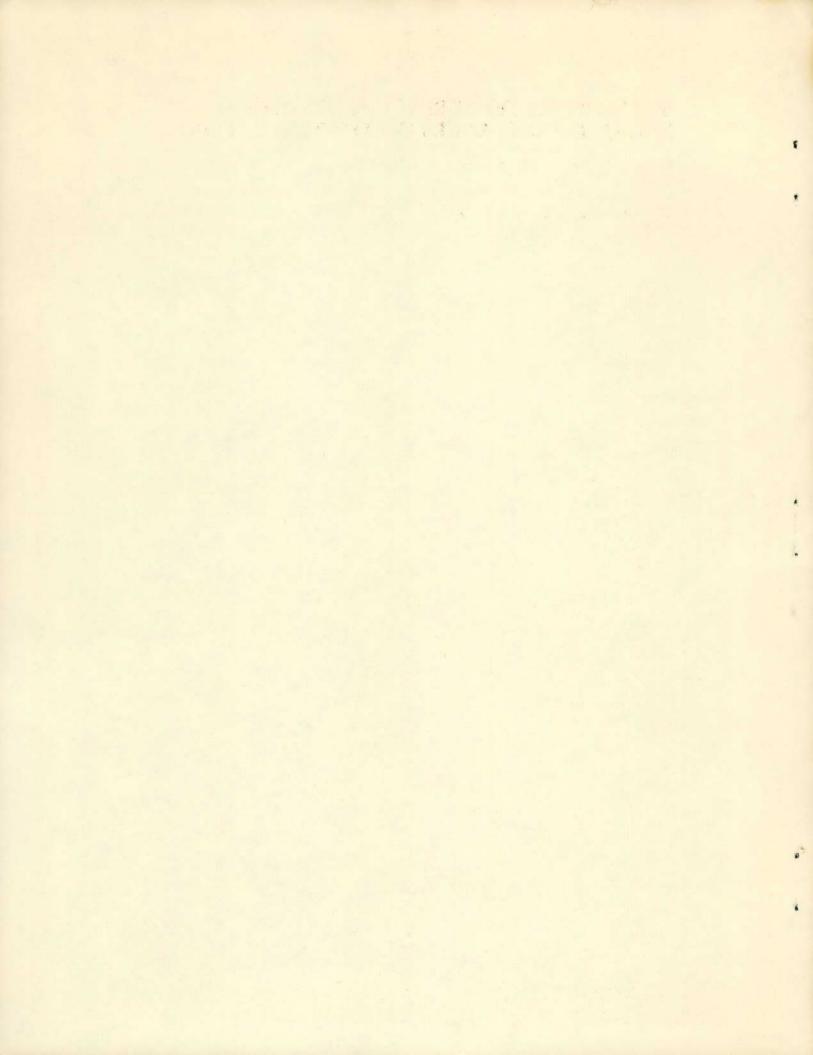# SHALLOW-WATER SURFACE AREAS AND
SHORELINE DISTANCES ON THE TEXAS COAST

by Gary C. Matlock and Maury F. Osborn (Ferguson)

Management Data Series, Number 37
1982

Texas Parks & Wildlife
Coastal Fisheries Branch

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ACKNOWLEDGEMENTS

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ABSTRACT

The surface area of Texas bays covered by water ≤ 1.2 m (4 feet), (≤ 1.8 m in Corpus Christi Bay system), deep was 243,000 ha (601,000 acres). Almost 25% of the area was in the lower Laguna Madre. The Galveston and Matagorda Bay systems each had about 40,000 ha (99,000 acres) of water ≤ 1.2 m deep. About 23,000 ha (57,000 acres) of ≤ 1.2 m deep water was in the San Antonio Bay, Aransas Bay and upper Laguna Madre systems. East Matagorda had about 15,000 ha (37,000 acres) ≤ 1.2 m deep and Corpus Christi had about 13,000 ha (32,000 acres) of water ≤ 1.8 m deep.

The distance of shoreline in Texas was 3798.1 km (2361.3 mi) including 585.6 km (365.1 mi) of Gulf beaches. Galveston Bay system had the longest shoreline of 661.7 km (411.2 mi) followed by Matagorda with 458.3 km (284.8 mi), Aransas with 424.1 km (263.5 mi) and the lower Laguna Madre with 405.7 km (252.1 mi). San Antonio and upper Laguna Madre Bay systems each had about 360 km (224 mi) of shoreline while Corpus Christi Bay system had 275.7 km (171.3 mi) of shoreline. Sabine Lake, East Matagorda Bay and Cedar Lakes each had less than 125 km (78 mi) of shoreline.

INTRODUCTION

The Coastal Fisheries Branch of the Texas Parks and Wildlife Department uses various sampling techniques to measure relative abundance of adult and juvenile fish in the shoreline areas of Texas bays. Trammel nets have been used intermittently since 1960 to obtain catch per area samples of adult fish, bag seines have been used since 1975 for catch per area samples of juvenile fish and gill nets have been used since 1975 to obtain catch per hour samples of adult fish. To calculate average coast-wide catch rates from these samples a factor of area, volume or shoreline distance is required to weight bay system means. Total surface areas have been published in Diener (1975) however, shoreline distances by bay and surface areas of shallow shoreline waters where samples have been collected have not been published. The purpose of this report was to provide estimates by bay system of the surface area covered by water ≤ 1.2 m and shoreline distances.

MATERIALS AND METHODS

The shallow-water (≤ 1.2 m) surface area of Galveston, East Matagorda, Matagorda, San Antonio, Aransas and upper and lower Laguna Madre Bay systems was determined. In the Corpus Christi Bay system shallow water surface area ≤ 1.8 m was determined. The physical boundaries of each system were as follows:

1. Galveston Bay system: That area bounded by a line extending from the point of junction of the Intracostal Waterway and East Bay Bayou along the shoreline to Drum Point in the southwest end of Drum Bay along Follets and Galveston Islands to and along Bolivar Peninsula to the mouth of East Bay Bayou.

2. East Matagorda Bay system: That area bounded by Caney Creek at the northeast end and the Colorado River at the southwest end.

3. Matagorda Bay system: That area bounded by a line extending along the shoreline from the point of junction of the Colorado River and the Intracoastal Waterway to the west end of the jetty at Port O'Connor and due south to the north end of Matagorda Island and northeast to Decros Point along the shoreline of Matagorda Peninsula to the south end of the Colorado River and along the Colorado River to the Intracoastal Waterway.

4. San Antonio Bay system: That area bounded by a line extending along the shoreline from the west end of the jetty at Port O'Connor to the northeast end of Rattlesnake Island to the northeast end of Ayres Island, along Ayres Reef

and east to Matagorda Island and along the shoreline
to Pass Cavallo and due north to the west end of the
jetty at Port O'Connor.

5. Aransas Bay system: That area bounded by a line extending
along the shoreline from the northeast end of Sundown Bay
to the point of junction of the Intracoastal Waterway and
Aransas Channel, along Aransas Channel to San Jose Island
and along San Jose Island to the bay opening of Cedar Bayou
to and along the shoreline of Matagorda Island to Ayres
Dugout and along Ayres Reef to the northeast end of Ayres
Island to the northeast end of Sundown Bay.

6. Corpus Christi Bay system: That area bounded by a line
extending along the shoreline from the point of junction
of the Intracaostal Waterway and Aransas Channel to the
east end of Demit Island due east to Intracoastal Waterway
Marker 3 to the bay opening of the Water Exchange Channel
and along Mustang Island to the point of junction of Corpus
Christi and Aransas channels to the point of junction of
the Intracoastal Waterway and Aransas Channel.

7. Upper Laguna Madre system: That area bounded by a line
extending along the shoreline from the east end of Demit
Island to Rincon de San Jose due south to Padre Island
and along the shoreline to the Water Exchange Channel then
to Intracoastal Waterway Marker 3 and west to Demit Island.

8. Lower Laguna Madre system: That area extending from Rincon
de San Jose to the south end of South Bay.

Nautical charts of the National Oceanic and Atmospheric Charts were
used to estimate the surface area of water <1.2 m deep in all bays except
Nueces Bay; specific charts used are listed in Table 1. For Nueces Bay,
a Texas Game and Fish Commission map (scale: 1 inch = 2000 feet) prepared
18 August 1958 located in the Texas Parks and Wildlife Department's library
at Rockport, Texas (map case – pocket 14, folder 2) was used. Isopleths
were drawn on each map except for Corpus Christi by connecting all 1.2 m
(4 feet) depths that formed a boundary with higher depths. On the Corpus
Christi map isopleths were drawn connecting all 1.8 m (6 feet) depths
which was the shallowest depth charted. A grid of clear plastic (each
square = 1 acre on a 1:40,000 scale map) was placed on the chart, and the
number of whole squares contained between the shore and the isopleth were
counted. The proportional of each square contained partially within the
specified area was calculated and added to the total square count.
Conversions were calculated when the map scale differed from the plastic
grid scale.

Shoreline distances were determined for the eight bay systems
described above and also for Sabine Lake, Cedar Lakes and the Gulf beaches.

The Physical boundaries for these additional areas were as follows:

1. Sabine Lake: That area bounded by a line extending from the Gulf opening of Sabine Pass along the shoreline to the mouth of the Nueces River to the mouth of the Sabine River and returning to the Gulf opening of Sabine Pass.

2. Cedar Lakes: That area bounded by the Gulf beaches on the eastern edge to the spoil banks along the Intracoastal Waterway along the western edge and including all of Cow Trap Lake.

3. Gulf beaches: That area extending from the western edge of Sabine Pass along the Gulf shoreline south to the northern edge of the Rio Grande River, but not including jetties and piers.

A Hamilton map measurer was used to trace the shorelines on Soundings in Feet Charts and Nautical Charts of the National Oceanic and Atmospheric Administration, and in a few areas and the Gulf beach Contour Interval Charts of the United States Geological Survey (Table 2). The shorelines along the mainland, the bay sides of the barrier islands and islands larger than 0.65 km^2 (0.25 mi^2) were traced three times in each bay system. The only exception was in the lower Laguna Madre where the bay side of Padre Island was traced as a straight line due to extremely shallow water along that shore. The entire length of the Gulf beaches from Sabine Pass to the Rio Grande River was traced three times without tracing pass openings or jetties. Inches measured were multiplied by the scale of the map traced and the product divided by a factor of 63,360 inches to the statute mile. The mean and standard deviation for each bay system and the Gulf beaches were computed from the three replicates. Bay system means and standard deviations were added to obtain the total bay shoreline and total bay and Gulf shoreline.

RESULTS AND DISCUSSION

Approximately 243,000 ha (601,000 acres) of Texas' bays were ≤ 1.2 m deep (Table 3). The lower Laguna Madre alone accounted for 25% of this shallow area. Each of the Galveston and Matagorda Bay systems had over 40,000 ha covered by water ≤ 1.2 m deep; about 23,000 ha of water ≤ 1.2 m deep were in each of the San Antonio Bay, Aransas Bay and upper Laguna Madre systems. East Matagorda Bay system had over 15,000 ha of water ≤ 1.2 m deep. Corpus Christi Bay system had almost 13,000 ha of water ≤ 1.8 m deep.

In April 1972 a planimeter survey of the areas covered by water ≤ 1.2 m deep was conducted using United States Geodetic Survey Nautical Charts in the 500, 800 and 1200 series (Texas Parks and Wildlife Department, unpublished data). Approximately 80,000 ha less were present in 1977 than

in 1972 (Table 3). Most of this apparent difference was due to a large
discrepancy in the Laguna Madre. Diener (1975) reported that the total
surface area of the Laguna Madre was 113,769 ha (Table 3); that is about
71,000 ha less than the 1972 estimate for shallow water. Unfortunately,
no additional details on the methods used in 1972 were available and no
definitive conclusion can be made regarding the cause of the differences.

If the Laguna Madre data are excluded from the 1972 and 1977 coastwide
estimate, then the estimates of the area covered by water ≤ 1.2 m deep in
the 2 years are very similar (141,513 ha in 1972 and 156,457 in 1977).
These data suggest that the amount of shallow water (≤ 1.2 m) in Texas bays
actually increased slightly from 1972 to 1977 and the maps had been
changed. However, the area may have remained constant during the 5-year
period since both estimates have an unknown amount of error associated
with them.

Admittedly, the precision of the estimates could probably be improved
with the use of more sophisticated techniques (e.g. landsat maps). However,
a surface area estimate is 10 years overdue. Also, admittedly, the accuracy
of coastwide average catch rates could possibly be improved by using
accurate volume estimates instead of area as a basis for normalization.

The total distance of shoreline in Texas was 3798.1 km (2361.3 mi)
including 585.6 km (365.1 mi) of Gulf beach (Table 4). The Galveston Bay
system had 661.7 km (411.2 mi) of shoreline or 20.6% of the total bay
shoreline in Texas. All other bay systems contributed less than 15% each
to the total bay shoreline. In 1962 there were 1,740 km of beach (The
George Washington University 1962). By 1975 there were 4,025 km of shore-
line including 612 km of beach (Bureau of Land Management 1981). The
procedures used to obtain these estimates were not provided, so their
reliability cannot be evaluated. The 1975 estimate for total shoreline
falls within the 95% confidence limits of this study. If the 1962
estimate is accurate, an increase in excess of 2 fold in shoreline from
1962 to 1979 is indicated. Undoubtedly, this change is due partially to
man-made alternations such as dredging and filling (Lindall and Saloman
1977), but the impact of natural forces such as hurricanes and subsidence
cannot be ignored. The relative impacts of man and nature on increasing
shoreline cannot be determined from the available data. Additional
details on the types and amounts of available habitat within each bay
system and on temporal fluctuations are requisite to that type of analysis.

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Lindall, W. N., Jr. and C. H. Saloman. 1977. Alteration and destruction of estuaries affecting fishery resources of the Gulf of Mexico. Mar. Fish. Rev. pp. 4-5.

Table 1. List of NOAA nautical charts used to calculate surface area covered by water $\leq$1.2 m deep in each Texas bay system.

Bay system	Chart used
Galveston	NOAA Nautical Chart 11326 (June 1976) NOAA Nautical Chart 11325 (June 1976) NOAA Nautical Chart 11331 (October 1976)
East Matagorda	NOAA Nautical Chart 11319 (October 1976)
Matagorda	NOAA Nautical Chart 11318 (August 1978) NOAA Nautical Chart 11319 (October 1976)
San Antonio	NOAA Nautical Chart No. 889-SC (December 1973) NOAA Nautical Chart 11315 (February 1976)
Aransas	NOAA Nautical Chart 11314 (September 1976) NOAA Nautical Chart 11315 (February 1977)
Corpus Chrisit[a] /Nueces Bay	NOAA Nautical Chart 11309 (August 1974) Texas Game and Fish Commission Chart (August 1958)
Upper Laguna Madre	NOAA Nuatical Chart No. 11308 (August 1974)
Lower Laguna Madre	Coast and Geodetic Survey maps 896, 897, and 898 (date unknown)

[a]Water depth was $\leq$1.8 m.

Table 2. List of charts used to calculate shoreline distances in Texas.

Bay system	Chart used	Edition and date
Sabine Lake	NOAA Soundings in Feet 11342	36th Ed., Nov 22/80
Galveston West Lake to Texas City Dike and the South Jetty:	NOAA Nautical Chart 11322	8th Ed., Nov 2/72
Texas City Dike to Trinity Bay and upper Galveston Bay and North Jetty to end of East Bay:	NOAA Nautical Chart 152-SC	10th Ed., May 12/73
Cedar Lakes	NOAA Soundings in Feet 11321	20th Ed., April 19/80
East Matagorda Lake Austin and East Matagorda Bay, North of 50' long.:	NOAA Soundings in Feet 11321	20th Ed., April 19/80
East Matagorda Bay, South of 50' long.:	NOAA Soundings in Feet 11316	25th Ed., May 31/80
Matagorda	NOAA Soundings in Feet 11316	25th Ed., May 31/80
San Antonio NE 1/3 of Espiritu Santo Bay:	NOAA Soundings in Feet 11316	25th Ed., May 31/80
Hynes and Guadalupe Bays north of line from Swan Point to Mcdowell Point:	NOAA Nautical Chart 891-SC	7th Ed., Feb 2/74
Remainder of San Antonio Bay system:	NOAA Soundings in Feet 11313	14th Ed., June 9/79
Aransas	NOAA Soundings in Feet 11313	14th Ed., June 9/79
Corpus Christi Nueces Bay North of White Point:	USGS Contour Intervals NH 14-3	1966
Remainder of Nueces & Corpus Christi:	NOAA Soundings in Feet 11307	26th Ed., Aug 11/79

Table 2 (Continued).

Bay system	Chart used	Edition and date
Upper Laguna Madre From upper boundary to Point of Rocks on mainland side and south to point on Padre Island across from Pt. Penascal:	NOAA Soundings in Feet 11307	26th Ed., Aug 11/79
Baffin & Alazan Bay from Point of Rocks to Pt. Penascal:	NOAA Nautical Chart 11308	5th Ed., Aug 10/74
Southern portion of upper Laguna Madre:	NOAA Soundings in Feet 11304	9th Ed., Sept 15/79
Lower Laguna Madre Northern portion to Port Mansfield Channel:	NOAA Soundings in Feet 11304	9th Ed., Sept 15/79
Southern portion:	NOAA Soundings in Feet 11301	13th Ed., Sept 15/79
Gulf beaches	USGS Contour Intervals NH 15-8, NH 15-7 NH 15-10, NH 14-12 NH 14-3, NH 14-6	1964-1966

Table 3. Total surface area in 1975 and surface area of shallow ($\leq$1.2 m deep) water in 1972 and 1977 in each of eight Texas bay systems.

Bay system	Total area[a]		Shallow water area			
	Hectares	Acres	Hectares		Acres	
			1972	1977	1972	1977
Galveston	141,676	349,940	53,960	41,222	133,281	101,782
East Matagorda	15,308	37,810	13,013	15,590	32,142	38,521
Matagorda	98,984	244,490	30,144	42,058	74,456	103,928
San Antonio	55,158	136,240	14,939	21,774	36,899	53,800
Aransas	45,296	111,880	22,670	22,905	55,995	56,486
Corpus Christi	43,316	106,990	6,787	12,908[b]	16,764	31,874[b]
Upper Laguna Madre[c]	41,040	101,370		25,701		36,460
Lower Laguna Madre[c]	72,688	179,540		61,161		151,016
Total	513,466	1,268,260	326,035	243,319	805,306	600,867

[a] Diener 1975, mean low water.

[b] $\leq$1.8 m

[c] Combined total for the Laguna Madre was 184,522 hectares (455,769 acres) in 1972 which compares to (214,549 acres) in 1977.

Table 4.   Distance of shoreline in Texas bays and the Texas Gulf.

Bay system	Distance of shoreline			
	Miles	S.D.	Kilometers	S.D.
Sabine	75.6	2.7	121.7	4.3
Galveston	411.2	9.6	.661.7	15.4
Cedar Lakes	25.8	0.7	41.5	1.1
East Matagorda	64.4	2.8	103.6	4.5
Matagorda	284.8	14.8	458.3	23.8
San Antonio	225.2	12.2	362.4	19.6
Aransas	263.5	8.4	424.1	13.5
Corpus Christi	171.3	11.5	275.7	18.5
Upper Laguna Madre	222.3	13.5	357.7	21.7
Lower Laguna Madre	252.1	4.2	405.7	6.8
All bays	1996.2	80.4	3212.5	129.4
Gulf beaches	365.1	2.5	585.6	4.1
Total	2361.3	82.9	3798.1	133.5

PWD 3000-137
May 1982