SHORELINE CHANGES IN THE
TIMBALIER BARRIER ISLAND ARC- 1887 TO 1996
TERREBONNE PARISH, LOUISIANA

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INTRODUCTION

The U.S. Geological Survey (USGS), in cooperation with the Coastal Research Laboratory in the Department of Geology and Geophysics at the University of New Orleans (UNO) and the Center for Coastal Energy and Environmental Resources at Louisiana State University (LSU), is investigating the processes of coastal erosion and wetland loss in Louisiana (Sallenger and others, 1987; Sallenger and Williams 1989; Penland and others, 1992). Building on the USGS Louisiana Barrier Island Study (Williams and others, 1992), this USGS Open-File Report depicts shoreline changes between 1887 and 1996, which provides an 8.9-year update of McBride and others (1992).

The Timbalier Islands are located about 100 km south-southwest of New Orleans (Figure 1). This barrier island shoreline is 30 km long and extends east from Cat Island Pass to Raccoon Pass. The Timbalier Islands represent a flanking barrier island system developed from the reworking and erosion of an abandoned distributary of the Lafourche delta complex within the Mississippi River delta plain (Penland and others, 1988). Island evolution is driven by predominant longshore sediment transport and storm overwash, causing the island arc to migrate to the north and west. The present configuration of the Timbalier Islands consists of Timbalier Island to the west, Timbalier Shoal, and East Timbalier Island to the east. Timbalier Shoal, located between the two islands within Little Pass Timbalier, is a transient area of moving sand, which is subaerial for some periods of measurement. The Gulf shoreline of East Timbalier Island has been armored by a rock seawall with a second seawall constructed landward in an attempt to protect oil and gas facilities on the bayside.

In order to quantify shoreline changes since January 21, 1988, new vertical aerial mapping photography was acquired on December 9, 1996 The methods and transects used by McBride and others (1992) were used to insure data compatibility of the new measurements and analysis (Plate 7). Table 1 presents the transect measurements of shoreline change for the Timbalier Islands. For gulfside change measurements, a negative (-) sign signifies landward movement or erosion and a positive (+) sign signifies a seaward movement or progradation. For bayside change measurements, a negative sign signifies a seaward movement or erosion and a positive sign signifies a landward movement or accretion

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Island evolution is predominantly driven by longshore sediment transport and storm overwash, causing the island arc to migrate to the north and west while slowly losing total area. Storm overwash predominates along East Timbalier and Timbalier Shoal, while longshore transport dominates at Timbalier Island. The highest rates of erosion occur on the eastern ends of each island and lessen along the Gulf shoreline toward the west. The bayside of the islands experiences edge-erosion caused by wave action from Timbalier Bay to the north. For long-term comparisons, area change data is more meaningful than lateral shoreline retreat along the Timbalier Islands because of the high rate of island migration. Island area has been significantly reduced by periodic severe freezes which killed extensive areas of black mangrove swamp, and hurricanes which significantly altered the landscape in a short amount of time.

Between 1887 and 1996, shoreline change was dramatic along the entire length of the Timbalier barrier island arc (Plate 6). The land areas shifted by island migration so that many transects yielded meaningless data.

GULFSIDE SHORELINE CHANGES

In terms of long-term, gulfside shoreline change history for the 109 year period between 1887 and 1996 (Table 1; Plate 6), the shore-perpendicular transects measured changes that ranged between +798 m at the prograding west end of Timbalier Island and -2685 m at the east end of East Timbalier Island. This was an average change of -1084 m at an average rate of -9.9 m/yr for the Timbalier barrier island arc shoreline. Timbalier Island experienced shoreline changes between +798 m and -1132 m with an average change of -147.8 along the Gulf shoreline, for an average rate of change of -1.4 m/yr. The highest rates of shoreline erosion occurred where East Timbalier Island migrated to the northwest. The erosion at East Timbalier Island was measured between -1657 m and -2685 m with the astounding average measurement of -2229.1 m. The average annual rate of change for this 109-year period for East Timbalier Island was -20.5 m/yr.

In terms of short-term shoreline change for the 8.9-year period between 1988 and 1996 (Table 1; Plate 5), the island arc experienced less western migration and more edge erosion, probably due to the severe hurricane impact sustained in 1992. The measurements of gulfside shoreline change along the Timbalier Barrier Island arc ranged between +100 m at the western end of Timbalier Island to -480 m at the east end of Timbalier Island with an average of -93.9 m. Although Timbalier Island measured both extremes, East Timbalier Island experienced higher consistent gulfside shoreline erosion. East Timbalier Island measurements ranged between -15 m where the shoreline was sheltered by the rock seawall and -465 m where the seawall failed and the shoreline retreated to the next rock seawall. Timbalier Island had an average shoreline change measurement of -44.6 m with and average rate of shoreline change of -4.8 m/yr. East Timbalier Island had an average shoreline change measurement of -152.9 m for an average rate of shoreline change of -17.2 m/yr.

Previous work by McBride and others (1992) for the Timbalier Islands documented a long-term (1887- 1988) gulfside change rate of -15.2 m/yr and a short-term (1978-1988) gulfside change rate of -14.0 m/yr (Table 2). Between 1887 and 1996, the average rate of

gulfside shoreline change for the Timbalier barrier island arc was -9.9 m/yr. Comparing 1988 and 1996 for the new short-term gulfside change rates, the amount of gulfside shoreline change ranged between +100 m and -480 m with an average of -93.9 m with the new short-term gulfside change rate of -10.3 m/yr. Although the rates of erosion are still high, our new analysis indicates that the long-term rate of erosion has decelerated by 5.0 m/yr since 1988. The new longterm erosion rate has also decelerated from -23.1 m/yr (1887-1988) to -20.5 m/yr (1887-1996).

BAYSIDE SHORELINE CHANGES

In terms of long-term shoreline change history for the 109 year period between 1887 and 1996, the measurements of bayside shoreline change is difficult to analyze along the entire length of the Timbalier barrier island arc because of the tremendous lateral migration of the islands. The changes ranged between +2953 m at the retreating east end of East Timbalier Island and -1403 m at the east end of Timbalier Island where a large area of mangroves was lost during a freeze. The average shoreline change for the Timbalier barrier island arc shoreline was +950.8 m of landward migration at an average rate of +8.7 m/yr. For the small area that could be compared statistically at Timbalier Island, the bayside shoreline changes measured between -149 m and -1403 m with an average change of -606.4 m. The average long-term bayside rate of change at Timbalier Island was -5.6 m/yr. The bayside shoreline changes at East Timbalier Island was measured between +1590 m and +2953 m with the astounding average measurement of +2352.4 m as a result of landward island migration. The average annual bayside rate of change for this 109 year period for 6 East Timbalier Island was +21.6 m/yr.

In terms of short-term shoreline change for the 8.9 year period between 1988 and 1996, the island arc experienced less migration and more edge erosion along the bayside shoreline, probably due to the severe hurricane impact sustained in 1992 and the rock seawall along East Timbalier Island. The measurements of bayside shoreline change along the Timbalier Barrier Island arc ranged between +437 m at Timbalier Shoal to -514 m at the center of Timbalier Island with an average of -71.9 m. The bayside shoreline changes at Timbalier Island ranged between +28.3 m as the west spit migrated landward and -57.6 m in the center of the island, for an average bayside shoreline change measurement of -67.7 m. The average rate of bayside shoreline change at Timbalier Island was -7.6 m/yr.

Previous work by McBride and others (1992) for the Timbalier Islands documented a long-term (1887- 1988) bayside change rate of +11.7 m/yr and a short-term (1978-1988) bayside change rate of -7.8 m/yr (Table 3). Between 1887 and 1996 for the new long-term rate, the average rate of bayside shoreline change for the Timbalier barrier island arc was +8.7 m/yr. Comparing 1988 and 1996, the new short-term bayside change rate was -8.3 m/yr. Our new analysis indicates that the long-term landward migration has given way to short-term shoreline edge-erosion. The long-term bayside shoreline change rate for the Timbalier barrier island arc has decelerated from +11.7 m/yr (1887-1988) to +8.7 m/yr (1887-1996) which indicates an overall slowing of landward migration. The short-term bayside shoreline change rate has increased from -7.8 m/yr (1978 - 1988) to -8.3 m/yr

(1988-1996) which indicates an increase in bayside erosion.

AREA CHANGES

Area changes of the Timbalier barrier island arc have been dramatic since 1887. Between 1887 and 1996, the Timbalier barrier island arc decreased from 4125 acres to 1442 acres at a rate of -24.6 acres per year (a/yr) (Table 4). If this long-term rate of area loss continued working on the area measured in 1996, it forecasts a disappearance date of 2055. Previously in McBride and others (1992), the Timbalier island barrier arc decreased in area at a rate of -22.0 a/yr between 1887 and 1988, suggesting the long-term date of disappearance based on the 1988 island area would be 2076 (Table 5). The small increase in the longterm rate of land loss was calculated to shorten the life of the Timbalier barrier island arc by 21 years. The previous short-term rate of area loss for the Timbalier barrier island arc between 1978 and 1988 was - 176.7 a/yr, probably due to the loss of mangrove swamp by severe freezes and heavy hurricane and winter storm impacts. Between 1988 and 1996, the rate of land loss was still high but had slowed to - 46.2 a/yr. The predicted disappearance date forecast by these rates changed from 1999 to 2027, increasing the life of the barrier islands by 28 years.

At the long-term rate of -22.0 a/yr, 1.2% of the 1988 landscape was expected to disappear per year. At - 24.6 a/yr, 1.7% of the 1996 landscape was expected to disappear per year. At short-term rates of -176.7 a/yr, 9.5% of the 1988 landscape was being lost per year, and at -46.2 a/yr, 3.2% of the 1996 landscape was being lost per year.

Between 1887 and 1996, Timbalier Island decreased from 3652 acres to 1114 acres at a rate of -23.3 a/yr (Table 4). This long-term rate of area loss acting on the area of Timbalier Island in 1996 forecasts a disappearance date of 2044. Previously in McBride and others (1992), Timbalier Island decreased in area at a rate of -23.0 a/yr between 1887 and 1988, suggesting the long-term date of disappearance would be 2046 (Table 5). The very small decrease in the long-term rate of land loss was calculated to lengthen the life of Timbalier Island by 2 years. The previous short-term rate of area loss for the Timbalier Island between 1978 and 1988 was -112.9 a/yr, and had a predicted disappearance date of 2000. This high rate of land loss was probably due to heavy hurricane and winter storm impacts, a severe freeze that killed the black mangrove swamp, and partly due to the direct removal of area by the construction of canals. Between 1988 and 1996, the rate of land loss had slowed significantly to -20.9 a/yr. The predicted disappearance date calculated by these rates changed from 2000 to 2049, increasing the life of Timbalier Island by 49 years.

East Timbalier Island increased in area from 1887 until approximately 1978 when it began to experience a cumulative land loss. Previously in McBride and others (1992), the East Timbalier Island increased in area at a long-term area change rate of +1.0 a/yr between 1887 and 1988, and therefore had no predicted date of disappearance (Table 5). Between 1887 and 1996, East Timbalier Island experienced a cumulative decrease in area from 473 acres to 300 acres at a rate of -1.6 a/yr (Table 4). This long-term rate of area loss forecasted a disappearance date of 2184. The previous short-term rate of area loss for

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the barrier island arc between 1978 and 1988 was -63.5 a/yr, probably due to heavy hurricane and winter storm impacts, and partly due to the direct removal of area by the construction of canals. Between 1988 and 1996, the short-term rate of land loss slowed to -26.2 a/yr. The predicted disappearance date for East Timbalier Island calculated by these rates changed from 1997 to 2007

SUMMARY

The Timbalier barrier island arc has historically exhibited high rates of lateral and landward migration with varying rates of area loss. Longshore sediment transport and across-island overwash has kept the islands moving but generally healthy, up until the last few decades. The previous short-term data for 1978 to 1988 documented exceptionally high landloss rates that have since slowed for the short-term data documented for 1988 to 1996. The new short-term rates of land loss are still close to double the long-term average.

A comparison of the previous and new long-term shoreline change rates for the Timbalier barrier island arc show that the general trend of island migration has slowed, while the loss of land area has increased. The gulfside shoreline is not eroding as rapidly and the bayside is not prograding as quickly as previous data indicated, with a increase in rate of land loss.

For short-term changes, the short-term gulfside shoreline erosion rates of 1988-1996 have slowed since the erosion rates documented during 1978-1988, while the bayside short-term erosion rates have increased.

ACKNOWLEDGEMENTS

DISCLAIMER

This poster is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards (and stratigraphic nomenclature). Any use of trade names is for descriptive purposes only and does not imply endorsement by the USGS.

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FIGURES

Figure 1: The Timbalier barrier islands are located 120 km southwest of New Orleans.
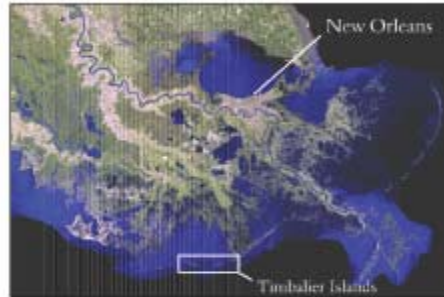
Figure 1. The Timbalier barrier island are located 120 km southeast of New Orleans.

MAPS

December 9, 1996
- LAND

Plate 3

1887 vs. January 21, 1988
- LAND
- LAND LOSS

Plate 4

January 21, 1988 vs. December 9, 1996
- LAND
- LAND LOSS

Plate 5

1887 vs. December 9, 1996
- LAND
- LAND LOSS

Plate 6

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Timbalier Islands Aerial Photographic Mosaic 1996

Timbalier Island

East Timbalier Island

Little Pass Timbalier

Plate 7

Transects
   Gulf Side ——
   Bay Side ——

Plate 8
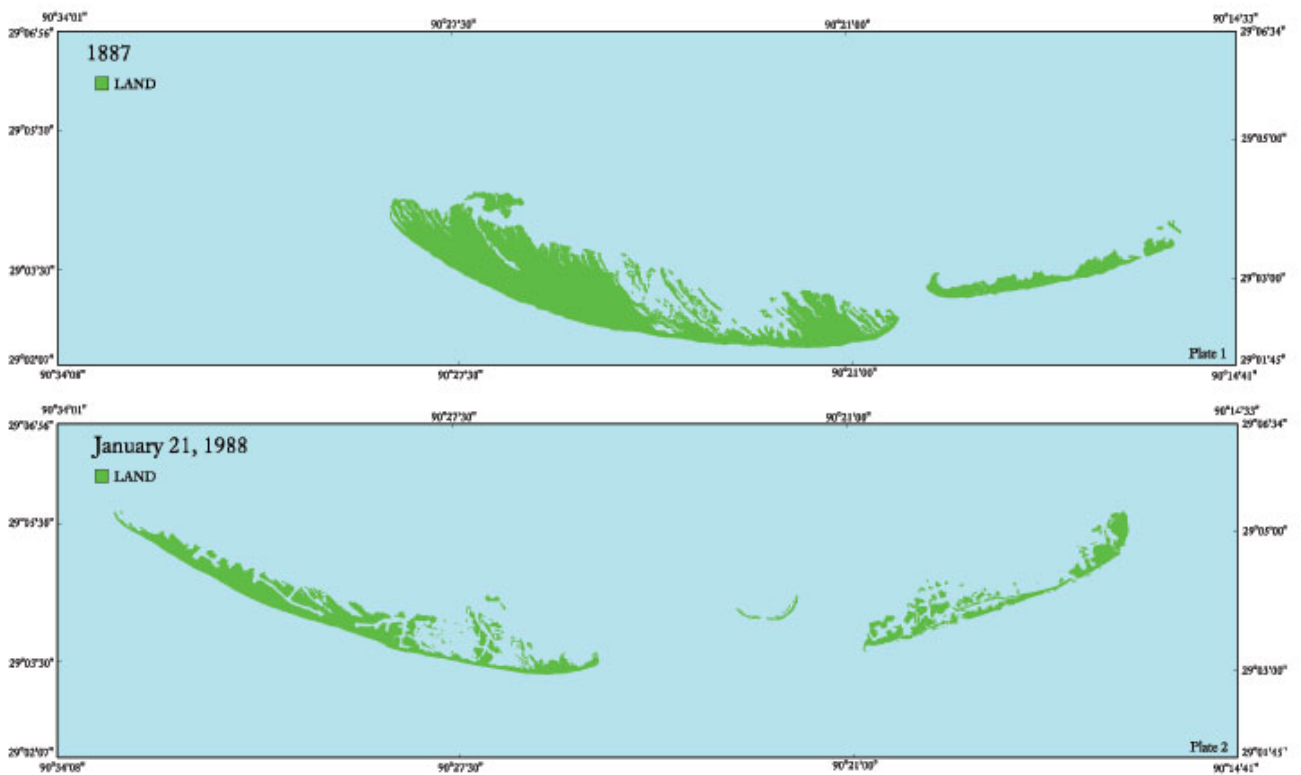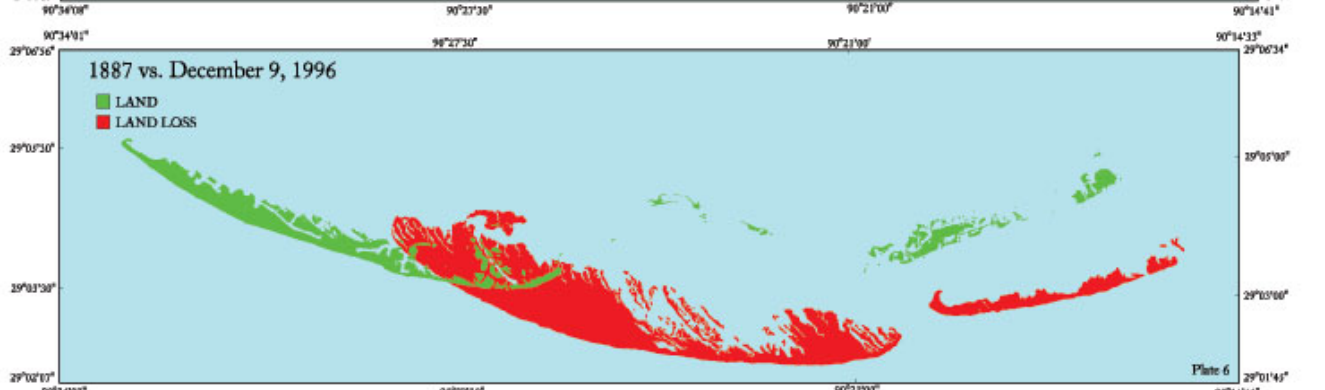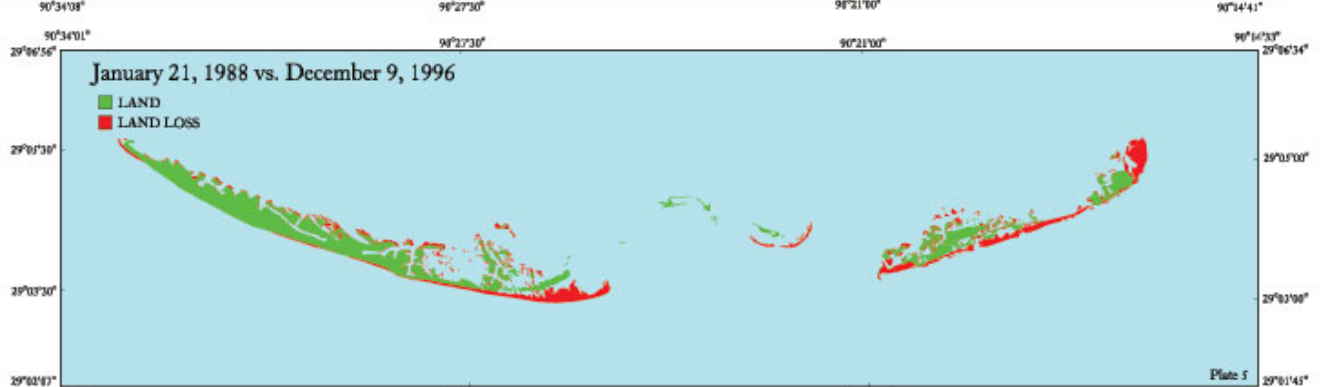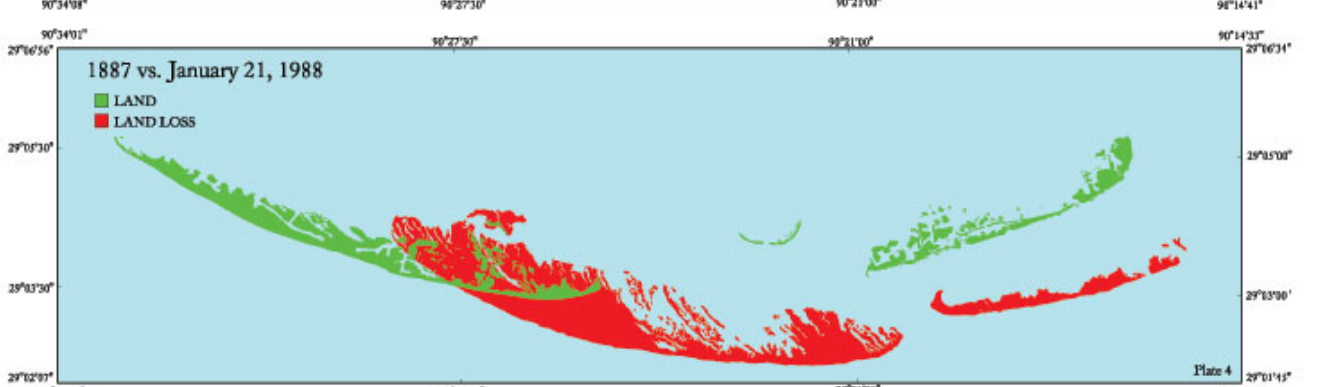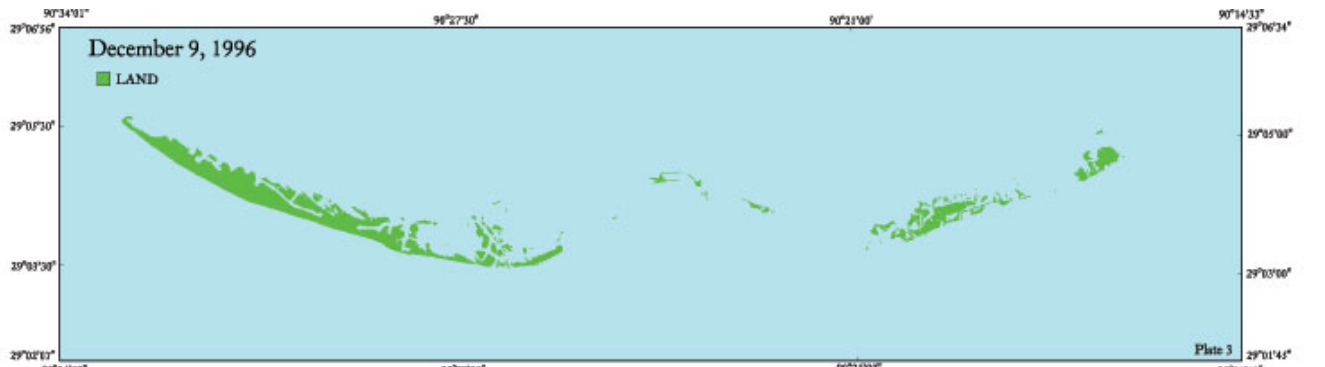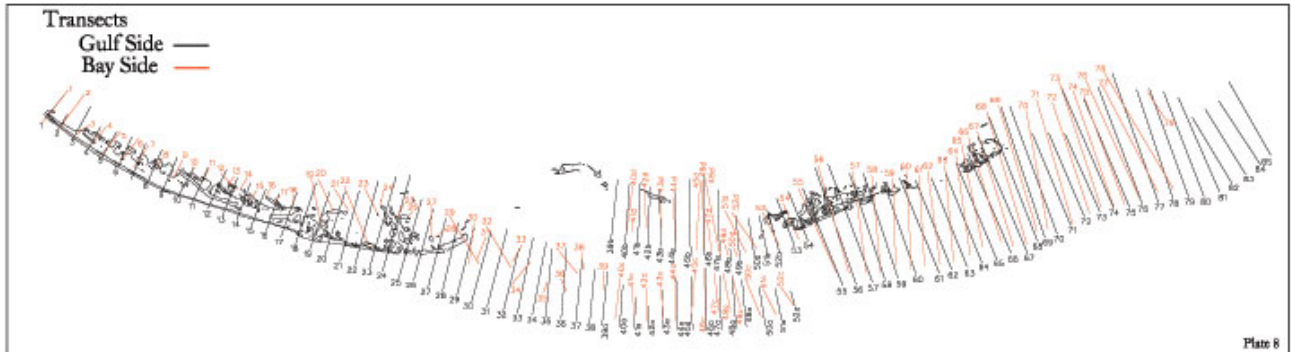
TABLES

Table 1

Timbalier Islands gulfside magnitude of change (meters)							Timbalier Islands bayside magnitude of change (meters)					
1887 - 1988		1988 - 1996		1887 - 1996			1887 - 1988		1988 - 1996		1887 - 1996	
1	na	1	-57	1	na		1	na	1	252	1	na
2	na	2	-39	2	na		2	na	2	-45	2	na
3	na	3	49	3	na		3	na	3	-35	3	na
4	na	4	58	4	na		4	na	4	-17	4	na
5	na	5	79	5	na		5	na	5	-28	5	na
6	na	6	92	6	na		6	na	6	-84	6	na
7	na	7	100	7	na		7	na	7	-42	7	na
8	na	8	86	8	na		8	na	8	-24	8	na
9	na	9	79	9	na		9	na	9	1	9	na
10	na	10	4	10	na		10	na	10	-4	10	na
11	na	11	-33	11	na		11	na	11	2	11	na
12	na	12	-27	12	na		12	na	12	0	12	na
13	na	13	-46	13	na		13	na	13	-82	13	na
14	na	14	-9	14	na		14	na	14	-76	14	na
15	na	15	5	15	na		15	na	15	-11	15	na
16	na	16	-33	16	na		16	na	16	-43	16	na
17	na	17	-53	17	na		17	na	17	-95	17	na
18	809	18	-3	18	798		18	na	18	-37	18	na
19	604	19	-20	19	588		19	-527	19	-514	19	-1046
20	404	20	-44	20	363		20	-602	20	-117	20	-722
21	202	21	-66	21	156		21	-466	21	na	21	na
22	46	22	-57	22	-5		22	-1478	22	72	22	-1403
23	-75	23	-72	23	-144		23	-695	23	2	23	-693
24	-182	24	-105	24	-281		24	-366	24	na	24	na
25	-316	25	-115	25	-435		25	-144	25	-197	25	-319
26	-459	26	-185	26	-645		26	-140	26	-32	26	-173
27	-578	27	-307	27	-889		27	-591	27	-85	27	-680
28	-652	28	-480	28	-1132		28	-197	28	-76	28	-273
29	-824	29	na	29	na		29	-514	29	364	29	-149
30	-1057	30	na	30	na		30	-364	30	na	30	na
31	-1308	31	na	31	na		31	-433	31	na	31	na
32	na	32	na	32	na		32	-490	32	na	32	na
33	na	33	na	33	na		33	na	33	na	33	na
34	na	34	na	34	na		34	na	34	na	34	na
35	na	35	na	35	na		35	na	35	na	35	na
36	na	36	na	36	na		36	na	36	na	36	na
37	na	37	na	37	na		37	na	37	na	37	na
38	na	38	na	38	na		38	na	38	na	38	na
39a	na	39a	na	39a	na		39a	na	39a	na	39a	na
39b	na	39b	na	39b	na		39b	na	39b	na	39b	na

40a	na	40a	na	40a	na	40a	na	40a	na	40a	na
40b	na	40b	na	40b	na	40b	na	40b	na	40b	na
41a	na	41a	na	41a	na	41a	na	41a	na	41a	na
41b	na	41b	na	41b	na	41b	na	41b	na	41b	na
42a	na	42a	na	42a	na	42a	na	42a	na	42a	na
42b	na	42b	-352	42b	na	42b	na	42b	437	42b	na
43a	na	43a	na	43a	na	43a	na	43a	na	43a	na
43b	na	43b	-401	43b	na	43b	na	43b	359	43b	na
44a	na	44a	na	44a	na	44a	na	44a	na	44a	na
44b	na	44b	na	44b	na	44b	na	44b	na	44b	na
45a	na	45a	na	45a	na	45a	na	45a	na	45a	na
45b	na	45b	na	45b	na	45b	na	45b	na	45b	na
46a	na	46a	na	46a	na	46a	na	46a	na	46a	na
46b	na	46b	na	46b	na	46b	na	46b	na	46b	na
47a	na	47a	na	47a	na	47a	na	47a	na	47a	na
47b	na	47b	na	47b	na	47b	na	47b	na	47b	na
48a	na	48a	na	48a	na	48a	na	48a	na	48a	na
48b	na	48b	na	48b	na	48b	na	48b	na	48b	na
49a	na	49a	na	49a	na	49a	na	49a	na	49a	na
49b	na	49b	na	49b	na	49b	na	49b	na	49b	na
50a	na	50a	na	50a	na	50a	na	50a	na	50a	na
50b	na	50b	na	50b	na	50b	na	50b	na	50b	na
51a	na	51a	na	51a	na	51a	na	51a	na	51a	na
51b	na	51b	-148	51b	na	51b	na	51b	-148	51b	na
52a	na	52a	na	52a	na	52a	na	52a	na	52a	na
52b	na	52b	-133	52b	na	52b	na	52b	-133	52b	na
53	na	53	-183	53	na	53	na	53	-183	53	na
54	na	54	-54	54	na	54	na	54	-54	54	na
55	-1647	55	-15	55	-1657	55	1768	55	-15	55	1590
56	-1826	56	-152	56	-1976	56	2239	56	-152	56	2328
57	-1850	57	-154	57	-1999	57	2092	57	-154	57	2325
58	-1883	58	-465	58	-2346	58	2210	58	-465	58	2208
59	-1949	59	-242	59	-2186	59	1954	59	-242	59	1936
60	-2017	60	-245	60	-2262	60	2400	60	-245	60	2241
61	-2159	61	na	61	na	61	2056	61	na	61	na
62	-2207	62	na	62	na	62	2101	62	na	62	na
63	-2256	63	na	63	na	63	2130	63	na	63	na
64	-2354	64	na	64	na	64	2164	64	na	64	na
65	-2450	65	na	65	na	65	2402	65	na	65	2386
66	-2384	66	-59	66	-2440	66	2749	66	-59	66	2718
67	-2440	67	-73	67	-2511	67	3021	67	-73	67	2839
68	-2621	68	-65	68	-2685	68	2998	68	-65	68	2953
69	-2879	69	na	69	na	69	3302	69	na	69	na
70	-3368	70	na	70	na	70	na	70	na	70	na
71	na	71	na	71	na	71	na	71	na	71	na

Table 2: Average Gulfside Erosion Rates for the Timbalier Islands: 1887 - 1996

Years	Average Gulfside Erosion Rates (m/yr)		
	Timbalier Island	East Timbalier Island	Timbalier Barrier Island Arc
Previous Analysis[1] 1978 - 1988 (short-term)	-7.0	-21.2	-14.0
1887 - 1988 (long-term)	-2.4	-23.1	-15.2
New Analysis[2] 1988 - 1996 (short-term)	-4.8	-17.2	-10.3
1887 - 1996 (long-term)	-1.4	-20.5	-9.9

[1] McBride and others (1992)
[2] This USGS Open-File Report

Table 3: Average Bayside Erosion Rates for the Timbalier Islands: 1887 - 1996

Years	Average Bayside Erosion Rates (m/yr)		
	Timbalier Island	East Timbalier Island	Timbalier Barrier Island Arc
Previous Analysis[1] 1978 - 1988 (short-term)	-14.1	-1.2	-7.8
1887 - 1988 (long-term)	-5.0	+24.0	+11.7
New Analysis[2] 1988 - 1996 (short-term)	-4.0	-5.5	-2.0
1887 - 1996 (long-term)	-5.6	+21.6	+8.7

[1] McBride and others (1992)
[2] This USGS Open-File Report

Table 4: The Timbalier Islands Area Measurements by Island (acres)

	Previous[1]			Update[2]
	1887	1978	Jan 1988	Dec 1996
Timbalier Island	3667	2468	1339	1114
Timbalier Shoal	na	na	20	28
East Timbalier Island	477	1223	568	300
Total	4143	3691	1927	1442

[1] McBride and others (1992)
[2] This USGS Open-File Report

Table 5: Timbalier Island Area Change Rate and Predicted Disappearance Dates: 1887 – 1996[1]

	Long-Term Rate		Short-Term Rate		Previous Long-Term DD[5]	Previous Short-Term DD[6]	New Long-Term DD[3]	New Short-Term DD[4]
	Previous 1884 - 1988[2]	New 1884 - 1996	Previous 1973 - 1988[2]	New 1988 - 1996				
Timbalier (west) Island	-23	-23.4	-112.9	-25.3	2046	2000	2044	2040
East Timbalier Island	+1.0	-1.6	-63.5	-30.1	na[7]	1997	2184	2006
Timbalier Islands (total)	-22	-24.8	-176.7	-54.5	2076	1999	2054	2022

[1] Area Change Rate in acres per year (a/y)
[2] Data Converted from hectares to acres from McBride and others (1992)
[3] New long-term disappearance date: 1887 - 1996 [109 yrs]
[4] New short-term area change date: 1988 - 1996 [8.9 yrs]
[5] Previous long-term disappearance date: 1887 - 1988 (McBride and others, 1992)
[6] Previous short-term disappearance date: 1978 - 1988 (McBride and others, 1992)
[7] Not Applicable because of increase in area