HISTORIC SHORELINE CHANGES IN TEXAS

Prepared by

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ABSTRACT

The Texas coastal zone has come under more intensive investigation as coastal areas increasingly become valuable to private landowners, industrial concerns, and government agencies. Although research is in process, coastal changes have not been identified in many areas. The net changes in mean low water (MLW) position at 226 points on the Texas coast have been examined using both the earliest and newer official topographic surveys. Shoreline changes at selected points have been examined in greater detail to suggest uses and limitations of the net MLW change information.

BACKGROUND

In response to a variety of legal problems concerning the Texas coastline, the National Ocean Survey (NOS) of the National Oceanic and Atmospheric Administration spearheaded a project[1] to describe mean low water (MLW) locations in Texas as close in time as possible to the 1845 date that the state entered the Union. To accomplish this, NOS compiled the earliest available series of topographic surveys. Original plane table stations, early coordinate systems, and major coastline features were used to convert the surveys to the Texas South- and South Central Zone-coordinate systems. In addition, the shoreline indicated on early topographic sheets was adjusted to MLW for the 1927 North American Datum using hydrographic sheets.

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[1] PH 6807, National Ocean Survey, 1968.

With these data, the National Ocean Survey, the Bureau of Land Management, the U.S. Department of Justice, and the State of Texas jointly chose 226 turning points to define as accurately as possible the 1845 mean low water line of Texas. To facilitate use of the early shoreline position, the NOS transferred the official 226 turning points to current topographic sheets. All work was done on a 1:20,000 scale.

MEASUREMENT

These topographic sheets, showing both the early turning points and the recent shoreline positions, were used along with recent charts to determine net changes in mean low water positions. The distance between the recent approximate MLW and the early shoreline was determined by drawing a line perpendicular to the recent shoreline through the corresponding turning point and measuring the scaled distance to the nearest 10 feet. For the time interval examined, positive values of the distance measured reflect net MLW advance; negative values reflect net retreat.

PRESENTATION OF DATA

Appendix A gives the following information on the 226 turning points: (a) turning point number, (b) dates of the early and recent surveys, (c) coordinates on the Texas Coordinate System for the official early point, and (d) net rate of changes for the two dates. The net rate of change was determined by dividing the overall shoreline change by the number of years (67-year minimum; 116-year maximum) to put overall net change on a common time base for comparison. For simplicity, these "annual change rates" representing overall net change were classified into seven categories:

Category		
I	More than +24 feet/year	Extreme Advance
II	+24 to +15 feet/year	High Advance
III	+14 to +5 feet/year	Advance
IV	+4 to -5 feet/year	Small Change
V	-6 to -15 feet/year	Recession
VI	-16 to -25 feet/year	High Recession
VII	More than -25 feet/year	Extreme Recession

The general rate of change at each point is indicated on Figure 1. Specific values are presented in Appendix A.

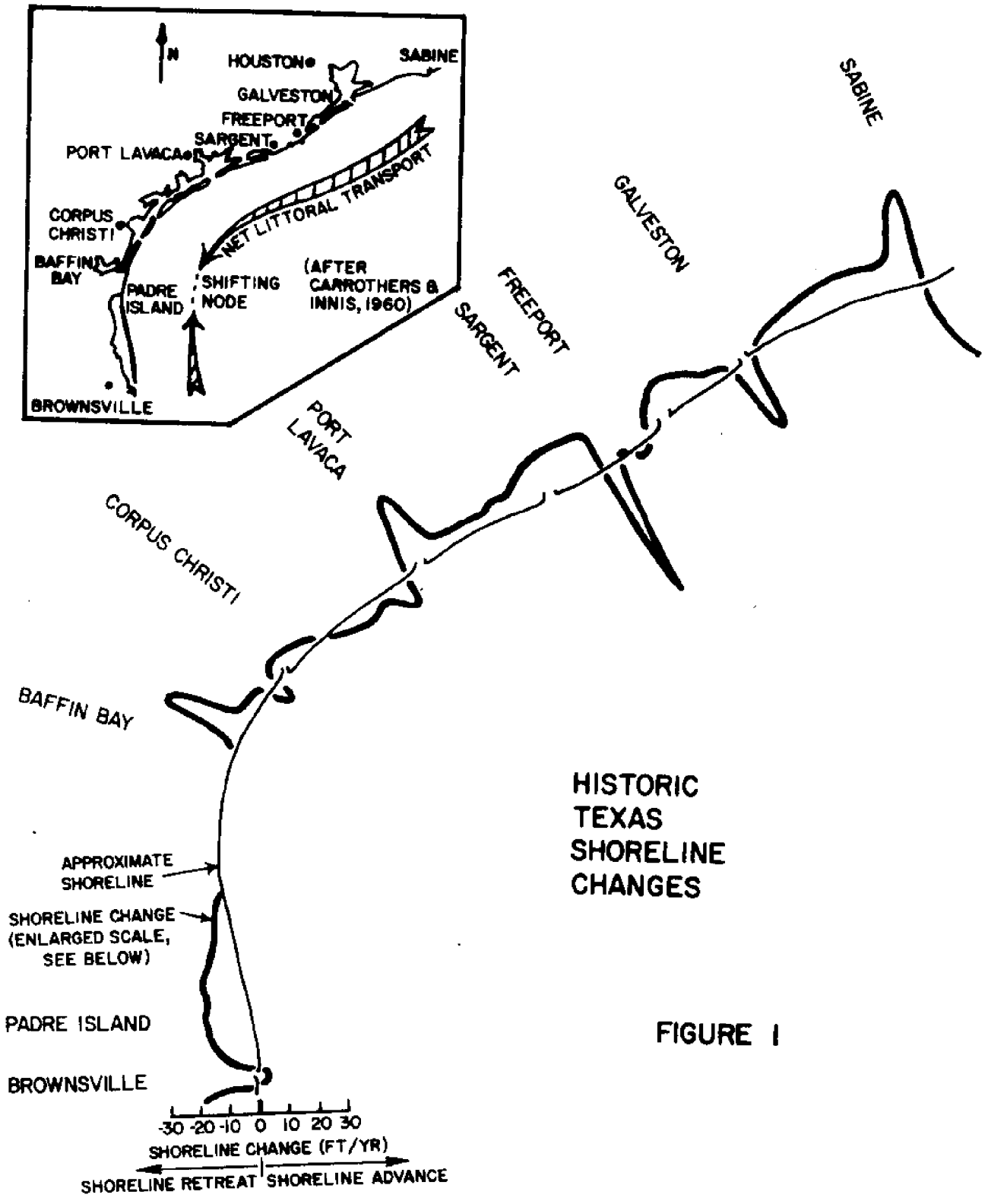
The distribution of mean low water change at 226 points (Figure 2) is centered around the "Small Change" category (50% of total), with more points of recession (40%) than of advance (10%). Note that this distribution is biased toward curved sections of the coast (i.e., Galveston; portions of Padre Island; Sabine Pass) because more turning points per linear unit of coastline were used to define these areas than for straighter coastal sections (i.e., the coast adjacent to Sargent).

USES AND LIMITATIONS OF DATA

Several points on the Texas coast were examined in greater detail to explore the usefulness and reliability of shoreline position data.

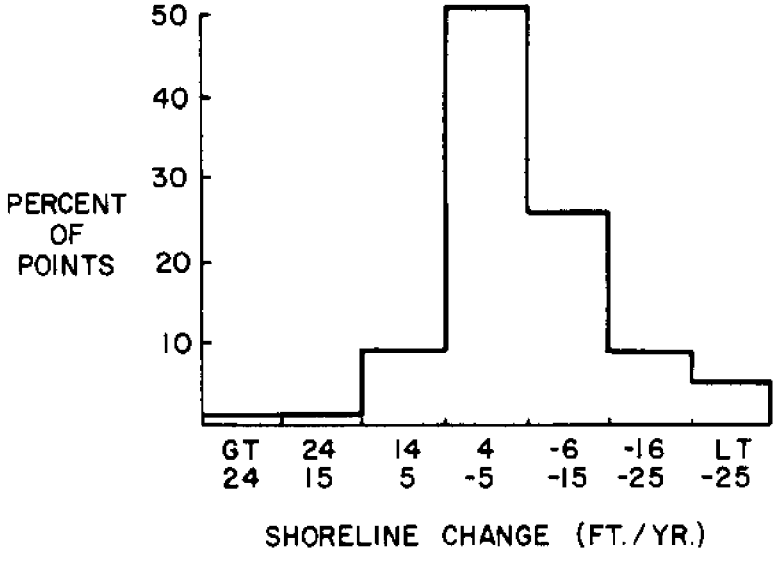
At Sargent (Point 134) the measured net recession rate (-13 feet/year, or a change of -1,220 feet from 1853 to 1946) was analogous to the recession rate determined by measuring mean high water (MHW) on aerial photographs from 1930 to 1970.[2] Rates estimated from photos vary from -10 to -50

[2]Seelig, 1973.



HISTORIC TEXAS SHORELINE CHANGES

FIGURE 1



FREQUENCY OF SHORELINE CHANGES FOR 226 POINTS ON THE TEXAS COAST

FIGURE 2

feet/year. Corps of Engineers surveys lasting from May 1967 through September 1972 indicate a mean sea level (MSL) retreat of -34 feet/year and that the shapes of profiles are approximately the same for the inshore zone.[3] Retention of profile shape implies that mean low water, mean sea level and mean high water rate determinations reflect a similar overall change.

At Follets Island (Point 153) the measured change (-9 feet/year from 1842 to 1962) also indicates recession[4]; however, recent MHW measurements show that 90% of this recession occurred from 1942 to 1962 at a minimum rate of -35 feet/year.

The misleading nature of net change measurements for time periods on the order of 100 years is illustrated by a point on the Old Brazos Delta west of the Freeport Jetties (Point 145). For the 1882-1962 interval, the net change is -3 feet/year. During that interval, however, a large delta was created and destroyed, which resulted in some of the highest rates of shoreline change in Texas: +50 to -250 feet/year.[5]

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[3]Corps of Engineers, Galveston District, 1972.

[4]Seelig, 1973.

[5]Carothers and Innis, 1960.

Comparisons of overall net change rates at other locations are shown below:

Location	Point	Rates of Change (ft/yr) 1800's to 1900's (MLW)	Rates of Change (ft/yr) 1967 to 1972[6] (MSL)
High Island	190	-7	-8
San Luis Pass	157	-3	-67
Panther Point	93	-12	4
Yarborough mid point	50	0	5
Willacy County Line	24	-14	-16

Another limitation of the data presented in this paper is that rates of change are based on nonuniform time intervals.

GENERAL SHORELINE PROCESSES

Carothers and Innis[7] suggest that predominant littoral transport (Figure 1) in conjunction with hurricane forces may upset what they call the "dynamic balance" of an area. Their theory is substantiated by these findings because the two major areas of shoreline retreat, Sargent (from the San Bernard River to Brown Cedar Cut) and Southern Padre Island, are both in zones of high littoral drift, while the stable shoreline adjacent to Baffin Bay is found at a node between drift patterns. Sand is apparently carried from the south and northeast coasts of Texas into this stable region, but rather than producing shoreline advance, winds appear to be carrying the

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[6]Corps of Engineers, Galveston District, 1972.

[7]Carothers and Innis, 1960.

beach sand back into the neighboring bays.[8] Other factors affecting the shoreline in local areas are sediment input and man-made changes.[9] In addition, studies of tide records suggest that sections of Texas are sinking in relation to the local sea level.[10] For example, Galveston sank more than a foot between 1909 and 1971, and Freeport is presently sinking at the rate of almost one-half inch per year. If such conditions persisted for time periods on the order of 100 years, significant changes in shoreline position could be expected on the relatively flat Texas beaches.

CONCLUSIONS

Net mean low water (MLW) position changes for 226 points on the Texas coast may be useful in determining overall changes. They may not, however, reflect recent or gross rates of change. It is suggested that data presented be used as an indication of approximate values only, and that additional sources of information (i.e., National Ocean Survey topographic and hydrographic sheets; U.S. Geological Survey maps; photographs provided by many organizations such as NASA; and Corps of Engineers surveys) be investigated if more precise values are required. Data presented here indicate that the landward limit of Texas, as defined by MLW, has retreated during the past century due to various apparently complex processes.

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[8]Conclusion reached on basis of 1973 NASA photographs in conjunction with 1968 National Ocean Survey files.

[9]Seelig, 1973.

[10]Hicks (1972 and 1973 personal communication) and Swanson and Thurlow (1972), all of National Ocean Survey, Rockville, Md.

ACKNOWLEDGMENTS

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APPENDIX A

NET RATES OF TEXAS SHORELINE CHANGE

Turning Point Number	Dates		** Location of Early Point Texas Coordinate System		Rate of Shoreline Change (ft/yr)*
	Early	Recent	x	y	
			South	Zone	
1	1854	1948	2447717	104830	- 18
2	1854	1948	2446349	107158	- 5
3	1854	1948	2445434	109057	+ 3
4	1854	1948	2444827	111262	+ 8
5	1854	1948	2444457	113388	+ 7
6	1854	1948	2443661	121256	+ 2
7	1854	1948	2443356	122484	+ 3
8	1854	1948-50	2443012	123854	+ 5
9	1854	1948-50	2442975	125671	+ 3
10	1854	1948-50	2442354	134247	+ 2
11	1854	1948-50	2442471	140407	- 2
12	1854	1948-50	2442693	143530	- 4
13	1854	1948-50	2442474	145254	0
14	1867	1948-50	2441657	150011	- 9
15	1867	1948-50	2440946	153376	- 11
16	1867	1948-50	2440490	156784	- 14
17	1867	1948-50	2438148	176509	- 15
18	1867	1948-50	2436430	189092	- 11
19	1867	1948-50	2434570	202218	- 10
20	1879-80	1948-50	2432546	213687	- 10
21	1879-80	1948-50	2430308	225810	- 11
22	1879-80	1948-50	2425720	245280	- 10
23	1879-80	1948-50	2422684	257436	- 11
24	1879-80	1948	2419092	271676	- 14
25	1879-80	1948	2414367	286793	- 7
26	1879-80	1948	2409184	303522	- 7
27	1879-80	1948-50	2398901	335277	- 10
28	1879-80	1948-50	2395915	342780	- 5
29	1879-80	1948-50	2393741	348938	- 4
30	1879-80	1948-50	2389815	360967	- 3
31	1879-80	1948-50	2385061	377541	- 5

*Plus = advance; Minus = retreat.

**Available from U.S. Geological Survey Quadrangle (7.5-minute series).

Turning Point Number	Dates		Location of Early Point Texas Coordinate System		Rate of Shoreline Change (ft/yr)*
	Early	Recent	x	y	
			South	Zone	
32	1879-81	1948-50	2384205	380784	- 6
33	1879-81	1948-50	2383273	383512	- 4
34	1879-81	1948	2379485	396996	- 3
35	1879-81	1948	2374202	419807	- 2
36	1879-81	1948	2370432	437957	0
37	1879-81	1948-50	2368469	450923	0
38	1879-81	1948-50	2367956	453584	+ 2
39	1879-81	1948-50	2367051	463714	- 1
40	1879-81	1948-50	2366540	468192	0
41	1881	1948-50	2366216	470067	+ 2
42	1881	1948-50	2365289	484760	0
43	1881	1948-50	2364914	492350	+ 2
44	1881	1948-50	2364887	498418	+ 1
45	1881	1948-50	2364738	507150	+ 3
46	1881	1948-50	2365124	516614	- 1
47	1881	1948-50	2365364	521120	0
48	1881	1948-50	2365603	524676	- 1
49	1881	1948-50	2365752	529302	- 1
50	1881	1948-50	2366824	542751	- 1
51	1881	1948-50	2367018	546327	+ 4
52	1881	1948-50	2367705	550301	0
53	1881	1948-50	2368336	556507	+ 3
54	1881	1948-50	2369110	560755	0
55	1881	1948-50	2369760	564719	- 1
56	1881	1948-50	2371976	576209	0
57	1881-82	1948	2372538	578930	- 1
58	1881-82	1948	2377261	599229	- 1
59	1881-82	1948	2382889	618608	- 2
60	1881-82	1948	2385829	628108	- 1
61	1881-82	1948	2389178	638015	0
62	1881-82	1948	2392743	647783	+ 1
63	1881-82	1948	2399225	663013	- 3
64	1881-82	1948	2406245	678967	- 1

Turning Point Number	Dates		Location of Early Point Texas Coordinate System		Rate of Shoreline Change (ft/yr)*
	Early	Recent	x	y	
			South	Zone	
65	1881-82	1948	2409904	686607	- 2
66	1881-82	1948	2415891	698927	- 9
67	1881-82	1948	2417442	700357	- 22
68	1881-82	1948	2419058	701605	- 36
69	1881-82	1948	2423245	710909	- 34
70	1881-82	1948-51	2423955	717016	- 5
71	1881-82	1948-51	2428548	706728	- 1
72	1867	1948-51	2437520	742900	- 3
73	1867	1948-51	2446447	757630	- 3
74	1867	1947-48	2457513	774821	- 2
75	1867	1947-48	2466716	788468	+ 12
76	1860-61,6	1947-48	2471092	794467	- 6
77	1860-61,6	1947-48	2473039	800004	- 4
78	1860-61,6	1948	2476073	806089	- 1
79	1860-61,6	1948	2480634	813586	0
80	1860-61,6	1948	2492343	829330	- 2
81	1860-61,6	1948	2501581	841108	0
82	1860-61,6	1948	2508434	848839	- 3
83	1860-61,6	1934	2511709	852930	+ 1
84	1860	1934	2518703	860574	0
85	1860	1934	2523416	865604	0
86	1860	1934	2529826	872343	- 1
87	1860	1934	2530424	872532	- 3
88	1860	1934	2531968	874391	- 1
89	1860	1934	2546458	888310	+ 1
90	1860	1934	2561319	901916	+ 4
91	1859	1934	2564425	904626	+ 5
92	1859	1934	2579881	917086	+ 4
93	1859	1934	2585660	921654	+ 4
94	1859	1934	2588577	924161	+ 7
95	1859	1934	2597990	931056	+ 4
96	1859	1934	2607399	937924	+ 4
97	1859	1934	2616946	944411	+ 5

Turning Point Number	Dates		Location of Early Point Texas Coordinate System		Rate of Shoreline Change (ft/yr)*
	Early	Recent	x	y	
			South Central Zone		
98	1859	1934	2785963	165112	0
99	1859	1934	2796421	171787	+ 8
100	1859	1934	2805938	177142	+ 13
101	1859	1946	2814814	181455	+ 7
102	1859	1946	2819460	183253	0
103	1857	1946	2824449	185281	- 8
104	1857	1946	2831301	187917	- 8
105	1857	1946	2833368	188226	- 18
106	1857	1946	2834725	189145	- 21
107	1857	1946	2835314	189986	- 20
108	1857	1946	2837368	193679	- 12
109	1857	1946	2837642	194614	- 10
110	1857	1946	2843740	204903	- 49
111	1856	1946	2847047	213969	- 24
112	1856	1946	2849794	215738	- 18
113	1856	1946	2851643	217335	- 15
114	1856	1946	2854399	220297	- 8
115	1856	1946	2863697	228480	- 2
116	1856	1946	286747	230194	- 1
117	1856	1946	2877417	238678	0
118	1856	1946	2883477	242568	- 1
119	1856	1946	2899327	252451	- 7
120	1857	1946	2909286	258409	- 4
121	1857	1946	2924510	267105	- 2
122	1857	1946	2936362	273389	- 6
123	1857	1946	2955338	282788	- 5
124	1857	1946	2964991	287167	- 8
125	1857	1946	2975057	292034	- 4
126	1855-57	1946	2979602	294204	- 3
127	1855-57	1933	2983797	296051	- 5
128	1855-57	1933	3002687	305149	- 6
129	1855-57	1933	3022018	315410	- 6
130	1855-57	1933	3032622	321278	- 7

Turning Point Number	Dates		Location of Early Point Texas Coordinate System		Rate of Shoreline Change (ft/yr)*
	Early	Recent	x	y	
			South Central Zone		
131	1855-57	1933	3050575	332143	- 9
132	1856	1946-47	3055053	335097	- 11
133	1856	1946-47	3063896	340470	- 15
134	1853	1946-47	3082018	351668	- 13
135	1853	1946	3099968	362901	- 11
136	1853	1946	3122098	377410	- 13
137	1853	1946	3128083	381662	- 12
138	1853	1946	3138717	388622	- 12
139	1853	1946	3140375	389966	- 12
140	1853	1962	3147981	394907	+ 11
141	1853	1962	3153906	398878	+ 55
142	1853	1962	3164899	406885	+ 25
143	1853	1962	3172115	411842	+ 16
144	1852	1962	3180773	417531	+ 4
145	1852	1962	3182950	418115	- 3
146	1852	1962	3183794	418677	- 2
147	1852	1962	3184637	420411	+ 5
148	1852	1962	3185849	422824	+ 7
149	1852	1962	3187794	425139	+ 5
150	1852	1962	3190919	428310	+ 2
151	1852	1962	3204169	440456	- 6
152	1852	1962	3223304	456811	- 5
153	1852	1962	3229733	461963	- 9
154	1852	1962	3238975	468453	- 11
155	1852	1962	3239802	468683	- 18
156	1852	1962	3240126	469071	- 19
157	1852	1962	3241537	476036	- 3
158	1852	1962	3243592	478024	- 1
159	1852	1962	3247831	482390	- 3
160	1852	1962	3253890	487767	- 3
161	1852	1962	326	494817	- 3
162	1852	1962	3268981	499877	- 3
163	1851	1962	3282423	510160	- 1

Turning Point Number	Dates		Location of Early Point Texas Coordinate System		Rate of Shoreline Change (ft/yr)*
	Early	Recent	x	y	
			South Central Zone		
164	1851	1962	3289223	515123	0
165	1851	1962	3298012	521219	- 1
166	1851	1962	3315417	530934	- 11
167	1851	1966	3318015	354280	- 10
168	1851	1966	3333261	546181	- 3
169	1850	1966	3341062	552000	- 4
170	1850	1966	3344451	554830	- 5
171	1850	1966	3347926	558190	- 7
172	1850	1966	3348733	559391	- 3
173	1850	1966	3349533	561270	+ 5
174	1850	1966	3350290	563601	+ 16
175	1850	1966	3350722	566851	+ 36
176	1850	1966	?	?	~ 0
177	1850	1966	3351002	581333	0
178	1850	1966	3351675	581823	0
179	1850	1966	?	?	~ 0
180	1851	1962	3357627	587588	+ 23
181	1851	1962	3364594	595059	+ 6
182	1851	1962	3368328	598683	+ 2
183	1851	1962	3372873	602620	0
184	1851	1962	3377851	606321	- 1
185	1851	1962	3384508	610742	- 1
186	1851	1962	3394406	616701	- 1
187	1851	1962	3403999	621974	- 2
188	1851	1962	3423591	631654	- 3
189	1851	1962	3443267	640994	- 5
190	1882	1962	3457115	647690	- 7
191	1882	1963	3474153	655599	- 5
192	1882	1963	3489524	662853	- 8
193	1882	1963	3506393	671135	- 8
194	1882	1963	3530811	682981	- 10
195	1882	1963	3547420	691372	- 9
196	1882	1963	3560576	697746	- 3

Turning Point Number	Dates		Location of Early Point Texas Coordinate System		Rate of Shoreline Change (ft/yr)*
	Early	Recent	x	y	
			South Central Zone		
197	1882	1963	3562396	698348	- 5
198	1882	1963	3564669	698869	- 10
199	1882	1963	3568239	700283	- 8
200	1882	1963	3570700	700751	- 12
201	1882	1963	3572042	701172	- 13
202	1882	1963	3576173	702024	- 18
203	1882	1963	3577024	702364	- 16
204	1882	1963	3578094	702328	- 20
205	1882	1963	3580917	703197	- 17
206	1882	1963	3582426	703221	- 21
207	1882	1963	3583787	702763	- 30
208	1882	1963	3584843	702636	- 34
209	1882	1963	3585544	702363	- 39
210	1882	1963	3587625	702634	- 40
211	1882	1963	3588465	702397	- 44
212	1882	1963	3593052	704343	- 26
213	1882	1963	3597609	703689	- 35
214	1882	1963	3598298	703082	- 42
215	1882	1963	3600601	704132	- 28
216	1882	1963	3604769	704726	- 20
217	1882	1963	3609435	704625	- 19
218	1882	1963	3611875	704963	- 13
219	1882	1963	3616758	704337	- 17
220	1874	1963	3621054	704433	- 8
221	1874	1957	3627884	704530	+ 2
222	1874	1957	3630347	704739	+ 3
223	1874	1957	3632410	705598	+ 7
224	1874	1957	3633670	706473	+ 11
225	1874	1957	3634811	708019	+ 20
226	1874	1957	3640285	716400	+ 30