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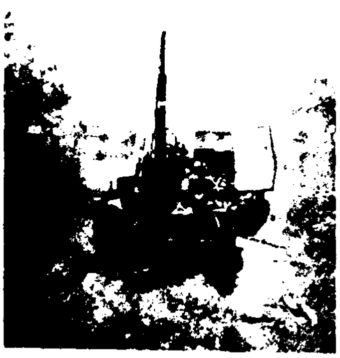

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LAND LOSS RATES: MISSISSIPPI RIVER DELTAIC PLAIN

by

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Land loss mapping and rate curve development for 50 quadrangles located in the Mississippi River deltaic plain show that land loss rates calculated for the 1930's to 1956-58, 1956-58 to 1974, and 1974 to 1983 time periods vary significantly throughout the deltaic plain. Differences between land loss rates of individual quadrangles are a function of the geologic setting and the factors which contribute to land loss such as subsidence, storm-induced erosion, channelization of streams, and canal dredging. Of the 50 quadrangles mapped, 14 show an increase in the land loss rate, 29 show a decrease, and 7 remained approximately the same. Specific causes of land loss are not evaluated in this report. On a regional scale, the land loss rate for the entire Mississippi River deltaic plain (an area of approximately 13,000 square miles) has decreased from an average yearly rate of 28.02 square miles for the 1956-58 to 1974 period to 22.97 square miles for the 1974 to 1983 period. Another data set is needed to verify whether this decrease in the average annual land loss rate is continuing.

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Land loss data generated during this investigation is being combined with geologic data in a Geographic Information System to facilitate detailed analyses of the causes of land loss in future reports.

PREFACE

This investigation was authorized by the US Army Engineer District, New Orleans (NOD), under the heading "Land Loss Mapping and Rate Curve Development: Mississippi River Deltaic Plain."

The investigation was performed and the report prepared during the period 1 October 1987 to 15 March 1990. The land loss mapping and rate curve development were performed by Mr. L. D. Britsch of the Geologic Environments Analysis Section (GEAS), Engineering Geology Branch (EGB), Earthquake Engineering and Geosciences Division (EEGD), Geotechnical Laboratory (GL). The report was prepared by Mr. Britsch and Mr. E. Burton Kemp III of the Geology Section, Engineering Division, NOD. The investigation was conducted under the direct supervision of Mr. Robert J. Larson, Chief, GEAS, and under the general supervision of Dr. L. M. Smith, Chief, EGB; Dr. A. G. Franklin, Chief, EEGD; and Dr. W. F. Marcuson III, Chief, GL.

Mr. A. N. Williamson, GEAS, provided assistance in the development of computer programs used for area calculation and data management. Mr. J. B. Dunbar, GEAS, served as a technical reviewer for the land loss mapping.

COL Larry B. Fulton, EN, was Commander and Director of WES during the preparation of this report. Dr. Robert W. Whalin was Technical Director.

CONTENTS

LAND LOSS RATES: MISSISSIPPI RIVER DELTAIC PLAIN

PART I: INTRODUCTION

Background

1. Over the past 7,000 years five major delta complexes have prograded into coastal Louisiana (Figure 1). The result of this long period of deltaic sedimentation is the vast expanse of marshlands separated by active and abandoned distributary channels. After progradation, each delta complex was abandoned by the Mississippi River in favor of a more advantageous gradient. As the focus of sedimentation shifted, destructive processes (i.e. shoreline erosion) began in the abandoned delta resulting in some land loss. This land loss was more than offset by the land gain occurring at the new site of Mississippi River deposition. The overall result of this shifting in the Mississippi River was a net gain of land within the Mississippi River deltaic plain. Since the early 1900's this trend of land building has reversed and the Louisiana coastal zone is losing land at a high rate, leading to the destruction of hundreds of square miles of wetlands. Causes for this loss range from man's activities (i.e. canal dredging, channelization of streams by levee construction, and hydrocarbon extraction) to various natural phenomena such as subsidence, storm-induced wave erosion, and subsurface geologic control (i.e. faulting).

2. Numerous studies have examined land loss along the Louisiana coastline. Comprehensive inventories of land loss in the Mississippi River deltaic plain have been conducted by Gagliano, Meyer-Arendt, and Wicker (1981) and May and Britsch (1987). The study by Gagliano, Meyer-Arendt, and Wicker involved comparison of various vintages of US Geological Survey (USGS) topographic maps (1890-1967) and aerial photography (1955-56, 1978). The data sources were interpreted by either a point count method or by overlaying photography and digitizing the results. The results of this study yielded a land loss rate curve depicting high land loss rates increasing geometrically. The Gagliano study used different methods of interpretation and map and photographic vintages from the ones discussed in this report. The results of the Gagliano study will be compared with those identified during this investigation later

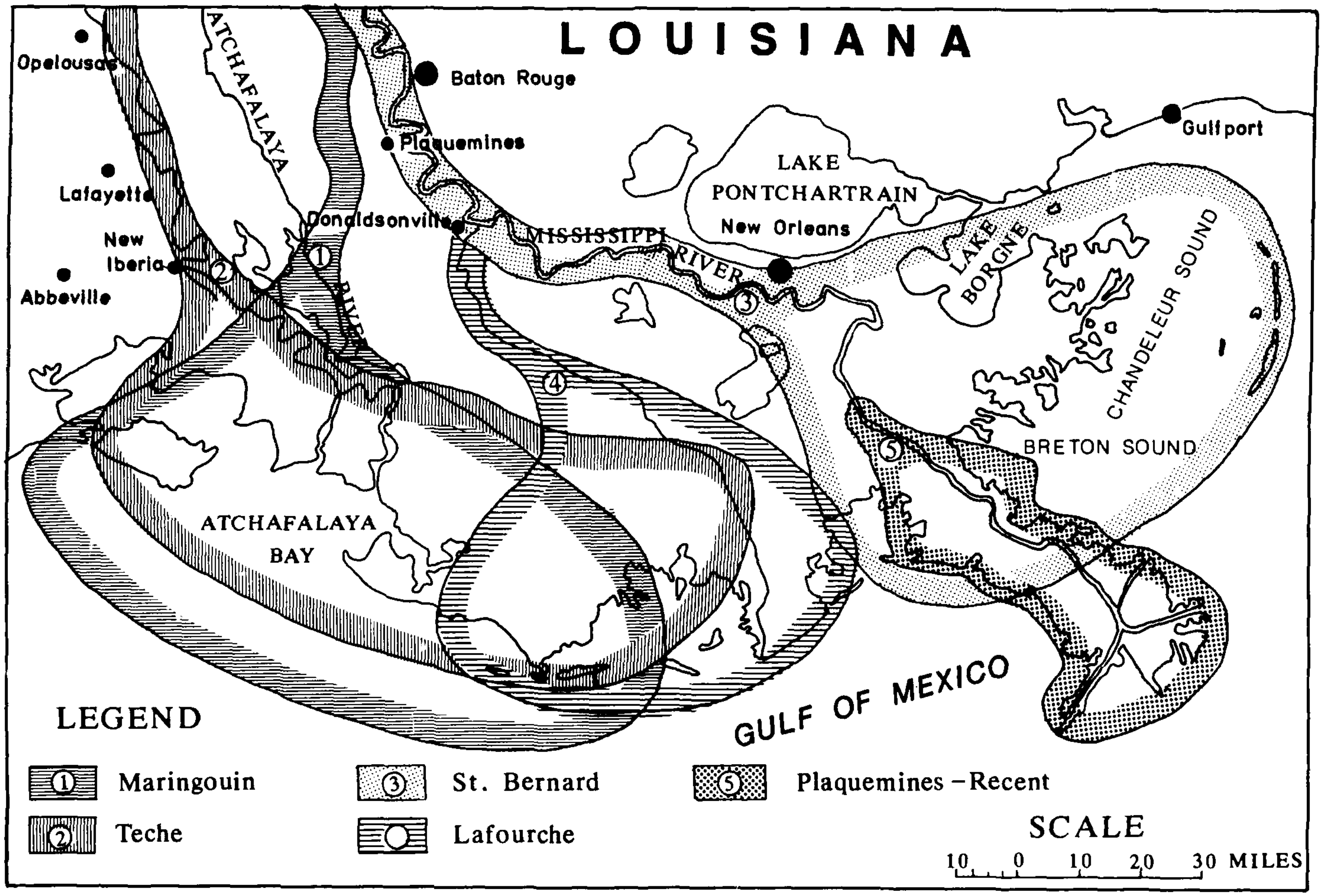

Figure 1. Delta complexes comprising the Mississippi River deltaic plain (from Kolb and Van Lopik 1966)

in this report. May and Britsch (1987) produced a folio of maps depicting land loss and land accretion throughout the deltaic plain for the 1930's to 1983 time period. This folio illustrates that much of the land loss is not equally distributed in the study area, rather it is concentrated in specific areas.

3. A detailed examination of habitat change in the Mississippi River deltaic plain, conducted for the US Fish and Wildlife Service, was carried out by comparing 1955-56 black and white aerial photo mosaics with 1978 NASA color infrared (IR) photography (Wicker 1980). Habitat types were interpreted and digitized and used to extract land loss data. The Fish and Wildlife study was used as part of the land loss investigation conducted by Gagliano, Meyer-Arendt, and Wicker (1981).

4. A more recent study by Turner and Cahoon (1987) provides a comprehensive analysis of the causes of land loss, especially in relationship to offshore oil and gas activity along the Louisiana, Texas, and Mississippi coastlines.

5. Many smaller site-specific studies have examined land loss and/or its causes along the Louisiana coastline (DeLaune, Smith, and Patrick 1986; Johnson and Gossilink 1982; Craig, Turner, and Day 1979; Baumann, Day, and Miller 1984; and Turner 1985). These studies provide valuable insight into the magnitude of the land loss problem and the factors contributing to land loss at specific sites along the Louisiana coast.

6. The study discussed in this report expands upon the land loss data published in previous studies and provides the New Orleans Engineer District with the most recent comprehensive land loss information available.

Purpose and Scope

7. The purpose of this study was to document on maps the land loss that has occurred in the Mississippi River deltaic plain during each of three successive time intervals beginning in the 1930's. Area calculations from this map data were then used to construct a land loss rate curve for each 15-min (1:62,5000 scale) map unit within the study area, as well as a regional curve representing the entire Mississippi River deltaic plain. The study area is contained on fifty, 15-min quadrangle maps as shown in Figure 2. Each map unit was assigned the name of the corresponding USGS quadrangle map. When no

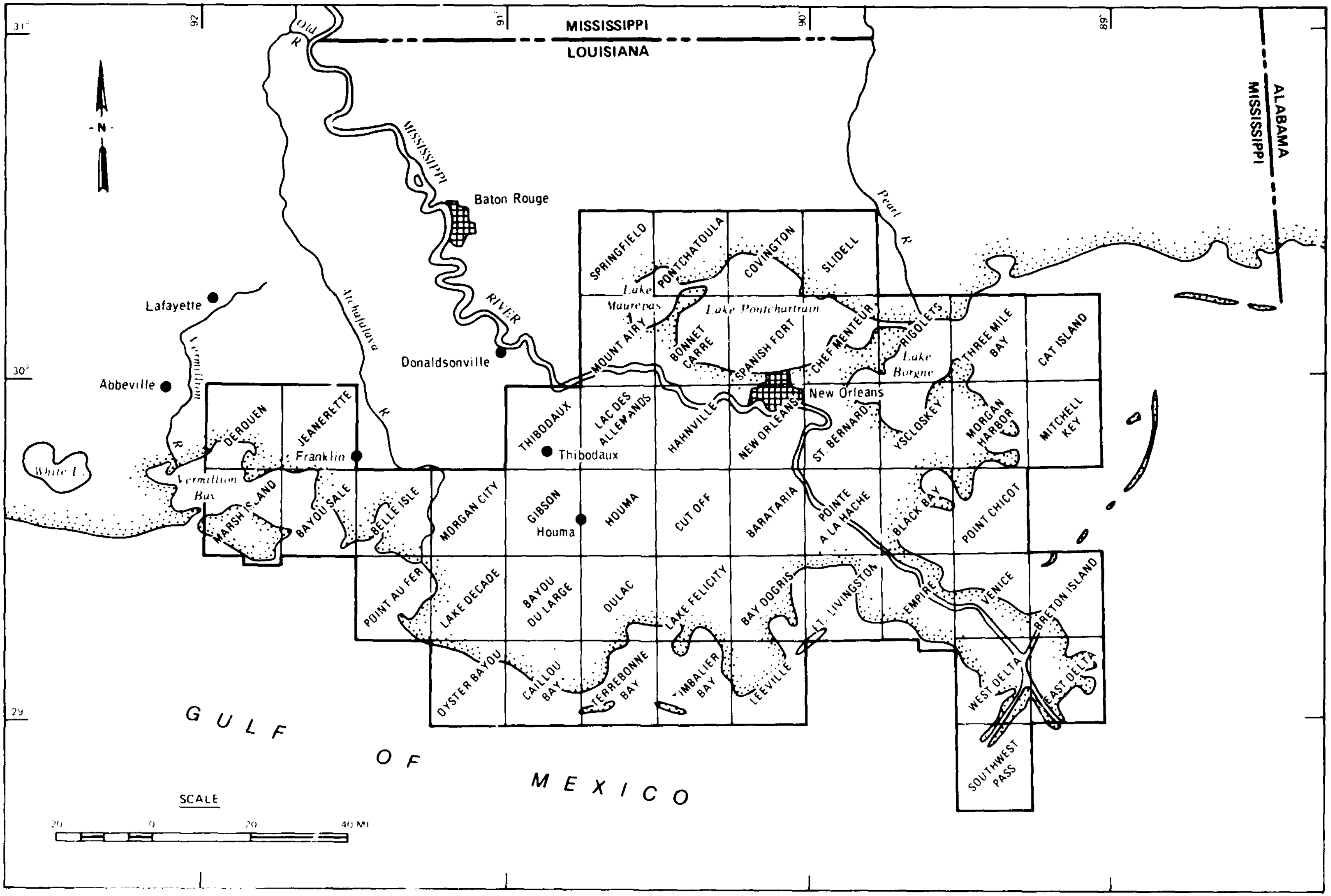

Figure 2. Location of study area

15-min map was available the name of one of the 7-1/2-min quadrangles was used to represent the larger 15-min unit.

8. This paper describes the data sources and methods of interpretation used during the investigation, and presents the results of the land loss mapping and rate curve development.

Data Sources

9. The land loss mapping was accomplished by comparisons between four vintages of aerial photography, from which the change in land/water area was delineated. The four vintages of photography used in the study are defined in Table 1. The US Coast and Geodetic Survey Air Photo Compilation Sheets (T-sheets) were used as base maps on which areas of land loss were identified. The T-sheets were not available for the entire study area. For those areas not covered, USGS 15-min quadrangle maps published closest to 1932 were used.

Table 1

Source and Description of Photographic Products Used During Investigation

Date	Source	Original Scale
1932-33	US Coast and Geodetic Survey Air Photo Compilation Sheets (T-sheets)	1:20,000
1956-58	Tobin Surveys, black-and-white, aerial photo mosaics	1:24,000
1974	NASA color IR	1:120,000
1983	National High Altitude Program, color IR	1:58,000

10. The T-sheets were found to be the oldest suitable coverage available for a majority of the study area, containing the level of detail necessary for the mapping. The T-sheets contained a large amount of additional information such as bench marks, latitude and longitude grid lines, and cultural features. Also, the T-sheets were produced at a time before land loss had become a major problem, and therefore represent an excellent temporal baseline for the study.

The three remaining photographic coverages were available for the entire study area. Criteria used to select the photo coverages used in this study were: (a) the photography provided coverage of the entire study area; (b) the photography had little or no cloud cover, and good color contrast between land and water; (c) appropriate interval between dates when the photography was flown; and (d) the photography was flown during the winter when most floating vegetation is dormant, aiding in identification of land/water interfaces. The time interval between photographic coverages was spaced as equally as possible so that the calculated average land loss rates represent somewhat comparable time spans.

PART II: METHODOLOGY

Interpretation and Classification

11. The land loss study documents changes from land to water in the Mississippi River deltaic plain for a period of approximately 50 years. Land loss was considered to be any land area present in the 1930's photography that was interpreted as water on later photographic coverages. This includes loss from man-made causes as well as loss due to natural processes. Most of the land loss classified as man-made is the result of dredging activity. Drill rig location canals and waterways designed to aid navigation account for most of the man-made land loss in the Mississippi River deltaic plain. All land loss not the direct result of man's activities was considered natural loss.

12. Because the distinction between land and water is so critical to the accuracy of the study, it is important to identify the criteria used for their identification. Water was classified as any area of water having no permanent vegetation visible at the surface. Permanent vegetation, for purposes of this investigation, is that which is attached to the substrate, not floating vegetation such as hydrilla and hyacinths. Land was simply defined as everything on the photography not classified as water. The only land features without some visible vegetation were some beaches and dredged material.

Land Loss Mapping and Rate Curve Development

13. Land loss maps were compiled from comparisons of four vintages of aerial photography. Land loss mapping was conducted at a scale of 1:62,500. The T-sheets (dated 1932-33) were used as a base on which areas of land loss were delineated. As previously mentioned, where T-sheets were not available, the USGS quadrangle published closest to 1932 was used. The T-sheets (original scale 1:20,000) were reduced to 1:62,500, and printed on stable material. Interpretative overlays delineating land/water interfaces were made of the 1956-58, 1:24,000, Tobin photography for the entire study area. These overlays were photographically reduced to 1:62,500 on stable material. The 1974 color IR photography was purchased as custom enlargements to 1:62,500 for this project. The 1983 color IR was reduced to 1:62,500 from 1:58,000 using an

adjustable mapping projector onsite at WES. The mapping began once the photographic products had been referenced to a scale of 1:62,500.

14. The first step in the mapping process involved placing the base map (T-sheet) over the 1956-58 Tobin photography overlay, orienting it with the aid of control points, and delineating the land loss which had occurred from the date of the T-sheet to 1956-58. The areas of land loss (both natural and man-made) were represented by polygons which were physically inked onto the base maps. These polygons were color coded to reflect the time period which they represent and to differentiate between natural and man-made land loss. The result of this first step was a base map with the land loss that occurred during the 1932 to 1956-58 time period represented as colored polygons. This step was repeated using the 1974 color IR. The base map, with the 1932 to 1956-58 land loss delineated, was placed over the 1974 photography, oriented using control points, and the land loss which occurred from 1956-58 to 1974 was delineated. The inked polygons representing the land loss between 1956-58 and 1974 were color coded.

15. The final step in the mapping involved placing the base map, which already had the land loss from the 1932 to 1956-58 and 1956-58 to 1974 time periods defined, over the 1983 color IR. The base map was aligned, with the aid of the mapping projector using control points, and the land loss from 1974 to 1983 was added to the base map and color coded. The final land loss map may be represented by well over a thousand polygons, each spatially oriented with respect to the base map, and color coded to reflect the time interval each represented and whether the land loss was natural or man-made. This procedure was followed for all 50 quadrangles in the study area. Figures 3, 4, 5, and 6 show the stages of development for the land loss map of Southwest Pass.

16. Completed land loss maps were used to calculate the total number of acres of land loss that occurred during each time interval and what portion of that total is attributed to natural and man-made causes. To derive these values, a separate overlay representing all the polygons for each color was drafted (two for each time period, one natural and one man-made, six total for each map). The overlays were converted to digital data by optical scanning. From this digital data the number of acres of land loss for each color separate was determined. The total acres of land loss for each time interval was converted to square miles of land loss. The square miles of loss were

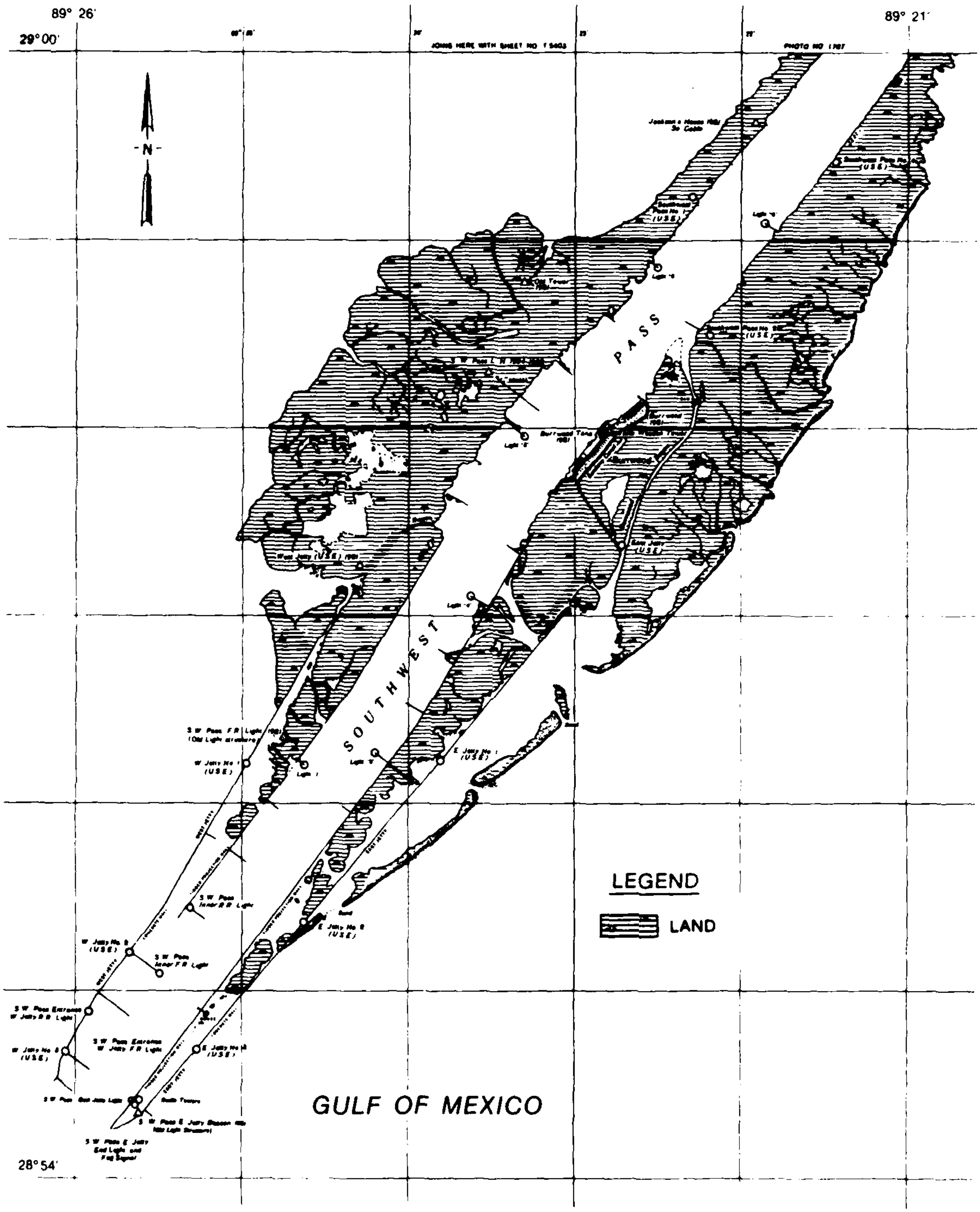

Figure 3. 1932 US Coast and Geodetic Survey Air Photo Compilation Sheet of Southwest Pass used as the base map for the land loss mapping

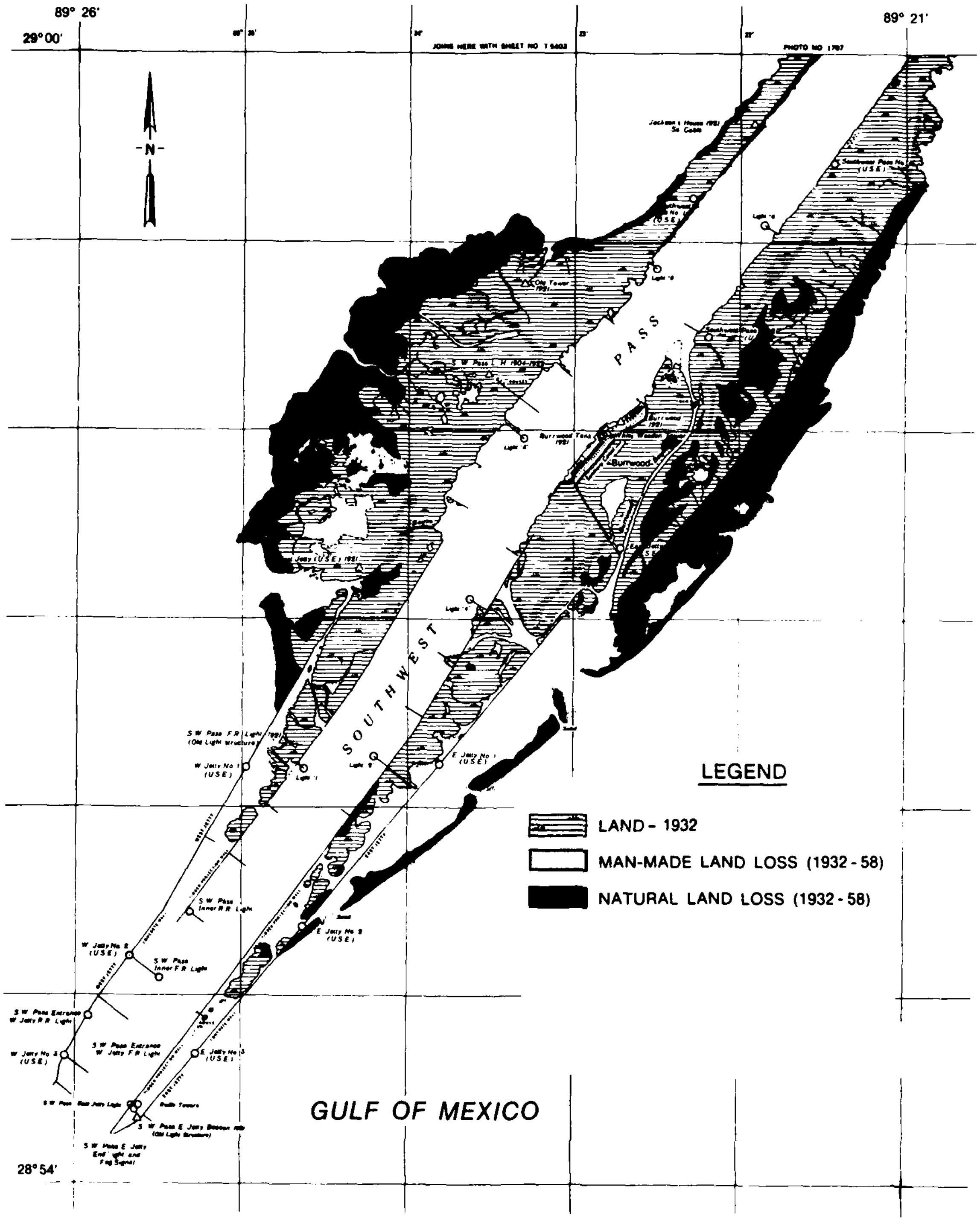

Figure 4. 1932 base map of Southwest Pass with land loss from 1932 to 1958 delineated

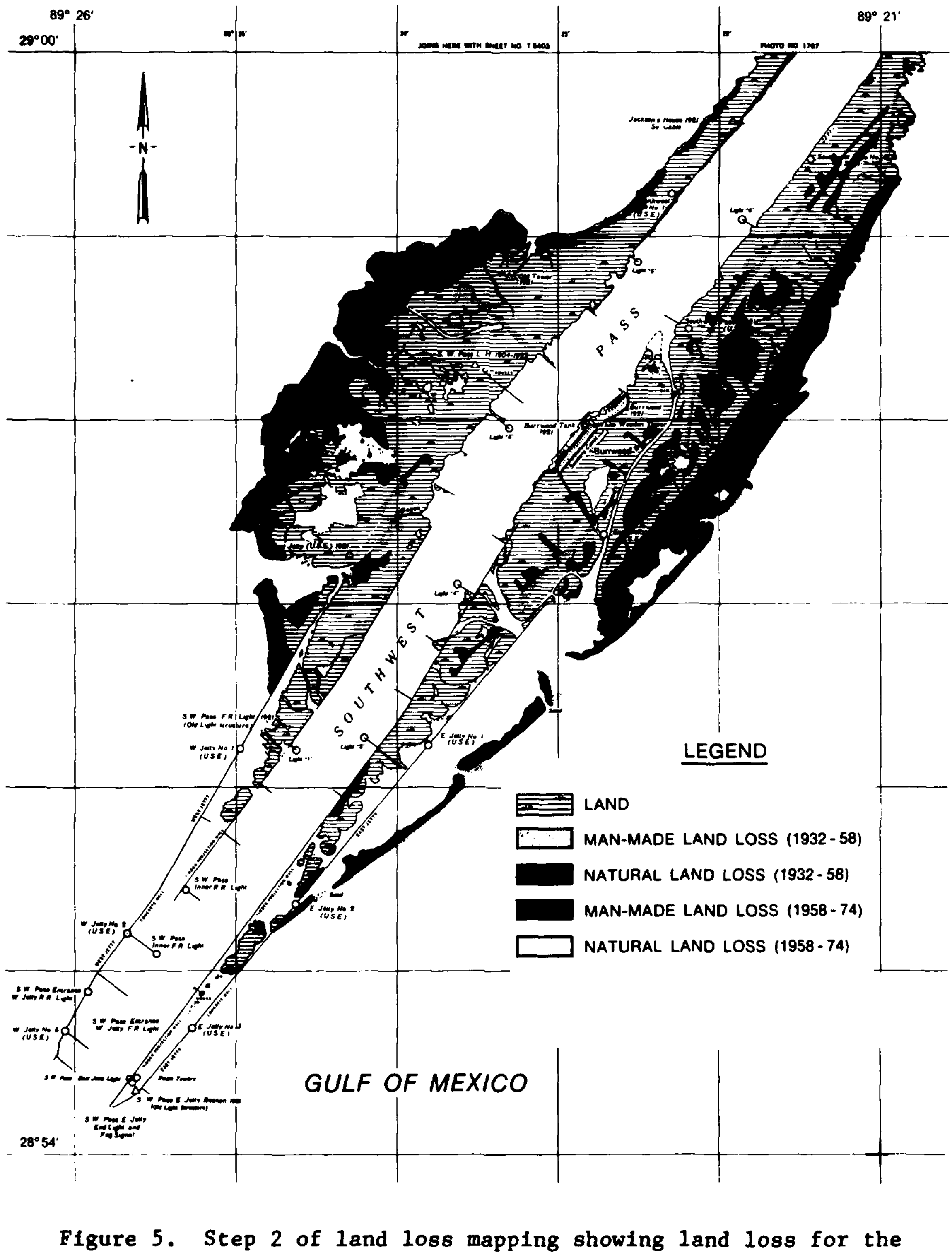

Figure 5. Step 2 of land loss mapping showing land loss for the 1958 to 1974 period added to the base map

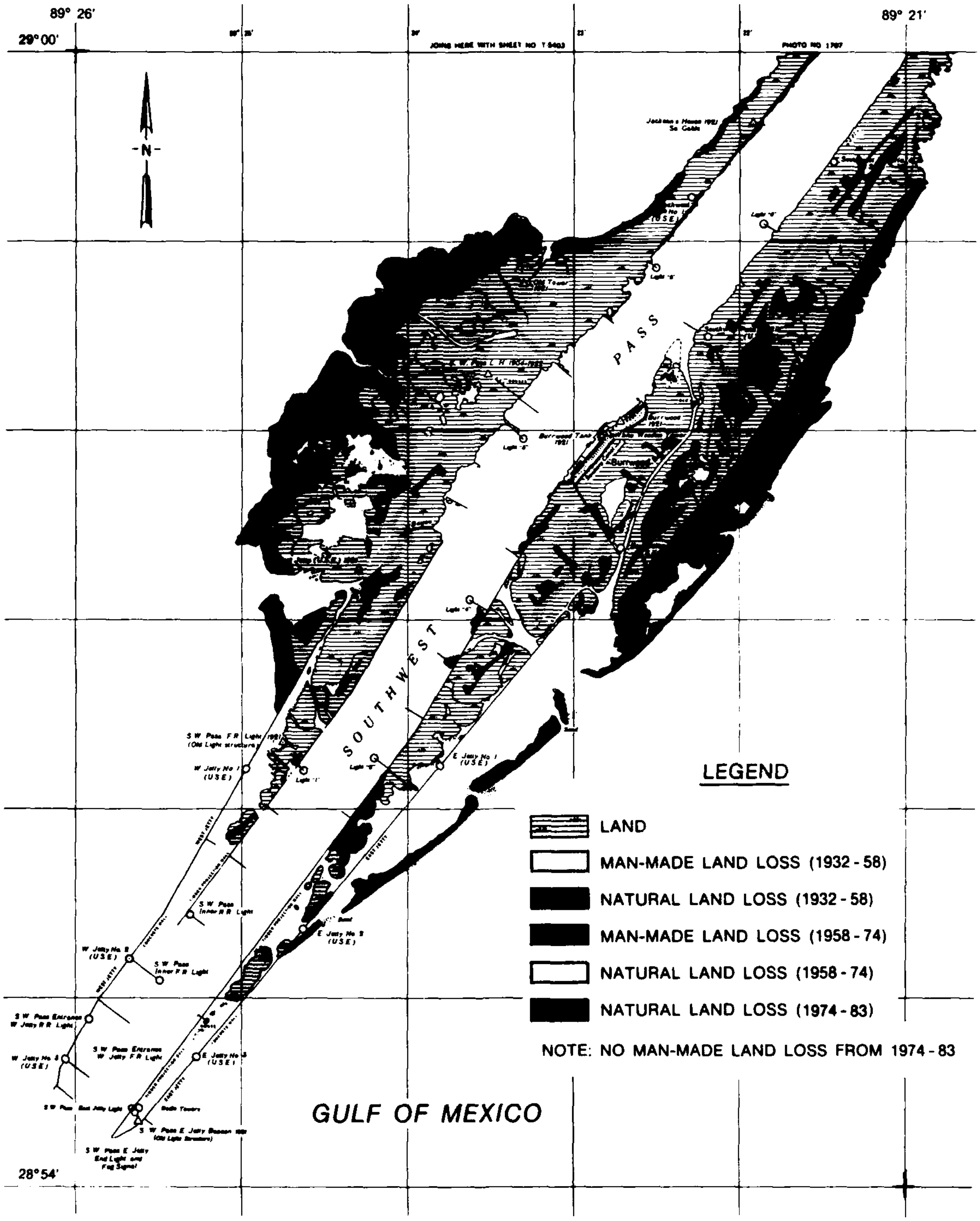

Figure 6. Final step of land loss mapping showing land loss from 1974 to 1983 added to base map. This figure represents the completed land loss map for the Southwest Pass quadrangle

divided by the number of years in the time interval covered to derive the average square miles of land loss per year for each time interval. These values were used to construct a rate curve for each quadrangle.

17. The rate curves were produced by plotting the average land loss, in square miles per year, for each time interval at the chronological midpoint of the time interval represented. The resulting three points were connected with a best-fit line to form the rate curve. Horizontal lines drawn through each point define the time interval represented by the land loss rate. The points through which the curves are drawn may be somewhat misleading in that they represent average land loss for the whole time period without regard for when the loss may have occurred within each interval. No attempt was made to extrapolate the data.

PART III: RESULTS

18. A total of 50 maps representing land loss in the Mississippi River deltaic plain were completed during this investigation (see Figure 2). Each map portrays the land loss which has occurred during three intervals of time over approximately a 50-year period, relative to a 1930's base map. The individual areas of land loss were color-coded by time interval, and according to whether land loss was natural or man-made. Figures 6, 7, and 8 are examples of completed land loss maps.

19. Land loss area calculations were made from overlays of the land loss maps (one overlay for each color, six total for each quadrangle). The results of the land loss area calculations, showing average land loss per year for each time interval by quadrangle, are shown in Table 2. The data in Table 2 were used to construct the land loss rate curves presented in Appendix A. The recent trend in land loss rates for each quadrangle, as shown by the rate curves, is generalized in Figure 9. The recent trend was determined by comparisons between the land loss rate for the 1956-58 to 1974 period with the 1974 to 1983 period. The trend in the land loss rate was determined to be increasing if the rate increased by more than 10 percent from the previous period. Similarly, the trend was said to be decreasing if the rate decreased by more than 10 percent from the previous period. If the change in the land loss rate was less than or equal to 10 percent then the trend was considered to be unchanged. A change of 10 percent was arbitrarily selected as the amount of change necessary to be significant. As illustrated by the rate curves in Appendix A and by Figure 9, land loss rates as well as the recent trend of these rates vary significantly throughout the Mississippi River deltaic plain. This variability reflects differences in the geologic settings of individual quadrangles as well as differences in the factors responsible for land loss.

20. The land loss data contained in Table 2 were used to construct a regional curve for the entire Mississippi River deltaic plain (Figure 10). Each point on the curve was plotted at the average of the chronological midpoints of all the individual curves. The land loss rate values represent the average annual loss in square miles per year for each time interval. As shown in Figure 10, the land loss rate has decreased from an average yearly rate of 28.02 square miles for the 1956-58 to 1974 period to 22.97 square miles for

Figure 7. Land loss map of the Dulac quadrangle located in the south-central portion of the deltaic plain

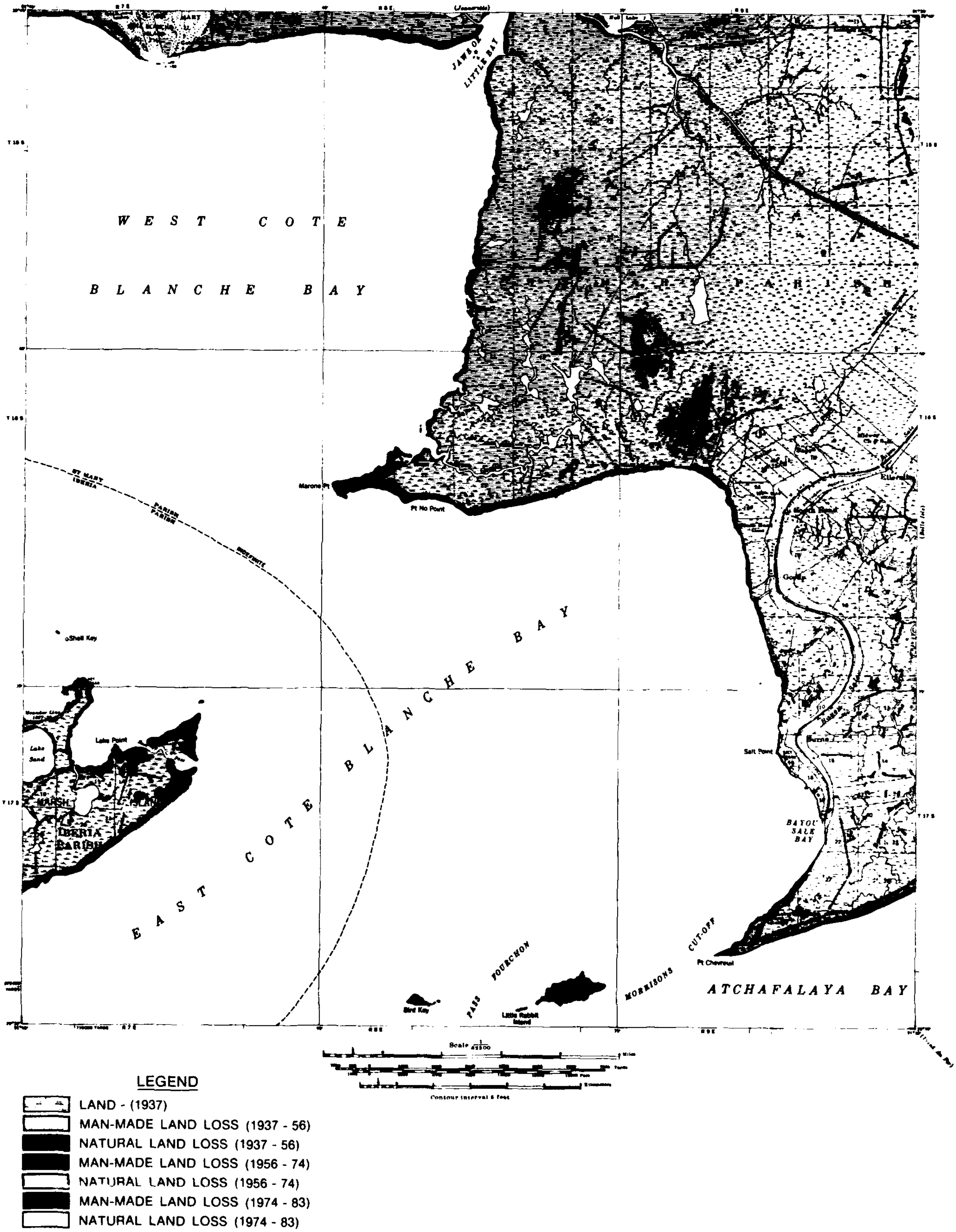

Figure 8. Land loss map of the Bayou Sale quadrangle located in the southwestern portion of the deltaic plain

Table 2

Land Loss Rates Derived From Area Calculations

Quadrangle Name	Time Period 1	Average Loss in Square Mile/year	Time Period 2	Average Loss in Square Mile/year	Time Period 3	Average Loss in Square Mile/year
Barataria	1939-1956	1.08	1956-1974	1.20	1974-1983	0.70
Bay Dogris	1932-1958	0.42	1958-1974	1.44	1974-1983	1.26
Bayou Du Large	1932-1958	0.18	1958-1974	1.61	1974-1983	0.65
Bayou Sale	1937-1956	0.31	1956-1974	0.36	1974-1983	0.19
Belle Isle	1940-1956	0.38	1956-1974	0.32	1974-1983	0.15
Black Bay	1932-1958	0.21	1958-1974	0.37	1974-1983	0.52
Bonnet Carre	1936-1958	0.10	1958-1974	0.44	1974-1983	0.19
Breton Island	1932-1958	0.26	1958-1974	0.18	1974-1983	0.11
Caillou Bay	1932-1958	0.22	1958-1974	0.40	1974-1983	0.43
Cat Island	1932-1958	0.07	1958-1974	0.09	1974-1983	0.11
Chef Menteur	1932-1958	0.49	1958-1974	0.41	1974-1983	0.28
Covington	1932-1958	0.02	1958-1974	0.18	1974-1983	0.02
Cut Off	1939-1958	0.22	1958-1974	0.53	1974-1983	0.39
Derouen	1932-1956	0.24	1956-1974	0.22	1974-1983	0.24
Dulac	1932-1958	0.37	1958-1974	0.98	1974-1983	1.99
East Delta	1932-1958	1.17	1958-1974	1.90	1974-1983	0.27
Empire	1932-1958	0.35	1958-1974	1.12	1974-1983	2.66
Fort Livingston	1932-1958	0.34	1958-1974	0.53	1974-1983	0.89
Gibson	1939-1958	0.11	1958-1974	1.50	1974-1983	0.45
Hahnville	1935-1958	0.11	1958-1974	0.57	1974-1983	0.43
Houma	1939-1958	0.13	1958-1974	0.24	1974-1983	0.17
Jeanerette	1937-1956	0.08	1956-1974	0.08	1974-1983	0.06
Lac des Allemands	1945-1958	0.13	1958-1974	0.11	1974-1983	0.66
Lake Decade	1931-1956	0.25	1956-1974	1.31	1974-1983	0.38
Lake Felicity	1932-1958	0.29	1958-1974	1.32	1974-1983	1.61
Leeville	1932-1958	0.28	1958-1974	0.40	1974-1983	0.90
Marsh Island	1932-1956	0.23	1956-1974	0.39	1974-1983	0.24
Mitchell Key	1932-1956	0.05	1958-1974	0.03	1974-1983	0.07

(Continued)

Table 2 (Concluded)

Quadrangle Name	Time Period 1	Average Loss in Square Mile/year	Time Period 2	Average Loss in Square Mile/year	Time Period 3	Average Loss in Square Mile/year
Morgan City	1931-1956	0.20	1956-1974	1.37	1974-1983	0.93
Morgan Harbor	1932-1958	0.19	1958-1974	0.32	1974-1983	0.38
Mount Airy	1939-1958	0.05	1958-1974	0.08	1974-1983	0.08
New Orleans	1935-1958	0.17	1958-1974	0.26	1974-1983	0.14
Oyster Bayou	1931-1956	0.07	1956-1974	0.18	1974-1983	0.15
Point Chicot	1932-1958	0.08	1958-1974	0.08	1974-1983	0.07
Point au Fer	1931-1956	0.11	1956-1974	0.16	1974-1983	0.17
Pointe a la Hache	1932-1958	0.28	1958-1974	0.75	1974-1983	0.71
Pontchatoula	1939-1958	0.07	1958-1974	0.09	1974-1983	0.08
Rigolets	1932-1958	0.11	1958-1974	0.24	1974-1983	0.26
Slidell	1939-1958	0.06	1958-1974	0.15	1974-1983	0.05
Southwest Pass	1932-1958	0.10	1958-1974	0.12	1974-1983	0.02
Spanish Fort	1936-1958	0.03	1958-1974	0.01	1974-1983	0.003
Springfield	1939-1958	0.01	1958-1974	0.01	1974-1983	0.03
St. Bernard	1932-1958	0.29	1958-1974	1.23	1974-1983	0.70
Terrebonne Bay	1932-1958	0.18	1958-1974	0.29	1974-1983	0.49
Thibodaux	1949-1958	0.003	1958-1974	0.02	1974-1983	0.07
Three Mile Bay	1932-1958	0.08	1958-1974	0.11	1974-1983	0.10
Timbalier Bay	1932-1958	0.21	1958-1974	0.22	1974-1983	0.41
Venice	1932-1958	0.61	1958-1974	1.50	1974-1983	0.54
West Delta	1932-1958	1.41	1958-1974	2.0	1974-1983	1.04
Yscloskey	1932-1958	0.12	1958-1974	0.60	1974-1983	0.53

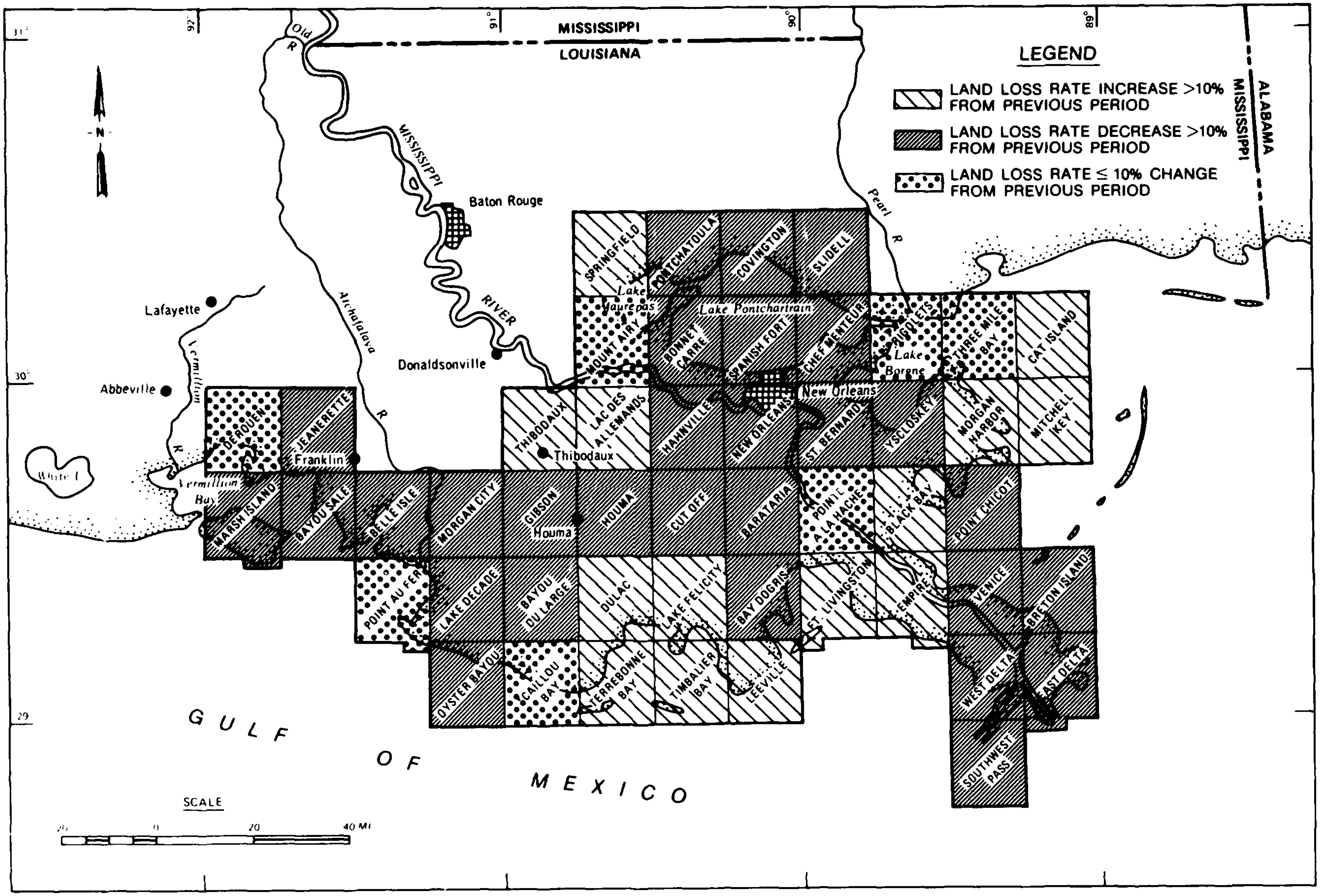

Figure 9. Recent trend in land loss rates by quadrangle. The trends were determined by comparisons between the land loss rates for the 1956-58 to 1974 time period with the 1974 to 1983 period

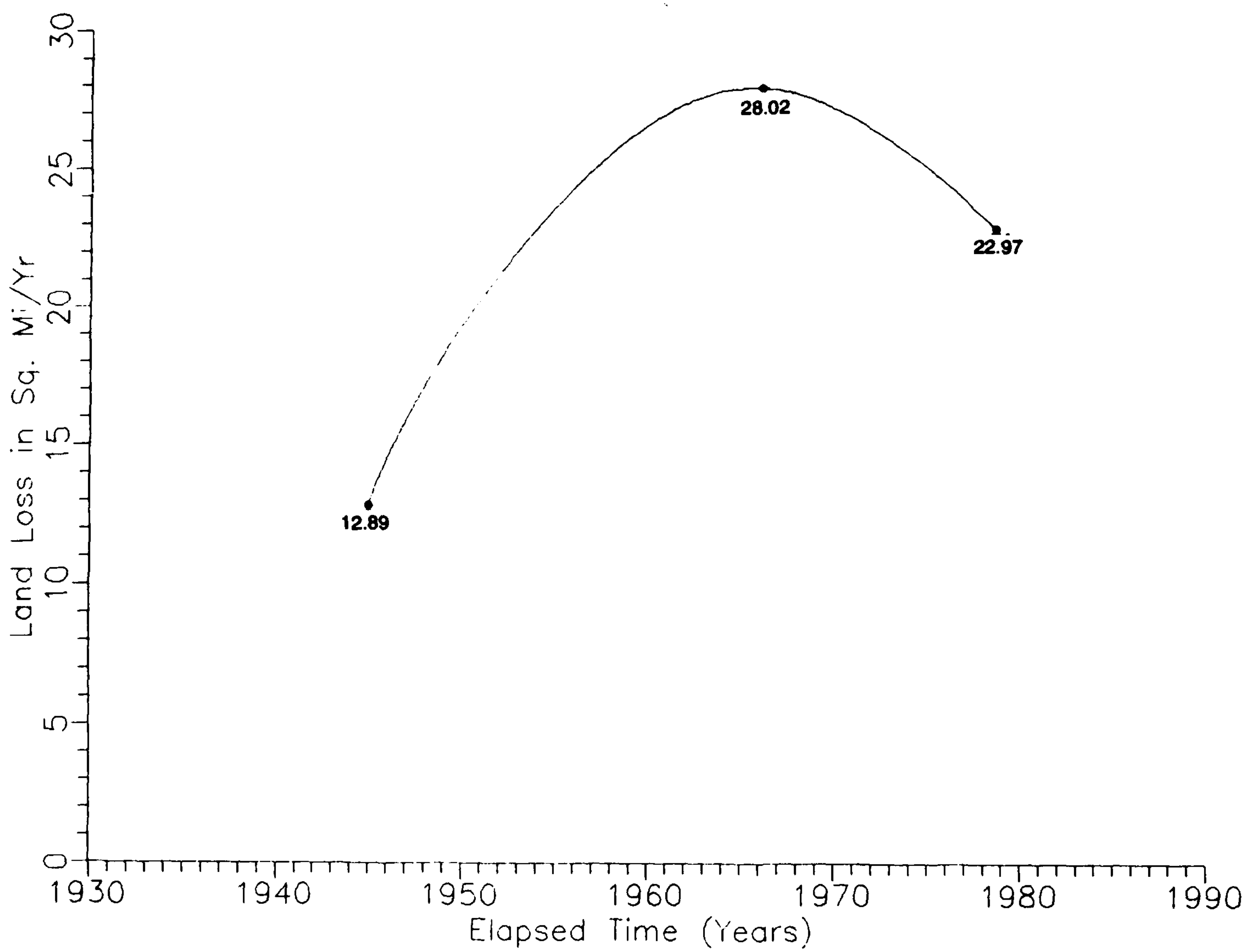

Figure 10. Composite land loss rate curve for entire Mississippi River deltaic plain

the 1974 to 1983 period. This decrease follows a period of increasing land loss rates for the deltaic plain (Figure 10). No attempt was made to extrapolate the data used to construct the regional curve. Another data point is needed to determine whether this trend toward a decreasing regional land loss rate is continuing.

21. The regional land loss rates shown in Figure 10 compare closely with those determined by Gagliano, Meyer-Arendt, and Wicker (1981) for those time periods which were similar. For the 1930 to 1967 period Gagliano, Meyer-Arendt, and Wicker determined a land loss rate of 15.8 square miles per year. The present study determined a loss rate of 12.89 for the 1930's to 1956-58 period. For the 1955-56 to 1978 period Gagliano, Meyer-Arendt, and Wicker calculated a loss rate of 28.1 square miles per year. A loss rate of 28.02 was determined for the 1956-58 to 1974 period during this investigation. In addition, the study discussed in this report contains land loss rate data for the 1974 to 1983 time period; whereas, the study conducted by Gagliano, Meyer-Arendt, and Wicker contained data only up to 1978.

Conclusions

22. Land loss mapping and rate curve development of 50 quadrangles in the Mississippi River Deltaic Plain indicate that the magnitude of land loss as well as the trend in land loss rates is highly variable throughout the deltaic plain. Fourteen of the 50 quadrangles comprising the deltaic plain show an increase in the land loss rate when comparing the rates for the 1956-1958 to 1974 period with the 1974 to 1983 period. Most of these quadrangles are located along the coastline (Figure 9). The land loss rate has decreased on 29 quadrangles during the same period. These quadrangles are generally located in the vicinity of the Atchafalaya River delta, the Mississippi River delta, Lake Pontchartrain, and the central interior of the deltaic plain. The land loss rate for seven quadrangles has shown little or no change. On a regional scale, the land loss rate for the entire Mississippi River deltaic plain as a whole has decreased from its high estimated to have occurred sometime in the early 1970's. As of 1983 the land loss rate for the Mississippi River deltaic plain (50 quads) was 22.97 square miles per year. Another data point is necessary to determine whether this trend toward decreasing land loss rates is continuing.

23. Detailed discussion concerning the factors responsible for land loss in the Mississippi River deltaic plain is beyond the scope of this report. However, the land loss data indicate that many factors contribute to the resultant land loss rate. These include, but are not limited to, geologic factors such as faulting, subsidence, geomorphology, depth to Pleistocene, differences in the engineering properties of the various environments of deposition, sediment age, and hydrologic setting. Man-made factors responsible for land loss such as dredging of location canals, and navigation waterways, as well as levee construction, also account for a significant portion of the total land loss.

Epilogue

24. To effectively address, in detail, the specific factors mentioned above, all of the land loss data generated during this study, as well as engineering geology and Pleistocene data previously completed by WES, are being assembled into a Geographic Information System that will be used to analyze the data to determine the causes of land loss throughout the deltaic plain in future reports.

25. At the present time, WES is conducting land loss mapping of the chenier plain in southwest Louisiana using the procedures developed for the deltaic plain. In addition, it is anticipated that a high altitude photo mission will be flown in the winter of 1990 to update the land loss maps and rate curves of the deltaic and chenier plain. This will enable the Corps to determine whether the trend of land loss for the Louisiana coastal zone is increasing or decreasing.

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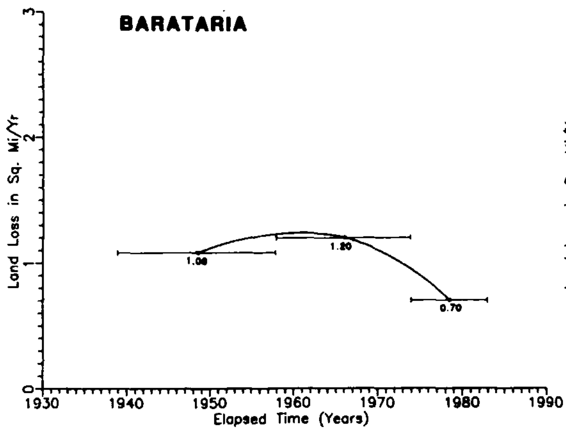
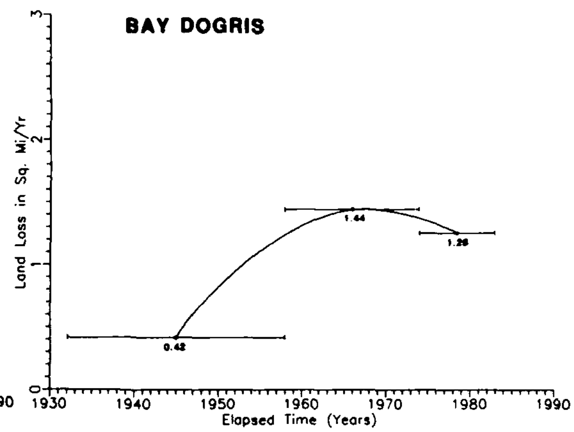
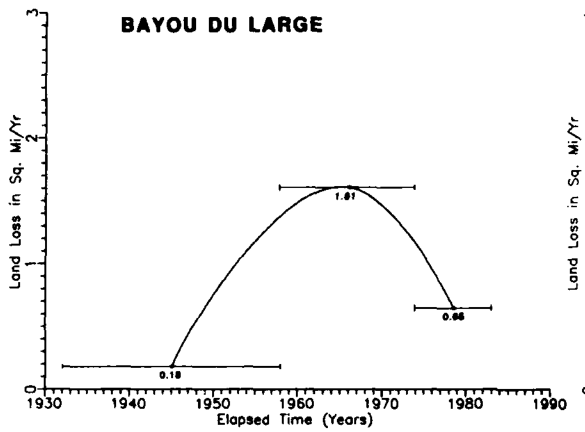
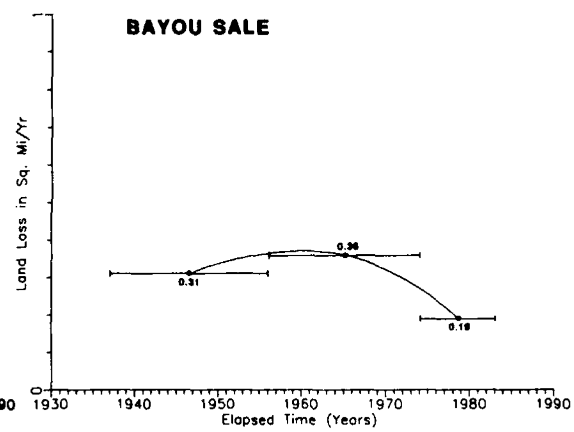
APPENDIX A: LAND LOSS RATE CURVES OF INDIVIDUAL QUADRANGLES

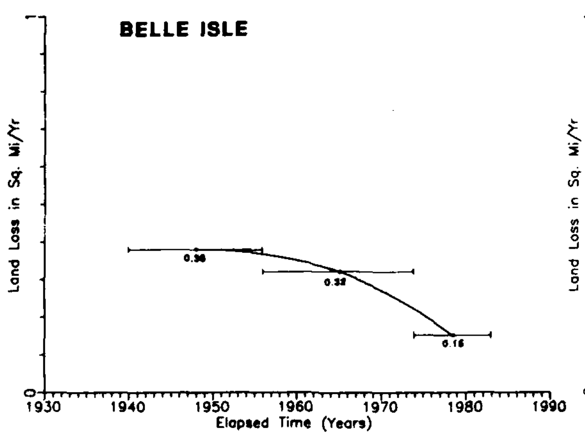
Note: Scale of Y axis varies depending on magnitude of land loss rate for presentation purposes.

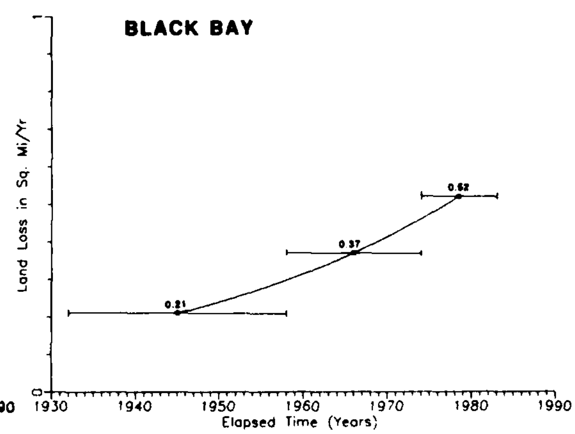

BARATARIA
Land Loss in Sq. Mi/Yr
Elapsed Time (Years)
1.08
1.20
0.70

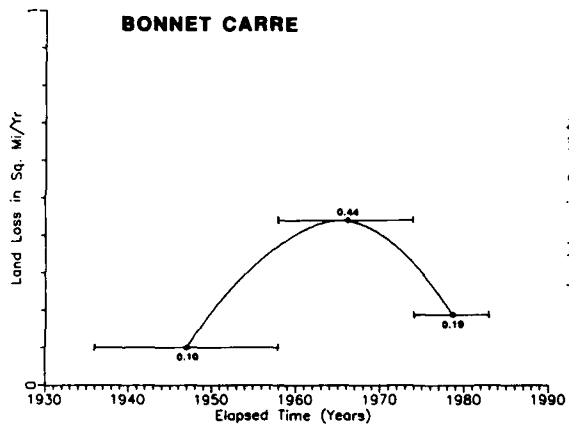

BAY DOGRIS
Land Loss in Sq. Mi/Yr
Elapsed Time (Years)
0.42
1.44

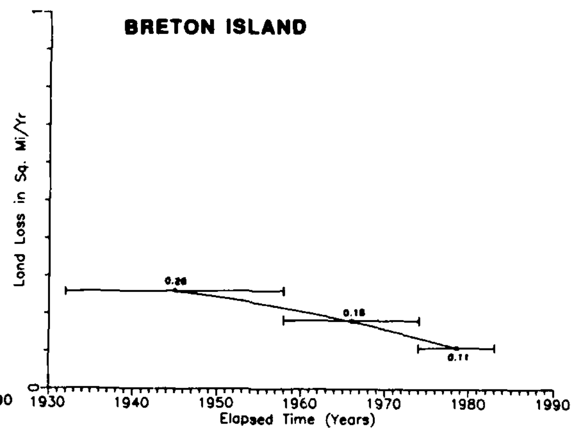

BAYOU DU LARGE
Land Loss in Sq. Mi/Yr
Elapsed Time (Years)
0.18
1.61

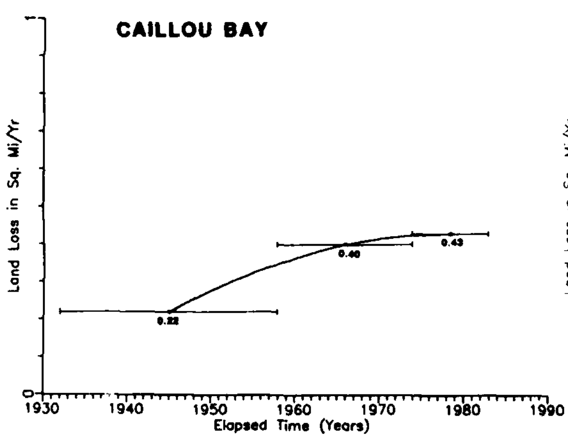

BAYOU SALE
Land Loss in Sq. Mi/Yr
Elapsed Time (Years)
0.31

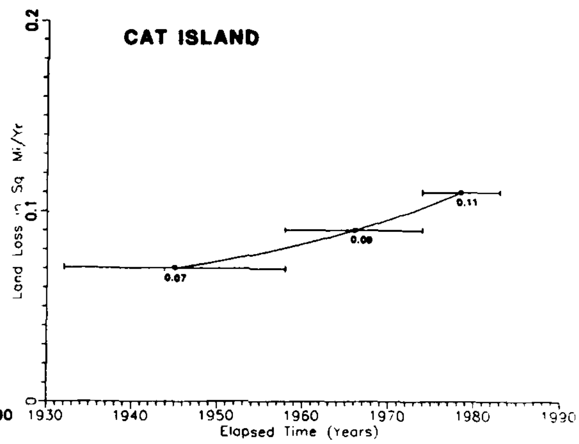

BELLE ISLE
Land Loss in Sq. Mi/Yr
Elapsed Time (Years)
0.36
0.32
0.15

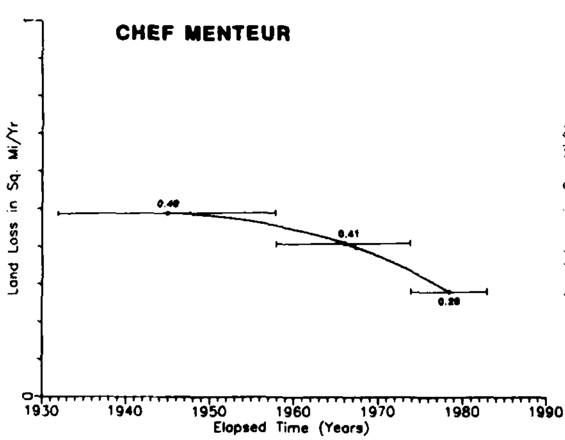

BLACK BAY
Land Loss in Sq. Mi/Yr
Elapsed Time (Years)
0.21
0.37
0.52

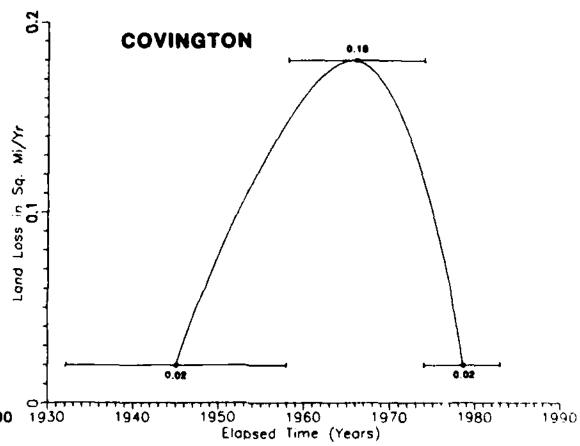

BONNET CARRE
Land Loss in Sq. Mi/Yr
0.44
0.19
0.10
1930 1940 1950 1960 1970 1980 1990
Elapsed Time (Years)

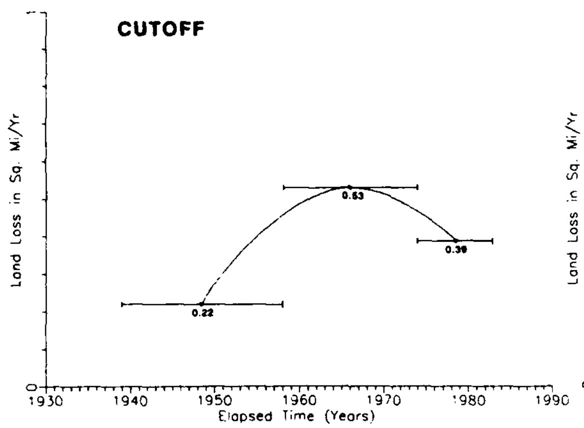

BRETON ISLAND
Land Loss in Sq. Mi/Yr
1930 1940 1950 1960 1970 1980 1990
Elapsed Time (Years)

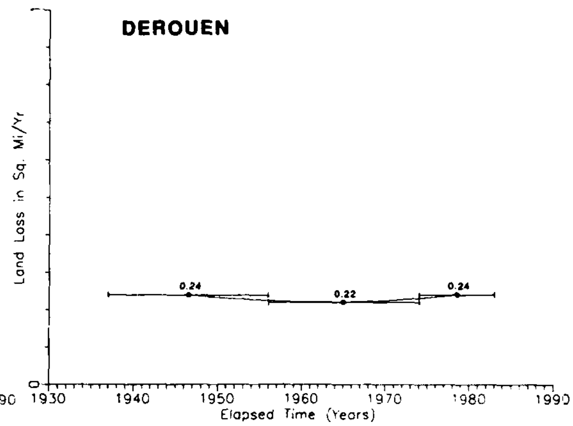

CAILLOU BAY
Land Loss in Sq. Mi/Yr
0.40
0.43
0.22
1930 1940 1950 1960 1970 1980 1990
Elapsed Time (Years)

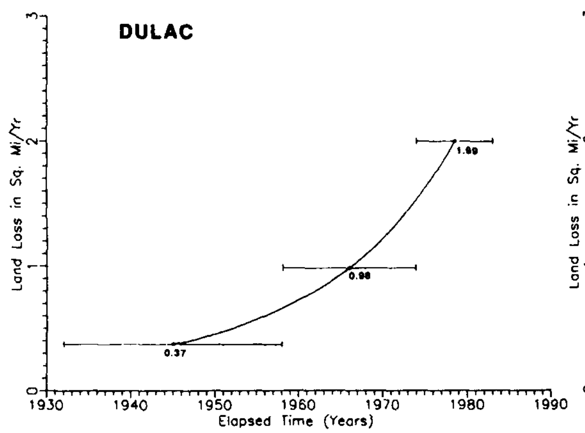

CAT ISLAND
0.2
0.1
Land Loss in Sq. Mi/Yr
0.11
0.07
1930 1940 1950 1960 1970 1980 1990
Elapsed Time (Years)

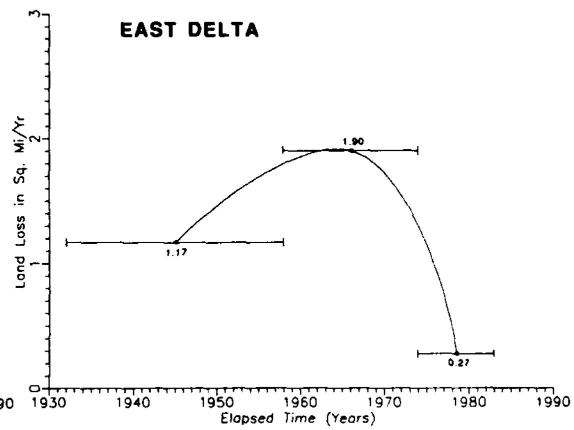

CHEF MENTEUR
Land Loss in Sq. Mi/Yr
0.41
1930 1940 1950 1960 1970 1980 1990
Elapsed Time (Years)

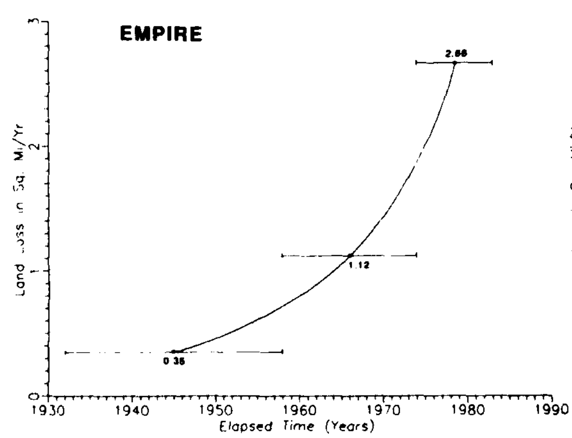

COVINGTON
0.2
0.1
Land Loss in Sq. Mi/Yr
0.02
0.02
1930 1940 1950 1960 1970 1980 1990
Elapsed Time (Years)

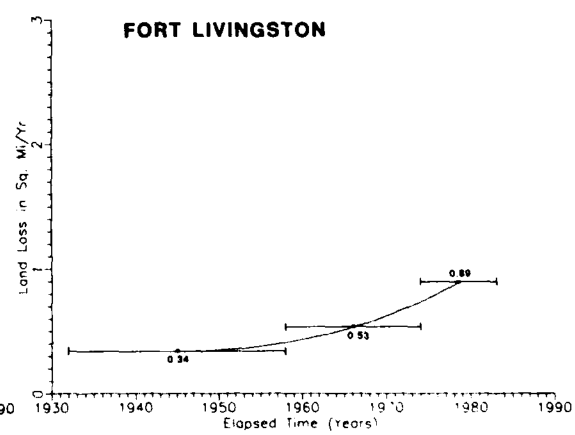

CUTOFF
Land Loss in Sq. Mi/Yr
0
0.22
0.53
0.39
1930
1940
1950
1960
1970
1980
1990
Elapsed Time (Years)

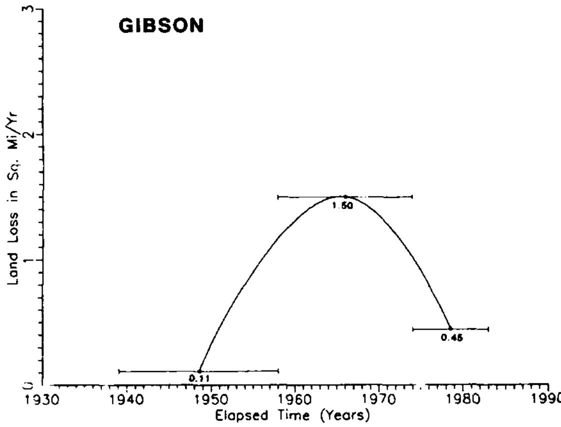

DEROUEN
Land Loss in Sq. Mi/Yr
0
0.24
0.22
0.24
1930
1940
1950
1960
1970
1980
1990
Elapsed Time (Years)

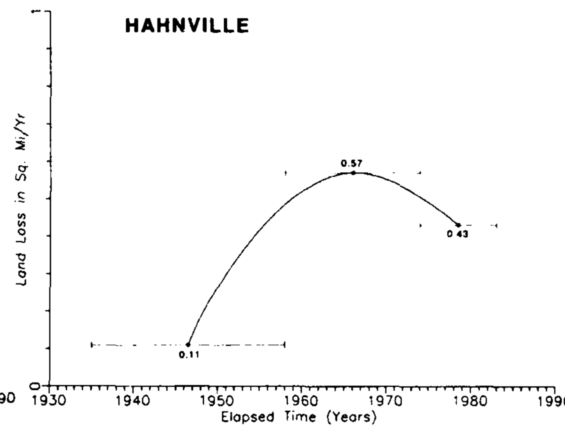

DULAC
Land Loss in Sq. Mi/Yr
0
1
2
3
0.37
0.98
1930
1940
1950
1960
1970
1980
1990
Elapsed Time (Years)

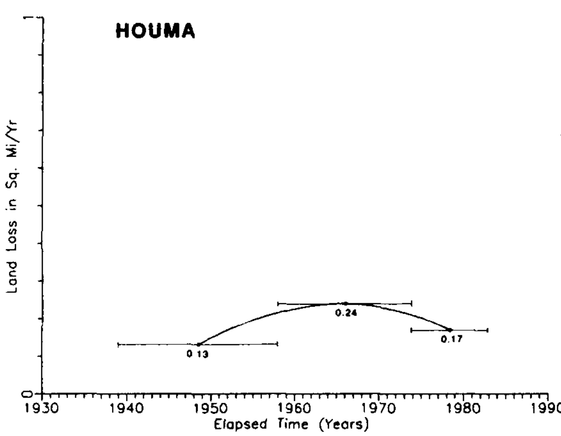

EAST DELTA
Land Loss in Sq. Mi/Yr
0
1
2
3
1.17
1.90
0.27
1930
1940
1950
1960
1970
1980
1990
Elapsed Time (Years)

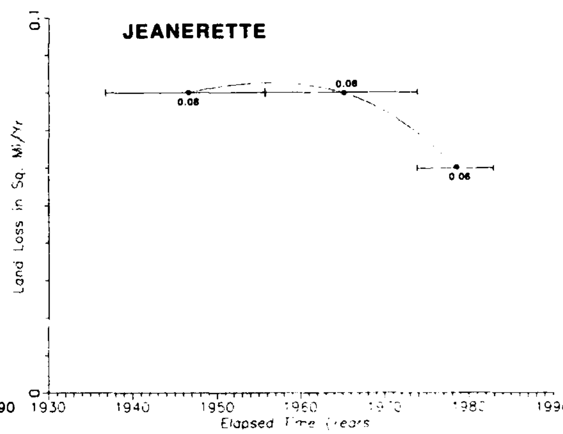

EMPIRE
Land Loss in Sq. Mi/Yr
0
1
2
3
0.35
1.12
1930
1940
1950
1960
1970
1980
1990
Elapsed Time (Years)

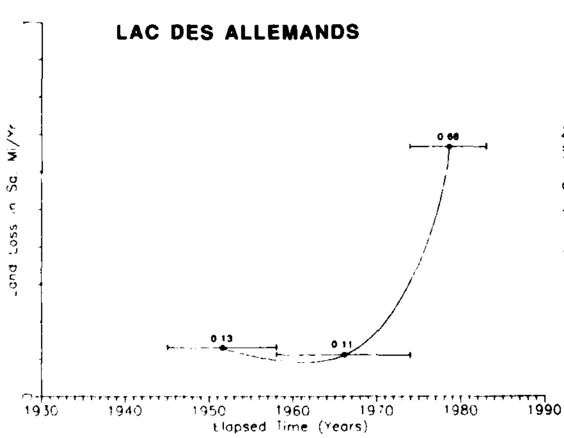

FORT LIVINGSTON
Land Loss in Sq. Mi/Yr
0
1
2
3
0.34
0.53
0.89
1930
1940
1950
1960
1970
1980
1990
Elapsed Time (Years)

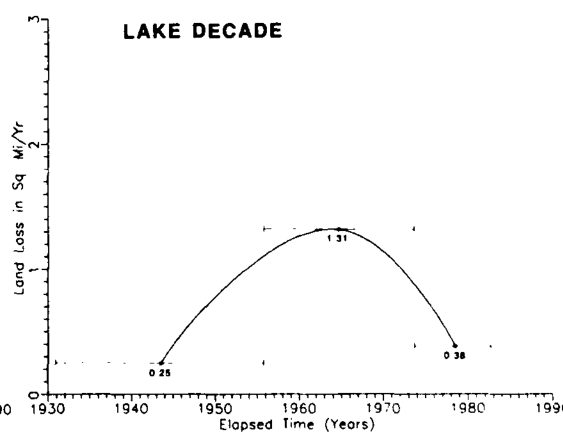

GIBSON
Land Loss in Sq. Mi/Yr
Elapsed Time (Years)
0.11
1.50
0.45

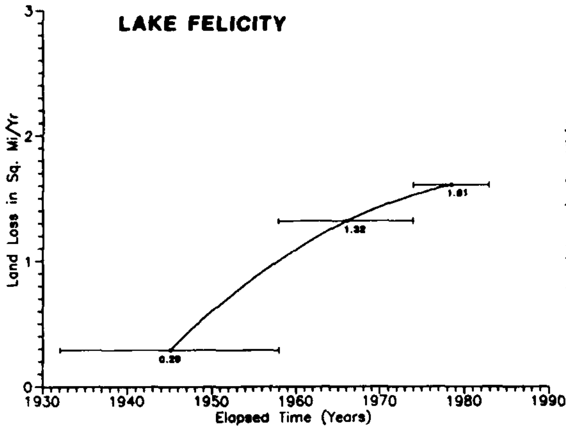

HAHNVILLE
Land Loss in Sq. Mi/Yr
Elapsed Time (Years)
0.11
0.57
0.43

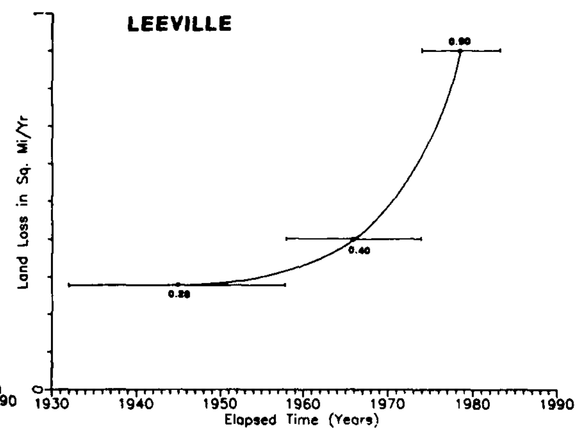

HOUMA
Land Loss in Sq. Mi/Yr
Elapsed Time (Years)
0.13
0.24
0.17

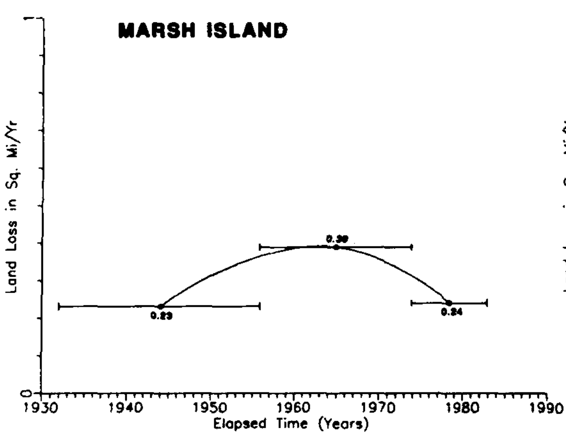

JEANERETTE
Land Loss in Sq. Mi/Yr
0.08
0.08
0.06

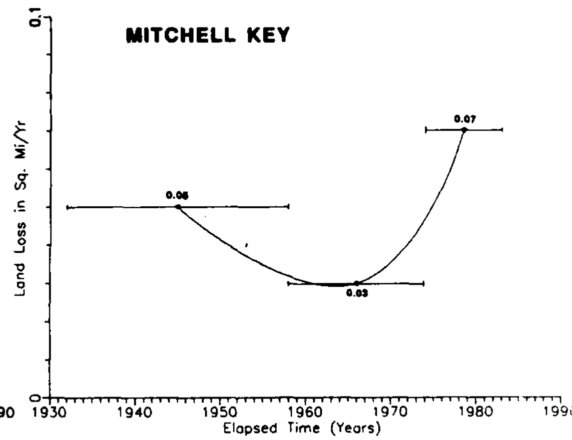

LAC DES ALLEMANDS
0.13
0.11
0.66

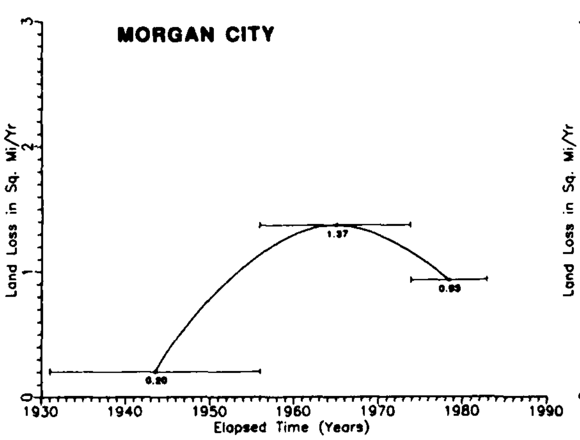

LAKE DECADE
Land Loss in Sq Mi/Yr
Elapsed Time (Years)
0.25
1.31
0.38

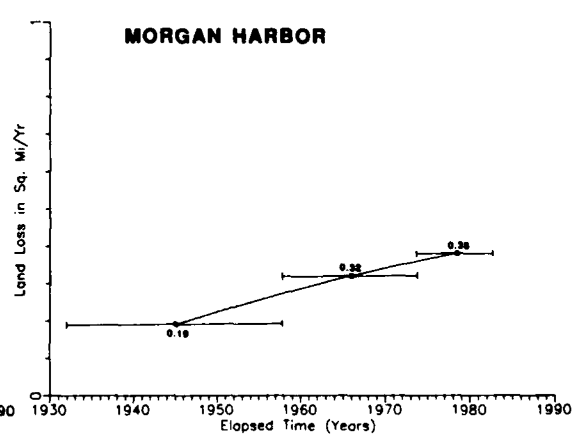

LAKE FELICITY
Land Loss in Sq. Mi/Yr
Elapsed Time (Years)

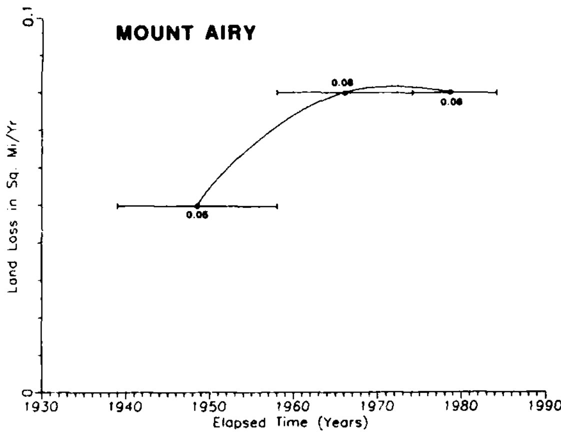

LEEVILLE
Land Loss in Sq. Mi/Yr
Elapsed Time (Years)

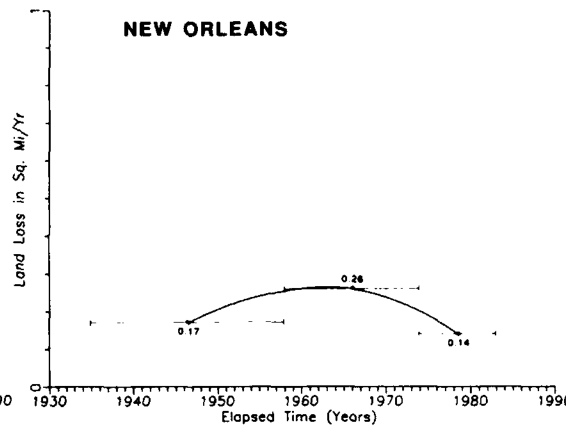

MARSH ISLAND
Land Loss in Sq. Mi/Yr
Elapsed Time (Years)

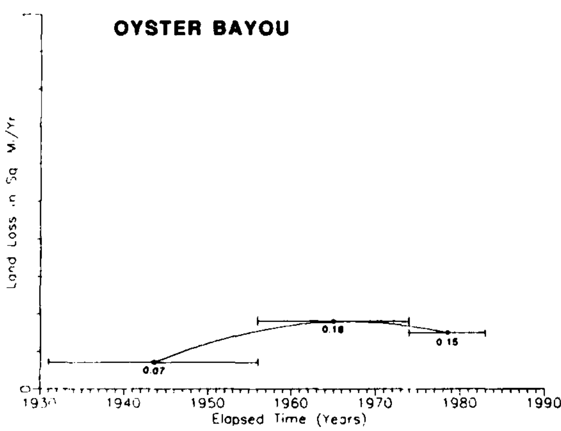

MITCHELL KEY
Land Loss in Sq. Mi/Yr
Elapsed Time (Years)

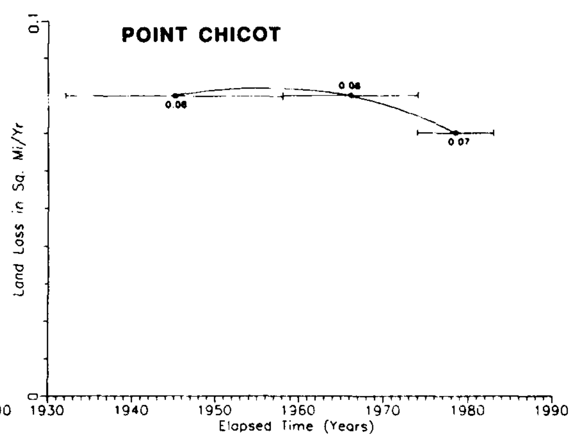

MORGAN CITY
Land Loss in Sq. Mi/Yr
Elapsed Time (Years)

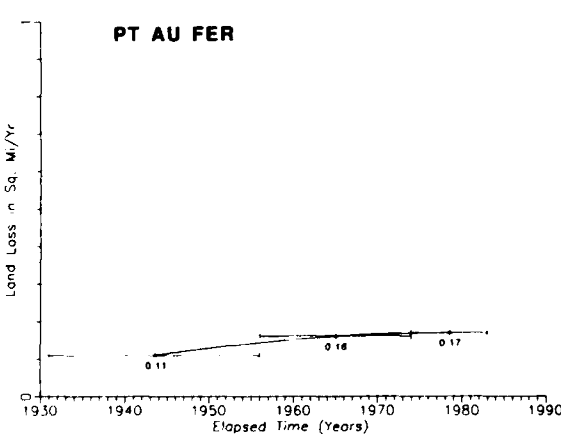

MORGAN HARBOR
Land Loss in Sq. Mi/Yr
Elapsed Time (Years)

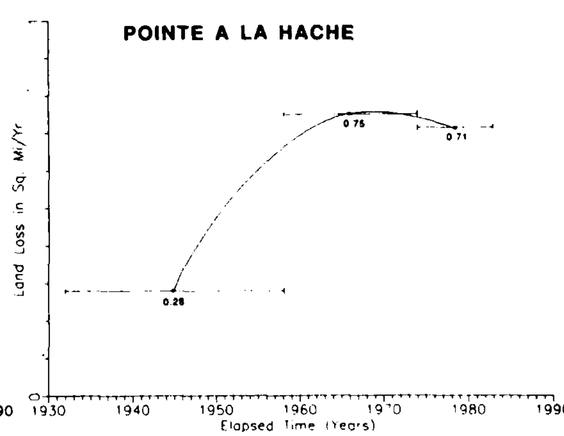

MOUNT AIRY
0.1
0
0.08
0.08
0.06
Land Loss in Sq. Mi/Yr
1930
1940
1950
1960
1970
1980
1990
Elapsed Time (Years)

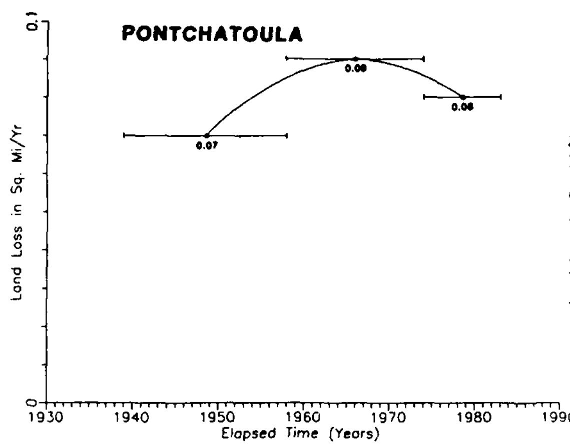

NEW ORLEANS
0
0.26
0.17
0.14
Land Loss in Sq. Mi/Yr
1930
1940
1950
1960
1970
1980
1990
Elapsed Time (Years)

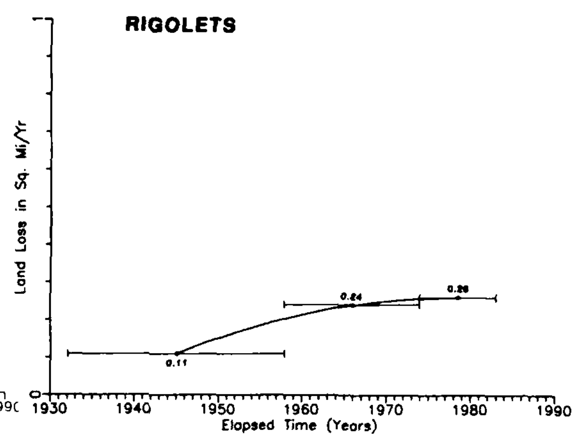

OYSTER BAYOU
0.18
0.15
0.07
Land Loss in Sq. Mi/Yr
1940
1950
1960
1970
1980
1990
Elapsed Time (Years)

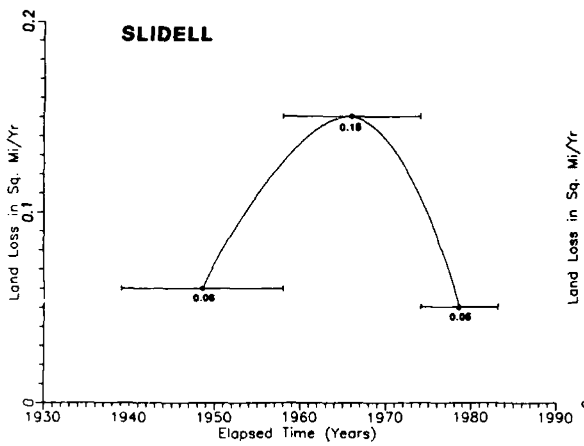

POINT CHICOT
0.1
0
0.08
0.08
0.07
Land Loss in Sq. Mi/Yr
1930
1940
1950
1960
1970
1980
1990
Elapsed Time (Years)

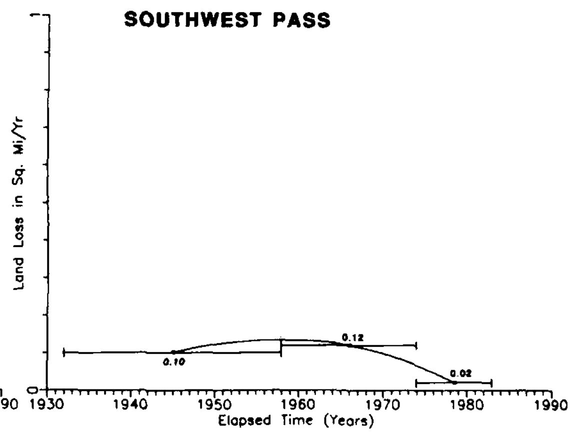

PT AU FER
0
0.11
0.16
0.17
Land Loss in Sq. Mi/Yr
1930
1940
1950
1960
1970
1980
1990
Elapsed Time (Years)

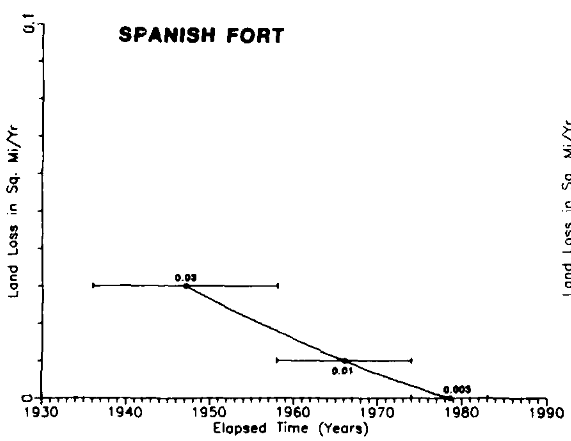

POINTE A LA HACHE
0
0.75
0.71
0.28
Land Loss in Sq. Mi/Yr
1930
1940
1950
1960
1980
1990
Elapsed Time (Years)

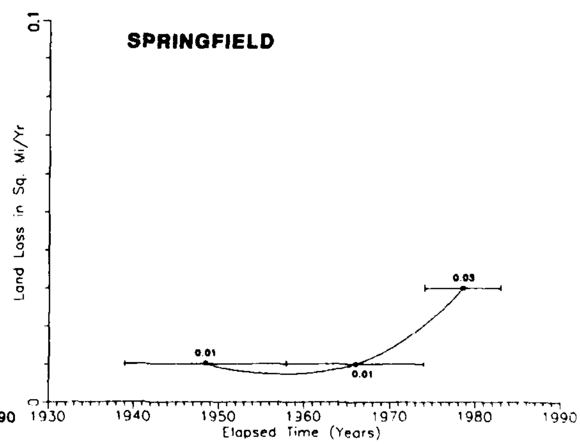

PONTCHATOULA
0.1
0
Land Loss in Sq. Mi/Yr
0.07
1930
1940
1950
1960
1970
1980
Elapsed Time (Years)

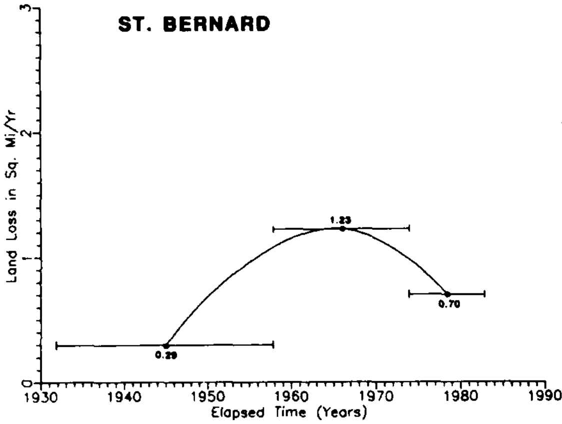

RIGOLETS
0
Land Loss in Sq. Mi/Yr
0.11
0.24
1930
1940
1950
1960
1970
1980
1990
Elapsed Time (Years)

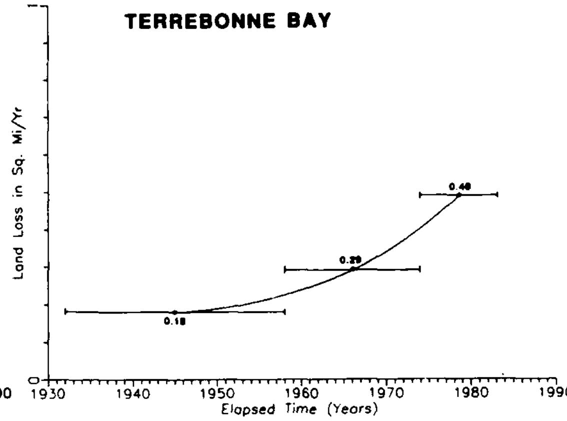

SLIDELL
0.2
0.1
0
Land Loss in Sq. Mi/Yr
1930
1940
1950
1960
1970
1980
1990
Elapsed Time (Years)

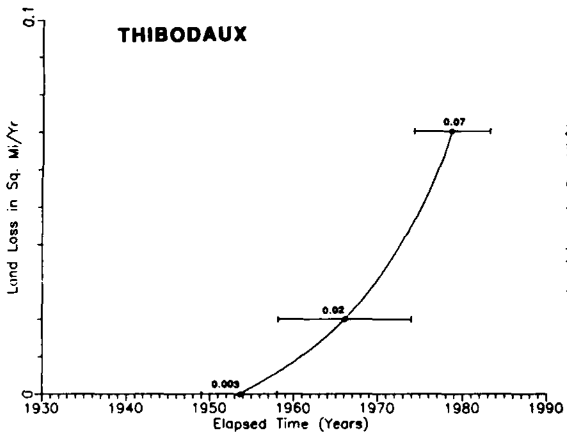

SOUTHWEST PASS
0
Land Loss in Sq. Mi/Yr
0.10
0.12
0.02
1930
1940
1950
1960
1970
1980
1990
Elapsed Time (Years)

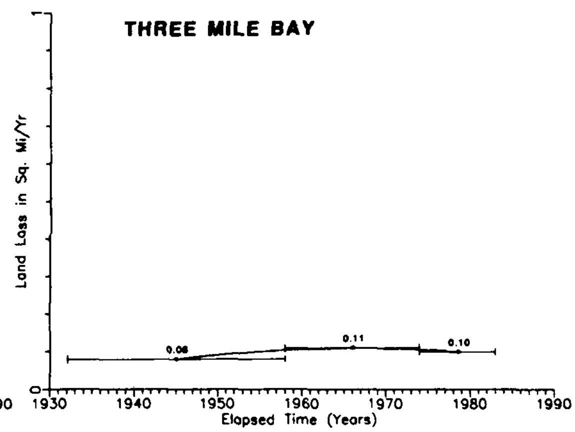

SPANISH FORT
0.1
0
Land Loss in Sq. Mi/Yr
0.03
0.01
0.003
1930
1940
1950
1960
1970
1980
1990
Elapsed Time (Years)

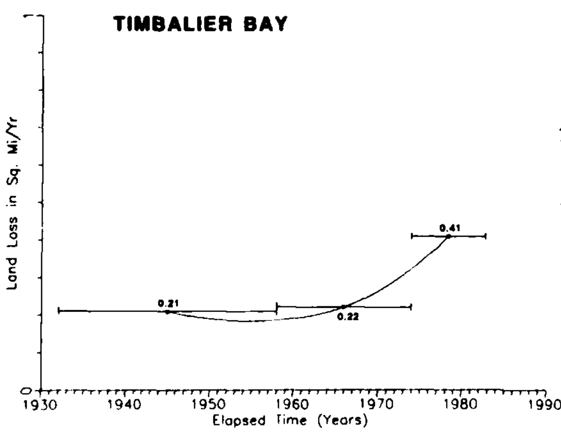

SPRINGFIELD
0.1
0
Land Loss in Sq. Mi/Yr
0.01
0.01
0.03
1930
1940
1950
1960
1970
1980
1990
Elapsed Time (Years)

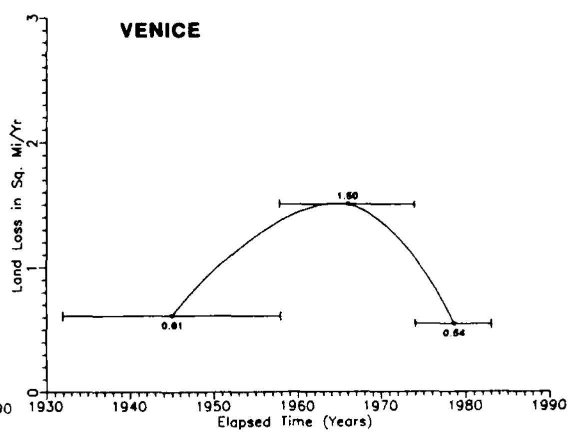

ST. BERNARD
Land Loss in Sq. Mi/Yr
Elapsed Time (Years)
0.29
1.23
0.70

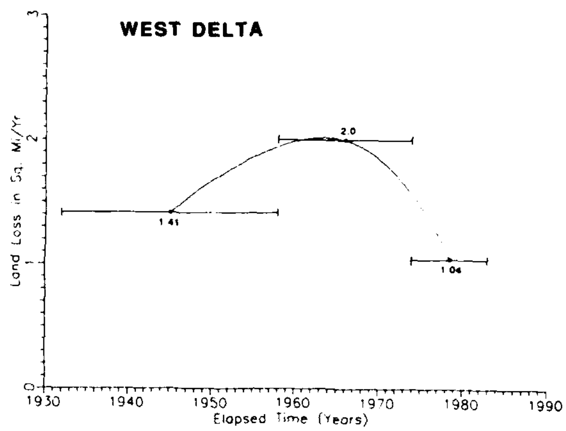

TERREBONNE BAY
Land Loss in Sq. Mi/Yr
Elapsed Time (Years)
0.18
0.29
0.48

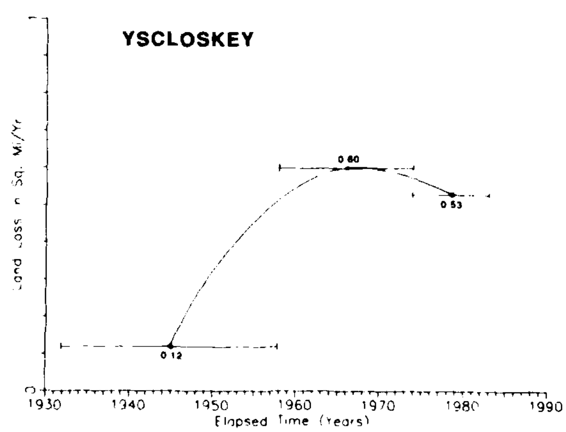

THIBODAUX
Land Loss in Sq. Mi/Yr
Elapsed Time (Years)
0.003
0.02
0.07


THREE MILE BAY
Land Loss in Sq. Mi/Yr
Elapsed Time (Years)
0.11
0.10


TIMBALIER BAY
Land Loss in Sq. Mi/Yr
Elapsed Time (Years)
0.21
0.22
0.41


VENICE
Land Loss in Sq. Mi/Yr
Elapsed Time (Years)
0.61
1.50
0.54


WEST DELTA
Land Loss in Sq. Mi./Yr
0
1
2
3
2.0
1.41
1.04
1930
1940
1950
1960
1970
1980
1990
Elapsed Time (Years)


YSCLOSKEY
0.60
0.53
0.12
0
1930
1950
1960
1970
1990