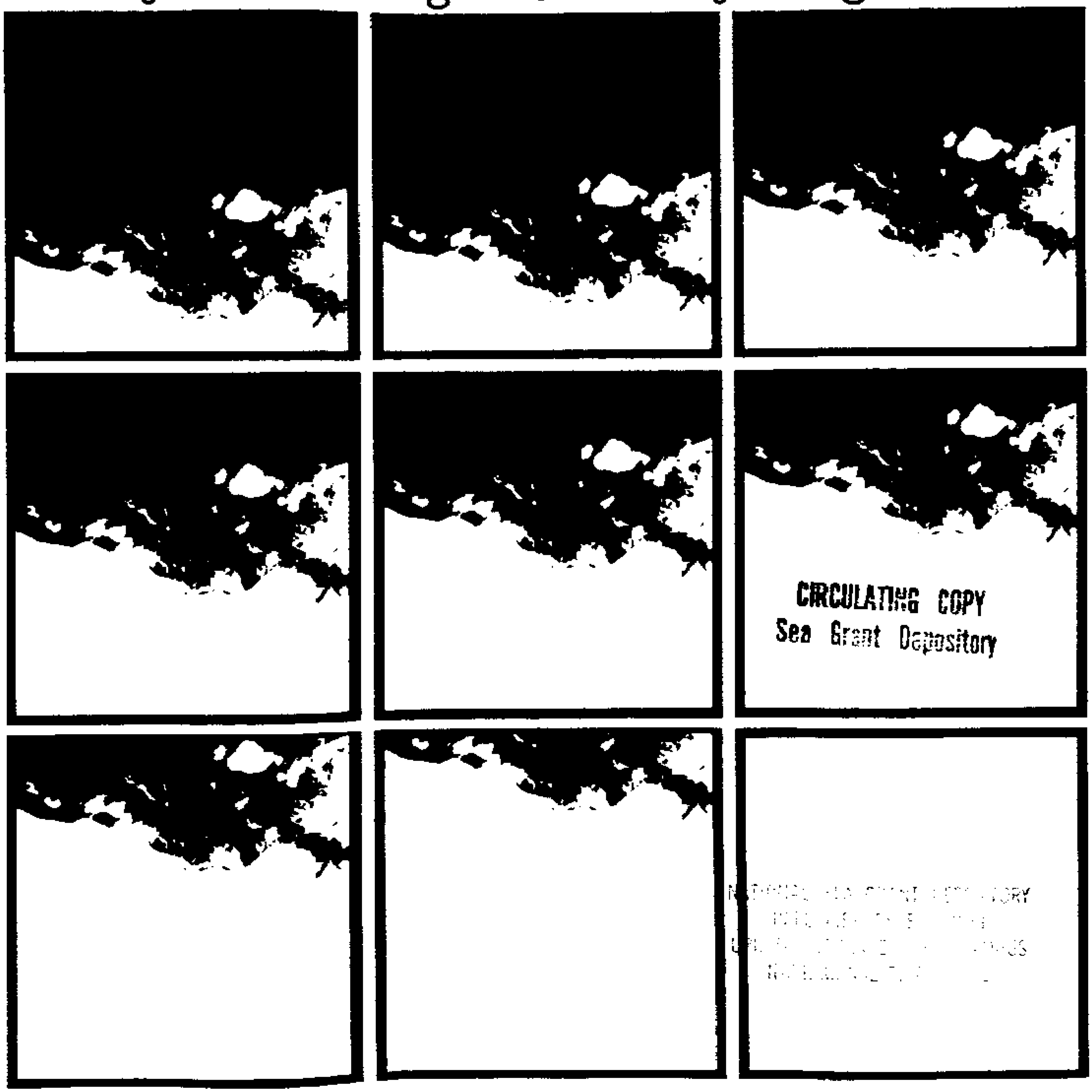
accelerating retreat rates along louisiana's coast

james p. morgan & david j. morgan



Accelerating Retreat Rates Along Louisiana's Coast

Prepared for the
Office of the Attorney General
State of Louisiana
February 1977

by
JAMES P. MORGAN
DAVID J. MORGAN

SEAGRANT

Published December 1983 by the Louisiana Sea Grant College Program, Center for Wetland Resources, Louisiana State University, Baton Rouge, Louisiana. The Louisiana Sea Grant College Program is part of the National Sea Grant Program maintained by NOAA, U.S. Department of Commerce.

TABLE OF CONTENTS

ABSTRACT

A detailed comparison of Louisiana's shoreline, as shown on 1969 aerial photographs with the shorelines of two earlier periods (1954 and 1932), enables the determination of amounts and rates of coastal land gain or loss. The comparison reveals that areas of land loss far exceed areas of new land formation. The dominant causes of land loss are the erosion by waves of soft unconsolidated sediments that comprise the low-lying coastal marshlands and the general subsidence of the coastal zone, especially in the Mississippi delta plain.

Both linear shoreline retreat rates and areal land changes have been evaluated where possible. These measurements establish trends that point to continuing and accelerating rates of land loss along most of coastal Louisiana. For example, Louisiana's shoreline has been retreating at an average linear rate of approximately 10 feet per year for the past 37 years. However, that average reflects an increase from about 6.5 feet per year in the interval between 1932 and 1954 to 17 feet per year during the period from 1954 to 1969.

Similarly, areal change measurements for the 75% of the coast where they can be made, show a loss of about 374 acres per year (0.58 sq. mi./year) during the 37-year period, 1932-1969. Again, however, there has been an increase in rate of land loss from 348 acres per year (0.54 sq. mi./year) during the period, 1932-1954, to 413 acres per year (0.64 sq. mi./year) during the years from 1954 to 1969.

INTRODUCTION

Over half of the state of Louisiana is surfaced with sediments directly attributable to the Mississippi River, as they are either alluvial soils or deltaic sediments deposited by the river as it has gradually extended its mouth into the Gulf of Mexico. Included is the broad belt of Louisiana coastal marshlands, created during the past few thousand years, either directly by river deposition or by waves reworking and redepositing those deltaic sediments.

Consequently, there is a popular belief that Louisiana is steadily growing in size as a result of new land formation. Although this has been the case in the geologic past, Louisiana is now losing land at a more rapid rate than any other coastal state in the Union. This is not a new concept; it has been documented in a number of papers by this writer (Morgan 1955; Morgan and Larimore 1957) and more recently by other researchers (Gagliano and Van Beek 1970; D. J. Morgan 1973). All of these reports suggest that coastal land loss is accelerating. Thus, it is necessary to update such studies periodically in order to monitor shoreline retreat and to isolate areas in which particularly rapid retreat might lead to significant problems.

Since the early 1950s, the state of Louisiana and the federal government have been engaged in a dispute involving the ownership of and jurisdiction over offshore water-bottoms. This controversy has generally become known as the "tidelands case." Difficulties in resolving this state-federal litigation and establishing ownership of the enormous quantities of underlying mineral resources have been directly related to the rapid land-water boundary changes that have occurred within the delta and adjacent coastal areas.

The state of Louisiana, through the office of the attorney general, has maintained a continuing evaluation of coastal zone changes which, among others, included the 1955 Morgan report as well as this study. The earlier report established quantitatively that the Louisiana shoreline was retreating under the influence of land subsidence and wave attack except in a few isolated areas where rates of sediment accumulation exceeded those of coastal retreat.

After the 1955 study, a joint state-federal committee was charged with the responsibility of assembling an appropriate series of large-scale maps showing the low-water line along the Louisiana coast. The committee's product, based on aerial photography taken from 1954 to 1960, is the so-called "Set of 54 Maps," which collectively portrays both the high-water and low-water line along the entire Louisiana coast at a scale of 1:20,000. The series has been used throughout the submerged land litigation as the basis for determining Louisiana's "coastline" under the 1953 Submerged Lands Act.

In 1969 additional coastal aerial photography resulted in a series of photo mosaics covering the entire Louisiana shoreline. The primary objectives of this study were to update seaward boundary information utilizing this new photography in order to determine the following.

(a) To what degree the "present" shoreline (taken from 1969 aerial photography) deviates from the "official" shoreline (based on 1954-60 photography) that is shown on the Set of 54 Maps;

(b) To what degree coastal change trends recognized in the 1965 study for the period 1932-1954 deviate from subsequent change trends (i.e., the period 1954-1969);

(c) Whether it is possible to predict rates of change for specific coastal areas in order to plan realistically for coastal zone protection and management.

The 1955 Study: Coastal Change Prior to 1954

Coastal Surveys Utilized

When Louisiana was admitted to the Union in 1812 much of the territory was imperfectly known and poorly mapped. In south Louisiana most of the early French, Spanish, and German settlements, as shown in the maps depicting land ownership, were concentrated along the habitable, higher natural levees of the Mississippi River and its abandoned distributaries. Most of the low marshlands bordering the coast were virtually uninhabited and consequently unsurveyed. The U.S. General Land Office survey system, though established by the Ordinance of 1796, was not applied to Louisiana until about 1811 (Hall 1970). During the 1820s and 1830s, most of the township plants of the habitable "high lands" of Louisiana were surveyed, but most of the coastal marshlands and many low-lying and swampy areas remained unmapped.

In the 1850s, selected parts of the Louisiana coast were reconnoitered by the U.S. Coast Guard and a resulting coastal map was published (Register No. 442, 1853, E. H. Gerdes). This survey involved a triangulation that tied together special reconnaissance maps of the Barataria Bay entrance, Grand Pass into Timbalier Bay, and a topographical survey of Isle Derniere (which was then one island). Although a few other isolated areas were subsequently mapped by the Coast Survey, the War Between the States interrupted all such activities for a considerable period. It was not until the late 1870s that relatively accurate and detailed coastal charts became available for the entire Louisiana coastline. In the ensuing half century, the Coast Survey (later known as the Coast and Geodetic Survey) and other agencies periodically resurveyed various sections of the coast and updated their maps.

In 1922, a new mapping technique was developed that utilized overlapping aerial photographs taken by the U.S. Naval Air Service to make detailed charts of the inaccessible Mississippi River delta. The technique was highly successful and soon augmented the conventional ground surveys in making maps and charts, particularly in the marshy and swampy areas that are typical of coastal Louisiana. Subsequently, a set of coastal photographs, taken in 1932, was used to construct a new set of charts with a much more precise shoreline configuration than had been hitherto possible (the U.S. Coast and Geodetic Survey T-Sheet Series).

The inherent precision of aerial photographs for mapping leads to additional problems. The shoreline or boundary between land and water varies with tidal fluctuations. The shoreline shown by aerial photographs at times of high lunar tide or with strong onshore winds will differ considerably from the shoreline at low tide or at times of offshore winds. In flat, low coastal marshland areas, such as the deltaic plain of Louisiana, even the relatively low tidal range of 18 to 24 inches can result in a significant lateral shift of the mapped shoreline position. Furthermore, there are problems involved in interpreting a precise low-tide shoreline on aerial photography in that the recently exposed, wet foreshore may be difficult to differentiate from an adjacent area covered with shallow water. In recent years, this problem has been alleviated to some degree through the utilization of infrared-sensitive photographic film, which aids in the differentiation of water from wet land. However, even with infrared photography, it should be recognized that there are often broad, flat, shoal areas near sea level that may be considered land by one interpreter and water by another.

Tidal conditions were not considered when the 1932 aerial photographs were taken. Consequently, the shoreline that was interpreted from aerial photographs and shown on the T-sheets is precisely neither the high-tide nor the low-tide shoreline, but generally lies between the two limits.

Aerial photographs taken in 1953-1954 by the Jack Ammann Corporation were taken at abnormally low tide; that is, at lunar low tide, which coincided with a time of north wind. The low-tide shoreline interpreted from these photographs, therefore, lies somewhat seaward of the normal low-tide line and varies significantly in places from the uncontrolled shoreline that was interpreted from the earlier (1932) photography.

Techniques Employed

When the 1955 study was made, the reconstruction of an 1812 shoreline was considered an essential parameter in ascertaining the extent of Louisiana's jurisdiction over resource ownership in the offshore coastal zone. The reconstructed 1812 shoreline was calculated by determining the rates of shoreline change between the times represented by each of the earlier detailed coastal surveys, plus the changes shown in the 1932 and 1954 aerial photo surveys.

At least three different shorelines were used for comparison. In order to establish rates of shoreline advance or retreat, a series of arbitrary section lines were selected about every mile for data analysis. Specifically, those sections were constructed perpendicularly to the shoreline shown on the 1932 U.S.C. & G.S. charts at the position of its intersection with each minute of longitude and latitude from the Texas to the Mississippi border. The three or more points determined by the graphically advance and retreat rates at each line of section. By extrapolating these rates backward in time, it was possible to reconstruct the legally significant 1812 shoreline configuration to simulate the shoreline at the time that the state came into the Union. Similarly, extrapolating forward, using the same data, served as a means of predicting future rates of change.

Results

In addition to the reconstruction of the 1812 shoreline, the 1955 study presented several important facts that are summarized below:

(1) The Louisiana coastline was subject to rapid changes, and some areas experienced tens to hundreds of feet of shoreline migration each year.

(2) Rates of change were increasing in some areas and decreasing in others.

(3) Shoreline erosion was much more common than shoreline accretion.

(4) The coastal zone could be subdivided into 12 sectors that had experienced comparable rates of change within each sector (Figures 1 and 2). Of those sectors, seven reflected predominant erosion (labeled R on Figures 1 and 2), three showed shoreline advances (labeled A), and one maintained relative stability.

(5) A number of the retreating coastal sectors could be correlated with the several abandoned Mississippi River deltas that comprise the deltaic plain (Figure 2). Recently abandoned deltas exhibit more rapid retreat rates than older deltas.

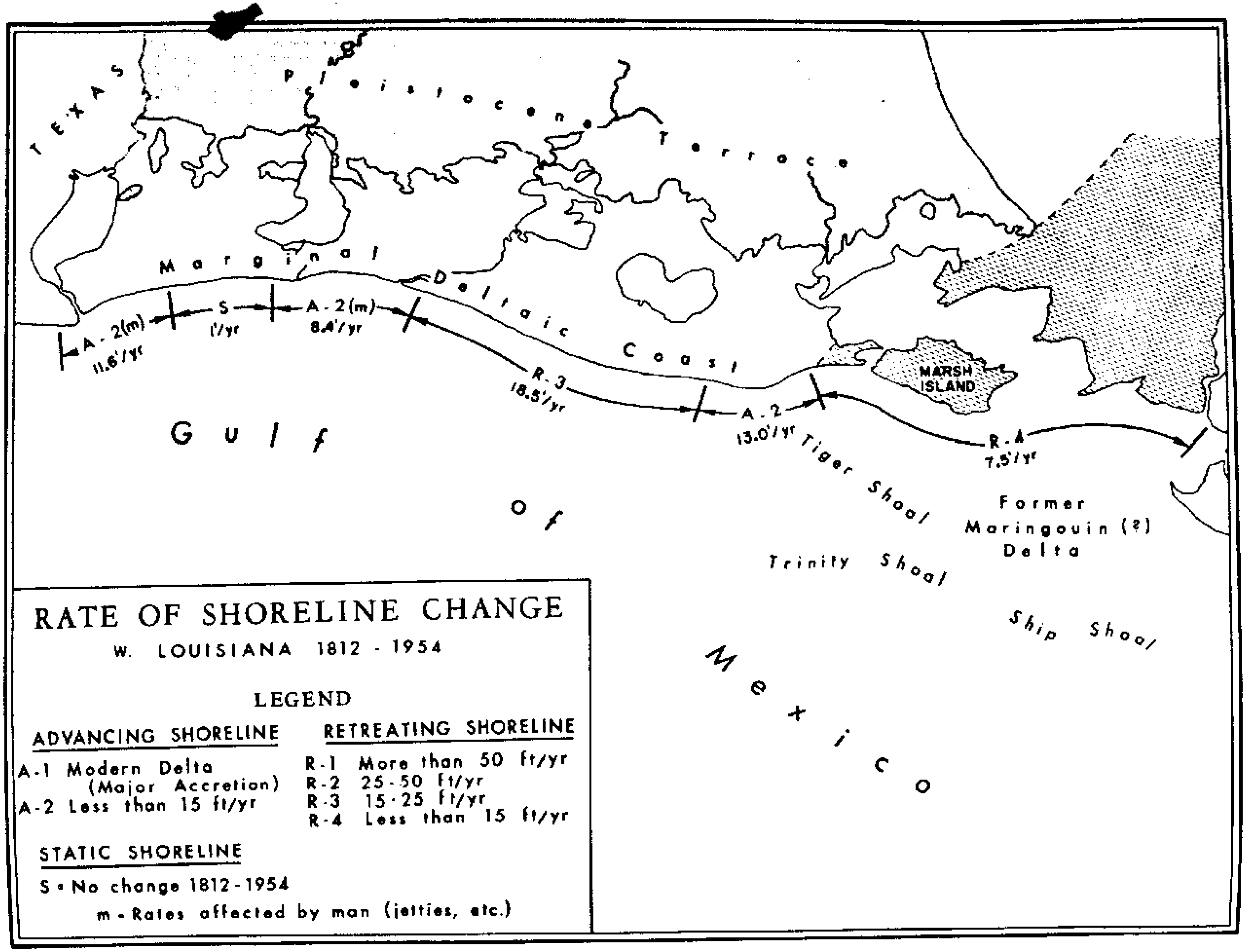


Figure 1. Coastal sectors (west half); 1955 study (from Morgan and Larimore 1957)

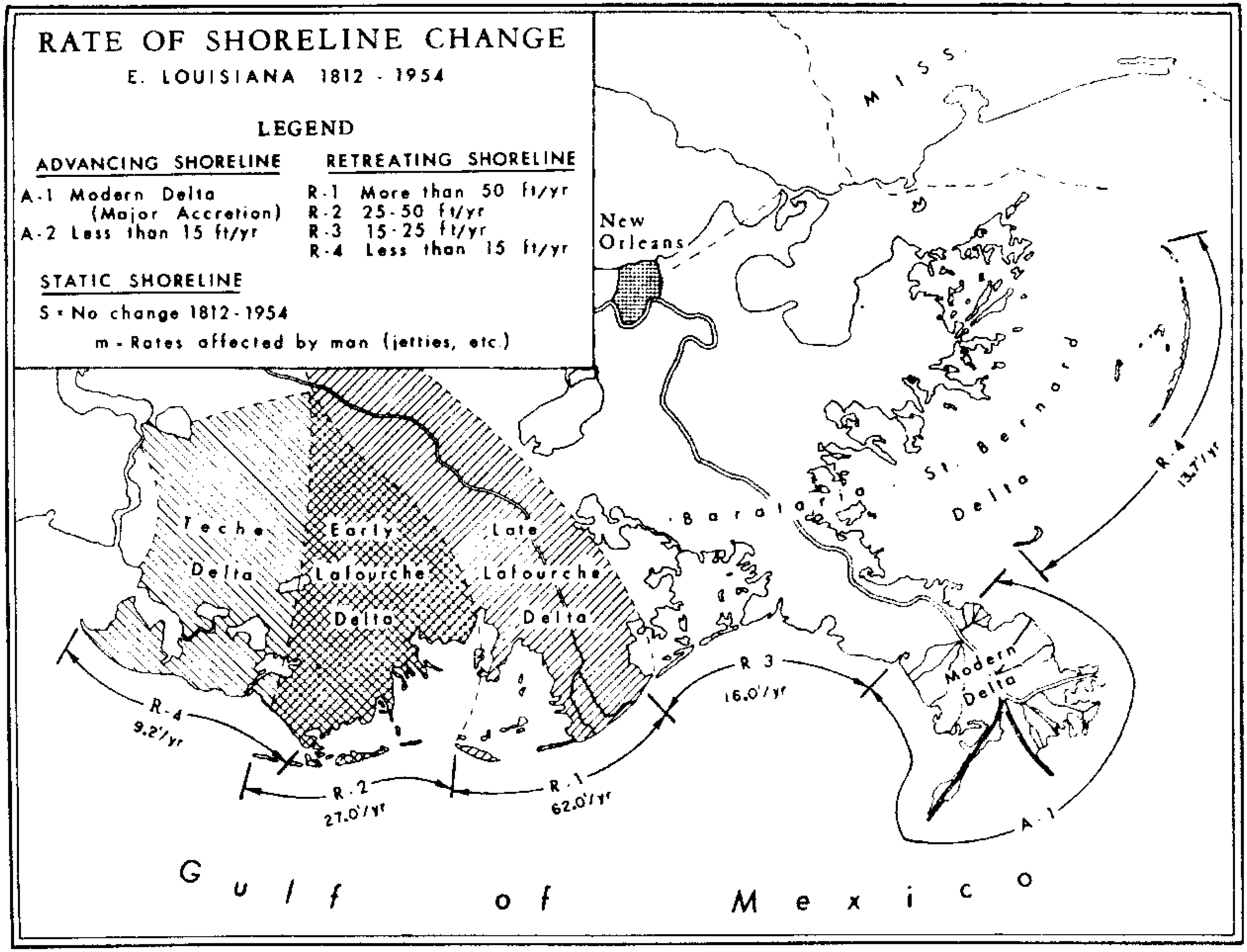


Figure 2. Coastal sectors (east half); 1955 study (from Morgan and Larimore 1957)

Subsequent Coastal Changes: 1954-1969

Recent Coastal Photography

The U.S. Army Corps of Engineers (New Orleans District) has compiled a series of uncontrolled aerial photographic mosaics that are based on photography taken in 1969 and cover southern coastal Louisiana. The interpretation of these photographs makes possible the establishment of a 1969 shoreline for the entire state. These photographs are not tide-controlled; therefore, the shoreline that has been interpreted from them reflects neither the low-tide datum nor the high-tide line, but lies somewhere between. In addition, the U. S. Geological Survey has issued a series of Orthophoto Quadrangle sheets of the lower Mississippi delta area that are based on 1971 photography. Again, the shoreline that has been interpreted for that data lies between the high-tide and low-tide line.

Techniques Employed

The Set of 54 Maps, accepted by the joint state-federal committee, was employed for base maps in the current study. Along most of the coast, these maps were based on the same set of aerial photos (Jack Ammann 1953-1954) that were used to interpret the shoreline in the 1955 study. Although several years had elapsed since the 1954 Ammann "low-water" photography was taken, the joint committee determined that it was useable along most of the coast. However, new tide-controlled photography was taken in areas where water stage was critical--the Mississippi River delta and the Atchafalaya Bay reef areas.

Using the Set of 54 Maps, at the scale of 1:20,000, the 1969 shoreline has been plotted as interpreted from the Corps of Engineers mosaics. Additionally, the 1932 shoreline, taken from the original U.S.C. & G.S. Topographic Sheets, has been superimposed.

Linear Shoreline Changes. At each meridianal line on the map, representing one minute of latitude or longitude (intervals of approximately one mile), a section was established perpendicularly to the 1954-1960 shoreline (hereafter called the 1954 shoreline). Distances rounded to the nearest hundred feet were measured and tabulated for the intervals 1932-1954 and 1954-1969 (Appendix I). The figures are designated positive or negative as they reflect shoreline advance or retreat. Average change rates for each of the 12 sectors established in the 1955 report are listed in Table I and are shown in Figures 3 and 4 (labeled from west to east as I through XIII).

Whereas the earlier study revealed 12 areas that indicated comparable rates of shoreline retreat or advance, inspection of change rates for the 1954-69 interval suggests a more refined grouping arrangement. Tabulated data in Appendix I indicate 20 different sectors (labeled A-T), which differ from the 12 sectors used previously (Figure 5). Change rates for individual sector profiles are included in Appendix I, while overall sector averages are summarized in Table II.

Areal Shoreline Changes. In order to evaluate coastal changes in a more comprehensive and quantitative fashion, areal rates of change have also been determined. Areas bounded by the 1932-1954 and 1954-1969 shorelines have been measured, with either a planimeter or a digitizer, from the base map films. Areal changes have been determined along the coast for each two minutes of longitude for

LINEAR RATES OF CHANGE BY COASTAL SECTOR

SECTOR*	1932 - 1954 AVG. (ft/yr)	1954 - 1969 AVG. (ft/yr)	CHANGE AND SIGNIFICANCE
I	+11.6	-11.1	Former accreting area, now retreating
II	stable area	- 9.0	Considerable increase in retreat rate
III	+ 8.4	+ 4.9	Reduction in rate of accretion
IV	-18.5	-40.0	Large increase in retreat rate
V	+13.0	- 7.9	Former accreting area, now retreating
VI	- 7.5	- 8.4	Minor increase in retreat rate
VII	- 9.2	-13.7	Moderate increase in retreat rate
VIII	-27.0	-23.0	Minor decrease in retreat rate
IX	-62.0	-37.2	Large decrease in retreat rate
X	-16.0	-17.1	Minor increase in retreat rate
XI	--	--	Not evaluated - see Text
XII	-13.7	-18.0	Moderate increase in retreat rate

*As indicated on Figures 3 and 4

TABLE I

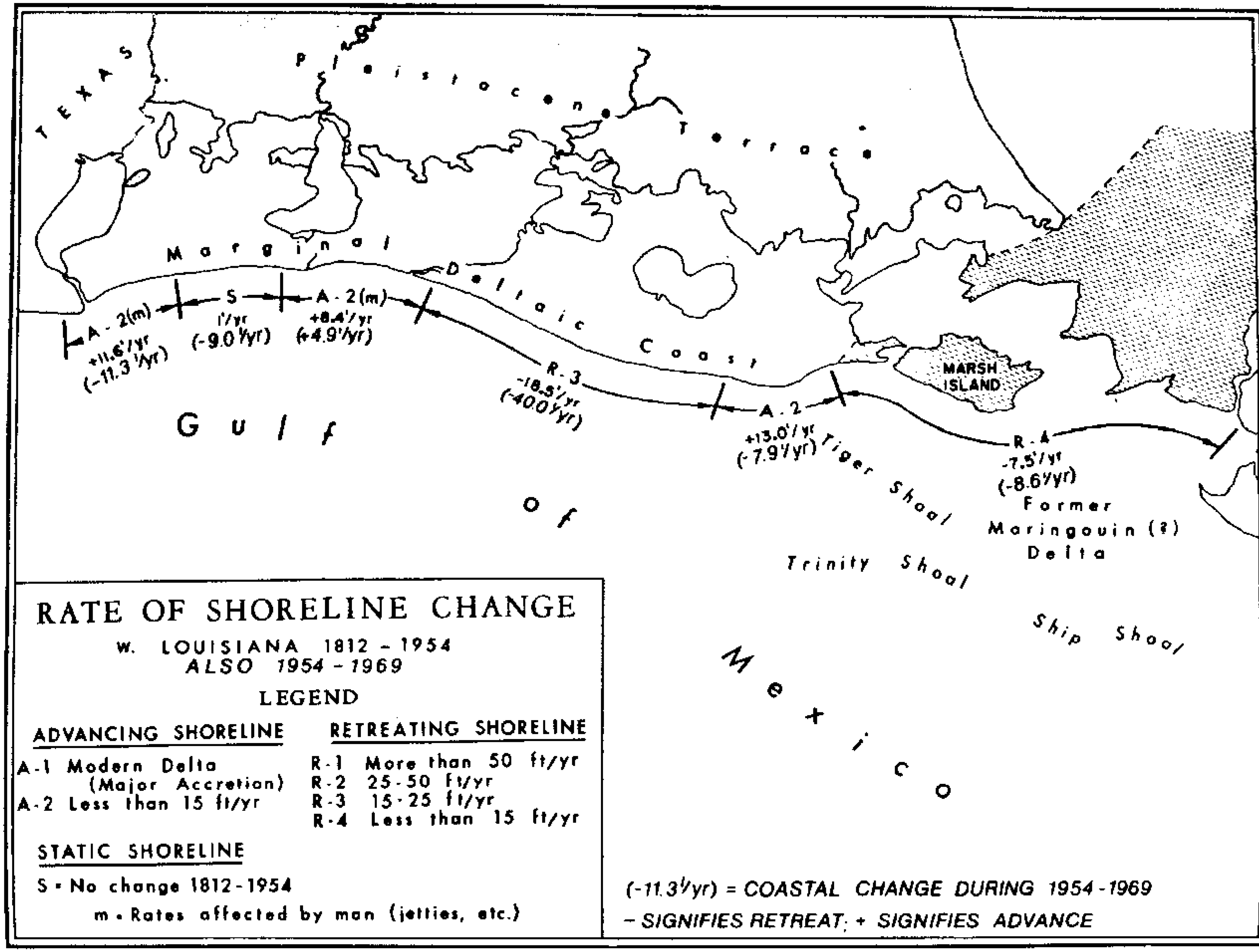


Figure 3. Coastal sectors (west half); present report compared with 1955 study

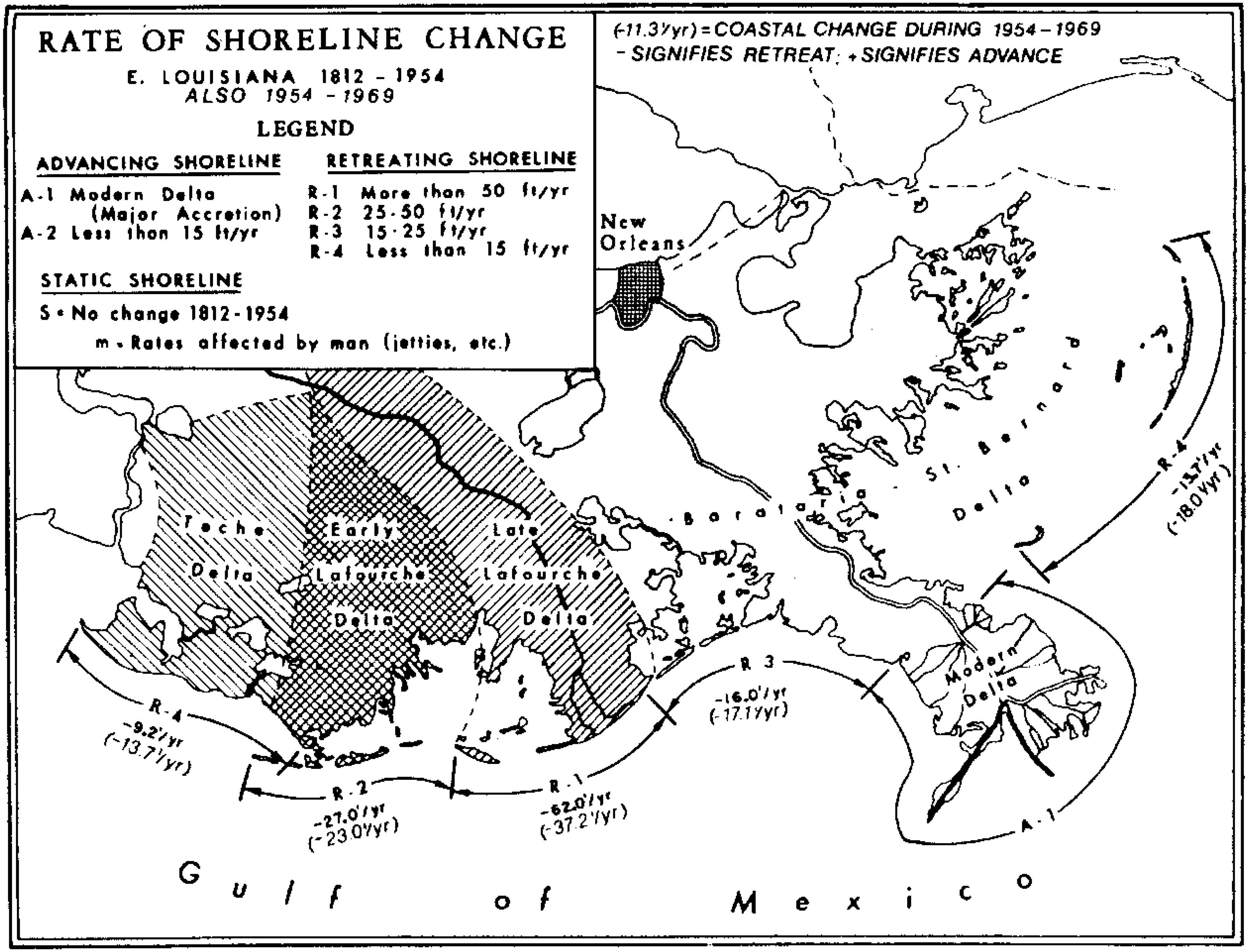


Figure 4. Coastal sectors (east half); present report compared with 1955 study

the two intervals involved (1932-1954 and 1954-1969). These are listed in Appendix II, and summaries of average rates for each of the 20 sectors (A-T) are included in Table III.

Evaluation of Natural Coastal Subdivisions

It is obvious from the comparison of linear changes shown in Table I that shoreline retreat is dominant for most of the coastal area and, with the exception of two sectors, the rate of shoreline retreat is increasing. The trend has reversed in two of the areas that were previously advancing (I and V), and the formerly stable area (II) is now retreating under wave attack. Only one segment (III) continues to show coastal advance but even here the rate of advance has diminished. Whereas the earlier study revealed 12 areas that indicated comparable rates of shoreline retreat of advance, an inspection of change rates for the interval 1954-1969 suggests a more refined grouping arrangement. Tabulated data in Appendix I indicate 20 different sectors (labeled A-T) that differ from the 12 sectors used previously (Figure 5). Change rates for individual sectors are included in Appendix I, while overall sector averages are summarized in Table II.

Areal change rates in sectors A through H (the western third of the Louisiana coastline) can be related directly to the intensity of erosional and depositional coastal processes. The central part of the coast, including Terrebonne, Lafourche, and western Plaquemines parishes (Sectors J-Q), must be considered in a somewhat different fashion. Much of the coastline is composed of discontinuous islands (Isles Dernieres, West Timbalier, East Timbalier, Grand, and Grand Terre) which are not only retreating landward or building seaward but also are moving laterally along the coast as a result of littoral sediment transport. Linear and areal coastal changes in this region must also be related to the lateral shifts of the entire mass of the sandy islands.

The Mississippi delta area of Plaquemines Parish (Sector R) again must be considered independently. This exceedingly low, flat area, near sea level, is subject to very rapid changes because of local sedimentational and erosional processes, as well as a general subsidence that can convert low marshland to shallow lakes or bays in a very few years.

The final coastal area to be considered is the Chandeleur Island chain, including Breton Island (Sectors S and T), which contrasts with the rest of the coastal area by lying in a generally north-south direction, thereby facing the prevailing southeasterly winds.

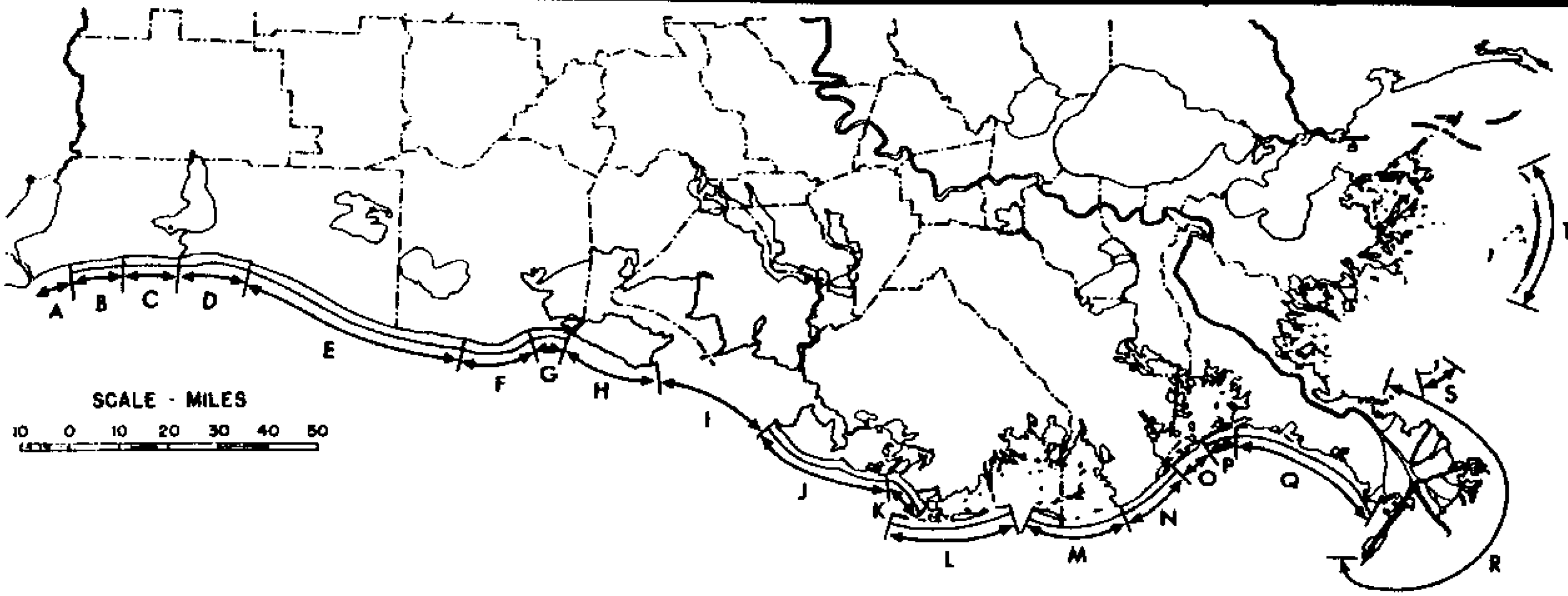
An evaluation of change and rate of change will be made for each coastal sector, including a consideration of the intensity and type of geological process that is influencing each area. Table IV is a general summary of both linear and areal changes for each interval are compared with the total change (1932-69), it is possible to evaluate changes. Such predictions are mandatory for any realistic coastal zone management program.

Table IV also includes totals or averages that are indicative of trends for the entire state. For example, if all sectors subject to areal evaluation are considered, there has been an average loss of 368 acres per year over the 37-year period studies. This is equivalent to 21.3 square miles of <u>shoreline land loss</u> in the past 37 years, a rate of 0.58 square miles per year. Even more significant is the fact that this rate has increased form 0.54 square miles per year during the interval 1932-1954 to 0.63 square miles per year during the 1954-1969 interval. It is important that this accelerating trend of land loss be reduced, but if that is not feasible, antici-

SUMMARY OF SHORELINE CHANGES LINEAR RATES OF CHANGE					
SHORELINE SECTOR INVOLVED	LATITUDE INCLUDED	NUMBER SECTIONS PLOTTED	AVERAGE CHANGE 1932-1954 (ft/yr)	AVERAGE CHANGE 1954-1969 (ft/yr)	AVERAGE CHANGE 1932-1969 (ft/yr)
A	93°50-93°45	6	+17	-17	0
B	93°44-93°33	12	+ 6	- 2	+3
C	93°32-93°21	12	+ 2	-13	-3
D	93°20-93°07	14	+11	+12	+11
E	93°06-92°25	42	-28	-37	-32
F	92°24-92°12	13	+23	- 5	+12
G	92°11-92°03	9	- 6	-26	-14
H	92°02-91°46	17	- 8	- 6*	- 5
I	91°45-90°22	NOT	EVALUATED	--	--
J	91°21-91°00	22	-11	-13	-12
K	90°59-90°53	7	- 7	-16	-11
L	90°58-90°39	20	-21	-24	-17**
M	90°32-90°14	19	-11	-31	-17***
N	90°13-90°03	11	-43	-46	-44
O	90°02-89°57	6	- 2	- 2	0
P	89°57-89°52	6	-12	-17	-14
Q	89°51-89°30	30	- 9	-18	-13
R	NOT EVALUATED	--	--	--	--
S	NOT EVALUATED	--	--	--	--
T	29°31-30°03	33	-14	-18	-15

*Based on 1960-1969 interval
**Average of 15 sections
***Average of 11 sections

TABLE II



SECTOR	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
LIMITS (Latitude or Longitude)	93°50- 93°45	93°45- 93°34	93°34- 93°21	93°21- 93°06.8	93°06.8- 92°24	92°24- 92°12	92°12- 92°02.5	92°02.5- 91°45.7	91°45.7- 91°22	91°21.5- 91°00	91°00- 90°52.5	90°58- 90°37.5	90°32.5- 90°14	90°14- 90°03	90°03- 89°57	89°57- 89°51	89°51- 89°30	89°30- 29°22*	89°14- 89°00	29°31- 30°03*
SHORELINE LENGTH (Miles)	6	12	13	14	45	13	10	18	27	25	8	21	20	13	7	6	24	-	-	44

*Latitude

Figure 5. Natural sectors used in evaluating coastal change rates

SUMMARY OF SHORELINE CHANGES AREAL RATES OF CHANGE							
		1932-1954		1954-1969		1932-1969	
SHORE-LINE SECTOR	LATITUDE INCLUDED	TOTAL ACRES	ACRES PER YEAR	TOTAL ACRES	ACRES PER YEAR	TOTAL ACRES	ACRES PER YEAR
A	93°50-93°45	+147	+ 6.7	-170	-11.3	- 23	- 0.6
B	93°44-93°33	- 8	- 0.4	+167	+11.1	+ 159	+ 4.3
C	93°32-93°21	-174	- 7.9	-138	- 9.2	- 312	- 8.5
D	93°20-93°07	+482	+22.9	+485	+32.2	+ 967	+26.1
E	93°06-92°25	-3916	-178.0	-2423	-161.6	-6339	-171.3
F	92°24-92°12	+791	+35.9	- 31	- 2.0	+ 760	+20.5
G	92°11-92°03	-278	-12.6	-226	-15.0	- 504	-13.6
H	92°02-91°46	-442	-20.1	-200	-22.2*	- 642	-17.4
I	91°45-91°22	NOT EVALUATED		---	---	---	---
J	91°21-91°00	-928	-42.2	-485	-32.2	-1412	-38.2
K	90°59-90°53	-325	-14.7	-165	-11.0	- 490	-13.2
L	90°58-90°39	-380	-17.3	-355	-23.7	- 735	-19.9
M	90°32-90°14	-156	+ 7.1	-678	-45.2	- 522	-14.1
N	90°13-90°03	-1590	-72.3	-1023	-68.2	-2614	-70.6
O	90°02-89°57	- 63	- 2.9	+ 90	+ 6.0	+ 27	+ 0.7
P	89°57-89°52	-144	- 6.5	-259	-17.3	- 402	-10.9
Q	89°51-89°25	-928	-42.2	-849	-56.6	-1773	- 4.8
R	NOT EVALUATED	---	---	---	---	---	---
S	NOT EVALUATED	---	---	---	---	---	---
T	NOT EVALUATED	---	---	---	---	---	---

*1960-1969 interval

TABLE III

SUMMARY
RATES OF COASTAL LAND CHANGES

COASTAL SECTOR	SHORELINE LENGTH (MILES)	1932 - 1954 LINEAR CHANGES Avg. (feet)	Feet per Year	1932 - 1954 AREAL CHANGES Total (acres)	Acres per Year	Acr/yr per Mile	1954-1969 LINEAR CHANGES Avg. (feet)	Feet per Year	1954-1969 AREAL CHANGES Total (acres)	Acres per Year	Acr/yr per Mile	TOTAL 1932-1969 LINEAR CHANGES Avg. (feet)	Feet per Year	TOTAL 1932-1969 AREAL CHANGES Total (acres)	Acres per Year	Acr/yr per Mile
A	6	+367	+17	+147	+7	+1.1	-367	-17	- 170	-11	-1.8	0	0	-23	-1	-0.1
B	12	+133	+ 6	+ 4	0	+ .0	- 25	- 2	+ 175	+12	+1.0	+108	+ 3	+179	+5	+0.4
C	13	+ 33	+ 2	-186	-8	- .7	-192	-13	- 147	-10	-0.7	-158	- 3	-333	-9	-0.7
D	14	+235	+11	+414	+19	+1.3	+179	+12	+ 507	+34	+2.4	+414	+11	+921	+25	+1.8
E	45	-619	-28	-3898	-177	-3.9	-552	-37	-2417	-161	-3.6	-1169	-32	-6314	-171	-3.8
F	13	+500	+23	+772	+35	+2.7	- 69	- 5	- 37	- 2	-0.2	+431	+12	+735	+20	+1.5
G	10	-133	- 6	-278	-13	-1.3	-389	-26	- 226	-15	-1.5	-522	-14	-504	-14	-1.4
H	18	-112	- 8	-442	-20	-1.1	- 53	- 6*	- 200	-22*	-1.2*	-165	-10	-641	-17	-1.0
I	27	No comparative data available				-	-	-	-	-	-	-	-	-	-	-
J	25	-232	-11	-928	-42	-1.7	-195	-13	- 485	-32	-1.3	-427	-12	-1412	-38	-1.5
K	8	-143	- 7	-325	-15	-1.8	-243	-16	- 165	-11	-1.4	-386	-11	-490	-13	-1.6
L	21	-460	-21	-448	-20	-1.0	-350	-23	- 381	-25	-1.2	-810	-22	-829	-22	-1.1
M	20	-254	-11	+156	+ 7	+0.4	-460	-31	- 678	-45	-2.3	-714	-19	-522	-14	-0.7
N	13	-945	-43	-1590	-72	-5.6	-691	-46	-1023	-68	-5.2	-1636	-44	-2614	-71	-5.4
O	7	+ 33	+ 2	- 63	- 3	-0.4	- 33	- 2	+ 90	+ 6	+0.9	0	0	+ 27	+ 1	+0.1
P	6	-280	-13	-143	- 7	-1.1	-380	-25	-259	-17	-2.8	-660	-18	-402	-11	-1.8
Q	24	-171	- 8	-748	-34	-1.4	-314	-21	-640	-43	-1.8	-485	-13	-1388	-38	-1.6
R&S	-	Not evaluated, see text					-	-	-	-	-	-	-	-	-	-
T	44**	-373	-14	N.A.	N.A.	N.A.	-276	-18	N.A.	N.A.	N.A.	-648	-15	N.A.	N.A.	N.A.
TOTAL or AVG.	282**/326			-7556	-343	-1.2			-6056	-404	-1.4			-13,610	-368	-1.3
	-	-142	- 6.5	-	-	-	- 259	-17	-	-	-	-401	-10.1			

TABLE IV

*1960-1969 interval
**Not included in areal calculations

pated rates of loss must be considered in future coastal zone management planning.

The 20 sectors A through T, shown in Figure 3, will be considered individually.

Sector A (93°50-93°45 latitude) = 6 miles. During the period 1932-1954, litorally transported sediment was trapped behind the jetties at the mouth of the Sabine River, causing land accretion of about 147 acres (Table IV), but during the ensuing period (1954-1969), some 170 acres were lost in the same area. Thus, little or no net change took place over the entire period (see Sector B evaluation).

Sector B (93°45-93°34) = 12 miles. This coastal area was effectively stable during the earlier period, but the accretion of some 175 acres occurred during the 1954-1969 period. These new sedimentary deposits (predominantly mudflats) can be related to concurrent erosion in the immediate updrift area (Sector C) during this interval. Apparently, during the last 15 years, the site of sediment accretion shifted from Sector A in the earlier period to this sector.

Sector C (93°34-93°21) = 13 miles. This coastal zone includes the area extending from Peveto Beach through Holly Beach to the mouth of the Calcasieu River, which bore the brunt of Hurricane Audrey in 1957 and Hurricane Carla in 1961. Rapid coastal erosion followed each of these storms (Morgan et al. 1958), with the sediment being washed inland or transported west to be trapped behind the Sabine River jetties (Sectors A and B). Similar erosion rates of eight to nine acres per year have continued through the entire period of this study. Continuing erosion has resulted in the periodic destruction of the coastal highway (La. Hwy. 82), necessitating its reconstruction and landward offset several times. In 1971, the state Department of Highways constructed several miles of experimental concrete block revetment in order to aid in road maintenance. Although the revetment has been washed out and destroyed in some places, it has been generally quite successful in restricting shoreline retreat through 1976.

Sector D (93°21-93°07) = 14 miles. This is an accreting part of the coast, lying on the updrift side of the Calcasieu Pass jetties, which extend more than a mile into the Gulf or Mexico. The normal longshore transport of sediment toward the west is blocked by the jetties, causing the seaward buildout of new land. Accretion during the past 37 years has resulted in the formation of over 900 acres of new land, predominantly mudflats.

Sector E (93°07-92°24) = 45 miles. This long coastal sector has been undergoing consistent coastal retreat during the entire period covered by the study. Over 6300 acres of land have been lost during the 1932-1969 interval, a rate of 3.8 acres per year for each mile of coast involved. Although shoreline erosion within this sector is furnishing the sediment that is causing mudflat accumulation behind the Calcasieu jetties (Sector D), it should be noted that the erosion of 3.8 acres/year/mile in Sector E is resulting in an accretion of only 1.8 acres/year/mile in Sector D. In other words, about half of the sediment being eroded is lost to the system, resulting in overall coastal land loss.

Sector F (92°24-92°12) = 13 miles. This coastal sector of Vermilion Parish has been accreting seaward for approximately the past 800 years, as determined by radiocarbon dating (Byrne et al. 1959). A series of coastal accretion ridges, known in south Louisiana as "cheniers," reflects coastal progradation of over three miles during the past 800-1000 years. Chenier au Tigre, Beef Ridge, Mulberry Island, Sand Ridge, and Bill Ridge are some of the named cheniers which, with their intervening marshes, reflect an overall process of coastal accretion. The formation of the individual cheniers, however, reflects shorter periods during which processes of shoreline retreat and accumulation of shell and sand have exceeded seaward buildout. The reason for the periodic shift between coastal buildout and shoreline erosion over the past 800 years are not known, but the presence of broad shoals offshore (Tiger and Trinity shoals) has no doubt played a role in altering the amount of wave energy expended upon the shore. During the period 1932-2954, this sector was rapidly accreting through the addition of some 2.7 acres of new land per year per mile of coast. However, during the subsequent interval, coastal accretion has terminated and minor erosion is now taking place. It is possible that this is another reversal in trend such as those typical of the past 800 years.

Sector G (92°12-92°02) = 10 miles. Moderate and consistent coastal retreat has typified this sector for the past 37 years. There has been a slight increase in retreat rate during the past 15 years, from 1.3 acres/year/mile to 1.5 acres/year/mile.

Sector H (92°02-91°45) = 18 miles. The area seaward of the Marsh Island Shoreline is dominated by massive oyster reefs, which can be related to a subsiding former delta of the Mississippi River. Oyster growth has effectively been terminated by an influx of Atchafalaya River mud during the past three decades; however, for hundreds of years previously, this coastal sector was ideally suited to natural oyster growth (Morgan et al. 1953; Coleman 1966). The massive reefs are very effective in reducing wave action. Consequently, the shoreline area in the lee of the reefs is one of the few areas in coastal Louisiana that has not changed measurably with the past 37 years. The western two miles and the eastern four miles of the Marsh Island coastline extend beyond the area protected by reefs and have been retreating at an average rate of some 15 feet per year--a rate comparable with the delta plain average.

Insufficient attention has been paid to the importance of reefs in protecting the shoreline form erosion. Many similar reefs within adjacent Atchafalaya Bay are currently being dredged commercially for shells. Such commercial utilization should not be allowed to destroy the effectiveness of these reefs as a barrier to coastal erosion.

Sector I (91°45-91°22) = 27 miles. This part of the Louisiana coastline consists of a discontinuous series of oyster reefs, near sea level, similar in origin to those fronting Marsh Island (Sector H). Detailed, tide-controlled, aerial photo maps were made of this area in 1960 by the U.S. Coast and Geodetic Survey (part of the Set of 54 Maps). The 1969 aerial photographs used for this study were not tide controlled and, therefore, reef changes cannot be determined through comparison with the Set of 54 Maps.

Sector J (91°22-91°00) = 25 miles. The shoreline from Point au Fer to Caillou Bay has been retreating consistently throughout the study period. A land loss rate of 1.7 acres/year/mile in the the 1932-1954 period has reduced to a rate of 1.3 acres/year/mile during the past 15 years. The rate reduction is not particularly significant; most of the sector is showing a somewhat accelerated retreat rate, which is counterbalanced by two local areas of sediment accretion. The reason for this cannot be stated with any certainty.

Sector K (91°00-90°52) = 8 miles. This sector contains the north shore of Caillou Bay, which is open to wave action from the southwest by protected by the western section of Isles Dernieres from southeast winds. Despite the protection offered, this very low coastal marsh area has retreated at an average rate of 1.6 acres/year/mile during the interval studied.

Sector L (91°58-90°32) = 21 miles. Although this sector measures some 21 miles between established limits, some of the area is open water, reflecting the discontinuous nature of the shoreline of Isles Dernieres. There are numerous passes or gaps between the island segments. In general, the islands are not only retreating landward but also migrating in a westerly direction. The calculated average areal loss for the entire 21-mile sector amounts to about 1.1 acres/year/mile. However, if the combined length of the islands (19 miles) is considered, retreat rates amount to 1.2 acres/year/mile.

Sector M (90°32-90°14) = 20 miles. East Timbalier and West Timbalier islands make up this coastal segment. As in the case of Isles Dernieres, the Timbalier Islands are migrating toward the west under the influence of sediment transport. The western end of the island complex is generally building westward and slightly seaward by the accretion of sediment, which has been eroded from the eastern part of the island chain. In Appendix II, areal changes in both the western and eastern Timbalier Islands are listed separately for convenience in evaluating changes. In both areas, coastal erosion has been the dominant process, especially in the past 15-year interval. Retreat rates for the entire sector average 0.7 acres/year/mile.

In order to protect its Timbalier Bay field, Gulf Oil Corporation has built a protective stone breakwater with associated groins for several miles along the shoreline of East Timbalier Island. The breakwater has not been in place long enough to determine its long-range effectiveness, but its construction has reduced erosion locally.

Sector N (90°14-90°02) = 13 miles. This includes the coastal areas flanking the mouth of Bayou Lafourche, the trunk channel of the most recently abandoned delta of the Mississippi River. Because of its abandonment by the river, the deltaic sediments composing this very low, flat area are rapidly compacting, and subsidence, with the resulting shoreline retreat, is unusually high. Shoreline retreat has resulted in the loss of approximately 5.5 acres/year/mile of shoreline, the maximum rate revealed by this study.

The normal westward littoral drift typical of the rest of the Louisiana coast is reversed in this specific area. Westward drift occurs to the west of the mouth of Bayou Lafourche, while the reverse characterizes the coast for some 15 miles eastward.

Sector O (90°02-89°57) = 7 miles. The shoreline of Grand Isle is retreating under wave attack at the west end and accreting at the east end as a result of the previously mentioned eastward littoral drift. For the island as a whole, these trends effectively balance one another, with the result that there has been little net areal change during the period involved.

Sector P (89°57-89°51) = 6 miles. The shoreline of Grand Terre Island has displayed an increase in land loss, from a moderate rate of about 1.1 acres/year/mile during the 1932-1954 interval to an extreme 2.8 acres/year/mile during the subsequent study period. This area suffered considerable storm modification during the later interval, especially from Hurricane Betsy in 1963. This may be a principal reason for the significant increase in rate of coastal erosion.

Sector Q (89°51-89°30) = 24 miles. The coastal zone extending from Cheniere Ronquille on the northwest to Sandy Point Island exhibited a retreating shoreline throughout the period of study. The rather moderate erosion rate of 1.4 acres/year/mile increased to 1.8 acres/year/mile during the later study interval. Such an increase in rate appears to be rather consistent for the entire delta plain.

Sector R (The active Mississippi River delta). The delta proper cannot be considered in the same way as the other coastal areas of Louisiana. This is a region of highly irregular shorelines; numerous islands, mudflats, and sand bars; and broad expanses of marsh that are near sea level and contain many lakes, ponds, and bays. The entire area is subject to rapid areal change as a result of deltaic sedimentation processes, wave erosion, and the general subsidence of the soft, unconsolidated sediment.

Many studies of deltaic sedimentation processes and the resulting landforms have been published and two recent papers in particular have emphasized land-change trends in the delta (Gagliano and Van Beek 1970; D. J. Morgan 1973). Both of these studies have illustrated trends in the growth, deterioration, and destruction of land areas comprising Mississippi River subdeltas. The only realistic way to evaluate such trends is through the comparison of total land with total water within a certain area.

Comparing the details of land changes as depicted on maps of the delta (Scale 1:20,000) is enormously tedious; however, with the use of a digitizer, such comparisons can be made. Two illustrative areas within the delta were selected for this study. The first was an area of 4.6 square miles near Pass du Bois in the West Bay region, and the second was 10.4 square miles near Bienvenue Pass in the Cubits Crevasse region. Table V shows the changes in land area for each of the two regions over two time intervals. The first was a 27-year interval between the 1932 photography and the tide-controlled 1959 Coast and Geodetic Survey photographs, and the second was a 12-year interval between the 1959 shoreline data and U.S. Geological Survey Orthophotomap Quadrangle Sheets of the delta based on 1971 photography.

The Pass du Bois area lies in the deteriorating West Bay subdelta. Both time intervals reflect the dominance of regional subsidence and resulting land loss at rates of 8.2 acres/square mile/year and 6.7 acres/square mile/year (Table V).

Bienvenue Pass in the Cubits Crevasse region is an area of still-active deltaic sedimentation. Resulting shoreline progradation is reflected by the change from a land loss rate of 2.8 acres/square mile/year during the earlier interval to a land gain of 4.6 acres/square mile/year during the later interval.

The only accurate way to evaluate rates of deltaic change would be to prepare digitized areal comparisons for the entire region, a project that would be prohibitively time consuming. It has been suggested in previous studies that for the past decade or so, land loss in the delta has exceeded new land formation. This seems to be the case, but it is not possible to quantify these trends except in a general way.

Sector S (Breton Island) = 4 miles. Breton Island, at the southern end of the Chandeleur Island chain, is considered independently from the rest of the islands that compose the eastern Louisiana coast. A comparison of the surveys of 1869 and 1922 with photography taken in 1950 and 1969 indicates variable rates of shoreline change for Breton Island, ranging from retreat at the northern end through stability in the central area to accretion at the southern end. In effect, the island has rotated in counterclockwise direction around a pivotal point near its center (D. J. Morgan 1973). At the time of the 1950 photography, there were two sections of Breton Island. The islands were severely eroded again by the intense wave action and high tides of Hurricane Camille, which passed directly over the island in 1969. The 1969 photography used in this study was taken shortly after the storm's passage. Shoreline change rate cannot be quantified with accuracy.

Sector T (Longitude 29°30-30°04) = 44 miles The eastern boundary of St. Bernard and

REPRESENTATIVE LAND AREA CHANGES
MISSISSIPPI RIVER DELTA

	1932 - 1959				1959 - 1971				1932 - 1971			
	$Feet^2$	Acres	Acres per $Mile^2$	Acres per $Mile^2$ per Year	$Feet^2$	Acres	Acres per $Mile^2$	Acres per $Mile^2$ per Year	$Feet^2$	Acres	Acres per $Mile^2$	Acres per $Mile^2$ per Year
WEST BAY (Pass du Bois) 4.6 $mile^2$; Bounded by: 89°23'-89°25' 29°05'-29°07'	-44.3×10^6	-1017	-221	-8.2	-16.2×10^6	-372	-81	-6.7	-60.5×10^6	-1389	-302	-7.7
CUBITS GAP (Bienvenue Pass) 10.4 $mile^2$; Bounded by: 89°08'-89°11' 29°15'-29°18'	-33.8×10^6	- 775	- 75	-2.8	$+25.1 \times 10^6$	+576	+55	+4.6	$- 8.7 \times 10^6$	- 198	- 19	-0.5

TABLE V

Plaquemines parishes is delineated by an elongate, discontinuous chain of sandy islands and shoals generally known as the Chandeleur Islands. A number of subsidiary islands (specifically Stake, Curlew, Errol, Grand Gosier, and Breton) are recognized and named on different maps and charts. The Chandeleur Islands are composed predominantly of sands reworked from older deltaic deposits, and these unconsolidated materials are subject to rapid and dramatic changes, particularly when attacked by hurricanes and strong storms. The islands are often breached or washed away, only to rebuild gradually in another place a few years later.

It is possible to calculate an approximate linear retreat rate of about 15 feet per year for the chain, as indicated in Appendix I. It should be pointed out, however, that in 1969 Hurricane Camille did extensive damage, especially to the southern part of the chain, where the islands retreated landward a distance greater than their width. Consequently, pending a retriangulation of the area, there is no way to locate those islands precisely with respect to the latitude-longitude grid network. Similarly, it is meaningless to try to calculate areal coastal land loss in the Chandeleurs because they do not have a continuous, regular shoreline. An alternative method of evaluation is simply to consider the total amount of land above the high water mark. Table VI is a comparison of total land area as revealed by three different types of surveys.

Many of the islands within the Chandeleur chain are barren sand shoals very close to sea level. Interpreting the land-water boundary from aerial photographs is difficult. With this inherent inaccuracy in determining island area, Table VI suggests a remarkable consistency in total area with time. It is apparent that a rather consistent volume of sand is available, and storm waves are simply reworking and redistributing the sand with time as the island chain progressively moves landward. This suggests either that there has been negligible loss or gain of sediment to the entire island system, or that the amount of sediment loss through storms is approximately balanced by new sediment added through the erosion of underlying deltaic deposits.

Evaluation of Political Coastal Subdivisions

The 20 natural subdivisions of coastal Louisiana described previously were selected because they showed comparable tendencies toward change. For political, economic, and managerial purposes, other subdivisions may be of more practical value. Evaluations of two other subdivisions of the Louisiana coast by parish and by Coastal Zone Management Districts are included.

Louisiana Coastal Parishes. Parish boundaries delineate the most obvious political subdivisions of the state. Table VII includes a summary of areal changes affecting all coastal parishes, with the exceptions of a part of Plaquemines and all of St. Bernard, as these parishes have shorelines not conducive to evaluation for change, either areal of linear.

The evaluation shows that Cameron Parish has lost a total of 3557 acres of land along its 76-mile coast during the past 37 years. This is a rate of 1.3 acres per year for each linear mile of coastline in the parish. Vermilion Parish has lost 1782 acres during the same period, which reflects a similar rate of 1.3 acres per year for its 36-mile coastal sector. The Iberia Parish shoreline is principally that of Marsh Island, about 18 miles in length. Much of Marsh Island is protected from wave erosion by massive oyster reefs immediately offshore, so that it has undergone land loss of only 1.0 acres per year per linear mile of shore.

Terrebonne Parish has a shoreline 67 miles long if measured from Point au Fer along the seaward periphery of Isles Dernieres and West Timbalier Island. Much of the island migration is westward as well as landward; consequently, the parish shows a land loss of 2315 acres, a rate of 0.9 acres/year/mile.

Lafourche Parish has only about 22 miles of shoreline, yet it has lost 2831 acres of land during the past 37 years. This is an extreme rate of land loss, approaching 3.5 acres per year per linear mile.

The 13-mile length of Jefferson Parish, principally Grand Isle and Grand Terre, has lost some 200 acres, a rate of about 0.4 acre per year per linear mile. This slower rate has been influenced to some degree by protective measures (a series of groins extending seaward from the Grand Isle beach), but is mainly caused by a local reversal in direction of coastal currents, with a resulting influx of sediment from the rapidly eroding coastal area to the west.

The highly irregular shoreline characterizing most of Plaquemines Parish does not lend itself simply to coastal change evaluation. From Grand Terre Island to Sand Point (89°30' latitude), a distance of 24 miles, the shoreline is relatively regular and has been eroding consistently, with an overall loss of 1940 acres. This amounts to 2.1 acres per year per mile of coast. The remainder of the delta area of Plaquemines Parish is composed of many small islands, low banks of distributary streams, and miles of near-sea-level marsh. This region can be evaluated only by a comparison of changes in land/water ratio per unit area as described previously.

CHANGE IN TOTAL AREA
CHANDELEUR ISLAND CHAIN*

Date	1922	1954	1969
Type of Survey	High water line as established by Topographical Survey, U.S.C.&G.S. (T-3918, T-3919)	High water line as interpreted from aerial photos by U.S.C.&G.S. (Set of 54 Maps)	High water line as interpreted from aerial photos by writer (U.S. Army Engrs. Photographs)
Land area above high water line	6640 acres	7160 acres	7290 acres
Percent deviation in area from mean	5.5%	1.8%	3.6%

* Exclusive of Breton Islands

TABLE VI

LAND LOSS THROUGH SHORELINE RETREAT, LOUISIANA COASTAL PARISHES

COASTAL PARISH INVOLVED	SHORELINE LENGTH (MILES)	1932-1954			1954-1969			1932-1969		
		TOTAL ACRES	ACRES PER YEAR	ACRES PER YEAR PER MILE	TOTAL ACRES	ACRES PER YEAR	ACRES PER YEAR PER MILE	TOTAL ACRES	ACRES PER YEAR	ACRES PER YEAR PER MILE
CAMERON 93°50'-92°37'	76	-2372	-108	-1.4	-1185	-79	-1.0	-3557	-96	-1.3
VERMILION 92°37'-92°02.5'	36	- 654	- 30	-0.8	-1128	-51	-1.4	-1782	-48	-1.3
IBERIA 92°02.5'-91°45.6'	18	- 441	- 20	-1.1	- 200	-22**	-1.2**	- 641	-17	-1.0
ST. MARY 91°45.6'-91°21.4'	--	Insufficient data available to evaluate oyster reef changes								
TERREBONNE 91°21'-90°22'30"	67	-1344	- 61	-0.9	- 971	-65	-1.0	-2315	-63	-0.9
LAFOURCHE 90°22'30"-90°05'	22	-1400	- 64	-2.9	-1430	-95	-4.3	-2831	-77	-3.5
JEFFERSON 90°05'-89°54'	13	- 52	- 2	-0.2	- 147	-10	-0.7	- 198	- 5	-0.4
PLAQUEMINES 89°54'-	25	-1051	- 48	-1.9	- 889	-59	-2.4	-1940	-52	-2.1
ST. BERNARD		Cannot be evaluated by same methods (see test)								

TABLE VII

*Part of Plaquemines Parish
**1960 - 1969 interval

The shoreline of St. Bernard Parish and eastern Plaquemines Parish is delineated by the discontinuous Chandeleur-Breton Island chain. This narrow, low-lying chain of sandy islands is constantly retreating under wave attack and suffered extreme dissection and erosion in 1969 during Hurricane Camille. In places, the islands have retreated a distance that exceeds their width--making it impossible to calculate rates until the entire island chain is resurveyed with relation to the mainland. The total land area of the Chandeleur Islands has not changed significantly, suggesting that there is no major net gain or loss of sediment, although the entire chain has been migrating westward at a rate of approximately 15 feet per year.

In summary, it should be noted that all coastal parishes are suffering some degree of shoreline land loss. Rates differ, and some parishes contain local coastal areas of shoreline accretion. In all cases, however, land loss exceeds gain.

Louisiana Basin Management Units. The Louisiana coast has been divided into nine Basin Management Units for the establishment and application of the Coastal Zone Management Program. The boundaries of these hydrologic units do not necessarily coincide with the natural or the parish political units considered previously.

In order to simplify the comparison of shoreline changes within the various Basin Management Units, areal change rates for each of the two time intervals have been calculated and added to Figure 6, which indicates the boundaries of each basin hydrologic unit.

It should be noted that the Calcasieu Sabine Basin Management Unit (IX) shows land gain during each of the two time intervals studies (1932-1954 and 1954-1969). This is because the unit includes the two areas of sediment trapping on the updrift side of the Sabine and Calcasieu jetties. The adjacent coastal area from which sediment is being eroded falls into Basin Management Unit VIII.

Again, the Mississippi delta and the Chandeleur Island chain (which compose Basin Management Units I, II, and III) are not considered in the areal land change evaluation.

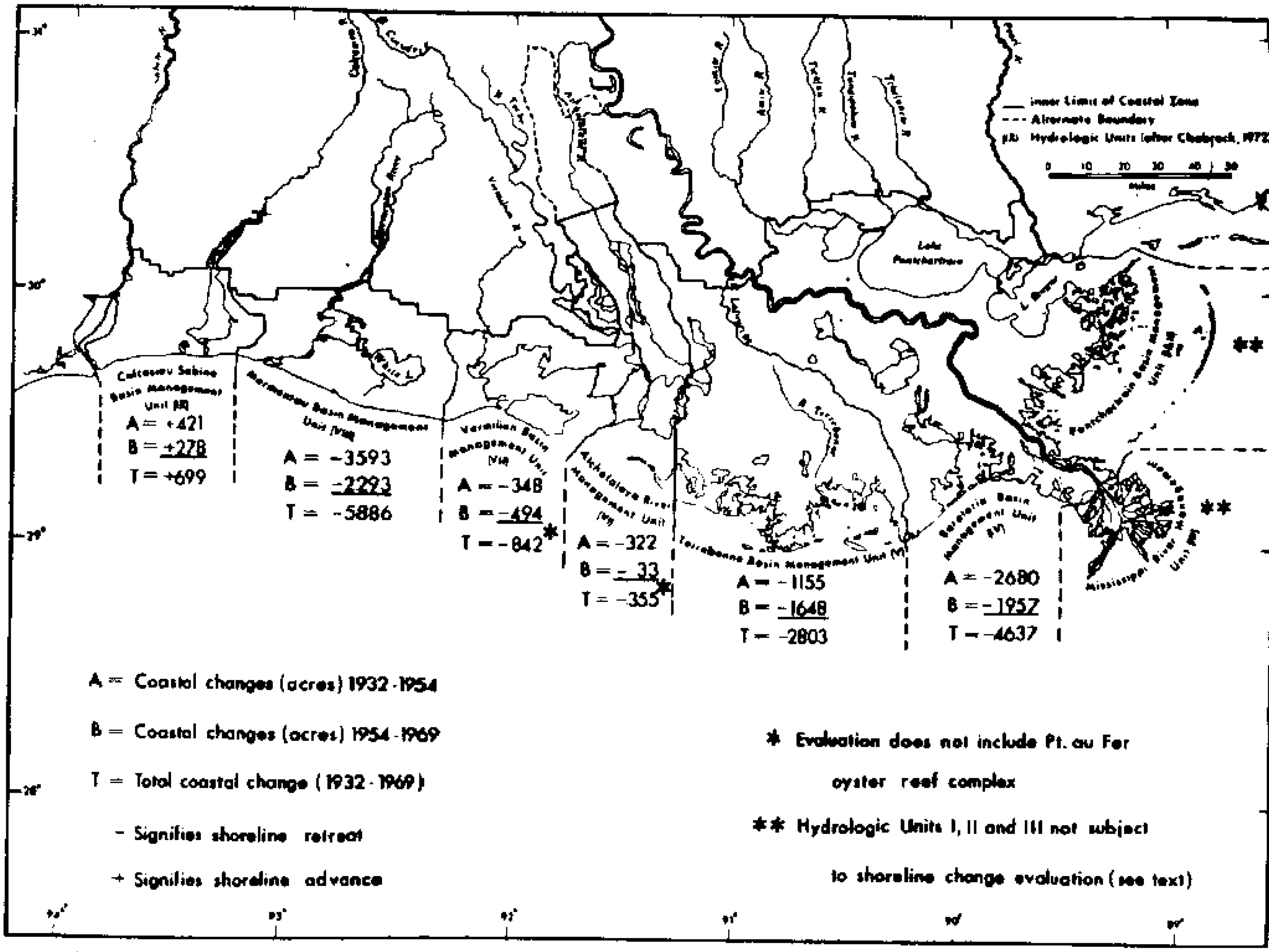


Figure 6. Shoreline change rates by Coastal Basin Management Units

Conclusions

The Louisiana coast is the seaward border of the Mississippi River delta plain and the adjacent "marginal delta" or chenier plain to the west. These two areas together comprise nearly a quarter of the state of Louisiana. They are the result of an accumulation of sediment deposited by the Mississippi River during the past 5000-6000 years and the continual reworking and redistribution of those sediments by marine processes. It is logical to suppose that the continuing deposition of sediment by the Mississippi River would have maintained the processes of land building to the present time, but that is not the case. During the past several hundred years, the Mississippi River has constructed an elongated platform, commonly called the "bird's foot" delta, which extends into the deep water of the Gulf of Mexico almost to the edge of the continental shelf. Sediment deposited by the river during the past century has not been nearly as effective in building new land, because most of it is being transported into the deep Gulf basin and effectively lost. Consequently, most of the deltaic plain has been deprived of a continuing sediment supply. With the cessation of sedimentation, the soft, wet, organically rich, deltaic soils tend to compact and subside, principally through interstitial water loss.

The Mississippi delta plain is composed of several overlapping, lobe-shaped, sedimentary masses, or delta, that have shifted laterally from time to time while progressively building seaward. The more recently abandoned deltas compact and subside at a faster rate than the older deltas. Rates of subsidence directly influence rates of shoreline retreat. Consequently, varying sectors of the abandoned delta plain would naturally display differing rates of shoreline retreat.

Subsidence is not the only cause of coastal land loss, however. Other natural factors, such as storm erosion, saltwater invasion, and long-term rise in sea level all influence the coastal zone. It is usually impossible to separate these causes when evaluating shoreline change.

In other words, subsidence and related shoreline retreat are natural phenomena that characterize the delta and chenier plain of coastal Louisiana. So long as the bulk of deltaic sedimentation is finding its way into the deep Gulf basin, the delta plain will continue to reflect predominantly erosional processes. However, this study shows that shoreline land loss has increased from an average of 1.2 acres per year per mile of coast during the 1930s and 1940s to 1.4 acres per year per mile of coast during the 1950s and 1960s. This represents an increase in total rate of land loss from 0.54 square miles per year to 0.64 square miles per year.

It is significant that the time intervals considered in this study, 1932-1954 and 1954-1969, coincide with a time of increasing human involvement in and utilization of the Louisiana coastal marshlands. Recently, considerable attention has been focused on the dirupting effects of roads, canals, pipelines, dredging, and boat traffic on the ecology of the coastal marshlands. These man-induced factors often accelerate the natural processes of subsidence and erosion that are taking place. There can be no doubt that man has, and is, playing an unintentional role in accelerating and intensifying the natural processes that are leading to the dissection and modification of the coastal marshlands. Such modification can be seen in many ways, only one of which has been considered here--the increasing rate of shoreline retreat.

Bibliography

Byrne, J. V., Leroy, D. O., and Riley, C. M. 1959. The chenier plain and its stratigraphy, southwestern Louisiana. Transactions, Vol. 8, p. 237-260.

Coleman, J. M. 1966. Recent coastal sedimentation, central Louisiana coast. Louisiana State University, Coastal Studies Institute, Technical Report No. 29, 73 p.

Gagliano, S. M., and Van Beek, J. L. 1970. Geologic and geomorphic aspects of deltaic processes, Mississippi delta system, in Hydrologic and geologic studies of coastal Louisiana, Report No. 1, Louisiana State University, Coastal studies Institute and Department of Marine Sciences, 140 O.

Hall, J. W. 1970. Louisiana survey systems; their antecedents, distribution and characteristics, Louisiana State University, Ph.D. dissertation.

Morgan, D. J. 1973. The Mississippi River delta--legal-geomorphic evaluation of historic shoreline changes. Louisiana State University, M.S. These, 369 p.

Morgan, J. R., Van Lopik, J. R., and Nichols, L. G. 1953. Occurrence and development of mudflats along the western Louisiana coast. Louisiana State University, Coastal Studies Institute, Technical Report No. 2, 34 p.

Morgan, J.P., and Staff of Coastal Studies Institute. 1955. A geographical and geological study of the Louisiana coast with emphasis upon establishment of the historic shoreline. Louisiana State University. Privately printed for the Office of the Attorney General, State of Louisiana, 51 p.

Morgan, J.P., and Larimore, P.B. 1957. Changes in the Louisiana shoreline. Transactions, Vol. 7, Gulf Coast Association of Geological Societies, p. 303-310.

Appendix I. Linear Rates of Shoreline Change

Positive figures = shoreline advance
Negative figures = shoreline retreat

		1932 - 1954		1954 - 1969		1932 - 1969	
		Change (feet)	Rate/ Year	Change (feet)	Rate/ Year	Total Change	Rate/ Year
Cameron Psh.	93°50'	+400	+18	-700	-47	-300	- 8
Sector A	93°49'	+200	+ 9	-500	-33	-300	- 8
93°50'-93°45'	93°48'	+400	+18	-500	-33	-100	- 3
Sabine Jetties-	93°47'	+500	+23	-400	-27	+100	+ 3
Smith B.	93°46'	+300	+14	0	0	+300	+ 8
	93°45'	+400	+18	-100	- 7	+300	+ 8
	AVG.	+367	+17	-367	-17	0	0
Cameron Psh.	93°44'	+300	+14	0	0	+300	+ 8
Sector B.	93°43'	+500	+23	0	0	+500	+14
93°44'-93°33'	93°42'	+400	+18	0	0	+400	+11
Smith B.-	93°41'	+300	+14	0	0	+300	+ 8
Peveto Bch.	93°40'	+100	+ 5	0	0	+100	+ 3
	93°39'	0	0	0	0	0	0
	93°38'	0	0	-200	-13	-200	- 5
	93°37'	0	0	0	0	0	0
	93°36'	0	0	0	0	0	0
	93°35'	0	0	0	0	0	0
	93°34'	0	0	-100	- 7	-100	- 3
	93°33'	0	0	0	0	0	0
	AVG.	+133	+ 6	- 25	- 2	+108	+ 3
Cameron Psh.	93°32'	0	0	-200	-13	-200	- 5
Sector C	93°31'	0	0	-200	-13	-200	- 5
93°32'-93°21'	93°30'	0	0	-100	- 7	-100	- 3
Holly Bch-	93°29'	0	0	-200	-13	-200	- 5
Calcasieu Jet.	93°28'	0	0	-300	-20	-300	- 8
	93°27'	0	0	-200	-13	-200	- 5
	93°26'	-300	-14	-100	- 7	-400	-11
	93°25'	-300	-14	-100	- 7	-400	-11
	93°24'	-200	- 9	-100	- 7	-300	- 8
	93°23'	-200	- 9	-200	-13	-200	- 5
	93°22'	0	0	-200	-13	-200	- 5
	93°21'	+1400	+64	-500	-33	+900	+24
	AVG.	+ 33	+ 2	-192	-13	-158	- 3

APPENDIX I
(cont'd)

		1932 - 1954		1954 - 1969		1932 - 1969	
		Change (feet)	Rate/ Year	Change (feet)	Rate/ Year	Total Change	Rate/ Year
Cameron Psh.	93°20'	+100	+ 5	+500	+33	+600	+16
Sector D	93°19'	+600	+27	+500	+33	+1100	+30
93°20'-93°07'	93°18'	+600	+27	+600	+40	+1200	+32
Calcasieu Jet-	93°17'	+300	+14	+500	+33	+800	+22
Mermentau R.	93°16'	+300	+14	+400	+27	+700	+19
	93°15'	+500	+23	+100	+ 7	+600	+16
	93°14'	+300	+14	-100	- 7	+200	+ 5
	93°13'	+500	+23	-100	- 7	+400	+11
	93°12'	+300	+14	0	0	+300	+ 8
	93°11'	+200	+ 9	0	0	+200	+ 5
	93°10'	+100	+ 5	0	0	+100	+ 3
	93° 9'	0	0	+100	+ 7	+100	+ 3
	93° 8'	0	0	+100	+ 7	+100	+ 3
	93° 7'	-500	-23	-100	- 7	-600	-16
	AVG.	+235	+11	+179	+12	+414	+11

Cameron Psh.	93°06'	0	0	0	0	0	0
Sector E	93°05'	-100	- 5	0	0	-100	- 3
93°06'-92°25'	93°04'	-100	- 5	-100	- 7	-200	- 5
Mermentau R.-	93°03'	-400	-18	-500	-33	-900	-24
Mulberry I.	93°02'	-800	-36	-500	-33	-1300	-35
	93°01'	-700	-32	-400	-27	-1100	-30
	93°00'	-500	-23	-300	-20	-800	-22
	92°59'	-600	-27	-500	-33	-1100	-30
	92°58'	-700	-32	-700	-47	-1400	-38
	92°57'	-800	-36	-500	-33	-1300	-35
	92°56'	-700	-32	-700	-47	-1400	-38
	92°55'	-800	-36	-500	-33	-1300	-35
	92°54'	-700	-32	-600	-40	-1300	-35
	92°53'	-700	-32	-500	-33	-1200	-32
	92°52'	-500	-23	-600	-40	-1100	-30
	92°51'	-600	-27	-600	-40	-1200	-32
	92°50'	-800	-36	-600	-40	-1400	-38
	92°49'	-700	-32	-600	-40	-1300	-35
	92°48'	-600	-27	-500	-33	-1100	-30
	92°47'	-700	-32	-500	-33	-1200	-32
	92°46'	-700	-32	-500	-40	-1300	-35
	92°45'	-700	-32	-600	-40	-1300	-35
	92°44'	-700	-32	-600	-40	-1300	-35
	92°43'	-800	-36	-700	-47	-1500	-41
	92°42'	-900	-41	-700	-47	-1600	-43
	92°41'	-800	-36	-700	-47	-1500	-41
	92°40'	-800	-36	-600	-40	-1400	-38
	92°39'	-700	-32	-600	-40	-1300	-35
	92°38'	-700	-32	-600	-40	-1300	-35
	92°37'	-900	-41	-600	-40	-1500	-41
	92°36'	-800	-36	-600	-40	-1400	-38
	92°35'	-800	-36	-600	-40	-1400	-38
	92°34'	-800	-36	-700	-47	-1400	-41

APPENDIX I (cont'd)		1932 - 1954 Change (feet)	1932 - 1954 Rate/ Year	1954 - 1969 Change (feet)	1954 - 1969 Rate/ Year	1932 - 1969 Total Change	1932 - 1969 Rate/ Year
Mermentau R.- Mulberry I. (cont'd)	92°33'	-700	-32	-800	-53	-1500	-41
	92°32'	-800	-36	-800	-53	-1600	-43
	92°31'	-700	-32	-800	-53	-1500	-41
	92°30'	-700	-32	-600	-40	-1300	-35
	92°29'	-700	-32	-700	-47	-1400	-38
	92°28'	-600	-27	-700	-47	-1300	-35
	92°27'	-300	-14	-600	-40	-900	-24
	92°26'	-200	- 9	-400	-27	-600	-16
	92°25'	+300	+14	-500	-33	-200	- 5
	AVG.	-619	-28	-552	-37	-1169	-32
Vermilion Psh. Sector F 92°24'-92°12' Mulberry I.- Cheniere au Tigre	92°24'	+200	+ 9	+200	+13	+400	+11
	92°23'	+500	+23	+600	+40	+1100	+30
	92°22'	+1000	+45	-200	-13	+800	+22
	92°21'	+600	+27	-200	-13	+400	+11
	92°20'	+400	+18	-100	- 7	+300	+ 8
	92°19'	+400	+18	-300	-20	+100	+ 3
	92°18'	0	0	-200	-13	-200	- 5
	92°17'	+200	+ 9	-200	-13	0	0
	92°16'	+600	+27	-300	-20	+300	+ 8
	92°15'	+600	+27	-300	-20	+300	+ 8
	92°14'	+800	+36	0	0	+800	+22
	92°13'	+800	+36	+300	+20	+1100	+30
	92°12'	+400	+18	-200	-13	+200	+ 5
	AVG.	+500	+23	- 69	- 5	+431	+12
Vermilion Psh. Sector G 92°11'-92°03' Cheniere au Tigre-Marsh I.	92°11'	0	0	-400	-27	-400	-11
	92°10'	0	0	-500	-33	-500	-14
	92°09'	0	0	-500	-33	-500	-14
	92°08'	-200	- 9	-600	-40	-800	-22
	92°07'	-400	-18	-300	-20	-700	-19
	92°06'	-100	- 5	-300	-20	-400	-11
	92°05'	-100	- 5	-300	-20	-400	-11
	92°04'	-200	- 8	-300	-20	-500	-14
	92°03'	-200	- 8	-300	-20	-500	-14
	AVG.	-133	- 6	-389	-26	-522	-14
Iberia Psh. Sector H 92°02'-91°46' Lighthouse Point- South Point (Marsh Island)	92°02'	-500	-23	-200*	-22*	-700	-19
	92°01'	-300	-14	-100	-11	-400	-18
	92°00'	0	0	0	0	0	0
	91°59'	0	0	0	0	0	0
	91°58'	0	0	0	0	0	0
	91°57'	0	0	0	0	0	0
	91°56'	0	0	0	0	0	0

* 1960-1969 interval.

APPENDIX I
(cont'd)

		1932 - 1954		1954 - 1969		1932 - 1969	
		Change (feet)	Rate/ Year	Change (feet) *	Rate/ Year *	Total Change	Rate/ Year
Lighthouse Point-South Point (Marsh Island) (cont'd)	91°55'	+100	+ 5	+100	+ 11	+200	+ 5
	91°54'	+100	+ 5	+100	+ 11	+200	+ 5
	91°53'	0	0	0	0	0	0
	91°52'	0	0	0	0	0	0
	91°51'	-100	- 5	-100	- 11	-200	- 5
	91°50'	0	0	0	0	0	0
	91°49'	-200	- 9	-200	- 22	-400	-11
	91°48'	-300	-14	-200	- 22	-500	-14
	91°47'	-300	-14	0	0	-300	- 8
	91°46'	-400	-18	-300	- 33	-700	-19
	AVG.	-112	- 8	- 53	- 6	-165	- 5
Iberia Psh. Sector I 91°45'-91°22' Point au Fer Shell Reef	No comparative data available						
Terrebonne Psh. Sector J 91°21'-91°00' Pt. au Fer Caillou Bay	91°21'	-300	-14	-100	- 7	-400	-11
	91°20'	-300	-14	-400	-27	-700	-19
	91°19'	-100	- 5	+400	+33	+400	+11
	91°18'	-200	- 9	+600	+40	+400	+11
	91°17'	0	0	-200	-13	-200	- 5
	91°16'	-400	-18	-500	-33	-900	-24
	91°15'	-300	-14	-300	-20	-600	-16
	91°14'	-300	-14	-300	-20	-600	-16
	91°13'	-300	-14	-400	-27	-700	-19
	91°12'	-100	- 5	-300	-20	-400	-11
	91°11'	-300	-14	-300	-20	-600	-16
	91°10'	-300	-14	-300	-20	-600	-16
	91°09'	-300	-14	-200	-13	-500	-14
	91°08'	-200	- 9	-200	-13	-400	-11
	91°07'	-300	-14	-200	-13	-500	-14
	91°06'	-100	- 5	-300	-20	-400	-11
	91°05'	-300	-14	-300	-20	-600	-16
	91°04'	-200	- 9	-300	-20	-500	-14
	91°03'	-300	-14	-300	-20	-600	-16
	91°02'	-200	- 9	-200	-13	-400	-11
	91°01'	-100	- 5	-100	- 7	-200	- 5
	91°00'	-200	- 9	-200	-13	-400	-11
	AVG.	-232	-11	-195	-13	-427	-12
Terrebonne Psh. Sector K 90°59'-90°53' Caillou Bay (behind I. Dernieres)	90°59'	-100	- 5	-300	-20	-400	-11
	90°58'	-100	- 5	-300	-20	-400	-11
	90°57'	0	0	-300	-20	-300	- 8
	90°56'	-200	- 9	-200	-13	-400	-11
	90°55'	-200	- 9	-200	-13	-400	-11
	90°54'	-200	- 9	-200	-13	-400	-11
	90°53'	-200	- 9	-200	-13	-400	-11
	AVG.	-143	- 7	-243	-16	-386	-11

* 1960-1969 interval

APPENDIX I (cont'd)		1932 - 1954 Change (feet)	1932 - 1954 Rate/ Year	1954 - 1969 Change (feet)	1954 - 1969 Rate/ Year	1932 - 1969 Total Change	1932 - 1969 Rate/ Year
Terrebonne Psh.	90°58'	+1000	+45	-1100	-73	-100	- 3
Sector L	*90°57'	-500	-23	-300	-20	-800	-22
90°58'-90°39'	90°56'	-500	-23	-300	-20	-800	-22
Isles Dernieres	90°55'	+600	+27	+400	+27	+1000	+27
	*90°54'	W	-	-800	-53	(-800)	(-53)
	90°53'	W	-	W	-	-	-
	*90°52'	-1500	-68	W	-	(-1500)	(-68)
	90°51'	W	-	-	-	-	-
	*90°50'	-1000	-45	-300	-20	-1300	-35
	90°49'	-800	-36	-400	-27	-1200	-32
	90°48'	W	-	-700	-47	(-700)	(-47)
	90°47'	-1300	-59	-400	-27	-1700	-46
	90°46'	-600	-27	-600	-40	-1200	-32
	90°45'	-500	-23	-300	-20	-800	-22
	*90°44'	-400	-18	-200	-13	-600	-16
	90°43'	-200	- 9	-400	-27	-600	-16
	90°42'	0	0	-400	-27	-400	-11
	90°41'	0	0	-300	-20	-300	- 8
	*90°40'	0	0	-300	-20	-300	- 8
	90°39'	-200	- 9	-300	-20	-500	-14
	AVG.	-460	-21	-350	-23	-640	-17

*Equivalent points chosen

Terrebonne Psh.	90°32'	W	-	no photo	-	-	-
Sector M	90°31'	W	-	+300	+20	(+300)	(+20)
90°32'-90°14'	90°30'	+1000	+45	+100	+ 7	+1100	+30
Timbalier Island	90°29'	+500	+23	-200	-13	+300	+ 8
	90°28'	0	0	-600	-40	-600	-16
	90°27'	-400	-18	-500	-33	-900	-24
	90°26'	-500	-23	-300	-20	-800	-22
	90°25'	-500	-23	no photo	-	(-500)	(-23)
	90°24'	-1000	-45	no photo	-	(-1000)	(-45)
	90°23'	W	-	W	-	-	-
	90°22'	W	-	0	0	(0)	(0)
	90°21'	W	-	-1400	-93	(-1400)	(-93)
	90°20'	W	-	-800	-53	(-800)	(-53)
	90°19'	+1400	+64	-700	-47	+700	+19
	90°18'	-200	- 9	-600	-40	-800	-22
	90°17'	-900	-41	-400	-27	-1300	-35
	90°16'	-600	-27	-1000	-67	-1600	-43
	90°15'	-600	-27	-400	-27	-1000	-27
	90°14'	-1500	-68	-400	-27	-1900	-51
	AVG.	-254	-11	-460	-31	-618	-17

APPENDIX I (cont'd)		1932 - 1954 Change (feet)	1932 - 1954 Rate/ Year	1954 - 1969 Change (feet)	1954 - 1969 Rate/ Year	1932 - 1969 Total Change	1932 - 1969 Rate/ Year
Lafourche Psh.	90°13'	-2000	-91	-400	-27	-2400	-65
Sector N	90°12'	-1800	-82	-700	-47	-2500	-68
90°13'-90°03'	90°11'	-1500	-68	-1200	-80	-2700	-68
Chenier	90°10'	-1300	-59	-1100	-73	-2400	-65
Caminada	90°09'	-1200	-55	-1000	-67	-2200	-59
	90°08'	-1100	-50	-700	-47	-1800	-49
	90°07'	-700	-32	-700	-47	-1400	-38
	90°06'	-400	-18	-600	-40	-1000	-27
	90°05'	-400	-18	-500	-33	-900	-14
	90°04'	0	0	-500	-33	-500	-14
	90°03'	0	0	-200	-13	-200	- 5
	AVG.	-945	-43	-691	-46	-1636	-44
Jefferson Psh.	90°02'	+500	+23	-400	-27	+100	+ 3
Sector O	90°01'	+200	+ 9	-200	-13	0	0
90°02'-89°57'	90°00'	+100	+ 5	-200	-13	0	0
Grand Isle	89°59'	-100	- 5	0	0	-100	- 3
	89°58'	-300	-14	0	0	-300	- 8
	89°57'	-200	- 9	+400	+27	+200	+ 5
	AVG.	+ 33	+ 2	- 33	- 2	0	0
Jefferson Psh.							
Sector P	89°56'	+200	+ 9	-300	-20	-100	- 3
89°57'-89°52'	89°55'	+200	+ 9	0	0	+200	+ 5
Grand Terre Isl.	89°54'	-400	-18	-600	-40	-1000	-27
	89°53'	-800	-36	-500	-33	-1300	-35
	89°52'	-600	-27	-500	-33	-1100	-30
	AVG.	-280	-13	-380	-25	- 660	-18
Plaquemines Psh.	89°51'	W	-	W	-	-	-
Sector Q	89°50'	-1300	-59	-600	-40	-1900	-51
89°51'-89°	89°49'	-500	-23	-400	-27	-900	-24
Cheniere	89°48'	-300	-14	-400	-27	-700	-19
Ronquille-	89°47'	-100	- 5	-700	-47	-800	-22
Sandy Point	89°46'	-400	-18	-400	-27	-800	-22
	89°45'	-100	- 5	-200	-13	-300	- 8
	89°44'	0	0	-200	-13	-200	- 5
	89°43'	0	0	0	0	0	0
	89°42'	+100	+ 5	0	0	+100	+ 3
	89°41'	+300	+14	0	0	+300	+ 8
	89°40'	+700	+32	-100	- 7	+600	+16
	89°39'	-200	- 9	-300	-20	-500	-14
	89°38'	-500	-23	-600	-40	-1100	-30
	89°37'	-700	-32	-500	-33	-1200	-32
	89°36'	-500	-23	-300	-20	-800	-22

APPENDIX I (cont'd)		1932 - 1954 Change (feet)	1932 - 1954 Rate/ Year	1954 - 1969 Change (feet)	1954 - 1969 Rate/ Year	1932 - 1969 Total Change	1932 - 1969 Rate/ Year
Plaquemines Psh.	89°51'	W	–	W	–	–	–
Sector Q	89°50'	-1300	-59	-600	-40	-1900	-51
89°51-89°30	89°49'	-500	-23	-400	-27	-900	-24
Cheniere	89°48'	-300	-14	-400	-27	-700	-19
Ronquille-	89°47'	-100	-5	-700	-47	-800	-22
Sandy Point	89°46'	-400	-18	-400	-27	-800	-22
	89°45'	-100	-5	-200	-13	-300	-8
	89°44'	0	0	-200	-13	-200	-5
	89°43'	0	0	0	0	0	0
	89°42'	+100	+5	0	0	+100	+3
	89°41'	+300	+14	0	0	+300	+8
	89°40'	+700	+32	-100	-7	+600	+16
	89°39'	-200	-9	-300	-20	-500	-14
	89°38'	-500	-23	-600	-40	-1100	-30
	89°37'	-700	-32	-500	-33	-1200	-32
	89°36'	-500	-23	-300	-20	-800	-22
	89°35'	0	0	-400	-27	-400	-11
	89°34'	+1100	+50	-100	-7	+1000	+27
	89°33'	0	0	-200	-13	-200	-5
	89°32'	-300	-14	-200	-13	-500	-14
	89°31'	-400	-18	-500	-33	-900	-24
	89°30'	-500	-23	-500	-33	-1000	-27
	AVG.	-171	-8	-314	-21	-485	-13

Plaquemines Psh. Sector R 89°00-89°30' 28°54'-29°22' Mississippi Delta	Not subject to evaluation. Shoreline is non-linear.
Plaquemines Psh. Sector S 89°09'-89°14' Breton Islands	Cannot be evaluated; erratic, non-linear changes.

APPENDIX I (cont'd)		1922 - 1954 Change (feet)	1922 - 1954 Rate/ Year	1954 - 1969 Change (feet)	1954 - 1969 Rate/ Year	1922 - 1969 Total Change	1922 - 1969 Rate/ Year
Plaquemines-	29°31'	0	0	0	0	0	0
St. Bernard	29°32'	W	-	-700	-47	-700	-15
Pshs.	29°33'	W	-	W	-	W	-
Sector T	29°34'	W	-	W	-	W	-
29°31'-30°03'	29°35'	W	-	W	-	W	-
Chandeleur	29°36'	W	-	W	-	W	-
Island Chain	29°37'	W	-	W	-	W	-
	29°38'	-300	- 9	-400?	-27	-700	-15
	29°39'	0	0	-400?	-27	-400	- 9
	29°40'	W	-	-300?	-20	-300	- 6
	29°41'	-500	-15	-1200?	-80	-1700	-36
	29°42'	-1200	-38	W	-	-1200	-26
	29°43'	-1500	-47	W	-	-1500	-32
	29°44'	-1200	-38	-200	-13	-1400	-30
	29°45'	-800	-25	-700	-47	-1500	-32
	29°46'	-800	-25	-700	-47	-1500	-32
	29°47'	-800	-25	-500	-33	-1300	-28
	29°48'	-700	-22	-500	-33	-1200	-26
	29°49'	-400	-12	-500	-33	-900	-19
	29°50'	-400	-12	-500	-33	-900	-19
	29°51'	-400	-12	-400	-27	-800	-17
	29°52'	-500	-15	-400	-27	-900	-19
	29°53'	-300	- 9	-400	-27	-700	-15
	29°54'	-200	- 6	-300	-20	-500	-11
	29°55'	-500	-15	-200	-13	-700	-15
	29°56'	-400	-12	-200	-13	-600	-13
	29°57'	-100	- 3	-200	-13	-300	- 6
	29°58'	-200	- 6	-100	- 7	-300	- 6
	29°59'	-100	- 3	-100	- 7	-200	- 4
	30°00'	W	-	0	0	0	0
	30°01'	-500	-15	0	0	-500	-11
	30°02'	-300	- 9	0	0	-300	- 6
	30°03'	-200	- 6	-200	-13	-400	- 9
	AVG.	-373	-14	-276	-18	-648	-15

Appendix II. Areal Rates of Shoreline Change

Positive Figures = shoreline advance
Negative Figures = shoreline retreat

		1932 - 1954		1954 - 1969		1932 - 1969	
		Change (acres)	Rate/ Year	Change (acres)	Rate/ Year	Change (acres)	Rate/ Year
Cameron Psh.	93°50.1'-93°49'	+32.52	+1.48	-84.81	-5.65	-52.29	-1.41
Sector A	93°49'-93°47'	+53.57	+2.44	-96.93	-6.46	-43.36	-1.17
93°50'-93°45'	93°47'-93°45'	+60.58	+2.75	+12.12	+0.81	+72.70	+1.96
Sabine Jetties-							
Smith B.							
	TOTAL	+146.67		-169.62		-22.95	
Cameron Psh.	93°45'-93°43'	+17.86	+0.81	+84.18	+5.61	+102.04	+2.76
Sector B	93°43'-93°41'	+56.12	+2.55	+31.25	+2.08	+87.37	+2.36
93°45'-93°34'	93°41'-93°39'	-10.84	-0.49	+36.99	+2.47	+26.15	+0.71
Smith B.-	93°39'-93°37.5'	-21.68	-0.99	+ 5.74	+0.38	-15.94	-0.43
Peveto Bch.	93°37.5-93°36'	-12.12	-0.55	+24.23	+1.10	+12.11	+0.33
	93°36'-93°34'	-25.51	-1.16	- 7.01	-0.32	-32.52	-0.88
	TOTAL	+ 3.83		+175.38		+179.21	
Cameron Psh.	93°34'-93°33'	-12.12	-0.55	- 8.29	-0.55	-20.41	-0.55
Sector C	93°33'-93°32'	-15.94	-0.72	-18.49	-1.23	-34.44	-0.93
93°34'-93°21	93°32'-93°30'	-27.42	-1.25	-17.22	-0.78	-44.64	-1.21
Peveto Beach-	93°30'-93°28'	+ 8.93	+0.41	-18.49	-1.23	- 9.56	-0.26
Calcasieu Pass	93°28'-93°26'	-27.42	-1.25	-33.16	-2.21	-60.58	-1.64
	93°26'-93°24'	-87.36	-3.97	-10.84	-0.72	-98.20	-2.65
	93°24-93°22.5'	-59.94	-2.72	- 1.91	-0.13	-61.85	-1.67
	93°22.5'-93°21'	+35.07	+1.59	-38.26	-2.55	- 3.19	-0.09
	TOTAL	-186.20		-146.66		-332.86	
Cameron Psh.	93°21'-93°19'	+115.42	+5.25	+119.25	+7.95	+234.67	+6.34
Sector D	93°19'-93°17'	+131.36	+5.97	+163.89	+10.93	+295.25	+7.98
93°21'-93°06.8'	93°17'-93°15'	+56.12	+2.55	+109.05	+7.27	+165.17	+4.46
Calcasieu Pass-	93°15'-93°13'	+100.76	+4.58	+21.04	+1.40	+121.80	+3.29
Mermentau R.	93°13'-93°11'	+52.29	+2.38	+ 5.74	+0.38	+58.03	+1.57
	93°11'-93°09'	+ 0.64	+0.03	+43.36	+2.89	+44.00	+1.19
	93°09'-93°07.5'	-14.67	-0.67	+22.32	+1.49	+ 7.65	+0.21
	93°07.5'-93°06.8'	-28.06	-1.27	+22.32	+1.49	- 5.74	-0.16
	TOTAL	+413.86		+506.97		+920.83	

APPENDIX II
(cont'd)

		1932 - 1954		1954 - 1969		1932 - 1969	
		Change (acres)	Rate/ Year	Change (acres)	Rate/ Year	Change (acres)	Rate/ Year
Cameron/	93°06.8'-93°04'	- 35.71	-1.62	+ 23.59	+1.57	- 12.12	-0.33
Vermilion Psh.	93°04'-93°02'	-126.90	-5.77	- 98.20	-6.55	-225.10	-6.08
Sector E	93°02'-93°	-190.03	-8.64	- 84.81	-5.65	-274.84	-7.43
93°06.8'-92°24'	93° -92°58'	-190.03	-8.64	-105.22	-7.01	-295.25	-7.98
Mermentau R.-	92°58'-92°56'	-223.19	-10.15	-127.54	-8.50	-350.73	-9.48
Mulberry Is.	92°56'-92°54'	-177.28	-8.06	-121.16	-8.08	-298.44	-8.07
	92°54'-92°52.5'	-157.51	-7.16	- 93.10	-6.21	-250.61	-6.77
	92°52.5'-92°51'	-134.55	-6.12	- 93.74	-6.25	-228.29	-6.17
	92°51'-92°49'	-231.80	-10.54	-136.79	-9.12	-368.59	-9.96
	92°49'-92°47'	-200.55	-9.12	-102.03	-6.80	-302.58	-8.18
	92°47'-92°45'	-212.03	-9.64	-111.92	-7.46	-323.95	-8.76
	92°45'-92°43'	-228.29	-10.38	-127.22	-8.48	-355.51	-9.61
	92°43'-92°41'	-241.69	-10.99	-159.42	-10.63	-401.11	-10.84
	92°41'-92°39'	-236.90	-10.77	-118.29	-7.89	-355.19	-9.60
	92°39'-92°37.5'	-163.25	-7.42	- 95.33	-6.36	-258.58	-6.99
	92°37.5'-92°36'	-167.39	-7.61	- 88.64	-5.91	-256.03	-6.92
	92°36'-92°34'	-229.57	-10.44	-134.55	-8.97	-364.12	-9.84
	92°34'-92°32'	-203.42	-9.25	-163.25	-10.88	-366.67	-9.91
	92°32'-92°30'	-206.61	-9.39	-159.42	-10.63	-366.03	-9.89
	92°30'-92°28'	-281.86	-12.81	-140.93	-9.40	-422.79	-11.43
	92°28'-92°26'	- 90.55	-4.12	-129.45	-8.63	-220.00	-5.95
	92°26'-92°24'	+ 31.25	+1.42	- 49.10	-3.27	- 17.85	- .47
	TOTAL	-3897.86		-2416.52		-6314.38	
Vermilion Psh.	92°24'-92°22.5'	+ 94.38	+4.29	+ 92.47	+6.16	+186.85	+5.05
Sector F	92°22.5'-92°21'	+163.25	+7.42	- 12.75	-0.85	+150.50	+4.07
92°24'-92°12'	92°21'-92°19'	+107.13	+4.87	- 37.62	-2.51	+ 69.51	+1.88
Mulberry Is.-	92°19'-92°17'	+ 24.23	+1.10	- 51.02	-3.40	- 26.79	-0.72
Chenier au	92°17'-92°15'	+123.07	+5.59	- 71.42	-4.76	+ 51.65	+1.40
Tigre	92°15'-92°13'	+188.76	+8.58	+ 27.42	+1.83	+216.18	+5.84
	92°13'-92°12'	+ 71.42	+3.25	+ 15.94	+1.06	+ 87.36	+2.36
	TOTAL	+772.24		- 36.98		+735.26	
Vermilion Psh.	92°12'-92°11'	- 0.64		+ 38.26		+ 37.62	
Sector G	92°11'-92° 9'	- 75.89	-3.45	- 38.90	-2.59	-114.79	-3.10
92°12'-92°02.5'	92°9'-92°7.5'	- 69.51	-3.16	- 60.58	-4.04	-130.09	-3.52
Chenier au	92°7.5'-92°06'	- 63.77	-2.90	- 43.36	-2.89	-107.13	-2.90
Tigre -	92°06'-92°04'	- 43.36	-1.97	- 67.60	-4.51	-110.96	-3.00
Marsh Is.	92°04'-92°02.5'	- 24.87	-1.13	- 53.57	-3.57	- 78.44	-2.12
	TOTAL	-278.04		-225.75		-503.79	

APPENDIX II (cont'd)		1932 - 1954 Change (acres)	1932 - 1954 Rate/ Year	1954 - 1969 Change (acres)	1954 - 1969 Rate/ Year	1932 - 1969 Change (acres)	1932 - 1969 Rate/ Year
Iberia Psh.	92°02.5'-92°00'	-125.51	-5.71	-29.33*	- 3.25*	-154.84	-4.18
Sector H	92°00'-91°58'	0	0	0	0	0	0
92°02.5'-91°45.7'	91°58'-91°56'	0	0	0	0	0	0
Marsh Is.	91°56'-91°53.5'	0	0	0	0	0	0
	91°53.5'-91°51'	0	0	0	0	0	0
	91°51'-91°49.3'	0	0	0	0	0	0
	91°49.3'-91°45.7'	-316.04	-14.37	-170.39	-18.93	-486.43	-13.15
	TOTAL	-441.55		-199.72		-641.27	

*1960-1969 interval

Iberia Psh.
Sector I
91°45.7'-91°22'
Pt. au Fer Reef

Area includes numerous individual reefs. Insufficient data for area changes analysis.

		1932 - 1954 Change (acres)	1932 - 1954 Rate/ Year	1954 - 1969 Change (acres)	1954 - 1969 Rate/ Year	1932 - 1969 Change (acres)	1932 - 1969 Rate/ Year
Terrebonne Psh.	91°21.5'-91°21'	- 42.09	-1.91	-12.75	- .85	- 54.84	-1.48
Sector J	91°21'-91°19'	-137.10	-6.23	-48.46	-3.23	-185.56	-5.02
91°21.5'-91°0'	91°19'-91°17'	- 65.68	-2.99	+123.71	+8.25	+ 58.03	+1.57
Pt. au Fer-	91°17'-91°15'	- 77.16	-3.50	-97.57	-6.50	-174.73	-4.72
Caillou Bay	91°15'-91°13'	- 96.29	-4.38	-65.04	-4.34	-161.33	-4.36
	91°13'-91°11'	- 70.78	-3.22	-60.58	-4.04	-131.36	-3.55
	91°11'-91° 9'	- 95.65	-4.35	-45.28	-3.02	-140.93	-3.81
	91°9'-91°7.5'	- 58.67	-2.67	-41.45	-2.76	-100.12	-2.71
	91°7.5'-91°6'	- 50.38	-2.29	-43.36	-2.89	- 93.74	-2.53
	91°6'-91°4'	- 76.52	-3.48	-63.77	-4.25	-140.29	-3.79
	91°4'-91°2'	- 77.16	-3.51	-59.94	-4.00	-137.10	-3.71
	91°2'-91°00'	- 80.35	-3.65	-70.15	-4.68	-150.50	-4.07
	TOTAL	-927.83		-484.64		-1412.47	

		1932 - 1954 Change (acres)	1932 - 1954 Rate/ Year	1954 - 1969 Change (acres)	1954 - 1969 Rate/ Year	1932 - 1969 Change (acres)	1932 - 1969 Rate/ Year
Terrebonne Psh.	91°00'-90°58'	- 58.03	-2.64	-41.45	-2.76	- 99.48	-2.69
Sector K	90°58'-90°56'	- 72.70	-3.30	-47.83	-3.19	-120.53	-3.26
91°00'-90°52.5'	90°56'-90°54'	- 84.81	-3.86	-50.38	-3.36	-135.19	-3.65
Behind Isles	90°54'-90°52.5'	-109.04	-4.96	-25.51	-1.70	-134.55	-3.64
Dernieres	TOTAL	-324.58		-165.17		-489.75	

		1932 - 1954 Change (acres)	1932 - 1954 Rate/ Year	1954 - 1969 Change (acres)	1954 - 1969 Rate/ Year	1932 - 1969 Change (acres)	1932 - 1969 Rate/ Year
Terrebonne Psh.	90°58'-90°56'	-102.03	-4.64	-35.71	-2.38	-137.74	-3.72
Sector L	90°56'-90°54'	+ 26.78	+1.22	-45.28	-3.02	- 18.50	-0.50
90°58'-90°37.5'	90°54'-90°52.5'	+123.07	+5.59	-77.80	-5.19	+ 45.27	+1.22
Isles	90°52.5'-90°51'	-133.92	-6.09	+ 6.38	+0.43	-127.54	-3.45
Dernieres	90°51'-90°49'	-207.25	-9.42	+19.13	+1.26	-188.12	-5.08
	90°49'-90°47'	+136.47	+6.20	+112.23	+7.48	+248.70	+6.72
	90°47'-90°45'	-125.63	-5.76	-84.18	-5.61	-209.81	-5.67
	90°45'-90°43'	- 91.83	-4.17	-79.71	-5.31	-171.54	-4.64

APPENDIX II (cont'd)		1932 - 1954 Change (acres)	Rate/ Year	1954 - 1969 Change (acres)	Rate/ Year	1932 - 1969 Change (acres)	Rate/ Year
Isles Dernieres	90°43'-90°41'	- 12.12	-0.55	-100.12	-6.67	-112.24	-3.03
(cont'd)	90°41'-90°39'	+ 6.38	+0.29	-70.15	-4.68	- 63.77	-1.72
	90°39'-90°37.5'	- 68.23	-3.10	-25.51	-1.70	- 93.74	-2.53
	TOTAL	-448.31		-380.72		-829.03	
Terrebonne Psh.	90°32.5'-90°30'	+195.77	+8.90	+39.54	+2.64	+235.31	+6.36
Sector M-1	90°30'-90°28'	+131.36	+5.97	-39.54	-2.64	+ 91.82	+2.48
90°32.5'-90°22.5'	90°28'-90°26'	- 95.65	-4.35	-105.22	-7.01	-200.87	-5.43
W. Timbalier	90°26'-90°24'	-108.41	-4.93	no photo	-	-108.41+	-
Is.	90°24'-90°22.5'	- 91.15	-4.14	no photo	-	- 91.15+	-
	TOTAL	+ 31.92		-105.22		- 73.30	
Lafourche Psh.	90°22.5'-90°21'	+133.28	+6.06	-86.09	-5.74	+ 47.19	+1.28
Sector M-2	90°21'-90°19'	+413.86	+18.81	-176.00	-11.73	+237.86	+6.43
90°22.5'-90°14'	90°19'-90°17'	- 49.10	-2.23	-123.07	-8.20	-172.17	-4.65
E. Timbalier	90°17'-90°15'	-192.58	-8.75	-130.73	-8.71	-323.31	-8.74
Is.	90°15'-90°14'	-181.01	-8.23	- 56.76	-3.78	-237.77	-6.43
	TOTAL	+124.45		-572.65		-448.20	
Lafourche-Jefferson Psh.	90°14'-90°13'	-128.81	-5.86	- 50.38	-3.36	-179.19	-4.84
Sector N	90°13'-90°11'	-550.97	-25.04	-209.80	-13.98	-760.77	-20.56
90°14'-90°03'	90°11'-90°09'	-398.56	-18.12	-279.31	-18.62	-677.87	-18.32
Belle Pass-	90°09'-90°07.5'	-225.75	-10.26	-129.45	-8.63	-355.20	-9.60
Caminada Pass	90°07.5'-90°06'	-152.41	-6.93	-129.45	-8.63	-281.86	-7.62
	90°06'-90°04'	-126.90	-5.77	-159.42	-10.63	-286.32	-7.74
	90°04'-90°03'	- 7.01	-0.32	- 65.68	-4.38	- 72.69	-1.96
	TOTAL	-1590.41		-1023.49		-2613.90	
Jefferson Psh.	90°03'-90°02'	+59.94	+2.72	- 47.19	-3.15	+ 12.75	+0.34
Sector O	90°02'-90°0'	-23.59	-1.07	+ 52.93	+3.53	+ 29.34	+0.79
90°03'-89°57'	90°0' -89°58'	-65.68	-2.99	+ 26.15	+1.74	- 39.53	-1.07
Caminada Pass-	89°58'-89°57'	-33.80	-1.54	+ 58.03	+3.87	+ 24.23	+0.65
Barataria Pass							
	TOTAL	-63.13		+ 89.92		+ 26.79	
Jefferson-	89°57'-89°56'	+47.83	+2.17	- 51.65	-3.44	- 3.82	-0.10
Plaquemines Psh.	89°56'-89°54'	+31.88	+1.45	- 23.59	-1.57	+ 8.29	+0.22
Sector P	89°54'-89°52.5'	-68.87	-3.13	-101.39	-6.76	-170.26	-4.60
89°57'-89°51'	89°52.5'-89°51'	-154.32	-7.01	- 82.26	-5.48	-236.58	-6.39
Barataria Pass-							
Quatre Bayou Pass	TOTAL	-143.48		-258.89		-402.37	

APPENDIX II
(cont'd)

		1932 - 1954		1954 - 1969		1932 - 1969	
		Change (acres)	Rate/ Year	Change (acres)	Rate/ Year	Change (acres)	Rate/ Year
Plaquemines Psh. Sector Q 89°51'-89°30' Quatre Bayou Pass- Sandy Point	89°51'-89°49'	-177.92	-8.09	-79.71	-5.31	-257.63	-6.96
	89°49'-89°47'	-103.94	-4.72	-107.77	-7.18	-211.71	-5.72
	89°47'-89°45'	-108.41	-4.93	- 79.71	-5.31	-188.12	-5.08
	89°45'-89°43'	- 31.88	-1.45	+ 11.48	+0.77	- 20.40	-0.55
	89°43'-89°41'	- 32.52	-1.48	+ 5.74	+0.38	- 26.78	-0.72
	89°41'-89°39'	- 1.91	-0.09	- 23.59	-1.57	- 25.50	-0.69
	89°39'-89°37'	-146.67	-6.67	-143.48	-9.57	-290.15	-7.84
	89°37'-89°36'						
	89°36'-89°34'	+ 21.68	+0.98	- 73.97	-4.93	- 52.29	-1.41
	89°34'-89°32'	- 39.54	-1.78	- 34.44	-2.30	- 73.98	-2.00
	89°32'-89°30'	-126.90	-5.77	-114.78	-7.65	-241.68	-6.53
	TOTAL	-748.01		-640.23		-1388.24	

SEAGRANT

Louisiana Sea Grant College Program

Center for Wetland Resources • Louisiana State University • Baton Rouge, LA