulf of Mexico. Vol. II. Text, photographic atlas, and appendices. U. S. Department of the Interior, Minerals Management Service, Gulf of Mexico Outer Continental Shelf Regional Office, New Orleans, LA. Contract No. AA851-CT1-12. 675 p.**

Scope: Review of data collected at 193 stations between 25-35° N, 91-97° 30' W (US Gulf of Mexico), but only 4 stations < 100 m depth.

Gear: Dredge, trawl, grab, corer, photography.

Notes: This may have interesting and useful data to reference deep water fisheries such as royal red shrimp and red crabs, but has no shallow shelf information.

Status: No data.

**Phillips, N. W. and James, B. M. 1988. Offshore Texas and Louisiana marine ecosystems data synthesis. Vol. II. Synthesis report. U. S. Department of the Interior, Minerals Management Service, Gulf of Mexico Outer Continental Shelf Regional Office, New Orleans, LA. Contract 14-12-0001-30380. 492 p.**

Scope: Review and synthesis of other data, with extensive list of references.

Gear: None.

Notes: Points out that there have been few offshore environmental characterizations, listing only South Texas Outer Continental Shelf, Buccaneer Oil and Gas, Offshore Ecology Investigation, Central Gulf Platform, Flower Gardens, and MMS-sponsored projects.

Status: No data.

**Rezak, R. and Bright, T. J. 1981. Northern Gulf of Mexico topographic features study. Final report. Vol. 1-5. U. S. Department of the Interior, Bureau of Land Management, OCS Office, New Orleans, LA. Contract No. AA 551-CT8-35. 124 p., 145 p., 164 p., 164 p., and 248 p.**

Scope: Biology, geology, hydrography, and bathymetry of the Florida Middle Grounds and 12 other bank sites off Texas and Louisiana, 1978-1980.

Gear: Seismic profiler, side-scan sonar, bottom profiler, divers, submersible, underwater video.

Notes: Has topographic maps of many sites; most banks have zones without live hard corals that are characterized by algal / sponge mixes or other anthozoans (soft corals, sea whips, sea pens, sea fans, gorgonians, etc.). Vol. 1 lists sites, gives sediment data, lists biological characteristics of 11 sites (pg. 74-81). Vol 2. gives latitude / longitude of some sites. Vol. 5 has maps of Florida Middle Grounds [28° 24' - 28° 44' N, 84° 10' - 84° 28' W] which rise up 10-18 m above sea floor at depths of 38-44 m. Text near pg 51 indicates clay was < 5% everywhere. Table on pg 54 indicates total organic carbon was < 0.5% in 40/41 sites and < 0.2% in 29/41 sites, but no actual sites with latitude / longitude given. Some benthic and macrofaunal data collected by quantitative sampling are given, but these data not used as most were associated with live bottom habitat. Vol. 1, Table III-5, lists many sediment sample data for sites DS1, DS2, and Z, but these are not identified in text. See also McGrail et al. (1982).

Status: Sediment data extracted.

**Science Applications International Corporation. 1997. Northeastern Gulf of Mexico coastal and marine ecosystem program: data search and synthesis. Synthesis report. U. S. Department of the Interior, U. S. Geological Survey, Biological Resources Division, Washington, D.C. USGS/BRD/CR-1997-0005 and U. S. Department of the Interior, Minerals Management Service, Gulf of Mexico Outer Continental Shelf Region, New Orleans, LA. OCS Study MMS 96-0014. 313 p.**

Scope: Review of regional physical, chemical, geological, and biological characteristics of the continental shelf off Florida Big Bend and Panhandle (Pensacola to Tampa).

Gear: None.

Notes: Benthos section refers to Dames and Moore (1979) as the only shelf-wide study.

Status: No data, but has wide reference list.

**Southwest Research Institute. 1981. Ecological investigations of petroleum production platforms in the central Gulf of Mexico. Vol. I. Pollutant fate and effect studies, Parts 1-3 and Parts 6-7. U. S. Department of the Interior, Bureau of Land Management, New Orleans, LA. Contract AA551-CT8-17. 224 p. and 391 p.**

Scope: Benthic and sediment sampling off Louisiana West Delta in vicinity of 20 oil platforms and 4 control sites ,1978-1979 (not all sites during all 3 cruises, May-Jun 1978, Aug-Sep 1978, Jan 1979).

Gear: Smith-McIntyre grab (0.09 sq. m x 9-16 cm depth), 6 grabs per site. Note that Vol. II of series (not cited here because it did not contain data) says grab was 0.1 sq. m x 12-15 cm depths. Sediments were taken from 5 x 5 cm within the grab sample.

Notes: Data retrieved primarily from Part 2: Sediment physical characterization and Part 6: Benthic biology. Four primary platforms and 4 controls sampled each cruise, 16 secondary platforms on cruise 2 only; 4 transects at primary sites (N, E, W, and S of platforms), 1 transect at secondary sites (N only), 1 site per control (no transect); sampled at 500 m and 2000 m along transects. No actual latitude / longitude of platforms or sample sites (see maps), but these were generated from platform lease area, block, and structure designation matched with MMS data base. No detectable long-term contamination by drilling muds beyond 500 m of platform (total lack of barite and sodium montmorillonite) - agrees with Kennicutt (1995) who detected influence at 500 m but not further. Only used 2000 m data. Total benthos only available. Vol I, Part 2 contains summary data by cruise in Appendices A1, A2, A3 and has lots of contour maps which may give some extra detail.

Status: Sediment and total benthos data extracted.

**U. S. Department of the Interior. 1983. Outer Continental Shelf visuals 1-14. U. S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Regional Office, New Orleans, LA. 14 maps.**

Scope: Summary of various types and sources of data to describe the Gulf of Mexico continental shelf.

Gear: None.

Notes: Visual No. 3. (Bottom sediments and selected endangered and threatened species) depicts shelf sediment textures, hard banks, and gravel deposits as a map and is summarized from 16 different sources. There are no data points.

Status: This picture was digitized.

**U. S. Navy. 2001. Northern Gulf of Mexico Littoral Initiative. available from the following web site: <http://www.navo.navy.mil/NGLI/> .**

Scope: Multi-year study of sediments and water column on continental shelf off Mobile Bay, AL, 1999-2001 and perhaps longer.

Gear: Corer, grab, bathymetry, circulation, currents, hydrography.

Notes: This project is in progress. Sediment data available for some cruises (Feb, May, Nov 1999, May, Jul 2000), but benthos data are not yet available (as of December 2001). Cruise dates and tracks are posted on the web site. Data are available on request.

Status: Sediment data extracted.

**Ward, C. H., Bender, M. E., and Reish, D. J. (editors). 1979. The Offshore Ecology Investigation. Effects of oil drilling and production in a coastal environment. Rice Univ. Stud. 65(4+5): 1-589.**

Scope: Physical, chemical, geological, and biological assessment of Timbalier Bay, LA and shallow offshore platform area.

Gear: Various.

Notes: Limited data availability, few data points have associated latitude / longitude, shelf information is concentrated around a single platform. Contains background biological information such as species lists.

Status: No data.

**White, W. A., Calnan, T. R., Morton, R. A., Kimble, R. S., Littleton, T. G., McGowen, J. H., and Nance, H. S. 1987. Submerged lands of Texas, Beaumont-Port Arthur area: sediments, geochemistry, benthic macroinvertebrates, and associated wetlands. The University of Texas at Austin, Bureau of Economic Geology, Austin, TX. 110 p. + maps.**

Scope: Sediments and benthos of state-owned submerged lands were mapped and described using bottom samples collected at 1 nmi (1.6 km) intervals on inner shelf out to 11 nmi (18 km), Oct 1976 and Sep 1977.

Gear: Smith-McIntyre grab (0.013 cu m max, 4-10 cm depth).

Notes: Sand / silt / clay and total organic carbon are tabulated by station number, which can be referenced to a map. Benthos data are not referenced to stations but are presented in general summary only.

Status: Map of sediment texture distribution was digitized.

**White, W. A., Calnan, T. R., Morton, R. A., Kimble, R. S., Littleton, T. G., McGowen, J. H. and Nance, H. S. 1988. Submerged lands of Texas, Bay City-Freeport area: sediments, geochemistry, benthic macroinvertebrates, and associated wetlands. The University of Texas at Austin, Bureau of Economic Geology, Austin, TX. 130 p. + maps.**

Scope: Sediments and benthos of state-owned submerged lands were mapped and described using bottom samples collected at 1 nmi (1.6 km) intervals on inner shelf out to 11 nmi (18 km), Oct 1976.

Gear: Smith-McIntyre grab (0.013 cu m max, 4-10 cm depth).

Notes: Sand / silt / clay and total organic carbon are tabulated by station number, which can be referenced to a map. Benthos data are not referenced to stations but are presented in general summary only.

Status: Map of sediment texture distribution was digitized.

**White, W. A., Calnan, T. R., Morton, R. A., Kimble, R. S., Littleton, T. G., McGowen, J. H. and Nance, H. S. 1989a. Submerged lands of Texas, Kingsville area: sediments, geochemistry, benthic macroinvertebrates, and associated wetlands. The University of Texas at Austin, Bureau of Economic Geology, Austin, TX. 137 p. + maps.**

Scope: Sediments and benthos of state-owned submerged lands were mapped and described using bottom samples collected at 1 nmi (1.6 km) intervals on inner shelf out to 11 nmi (18 km), Mar - May 1976.

Gear: Smith-McIntyre grab (0.013 cu m max, 4-10 cm depth).

Notes: Sand / silt / clay and total organic carbon are tabulated by station number, which can be referenced to a map. Benthos data are not referenced to stations but are presented in general summary only.

Status: Map of sediment texture distribution was digitized.

**White, W. A., Calnan, T. R., Morton, R. A., Kimble, R. S., Littleton, T. G., McGowen, J. H., and Nance, H. S. 1989b. Submerged lands of Texas, Port Lavaca area: sediments, geochemistry, benthic macroinvertebrates, and associated wetlands. The University of Texas at Austin, Bureau of Economic Geology, Austin, TX. 165 p. + maps.**

Scope: Sediments and benthos of state-owned submerged lands were mapped and described using bottom samples collected at 1 nmi (1.6 km) intervals on inner shelf out to 11 nmi (18 km), May and Oct 1976.

Gear: Smith-McIntyre grab (0.013 cu m max, 4-10 cm depth).

Notes: Sand / silt / clay and total organic carbon are tabulated by station number, which can be referenced to a map. Benthos data are not referenced to stations but are presented in general summary only.

Status: Map of sediment texture distribution was digitized.

**White, W. A., Calnan, T. R., Morton, R. A., Kimble, R. S., Littleton, T. G., McGowen, J. H., Nance, H. S., and Schmedes, K. E. 1983. Submerged lands of Texas, Corpus Christi area: sediments, geochemistry, benthic macroinvertebrates, and associated wetlands. The University of Texas at Austin, Bureau of Economic Geology, Austin, TX. 154 p. + maps.**

Scope: Sediments and benthos of state-owned submerged lands were mapped and described using bottom samples collected at 1 nmi (1.6 km) intervals on inner shelf out to 11 nmi (18 km), May 1976.

Gear: Smith-McIntyre grab (0.013 cu m max, 4-10 cm depth).

Notes: Sand / silt / clay and total organic carbon are tabulated by station number, which can be referenced to a map. Benthos data are not referenced to stations but are presented in general summary only.

Status: Map of sediment texture distribution was digitized.

**White, W. A., Calnan, T. R., Morton, R. A., Kimble, R. S., Littleton, T. G., McGowen, J. H., Nance, H. S., and Schmedes, K. E. 1985. Submerged lands of Texas, Galveston-Houston area: sediments, geochemistry, benthic macroinvertebrates, and associated wetlands. The University of Texas at Austin, Bureau of Economic Geology, Austin, TX. 145 p. + maps.**

Scope: Sediments and benthos of state-owned submerged lands were mapped and described using bottom samples collected at 1 nmi (1.6 km) intervals on inner shelf out to 11 nmi (18 km), Oct 1976 and Sep 1977.

Gear: Smith-McIntyre grab (0.013 cu m max, 4-10 cm depth).

Notes: Sand / silt / clay and total organic carbon are tabulated by station number, which can be referenced to a map. Benthos data are not referenced to stations but are presented in general summary only.

Status: Map of sediment texture distribution was digitized.

**White, W. A., Calnan, T. R., Morton, R. A., Kimble, R. S., Littleton, T. G., McGowen, J. H., Nance, H. S., and Schmedes, K. E. 1986. Submerged lands of Texas, Brownsville-Harlingen area: sediments, geochemistry, benthic macroinvertebrates, and associated wetlands. The University of Texas at Austin, Bureau of Economic Geology, Austin, TX. 138 p. + maps.**

Scope: Sediments and benthos of state-owned submerged lands were mapped and described using bottom samples collected at 1 nmi (1.6 km) intervals on inner shelf out to 11 nmi (18 km), Apr 1976.

Gear: Smith-McIntyre grab (0.013 cu m max, 4-10 cm depth).

Notes: Sand / silt / clay and total organic carbon are tabulated by station number, which can be referenced to a map. Benthos data are not referenced to stations but are presented in general summary only.

Status: Map of sediment texture distribution was digitized.

**Woodward-Clyde Consultants. 1979. Eastern Gulf of Mexico marine habitat study. Vol. 1 and 2. U. S. Department of the Interior, Bureau of Land Management, Washington, DC. Contract AA551-CT8-22. 60 p. + appendices and 26 maps.**

Scope: Geophysical, bathymetric, and habitat mapping of ten proposed oil / gas lease blocks on continental shelf between Pensacola and Charlotte Harbor / Ft. Myers, FL; all sites  $\leq 100$  m depth.

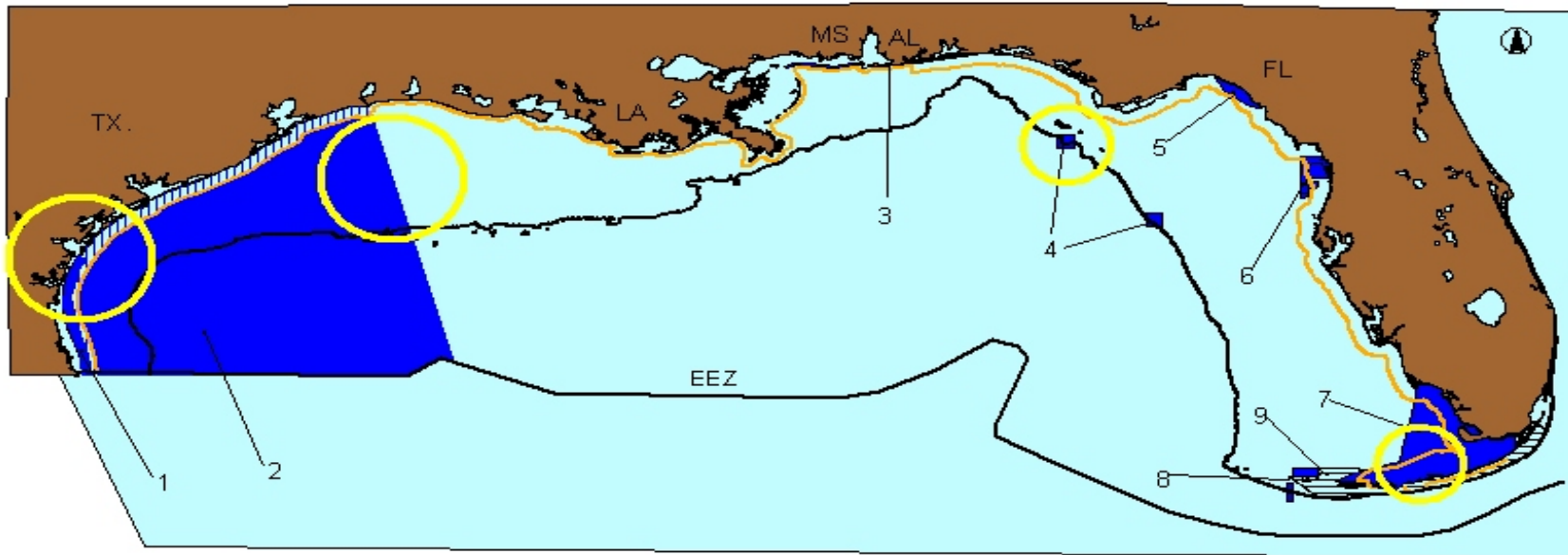
Gear: Transducer (depth), side-scan sonar, sub-bottom profiler, underwater video, still photography.

Notes: Vol. 1 describes biota seen in video transects [hard bottom and outcrop areas often had epifauna]. Information from Vol. 1: Area 1 (see maps): No video but no apparent epifauna; Area 2: bedrock outcrops, coarse rubble, sand dunes / waves in some areas, mostly soft featureless bottom, not much epifauna visible; Area 3: some hard bottom / pinnacle / reef features, but mostly soft featureless bottom with mounds and depressions (fish burrows?) up to 10 m in diameter; pinnacles rise up  $\leq 12$  m above sea floor, not much epifauna or epiflora; outcrops with soft and branching corals, sea fans, and sea whips; Area 4: carbonate outcrops and up to 11 m tall pinnacles in some areas, mostly soft fine sediments, coarse sediments and hard bottom areas have epifauna; Area 5: hard bottom and rock outcrops in 17-22 m depths, soft and hard corals, sponges, gorgonians, etc., and seagrass [*Halophila*]; Area 6: scattered outcrops with epifauna, mostly barren soft bottom; Area 7: sand with some outcrops having epifauna; Area 8: primarily sand with few outcrops; Area 9: hard and soft bottom with epifauna; Area 10: sand with no outcrops. Vol. 2 is a set of maps with interpretation - hard sand with ripple/dune features, featureless sand/mud, coarse bottom, hard bottom, pinnacles, etc.

Status: Maps were digitized.












-  100 m isobath
-  State and Federal Jurisdiction Line
-  Florida Keys Nat. Marine Sanctuary
-  Closed areas
-  Texas State Waters (Texas Closure)

Figure 1. Gulf of Mexico areas closed to trawling for all or part of the year. 1 = Texas Southern Shrimp Zone, 2 = Texas Closure, 3 = Gulf Islands National Seashore, 4 = Madison - Swanson and Steamboat Lumps MPAs, 5 = Taylor County FL Shrimp Closure, 6 = West FL Crab/Shrimp Zone, 7 = Tortugas Shrimp Sanctuary, 8 = Tortugas Ecological Reserve, 9 = FL Keys NMS. Circles indicate potential experimental areas.

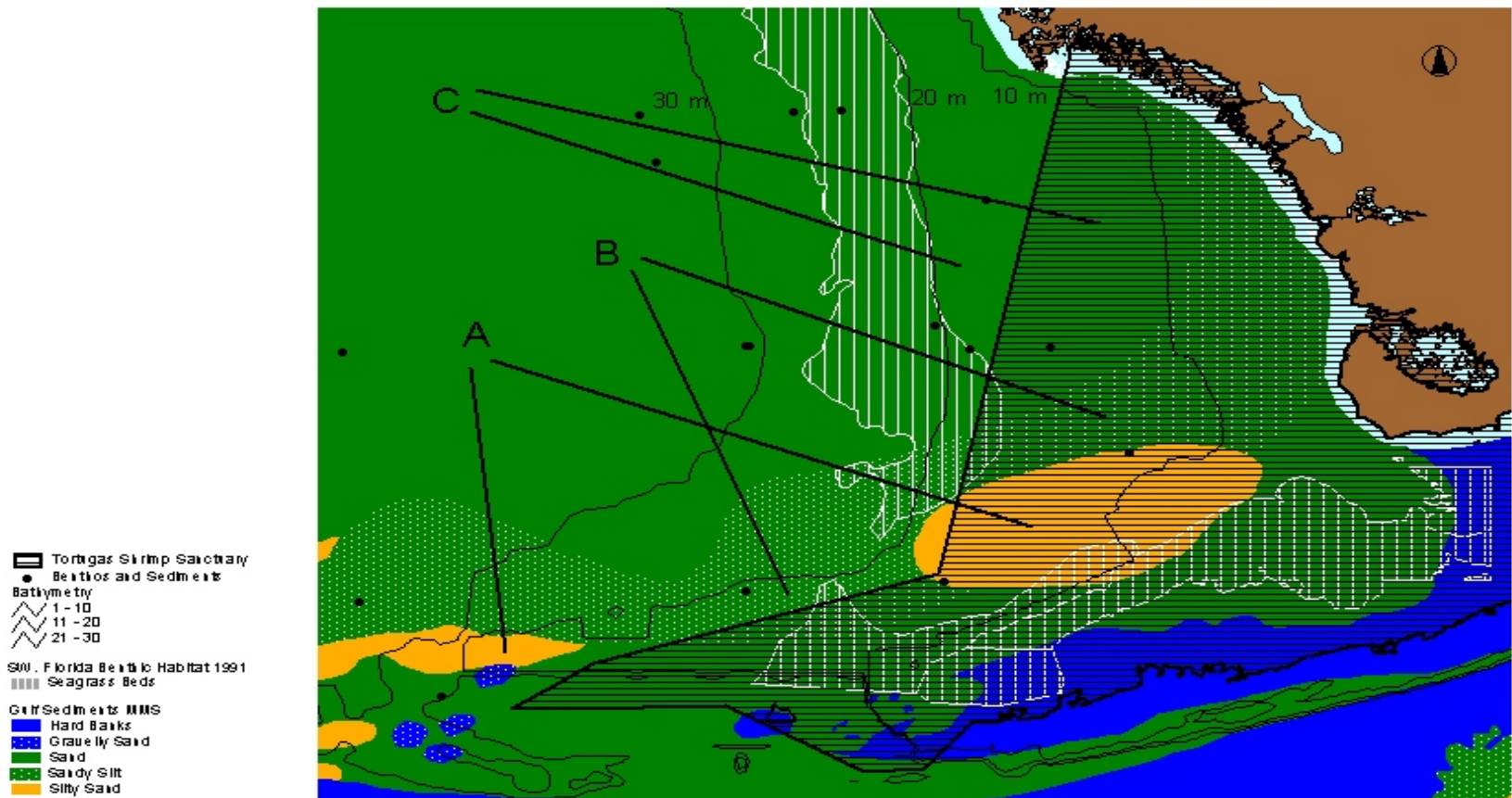
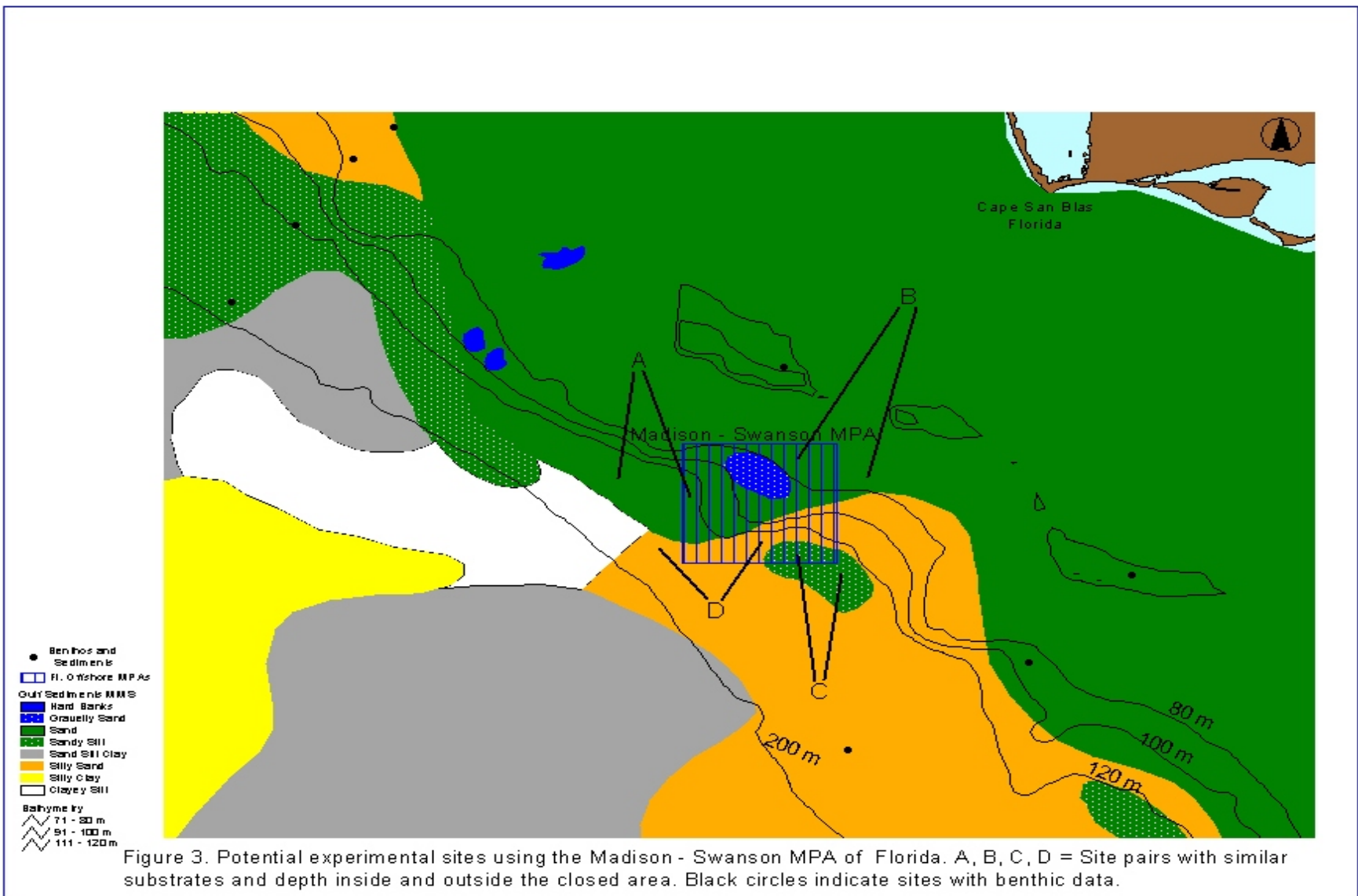


Figure 2. Potential experimental sites using the Tortugas Shrimp Sanctuary of SW Florida. A, B, C = Site pairs with similar substrates and depth inside and outside the closed area. Black circles indicate sites with benthic data.



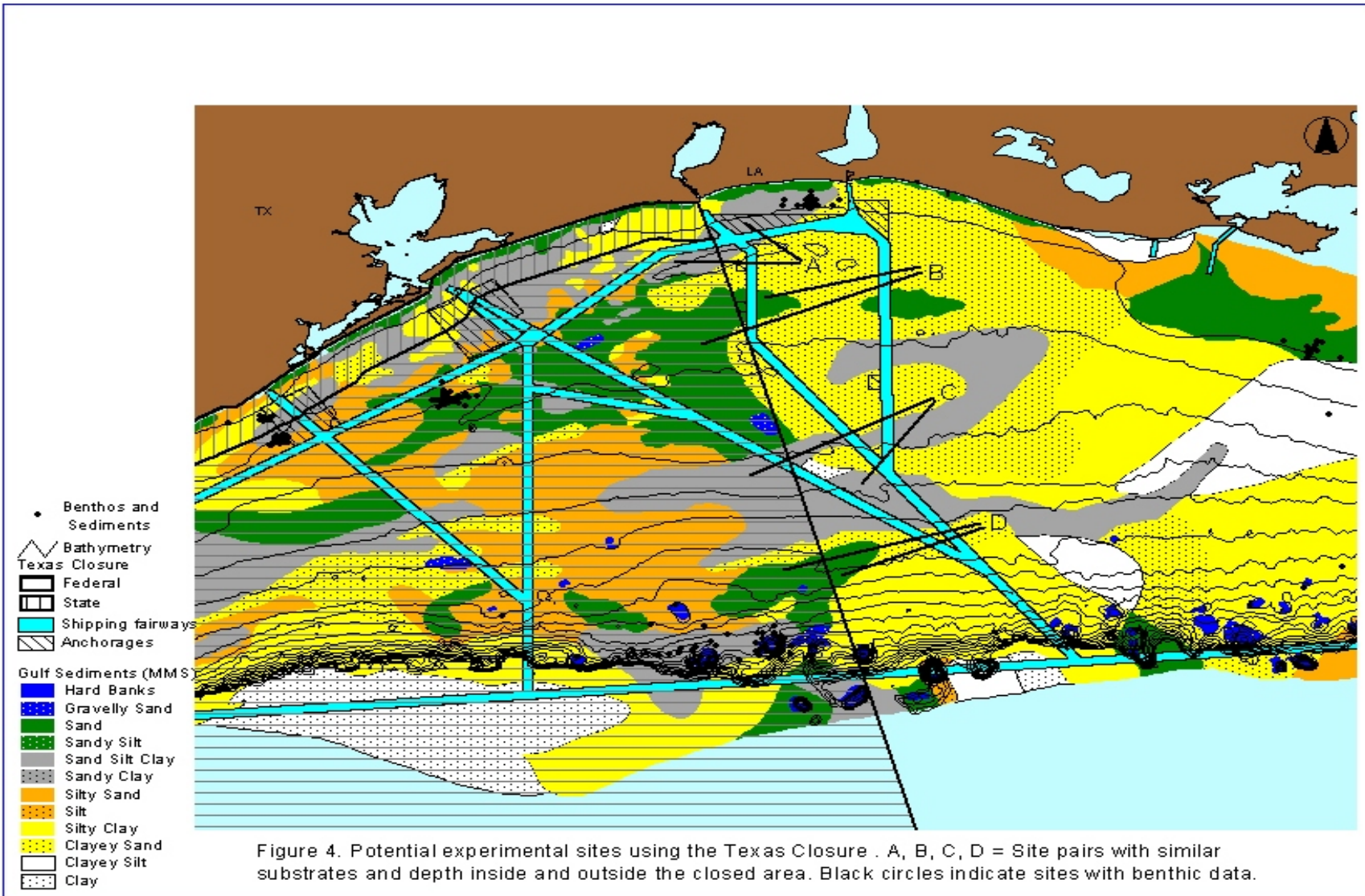


Figure 4. Potential experimental sites using the Texas Closure . A, B, C, D = Site pairs with similar substrates and depth inside and outside the closed area. Black circles indicate sites with benthic data.

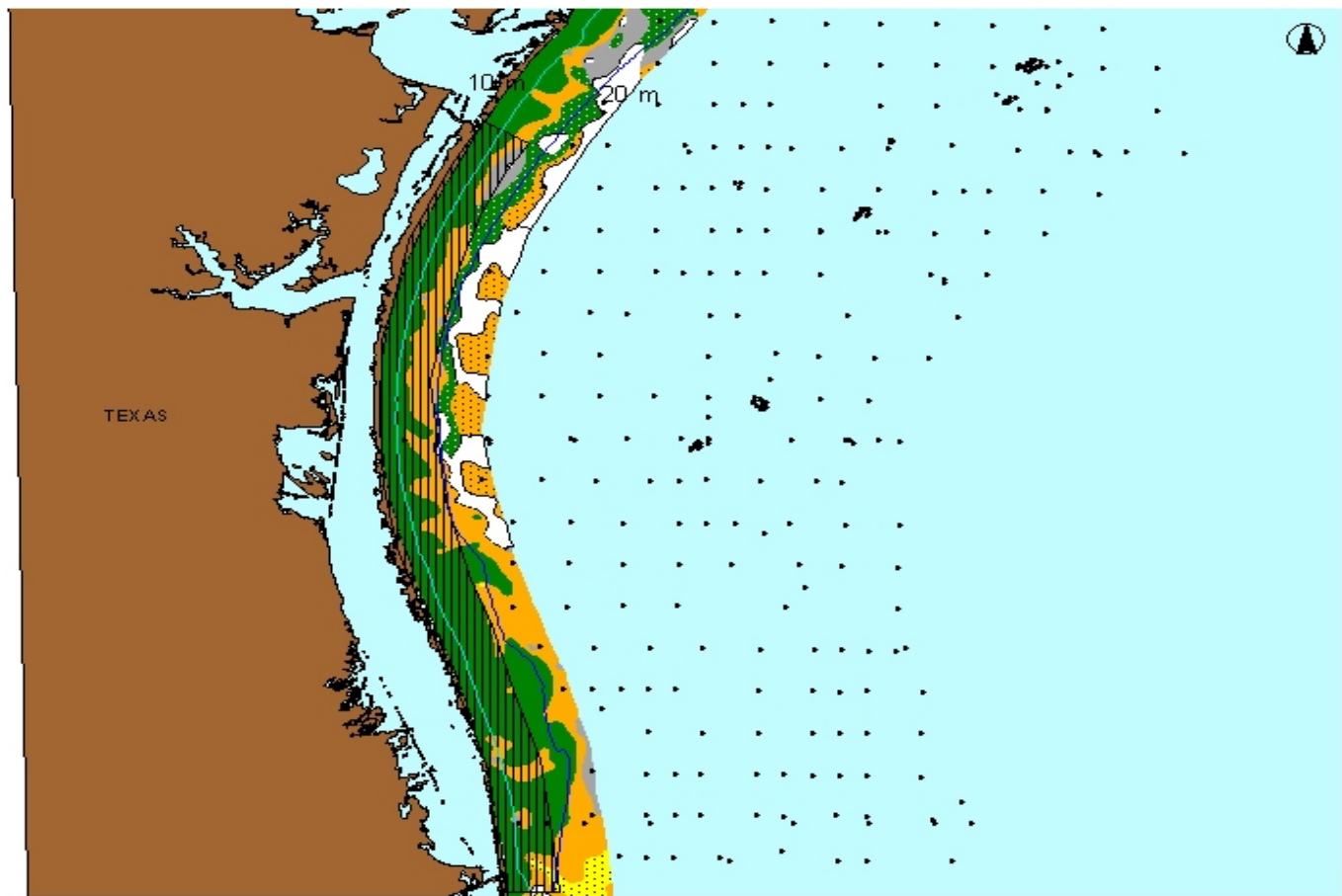


Figure 5. Environmental setting for the Texas Southern Shrimp Zone . Black circles indicate sites with benthic data.

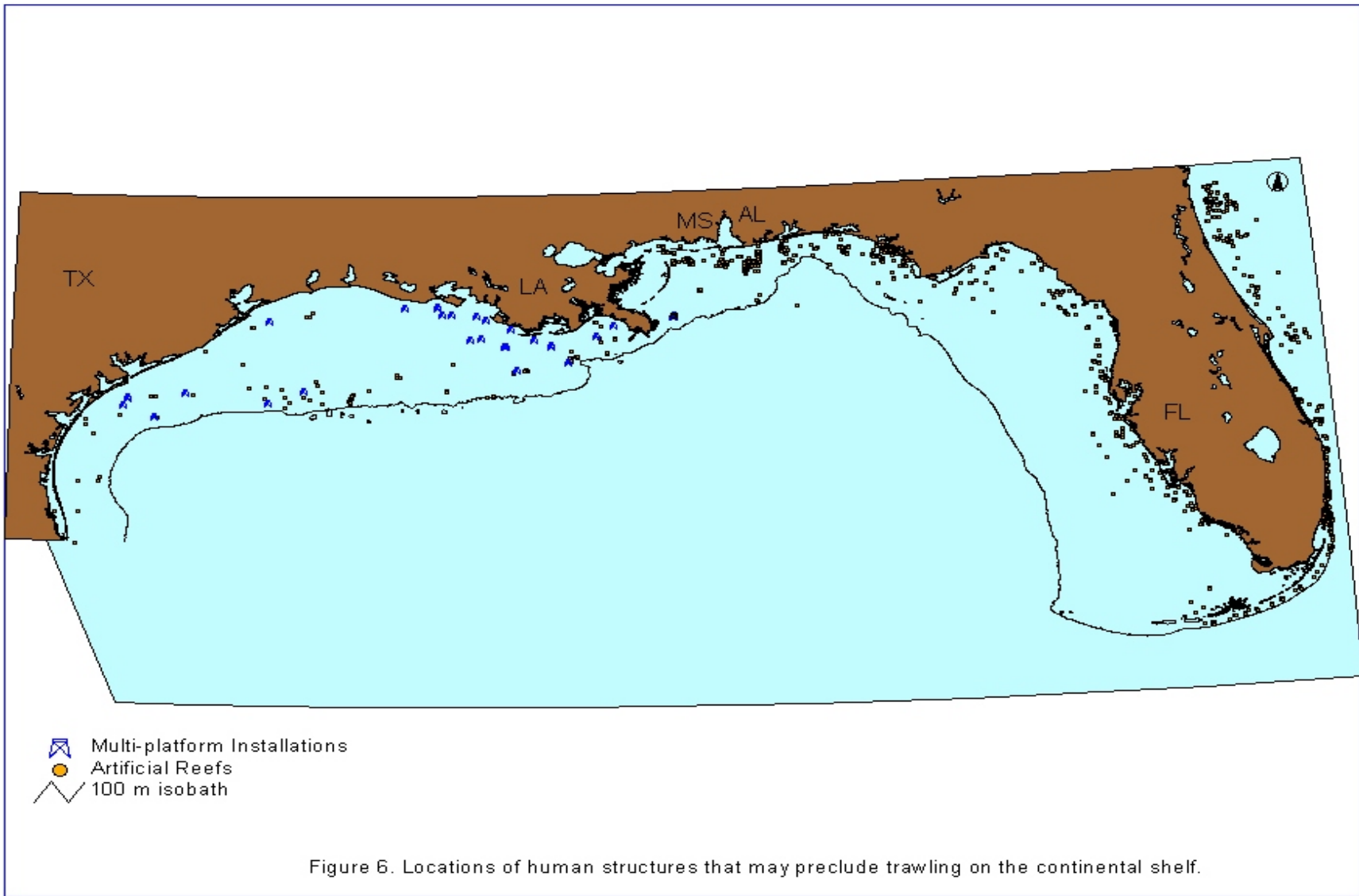
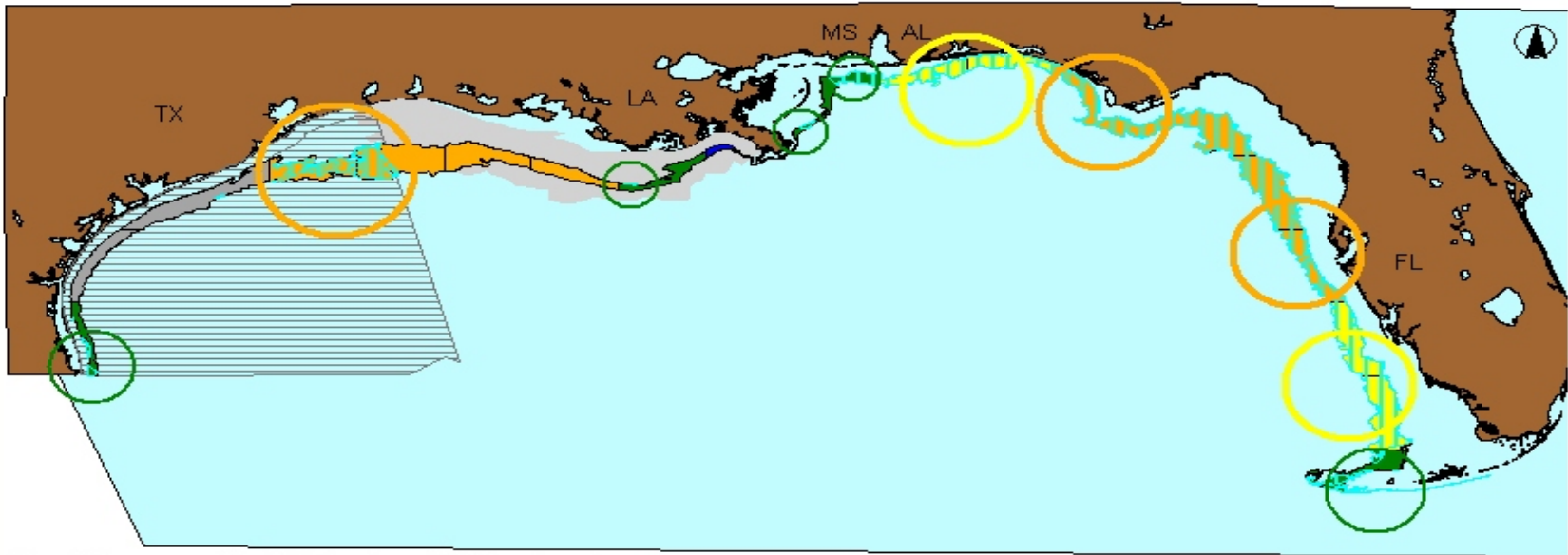


Figure 6. Locations of human structures that may preclude trawling on the continental shelf.



10 - 15 fm avg. effort 24 hr. days/100 hectares/year

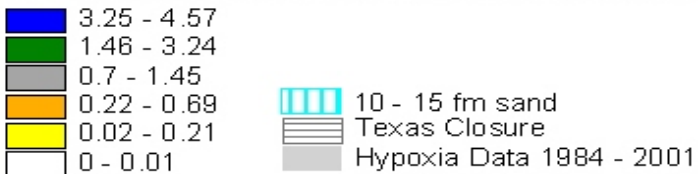


Figure 7. Potential research sites at depths of 18-27 m (10-15 fm) over sand bottoms at several levels of ambient shrimp effort. Multi-colored band indicates depth stratum, vertical bars indicate sand. Circles of same color indicate areas with similar levels of fishing effort (24 hr days, 1990-99 average).



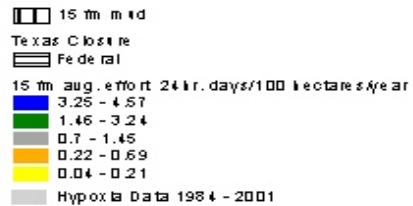
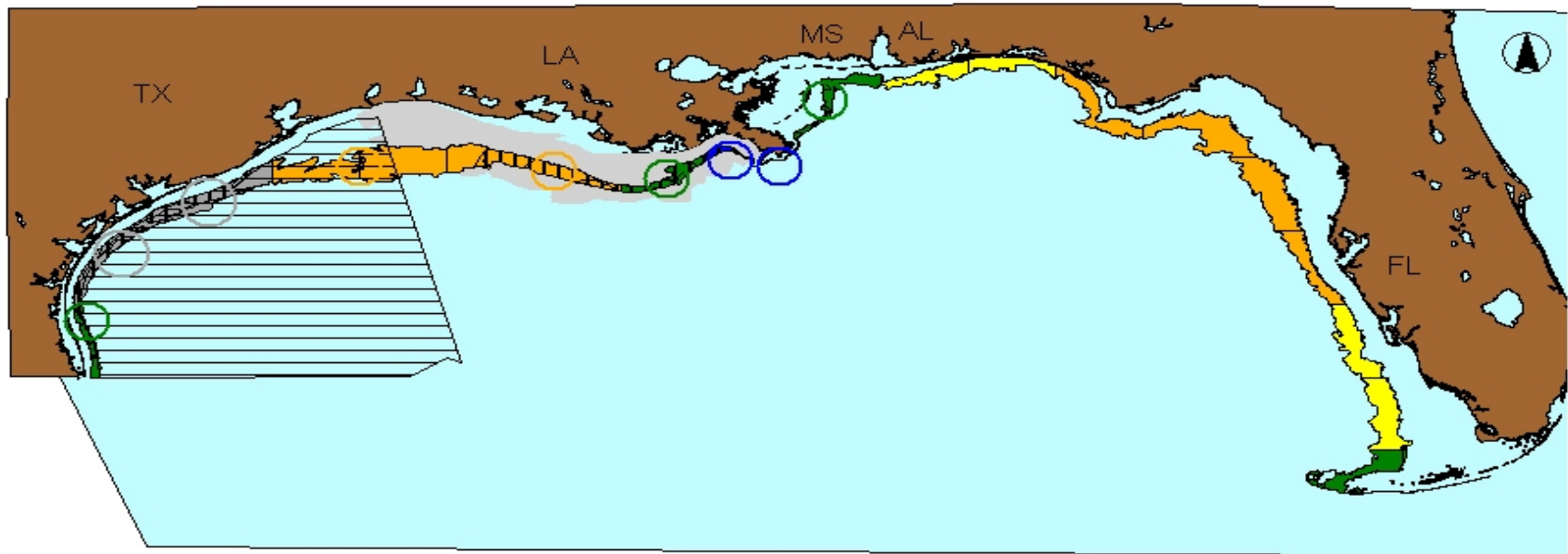
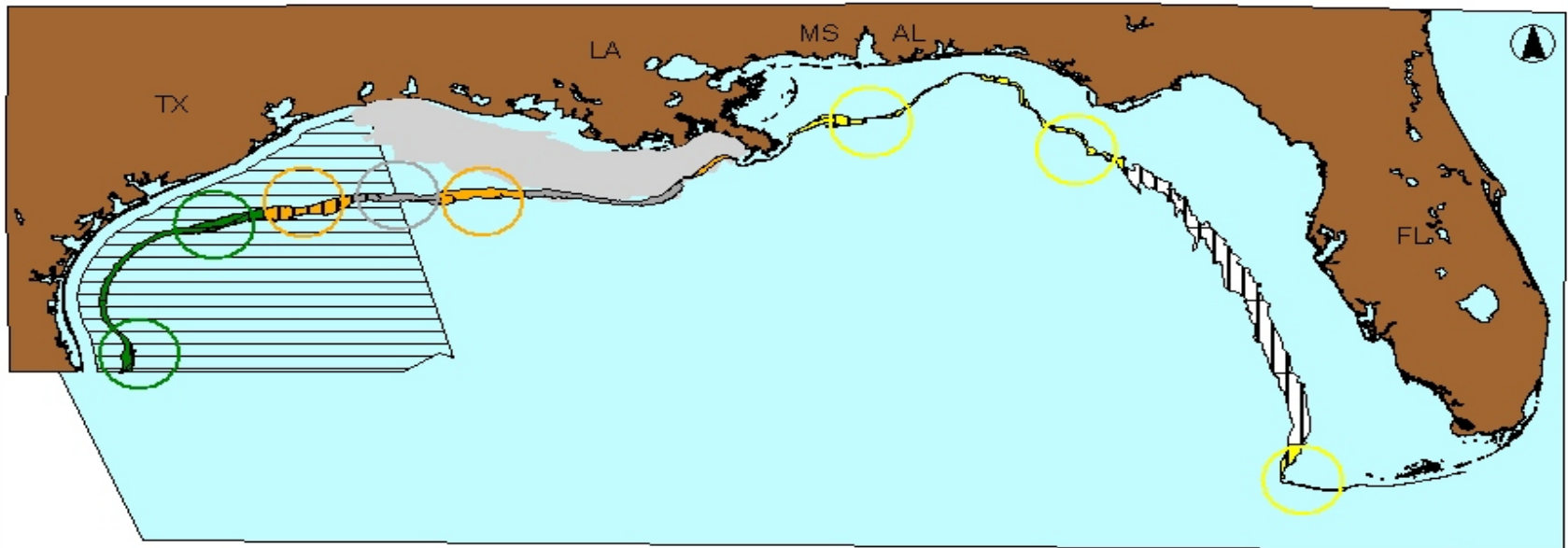


Figure 8. Potential research sites at depths of 18-27 m (10-15 fm) over mud bottoms at several levels of ambient shrimp effort. Multi-colored band indicates depth stratum, black vertical bars indicate mud. Circles of same color indicate areas with similar levels of fishing effort (24 hr days, 1990-99 average).



30 fm avg. effort 24 hr. days/100 hectares/year

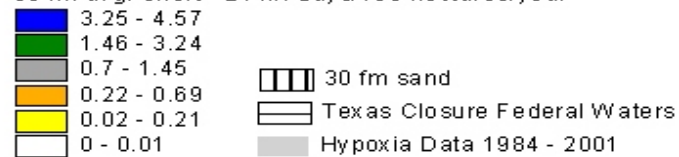
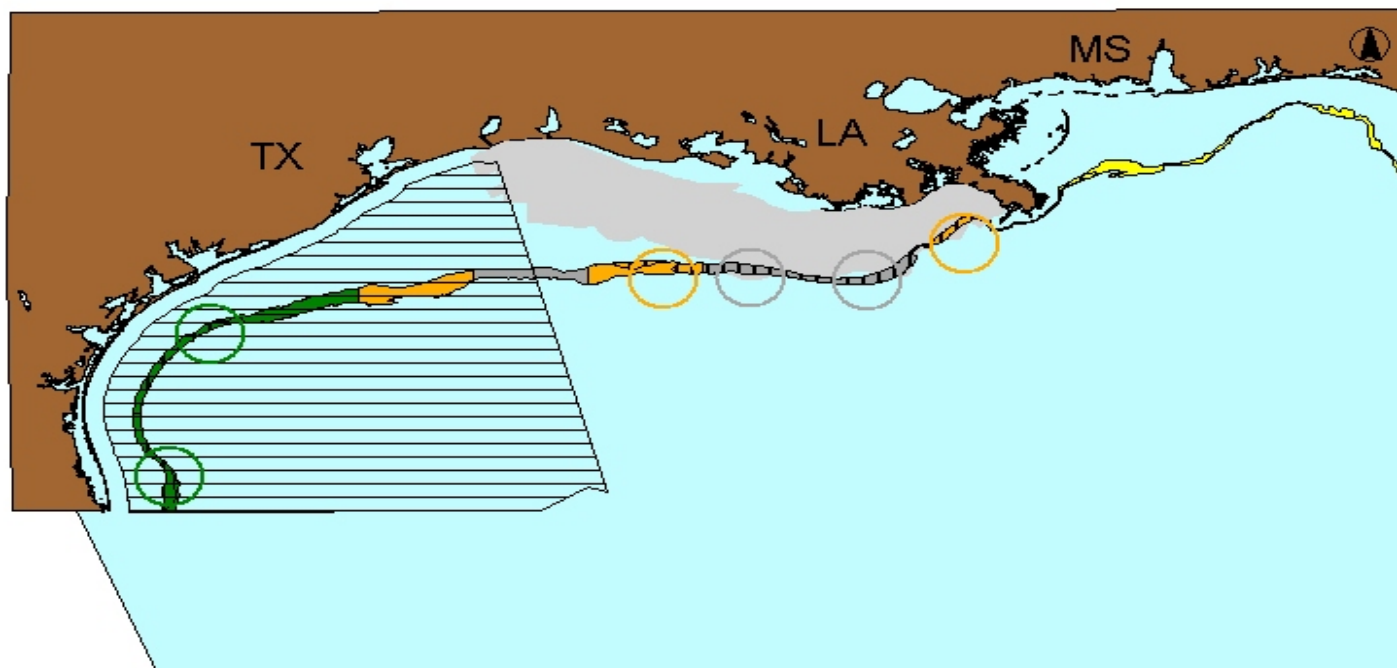


Figure 9. Potential research sites at depths of 46-55 m (25-30 fm) over sand bottoms at several levels of ambient shrimp effort. Multi-colored band indicates depth stratum, black vertical bars indicate sand. Circles of same color indicate areas with similar levels of fishing effort (24 hr days, 1990-99 average).



30 fm avg. effort 24 hr. days/100 hectares/year

3.25 - 4.57

1.46 - 3.24

0.7 - 1.45

0.22 - 0.69

0.02 - 0.21

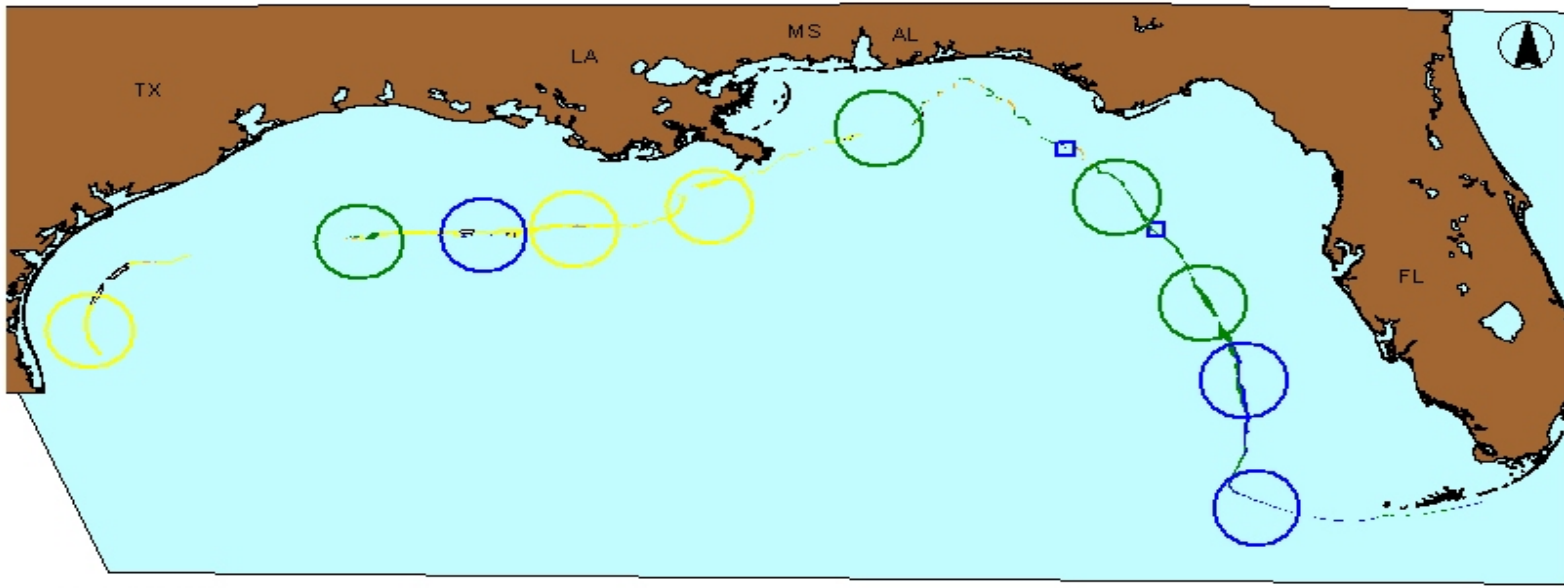
0 - 0.01

30 fm mud

Texas Closure Federal Waters

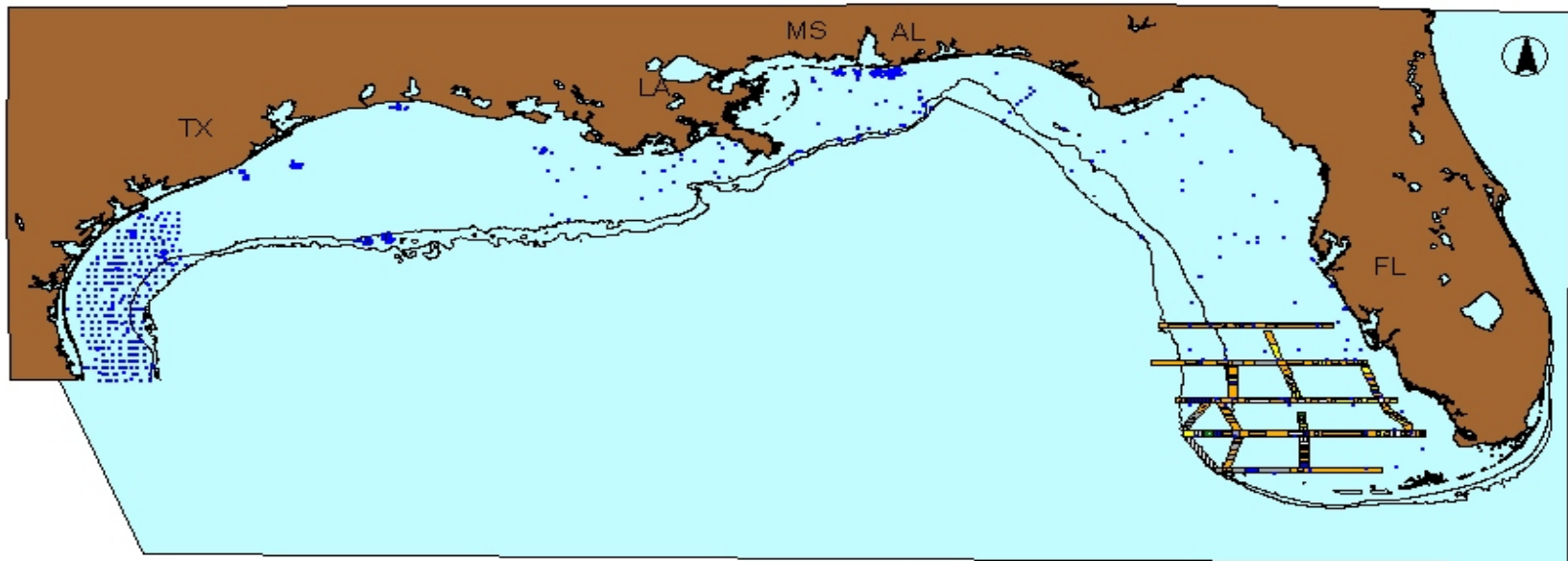
Hypoxia Data 1984 - 2001

Figure 10. Potential research sites at depths of 46-55 m (25-30 fm) over mud bottoms at several levels of ambient shrimp effort. Multi-colored band indicates depth stratum, black vertical bars indicate mud. Circles of same color indicate areas with similar levels of fishing effort (24 hr days, 1990-99 average).



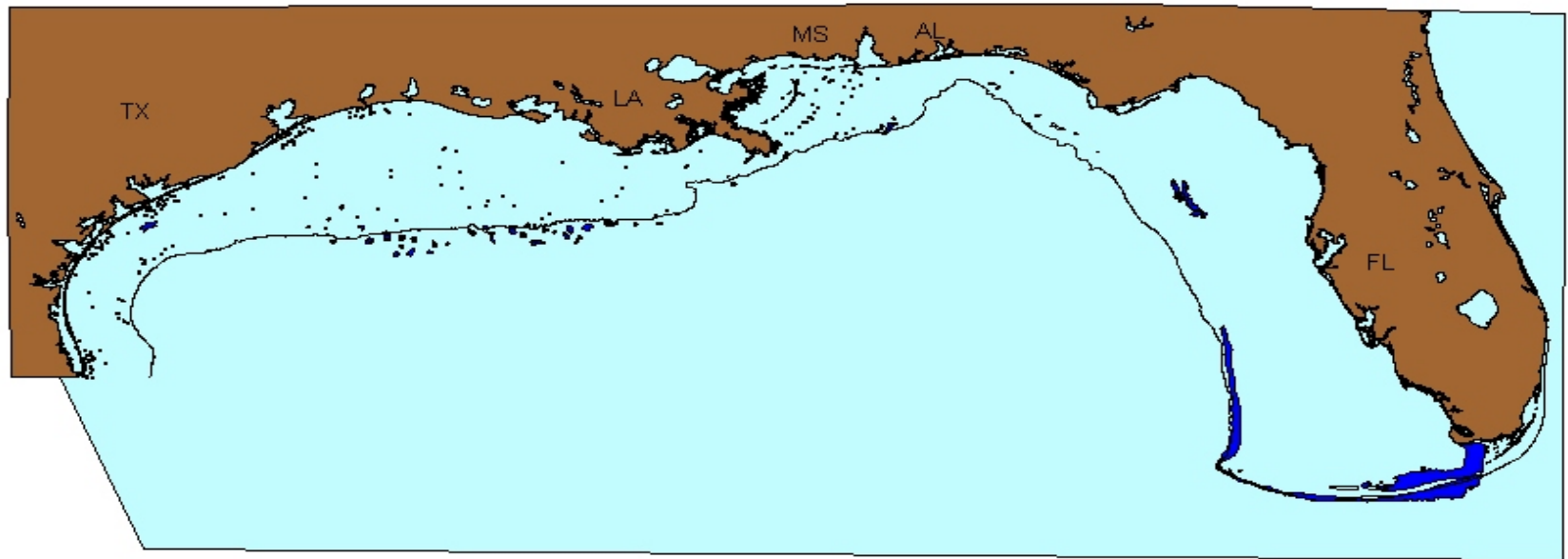
- 50 fm substrates
- Hard Banks
  - Gravelly Sand
  - Sand
  - Sandy Silt
  - Sand Silt Clay
  - Sandy Silt Clay
  - Silty Sand
  - Silt
  - Silty Clay
  - Clayey Sand
  - Clayey Silt
  - Clay
- Florida MPAs

Figure 11. Potential research sites at depths of 82-91 m (45-50 fm) over all substrates at ambient shrimp effort. Multi-colored band indicates depth stratum. Circles of same color indicate areas with similar substrates. All areas had low effort (24 hr days, 1990-99 average).



- Benthos, annelids, and epibiota
- ∧ 100m & 200 m isobath
- SW Florida Biological Communities 1987  
(see codes Offshore Data view)

Figure 12. Locations of quantitative benthos data sets and underwater video transects. Benthic data are either total benthos, various benthic categories such as annelids, or live bottom epibiota, all available as number per sq. m. See hotlink in Offshore Data view for Combined Codes Biological Community 1987.

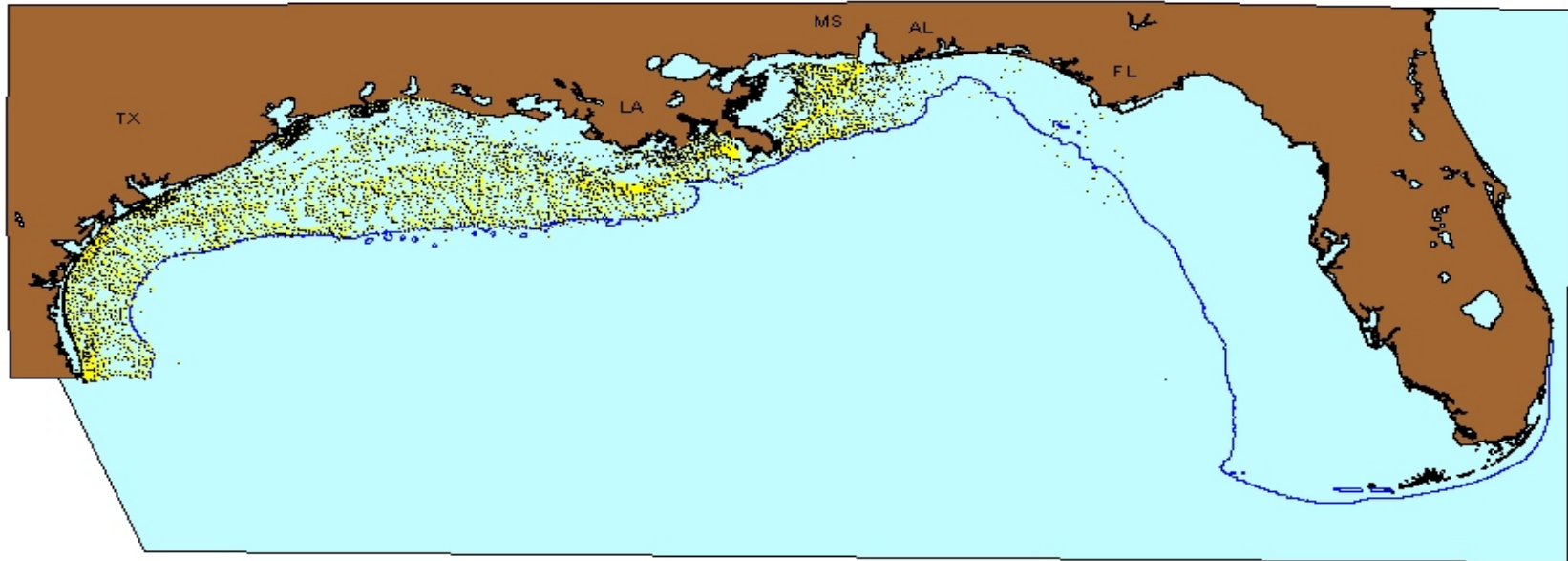


● Seamap Data - Live Bottom 1982-1999

∩ 100 meter isobath

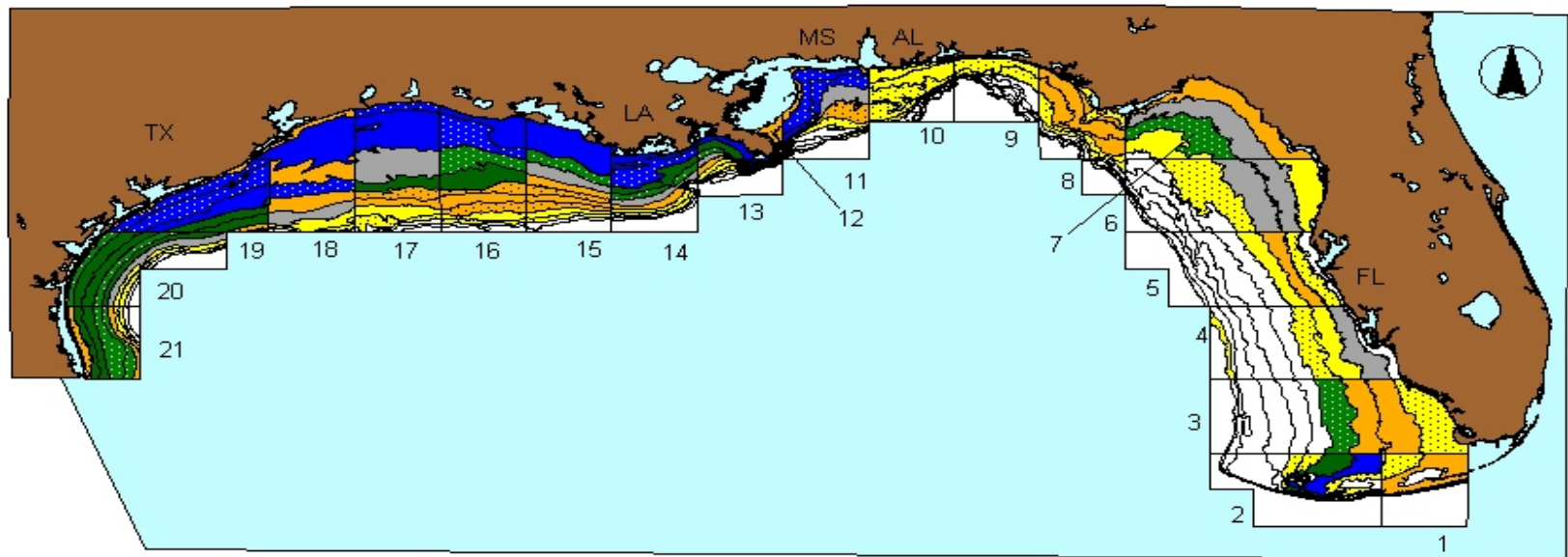
■ Hard banks

Figure 13. Records of live bottom organisms (hard and soft corals, gorgonians, etc.) from SEAMAP trawl stations during 1982-1999 in relation to hard bank locations.



- SEAMAP Managed Fishery Species
- SEAMAP Trawl Sites 1982 - 1999
- 100 meter isobath

Figure 14. Records of federally managed species from all SEAMAP trawl stations during 1982-1999.



Shrimping Effort (1990-1999) 24 hrs days/year

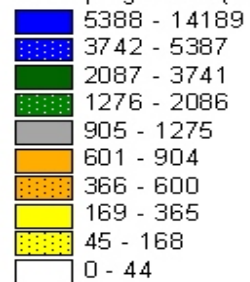
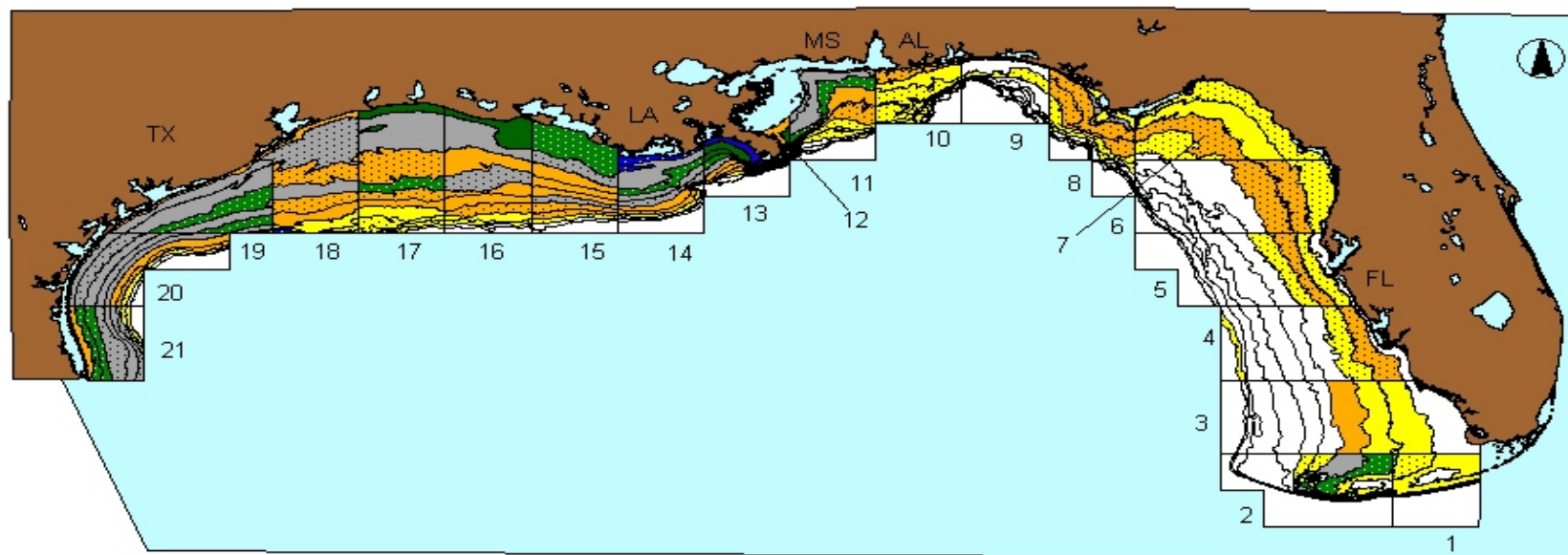


Figure 15. Mean annual shrimp fishing effort (24-hr days) in the Gulf of Mexico by NOAA Fisheries statistical subareas (1-21) and 9-m (5-fm) depth strata for the period January 1990 - December 1999.





Avg. Effort 24 hr. days/100 hectares/year

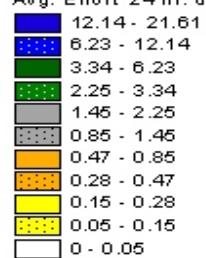
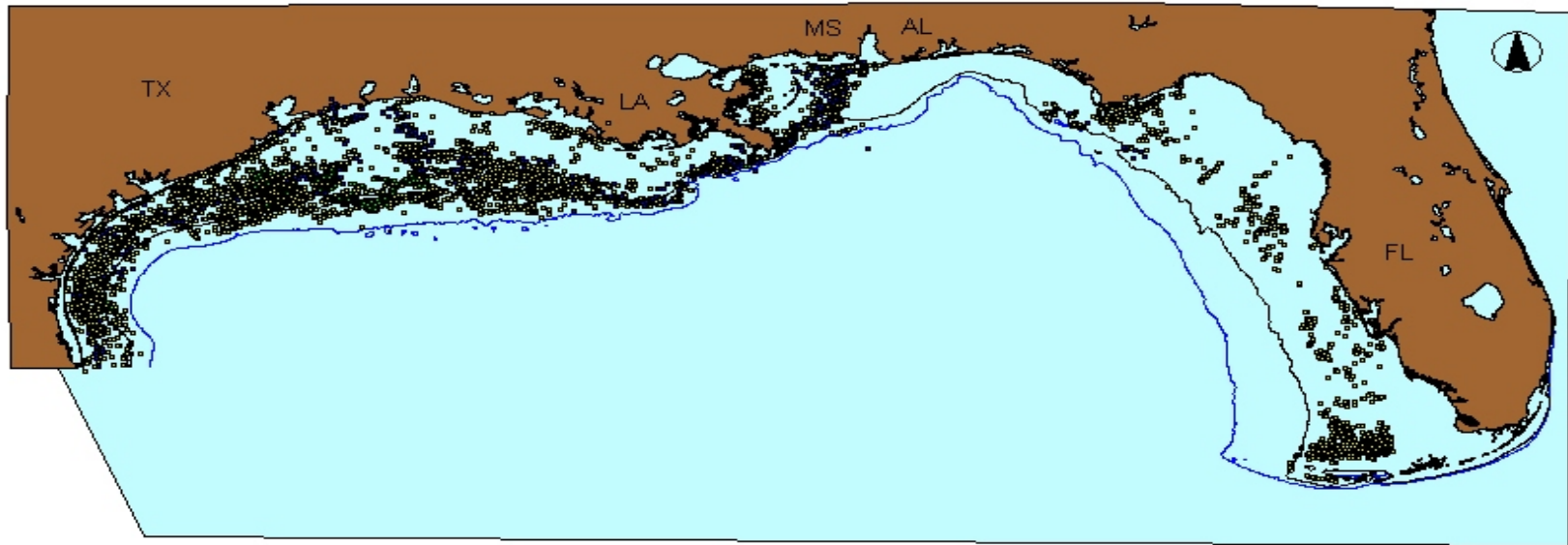


Figure 16. Mean annual shrimp fishing effort (24-hr days) per 100 hectares in the Gulf of Mexico by NOAA Fisheries statistical subareas (1-21) and 9-m (5-fm) depth strata for the period January 1990 - December 1999.








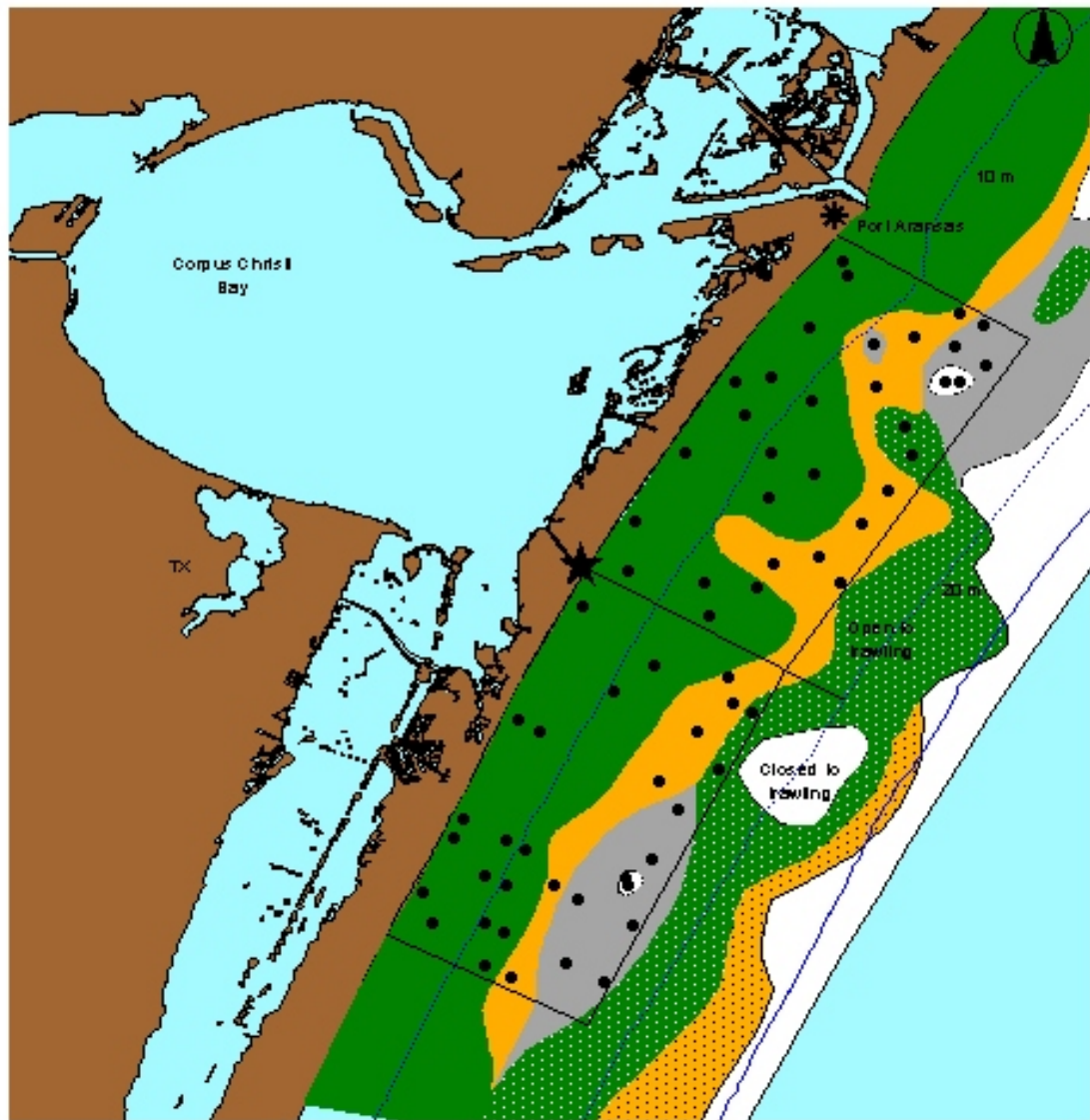
-  50 m isobath
-  NMFS Bycatch Data 1
-  NMFS Bycatch Data 2
-  NMFS BRD Observer Data
-  100 m isobath

Figure 17. Starting positions for 10,781 shrimp trawl tows in the Gulf of Mexico observed by NOAA Fisheries in three studies conducted during 1992-1999.



Corpus Area sediments BEG

- |   |  |
|---|--|
| <span style="display: inline-block; width: 15px; height: 10px; background-color: green; border: 1px solid black;"></span> Sand  | <span style="display: inline-block; width: 15px; height: 10px; border-bottom: 1px dashed black;"></span> State and Federal Jurisdiction Line |
| <span style="display: inline-block; width: 15px; height: 10px; background: repeating-linear-gradient(45deg, transparent, transparent 2px, black 2px, black 4px); border: 1px solid black;"></span> Sandy Silt | <span style="display: inline-block; width: 15px; height: 10px; border-bottom: 1px dotted black;"></span> 10m & 20 m isobaths                 |
| <span style="display: inline-block; width: 15px; height: 10px; background-color: grey; border: 1px solid black;"></span> Sand Silt Clay   | <span style="display: inline-block; width: 10px; height: 10px; background-color: black; border-radius: 50%;"></span> Random samples          |
| <span style="display: inline-block; width: 15px; height: 10px; background-color: yellow; border: 1px solid black;"></span> Silt Sand  | <span style="display: inline-block; width: 15px; height: 10px; border-bottom: 1px dashed black;"></span> Fish Pass                           |
| <span style="display: inline-block; width: 15px; height: 10px; background: repeating-linear-gradient(-45deg, transparent, transparent 2px, black 2px, black 4px); border: 1px solid black;"></span> Silt      |  |
| <span style="display: inline-block; width: 15px; height: 10px; border: 1px solid black;"></span> Clayey Silt  |  |

Figure 18. An experimental random stratified sampling design to assess trawling impacts at the northern edge of the Texas Southern Shrimp Zone. Samples are randomly placed in proportion to the area of various sediment types. Fish Pass divides open and closed waters.