DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

Louisiana Barrier Island Erosion Study: Surveys of the Isles Dernieres area, Louisiana taken from 1853 to 1936— Maps and description of data available on 9-track computer tape

by

Bruce Jaffe[1], Greg Gabel[1], Thang Phi[1], Graig McHendrie[1], Rob Wertz[2], and A.H. Sallenger, Jr.[2]

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[1]USGS, MS 999, 345 Middlefield Rd., Menlo Park, CA 94025

[2]USGS, MS 914, National Center, Reston, VA 22092

INTRODUCTION

Louisiana's barrier islands are eroding up to 20 meters per year. This is one of the fastest rates of coastal erosion in the United States. The United States Geological Survey (USGS), in cooperation with the Louisiana Geological Survey, is studying the processes that are causing the erosion of Louisiana's coast (Sallenger et al., 1987). As part of this study, the USGS is using information from topographic and hydrographic surveys to investigate changes in the barrier islands and seafloor in the vicinity of the Isles Dernieres barrier island arc, Louisiana (Fig. 1).

The U.S. Coast and Geodetic Survey (USCGS, now part of the National Ocean Service, NOS) surveyed this area in the 1850s, the 1890s, and in the 1930s. Several additional topographic surveys of the area have been made since the 1930s; however, the only hydrographic survey of the area after the 1930s was made in the summer of 1986 by the USGS (Williams et al., in review). Erosion of the Isles Dernieres over the period of these surveys is extremely rapid. Much of the islands' Gulf shoreline has retreated more than a kilometer during the past century.

We can develop a better understanding of the processes causing the erosion of the the islands by studying changes between the surveys. The first step in the study, to create a digital data base of the surveys to enable us to efficiently process the information using computers, is completed. This report describes the USCGS data from 1853 to 1936 and presents computer graphics displaying the data. The last section of the report gives a brief description of the areas geomorphology and changes to the islands and adjoining seafloor that took place from 1853 to 1936.

SURVEYS IN THE ISLES DERNIERES AREA FROM 1853 TO 1936

The U.S. Coast and Geodetic Survey completed three detailed surveys of the Isles Dernieres[1] area from 1853 to 1936. All of these surveys gathered both hydrographic and topographic information (Tables 1 and 2). For each of the surveys, the first step was to survey the land area and construct a topographic map to use as a basemap for the hydrographic survey. These maps delineated the mean high water line (shoreline) and the locations of shore stations that were used for navigation during the hydrographic survey. Topographic maps from this era also show information on vegetation, manmade features, and, in most cases, the low water line. The low water line and points above it were sometimes also defined by soundings taken during hydrographic surveys. Data from the hydrographic surveys were plotted on charts, known as smooth sheets, which show positions and values for depth soundings, navigation

[1]Isles Dernieres is French for Last Islands, another name commonly used for the islands.

fixes, and stations used for locating the ship during the survey. Smooth sheets also included hand-drawn contours of sounding values, bottom characteristics such as hardness or sediment type, and information on tides and the tidal datum used for the survey. See Sallenger et al., (1975) for a discussion of the data quality of USCGS hydrographic surveys.

THE SURVEYS OF 1853

The first detailed survey of the area, taken in 1853, mapped the western half of the Isles Dernieres and extends 25 kilometers offshore (fig. 2). The methods of sounding used for the 1853 survey were most likely the ones given in the first published instructions to hydrographic parties, "General Instructions in Regard to The Hydrographic Work of the Coast Survey" signed by Superintendent A.D. Bache, circa 1860. Schalowitz (1964, p. 218) paraphrases the instructions as:

> For sounding in depths up to 15 feet, a graduated pole was used with a disk on the lower end to prevent it sinking into muddy bottom (par. 15). Beyond this depth, the leadline was used.

On the 1853 smooth sheet, soundings taken with a leadline are given to one-sixth of a fathom (one foot), while those taken with a pole are given to one-quarter of a foot. Ship positions at navigation fixes are also shown on the smooth sheet. Schalowitz (1964, p. 218) gives the three methods used in the mid-1800s for determining the ships position as:

> (1) by running out ranges and timing the soundings; (2) by observing angles with a sextant from the boat on three signals; and (3) for offshore work, by measuring angles to survey vessel with theodolites at two shore stations and, for verification, by measuring the angle at the vessel between the two shore stations

Approximately 9,000 soundings were taken during the 1853 survey with the densest concentrations of soundings near the island and Ship Shoal. Three patterns for sounding lines were used in this survey; (1) radiating lines near Ship Shoal, (2) parallel straight lines trending north-south (across contours) in the region between Ship Shoal and the island, and (3) zig-zag lines within several kilometers of the shoreline. Each of these patterns resulted in varying numbers of sounding-line crossings, with the radiating pattern generating the most crossings and the parallel-line pattern the least number of crossings. Sounding-line crossings can be used to evaluate the quality of a survey by comparing the sounding values from two lines of soundings near a crossing. For a survey with no error, the depth values for the two passes over the same location would be identical. When the value of the soundings from each line is interpolated to the point where the lines cross, the difference between the crossing point values is a quantitative indication of the error in the survey. For a sample of 10 crossings evenly spaced throughout the 1853 survey area, the average depth difference at crossings is approximately five percent of the depth.

The land area was surveyed in great detail in 1853 and mapped at a scale of 1:10,000. In addition to locating the shoreline and low water line, the survey mapped features in the interior of the island such as vegetation, the bayou and canal system, and manmade structures. Among the features shown on the map is a small settlement on the western Isle Derniere.

This settlement was devastated in the Last Island Hurricane of 1856 in which over 140 people lost their lives (Ludlum, 1963) and only several of the structures standing in 1853 appear on the topographic maps made later in that century.

THE SURVEYS OF 1887-1891 AND 1906

The next survey of the study area was completed in two stages; most of the area was surveyed from 1887 to 1891, while the bay and shoreline behind the eastern Isles Dernieres were not surveyed until 1906 (Figs. 3-5). An 1889-1891 hydrographic survey, consisting of over 36,000 soundings, included the area offshore of the the Isles Dernieres extending seaward of Ship Shoal and eastward past Timbalier Island (Fig. 3). The bay landward of the eastern Isles Dernieres was surveyed in 1906 (Fig. 4). On the 1889-1891/1906 smooth sheets, sounding values were recorded to one-quarter of a foot, except for a small area on sheet H-1831 where values were given to one-quarter of a fathom (1 and one-half feet).

Sounding methods for these surveys were the same as for the 1853 hydographic surveys; but, the sounding-line patterns were different. Instead of a radiating line pattern near Ship Shoal there is an orderly pattern of north-south straight parallel lines (Fig. 3). However, this orderly pattern resulted in fewer sounding-line crossings, so it is more difficult to ascertain the quality of the offshore data. Within about a kilometer of the shoreline, the same zig-zag pattern as the one in the 1853 survey is utilized, with sounding-lines spaced closer together than in the 1853 survey. In the bays behind the islands (backbays) and from a kilometer seaward of the islands out to several kilometers, there is a rectangular sounding-line pattern with numerous crossings. The density of this rectangular pattern is increased in the area seaward of the islands where there are tidal inlets to the east of the Isles Dernieres. The difference in depth sounding at crossing lines indicates that the 1890/1906 surveys were of a higher quality than the 1853 survey. For a sample of 40 crossings from 4 different smooth sheets, the average crossing difference is 3 percent of the water depth.

Shorelines of the Isles Dernieres area were surveyed from 1887 to 1889 (Fig. 5), except the eastern Isles Dernieres backbay shoreline, which was surveyed in 1906. Features in the interiors of the islands are not shown on these 1:20,000 scale topographic maps. In general, the 1890/1906 topographic survey is less detailed than the 1853 topographic survey. However, the 1890/1906 surveys cover a much larger area which includes all of the Isles Dernieres island chain and the mainland to the north.

THE SURVEYS OF 1932-1936

The entire study area was resurveyed from 1932 to 1936. Shorelines were mapped from aerial photographs taken November 30, 1932 augmented by information from field surveys in 1934 (Fig. 6). Over 120,000 soundings were taken in the study area during the 1934-1936 hydrographic survey, by far the most soundings of the three surveys addressed in this report. Besides the smaller distance between sounding lines, there is a higher density of soundings along lines than in earlier surveys indicating a change in survey methods. The USCGS was able to take such a large number of soundings because of technological advances in acoustic instrumentation stimulated by World War I. The USCGS began using echo-sounding instruments to determine water depth in 1923, and by the 1930s survey of the study area had precision fathometers installed on some of their vessels (Adams, 1942, p. 442). Ship positioning was also done using acoustics- Radio Acoustic Ranging (RAR) was in use by the USCGS in 1924 (Adams, 1942, p. 556). Smooth sheets for the 1930s survey show positions of radio sonu-buoys used in RAR. Soundings were plotted on the smooth sheets to one-half foot in the backbays and to the integral foot elsewhere. Soundings were initially recorded to a greater precision in the Sounding Record for the survey before being converted to the values plotted on the smooth sheets. The conversion scheme to integral feet used by the USCGS is to truncate sounding values with fractions less than three-quarters of a foot; fractions greater than or equal to three-quarters of a foot are rounded up to the next higher integral foot (Adams, 1942, p. 716). Likewise, for areas where soundings are recorded in one-half foot units, the one-half fraction is retained when the sounding value is between one- and three-quarters of a foot.

The pattern for sounding lines takes a radical departure from those employed for earlier surveys of the area. Sounding lines are shore parallel in the backbay areas and seaward of the Isle Dernieres to approximately five kilometers offshore. There are no line crossings in this area, except for near the tidal inlets and in some of the backbay areas where additional orthogonal lines were also surveyed. Farther offshore than five kilometers from the islands, the lines are north-south (cross contour) with greater distance between lines and have east-west trending crossing lines spaced three to five kilometers apart. Due to the sounding-line patterns and the USCGS practice of plotting sounding values to integral feet or to the half foot on smooth sheets, it is difficult to assess the data quality of the 1930s hydrographic survey. For a sample of 10 crossings in the offshore area, the average crossing difference is three percent of the water depth- the same value as for the 1890/1906 survey. The average crossing difference in the backbay regions is about 10 percent of the water depth; but, this statistic is undoubtedly affected by the rounding off of sounding values using the reporting schemes noted above. The 1930s USCGS hydrographic data discussed above have been digitized by NOS and are available on 9-track computer tape from the National Geophysical Data Center (NGDC) in Boulder, C0.

DIGITIZATION METHODS AND DATA PROCESSING

All data presented in the companion tapes to this report were digitized by the USGS from stable-base copies of the original topographic and hydrographic (smooth) sheets. Both the mean high water lines (shorelines) and the mean low water lines were digitized from topographic sheets at 1-mm intervals. Points at changes in shoreline orientation not defined by the

1-mm digitization interval were also digitized. Digital representations of soundings, shorelines, and the mean low water lines were recorded in the computer file to the nearest 0.1 mm in digitizer-table coordinates. The digital data were then converted to latitude-longitude using a linear conversion, with different conversion factors for the north-south and east-west directions. The choice of conversion scheme was limited by the software available. The original sheets were constructed using a Polyconic projection which is linear for the scales of the sheets, so a linear conversion of table coordinates to latitude-longitude introduces a negligible error.

To check the accuracy of the digitization and processing, the digital data were plotted and overlain on the original sheets. Digitized shoreline positions were corrected to be within 1-mm of the position on the original sheet. This is a maximum error in the representation of the shoreline position of 20 meters at a scale of 1:20,000- the scale most commonly used for the topographic sheets. Digitized sounding values were corrected to the value on the hydrographic smooth sheets. Inaccuracies in digitization and processing introduced a small error into the locations of the soundings. Since the seafloor slopes, these positional error translate into errors in depth. Care was taken to correct sounding positions so that more than ninety-five percent of the soundings had position-induced depth errors of less than 10 centimeters. Position-induced depth errors for areas with steep slopes, for instance the sides of the tidal inlets, were as great as 25 centimeters.

DATUMS

In order to directly compare data from surveys taken in different years, the data must be referenced to a common coordinate system (datum). The latitude and longitude of the data on the computer tapes companion to this report are adjusted to the North American Datum of 1927 (NAD27). The topographic data presented in the tapes can be used as is for comparing changes in the islands. Soundings values are depths below mean low water during the period of the survey. We did not adjust the depth sounding values to a common vertical reference system. Therefore, the depth values given in the tapes cannot be directly compared since the vertical datum is not fixed in time, but changes with changing sea level relative to the land, caused by worldwide sea level changes or vertical changes in land elevation.

Since sea level is rising relative to land in the study area (Penland et al., 1987), a direct comparison of soundings for the same position will have a component of change due solely to sea level rise. For instance, if an area where the seafloor has not changed was surveyed in the 1890s and resurveyed in the 1930s, the depth sounding values for the 1930s survey would be greater due to the fact that the 1930s sea level is higher causing the 1930s ship to ride higher above the seafloor. A direct comparison of uncorrected sounding values would indicate, erroneously, erosion in that area. The amount of apparent erosion would be equal to the amount of sea level rise that raised the ship higher relative to the seafloor. Before depths for surveys from different years can be compared and changes in the seafloor can be calculated, the soundings must be corrected to a common vertical datum.

As mentioned above, all latitudes and longitudes of the digital data on the companion tapes are given in NAD27. The 1930s, 1887-1891, and 1906 data were digitized using the NAD27 coordinate system. For the 1930s data, the latitude-longitude graticule on the original sheets were used to define the coordinate system, since it was already in NAD27. For the 1887-1891 and 1906 data, NAD27 reference points that were added to the sheets by the USCGS in the 1930s were used to define the coordinate system. The USCGS did not add NAD27 reference marks to the 1853 sheets. The 1853 hydrographic data were digitized using a coordinate system we choose based on notes and markings on the survey sheets; but, because of ambiguities in the notes, this system turned out not to be NAD27. A coordinate system rotation was needed to correct the data to NAD27. Therefore, the error in the locations of the 1853 soundings is larger than the errors of the other surveys. Still, the quality criteria cited above hold for the 1853 hydrographic data. After reinterpreting the notes on the sheets, the 1853 topographic data were digitized using the NAD27 coordinate system. Since there was no coordinate system rotation, no additional errors were introduced, therefore the 1853 digital representation of the topographic data is of the same quality as the other years.

As a check for a proper horizontal datum correction, the adjusted shorelines from all three topographic surveys; 1853, 1887-1889, and 1932-1934, were plotted at a large scale on one sheet. Overplotting the data showed that the horizontal datum corrections were reasonable. Positions of the more stable geomorphic features (eg. some of the inactive channels in the interior of the islands) did not change between surveys and the patterns and amounts of shoreline change from survey to survey were reasonable and consistent.

COMPANION COMPUTER TAPES

The USGS is making the data described in this report (Tables 1 and 2, Figures 1-6) available to the public on 9-track computer tapes through the National Geophysical Data Center (NGDC). Inquires should be made to:

National Geophysical Data Center
NOAA/NESDIS E/GC3
325 Broadway
Boulder, CO 80303

Data for each hydrographic or topographic sheet is stored in a separate file on the tapes. The data format for the hydrographic data is MGD77 (NGDC, 1977). Topographic data on the tapes are stored in our in-house data format which is shown in Appendix 1.

GEOMORPHOLOGY AND CHANGES FROM 1853 TO 1936

The following discussion of geomorphology and changes within the study area is based upon results from modeling the data presented above using a computer surface modeling program. Results of the modeling are displayed in figures 7-12. Figures 7-9 are mesh perspective views of the study area for each of the three surveys. Figures 10-12, which are contour maps for each of the surveys, can be used to detect changes in the study area from 1853 to 1936. Future papers will incorporate the data from 1986 and give greater detail on the changes to the Isles Dernieres barrier island arc system.

The Isles Dernieres barrier island arc began forming when the Bayou Petit Caillou delta within the Lafouche delta complex was abandoned approximately 420 years B.P. (Penland et al., in press). In 1890, the first complete survey of the area, the island arc was approximately 30 km long, with a range in width from 200 m to a maximum in the center of the arc of approximately 3 km (Figs. 8 and 11). There is the beginning of a tidal inlet developing to the west of the center of the arc. A well developed 18-m deep inlet is about 1 km east of the arc, and another broader, shallower (8-m deep) inlet is 10 km to the east. The islands are backed by shallow (1 to 2 m deep) bays, except for a channel, parallel to the island trend, between the center of the arc and the mainland which is 9-m deep at its deepest point. Seaward of the islands, the seafloor slope became progressively gentler toward Ship Shoal. The average slope out to 5-m depth is 0.0025, from 5 to 6-m depth, 0.001, and from 8 to 9-m depth, 0.0005. Ship Shoal, a submerged barrier island arc associated with the 6000 year old Maringouin delta complex (Penland et Boyd, 1985), is approximately 15 km offshore in surrounding water 10-m deep. The shoal is a distinctive feature on hydrographic surveys of the area- the 5-m contour of the shoal spans approximately 20 km in the alongshore direction and 5 km in the on/offshore direction. The shoal is assymetrical, with the northward (landward) facing slope steeper (0.008) than the slopes on the Gulf side. The shallowest portion, on the west end of the shoal, is at 1.75-m water depth in 1890. Offshore of the eastern part of Ship Shoal there is a broad flat with an east-west elongate trough running from 18-m water depth in the east to 13 m water depth in the west. This trough is approximately 10-km wide and has a relief of 2 m.

The 1853 survey did not extend offshore far enough to ascertain whether this trough was present, but the 1930s survey picked up the feature (Figs. 9 and 12). Comparisons with the 1853 data are also limited to the western Isle Derniere since the eastern half of the arc was not mapped in detail. From 1853 to 1887, the islands eroded 300 to 400-m near the center of the arc and built out, in spit growth, 500 m on the western end. The offshore slopes in 1853 were similar to the 1890s and the shallowest portion of Ship Shoal was within 1.75-m of the seasurface, the same elevation as in the 1890s (Figs. 7 and 10).

In the 1930s, Ship Shoal's shallowest spot was 2.75-m below sea level, 1 m deeper than in the 1890s. Offshore slopes were similar to 1890, except that the average slope between the shoreline and 5-m water depth had decreased to 0.0018. This decrease in slope was due to the island retreating 500 to 700-m while the 5-m contour stayed in the same position. For the 5-m contour to stay in the same position with sea level rising, there must have been accretion at that location equal to the amount of sea level rise. The islands broke apart into three groups as tidal inlets developed on both sides of the center of the arc. The inlets to the east of the Isles Dernieres also grew as sea level rose. The inlet that was 10 km east of the arc in the 1890s migrated west and broadened but did not deepen. The inlet directly east of the arc deepened 10 m from an 8-m depth in 1890 to 18 m in the 1930s. The alongshore growth (700 m) of the arc at its eastern end could have contributed to this inlets deepening by constricting the passage that tides flowed through. The arc also elongated at the western end 700 m. Accompanying the elongation of the arc was a thinning of the islands. The maximum width of the islands, located at the center of the arc, was approximately 2 and one-half km in the 1930s compared to about 3 km in the 1890s. Behind the islands the bays remained shallow, and the channel between the center of the arc and the mainland widened and filled decreasing the maximum depth from 13 m in the 1890s to 7 m.

In summary, we note the following major changes that occurred from 1853 to 1936:

(1) Gulf shorelines retreated as much as a kilometer
(2) The Isles Dernieres barrier island arc grew at both ends
(3) The islands decreased in width
(4) The development of two new tidal inlets divided the Isles Dernieres into three groups of islands
(5) Offshore, though change was less pronounced, the average slope from the shoreline to five meters water depth decreased as sediment was deposited in five meters water depth

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APPENDIX 1, FORMAT FOR DIGITIZED TOPOGRAPHY

Files containing topographic data have three types of lines. The first line in the file, a file header line, is followed by a group header and point coordinate line, which is followed by a point coordinate line for each point in the group. Group header and point coordinate lines are then repeated to the end of the file. All latitudes and longitudes are in decimal degrees with southern latitude and western longitude negative. The following tables give column numbers, formats and descriptions of the three line types.

LINE 1, FILE HEADER LINE		
COL(S)	FORMAT	DESCRIPTION
1-19		blank
20-23	a4	The word 'AREA'
25-36	a12	A character string to identify the file
37-45	f9.5	The southern most point in the file
46-54	f9.5	The northern most point in the file
55-64	f10.5	The eastern most point in the file
65-74	f10.5	The western most point in the file
76-80	i5	The number of lines in the file

GROUP HEADER LINES		
COL(S)	FORMAT	DESCRIPTION
1-19		Blank
20-23	a4	One of the group id's- 'coas', 'isla', 'geol'
24	i1	A single digit code (0-9) for the point symbol
25-36	a12	A string to identify the group
37-45	f9.5	The southern most point in the group
46-54	f9.5	The northern most point in the group
55-64	f10.5	The eastern most point in the group
65-74	f10.5	The western most point in the group
76-80	i5	The number of lines in the group

The identifiers (group ids) for the line segments are:

isla- island shoreline (mean-high-water line), data in continuous line closing back on itself.
coas- section of large island or mainland shoreline (mean-high-water line).
geol- mean-low-water line

POINT COORDINATE LINES		
COL(S)	FORMAT	DESCRIPTION
1-9	f9.5	Latitude of point in decimal degrees
10-19	f10.5	Longitude of point in decimal degrees

FIRST FEW LINES OF A SAMPLE OUTPUT FILE

```
        AREA 18654 south  37.96739 38.09252-122.21739-122.52585  437
        coas Pinole       37.97214 38.05818-122.21739-122.38415  173
37.97214-122.38369
37.97435-122.38415
37.97648-122.38309
```

TABLE 1

U.S. COAST AND GEODETIC SURVEY HYDROGRAHIC SHEETS				
REGISTER #	**YEAR**	**DATES**	**SCALE**	**OFFICER IN CHARGE**
H-360	1853	April 3 to May 7	1:20,000	Lt. B.F. Sands
H-1831	1888	May 15 to May 25	1:80,000	Lt. F.H. Crosby
		Feb. 14 to June 8	1:80,000	Ens. L.M. Garrett
H-2014	1889	Dec. 17,'89 to May 15,'90	1:80,000	Lt. A.L. Hall
H-2015	1889	Dec. 17,'89 to May 15,'90	1:20,000	Lt. A.L. Hall
H-2016	1889	Jan. 11 to April 28	1:80,000	Lt. A.L. Hall
H-2069	1891	Mar. 13 to April 24	1:20,000	Lt. E.M. Hughes
H-2070	1891	Mar. 13 to April 24	1:20,000	Lt. E.M. Hughes
H-2071	1891	Mar. 13 to April 24	1:20,000	Lt. E.M. Hughes
H-2812	1906	May 21 to June 11	1:20,000	J.B. Miller

TABLE 2

U.S. COAST AND GEODETIC SURVEY TOPOGRAHIC SHEETS				
REGISTER #	**YEAR**	**SCALE**	**SURVEYING TECHNIQUE**	**NOTES**
T-410	1853	1:10,000	Ground survey	surveyed Feb.,1853
T-1691	1886	1:20,000	Ground survey	
T-1692	1886	1:20,000	Ground survey	surveyed May 1886
T-1762	1887	1:20,000	Ground survey	
T-1763	1887	1:20,000	Grond survey	
T-2752	1906	1:20,000	Ground survey	"entire area less than 3' above MHW"
T-5290	1932	1:20,000	Air photo compilation	photos taken Nov. 30, 1932 - 10:00 a.m.
T-5291	1932	1:20,000	Air photo compilation	Nov. 30, 1932- 10:00 a.m., outside coast from planetable surveys after hurricane of June 16, 1934
T-5294	1932	1:20,000	Air photo compilation	Nov. 30, 1932 - 10:55 a.m.
T-5295	1932	1:20,000	Air photo compilation	Nov. 30, 1932 - 11:00 a.m., outside coast from planetable surveys, East of 90 42.6 before June '34 hurricane; West of 90 42.6 after hurricane
T-5299	1932	1:20,000	Air photo compilation	Nov. 30, 1932 - 11:20 a.m., "MHW line and sand bars along outer coast taken from ground surveys Feb. to July, 1934", only digitized MHW line in study area

FIGURE CAPTIONS

Figure 1- Location of the study area in south-central Louisiana

Figure 2- 1853 U.S. Coast and Geodetic Survey hydrographic (soundings) and topographic (mean high water lines) data in the study area. Each dot is a sounding location. The shoreline was only surveyed in the western Isle Derniere.

Figure 3- 1888-1891 U.S. Coast and Geodetic Survey hydrographic data in the study area. Note the scale is smaller than figure 2. Each dot is a sounding location. In some areas, the density of soundings is so great that dots join and appear to be lines.

Figure 4- 1906 U.S. Coast and Geodetic Survey hydrographic and topographic data in the study area. Each dot is a sounding location. Shorelines were only surveyed for the eastern Isles Dernieres and the eastern mainland.

Figure 5- 1886-1887 U.S. Coast and Geodetic Survey topographic data in the study area. Tics on the shoreline separate surveys.

Figure 6- 1932-1934 U.S. Coast and Geodetic Survey topographic data in the study area. Each survey sheet is a 7 1/2 minute quadrangle.

Figure 7- Mesh perspective view of the western end of the Isle Derniere and the adjoining seafloor in 1853. Areas above the mean high water line are shaded. Ship Shoal, a submerged barrier island, is seen in the foreground. Vertical exaggeration is 300 times.

Figure 8- Mesh perspective view of the Isles Dernieres, the western end of Timbalier Island, and the adjoining seafloor in the 1890's. Note the scale is smaller than figure 7. Areas above the mean high water line are shaded. The Isles Dernieres are divided by a small tidal inlet just west of the center of the islands. Vertical exaggeration is 300 times.

Figure 9- Mesh perspective view of the Isles Dernieres, the western end of Timbalier Island, and the adjoining seafloor in 1930s. Areas above the mean high water line are shaded. The Isles Dernieres are divided into three groups of islands by tidal inlets to the west and east of the center of the islands. Vertical exaggeration is 300 times.

Figure 10- Contour map of the western end of the Isle Derniere and the adjoining seafloor in 1853. Contour interval is 1 meter. Areas above the mean high water line are shaded.

Figure 11- Contour map of the Isles Dernieres, the western end of Timbalier Island, and the adjoining seafloor in the 1890's. Note the scale is smaller than figure 7. Contour interval is 1 meter. Areas above the mean high water are shaded.

Figure 12- Contour map of the Isles Dernieres, the western end of Timbalier Island, and the adjoining seafloor in 1930s. Contour interval is 1 meter. Areas above the mean high water are shaded. Note the growth of tidal inlets in the Isles Dernieres and between the Isles Dernieres and Timbalier Island.

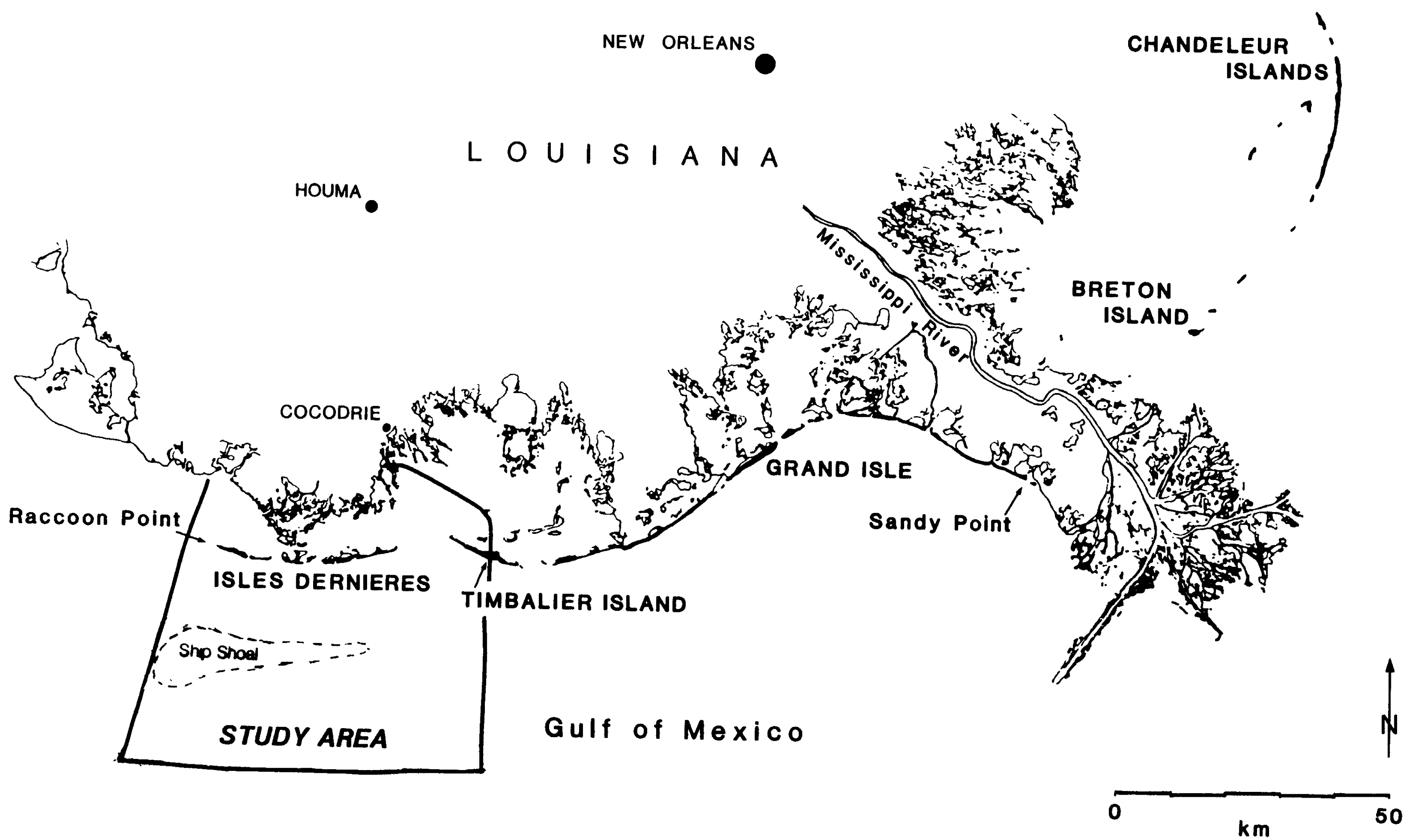

NEW ORLEANS
CHANDELEUR ISLANDS
LOUISIANA
HOUMA
Mississippi River
BRETON ISLAND
COCODRIE
GRAND ISLE
Raccoon Point
Sandy Point
ISLES DERNIERES
TIMBALIER ISLAND
Ship Shoal
STUDY AREA
Gulf of Mexico
N
0
km
50

Figure 1

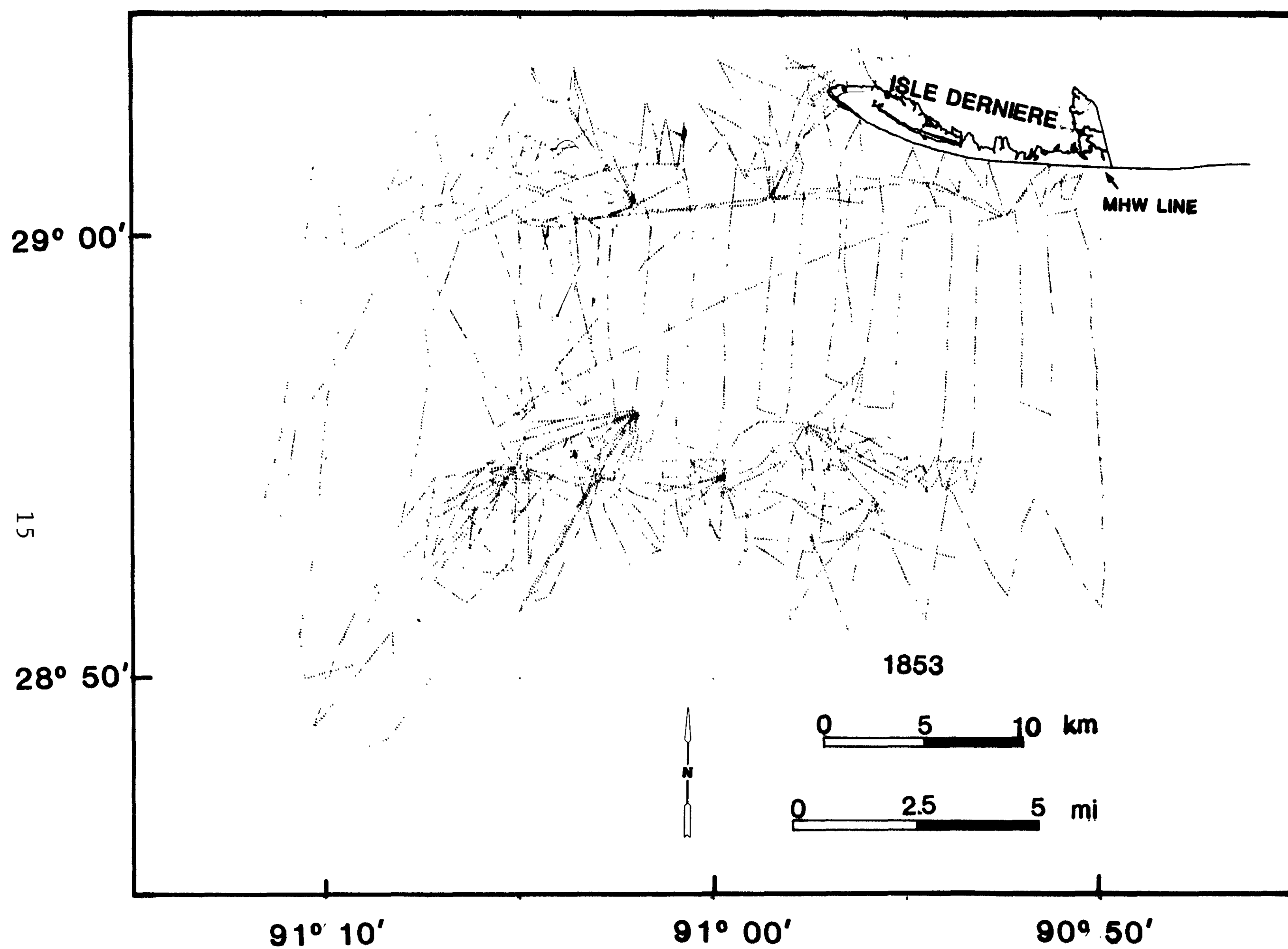

ISLE DERNIERE
MHW LINE
29° 00′
28° 50′
1853
0 5 10 km
0 2.5 5 mi
N
91° 10′
91° 00′
90° 50′

Figure 2

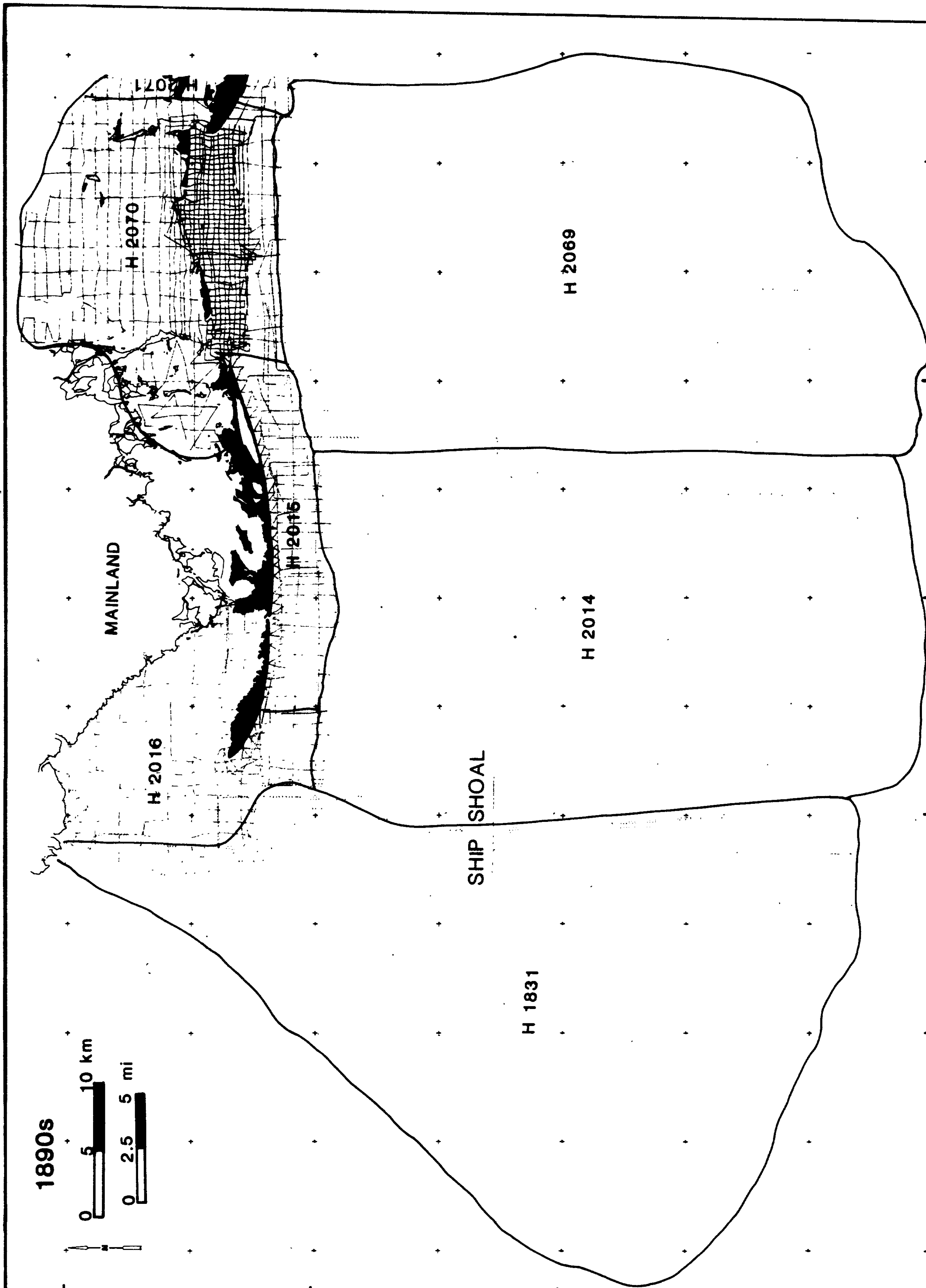

1890s
0
5
10 km
0
2.5
5 mi
MAINLAND
H 2070
H 2071
H 2069
H 2015
H 2014
H 2016
SHIP SHOAL
H 1831
29° 10'
29° 00'
28° 50'
28° 40'
90° 30'
90° 40'
90° 50'
91° 00'
91° 10'
91° 20'

Figure 3

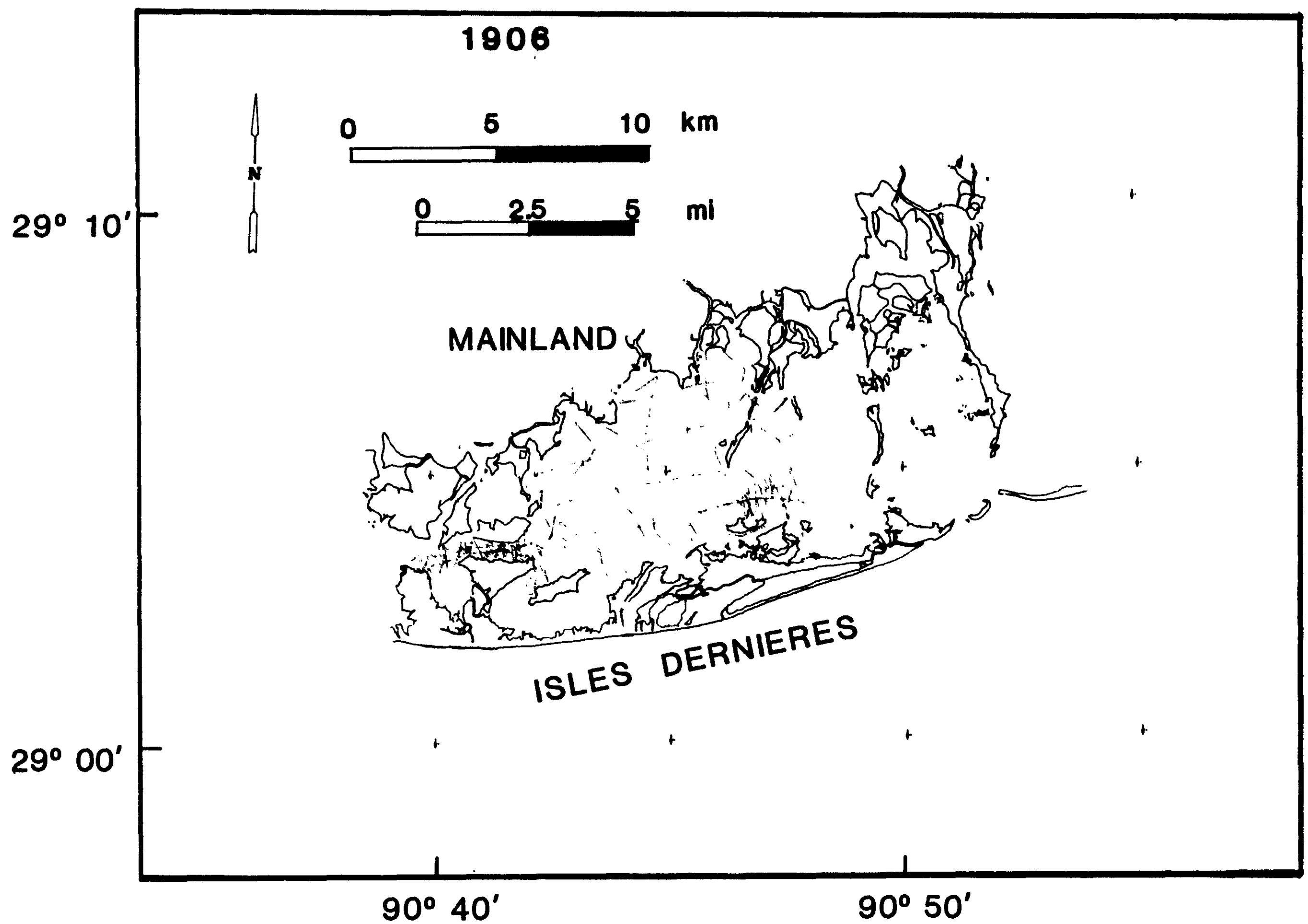

1906
N
0 5 10 km
0 2.5 5 mi
MAINLAND
ISLES DERNIERES
29° 10′
29° 00′
90° 40′
90° 50′

Figure 4

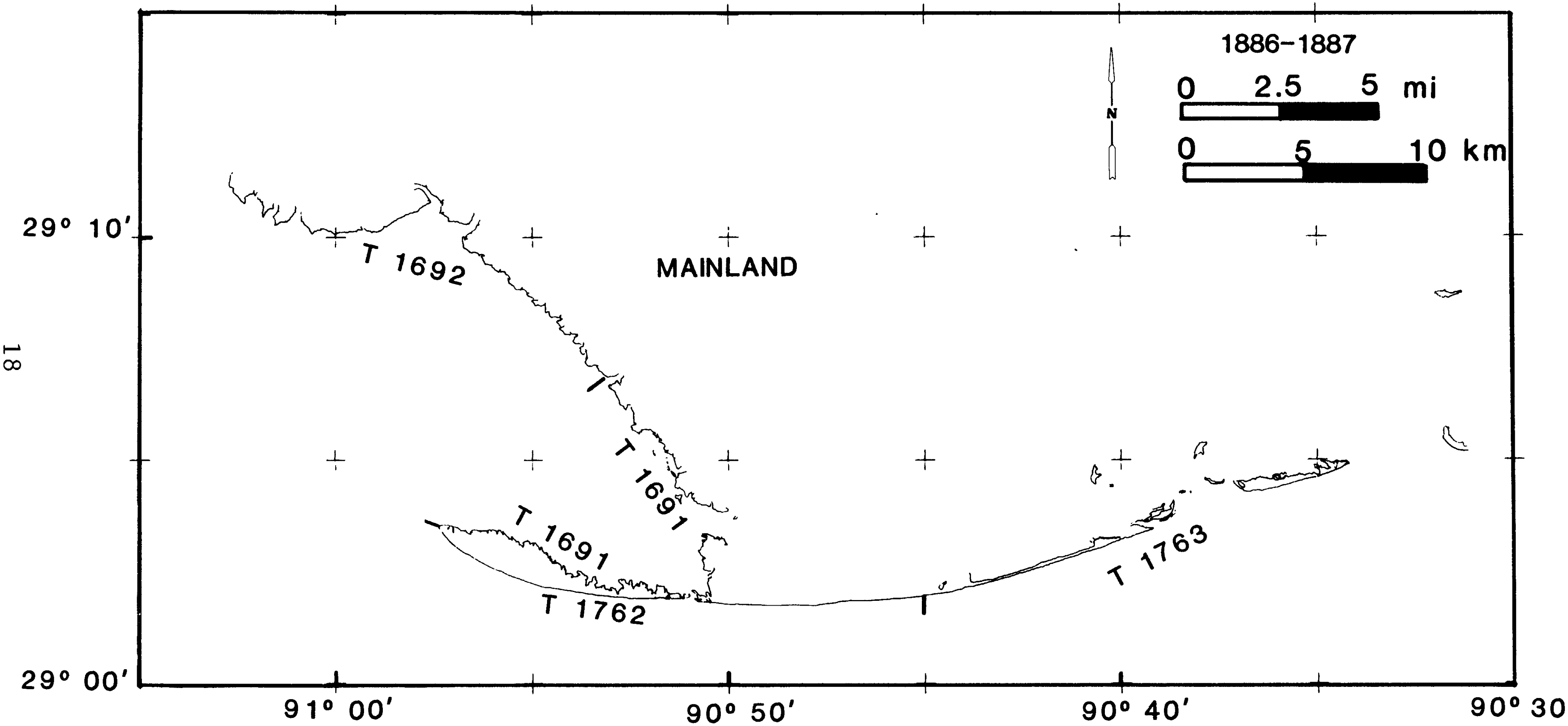

1886-1887
0 2.5 5 mi
0 5 10 km
N
MAINLAND
T 1692
T 1691
T 1691
T 1762
T 1763
29° 10′
29° 00′
91° 00′
90° 50′
90° 40′
90° 30′

Figure 5

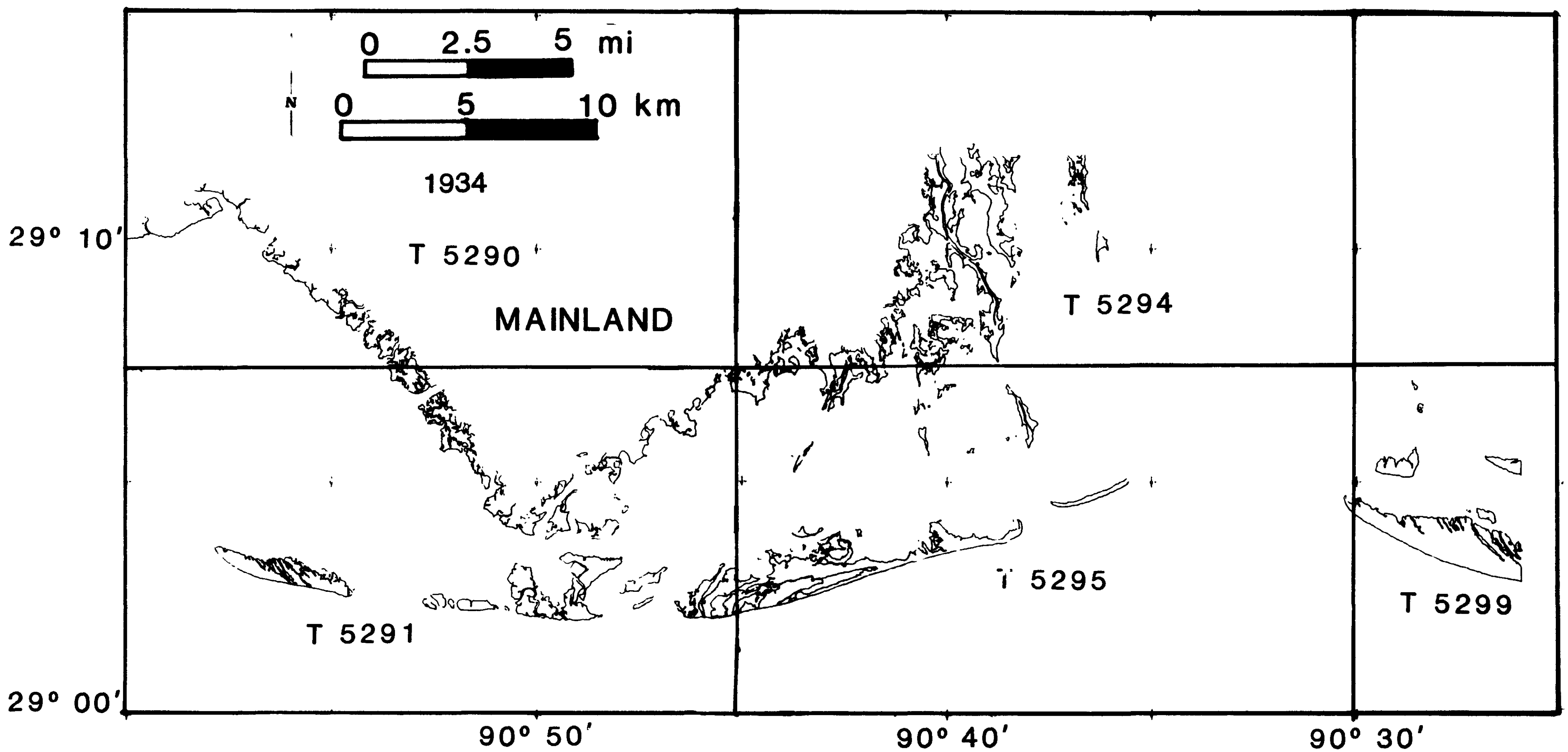
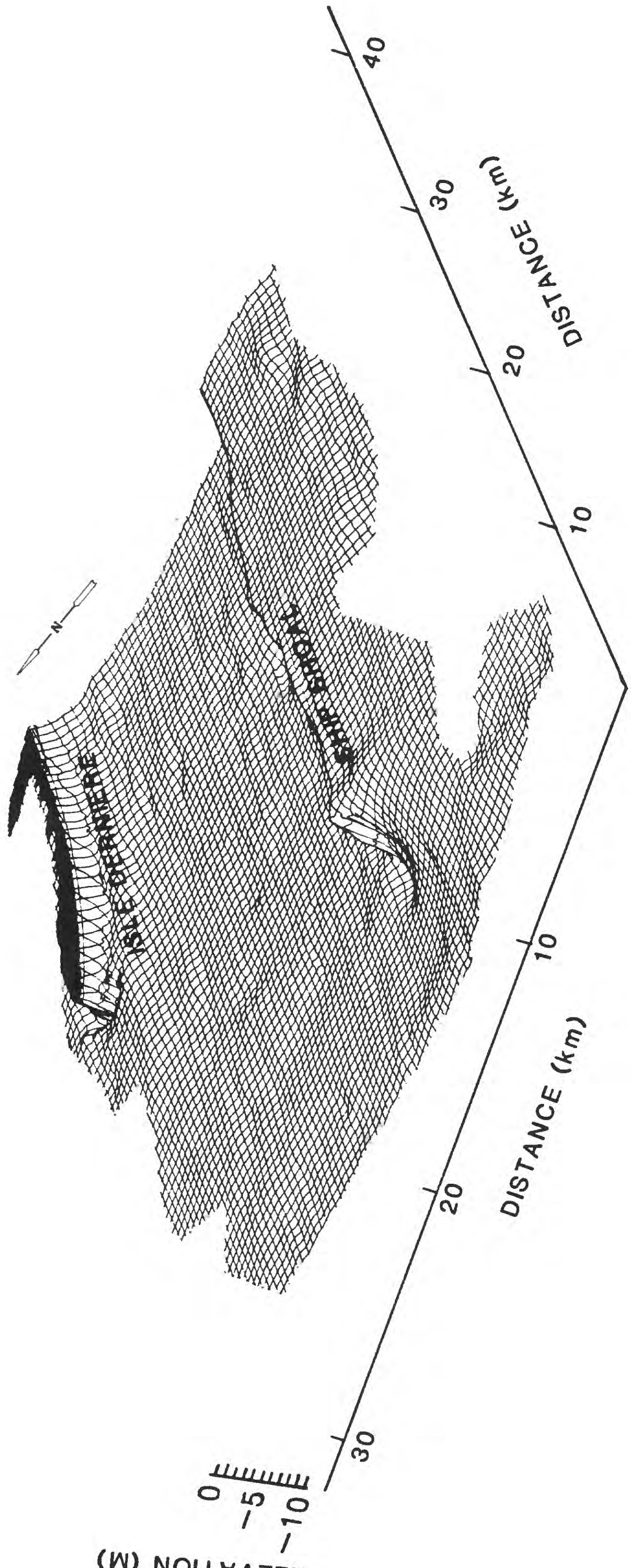
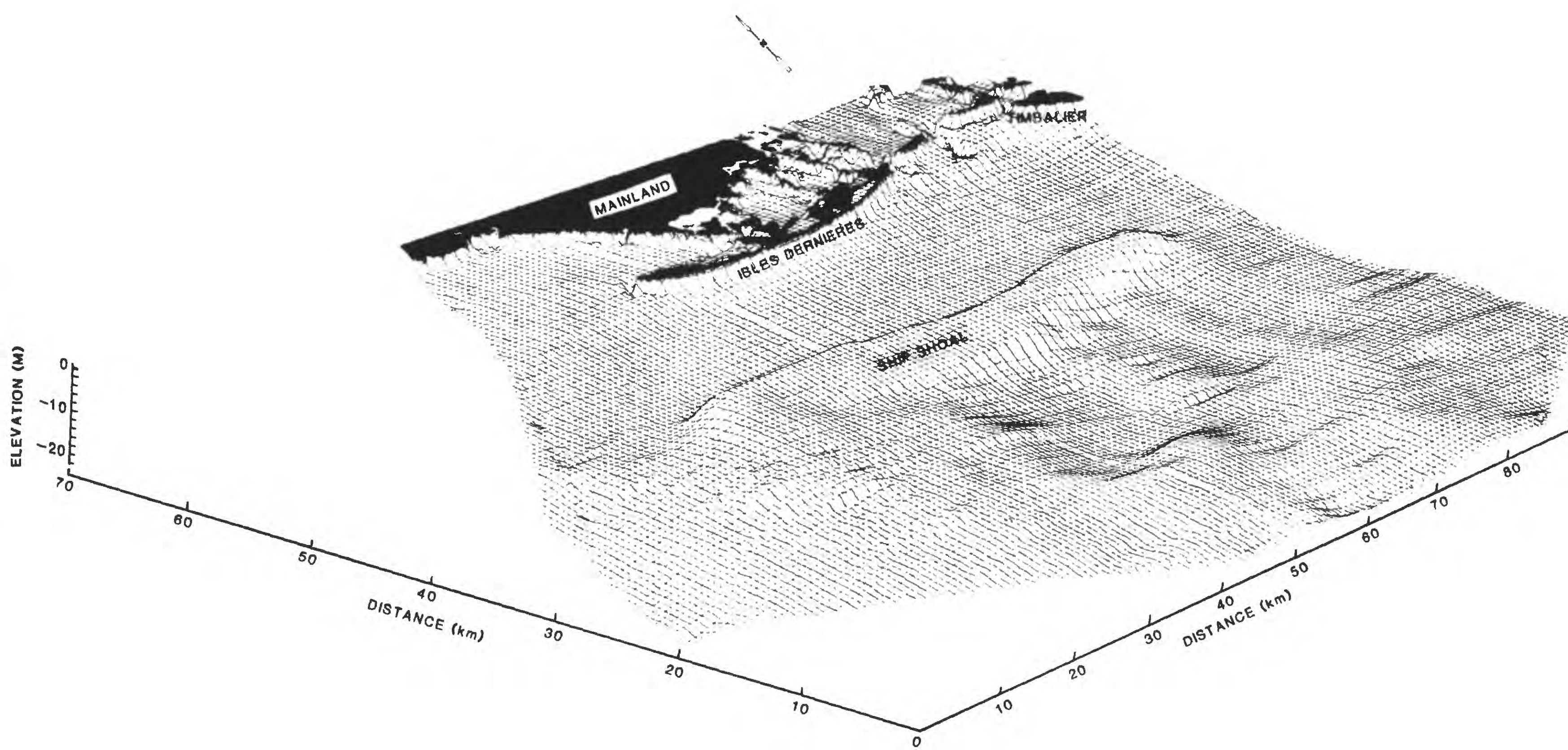

0 2.5 5 mi
0 5 10 km
N
1934
T 5290
MAINLAND
T 5294
T 5291
T 5295
T 5299
29° 10′
29° 00′
90° 50′
90° 40′
90° 30′

Figure 6



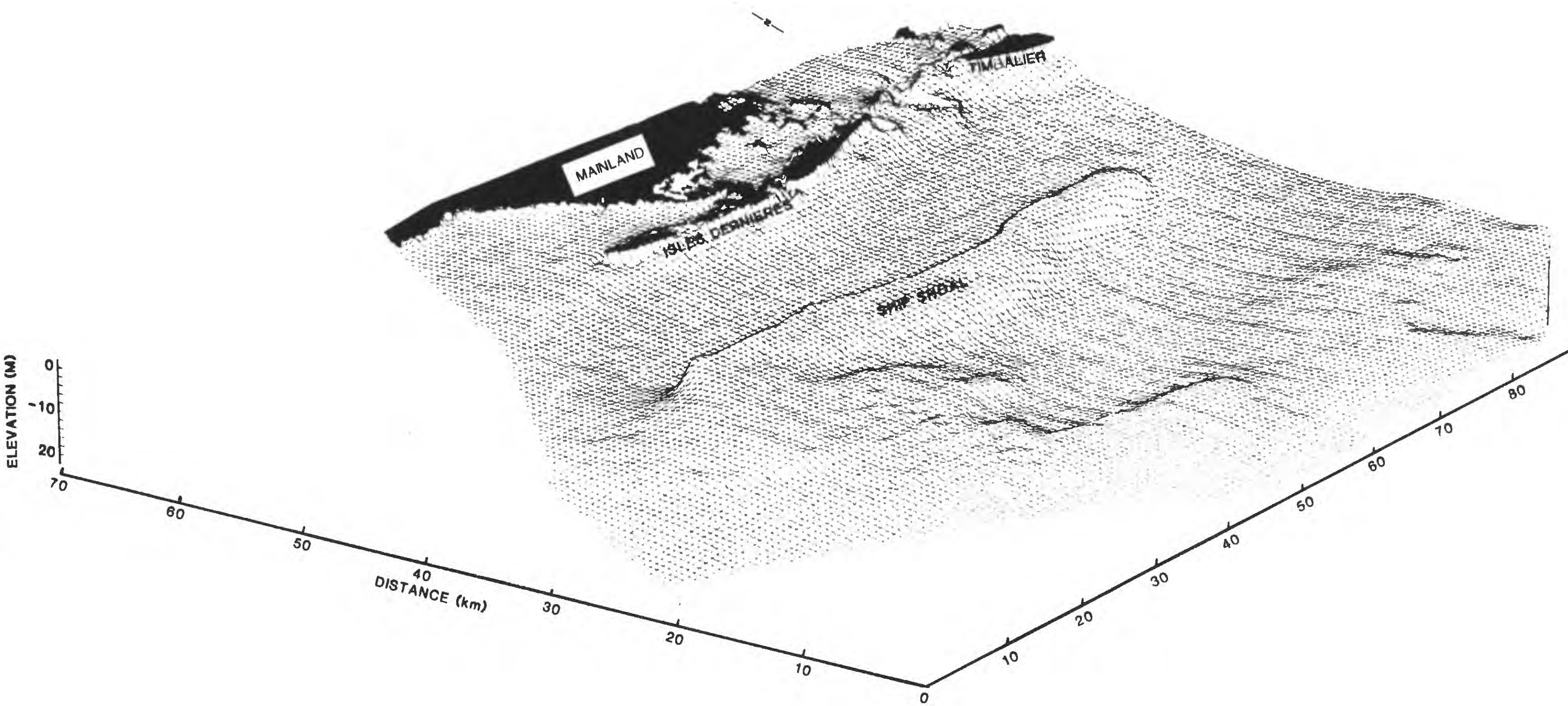
1853

Figure 7



1890s

Figure 8



1930s

Figure 9

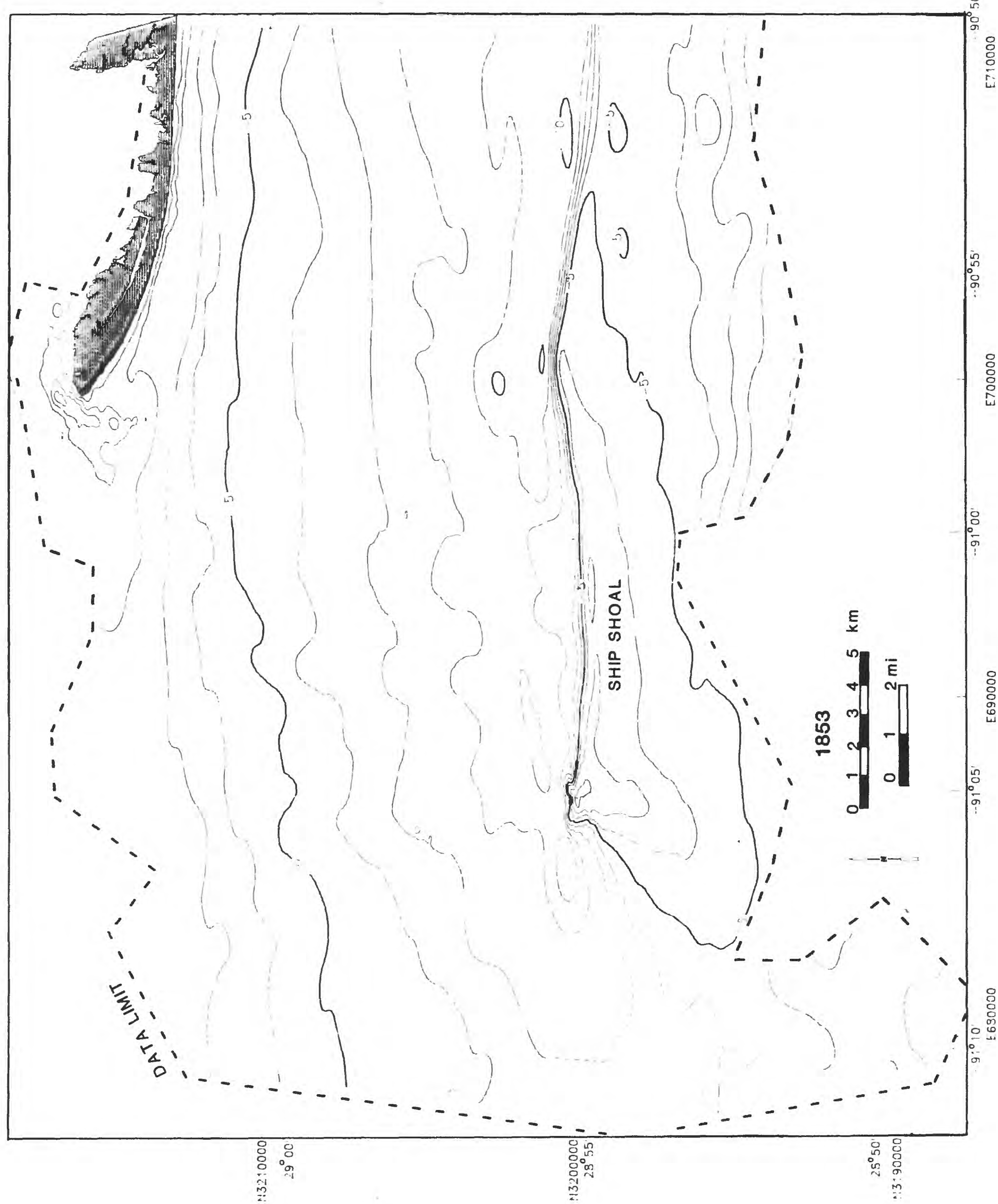

DATA LIMIT
SHIP SHOAL
1853
0 1 2 3 4 5 km
0 1 2 mi
5
E710000
E700000
E690000
-90°50'
-90°55'
-91°00'
-91°05'
N3210000
29°00'
N3200000

Figure 10

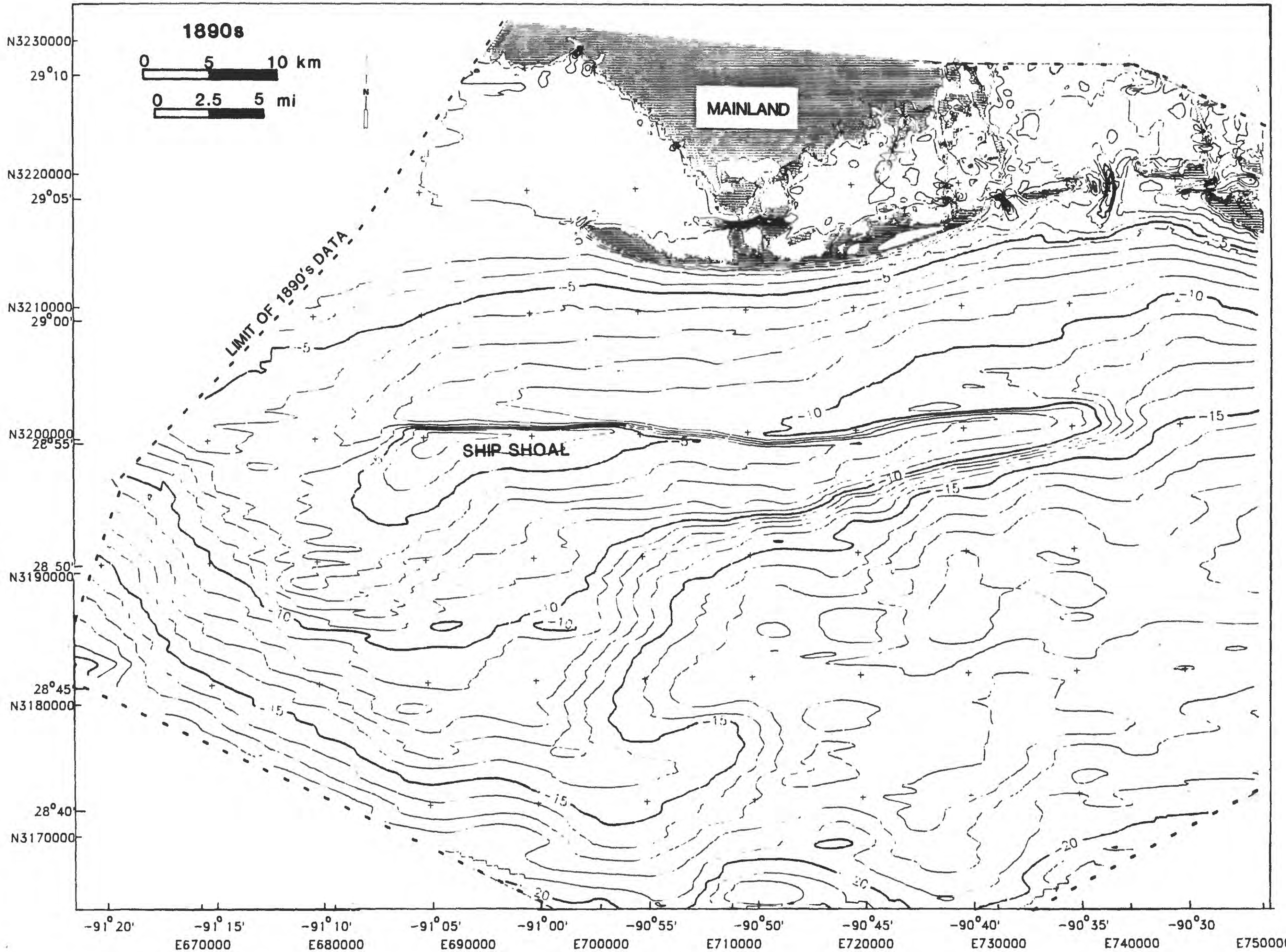

1890s
0 5 10 km
0 2.5 5 mi
MAINLAND
LIMIT OF 1890's DATA
SHIP SHOAL
-5
-10
-15
-20
N3230000
29°10
N3220000
29°05'
N3210000
29°00'
N3200000
28°55'
28 50'
N3190000
28°45'
N3180000
28°40'
N3170000
-91° 20'
-91° 15'
-91° 10'
-91° 05'
-91° 00'
-90° 55'
-90° 50'
-90° 45'
-90° 40'
-90° 35'
-90° 30
E670000
E680000
E690000
E700000
E710000
E720000
E730000
E740000
E750000

Figure 11

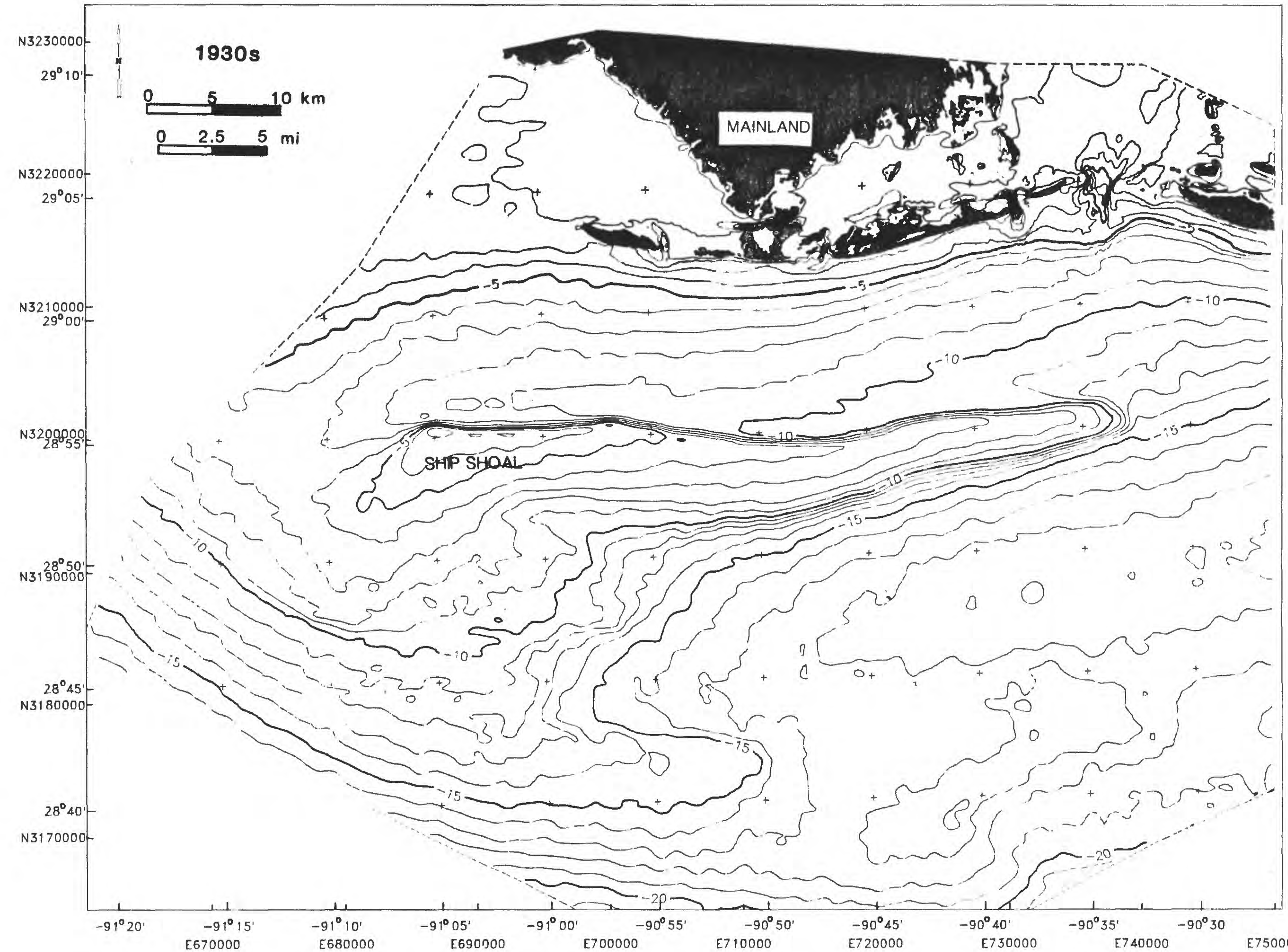

1930s
0 5 10 km
0 2.5 5 mi
MAINLAND
SHIP SHOAL
-5
-10
-15
-20
N3230000
29°10'
N3220000
29°05'
N3210000
29°00'
N3200000
28°55'
28°50'
N3190000
28°45'
N3180000
28°40'
N3170000
-91°20'
-91°15'
-91°10'
-91°05'
-91°00'
-90°55'
-90°50'
-90°45'
-90°40'
-90°35'
-90°30
E670000
E680000
E690000
E700000
E710000
E720000
E730000
E740000
E750000

Figure 12