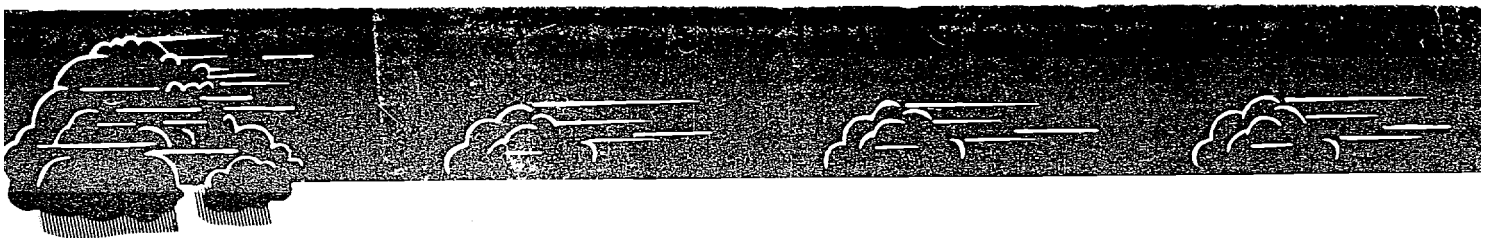

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Fishing Banks of the Texas Continental Shelf

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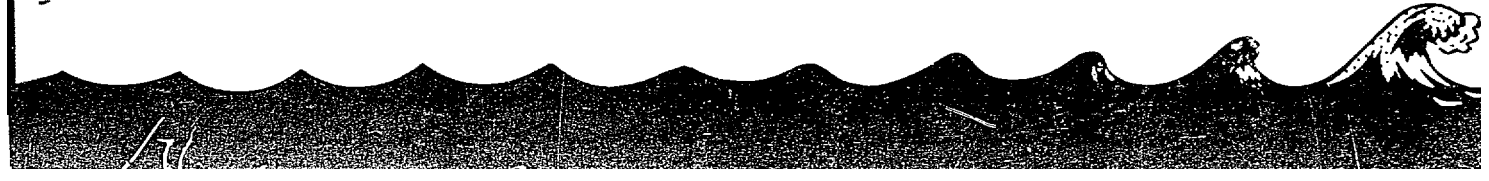

Fishing Banks of the Texas Continental Shelf

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INTRODUCTION

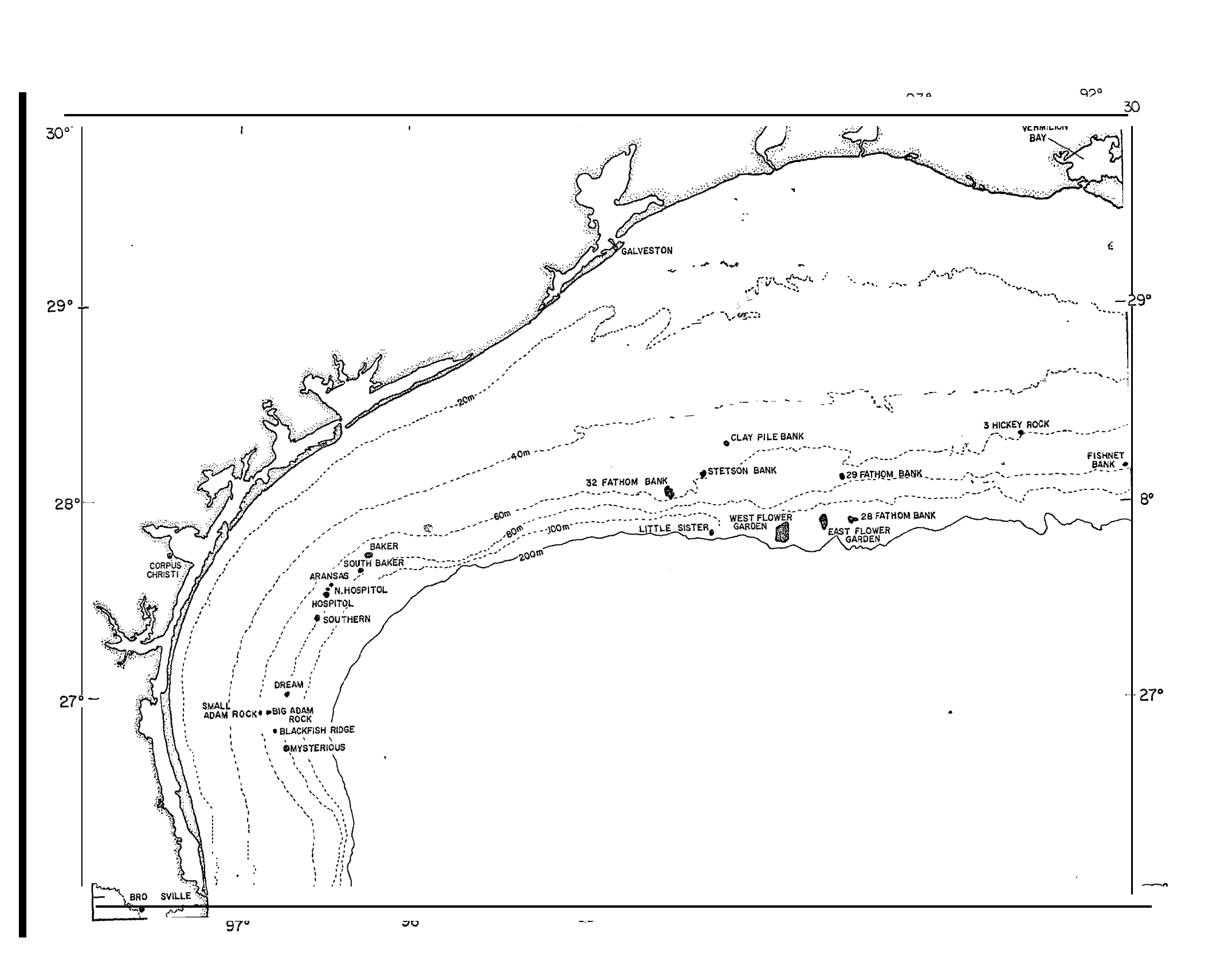
Although in recent years less than a half dozen commercial snapper fishing boats have worked out of Texas ports, a considerable number of such vessels from Florida and Alabama frequent the Texas-Louisiana continental shelf in pursuit of snappers of the genera Lutjanus and Rhomboplites, as well as groupers and hinds (Mycteroperca and Epinephelus). The western Gulf commercial hook-and-line fishery and the Texas head-boat sport fishery owe their existence to the presence of numerous offshore hard-banks and topographical features around which a number of important commercial and sport fishes continually congregate. From 1970 to the presentwe have had opportunity and funding to study, for reasons not directly related to fisheries, the biology and geology of some of the more important of these banks (Fig. 1). Much of the information we have gathered seems pertinent to the understanding of natural habitats of lutjanids and serranids in the Western Gulf of Mexico.

Bright and Pequegnat, 1974, described the biota of the West Flower Garden Bank which, with the East Flower Garden, represents the most complete and complexly developed reef and hard-bank assemblage on the Texas-Louisiana Outer Continental Shelf. The reader is referred to that publication for a bibliography of papers dealing with Western Gulf banks.

OBJECTIVES

In an attempt to add to the understanding of preferred natural offshore habitats of commercial and sport fishes in the Western Gulf of Mexico, we will

Figure 1. Major Texas-Louisiana Outer Continental Shelf Fishing Banks.


30°
29°
28°
27°
97°
92°
30
29°
8°
27°
VERMILION BAY
GALVESTON
20m
40m
60m
80m
100m
200m
3 HICKEY ROCK
CLAY PILE BANK
FISHNET BANK
STETSON BANK
29 FATHOM BANK
32 FATHOM BANK
28 FATHOM BANK
WEST FLOWER GARDEN
EAST FLOWER GARDEN
LITTLE SISTER
BAKER
SOUTH BAKER
ARANSAS
N. HOSPITOL
HOSPITOL
SOUTHERN
CORPUS CHRISTI
DREAM
SMALL ADAM ROCK
BIG ADAM ROCK
BLACKFISH RIDGE
MYSTERIOUS
BRO SVILLE

summarize here in diagrams and text the results of several years of sampling and. observation on reefs and hard-banks and make public detailed bathymetric charts which we hope will be useful to scientists and fishermen.

METHODS

Our studies have been ecologically-oriented biological and geological surveys. Sampling techniques have, therefore, employed corers, grabs, dredges, hook-and-line fishing, spearfishing, rotenone poisoning, gathering, observation and photography by SCUBA divers, underwater television, and, most effectively, observation and sampling by research submersible.

In 1972 we used the General Oceanographic submarine NEKTON GAMMA to investigate that part of the West Flower Garden lying below 45 meters depth. In 1974 and 1975 we examined eleven additional banks with the Texas A&M Oceanography Department submarine DIAPHUS. Mostof the biological and geological observations described here are results of dives made in the DIAPHUS. The NEKTON GAMMA and DIAPHUS are both equipped with manipulator arms, external sample containers, portable television recorders and cameras, all of which were used.

Three of the bathymetric charts presented here were taken from previous publications. The others were generated during a U.S. Bureau of Land Management funded "baseline" study of South Texas Outer Continental Shelf fishing banks using Decca Hi-Fix and Lorac positioning, Decca and Hydrosurveys side-scan sonar and Decca and Raytheon precision depth recorders.

BENTHIC BIOTA AND FISHES

Reef and hard-bank biota in the Western Gulf are easily distinguishable into at least four assemblages, all of which are faunally linked and composed of organisms known to occur at the diversely populated East and West Flower Garden banks.

Bright and Pequegnat, 1974, listed over 250 species of benthic invertebrates and more than 100 fishes from the West Flower Garden, the distinctive biotic zonation of which (Fig. 2) is basically the same as that of the East Flower Garden (Fig. 3), though differences are apparent. Above 45-49 meters both banks are covered with thriving submerged coral reefs which, except for their total lack of shallow-water alcyonarians, are good examples of the Diploria-Montastrea-Porites community so common on reefs in the Caribbean and Southern Gulf of Mexico.

The East Flower Garden harbors, in addition, sizeable knolls occupied almost entirely by populations of the small branching coral Madracis mirabilis (Madracis Zone). Finger-sized remains of dead Madracis are extremely important components of the sediment on and adjacent to the reef. In some cases the coarse carbonate sand which typically occurs between coral heads in the Diploria-Montastrea-Porites Zone is entirely supplanted by Madracis rubble.

Other knolls at the East Flower Garden are covered completely by lush growths of leafy algae including Caulerpa, Chrysymenia, Halymenia, Gloiophloea, Lobophora, Microdictyon, and others. The presence at the East Flower Garden of this Leafy Algae Zone, the Madracis Zone and knolls of intermediate biotic composition which bear various types of sponges, Madracis clumps, patches of leafy algae, and extensive encrustations of coralline algae is indicative of a greater degree of lateral biotic variability on the 70 or so acre crest of this bank than is found at the West Flower Garden where the Diploria-Montastrea-Porites Zone predominates everywhere above 45-49 meters (approximately 100 acres).

Table 1 indicates that the coral reefs at the East and West Flower Gardens (22-49 meters) house more species of epifauna and fishes than do

Figure 2. West Flower Garden.

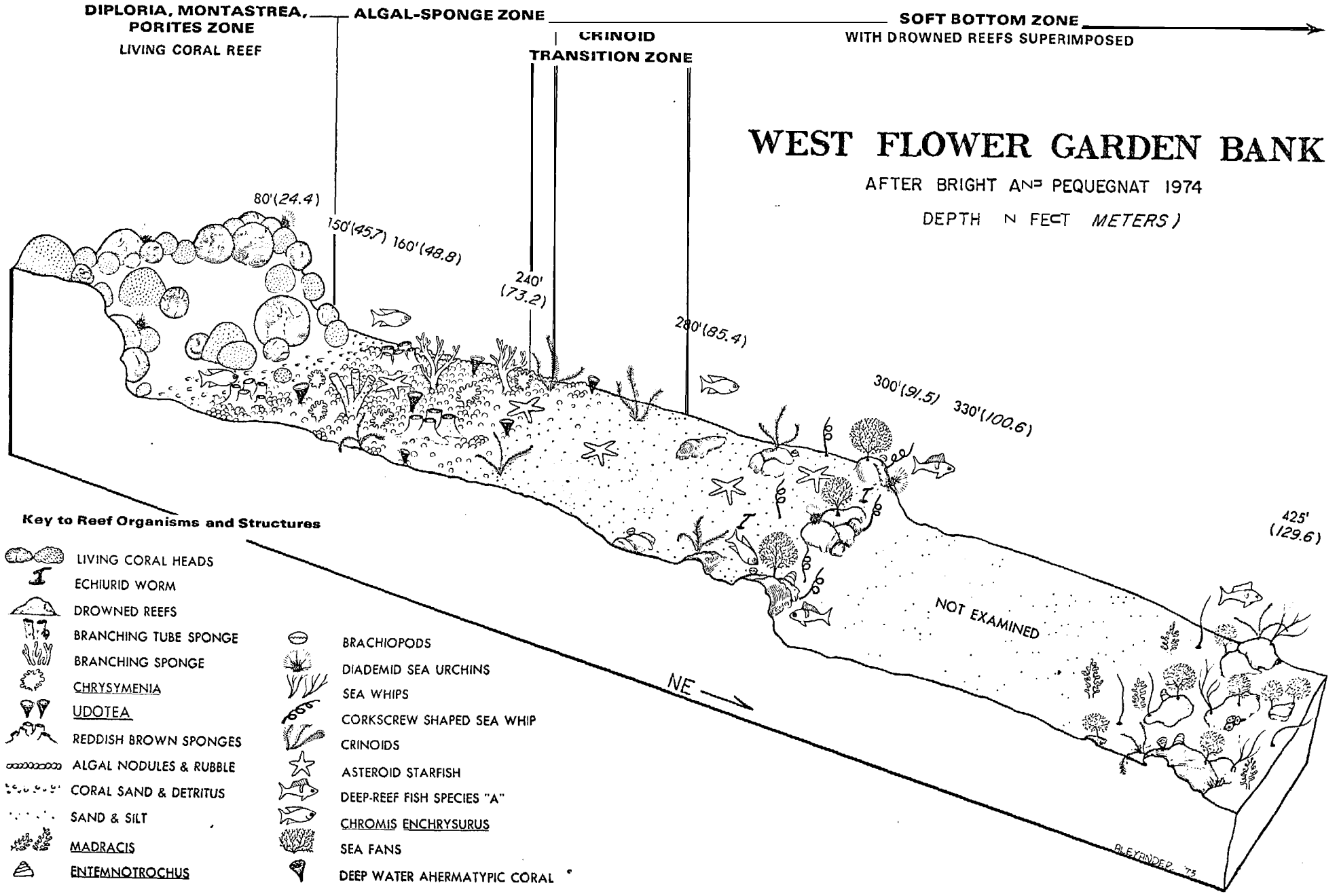

DIPLORIA, MONTASTREA, PORITES ZONE
LIVING CORAL REEF
ALGAL-SPONGE ZONE
CRINOID TRANSITION ZONE
SOFT BOTTOM ZONE
WITH DROWNED REEFS SUPERIMPOSED
WEST FLOWER GARDEN BANK
AFTER BRIGHT AND PEQUEGNAT 1974
DEPTH IN FEET (METERS)
80'(24.4)
150'(45.7)
160'(48.8)
240'(73.2)
280'(85.4)
300'(91.5)
330'(100.6)
425'(129.6)
NOT EXAMINED
NE
Key to Reef Organisms and Structures
LIVING CORAL HEADS
ECHIURID WORM
DROWNED REEFS
BRANCHING TUBE SPONGE
BRANCHING SPONGE
CHRYSYMENIA
UDOTEA
REDDISH BROWN SPONGES
ALGAL NODULES & RUBBLE
CORAL SAND & DETRITUS
SAND & SILT
MADRACIS
ENTEMNOTROCHUS
BRACHIOPODS
DIADEMID SEA URCHINS
SEA WHIPS
CORKSCREW SHAPED SEA WHIP
CRINOIDS
ASTEROID STARFISH
DEEP-REEF FISH SPECIES "A"
CHROMIS ENCHRYSURUS
SEA FANS
DEEP WATER AHERMATYPIC CORAL
BLEXINDER 73

Figure 3. East ‘Flower Garden.

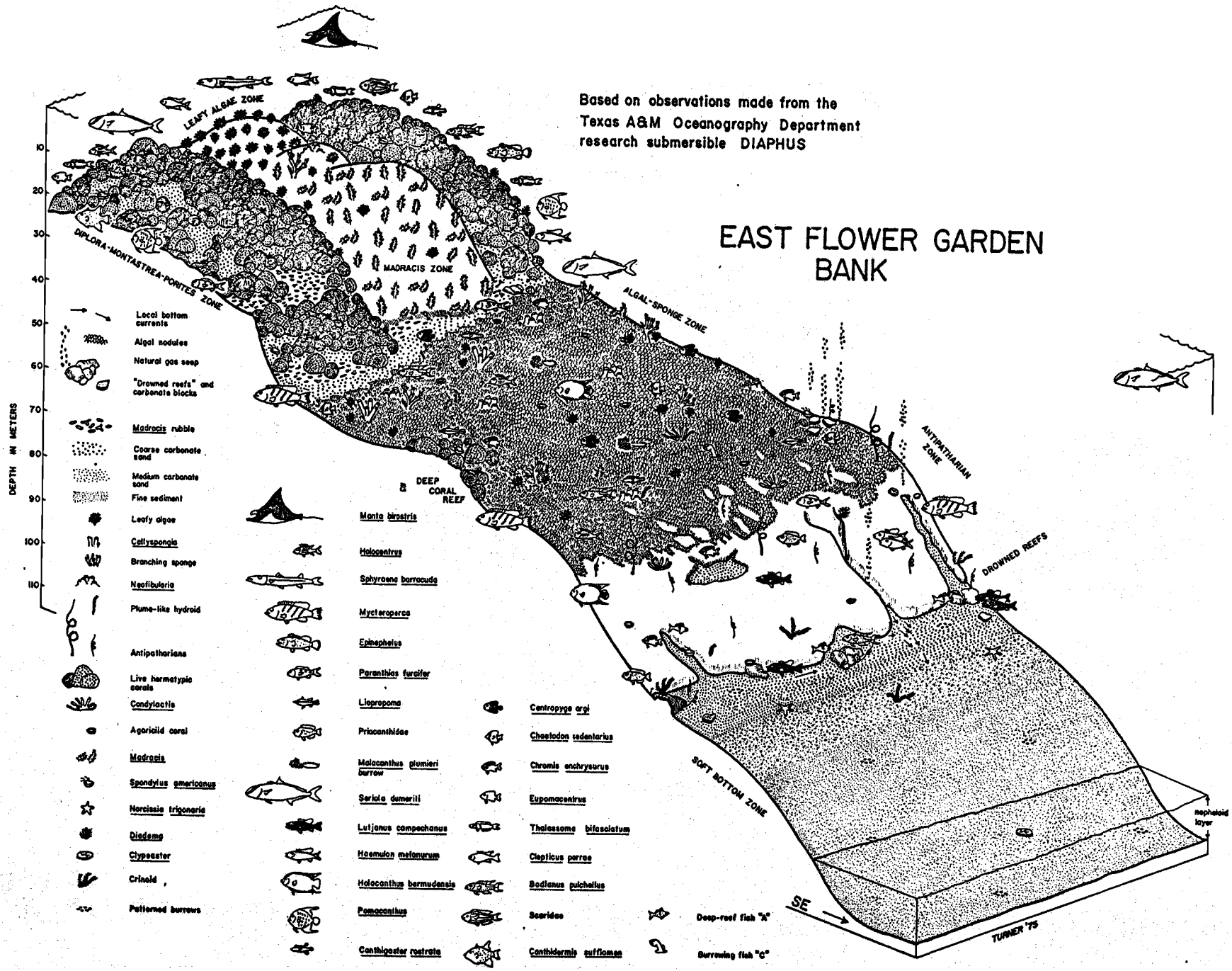
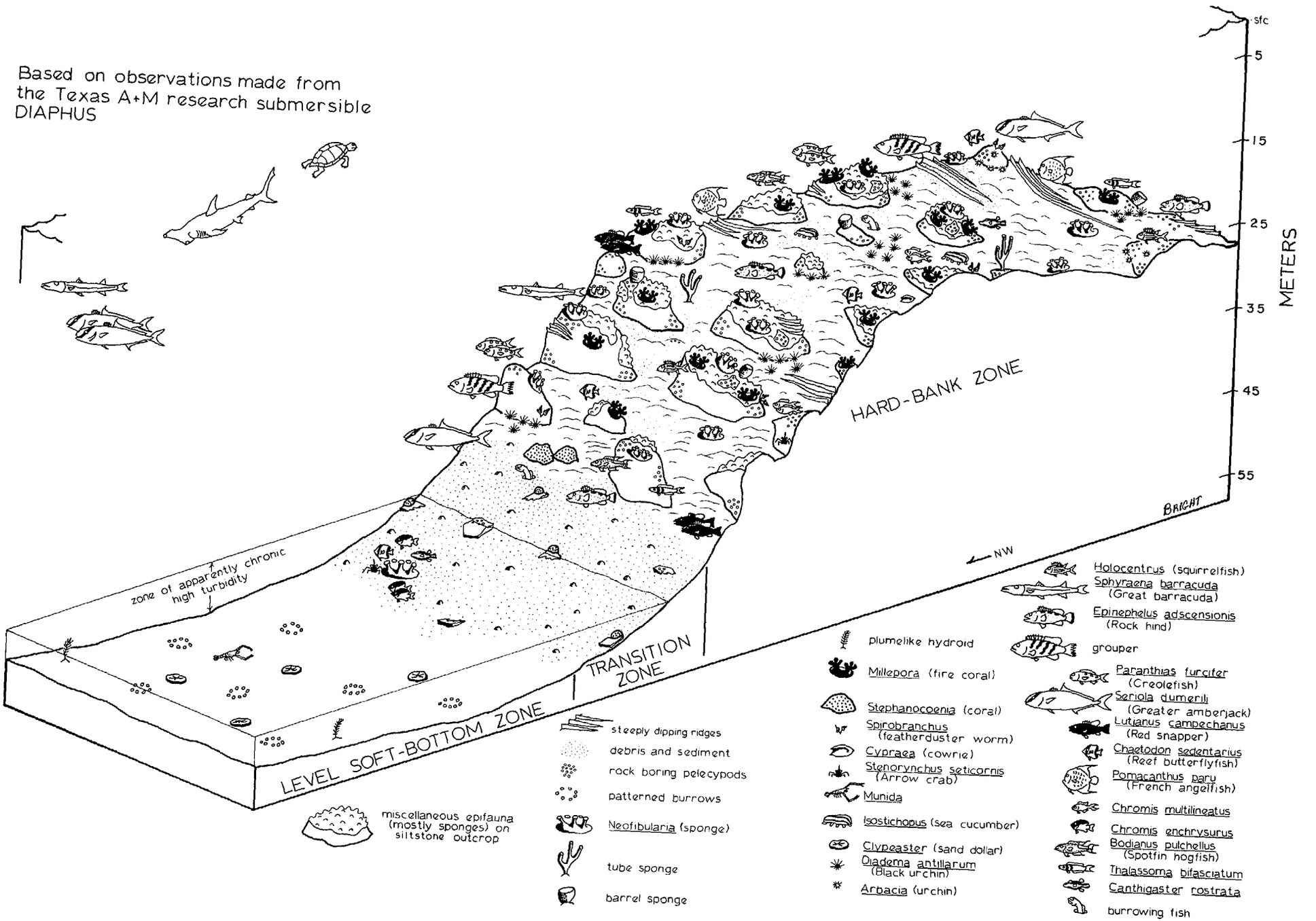

EAST FLOWER GARDEN BANK
Based on observations made from the Texas A&M Oceanography Department research submersible DIAPHUS
LEAFY ALGAE ZONE
DIPLORA-MONTASTREA-PORITES ZONE
MADRACIS ZONE
ALGAL-SPONGE ZONE
ANTIPATHARIAN ZONE
DEEP CORAL REEF
DROWNED REEFS
SOFT BOTTOM ZONE
DEPTH IN METERS
10
20
30
40
50
60
70
80
90
100
110
Local bottom currents
Algal nodules
Natural gas seep
"Drowned reefs" and carbonate blocks
Madracis rubble
Coarse carbonate sand
Medium carbonate sand
Fine sediment
Leafy algae
Callyspongia
Branching sponge
Neofibularia
Plume-like hydroid
Antipatharians
Live hermatypic corals
Condylactis
Agaricild coral
Madracis
Spondylus americanus
Narcissia trigonaria
Diadema
Clypeaster
Crinoid
Patterned burrows
Manta birostris
Holocentrus
Sphyraena barracuda
Mycteroperca
Epinephelus
Paranthias furcifer
Liopropoma
Priacanthidae
Malacanthus plumieri burrow
Seriola dumerili
Lutjanus campechanus
Haemulon melanurum
Holacanthus bermudensis
Pomacanthus
Canthigaster rostrata
Centropyge argi
Chaetodon sedentarius
Chromis enchrysurus
Eupomacentrus
Thalassoma bifasciatum
Clepticus parrae
Bodianus pulchellus
Scaridae
Canthidermis sufflamen
Deep-reef fish "A"
Burrowing fish "C"
nepheloid layer
SE
TURNER '75

Table 1. Organisms encountered by us at various fishing banks, with indications of relative abundances. **** very abundant, *** abundant, ** moderate population, * known to be present, p - Presumed present.

	Claypile	Stetson	East Flower Garden and West Flower Garden			South Texas Fishing Banks	Fishnet
Depths in meters	35-55	28-	2-4	49	76-92	92-107	53-78	61-82
CORALLINE ALGAE								
encrusting		*	***	*	**	*	*	*
nodules				*	*			
Lithothamnium spp.			***	*	**			
Lithophyllum spp.		*	**		*		*	*
CALCAREOUS GREEN ALGAE			*					*
LEAFY ALGAE	**		k**	*	*		*	*
FORAMINIFERS (encrusting)								
Gypsina plana		*	*	*	*			
SPONGES	**	**	* *	*	**	*	**	**
Agelas sp.		*	* *		*	*	*	
Callyspongia spp.	**	*	* *					
Ircinia campana							**	
Neofibularia nolitangere	*	*	*	*	**		*	
Verongia spp.	*		* *	*				
PLUME-LIKE HYDROIDS		*		*	**	**	**	
ALCYONARIAN WHIPS								
Ellisella sp.					*	*		
ALCYONARIAN FANS								
Hypnogorgia sp.					**	**	**	
Scleracis sp.	*						*	*
Thesea sp. "B"				*	*		**	
Thesea sp. "A"					*			
							*	
ANTIPATHARIANS			*	**	***	**	***	***
ANEMONES								
Condylactis sp.			*	**	**			
HYDROZOAN CORALS								
Millepora alcicornis		●	***	*				
ANTHOZOAN STONY CORALS								
Stephanocoenia intersepta		*	*					
Madracis decactis		*	**					
Madracis mirabilis			****					
Madracis asperula				●				
Madracis brueggemanni				*				
Agaricia agaricites agaricites							*	
Saucer-shaped agaricild			**					
Helioceris cucullata			*	* *	*		*	
Siderastrea sidera			*	*				
Porites astreoides	*		*					
Diploria strigosa			t***					
Diploria spp.			t***					
Colpophyllia natans			t***	* *				
Colpophyllia spp.			t**					
Montastrea annularis			***					
Montastrea cavernosa			****					
Scolymia sp.			****	**				
Mussa angulosa			*					
ahermatypic solitary sp. "A"			*					
ahermatypic solitary sp. "B"							*	
ahermatypic solitary					*			


Based on observations made from the Texas A+M research submersible DIAPHUS
sfc
5
15
25
35
45
55
METERS
HARD-BANK ZONE
TRANSITION ZONE
LEVEL SOFT-BOTTOM ZONE
zone of apparently chronic high turbidity
BRIGHT
NW
steeply dipping ridges
debris and sediment
rock boring pelecypods
patterned burrows
Neofibularia (sponge)
tube sponge
barrel sponge
miscellaneous epifauna (mostly sponges) on siltstone outcrop
plumelike hydroid
Millepora (fire coral)
Stephanocoenia (coral)
Spirobranchus (featherduster worm)
Cypraea (cowrie)
Stenorynchus seticornis (Arrow crab)
Munida
Isostichopus (sea cucumber)
Clypeaster (sand dollar)
Diadema antillarum (Black urchin)
Arbacia (urchin)
Holocentrus (squirrelfish)
Sphyraena barracuda (Great barracuda)
Epinephelus adscensionis (Rock hind)
grouper
Paranthias furcifer (Creolefish)
Seriola dumerili (Greater amberjack)
Lutjanus campechanus (Red snapper)
Chaetodon sedentarius (Reef butterflyfish)
Pomacanthus paru (French angelfish)
Chromis multilineatus
Chromis enchrysurus
Bodianus pulchellus (Spotfin hogfish)
Thalassoma bifasciatum
Canthigaster rostrata
burrowing fish

anthozoan corals and fishes. Where the important commercial and sport fishes are concerned, however, Stetson seemingly compares well (Table 2).

Possibly because the crest of Claypile Bank is somewhat deeper, approximately 35 meters, the Millepora-Sponge assemblage occupying Stetson has not developed there. Although the substratum is comparable to that at Stetson the fact that the outcrops are much lower in relief may be significant. The benthic community which has developed at Claypile is a rather limited one composed primarily of several species of leafy algae and a sparse population of sponges. The presence of numerous rock borers reflects the similarity of the outcropping rocks to those of Stetson. In places on Claypile sizeable meadows of leafy algae resembling Sargassum were recorded on videotape, but none was collected and the identification is speculative. The greatest concentrations of fishes were, however, seen in and over these meadows. Our information on Claypile is scanty, but it is obviously occupied by a benthic assemblage which must be categorized separately from those occupying the other banks studied. Corals of any kind are insignificant, although Siderastrea sidera occurs rarely in small knobs several inches in diameter. The fishes seen there all occur on the Flower Garden Banks, but the most conspicuous species, one which we have not yet identified and therefore call burrowing fish "C," has been seen by us at the Flower Gardens only below the coral reefs.

Twenty-eight Fathom Bank, unlike Stetson, 3 Hickey, and Claypile, is comparable to those parts of the East and West Flower Garden Banks designated Algal-Sponge Zone in Figures 2 and 3. A comparison of Table 3 with the two columns in Table 1 covering the 49-92 meter depth range at the Flower Gardens shows that the diverse populations on all three banks are extremely similar within that depth range. Twenty-eight Fathom Bank, however, lacks

Table 2. Summary of results of hook-and-line fishing from our research vessels, 1972-1975. *** most frequently caught,** often caught, * sometimes caught.

	EFG + WFC	Stetson	South Texas Fishing Banks
Carcharhinid sharks	*		**
Gymnothorax spp. morays	*		*
Enchelycore nigricans Viper moray	*		
Holocentrus spp. squirrelfishes	***	**	**
Sphyraena barracuda Great barracuda	**	**	***
Epinephelus guttatus Red hind	*		
Epinephelus adscensionis Rock hind	**	**	
Epinephelus cruentatus Graysby	***		
Mycteroperca spp. groupers	**	*	*
Dermatolepis inermis Marbled grouper	*		
Paranthias furcifer Creole fish	*	*	*
Priacanthidae bigeyes	**	**	
Malacanthus plumieri Sand tilefish	**		*
Rachycentron canadum Cobia			**
Seriola dumerili Greater amberjack	***	***	***
Caranx spp. jacks	**	**	*
Selene vomer Lookdown			*
Coryphaena hippurus Dolphin	*		* juveniles
Scomberomorus spp. mackerels	*	*	*
Lutjanus campechanus Red snapper	***	***	***
Lutjanus spp. snappers	*	*	*
Rhomboplites aurorubens Vermilion snapper	***	***	***
Haemulon melanurum Cottonwick	***	***	***
Calamus spp. porgies	**	*	*
Pomacanthus spp. angelfishes	*	*	
Acanthurus spp. surgeonfishes	*	*	
Balistes vetula Queen triggerfish	**	*	
Balistes capriscus Gray triggerfish		*	
Canthidermis sufflamen Ocean triggerfish	*		
Melichthys niger Black durgon	*		

Table 3. Conspicuous benthic organisms and groundfishes seen at Twenty-eight Fathom Bank. Depths given indicate our observations only and do not preclude presence of the species at other depths.

	Depths of observation (meters)	Comments
Algae		
Coralline algae	52-91	Probably Lithothamnium and Lithophyllum. Forming nodules. Encrusting outcrops and rubble.
Soft algae	52-67	Probably extends somewhat deeper.
Sponges		
Neofibularia	52-61	
Agelas	61	
Anemones		
Condylactis	61	
Antipatharians	52-85	
Echinoderms -		
Sea cucumber	55	Probably Isostichopus.
Comatulid crinoids	67-88	
Fishes		
Holocentrus spp.	67	
Mycteroperca spp.	52-67	
Paranthias furcifer	67	Dense schools.
Epinephelus spp.	52-67	
Malacanthus plumieri	52-61	
Seriola dumerili	55-67	
Lutjanus campechanus	61	
Equetus spp.	52	
Chaetodon sedentarius	67	
Holacanthus sp.	67	Either H. bermudensis or H. ciliaris.
Pomacanthus paru	52-67	
Centropyge argi	61	
Chromis enchrysurus	52-88	Very abundant.
Bodianus pulchellus	67-88	
Balistes capriscus	67	
Balistes vetula	52-67	
Xanthichthys ringens	67	Sargassum triggerfish.

the coral reef and other communities which cap the Flower Garden Banks. The bottoms in the Algal-Sponge Zones of all three banks are covered primarily with nodules (up to fist size and larger) composed of encrustations of coralline algae, mostly Lithothamnium with some Lithophyllum, and lesser amounts of the encrusting foraminifer Gypsina plana (Hogg, 1975; Abbott, 1975). The coralline algae are important and abundant on the coral reef as well as in the Algal-Sponge Zone and they extend significantly onto the Drowned Reefs to depths exceeding 90 meters. In the lower reaches of the Algal-Sponge Zone the nodules give way to coralline algal crusts adhering to the hard carbonate substratum. The coralline algae decrease downward in percent cover but are still quite abundant in depths of 80 meters or more. Among and attached to the nodules is a sizeable population of leafy algae, generally the same organisms which occur in the Leafy Algae Zone at the East Flower Garden. Sponges are very conspicuous, particularly the encrusting Neofibularia nolitangere oxeata, the tube sponge Callyspongia vaginalis, and the branching Verongia sp. Other particularly conspicuous invertebrates of this zone are small saucer-shaped growths of agariciid stony corals and a large anemone, Condylactis sp. The expected fishes are seemingly as abundant at Twenty-eight Fathom Bank as in similar depths at the Flower Gardens, the commercial species being well represented.

Natural gas seeps issue abundantly from Twenty-eight Fathom Bank and the East Flower Garden below the coral reef. These seeps are intermittent in nature and characteristically emit repeated short bursts of several to hundreds of bubbles, each less than one inch in diameter. There is no evidence that such seeps have had any effect on the benthic populations. We have observed very small amounts of white mucus-like material at the points from which gas escapes the rock. No such “deposits” have been detected

where gas escapes through sand, although the bottom of a large surge channel at 70-80 meters at the East Flower Garden was found to be totally covered with a similar-appearing substance. Speculation that fishes are attracted to gas seeps have not been confirmed by our observations. The fish are nearly always inclined to position themselves over or beside rocks, outcrops, or bottom irregularities. Where they occur, the gas seeps happen also to be associated with these features. However, fishes congregating nearby seem to be oblivious of the gas, showing no behavior which would indicated an affinity for it. In addition to the East Flower Garden and Twenty-eight Fathom Banks, gas seeps have been seen by us at Fishnet, Claypile, and Baker.

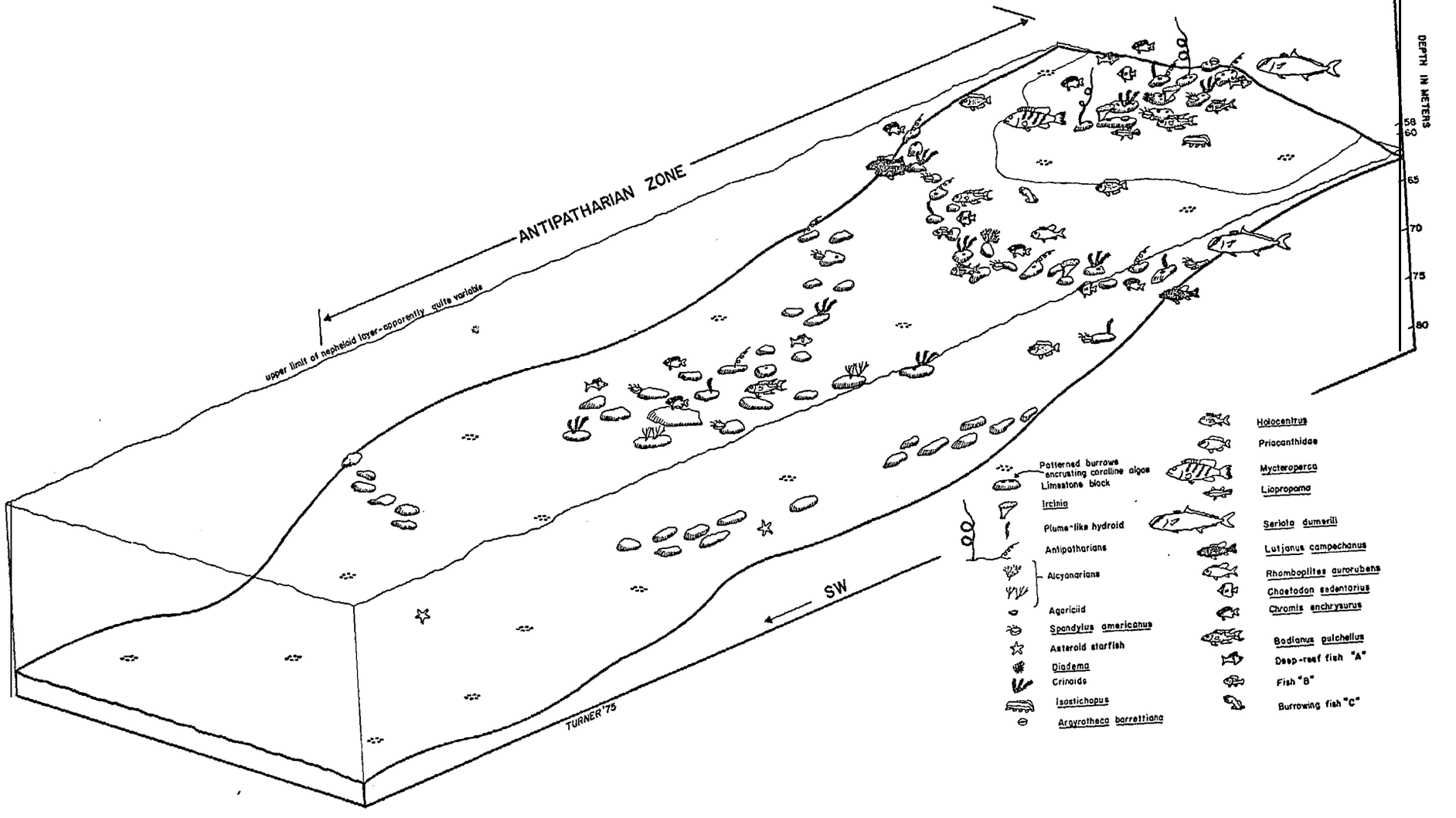
The deepest hard-bank assemblage examined by us (Antipatharian Zone, Fig. 5) occupies all of the South Texas Fishing Banks visited (Baker, South Baker, North Hospital, Hospital Rock, Southern, Dream, and Big Adam). We presume it also occurs at Aransas Bank, but we have no observations there. Fishnet Bank bears the Antipatharian Zone biota as do the Drowned Reefs and portions of the Flower Garden Banks adjacent to them.

The Antipatharian Zone represents a transition downward from the shallow-water benthic biota to a truly deep-water assemblage (Table 1). Interestingly, whereas the assemblage is developed at the crests of the South Texas Banks (53 meters or so), truly comparable deep-water populations at the Flower Gardens usually start at depths greater than 70 meters. The generally clearer water at the Flower Gardens may be a factor here, particularly in influencing the lower limit of lush coralline and soft algal growth. Missing from the zone proper are any stony corals except sparse populations of the saucer-shaped agariciid, a small species of Madracis, and solitary ahermatypic varieties. Lithophyllum is present in reduced quantities, and leafy algae are sparse. Present are abundant populations

Figure 5. Southern Bank, representative of the South Texas Fishing Banks.

Based on observations made from the
Texas A&M Oceanography Department
research submersible DIAPHUS

SOUTHERN BANK



of comatulid crinoids, deep-water alcyonarian fans, deep-reef fish "A" and fish "B, " all of which are either absent from or rare above 76 meters. The most conspicuous organisms in this zone are the bedspring-shaped white antipatharian "sea whips." Whereas their depth range extends almost to the coral reef, they are very rarely seen shallower than 55 meters at the Flower Gardens (Fig. 2 & 3). On the South Texas Fishing Banks and Fishnet they are abundant from the crests down, thinning out with depth. The South Texas Banks apparently differ from the others in their possession of conspicuous populations of the large white sponge Ircinia campana.

The deep-reef fish *'A" is a particularly reliable indicator of this assemblage. It has not been seen shallower than 80 meters at the Flower Gardens but occurs from the crests downward at Fishnet and the South Texas Banks. The Yellowtail reeffish, Chromis enchrysurus, is undoubtedly the most abundant species of its size, 5-10 cm., on the Texas-Louisiana banks below 50 meters and within the Antipatharian Zone particularly. It frequents all of the banks in schools of up to several hundred, though it occurs in smaller groups and singly. At least in the Spring, Chromis enchrysurus occupies territories and engages in agonistic behavior toward other fishes in which it changes temporarily from its typically dark-above/light-below coloration to a dusky gray. Although we have no evidence to indicate it, the species would seem to be an ideal forage fish for snappers and groupers.

The South Texas banks are particularly subject to nearly total inundation by the thick nepheloid layers (turbid water layers) which overlie the predominantly soft bottom of the Texas-Louisiana Outer Continental Shelf (Fig. 5). Off South Texas the difference between relief of the hard-banks and thickness of the nepheloid layers is so little that it is probable that most of the time only the top 10 or so meters of the banks are in relatively

clear water. We strongly suspect that during storms or prolonged heavy weather the banks are entirely covered by turbid water. Even the rocks at the tops of these carbonate banks are covered with a thin veneer of find sediment wherever the sparse epifauna and coral line algae do not occur. It is our impression that the epifauna and coral line algal encrustations are best developed at the crests of these banks and tend to decrease in abundance downward into the nepheloid layer. The nepheloid layerwe observed at Stetson Bank was well down toward its base (Fig. 4), those at the Flower Gardens were well off the hard-banks altogether (Fig. 2 & 3), and that at Fishnet started at 80 meters (Fishnet crests at about. 61 meters). The Flower Gardens are, therefore, because of their position at the edge of the continental shelf, bathed perpetually by clear oceanic water. Stetson is probably subject to occasional heavy doses of turbid neritic water, while the South Texas Banks must frequently be covered by the nepheloid layer. We speculate, therefore, that the assemblages of the South Texas Banks are rather adapted to turbid water conditions, whereas those of Stetson and the Flower Gardens are possibly less tolerant.

Even so, there seem to be indications that biota of the Antipatharian Zone thrive better in clear water. Certainly they are more numerous on the Drowned Reefs at the Flower Gardens than on the South Texas Banks, and appear to be better developed at the tops of the South Texas Banks than on their flanks. Big Adam Rock which has relatively little relief above the surrounding soft bottom was entirely covered by the nepheloid layer when we examined it. We found that it has a much sparser benthic population than those of its neighbors a few miles north. Fishnet Bank, on the other hand, with a nepheloid layer somewhat farther down on its sides, appeared to us to harbor a more diverse and abundant Antipatharian Zone population

than any of the South Texas Banks. However, speculations concerning the significance of the nepheloid layer as a controlling environmental factor are as yet unconfirmed.

Though Lutjanus campechanus and Rhomboplites aurorubens were about as abundant on the South Texas Fishing Banks as on the northern banks, we were surprised at the few sightings and hook-and-line captures of Mycteroperca in the south. Moreover, though we expected to encounter them, there were no sightings or captures of species of Epinephelus on the South Texas Banks. Fishnet Bank, on the other hand, harbored at least a moderate population of Mycteroperca, as do the lower reaches of the Flower Gardens, and Epinephelus was present. If indeed the groupers and hinds are less abundant on the South Texas Banks, the reasons are not apparent. We raise the question only because there is a possibility that there should be some concern *over* the status of the serranid populations off South Texas.

On the other hand we point out that on the banks from Stetson north we have observed large schools of good-sized Creole fish, Parathias furcifer, and the species is sometimes caught on hook-and-line. We wonder if this species as well as the Cottonwick, Haemulon melanurum, which is abundant and easily caught on all the banks, may deserve some consideration as future commercial fishery potentials.

GEOLOGY OF THE BANKS

The banks of the Texas Outer Continental Shelf may be divided into two main groups. Those banks north of 27° 46′ N. Lat. are associated with salt domes in the subsurface and their distribution is generally the same as the distribution of shallow salt domes. The banks south of 27° 46′ N. Lat. are

not associated with any shallow subsurface structures and their distribution is most probably controlled by an ancient shoreline at approximately -60 meters during the Late Pleistocene.

The relief on the banks is quite variable with those banks in the northern area generally having greater relief. 28 Fathom Bank has the greatest amount of relief with a maximum of 118 meters in a distance of 2200 ft. The least amount of relief is on 32 Fathom Bank with a total of 6 meters in a distance of 10,500 ft.

Banks such as those described here occur on the outer shelf eastward to the head of the Mississippi Canyon. The crests of these banks increase in depth towards the east, the deepest one is in the Mississippi Canyon at a depth of 98 fathoms. This increase in depth of crests is due to downwarping of the shelf caused by the weight. of the Mississippi Delta.

All of the banks are covered by a heavy growth of coral and coralline algae except for Stetson and Claypile Banks. These two banks are the only ones known to have outcrops of Tertiary bedrock exposed at the surface of the bank. Some of the banks such as the West and East Flower Gardens are living coral reefs. Most of the banks are covered by dead reefs (drowned reefs) that were living from 6,000 to 18,000 years ago at times when sea level was considerably lower than it is at present.

Northern Banks

Direct geological observations using submersibles have been made at West Flower Garden, East Flower Garden, 28 Fathom, Stetson, and Claypile Banks. Typical of the larger banks on the northern shelf is the occurrence of gently sloping terraces covered with sediment bounded by steep rocky

cliffs. These terraces and associated cliffs are especially obvious on the West Flower Garden and 28 Fathom Banks. The rocky cliffs represent drowned reefs that are now dead but were flourishing during a lower stand of sea level. Scattered over the terraces are isolated patch reefs that developed as sea level rose. These features are well illustrated on the chart of the West Flower Garden Bank. The rocky cliffs, patch reefs, as well as the irregular parts of the hard substrate of the Algal-Sponge Zone are places where large schools of snapper, grouper, creole fish, barracuda and jacks seem to congregate. There are three drowned reef levels at the West Flower Garden Bank. They occur at -56, -91, and -128 meters. At the East Flower Garden Bank there is one large drowned reef that occurs from about -63 meters to a depth of -85 meters. At 28 Fathom Bank drowned reefs occur at -52, -56, -80 and -90 meters on the north side and a single reef from -100 to -170 meters on the south side.

The sediments that surround the actively growing reefs are coarse sands and gravels grading into finer sediments with increasing depth of water. The distribution of sediment types on the West Flower Garden is typical of the actively growing reefs. At the crest of the reef, between the large coral heads, a coarse coral-molluscan sand covers the bottom. This sand is moved by severe storms into chutes that carry it to the base of the reef where it is spread by currents into a narrow band immediately adjacent to the base of the reef at depths of from -45 meters to -49 meters. Close to the base of the reef are large blocks of reefrock that have been torn loose by storms and tumbled down the steep slopes. Beginning at a

depth of about -49 meters and extending to a depth of about -73 meters the bottom is covered by a coarse gravel composed of nodules of coralline algae. This sediment is the substrate of the Algal-Sponge Zone illustrated in Figure 2. From -85 meters to a depth of -106 meters the sediment consists of a foraminiferal-coral-coral line algae sand. Below -106 meters the sand gives way to the sandy, silty clays that are the normal deposits of the outer continental shelf.

32 Fathom Bank has a very low relief but the nature of the record on the precision depth recorder indicates a hard bottom. No direct observations nor sampling have been conducted at 32 Fathom Bank. However, our experience with other banks at comparable depths indicates that the bottom there should be covered with the hard, coralline algae nodules typical of the Algae-Sponge Zone.

Southern Banks

Direct geological observations have been made on Baker, South Baker, North Hospital, Hospital Rock, Southern, Dream, and Big Adam. The greatest relief on the southern group of banks is found on Southern with a maximum relief of 22 meters, with the average relief on the other banks being about 10 to 12 meters. As mentioned earlier, these banks differ from the northern banks in that they are not associated with salt domes. The banks are all drowned reefs that were thriving coral-algae reefs during lower stands of sea level.

Southern Bank is typical of this group and the diagram in Figure 5

illustrates the nature of the bottom topography. Three levels of reef development are shown at -72, -68, and -63 meters. These are identical to the massive rocky, drowned reefs of the northern banks but have very little relief. The substrate between these reef levels is a pavement of dead coral line algae covered by a thin film of fine clay and silt size sediment deposited from the nepheloid layer which more or less continuously covers these banks.

As these reefs are no longer actively growing, the coarse, gravelly and sandy sediments that are found surrounding actively growing reefs to the north are not present at the surface. Sediment cores taken adjacent to the drowned reefs show the sandy and gravelly sediment to be covered by about a foot of sandy and silty clay.

SUMMARY

Biotic assemblages on reefs and hard-banks of the Texas-Louisiana Outer Continental Shelf can be distinctly grouped according to their natures into four general categories: 1) the sparse Claypile Bank biota (35-55 meters) of predominantly low-growing filamentous and leafy algae and sponges with occasional "meadows" of high-standing leafy algae occupied by numerous fish; 2) the more diverse Stetson and 3 Hickey Rock biota (28-56 meters) dominated by the hydrozoan fire coral Millepora alcicornis and sponges; 3) the highly diverse and abundant Flower Gardens/Twenty-eight Fathom Bank biota with coral reefs (22-49 meters), algal nodule and sand-covered platforms (45-76 meters), and Drowned Reefs (76-100+ meters, bearing an assemblage of organisms directly comparable to the deep-water biota of category 4 described below); 4) the deep-water biota of the South Texas Fishing Banks (53-78 meters) and Fishnet Bank (61-82 meters) characterized by the presence of antipatharian whips, deep-water alcyonarian fans, comatulid crinoids, certain species of deep-dwelling fishes, and sparse populations

of encrusting coralline algae.

Commercial snappers and groupers frequent all of the banks, though there is a possibility that serranid populations may be smaller on the South Texas Banks than on the others. The most abundant conspicuous fish on the banks, excluding the coral reefs at the Flower Gardens, is the small Yellowtail reffish, Chromis enchrysurus.

ACKNOWLEDGEMENTS

We thank the following people for their help in identifying specimens: Robert Abbott, Bart Baca, Dr. Elenor Cox, Charles Giammona, Arthur Leuterman, Glen Lowe, Dr. Linda Pequegnat, Jack Thompson (all from Texas A&M University}, and Joyce Teerling (Ecosystems Inc. of New Orleans, Louisiana).

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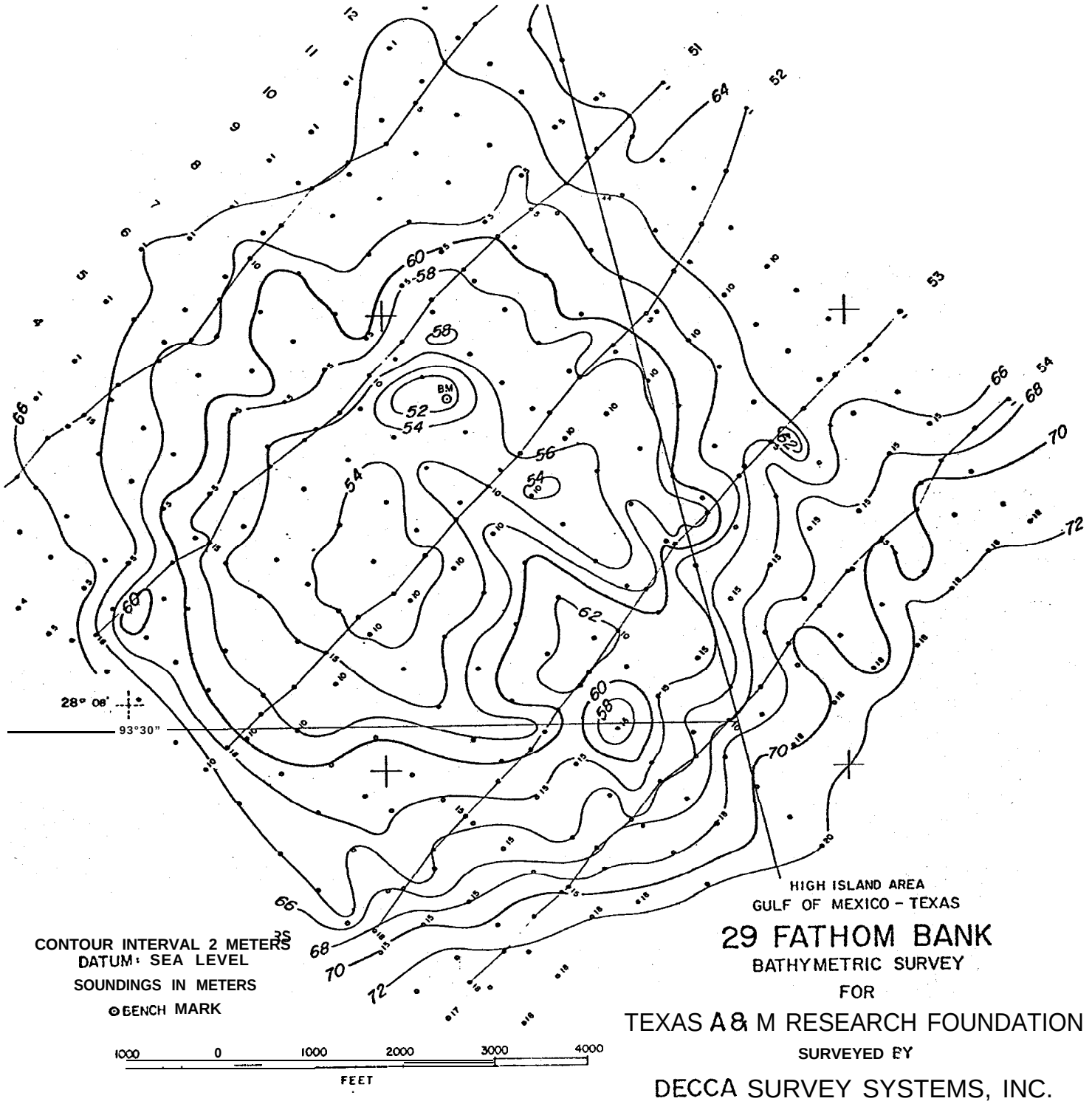
MAPS
(Stetson Bank contours in feet)



HIGH ISLAND AREA
GULF OF MEXICO - TEXAS

29 FATHOM BANK

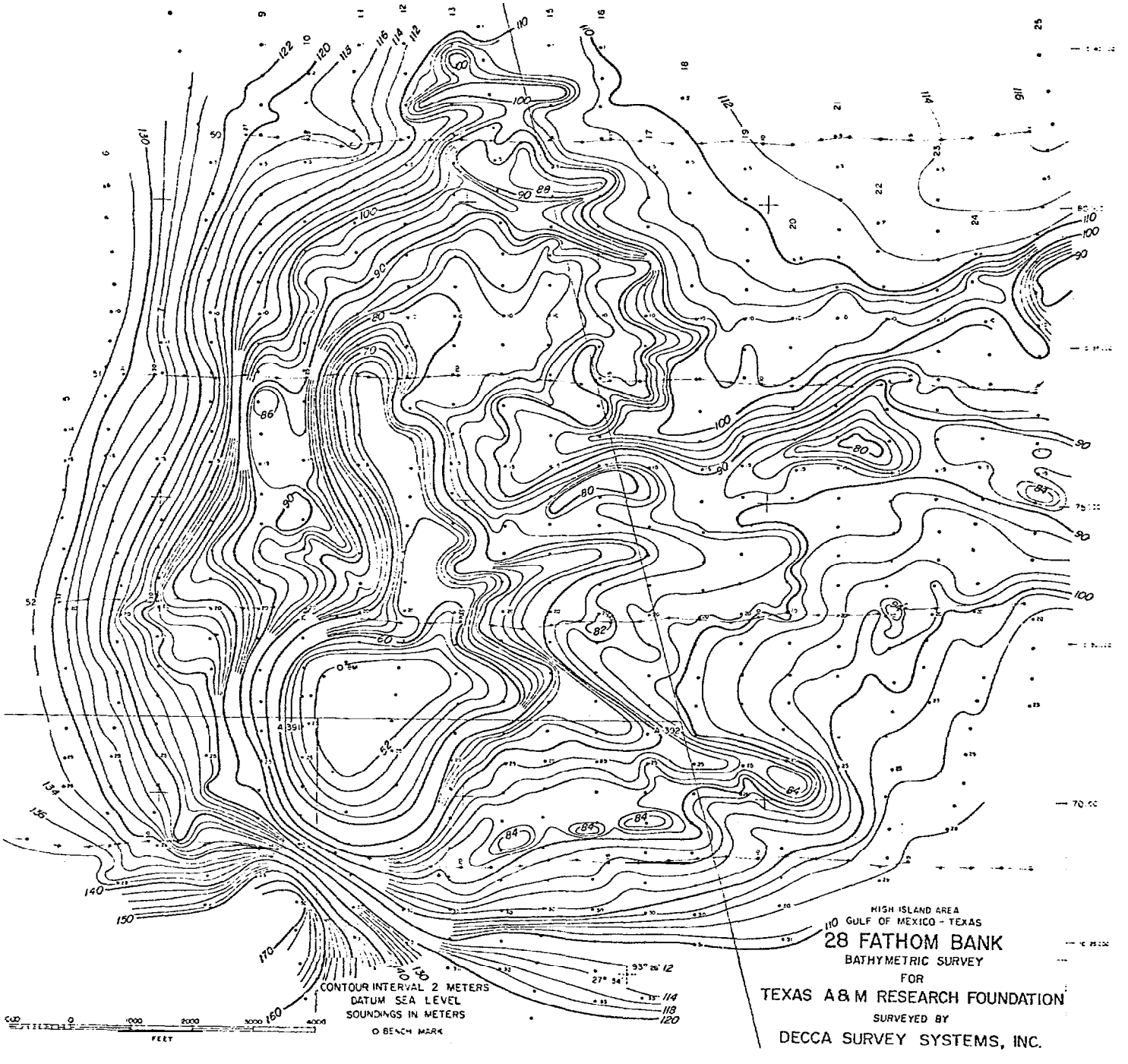
BATHYMETRIC SURVEY

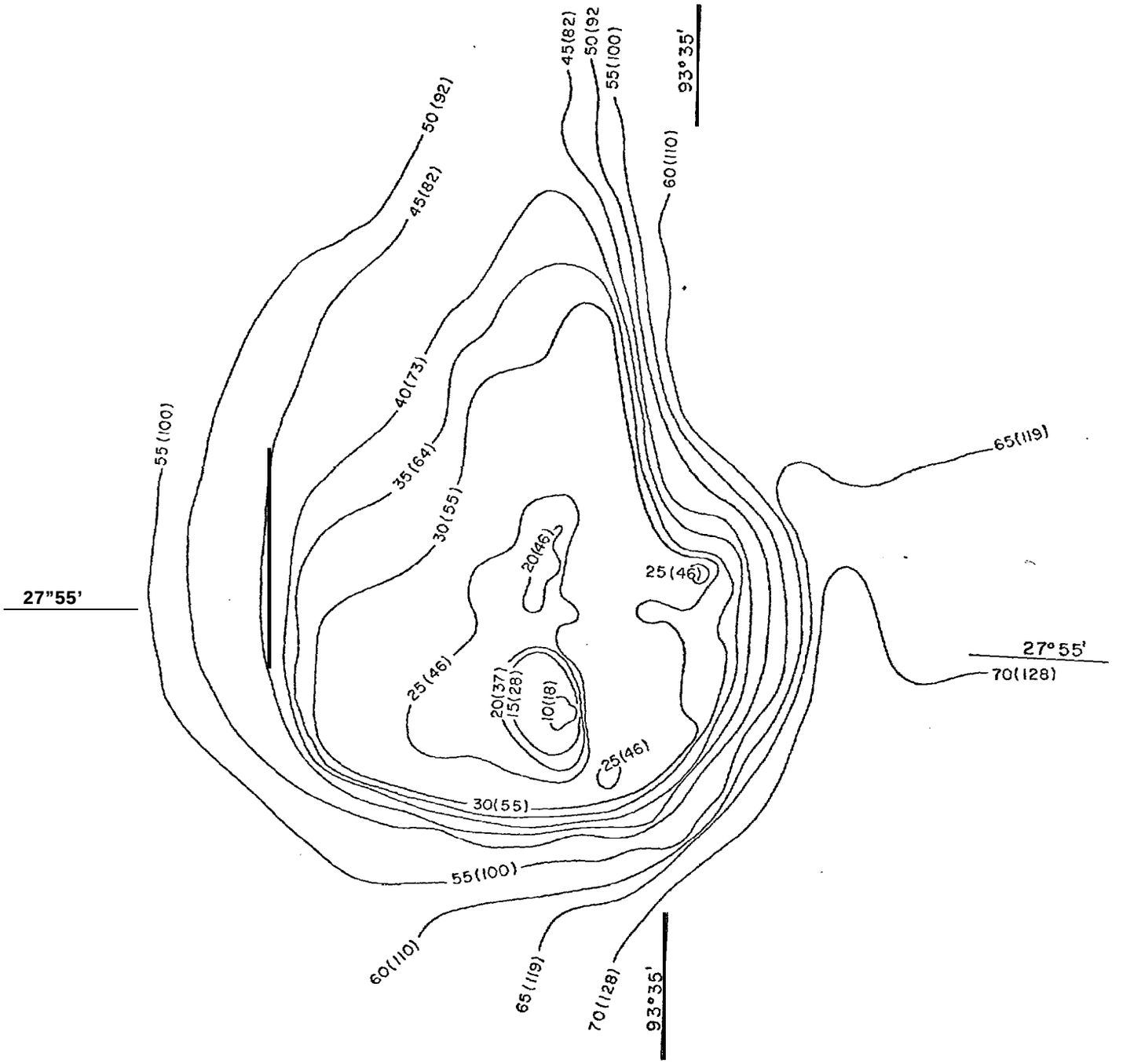
FOR

TEXAS A&M RESEARCH FOUNDATION

SURVEYED BY

DECCA SURVEY SYSTEMS, INC.


CONTOUR INTERVAL 2 METERS
DATUM SEA LEVEL
SOUNDINGS IN METERS
BENCH MARK
FEET
HIGH ISLAND AREA
GULF OF MEXICO - TEXAS
28 FATHOM BANK
BATHYMETRIC SURVEY
FOR
TEXAS A&M RESEARCH FOUNDATION
SURVEYED BY
DECCA SURVEY SYSTEMS, INC.



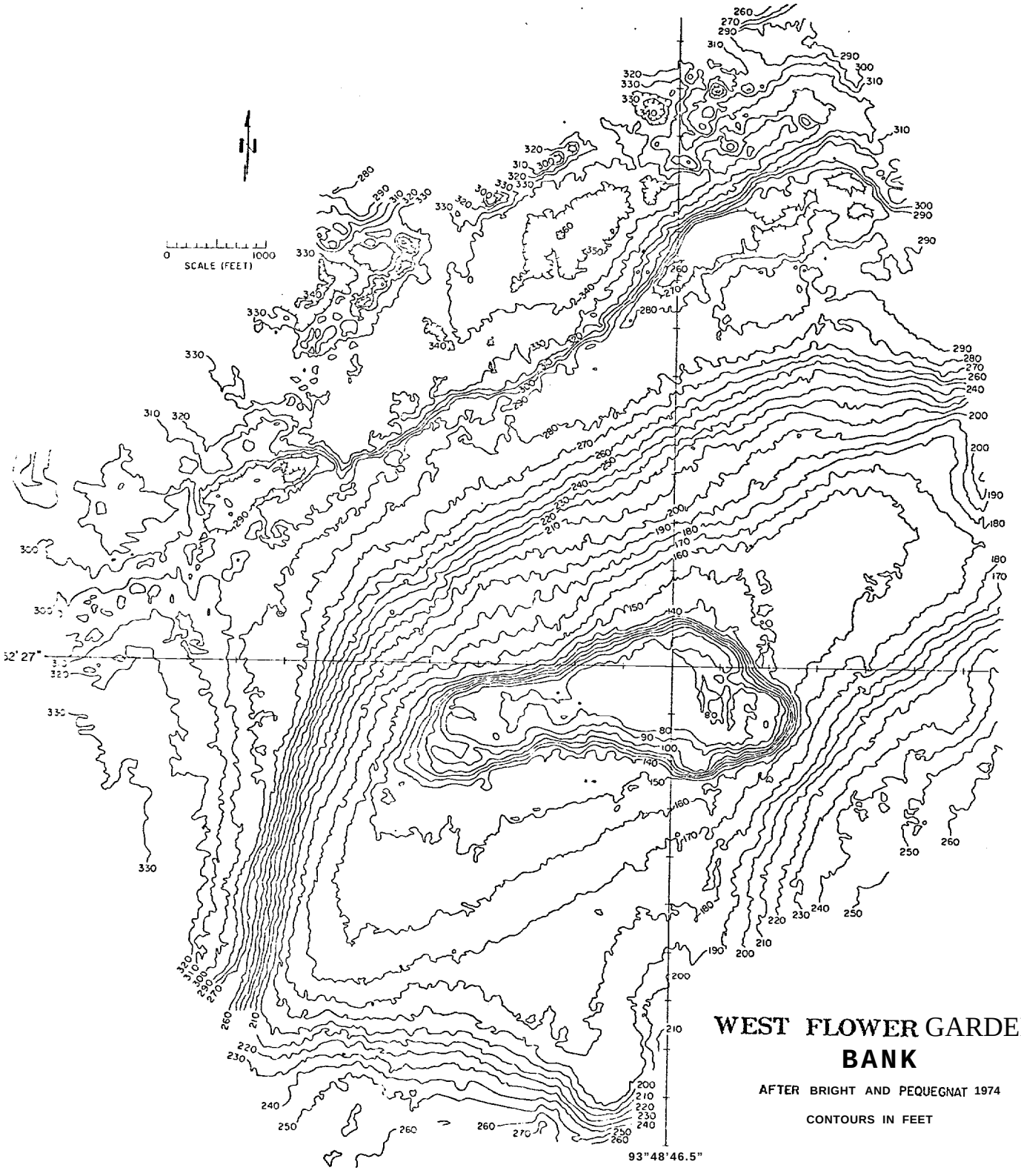
EAST FLOWER GARDEN BANK

AFTER PARKER AND CURRAY 1956

CONTOURS IN FATHOMS (METERS)

0 1 2

STATUTE MILES



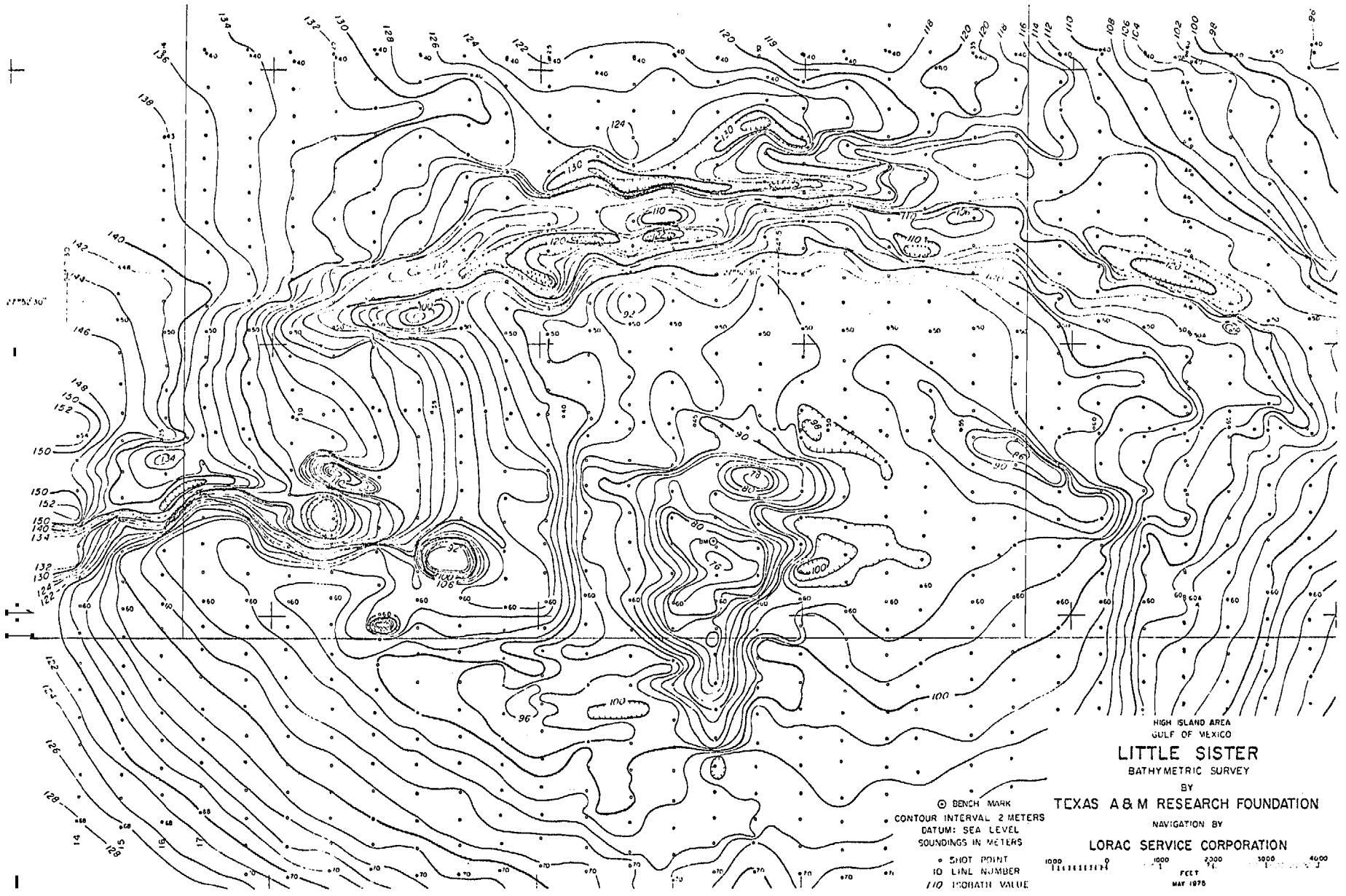
WEST FLOWER GARDEN BANK

AFTER BRIGHT AND PEQUEGNAT 1974

CONTOURS IN FEET

STETSON BANK BATHYMETRY

FROM C. NEUMAN 1958


HIGH ISLAND AREA
GULF OF MEXICO
LITTLE SISTER
BATHYMETRIC SURVEY
BY
TEXAS A & M RESEARCH FOUNDATION
NAVIGATION BY
LORAC SERVICE CORPORATION
⊙ BENCH MARK
CONTOUR INTERVAL 2 METERS
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SOUNDINGS IN METERS
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10 LINE NUMBER
110 ISOBATH VALUE
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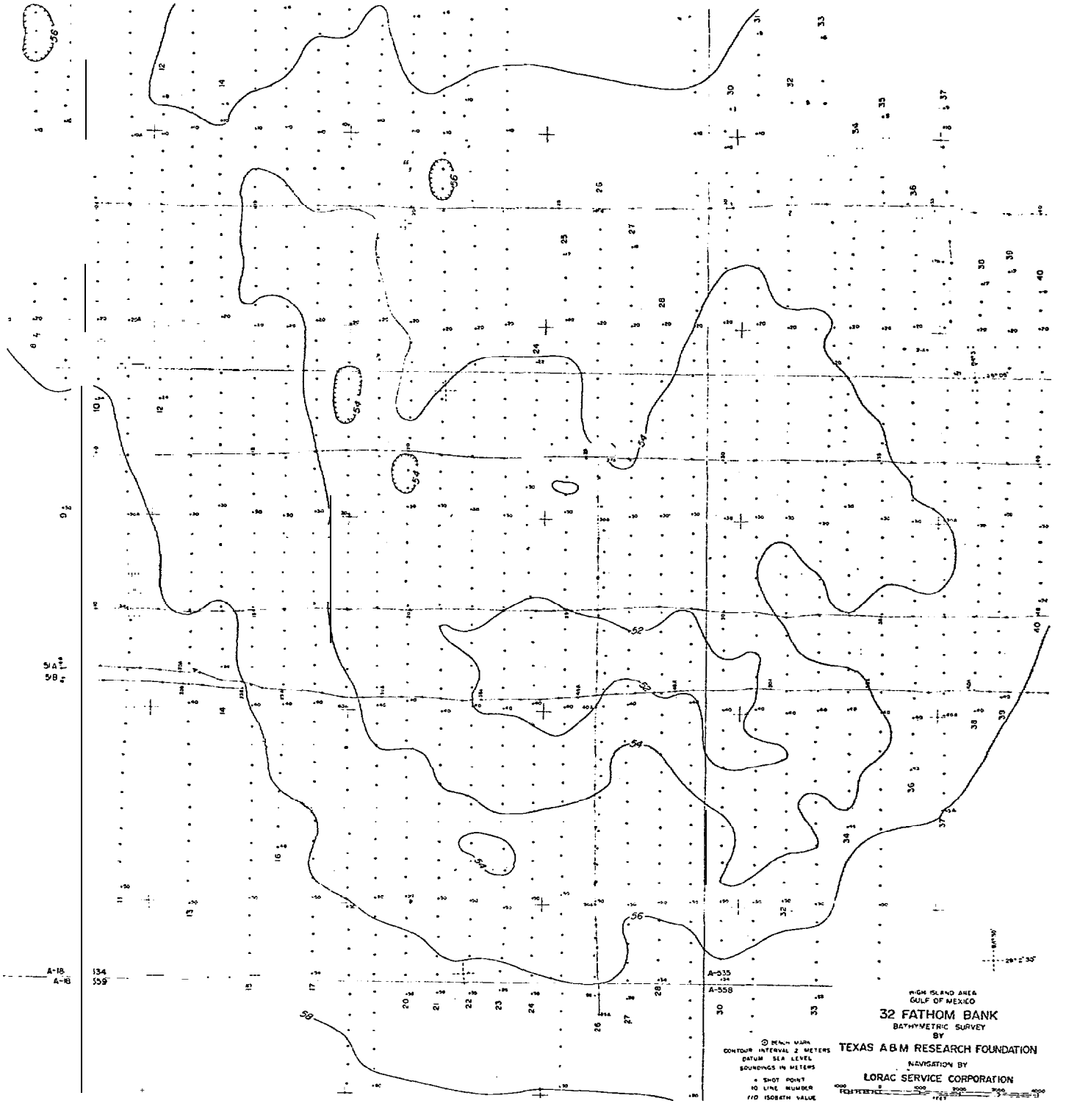
FEET
MAY 1975


HIGH ISLAND AREA
GULF OF MEXICO
32 FATHOM BANK
BATHYMETRIC SURVEY
BY
TEXAS A&M RESEARCH FOUNDATION
NAVIGATION BY
LORAC SERVICE CORPORATION
CONTOUR INTERVAL 2 METERS
DATUM SEA LEVEL
SOUNDINGS IN METERS
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A-558
A-18
A-18
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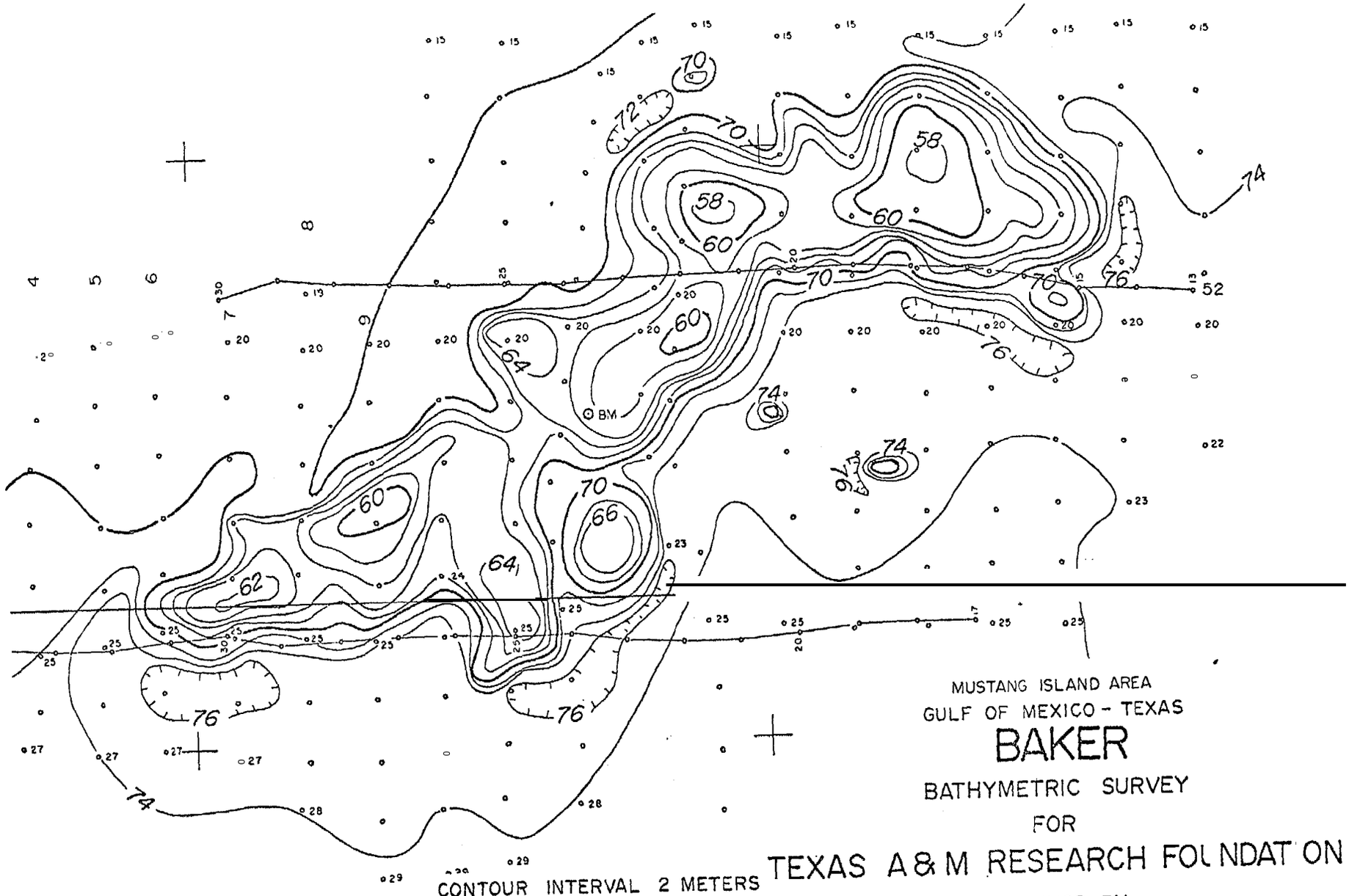
559
5/A
5/B



MUSTANG ISLAND AREA

GULF OF MEXICO - TEXAS

BAKER

BATHYMETRIC SURVEY

FOR

TEXAS A&M RESEARCH FOUNDATION

SURVEYED BY

DECCA SURVEY SYSTEMS, INC.

CONTOUR INTERVAL 2 METERS

DATUM: SEA LEVEL

SOUNDINGS IN METERS

⊙ BENCH MARK

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96° 14'

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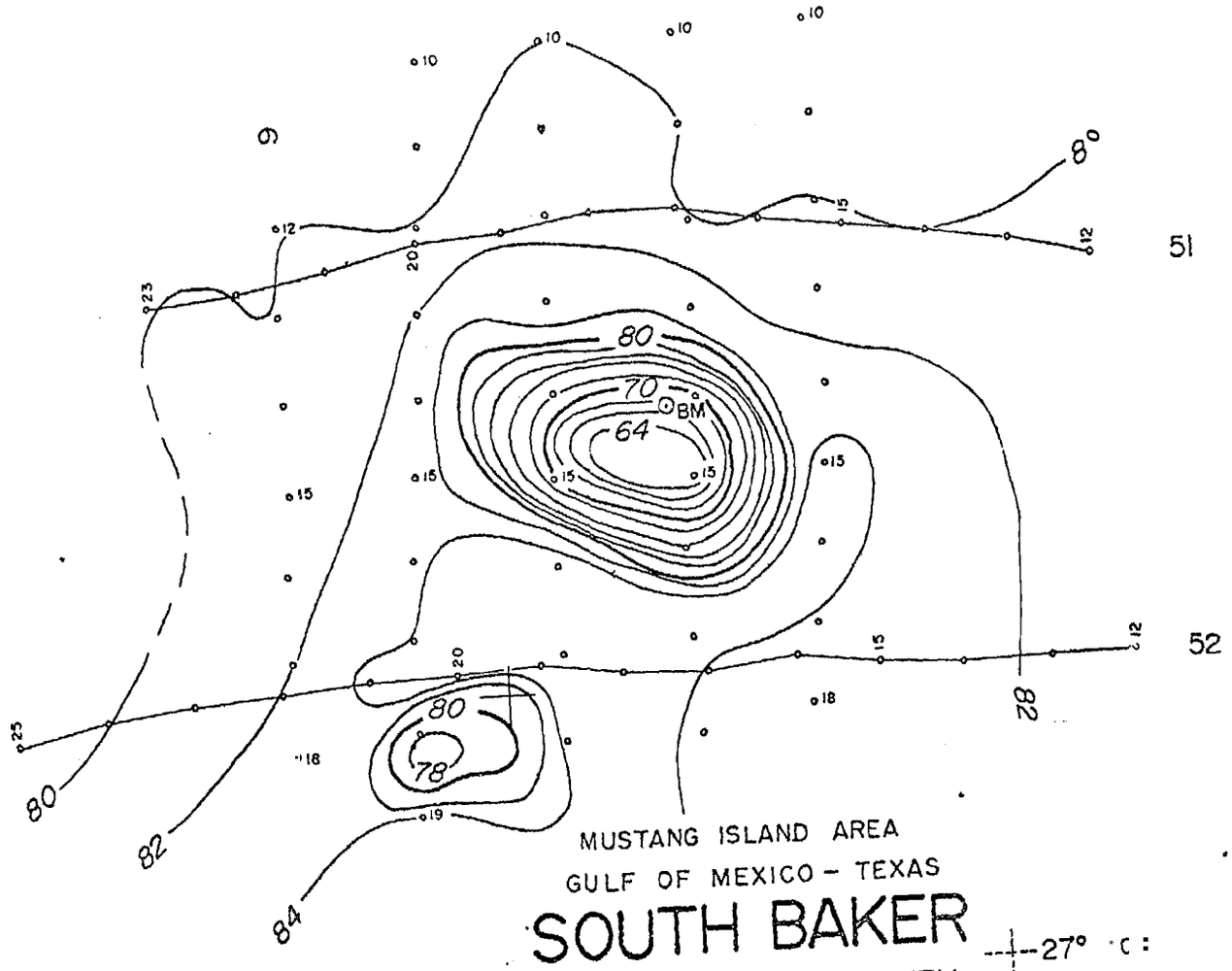
FEET



MUSTANG ISLAND AREA

GULF OF MEXICO – TEXAS

SOUTH BAKER

27° 0 :

BATHYMETRIC SURVEY 96° 16'

FOR

TEXAS A&M RESEARCH FOUNDATION

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DECCA SURVEY SYSTEMS, INC.

CONTOUR INTERVAL 2 METERS

DATUM: SEA LEVEL

SOUNDINGS IN METERS

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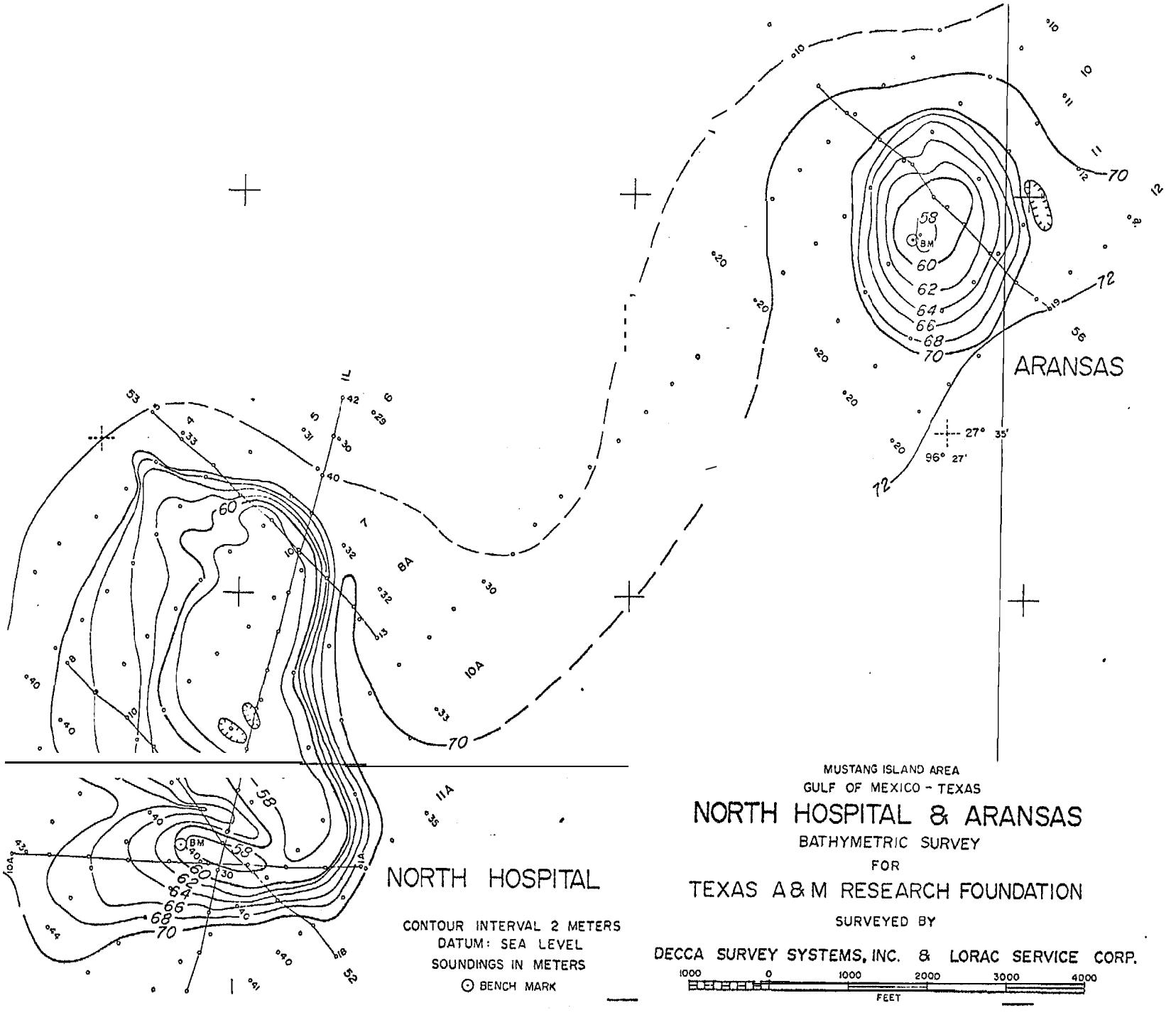

CONTOUR INTERVAL 2 METERS
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SOUNDINGS IN METERS
⊙ BENCH MARK

MUSTANG ISLAND AREA
GULF OF MEXICO - TEXAS

NORTH HOSPITAL & ARANSAS

BATHYMETRIC SURVEY
FOR
TEXAS A&M RESEARCH FOUNDATION
SURVEYED BY
DECCA SURVEY SYSTEMS, INC. & LORAC SERVICE CORP.

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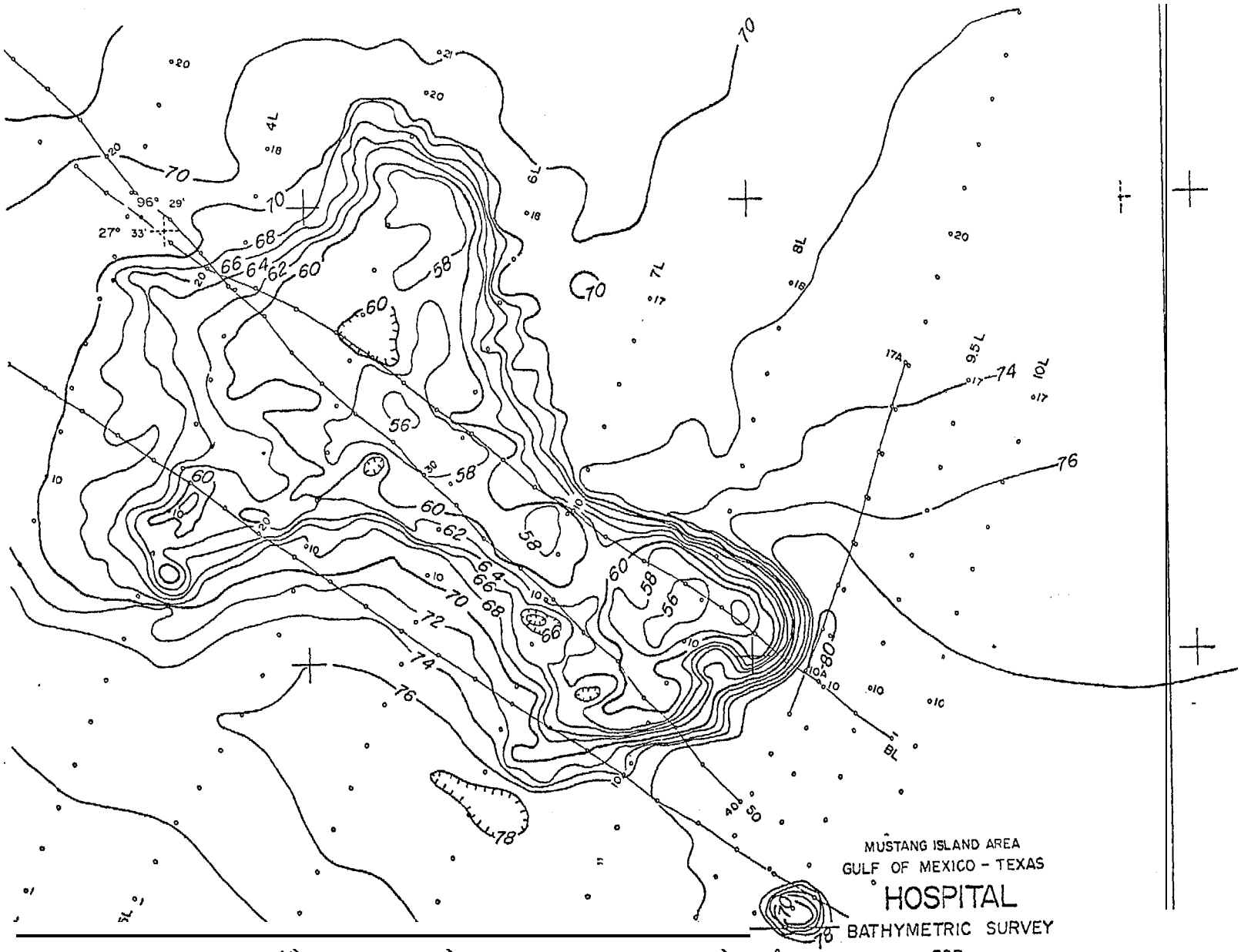
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GULF OF MEXICO - TEXAS
HOSPITAL
BATHYMETRIC SURVEY
FOR
TEXAS A&M RESEARCH FOUNDATION
DETAILED BATHYMETRY OF HOSPITAL FROM
BATHYMETRY OF HOSPITAL ROCK PREPARED
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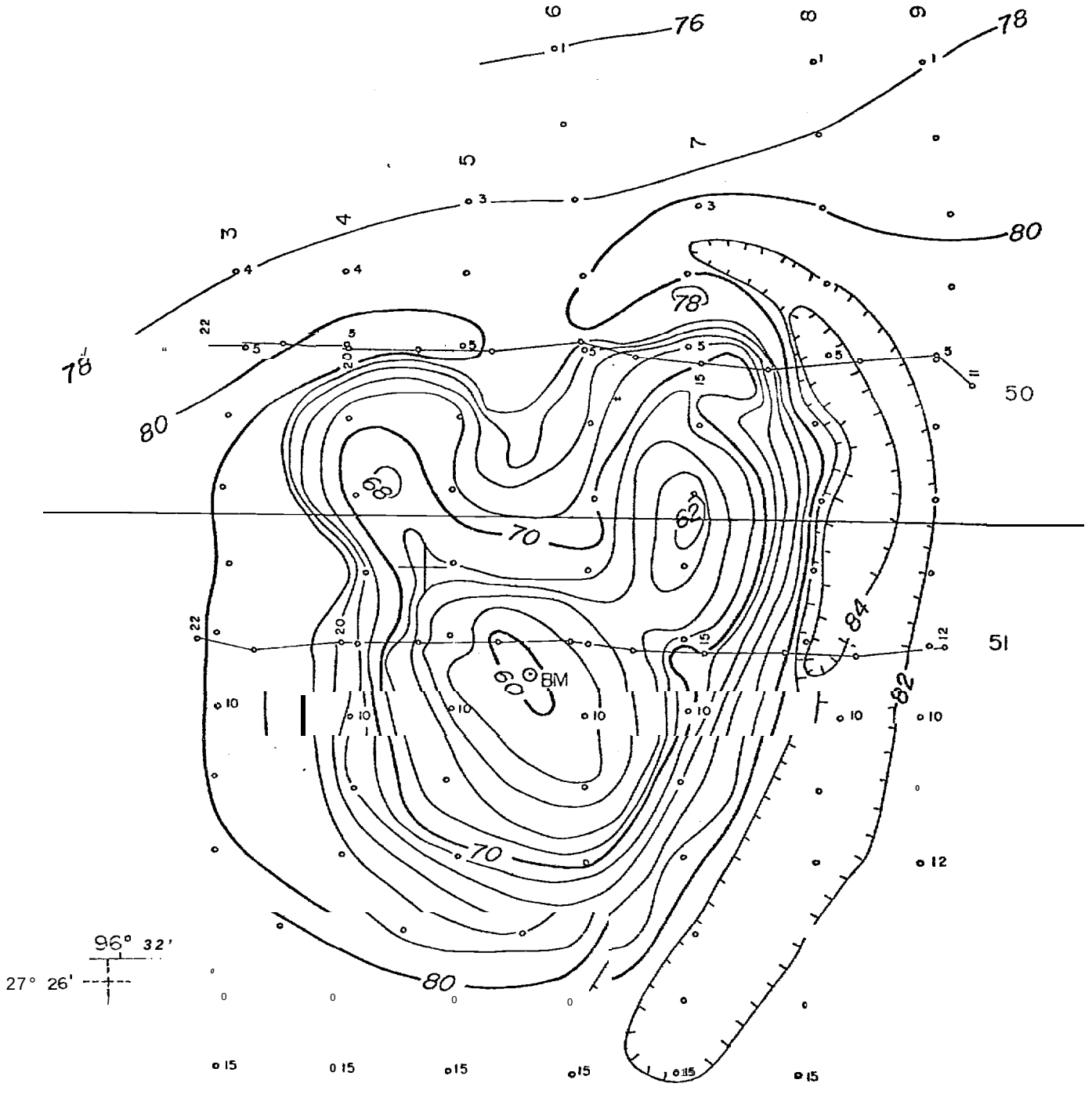

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SOUNDINGS IN METERS
⊙ BENCH MARK

MUSTANG ISLAND AREA
GULF OF MEXICO - TEXAS

SOUTHERN

BATHYMETRIC SURVEY

FOR

TEXAS A8i MRESEARCH FOUNDATION

SURVEYED BY

DECCA SURVEY SYSTEMS, INC.

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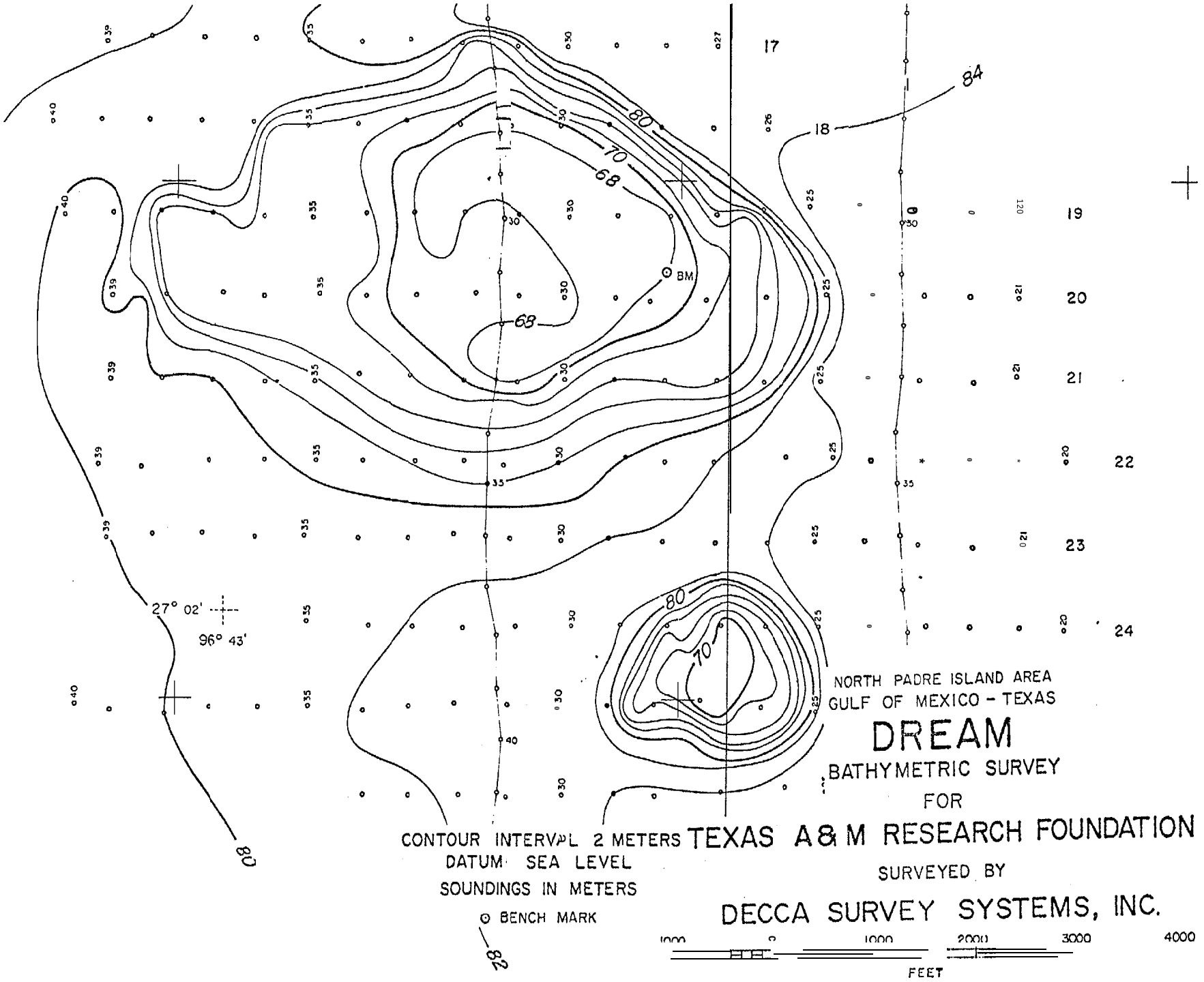
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96° 43'
NORTH PADRE ISLAND AREA
GULF OF MEXICO - TEXAS
DREAM
BATHYMETRIC SURVEY
FOR
TEXAS A&M RESEARCH FOUNDATION
SURVEYED BY
DECCA SURVEY SYSTEMS, INC.
CONTOUR INTERVAL 2 METERS
DATUM SEA LEVEL
SOUNDINGS IN METERS
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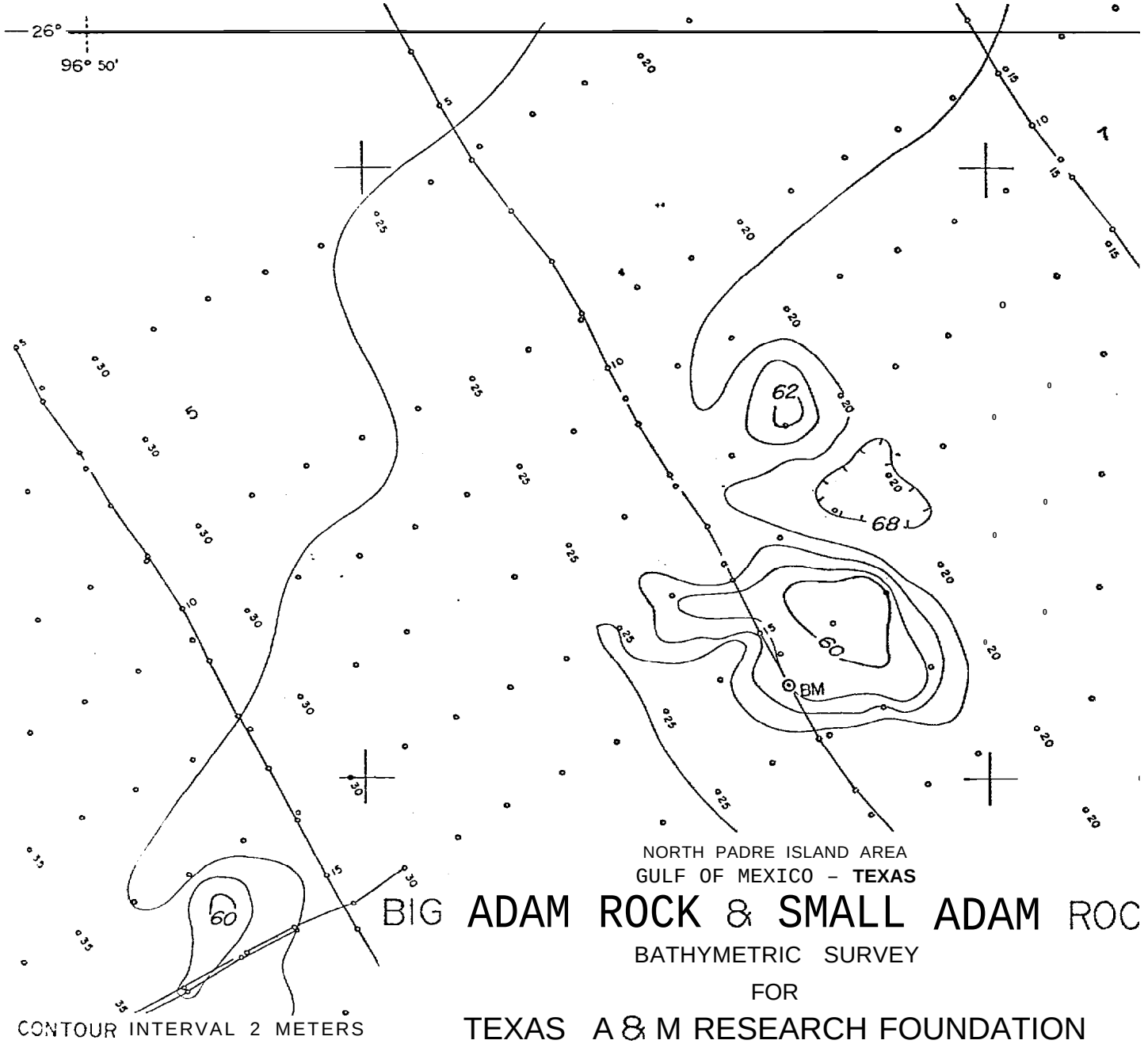

NORTH PADRE ISLAND AREA

GULF OF MEXICO – **TEXAS**

BIG ADAM ROCK & SMALL ADAM ROC

BATHYMETRIC SURVEY

FOR

TEXAS A & M RESEARCH FOUNDATION

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CONTOUR INTERVAL 2 METERS

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SOUNDINGS IN METERS

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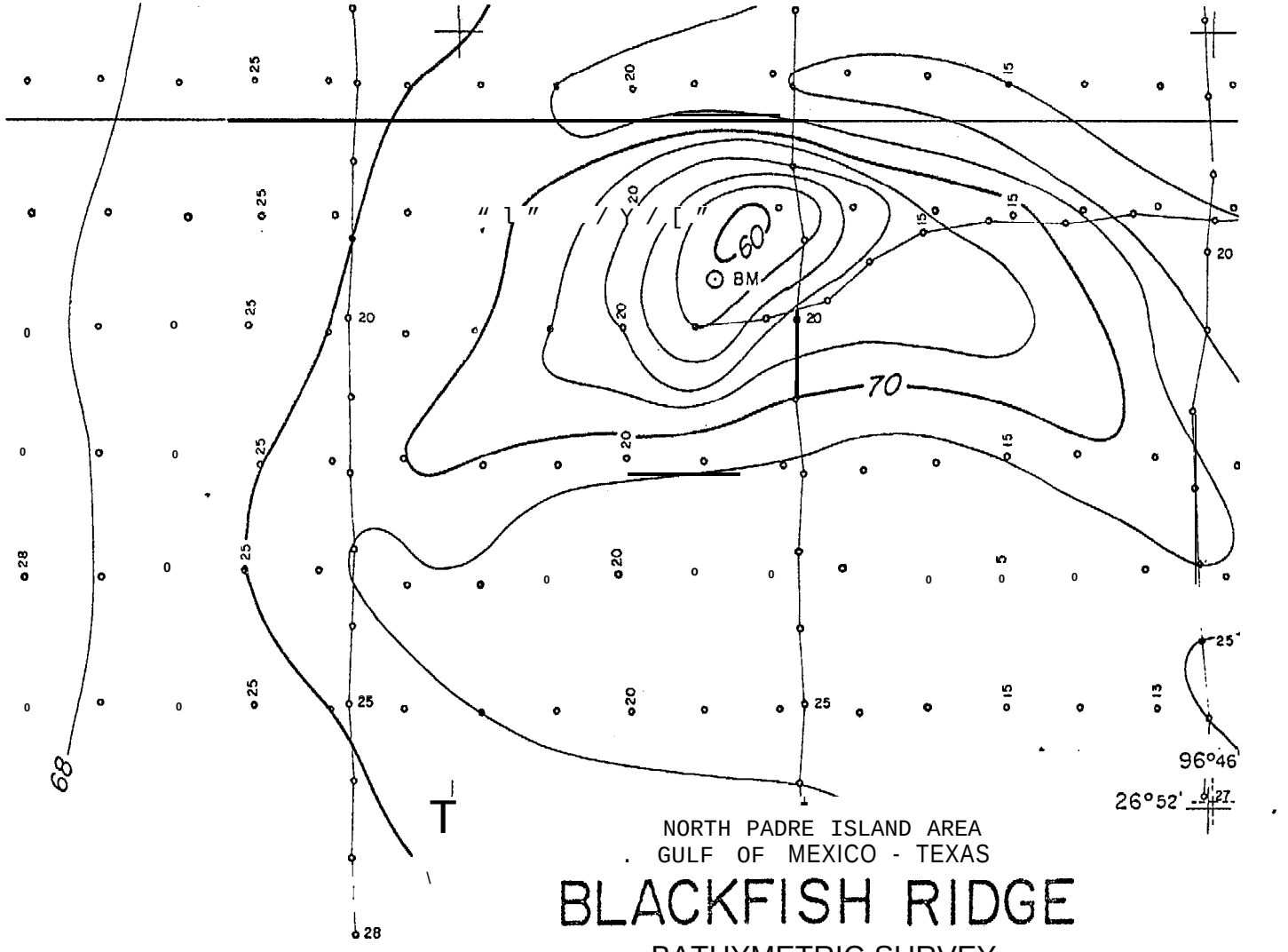

NORTH PADRE ISLAND AREA
GULF OF MEXICO - TEXAS

BLACKFISH RIDGE

BATHYMETRIC SURVEY

FOR

TEXAS A&M RESEARCH FOUNDATION

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CONTOUR INTERVAL 2 METERS
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SOUNDINGS IN METERS
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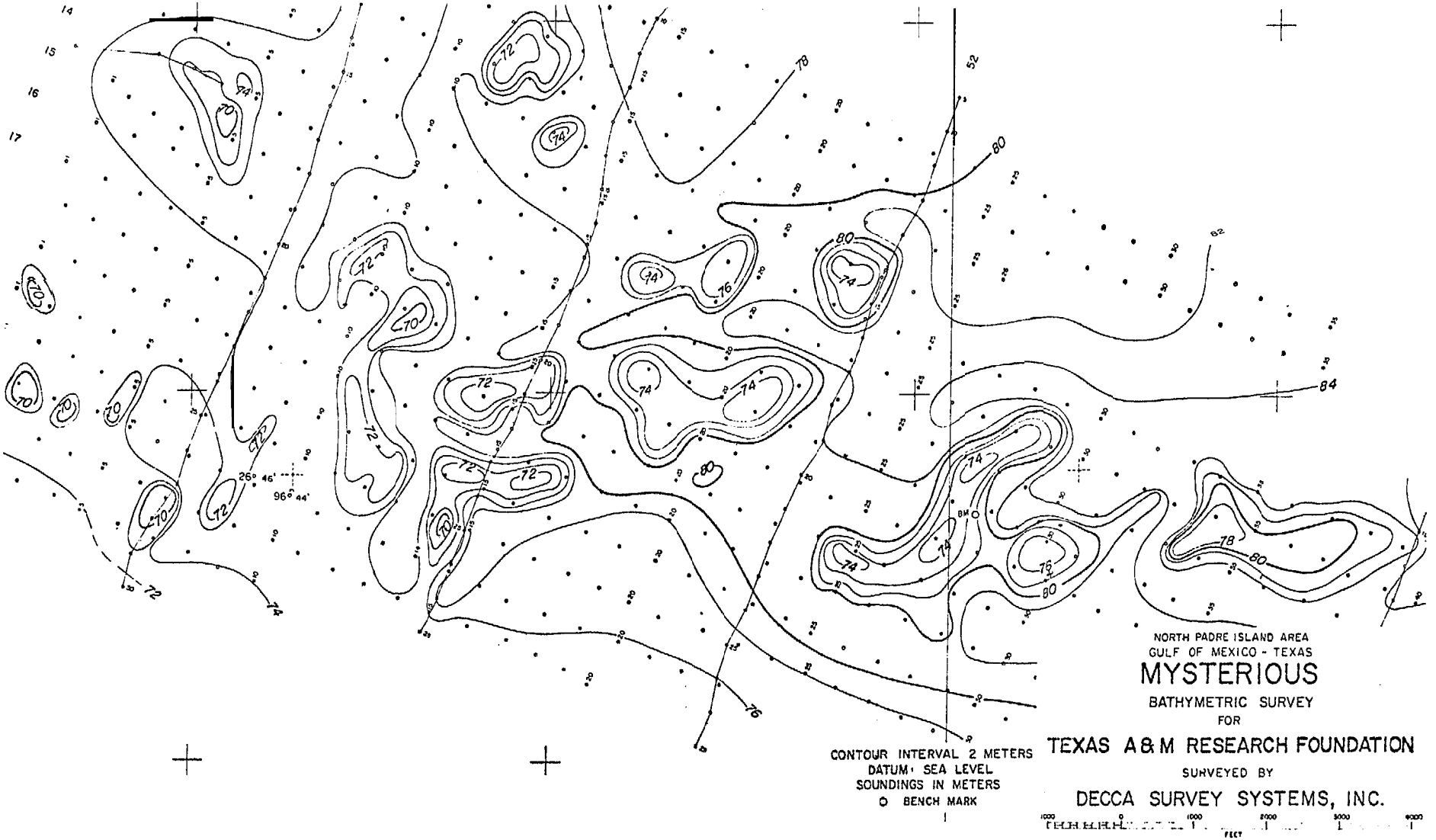
26° 46'
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GULF OF MEXICO - TEXAS
MYSTERIOUS
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FOR
TEXAS A&M RESEARCH FOUNDATION
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