RECREATIONAL FINFISH CATCH STATISTICS FOR TEXAS BAY SYSTEMS, SEPTEMBER 1979-AUGUST 1980

by L.W. McEachron and A.W. Green

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ABSTRACT

Weekend sport boat fishermen were surveyed in Galveston, Matagorda (including East Matagorda), San Antonio, Aransas and Corpus Christi Bays, upper Laguna Madre and lower Laguna Madre from 1 September 1979 to 31 August 1980. These fishermen expended 2,256,600 man-h to catch an estimated 1,138,000 fish (457,700 kg). Spotted seatrout (*Cynoscion nebulosus*), Atlantic croaker (*Micropogonias undulatus*) and sand seatrout (*C. arenarius*) constituted over 72% of all fish landed.

Annual catch rates for all fishes combined ranged from 0.39 to 0.55 fish/man-h in all bays except in Galveston Bay where the catch rate was 0.62 fish/man-h.

The smallest fishes landed were Atlantic croaker (0.09-0.30 kg) and sand seatrout (0.21-0.35 kg); the largest fishes were black drum (*Pogonias cromis*) (0.33-2.70 kg) and gafftopsail catfish (*Bagre marinus*) (0.93-1.43 kg).

Generally, pass and jetty sport boat fishermen in all areas had lower catch rates during the low use season (November-May)(0.12-0.63 fish/man-h) than during the high use season (May-November)(0.23-1.19 fish/man-h).

Mean high use season catch rates for Gulf of Mexico fishermen ranged from 0.13 to 0.54 fish/man-h. Catch rates were generally higher for king mackerel (*Scomberomorus cavalla*), red snapper (*Lutjanus campechanus*) and "other" fishes (0.01-0.33 fish/man-h) than for all other species. King mackerel mean weights generally declined from those in 1978 (4.18-6.87 kg) through 1980 (2.50-4.57 kg) in all areas. With the exception of red snapper, sand seatrout and "other" fishes catch rates during the low use season were generally $\leq$ 0.01 fish/man-h.

INTRODUCTION

Sampling during the third year of a 4-y project entitled "Survey of Finfish Harvest in the Texas Bays" was conducted from September 1979 through August 1980. This report presents the results of the third year's study.

The objectives of this study were:

1) To determine the total harvest of commercially important finfishes by species and method of capture in eight Texas bay systems. Commercial landings of finfish by weight (September 1979-August 1980) were reported in Hamilton (1981).

2) To determine the species, size and catch per effort of commercially important finfishes caught in bay waters by weekend sport boat fishermen.

3) To determine the species, size and catch per effort of commercially important finfishes caught in Gulf waters by sport boat fishermen.

MATERIALS AND METHODS

From September 1979 through August 1980 inventoried boat ramps were surveyed in the Galveston, Matagorda (including East Matagorda), San Antonio, Aransas, Corpus Christi, upper Laguna Madre and lower Laguna Madre Bay systems (Appendix A and B). Area descriptions for each bay (Matlock and Weaver 1979) are presented in Appendix C.

For presentation of the annual harvest and fishing pressure estimates, the project year was divided into a "low use" and "high use" season with the low use season from 21 November 1979 to 14 May 1980. The high use season was comprised of the early fall and summer (1 September-20 November 1979 and 15 May-31 August 1980). Interviews were conducted on 16 randomly selected weekend days and 8 weekdays per season in each bay except in San Antonio Bay where interviews were taken on 24 weekend days and 16 weekdays. Additionally, boat ramps used by Gulf sport boat fishermen were surveyed at Galveston and Port Aransas on 6 weekdays, and on 6 weekdays and 3 weekend days at Freeport during June-August 1981. Roving counts were made on 20 randomly selected weekend days and 8 weekdays per season in each bay system except in Galveston Bay where 14 weekend and 12 weekday roves were conducted.

For the purpose of comparing annual catch rate (No./man-h) estimates for weekend sport boat pass, jetty and Gulf of Mexico fishermen, the sample year (1 September-31 August) was divided into two major seasons (high use and low use) based on fishing pressure, harvest and catch rate analysis (Green in McEachron 1979 unpublished data). The high use season was defined as 15 May-20 November and the low use season as 21 November-14 May.

The same sampling design for sport fishermen described by Green in Heffernan et al. (1976) and modified by Green et al. (1978) was used in this study. A roving clerk traveled through each bay system at a constant rate on randomly selected weekend days and weekdays and counted boat trailers to obtain fishing pressure estimates. Department personnel were stationed at boat ramps on randomly selected weekend days and weekdays to collect catch data by interviewing fishing parties that had completed a trip. Weekday and weekend catch rates (No./man-h) were combined because it was found there was no difference between day type (Appendix D). Interviewers recorded species (Hoese and Moore 1977, Bailey et al. 1970), number and weight (kg) of all fish brought back by fishing parties as well as number of persons in the party, fishing location, gear used and trip length. Sport caught fish were measured (total length) to the nearest mm. All measurements were taken in the field during scheduled sample periods.

Interview sites were selected at random but were weighted according to mean boat trailer counts obtained during the 1974-79 creel surveys (Texas Parks and Wildlife Department unpublished data). This resulted in boat ramps with high mean trailer counts being visited more often than boat ramps with low mean trailer counts. Interviews were conducted from 1000 to 1800 CST. Evaluation of data obtained during the first 2-y study (Heffernan et al. 1976 and Breuer et al. 1977) indicated that sampling during this time period would increase the amount of data collected per unit of sampling effort. During September-November a rover traveled around the bay system during an early (0600-1300) or late (1300-1930) period; during December-February during an early (0600-1200) or late (1200-1800) period; during March-May during an early (0600-1300) or late (1300-2000) period and during June-August during an early (0600-1400) or late (1400-2100) period.

All fishermen fishing inside (bayward) of the surfline were considered to be bay fishermen. Gulf of Mexico fishermen were divided into two categories--pass and jetty fishermen and other Gulf of Mexico fishermen. Pass and jetty fishermen fished outside (Gulfward) of the surfline but within 1.6 km of an "open" (bay and Gulf connected by water) pass or jettied area. Other Gulf of Mexico fishermen were those who fished in the Gulf beyond the 1.6 km designation.

In previous studies the sport fish harvest was estimated as the product of the mean catch rate and the fishing pressure in man-h (Heffernan et al. 1977). Since interview sites were selected at random in proportion to total fishing pressure, this technique was dependent upon a roving clerk traveling through the fishery getting random measures of fishing pressure occurring at all sites at any given time during the survey period. In the fall of 1979 gas shortages and irregular operating hours by gas stations made it impossible to comply strictly with these procedures. The potential for similar problems arising in the future is very likely (1979 was the second period of gas shortages within a 4-y period). This situation required the development of an alternate method of estimating the sport fish harvest and the fishing pressure which would not depend upon the extensive use of an automobile.

The Texas Parks and Wildlife Department (TPWD) has been actively involved in sport fishing surveys since 1974. All of the data collected during this time were placed on magnetic tapes and were available for extensive analyses. These data were examined and used to estimate a set of probabilities that described the paterns of fishing pressure that occurred within a day and at each inventoried interview site. These analyses resulted in the development of the following formulae for estimating the harvest:

$$\hat{H} = \sum_{i=1}^{4} D_i \cdot \bar{h}_i,$$

where

$$\bar{h}_i = \frac{1}{n} \cdot \sum_{j=1}^{n} h_{ij} p_j / e_j$$

The variable $\bar{h}_i$ was the mean number of fish landed per day in the ith strata (weekend, weekdays, high and low use season) and D_i was the total number of days that occurred in the ith strata. The number of fish landed per day in the bay system within a given stratum (h_{ij}) was estimated by adjusting the total number of fish actually observed at the jth site by the proportion of parties missed (p_j) by the interviewers that day and by the estimated proportion of total fishing activity in the bay system that occurred at that site (e_j). The total number of days and sites sampled was n. The adjustment for missed interviews was calculated as the reciprocal of the total number of parties not interviewed divided by the total number of parties seen (interviewed and not interviewed). The proportion of total fishing activity occuring at site j (e_j) was estimated as

$$e_j = FH_j / \sum_{j=1}^{k} FH_j$$

where the total number of trailers or fishermen (FH_j) observed at site j for the most recent 3-y period (FH_j) was divided by the total number of trailers or fishermen observed at all sites (j=1,2,3,...k) within the strata during the most recent 3-y period.

This technique essentially corresponds to procedures described by Kish (1965) for selecting samples from clusters proportional to size. Data collected from September 1974 through August 1976 were used to test this procedure by comparing estimates made using the old procedure. The proportional probability estimates were consistently greater than previously made estimates indicating a positive bias. The source of this bias could be caused by two different phenomena. The proportion of fishing pressure that occurs at each ramp could be wrong and/or the number of samples selected at each site would have not been in proportion to the actual pressure at each site. Both of these occurred to some extent in the earlier phases of the first 2 y of the surveys because there was no historical data to estimate fishing activity by site and equal probabilities were used to select sites. This situation was improved later with the collection of pressure data and the bias that is introduced from these two sources has been reduced.

A roving clerk is still required to inventory fishing sites but the objective is no longer to estimate the total pressure occurring at each site but to estimate what proportion of the total pressure is occurring at each site. This can be done with fewer roves and care does not have to be taken to make sure that counts occur at each site at random times of the day throughout the survey period. This reduces the use of the automobile from 1/3 to 1/6 of the previous requirements depending on the actual rove schedule adopted.

Data collected from this survey, on an annual basis, are comparable to previous survey data. However, two assumptions must be made when comparing catch rate data from year to year. The first is that the mean catch rate and mean fish size for parties returning before or after the interview period are the same as those found for parties returning during the interview period. The second is that neither mean catch rate nor mean fish size is correlated with the use rate of the boat ramp.

Any differences in the estimates in this report compared with previously published estimates for the same item are due to updating of the data base and the most recent report should be considered the most accurate.

RESULTS

Bay Fishery

During 1979-80, 2,256,600 man-h (Table 1) were expended by weekend sport boat fishermen. They caught an estimated 1,138,000 fish weighing 475,700 kg (Tables 2 & 3). Total landings ranged from 51,800 fish (30,500 kg) in San Antonio Bay to 521,900 fish (156,100 kg) in Galveston Bay. Spotted seatrout (Cynoscion nebulosus) constituted over 34% (388,800 fish) of the coastwide landings, Atlantic croaker (Micropogonias undulatus) over 27% (301,700 fish) and sand seatrout (C. arenarius) over 11% (127,900 fish). All other species each constituted $\leq$ 8% of the landings. The estimated number of all fish landed during the high use season (870,600 fish) was ∿ 3 1/4 times the number reported during the low use season (267,400 fish).

Spotted seatrout which constituted 21-75% (22,900-134,400 fish) of each bay's harvest was the major fish landed except in Galveston Bay where Atlantic croaker and sand seatrout constituted ∿ 50% (260,900 fish) and 18% (95,600 fish) of the catch, respectively.

The coast wide annual catch rate was 0.50 fish/man-h (Table 4). The highest catch rates of 0.62 fish/man-h was reported in Galveston Bay; catch rates in all other bays ranged from 0.39 to 0.55 fish/man-h. On an annual basis catch rates for spotted seatrout (0.18-0.39 fish/man-h) were higher than for any other species in each bay, except for Galveston Bay and for Matagorda Bay.

Atlantic croaker and sand seatrout had the lowest mean weight/fish (0.09-0.35 kg) and smallest mean length (216-320 mm) of all fishes landed by sport boat fishermen in all bay systems (Tables 5 & 6). Gafftopsail catfish (Bagre marinus) was the heaviest fish landed in Galveston (0.93 kg), Matagorda (1.43 kg) and Aransas (1.35 kg) Bays; black drum (Pogonias cromis) was the heaviest fish caught in San Antonio (1.64 kg) and Corpus Christi (2.70 kg) Bays; red drum (Sciaenops ocellatus) was the heaviest fish caught in upper Laguna Madre (0.87 kg) and southern flounder (Paralichthys lethostigma) was the heaviest fish caught in lower Laguna Madre (0.71 kg). Spotted seatrout mean weights were 0.54 and 0.53 kg, respectively, in Galveston and Matagorda Bays; mean weights ranged from 0.41 to 0.48 kg in all other bay systems.

Pass, Jetty and Gulf of Mexico Sport Boat Fisheries

Pass and Jetty

During the high use season, mean catch rates, for all species combined were $\leq$ 0.67 fish/man-h except for the Corpus Christi Bay area in 1978 (1.19 fish/man-h) and 1980 (0.93 fish/man-h) (Table 7). During each year, fishermen adjacent to the Corpus Christi Bay system had a higher mean catch rate than fishermen in all other areas (0.67-1.19 fish/man-h). During the low use season mean catch rates for sport boat fishermen were $\leq$ 0.63 fish/man-h for all species combined in all bays during all years (Table 8). Generally, fishermen during the low use season had lower catch rates (0.00-0.63 fish/man-h) than those during the high use season (0.00-1.19 fish/man-h).

Gulf of Mexico

During the high use season mean catch rates for all species combined ranged from 0.13 to 0.54 fish/man-h (Table 9). Lowest catch rates (0.13-0.21 fish/man-h) were recorded for Gulf of Mexico fishermen near the Corpus Christi area. Generally, catch rates for king mackerel (Scomberomorus cavalla), red snapper (Lutjanus campechanus) and "other" fishes were higher than for any other species (0.01-0.33 fish/man-h). King mackerel mean weights generally declined from 1978 (4.18-6.86 kg) through 1980 (2.50-4.57 kg). Cobia (Rachycentron canadum) and "other" fishes were the heaviest landed in all areas.

In the low use season mean catch rates, for all fishes combined ranged from 0.00 to 2.14 fish/man-h (Table 10). Catch rates varies between years and between Gulf areas. With the exception of red snapper, sand seatrout and "other" fishes, catch rates were generally $\leq$ 0.01 fish/man-h.

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Table 1. Total pressure estimates in man-h (x 1000) for weekend sport boat fishermen by season and year in seven Texas bay systems (Sept. 1979-Aug. 1980).

Bay system	Season		Annual Total
	High use	Low use	
Galveston	619.7	225.6	845.3
Matagorda	199.2	80.8	280.0
San Antonio	76.6	53.9	130.4
Aransas	124.4	20.1	144.5
Corpus Christi	78.4	79.4	157.8
upper Laguna Madre	350.7	108.3	459.0
lower Laguna Madre	131.6	109.9	239.4
Grand Total	1580.5	676.0	2256.6

Table 2. Weekend sport boat finfish landings (No. x 1000) estimated for seven Texas bays by species and season (Sept. 1979-Aug. 1980).

Bay system	Spotted seatrout	Red drum	Black drum	Southern flounder	Sheepshead	Atlantic croaker	Sand seatrout	Gafftopsail catfish	Other	All[a] species combined
Galveston										
High use	29.1	11.9	19.2	16.0	19.5	248.5	80.2	4.3	37.3	469.9
Low use	20.3	0.7	0.7	1.7	0.6	12.5	15.4	0.0	4.0	56.0
Annual[a]	49.4	12.6	19.9	17.8	20.1	260.9	95.6	4.3	41.3	521.9
Matagorda										
High use	12.3	14.2	17.0	8.5	2.0	12.7	4.5	0.4	3.2	75.0
Low use	10.5	6.9	5.2	2.0	2.8	2.6	0.1	0.0	2.8	32.8
Annual[a]	22.9	21.1	22.2	10.5	4.8	15.3	4.6	0.4	6.0	107.8
San Antonio										
High use	24.2	5.4	0.9	4.3	0.9	1.0	1.2	0.1	1.2	39.3
Low use	3.4	5.8	0.8	0.9	0.1	0.5	0.0	0.5	0.4	12.5
Annual[a]	27.6	11.2	1.8	5.3	1.0	1.5	1.2	0.6	1.6	51.8
Aransas										
High use	22.2	5.4	8.7	3.1	1.8	1.1	5.7	0.3	1.3	49.6
Low use	10.0	2.7	0.0	0.4	0.0	0.1	0.1	0.1	0.0	13.2
Annual[a]	32.2	8.1	8.7	3.5	1.8	1.1	5.7	0.4	1.3	62.8
Corpus Christi										
High use	16.9	3.5	1.6	4.3	0.4	5.0	10.5	0.5	4.3	47.0
Low use	11.8	4.8	2.6	2.0	3.5	5.0	2.8	0.7	2.0	35.1
Annual[a]	28.7	8.3	4.3	6.3	3.8	10.0	13.3	1.2	6.2	82.1

Table 2. (Cont'd).

Bay system	Spotted seatrout	Red drum	Black drum	Southern flounder	Sheepshead	Atlantic croaker	Sand seatrout	Gafftopsail catfish	Other	All[a] species combined
upper Laguna Madre										
High use	89.5	13.3	2.9	3.3	0.3	11.1	1.7	0.1	1.5	123.6
Low use	44.9	6.5	0.9	1.2	0.4	0.4	1.2	0.0	0.5	55.9
Annual[a]	134.4	19.7	3.7	4.5	0.7	11.5	2.9	0.1	2.0	179.5
lower Laguna Madre										
High use	57.7	3.1	0.3	3.8	0.6	1.2	3.3	0.1	0.2	70.3
Low use	36.0	5.9	2.9	2.4	12.5	0.3	1.3	0.0	0.6	61.8
Annual[a]	93.7	9.0	3.2	6.2	13.1	1.4	4.6	0.1	0.8	132.1
Coastwide total[a]										
High use[a]	252.0	56.8	50.6	43.4	25.5	280.6	107.0	5.7	49.0	870.6
Low use[a]	136.8	33.3	13.1	10.7	20.0	21.1	20.9	1.3	10.3	267.4
Annual[a]	388.8	90.1	63.7	54.1	45.3	301.7	127.9	7.0	59.4	1138.0

[a] Due to rounding of numbers these totals may not exactly equal individual species totals

Table 3. Weekend sport boat finfish landings (kg x 1000) estimated for seven Texas bays by species and season (Sept. 1979-Aug. 1980).

Bay system	Spotted seatrout	Red drum	Black drum	Southern flounder	Sheepshead	Atlantic croaker	Sand seatrout	Gafftopsail catfish	Other	All[a] species combined
Galveston										
High use	15.1	10.2	7.5	8.5	12.3	52.2	15.2	4.0	10.1	135.1
Low use	12.8	0.5	0.4	0.8	0.5	1.3	3.9	0.0	0.8	21.0
Annual	27.9	10.7	7.9	9.3	12.8	53.5	19.1	4.0	10.9	156.1
Matagorda										
High use	4.7	12.1	5.3	4.5	1.3	2.2	1.1	0.6	1.1	32.9
Low use	6.4	4.6	2.7	1.0	2.4	0.3	<.1	0.0	3.1	20.6
Annual	11.1	16.7	8.0	5.5	3.7	2.5	1.2	0.6	4.2	53.5
San Antonio										
High use	11.1	5.1	0.3	2.9	0.9	0.3	0.3	0.1	0.5	21.5
Low use	1.6	3.5	2.2	0.4	0.1	0.1	0.0	0.7	0.4	9.0
Annual	12.7	8.6	2.5	3.3	1.0	0.4	0.3	0.8	0.9	30.5
Aransas										
High use	8.7	4.5	4.4	1.6	1.3	0.1	1.2	0.4	0.3	22.5
Low use	4.5	1.7	0.0	0.2	0.0	0.1	<.1	0.2	0.0	6.8
Annual	13.2	6.2	4.4	1.8	1.3	0.2	1.3	0.6	0.3	29.3
Corpus Christi										
High use	7.8	3.4	0.9	3.3	0.4	1.2	3.1	0.6	1.1	21.8
Low use	6.3	3.1	15.2	1.0	3.5	0.9	0.8	1.2	0.4	32.4
Annual	14.1	6.5	16.1	4.3	3.9	2.1	3.9	1.8	1.5	54.2

Table 3. (Cont'd).

Bay system	Spotted seatrout	Red drum	Black drum	Southern flounder	Sheepshead	Atlantic croaker	Sand seatrout	Gafftopsail catfish	Other	All[a] species combined
upper Laguna Madre										
High use	38.5	12.8	1.6	2.1	0.2	2.6	0.5	0.1	0.4	58.8
Low use	22.9	4.4	0.8	0.8	0.5	0.1	0.6	0.0	0.1	30.2
Annual	61.4	17.2	2.4	2.9	0.7	2.7	1.1	0.1	0.5	89.0
lower Laguna Madre										
Hihg use	27.7	2.1	0.2	2.9	0.4	0.3	1.1	0.1	<.1	34.9
Low use	14.0	3.4	1.5	1.0	7.6	0.1	0.4	0.0	0.2	28.2
Annual	41.7	5.5	1.7	3.9	8.0	0.4	1.5	0.1	0.3	63.1
Coastwide total										
High use	113.6	50.2	20.2	25.8	16.8	58.9	22.5	5.9	13.6	327.5
Low use	68.5	21.2	22.8	5.2	14.6	2.9	5.9	2.1	5.0	148.2
Annual	182.1	71.4	43.0	31.0	31.4	61.8	28.4	8.0	18.6	475.7

Table 4. Catch rates (No./man-h) estimated for sport boat fishermen in seven Texas bays by species and season (Sept. 1979-Aug. 1980).

Bay system	Spotted seatrout	Red drum	Black drum	Southern flounder	Sheepshead	Atlantic croaker	Sand seatrout	Gafftopsail catfish	Other	All[a] species combined
Galveston										
High use	0.05	0.02	0.03	0.03	0.03	0.40	0.13	0.01	0.06	0.75
Low use	0.09	<.01	<.01	0.01	<.01	0.05	0.07	0.00	0.02	0.25
Annual	0.06	0.02	0.02	0.02	0.02	0.31	0.11	0.01	0.05	0.62
Matagorda										
High use	0.06	0.07	0.09	0.04	0.01	0.06	0.02	<.01	0.02	0.38
Low use	0.13	0.09	0.06	0.03	0.03	0.03	<.01	0.00	0.04	0.41
Annual	0.08	0.08	0.08	0.04	0.02	0.06	0.02	<.01	0.02	0.39
San Antonio										
High use	0.32	0.07	0.01	0.06	0.01	0.01	0.02	<.01	0.02	0.51
Low use	0.06	0.11	0.02	0.02	<.01	0.01	0.00	0.01	0.01	0.23
Annual	0.21	0.09	0.01	0.04	0.01	0.01	0.01	0.01	0.01	0.40
Aransas										
High use	0.18	0.04	0.07	0.03	0.01	0.01	0.05	<.01	0.01	0.40
Low use	0.50	0.13	0.00	0.02	0.00	<.01	<.01	<.01	0.00	0.66
Annual	0.22	0.06	0.06	0.02	0.01	0.01	0.04	<.01	0.01	0.44
Corpus Christi										
High use	0.22	0.05	0.02	0.06	0.01	0.06	0.13	0.01	0.05	0.60
Low use	0.15	0.06	0.03	0.03	0.04	0.06	0.04	0.01	0.03	0.44
Annual	0.18	0.05	0.03	0.04	0.02	0.06	0.08	0.01	0.04	0.52

Table 4. (Cont'd).

Bay system	Spotted seatrout	Red drum	Black drum	Southern flounder	Sheepshead	Atlantic croaker	Sand seatrout	Gafftopsail catfish	Other	All[a] species combined
upper Laguna Madre										
High use	0.26	0.04	0.01	0.01	<.01	0.03	0.01	0.00	<.01	0.35
Low use	0.41	0.06	0.01	0.01	<.01	<.01	0.01	0.00	0.01	0.52
Annual	0.29	0.04	0.01	0.01	<.01	0.03	0.01	0.00	<.01	0.39
lower Laguna Madre										
High use	0.44	0.02	<.01	0.03	<.01	0.01	0.03	0.00	<.01	0.53
Low use	0.33	0.06	0.03	0.02	0.12	<.01	0.01	0.00	0.01	0.57
Annual	0.39	0.04	0.01	0.03	0.06	0.01	0.02	0.00	<.01	0.55
Coastwide Total										
High use	0.16	0.04	0.03	0.03	0.02	0.18	0.07	<.01	0.03	0.55
Low use	0.20	0.05	0.02	0.02	0.03	0.03	0.03	<.01	0.02	0.40
Annual	0.17	0.04	0.03	0.02	0.02	0.13	0.06	<.01	0.03	0.50

[a] Due to rounding of numbers these totals may not exactly equal individual species totals

Table 5 . Mean weight (kg) by species and season of finfishes caught by sport boat fishermen in seven Texas Bays (Sept. 1979-Aug. 1980). Blanks = no fish weighed.

Bay system	Spotted seatrout	Red drum	Black drum	Southern flounder	Sheepshead	Atlantic croaker	Sand seatrout	Gafftopsail catfish	Other
Galveston									
High use	0.52	0.86	0.39	0.53	0.63	0.21	0.19	0.93	0.27
Low use	0.63	0.68	0.60	0.47	0.88	0.10	0.25		0.21
Annual mean	0.54	0.83	0.40	0.51	0.63	0.19	0.21	0.93	0.26
Matagorda									
High use	0.38	0.85	0.31	0.53	0.64	0.17	0.24	1.43	0.34
Low use	0.61	0.66	0.51	0.50	0.85	0.13	0.20		1.11
Annual mean	0.53	0.81	0.33	0.52	0.78	0.16	0.23	1.43	0.56
San Antonio									
High use	0.46	0.95	0.34	0.67	0.95	0.30	0.23	1.37	0.39
Low use	0.47	0.60	2.72	0.40	0.80			1.34	1.09
Annual mean	0.46	0.77	1.64	0.62	0.93	0.30	0.23	1.34	0.55
Aransas									
High use	0.39	0.84	0.50	0.53	0.74	0.08	0.21	1.20	0.20
Low use	0.45	0.64		0.56		0.28	0.40	2.13	
Annual mean	0.41	0.74	0.50	0.53	0.74	0.09	0.21	1.35	0.20
Corpus Christi									
High use	0.46	0.97	0.57	0.76	1.07	0.24	0.29	1.11	0.25
Low use	0.53	0.65	5.86	0.48	1.00	0.18	0.27	1.68	0.21
Annual mean	0.48	0.80	2.70	0.69	1.00	0.21	0.28	1.36	0.24

Table 5 . (Cont'd).

Bay system	Spotted seatrout	Red drum	Black drum	Southern flounder	Sheepshead	Atlantic croaker	Sand seatrout	Gafftopsail catfish	Other
upper Laguna Madre									
High use	0.43	0.96	0.54	0.62	0.69	0.23	0.28		0.29
Low use	0.51	0.68	0.90	0.68	1.21	0.29	0.49		0.24
Annual mean	0.45	0.87	0.60	0.63	0.99	0.23	0.35		0.27
lower Laguna Madre									
High use	0.48	0.68	0.58	0.77	0.66	0.27	0.33		0.21
Low use	0.39	0.57	0.50	0.43	0.61	0.21	0.33		0.37
Annual mean	0.46	0.61	0.50	0.71	0.61	0.26	0.33		0.31
Coastwide mean									
High use	0.46	0.88	0.39	0.63	0.65	0.21	0.22	0.97	0.27
Low use	0.50	0.63	1.96	0.48	0.79	0.11	0.25	1.57	0.34
Annual mean	0.46	0.79	0.66	0.58	0.69	0.19	0.23	1.01	0.27

Table 6 . Mean length (mm) by species and season of finfishes caught by sport boat fishermen in seven Texas Bays (sept. 1979-Aug. 1980). Blanks = no fish measured.

Bay system	Spotted seatrout	Red drum	Black drum	Southern flounder	Sheepshead	Atlantic croaker	Sand seatrout	Gafftopsail catfish
Galveston								
High use	382	435	314	344	345	246	264	511
Low use	361	428	278	324	269	236	263	
Annual mean	377	434	312	337	342	244	264	511
Matagorda								
High use	369	451	284	347	330	236	276	434
Low use	383	400	438	342	366	221	279	
Annual mean	378	442	300	345	355	233	276	434
San Antonio								
High use	366	434	314	360	377	273	298	551
Low use	371	381	444	357	340			526
Annual mean	366	406	385	359	373	273	298	529
Aransas								
High use	350	435	317	355	341	216	277	
Low use	364	400		340		225	307	528
Annual mean	355	418	317	350	341	216	277	528
Corpus Christi								
High use	359	443	337	362	368	257	290	439
Low use	380	399	647	340	331	262	312	538
Annual mean	365	420	461	358	335	259	293	483

Table 6 . (Cont'd).

Bay system	Spotted seatrout	Red drum	Black drum	Souther flounder	Sheepshead	Atlantic croaker	Sand seatrout	Gafftopsail catfish
upper Laguna Madre								
High use	367	429	339	364	312	264	297	249
Low use	374	426	474	374	404	271	360	
Annual mean	369	428	362	366	365	264	320	249
lower Laguna Madre								
High use	367	405	437	414	322	280	285	
Low use	350	382	299	329	323	250	346	
Annual mean	364	390	311	401	322	276	287	
Coastwide mean								
High use	367	437	308	367	344	246	270	502
Low use	368	399	425	334	336	238	268	532
Annual mean	367	423	327	358	341	244	270	505

Table 7. Mean high use season (15 May-20 Nov.) catch rate (No./man-h) and mean weight (kg) by species of fishes caught by sport boat fishermen in the pass and jetty areas of Texas marine waters. Blanks = no fish weighed.

Species	Pass and jetty area							
	Galveston		Matagorda		Corpus Christi		Lower Laguna Madre	
Year	No./man-h	Kg	No./man-h	Kg	No./man-h	Kg	No./man-h	Kg
Spotted seatrout								
1978	0.06	0.85	0.08	0.63	0.44	0.37	0.00	
1979	0.20	0.76	0.28	0.62	0.19	0.40	0.00	
1980	0.12	0.78	0.17	0.59	0.03	0.65	0.00	
Red drum								
1978	0.01	5.26	0.01	3.87	0.00		0.00	
1979	0.01	3.82	0.04	3.35	0.01	0.53	0.00	
1980	0.03	2.72	0.05	2.53	0.06	1.77	0.02	8.15
Black drum								
1978	0.01	1.41	0.01	0.43	0.00		0.00	
1979	<.01	1.02	0.01	0.94	0.00		0.00	
1980	0.01	1.18	0.01	2.89	<.01		0.00	
Southern flounder								
1978	0.07	0.75	0.01	0.55	0.15	0.96	0.00	
1979	0.05	0.44	0.02	0.85	0.01	0.91	0.00	
1980	0.02	0.53	<.01	0.47	0.08	0.38	0.00	

Table 7. (Cont'd.)

Species	Pass and jetty area							
	Galveston		Matagorda		Corpus Christi		Lower Laguna Madre	
Year	No./man-h	Kg	No./man-h	Kg	No./man-h	Kg	No./man-h	Kg
Sheepshead								
1978	0.05	0.64	0.07	0.58	0.03	0.63	0.00	
1979	0.05	0.67	0.02	0.42	0.33	0.53	0.00	
1980	0.06	0.79	0.07	0.70	0.02	1.08	0.06	0.30
Atlantic croaker								
1978	0.06	0.25	<.01	0.13	0.01	0.22	0.00	
1979	0.03	0.16	0.01	0.25	0.02	0.27	0.00	
1980	0.03	0.13	0.06	0.33	0.32	0.29	0.00	
Sand seatrout								
1978	0.20	0.22	<.01	0.45	0.55	0.25	0.00	
1979	0.10	0.26	0.19	0.29	0.04	0.14	0.00	
1980	0.07	0.24	0.06	0.34	0.32	0.22	0.00	
Gafftopsail catfish								
1978	<.01	1.64	0.02	0.90	0.00		0.00	
1979	<.01	0.91	0.00		0.00		0.00	
1980	0.01	1.20	0.01	0.93	0.00		0.00	

Table 7. (Cont'd.)

Species / Year	Pass and jetty area: Galveston No./man-h	Galveston Kg	Matagorda No./man-h	Matagorda Kg	Corpus Christi No./man-h	Corpus Christi Kg	Lower Laguna Madre No./man-h	Lower Laguna Madre Kg
Other								
1978	0.03	0.47	0.03	10.79	0.01	0.22	0.00	
1979	0.09	0.57	0.04	1.24	0.07	0.45	0.00	
1980	0.07	0.39	0.04	1.09	0.07	1.76	0.49	0.69
All species combined[a]								
1978	0.48		0.23		1.19		0.00	
1979	0.53		0.60		0.67		0.00	
1980	0.41		0.48		0.93		0.58	

[a] Due to rounding of numbers, these totals may not exactly equal individual species totals.

Table 8 . Mean low use season (21 Nov.-14 May) catch rate (No./man-h) and mean weight (kg) by species of fishes caught by sport boat fishermen in the pass and jetty areas of Texas marine waters. Blanks = no fish weighed.

Species	Pass and jetty area							
	Galveston		Matagorda		Corpus Christi		Lower Laguna Madre	
Year	No./man-h	Kg	No./man-h	Kg	No./man-h	Kg	No./man-h	Kg
Spotted seatrout								
1978	0.00		0.01	1.52	0.00		0.00	
1979	0.01	0.81	0.02	1.15	0.00		0.00	
1980	0.00		0.13	0.55	0.06	0.97	0.00	
Red drum								
1978	<.01	4.26	0.02	2.44	0.00		0.00	
1979	0.01	3.17	0.04	2.01	0.01	0.96	0.00	
1980	0.01	3.44	0.03	1.01	0.02	1.83	0.00	
Black drum								
1978	0.05	11.93	0.01	8.38	0.00		0.00	
1979	<.01	5.28	0.00		0.00		0.00	
1980	<.01	1.82	0.00		0.00		0.00	
Southern flounder								
1978	0.01	0.49	0.00		0.00		0.00	
1979	0.01	0.47	0.00		0.00		0.00	
1980	0.01	0.82	0.00		0.00		0.00	

Table 8. (Cont'd.)

Species Year	Pass and jetty area							
	Galveston		Matagorda		Corpus Christi		Lower Laguna Madre	
	No./man-h	Kg	No./man-h	Kg	No./man-h	Kg	No./man-h	Kg
Sheepshead								
1978	<.01	0.84	0.19	0.48	0.00		0.00	
1979	<.01	1.81	0.09	0.80	0.47	0.54	0.00	
1980	<.01	1.55	0.18	0.84	0.46	0.66	0.00	
Atlantic croaker								
1978	<.01		0.01		0.00		0.00	
1979	0.02	0.21	0.00		0.00		0.00	
1980	0.02	0.11	0.00		0.00		0.00	
Sand seatrout								
1978	<.01	0.31	0.00		0.00		0.00	
1979	0.48	0.26	0.00		0.00		0.00	
1980	0.14	0.23	0.01	0.27	0.05	0.41	0.00	
Gafftopsail catfish								
1978	0.05	1.62	0.01	1.64	0.00		0.00	
1979	0.01	1.87	0.04	1.48	0.05	0.70	0.00	
1980	0.00		0.02	1.07	0.00		0.00	

Table 8. (Cont'd.)

Species Year	Pass and jetty area							
	Galveston		Matagorda		Corpus Christi		Lower Laguna Madre	
	No./man-h	Kg	No./man-h	Kg	No./man-h	Kg	No./man-h	Kg
Other								
1978	0.01	4.82	0.01	0.45	0.00		0.00	
1979	0.02	0.32	<.01		0.09	6.24	0.00	
1980	0.02	0.28	0.13	0.31	0.04	0.38	0.00	
All species combined[a]								
1978	0.12		0.24		0.00		0.00	
1979	0.54		0.20		0.63		0.00	
1980	0.20		0.50		0.63		0.00	

[a]Due to rounding of numbers, these totals may not exactly equal individual species totals.

Table 9. Mean high use season (15 May-20 Nov.) catch rate (No./man-h) and mean weight (kg) by species of fishes caught by sport boat fishermen in the Gulf of Mexico. Blanks = no fish weighed.

Species Year	Gulf area							
	Galveston		Matagorda		Corpus Christi		Lower Laguna Madre	
	No./man-h	Kg	No./man-h	Kg	No./man-h	Kg	No./man-h	Kg
Spotted seatrout								
1978	0.00		<.01	0.62	0.00		0.00	
1979	0.00		0.00		0.02	0.40	0.00	
1980	<.01	0.60	0.03	0.67	<.01	0.49	0.00	
Red drum								
1978	<.01	2.98	0.00		<.01	8.97	0.00	
1979	0.00		<.01	10.21	<.01	10.91	0.00	
1980	<.01		0.01	1.11	<.01	11.25	0.00	
King mackerel								
1978	0.02	6.86	0.09	5.78	0.05	6.37	0.08	4.18
1979	0.01	3.65	0.10	4.56	0.08	5.86	0.09	4.00
1980	0.08	4.57	0.10	4.06	0.10	4.17	0.14	2.50
Spanish mackerel								
1978	<.01	1.34	0.01	0.85	0.10	0.68	0.00	
1979	0.10	0.43	0.01	1.11	0.02	1.42	0.07	0.46
1980	0.03	1.17	0.01	0.77	0.02	0.45	0.00	

Table 9. (Cont'd.)

Species Year	Gulf area							
	Galveston		Matagorda		Corpus Christi		Lower Laguna Madre	
	No./man-h	Kg	No./man-h	Kg	No./man-h	Kg	No./man-h	Kg
Red snapper								
1978	0.10	0.38	0.01	0.52	<.01	0.05	0.25	0.51
1979	0.17	0.43	0.08	0.88	<.01	0.85	0.00	
1980	0.14	0.45	0.18	1.06	0.01	1.73	0.33	
Atlantic croaker								
1978	0.00		0.00		0.02	0.22	0.00	
1979	0.02	0.13	<.01	0.36	<.01	0.19	0.00	
1980	<.01	0.50	<.01	0.32	<.01	0.31	0.00	
Sand seatrout								
1978	0.02	0.34	0.01	0.42	0.02	0.24	0.00	
1979	0.03	0.31	0.04	0.40	0.05	0.29	0.00	
1980	0.02	0.26	0.14	0.37	0.01	0.23	0.01	0.22
Cobia (ling)								
1978	0.02	2.49	0.01	2.84	0.01	11.36	0.00	
1979	0.01	10.93	<.01	9.51	<.01	9.18	0.00	
1980	0.01	7.25	<.01	7.58	<.01	4.05	0.00	

Table 9. (Cont'd.)

Species	Gulf area							
	Galveston		Matagorda		Corpus Christi		Lower Laguna Madre	
Year	No./man-h	Kg	No./man-h	Kg	No./man-h	Kg	No./man-h	Kg
Other								
1978	0.06	1.09	0.06	2.72	0.03	2.90	0.06	2.74
1979	0.12	0.97	0.07	1.77	0.03	3.26	0.15	6.81
1980	0.07	2.22	0.04	3.84	0.05	3.25	0.06	68.25
All species combined[a]								
1978	0.22		0.18		0.13		0.39	
1979	0.45		0.31		0.21		0.31	
1980	0.35		0.51		0.20		0.54	

[a]Due to rounding of numbers, these totals may not exactly equal individual species totals.

Table 10. Mean low use season (21 Nov.-14 May) catch rate (No./man-h) and mean weight (kg) by species of fishes caught by sport boat fishermen in the Gulf of Mexico. Blanks = no fish weighed.

Species	Gulf area							
	Galveston		Matagorda		Corpus Christi		Lower Laguna Madre	
Year	No./man-h	Kg	No./man-h	Kg	No./man-h	Kg	No./man-h	Kg
Spotted seatrout								
1978	0.00		0.00		0.00		0.35	0.45
1979	0.00		0.01	0.79	0.00		0.00	
1980	0.00		0.00		0.00		0.00	
Red drum								
1978	0.00		<.01	12.84	0.00		0.00	
1979	0.01	11.36	<.01	4.31	0.00		0.00	
1980	0.01	1.82	0.00		0.00		0.00	
King mackerel								
1978	0.00		0.00		0.00		0.01	5.91
1979	0.00		0.00		0.00		0.00	
1980	0.05	5.18	<.01	5.95	0.00		0.00	
Spanish mackerel								
1978	0.00		0.00		0.00		0.00	
1979	0.00		0.00		0.47	0.42	0.00	
1980	0.00		0.00		0.00		0.00	

Table 10. (Cont'd.)

Species Year	Gulf area							
	Galveston		Matagorda		Corpus Christi		Lower Laguna Madre	
	No./man-h	Kg	No./man-h	Kg	No./man-h	Kg	No./man-h	Kg
Red snapper								
1978	0.00		0.02	0.77	0.00		0.00	
1979	1.08	0.32	0.11	0.82	0.00		0.00	
1980	0.00		0.37	0.91	0.00		2.14	0.92
Atlantic croaker								
1978	0.00		0.00		0.00		0.00	
1979	0.00		0.00		0.00		0.00	
1980	0.00		0.00		0.00		0.00	
Sand seatrout								
1978	0.00		0.00		0.00		0.00	
1979	0.10	0.21	0.41		0.00		0.00	
1980	0.03	0.24	0.17	0.42	0.00		0.00	
Cobia (ling)								
1978	0.00		<.01		0.00		0.00	
1979	0.00		0.00		0.00		0.00	
1980	0.02	6.80	0.00		0.00		0.00	

Table 10. (Cont'd.)

Species Year	Gulf area: Galveston No./man-h	Galveston Kg	Matagorda No./man-h	Matagorda Kg	Corpus Christi No./man-h	Corpus Christi Kg	Lower Laguna Madre No./man-h	Lower Laguna Madre Kg
Other								
1978	0.03	1.59	0.08	13.31	0.23	0.95	0.13	31.87
1979	0.06	0.63	0.10	0.30	0.01	14.55	0.00	
1980	0.01		0.02	3.78	0.01		0.00	
All species combined[a]								
1978	0.03		0.10		0.23		0.50	
1979	1.25		0.63		0.49		0.00	
1980	0.11		0.57		0.01		2.14	

[a] Due to rounding of numbers, these totals may not exactly equal individual species totals.

Appendix A: Boat ramp access points

Table 1 . Boat ramp access points in each bay system (Sept. 1979-Aug. 1980).

Bay system	Boat ramp[a] code number	Boat ramp identification
Galveston	79	Cotton Lake Park
	2	Woodall's Bait Camp
	3	Crawley's Bait Camp
	77	Will's Bait Camp
	4	Thompson's Bait Camp
	5	Roseland City Park
	6	State Boat Ramp (Tabb's Bay)
	90	San Jacinto Bay Bridge
	7	Morgan's Point Bait Camp
	8	Sylvan Beach
	91	Shoreacres Boat Ramp
	85	Clear Lake Boat Ramp
	9	Oddo's Boat Ramp
	10	State Boat Ramp (Clear Creek Channel
	11	Galveston County Park (Baycliff)
	12	HL&P Galveston County Park
	13	San Leon Marina
	14	Eagle Point Camp
	15	April Fool Point Bait Camp
	87	Cotton's Bait Camp
	16	Marge's Bait Camp
	17	Fiesta Marina
	78	Dickinson Bayou Public Ramp
	18	Sweden's Bait Camp Simpson's Bait Camp
	20	Moses Lake Bait Camp
	84	The Fish Spot
	21	Mowle's Bait Camp
	86	Dollar Bait Camp
	22	C. C. Camp
	24	Ritlat's Bait Camp Dub's Bait Camp
	25	Curl's Bait Camp
	26	Public Ramp (Texas City Dike)
	27	Public Ramp (Texas City Dike)
	28	Public Ramp (Texas City Dike)
	29	Texas City Dike Marina
	30	State Boat Ramp (Jones Lake)
	32	Terry's Lucky 7
	33	Pete's Bait Camp
	34	Louis' Bait Camp
	35	Hall's Bayou Bait Camp
	93	Hall's Bayou Bridge
	38	State Boat Ramp (Chocolate Bayou)

Table 1 . (Cont'd).

Bay system	Boat ramp[a] code number	Boat ramp identification
	37	Lute's Marina
	92	Tiger Marina
	39	Marlin Marina
	40	State Boat Ramp (Bastrop Bayou)
	41	Jack Booth's (Bastrop Marina)
	88	San Luis Pass Subdivision (Drum Bay)
	43	Shell Ramp (Christmas Bay)
	44	K.O.A. Campground
	45	San Luis Pass Shoreline (east side)
	46	San Luis Pass Bait Camp
	47	Bay Harbor subdivision
	48	Terramar Beach subdivision
	49	Sea Isle subdivision
	50	Jamaica Beach Marina
	51	Jamaica Beach Boat Ramp
	53	Pirate's Beach Marina
	54	Pirate's Beach Boat Ramp
	55	Andy's Bait Camp Galveston County Boat Ramp
	56	Galveston County Park (73rd St.)
	57	Galveston County Park (61st St.)
	59	Newell Marina
	60	M&M Camp
	61	Payco Marina
	62	Pleasure Island Bait Camp
	83	Galveston Yacht Basin
	80	South Galveston Jetty (1st ramp)
	81	Wilson's Bait Camp Waddell's Bait Camp Best's Bait Camp
	82	North Galveston Jetty Boat Ramp
	63	Jim Reid's Bait Camp
	64	Shirley's Cafeteria and Bait Camp
	66	Robin Seafood Bait Camp
	68	B&P Bait Camp
	70	Stingaree Marina
	72	Rollover Pass Boat Ramp
	89	State Boat Ramp (High Island)
	73	Van-et-un Bait Camp (Smith Point) Robbin's Park
	74	Chamber County Ramp
	75	Fort Anahuac Park

Table 1 . (Cont'd).

Bay system	Boat ramp[a] code number	Boat ramp identification
Matagorda	1	Capt's Fishing Camp
	2	Port O'Connor Fishing Center
	3	Uncle Bill's (Port O'Connor)
	4	Indianola Fishing Center
	5	Magnolia Boat Ramp
	6	Chocolate Bayou Boat Ramp
	7	Harbor Refuge Boat Ramp
	8	Lavaca Causeway Boat Ramp
	9	Point Comfort Boat Ramp
	10	Olivia Boat Ramp
	11	Crescent V
	12	Last Chance Marina
	29	The Wharf
	13	Turtle Bridge Boat Ramp
	14	The Hill
	15	Palacios Bait Camp
	16	East Bay
	18	Palacios River
	19	River Bend
	27	Bulkhead Marina
	20	Al's
	22	Rawling's
	26	Bailey's
	23	U.F.O. Boat Ramp
	28	Chinquapin Boat Ramp
	24	Bill & Effie's
	25	Hanna's
San Antonio	1	Port O'Connor Fishing Center
	2	Capt's Fishing Camp
	3	Uncle Bill's (Port O'Connor)
	4	Fulgrum's
	5	Swan Point (Seadrift)
	6	Seadrift
	8	Hopper's Landing (Austwell)
Aransas	1	Little Bay
	25	Key Allegro Marina
	26	Key Allegro North Ramp
	2	Fulton Harbor
	24	Sandollar Marina
	27	Raquet Club
	3	Copano Causeway

Table 1 . (Cont'd).

Bay system	Boat ramp[a] code number	Boat ramp identification
	4	Sea Gun Marina
	5	Goose Island State Park
	6	St. Charles Marina
	7	Holiday Beach
	8	Joe's Boat Basin
	21	Pouzee's
	9	Klein's (Rattlesnake Pt.)
	18	Port Bay Club
	10	Redfish Camp (Port Bay)
	11	Glenn's Marina (Bayside)
	22	Bayside Public Ramp
	12	Aransas Pass Boat Basin
	13	Louie's Bait Stand
	14	Fin & Feather Marina
	15	Billie & Gene's Bait Camp
	23	Hogan's Bait Camp
	20	Bait Hut
	16	Palm Harbor
	17	Cove Harbor
	19	Rockport Turning Basin
Corpus Christi	1	S. Nueces Causeway
	2	N. Nueces Causeway
	3	Ingleside Cove
	4	Bahia Mar
	5	Channel View Marina
	15	Sun Oil Co.
	7	Aransas Airport
	14	Causeway Bait Stand
	8	Fin & Feather Marina
	12	Port Aransas Public Ramp
	13	Woody's
	9	Wilson's Cut
	10	Oso Bridge Ramp
	11	L-Head Ramp
Upper Laguna Madre	1	Red's Place (Hap's Marina)
	2	Jerry's
	3	Coburn's
	4	Marina Madre
	5	Toll Gate
	6	Whitt's
	7	Fisherman's Folly
	8	Graham's

Table 1 . (Cont'd).

Bay system	Boat ramp[a] code number	Boat ramp identification
	9	B. G.'s
	10	Rainbow
	11	Black's
	12	Billing's
	13	P. I. V.
	14	Boat Hole
	15	Naval Ramp
	16	Kaufer Park
	17	Kratz's
	18	Williamson's
	19	Bird Island Basin
Lower Laguna Madre	1	Wiley's
	2	Jim's
	3	Sea Ranch
	4	Jetties
	7	White Sands
	8	San Martin
	9	Laguna Vista
	10	Arroyo Colorado (State Ramp)
	11	Sanchez
	12	Al's Place
	13	Marlin Marina
	14	Port Mansfield (State Ramp)
	15	Redfish
	16	South Padre Marina

[a]boat ramp code numbers that have been deleted from the master list as of September 1979 are not included.

Appendix B: Area maps of boat ramp access points

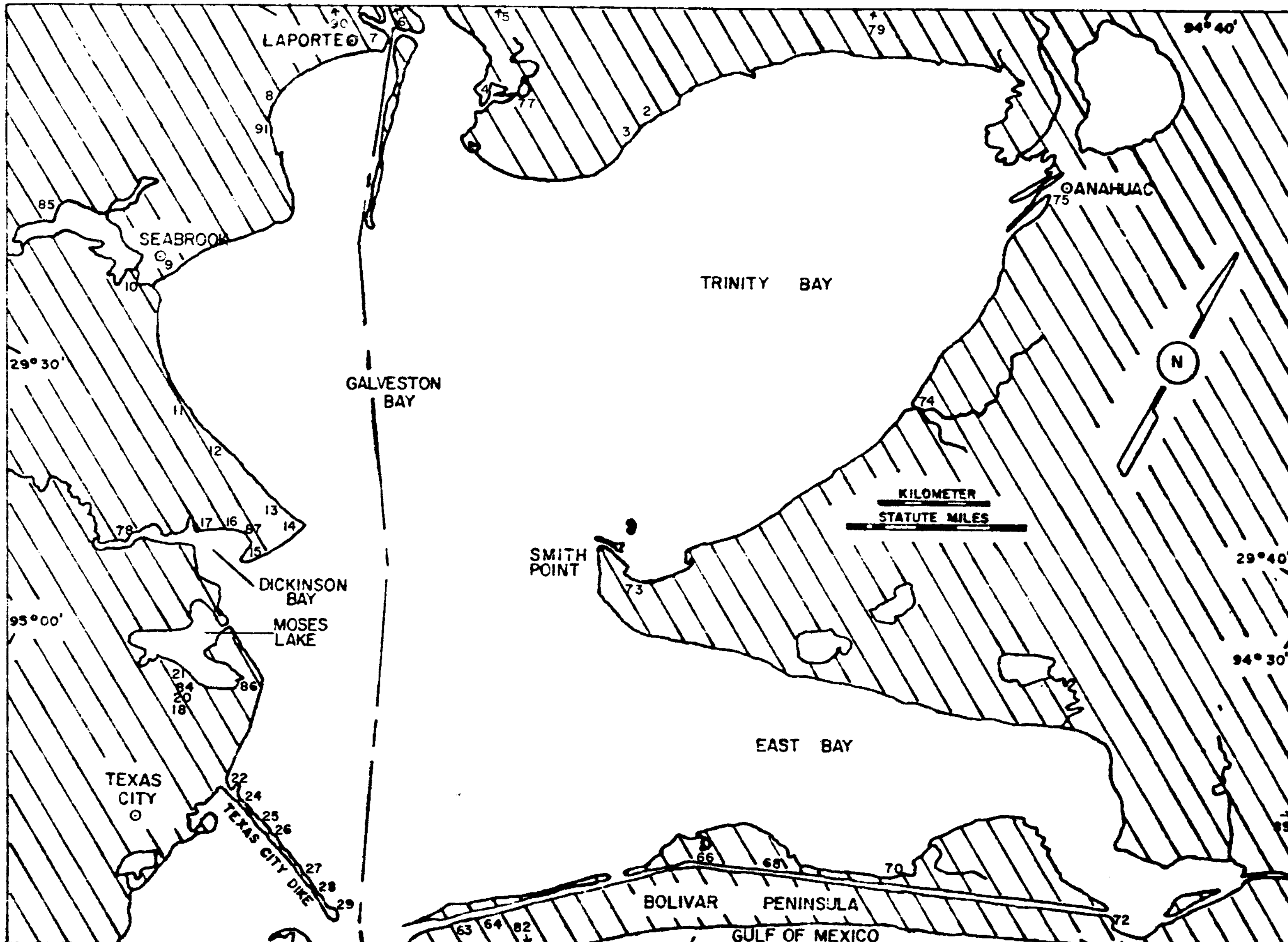

Figure 1 . Boat ramp access points in the Galveston Bay system (Sept. 1979-Aug. 1980).

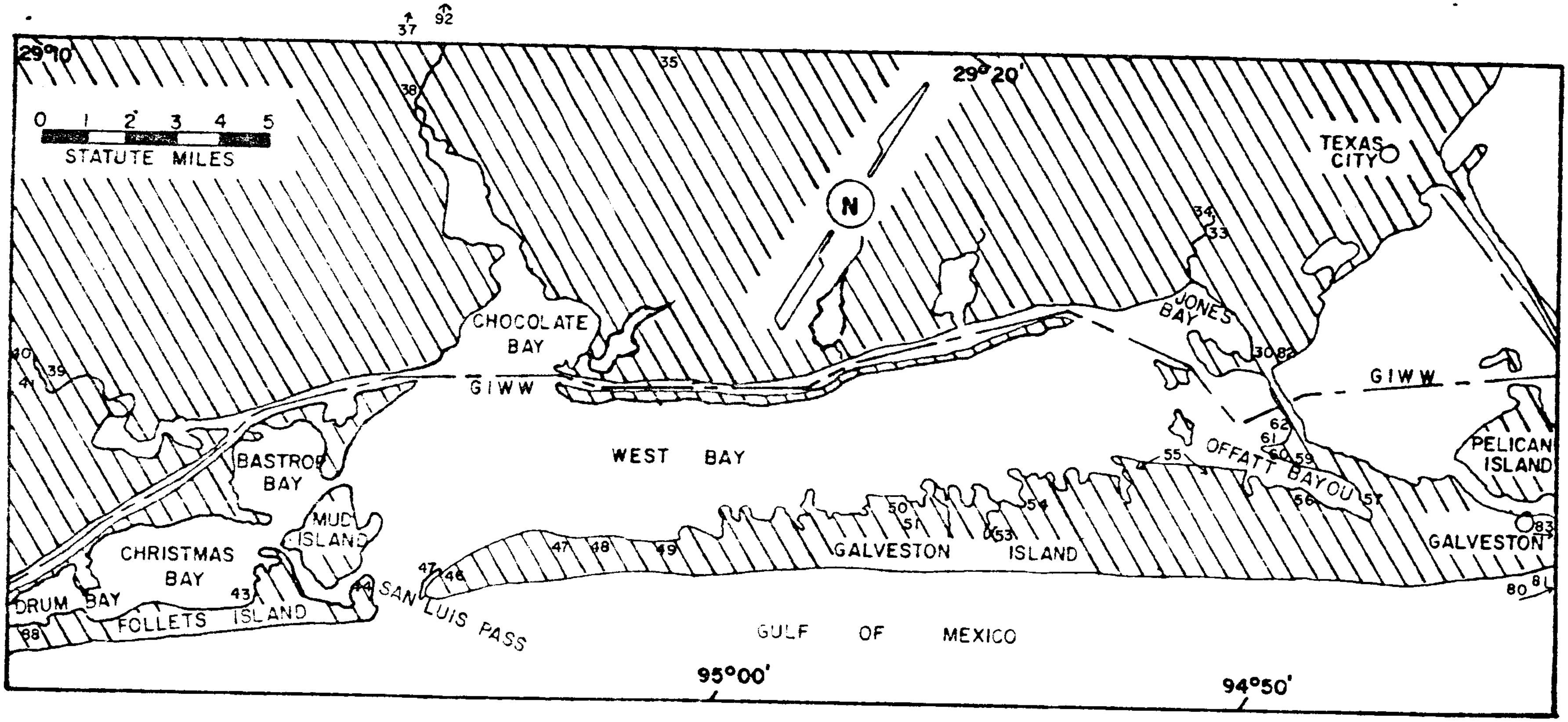

Figure 2 . Boat ramp access points in the Galveston Bay system (Sept. 1979-Aug. 1980).

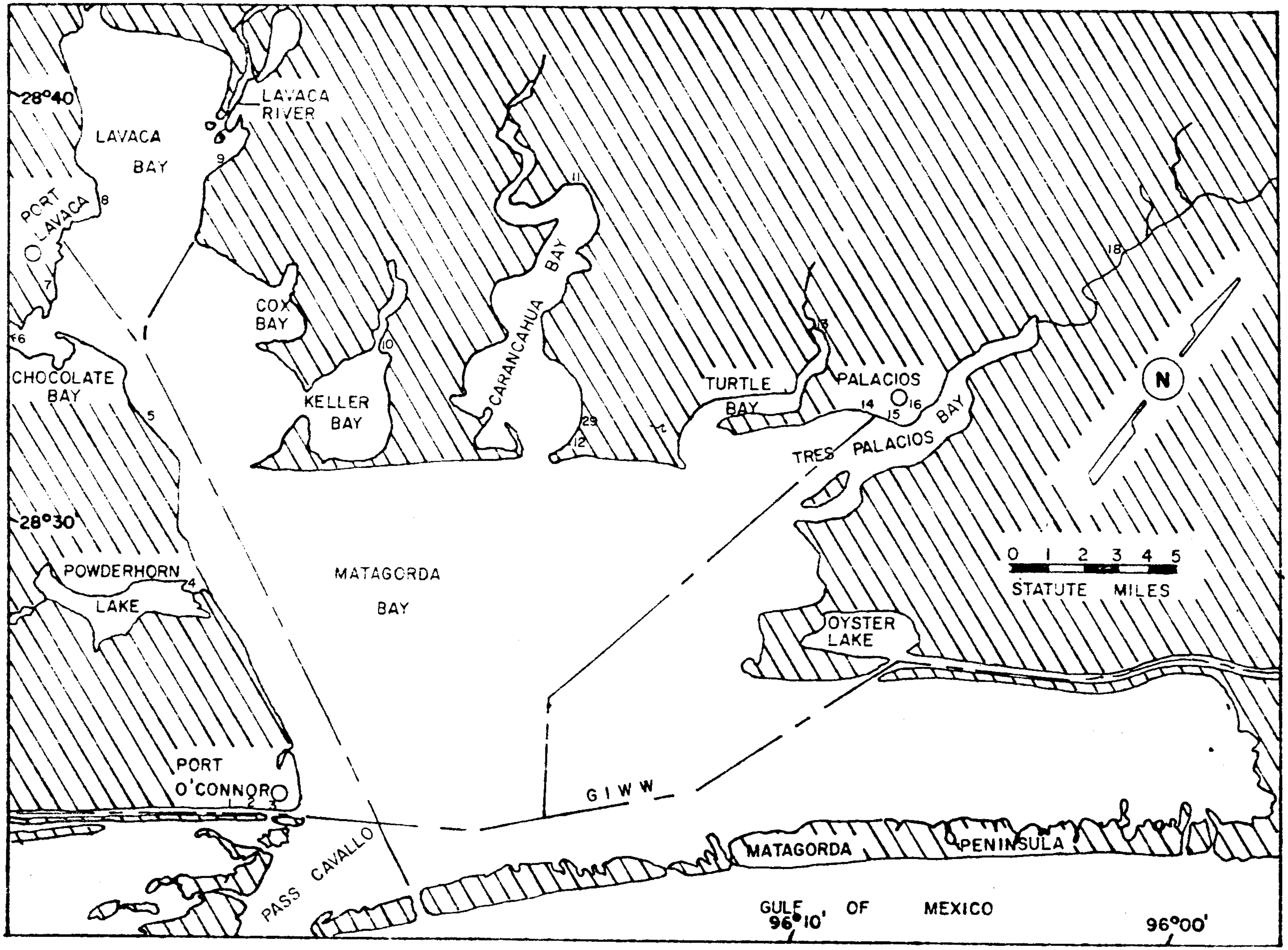

Figure 3 . Boat ramp access points in the Matagorda Bay system (Sept. 1979-Aug. 1980).

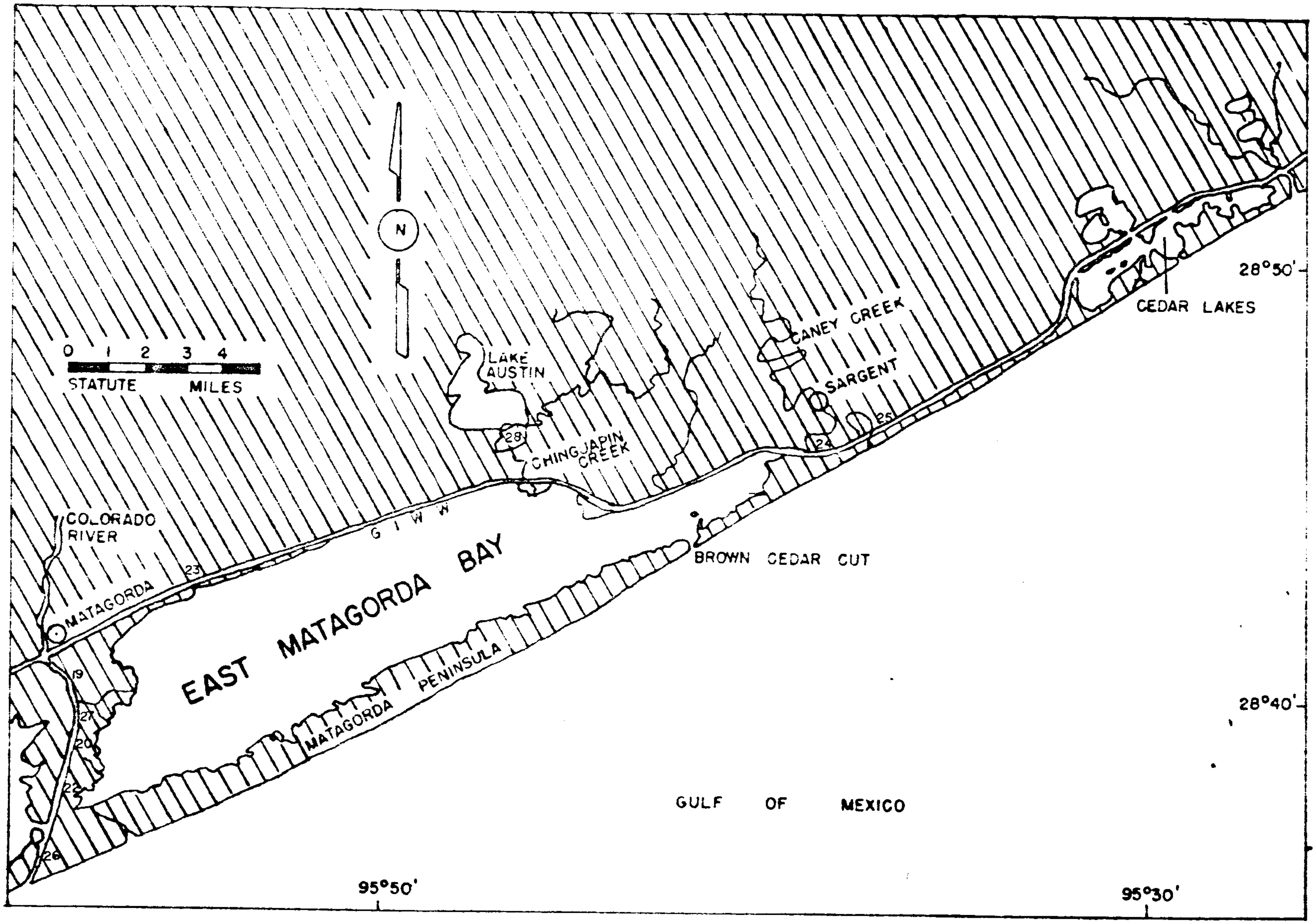

Figure 4 . Boat ramp access points in the Matagorda Bay system (Sept. 1979-Aug. 1980).

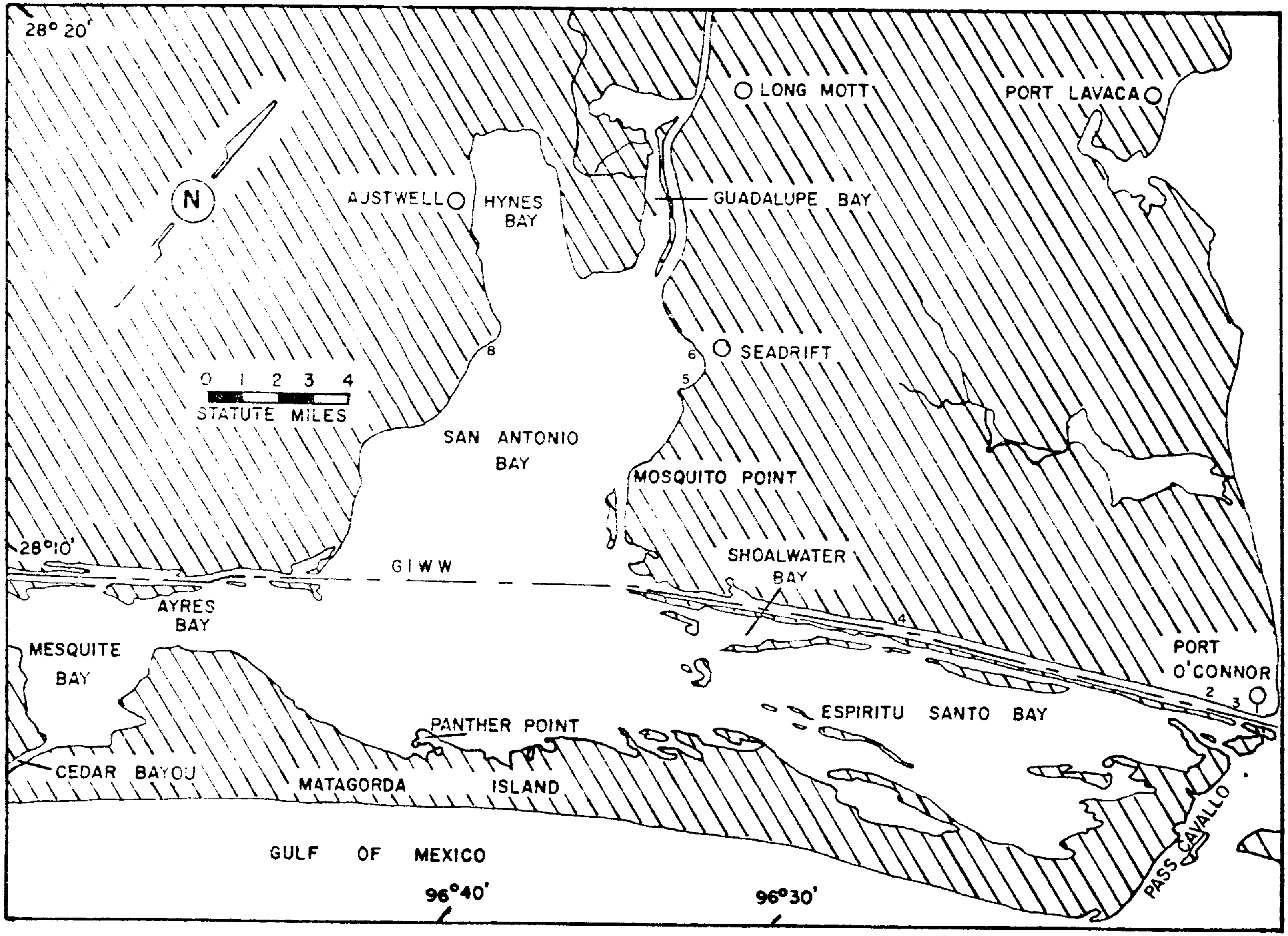

Figure 5 . Boat ramp access points in the San Antonio Bay system (Sept. 1979-Aug. 1980).

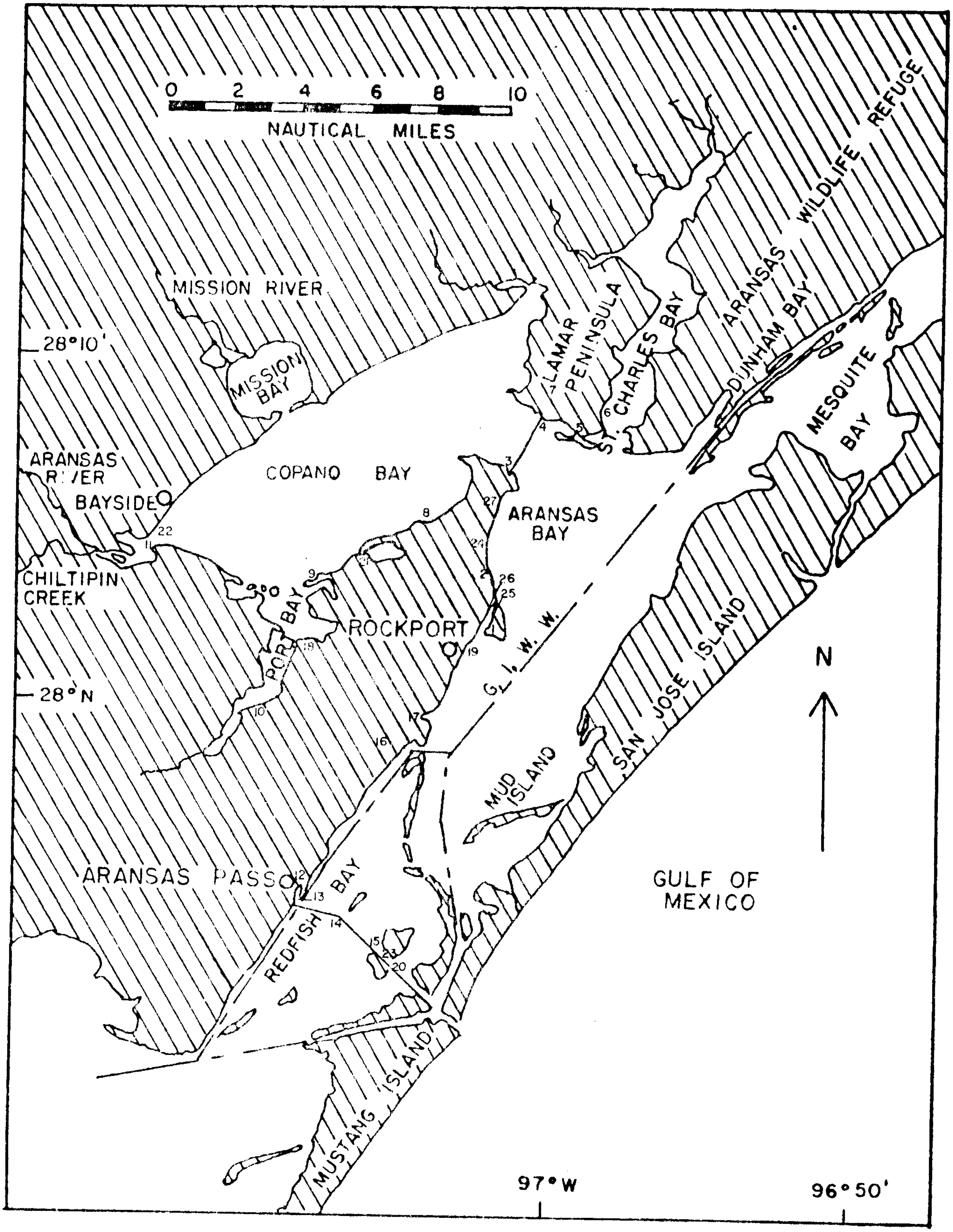

Figure 6 . Boat ramp access points in the Aransas Bay system (Sept. 1979-Aug. 1980)

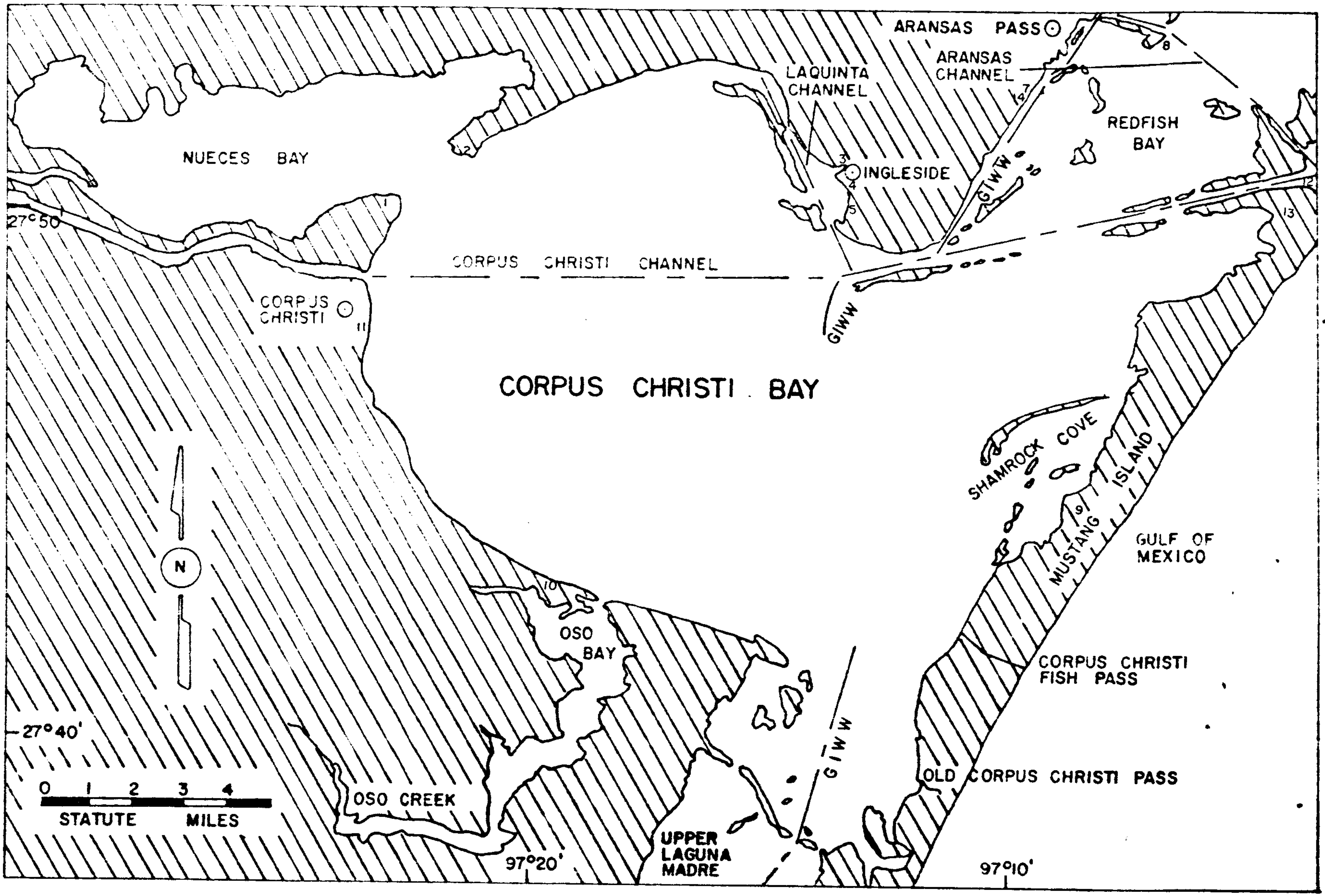

Figure 7. Boat ramp access points in the Corpus Christi Bay system (Sept. 1979-Aug. 1980).

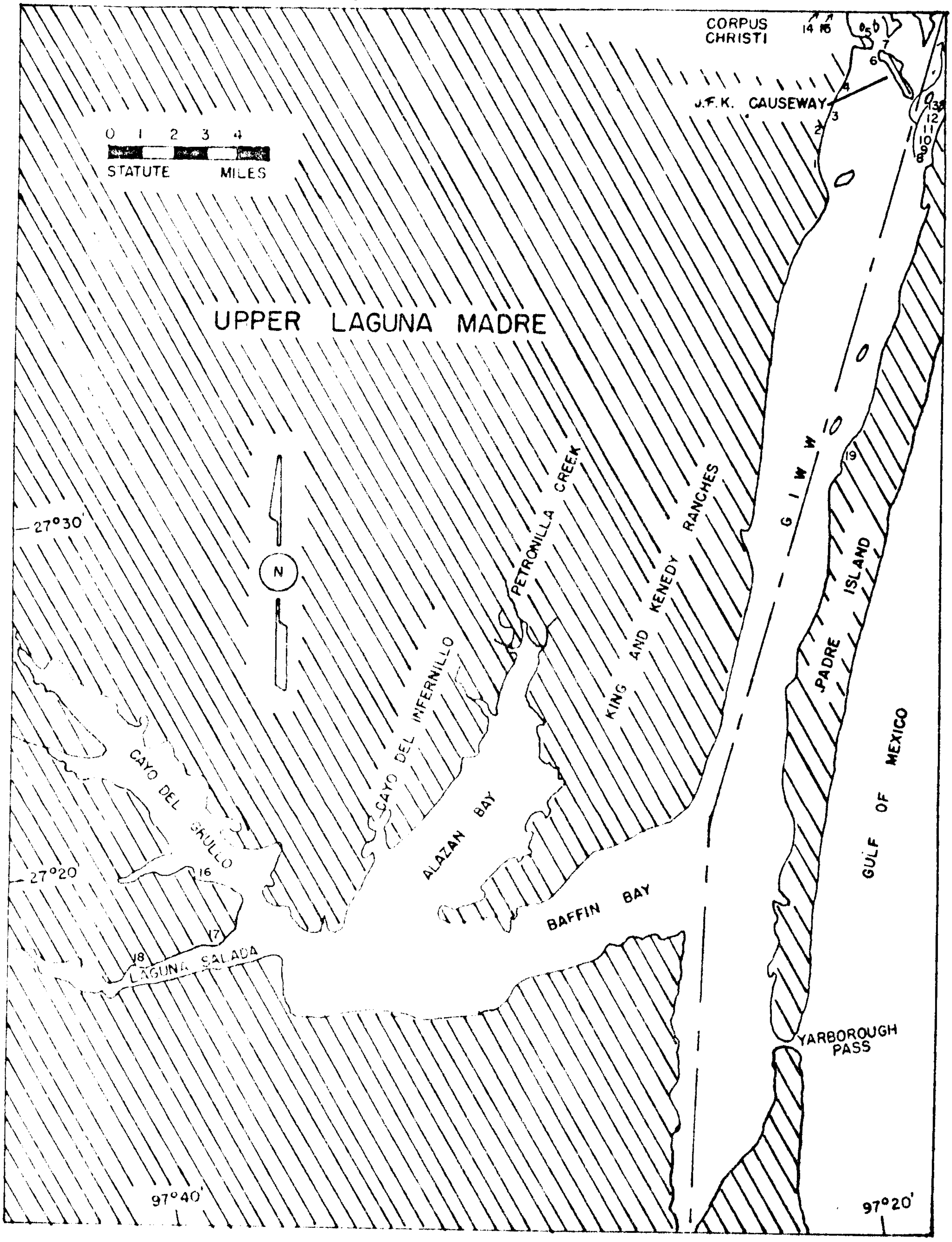

Figure 8 . Boat ramp access points in the upper Laguna Madre Bay system (Sept. 1979-Aug. 1980).

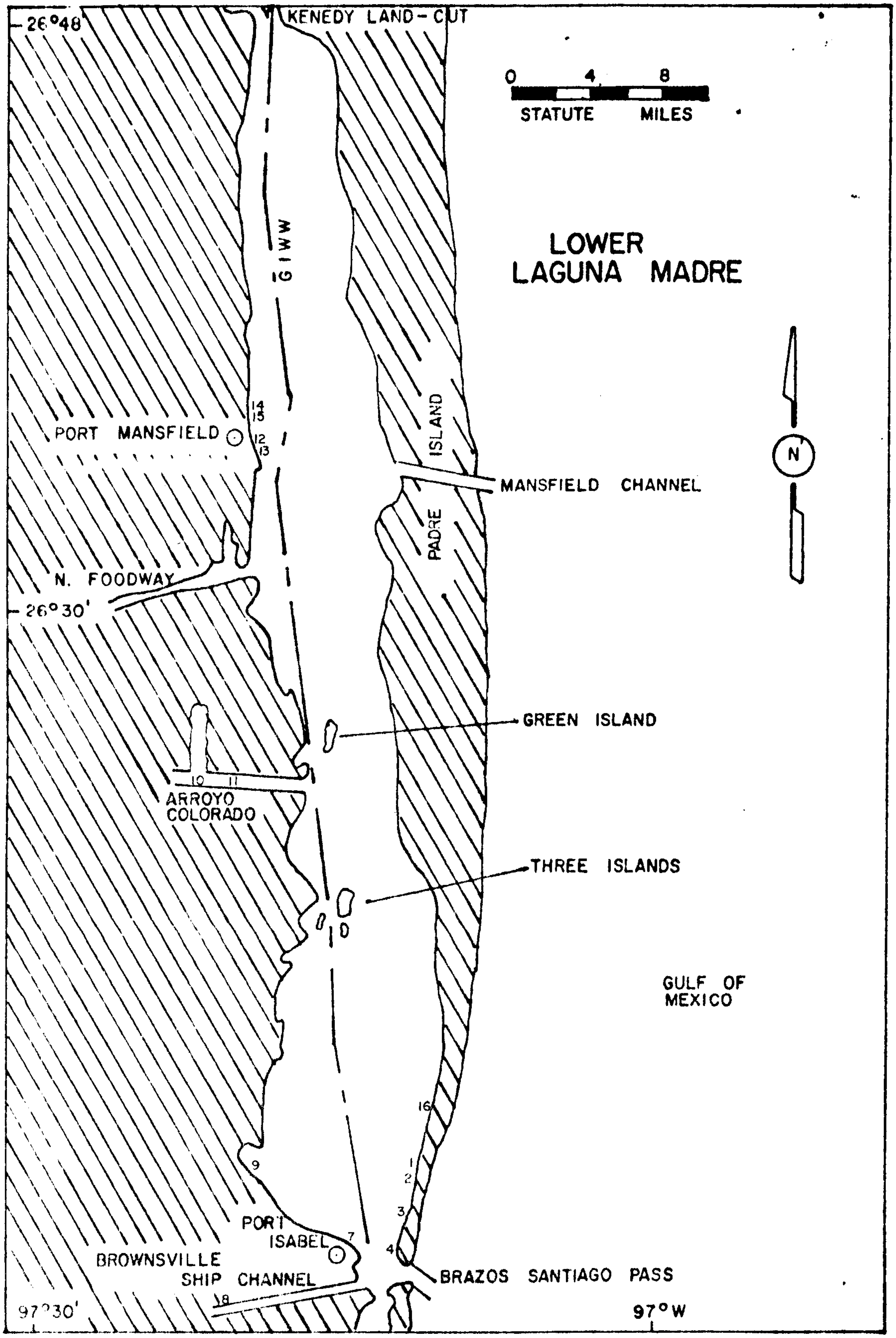

Figure 9 . Boat ramp access points in the lower Laguna Madre Bay system (Sept. 1979-Aug. 1980).

Appendix C: Area descriptions

AREA DESCRIPTIONS

Descriptions of each bay system except the East Matagorda Bay system were reproduced from Matlock et al. (1978).

Galveston Bay

The Galveston Bay system, which includes 353,768 acres, is the largest estuary on the Texas coast (Fisher et al. 1972) and consists of Galveston, Trinity, East, West, Dickinson, Chocolate, Christmas, Bastrop, Dollar, Drum and Tabbs Bays and Clear, Moses and Jones Lakes (Fig. 1a-b).

The estuary is separated from the Gulf of Mexico by Bolivar Peninsula, Galveston Island and Follets Island. Two natural passes, Bolivar Roads and San Luis Pass, and one man-made pass, Rollover Pass, connect the estuary with the Gulf.

Bay depths average 6.9 ft or less except in dredged channels. Bolivar Roads, Houston, Texas City, Galveston and Bayport Ship Channels are dredged to 40 ft. The Intracoastal Waterway is dredged to 12.1 ft through East, lower Galveston, and West Bays (Diener 1975).

Bay substrates include mud, shell and clay; barrier island shorelines are predominately sand. Approximately 7,527 acres of oyster reefs lie in Galveston, Trinity, East, West and Dickinson Bays (Benefield and Hofstetter 1976). Numerous spoil "islands" occur along most dredged channels.

Shoreline marshes are present along portions of East, West, Trinity, Christimas, Bastrop, Drum and Chocolate Bays. Diener (1975) listed 231,342 acres of emergent vegetation--smooth cordgrass (Spartina alterniflora), salt meadow cordgrass (S. patens), bulrush (Scirpus olney), shoregrass (Monothochloe littoralis), rush (Juncus romerianus), seashore saltgrass (Distichlis spicata) and saltwort (Batis maritima)--and 18,095 acres of submergent seagrasses--widgeon grass (Ruppia maritima) and Holodule beaudettei--in Galveston Bay. McEachron, Shaw and Moffett (1977) reported Halophilia engelmanni and turtle grass (Thalassia testudinum) in Christmas and Bastrop Bays.

The bay receives an average 2642 billion gal of fresh water annually, 90% of which comes from the Trinity and San Jacinto Rivers (Environmental Protection Agency 1971). Diener (1975) reported salinities ranging from 5-15 o/oo in Trinity and upper Galveston Bays to 20-30 o/oo in the lower portions of Galveston Bay near the Gulf. From November 1975 through March 1976 bay salinities at gill net stations ranged from 2.2 to 28.9 o/oo, dissolved oxygen varied from 5 to 18 ppm and water temperatures ranged from 40.1 to 76.1 F (Texas Parks & Wildlife Dept., Seabrook, Texas).

The Galveston Bay complex is adjacent to the most populated and industrialized area of Texas. A population of 2,424,800 people reside in the eight counties bordering the bay (1974 Census Data, Houston--Galveston Area Council, personal communication). The highest concentrations of people and industrial complexes are on the western shores of Galveston Bay and the eastern shores of West Bay. From 1967 to 1969 the daily average flow of domestic wastewater into the Galveston Bay complex was at least 16.7 million gal and the industrial wastewater inflow at least 300 million gal (Diener 1975).

Sport fishermen caught an estimated 2,774,297 lb of fish in the bay from September 1974 through August 1975 (Heffernan et al. 1977). The commercial fishing industry harvested over 45.1 million lb of shrimp worth $38,000,000, 15.4 million lb of blue crabs worth $1,700,000, 6.6 million lb of finfish worth $1,200,000, 21.4 million lb of shelled oysters worth $11,700,000 and 9.3 million lb of small bait shrimp worth $11,100,000 (O. B. Lynam, Texas Parks & Wildlife Dept., Seabrook, Texas, Unpublished data).

East Matagorda Bay

East Matagorda Bay (Fig. 2) is a relatively shallow (3.4 ft average depth), medium to high salinity (15-30 o/oo), turbid bay with a surface area of 37,810 acres at mean low water (MLW) (Diener 1975).

The bay's only connection with the Gulf of Mexico has historically been Brown Cedar Cut at the east end. Caney Creek and the Colorado River delta mark the northeast and southwest boundaries, respectively. The Matagorda Peninsula forms the southern boundary while the Intracoastal Waterway borders the northern shoreline of East Matagorda Bay.

Extensive stands of emergent cordgrass (Spartina sp.) occur along both the southern and northern boundaries with rush found on the northern shoreline. Submergent grasses include widgeon grass and Halodule beaudettei.

Oyster reefs are located throughout the system but no estimate of the acreage was available.

East Matagorda Bay receives fresh water from rainfall and runoff entering the Intracoastal Waterway from Caney Creek, the Colorado River and Peyton Creek (via Lake Austin and Live Oak Bayou). No estimates of the amount of annual fresh water inflow were available.

Population centers are located at each end of the bay in Matagorda (population 700) and in Sargent (population unknown). Fishing comprises the major activity of residents in both towns; however, information concerning commercial and recreational landings has been combined with data from the Matagorda Bay system.

Matagorda Bay

The Matagorda Bay system (Fig. 3) encompasses an area of 244,430 acres and has an average depth of about 6.9 ft at MLW (Diener 1975). It includes Tres Palacios, Turtle, Carancahua, Lavaca, Cox, Keller and Chocolate Bays and Oyster, Redfish, Salt and Powderhorn Lakes.

Matagorda Bay is a large primary bay of 167,529 acres and 7.9 ft mean depth (Diener 1975). The southern boundary is the long, narrow Matagorda Peninsula with sand shoreline and extensive areas of submergent and emergent grasses; the eastern confine is the Colorado River delta and the western boundary is a shallow sand shoreline with limited submergent and emergent vegetation. The community of Port O'Connor (population 1,400) is in the southwest corner. Several secondary and tertiary bays associated with major and minor drainages into Matagorda Bay indent the northern perimeter.

Oyster Lake is a shallow muddy tertiary system of 2335 acres and 2.6 ft mean depth (Diener 1975) located along the northwestern shoreline of Matagorda Bay. Numerous oyster reefs are located throughout the system and the periphery is surrounded by emergent vegetation. Tres Palacios Bay is a secondary system of 9436 acres and 3.9 ft mean depth (Diener 1975) with oyster reefs and scattered shell throughout. The community of Palacios (3,500 people) is located on the northern shoreline. Turtle Bay, with 1280 acres and 2.6 ft mean depth (Diener 1975), is a muddy system with a moderate number of oyster reefs. The shoreline is primarily clay bluffs with scattered emergent vegetation communities.

Carancahua Bay, along the north central shoreline of Matagorda Bay, covers 13,076 acres and has a 3.9-ft mean depth (Diener 1975). Several resort communities (Port Alto, Schicke Point and Cape Carancahua) are located along the bay. This bay has little marsh except in the southern portion where the tertiary systems of Redfish and Salt Lakes are located. Steep banks and sandy clay constitute the majority of the shore areas.

Lavaca Bay is a large secondary bay in the northwest corner of Matagorda Bay with 44,729 acres and 4.3-ft mean depth (Diener 1975). The shoreline is primarily clay bluffs. On the southeastern shoreline of Lavaca Bay are two smaller secondary areas: Cox Bay and Keller Bay. Cox Bay is a shallow muddy system with a clay bluff periphery and scattered oyster reefs throughout. Keller Bay is a deeper system and the southern perimeter has the largest submerged grass beds found in the Lavaca Bay complex. The community of Olivia (240 people) is located at the head of Keller Bay. On the western shoreline of Lavaca Bay is Chocolate Bay, a small, muddy bay of 699 acres and 2.6-ft mean depth with clay bank shoreline (Diener 1975). North of Chocolate Bay is the city of Port Lavaca (12,000 people). The area of central Lavaca Bay is the most heavily industrialized in the Matagorda Bay system.

South of Lavaca Bay, on the western shoreline of Matagorda Bay, is Powderhorn Lake. This is a moderately saline, shallow body of water of 2889 acres and 2.3-ft mean depth (Diener 1975). This "lake" connects with Matagorda Bay through Powderhorn Bayou on which the community of Indianola (200 people) is located. The periphery of this bay is surrounded by large emergent grass communities.

There are two direct exchanges with the Gulf of Mexico, Pass Cavallo and the Matagorda Ship Channel, both located in the southwest corner of Matagorda Bay, and one indirect connection, the Colorado River, on the eastern boundary. The western portion of Matagorda Bay and the southern two-thirds of Lavaca Bay are transected by the Matagorda Ship Channel, 35.4 ft deep (Diener 1975), with associated spoil banks. The channel originates at the ALCOA (Aluminum Company of America) plant on the eastern shoreline of Lavaca Bay and terminates at the Gulf of Mexico through the Matagorda jetties. Small channels branch off in Lavaca Bay to the Refuge Harbor at Port Lavaca and to the Lavaca River. The Intracoastal Waterway, dredged to 12.1 ft (Diener 1975), intersects the Matagorda Ship Channel near Port O'Connor. The Palacios Ship Channel branches from the Intracoastal Waterway in south central Matagorda Bay.

Diener (1975) listed 119,970 acres of emergent vegetation--smooth cordgrass, salt meadow cordgrass, saltwort, shoregrass and coastal dropseed (Sporobolus virginicus)--and 7037 acres of submergent vegetation (widgeon grass and Halodule beaudettei) in the Matagorda Bay system.

Between 1957 and 1968 Matagorda Bay received an average 713 billion gal of freshwater discharge annually (Diener 1975), mainly through the Tres Palacios, Carancahua, Lavaca and Navidad Rivers with partial flow entering the bay from the Colorado River. From November 1975 through March 1976, bay water salinities at gill net stations ranged from 10.0 to 28.0 o/oo, dissolved oxygen varied from 6.0 to 13.0 ppm and water temperatures ranged from 44.6 to 78.8 F (Texas Parks & Wildlife Dept., Palacios).

Sport fishermen caught an estimated 844,600 fish weighing 968,832 lb in Matagorda Bay from September 1975 through August 1976; during the same period commercial fishermen landed 176,370 lb of fish (Breuer et al. 1977).

San Antonio Bay

The San Antonio Bay system consists of the primary bays San Antonio and Espiritu Santo and the secondary bays Hynes, Guadalupe and Shoalwater (Fig. 4). Several large natural saltwater lakes occur along Matagorda Island and connect with the primary bays via sloughs and small passes. Two major passes, Cedar Bayou Pass to the west and Pass Cavallo to the east, provide circulation routes between the Gulf of Mexico and the bay system.

San Antonio, Hynes and Guadalupe Bays cover approximately 84,012 acres and Espiritu Santo Bay covers 34,099 acres for a total bay system area of 118,111 acres (Collier and Hedgpeth 1950). The average depths of the unaltered bay system are 3.9 ft in San Antonio Bay (maximum of 7.6 ft) and 4.9 ft in Espiritu Santo Bay (maximum of 7.9 ft) (Collier and Hedgpeth 1950).

Bottom substrates are generally silty clay and sand in the upper bay region which gradually change to sand clay and sand in the lower bay and Espiritu Santo bay regions (Texas Parks & Wildlife 1975). Approximately 3015 acres of spoil islands and 2001 acres of oyster reefs occur in the bay system (Burg 1974). One of the major oyster reefs is Panther Reef which extends from Panther Point north toward Mosquito Point.

The Guadalupe and San Antonio Rivers are the major sources of fresh water for the San Antonio Bay system, providing an average annual inflow of 449 billion gal from a drainage area of 6,559,920 acres (Childress et al. 1975). The amount of fresh water entering the system generally depends upon rainfall in the upland drainage rather than on local drainage. Local rainy periods usually occur during early summer and fall. The average annual rainfall for the area is 33.9 inches (Texas Parks & Wildlife 1975).

Salinity values for the bay system generally increase as the distance from the rivers increases. Out-flowing fresh water moves along the west shore of San Antonio Bay while incoming Gulf water moves along the east shore (Childress et al. 1975). Average surface salinities range from 0.0 o/oo in Guadalupe Bay to about 8.0 o/oo in lower San Antonio Bay and from 14.0 to 21.0 o/oo in Espiritu Santo Bay (Childress et al. 1975). No seasonal turbidity patterns are noted within the bay system; however, turbidities tend to increase toward the upper bay and river-influenced areas, as well as in areas disturbed by mud-shell and channel dredging operations (Childress et al. 1975). Dissolved oxygen concentrations increase during cold months and decrease during warm months. Between May 1972 and August 1973, average dissolved oxygen concentrations ranged from 7.0 to 12.4 ppm (Childress et al. 1975).

About 24,993 acres of emergent and 16,345 acres of submergent vegetation are found in the San Antonio Bay system (Diener 1975). Smooth cordgrass is the dominant emergent plant in all areas of the bay system except in upper San Antonio Bay where common reed, Phragmites communis, is dominant (Childress et al. 1975). Other species of emergent vegetation include saltwort, saltgrass, shoregrass and salt meadow cordgrass (Diener 1975). The dominant submergent vegetation of the San Antonio Bay system is shoal grass, Diplanthera wrightii.

This plant is located primarily in the low turbidity areas of lower San Antonio Bay and Espiritu Santo Bay and in the shallow lakes and sloughs found along the northern margin of Matagorda Island. Other species of submergent vegetation found in the bay system include widgeon grass, and the algae Polysiphona gorgoniae, Spyridia filimentosa, Gracilaria folifera, Ulva lactuca and U. fasciata (Childress et al. 1975). The algae are usually found attached to submerged solid objects such as oyster shells or pilings. However, some algae can be found in calm areas attached to mud or sand substrates.

Four small towns occur on the shoreline of the San Antonio Bay system: Austwell, Long Mott, Seadrift and Port O'Connor. Less than 4,000 inhabitants live in these four communities combined (1970 census). The primary businesses found in this area are farming, ranching and fishing, including shrimping and oystering. The majority of the bay shoreline as well as the San Antonio-Guadalupe River drainage occurs on or near ranchland and farmland. Two major industries exist on the San Antonio Bay system; Union Carbide Corporation at Long Mott and DuPont de Nemours E.I. & Company at Bloomington, a town on the Guadalupe River approximately 20 miles from the bay.

The tourist industry is not very extensive, but a few fishing centers at Seadrift and Port O'Connor furnish tackle, guides and access to the bay system. Most of the sport fishing occurs in Espiritu Santo Bay. Between September 1974 and August 1975, sport fishermen harvested an estimated 416,453 lb of fish from the entire bay system; commercial fishermen harvested an estimated 482,592 lb of fish (Heffernan et al. 1977). In addition, approximately 883,172 lb of shrimp, 1,125,239 lb of blue crabs and 196,873 lb of oysters were harvested commercially during the 1974 calendar year (O. B. Lynam, Texas Parks & Wildlife Dept., Seabrook Field Station, personal communication).

Aransas Bay

The Aransas Bay complex consists of primary, secondary and tertiary bays. The system extends from Aransas Pass, Texas, northeastward to Mesquite Bay, and from its eastern boundary of San Jose Island, westward across Copano Bay to the small community of Bayside, Texas (Fig. 5).

Aransas Bay is the primary bay with a surface area at MLW of 56,207 acres and an average depth of 7.9 ft (Diener 1975). A direct water circulation and marine life migration route from the Gulf of Mexico to the bay is provided by a deep water (45.0-46.9 ft) pass, 600 to 712 ft in width, between San Jose Island and Mustang Island at Port Aransas, Texas (Anonymous 1971). This accounts for the higher than average salinities in the southern region of the bay (approximately 30 o/oo). The middle of the bay is the deepest part with a maximum value of 13.1 ft at MLW (U. S. Dept. Commerce 1976a). Six major oyster (Crassostrea virginica) reefs ranging in area from 25 to 257 acres are concentrated in the northern portion of Aransas Bay, along with scattered smaller reefs (Heffernan 1961). There are no private oyster leases in the Aransas Bay system (Diener 1975).

Copano, St. Charles, Redfish and Dunham Bays are considerably shallower, secondary areas, supporting extensive growths of algae and "grasses", which provide valuable nursery grounds for juvenile fish and crustaceans (Heffernan 1972a). Nutrient circulation in these bays is generally affected by freshwater runoff as well as by tidal fluctuations.

Copano Bay is the largest secondary bay with 41,730 acres of surface water and an average depth of 3.6 ft with a maximum depth of 8.9 ft (Diener 1975). The Mission and Aransas Rivers flow into the bay with respective discharges of 733.3 and 65.0 gal/s (Diener 1975).

Copano Bay has five large oyster reefs, ranging in size from 22 to 42 acres, plus a compliment of smaller reefs (Heffernan 1961). The transverse position of a few of the reefs near the mouth of Copano Bay dampen tidal action in much of the bay (Collier and Hedgpeth (1950).

The narrow St. Charles Bay, extending between Lamar Peninsula and the Aransas National Wildlife Refuge, has a surface area of 8408 acres with a 3.6-ft average depth (Diener 1975). Freshwater flow from five creeks enters the bay along its northern reaches. Nearly the entire bay is considered prime nursery ground (Heffernan 1972a).

Redfish and Dunham Bays, at the southern and northern ends, respectively, of Aransas Bay, are also very shallow nursery areas but these bays do not receive direct freshwater flow. Redfish Bay is densely vegetated while Dunham Bay is a muddy, sparsely vegetated area.

Tertiary nursery grounds are located principally in the lower regions of creeks and streams which enter the secondary bays. Port Bay with 1651 acres extends southward from Copano Bay and receives freshwater from creek drainage at its southern tip (Diener 1975).

Mission Bay and lower Mission River with nearly 3939 acres and located off the northwest shore of Copano Bay are the most valuable nursery grounds of the tertiary areas (Heffernan 1972b).

Copano Creek harbors a small portion of nursery grounds in the northwest corner of Copano Bay (Heffernan 1972a).

Tertiary regions of Chiltipin Creek and the Aransas River system are located along the western shore of Copano Bay (Heffernan 1972a).

The Aransas Bay system contains 137,514 acres of water (Heffernan 1972a) of which 44,989 acres are occupied by eight major species of emergent vegetation--saltwort, shoregrass, glassworts (Salicornia sp.), smooth cordgrass, salt meadow cordgrass, coastal dropseed, sea purselane (Sesurium portulacastrum) and seashore saltgrass--and 4,124 acres by three major species of submerged vegetation--(Halodule beaudettei), widgeon grass and turtle grass (Diener 1975; W. E. Mercer, TPWD, Personal Communication).

The climate of this area varies from semi-arid to dry sub-humid. Southeast winds are dominant most of the year but from December through February northerly winds associated with advancing cold fronts are common (Whitehouse and Williams 1953). Winters in the Aransas Bay system produce the lowest average monthly water temperatures (59.2 F) and rainfall (0.8 inch). Water temperatures increase through the spring (70.9 F), reach the highest values in the summer (83.7 F) and decline through the fall (73.6 F). Rainfall is greatest in the fall (6.4 inches). The amounts of rainfall in spring and summer average about 2.6 inches. Salinity values are inversely related to rainfall with the lowest salinity (14.1 o/oo) occurring in the fall. The highest salinity occurs in spring (26.8 o/oo). Dissolved oxygen, pH and turbidity remain relatively constant throughout the year with average values of about 7.0 ppm, 8 and 50 Jackson Turmidity Units (JTU), respectively (Martinez 1970, 1971).

Water movement in the bay system is strongly influenced by wind action. Generally, however, the surface waters take a serpentine course, flowing during a falling tide from Copano Strait south toward Mud Island where there is a clockwise eddy which tends to return the bay water northward along the face of the more saline water from below Mud Island. On a strong rising tide this water is pushed east so that the eddy constricts into an ellipse (Collier and Hedgpeth 1950). The average tidal range for Aransas Bay is 0.49 ft (Diener 1975).

Mud is the predominant bottom sediment of the Aransas Bay system except along the sandy western shore of San Jose Island (Diener 1975).

The average total weight of finfish caught per year by commercial fishermen in the Aransas Bay system during the period 1969-1971 was 573,612 lb (Martinez 1970, 1971). The annual average harvest of commercially caught shrimp and crabs during the same period was 816,991 lb and 420,827 lb respectively.

Along the 230 miles of shoreline of the Aransas Bay system, the only communities of notable size are Lamar, Bayside, Fulton, Rockport and, the largest, Aransas Pass which has a population of about 6,000.

There are three domestic but no industrial waste outfalls in the bay system. Previous high discharges of toxic oilfield brine into Chiltipin Creek and the Mission River were ordered ceased in 1973 by the Texas Railroad Commission (Heffernan 1972b). A total of 14,796 acres in the Aransas Bay system are now closed to shellfishing by the Texas Board of Health (Diener 1975) because of domestic sewage problems.

Corpus Christi Bay

The Corpus Christi Bay system, composed of Corpus Christi, Nueces, lower Redfish and Oso Bays, is located on the lower third of the Texas Gulf coast between longitude 97° 02' and 97° 32' W and latitude 27° 41' and 27° 55' N (Fig. 6). It is bordered on the northeast by upper Redfish Bay, on the east by Mustang Island and on the south by the upper Laguna Madre. The city of Corpus Christi forms the western boundary of Corpus Christi Bay. Nueces Bay, the former coastal lagoon for the Nueces River basin, is positioned on an east-west axis, entering Corpus Christi Bay at the northwest corner, just north of Corpus Christi. The southern half of Redfish Bay separates Aransas from Corpus Christi Bay and enters Corpus Christi Bay in the northeast quadrant. Oso Bay, the semi-enclosed drainage area for Oso Creek, joins Corpus Christi Bay in the southwest quadrant.

The entire Corpus Christi Bay system has an area of 124,796 acres with 127 miles of shoreline. Corpus Christi Bay is the largest of the four bays in the system, having a total surface area of 95,997 acres. Nueces Bay has an area of 19,518 acres, Oso Bay covers approximately 17,095 acres and lower Redfish Bay covers approximately 5258 acres. The average depth of Corpus Christi Bay is 11.2 ft; Nueces, Oso and lower Redfish Bays average 2.0 ft in depth (Collier and Hedgpeth 1950, Hood 1953, Stevens 1959).

Sediment composition in Corpus Christi Bay ranges from fine sand to black mud. A mixture of gray clay and black mud is the dominant bottom type for the area. Brown silt occurs in areas of channelization while hard sand and fine shell can be found adjacent to Mustang Island.

Submergent vegetation is sparse in Corpus Christi Bay, except along its eastern shore where shoal grass and widgeon grass dominate. Emergent vegetation, found throughout the bay complex, consists primarily of saltwort, glassworts, shoregrass, smooth cordgrass, coastal dropseed, seablite, _Suaeda linearis_, sea oats, _Uniola paniculata_ and saltmarsh bullrush, _Scirpus maritimus_. In Corpus Christi Bay, 19 oyster reefs total 563 acres and are confined primarily to the western and northern portions. Oysters occur throughout Nueces Bay (Stevens 1959, 1960; Diener 1975). The primary sources of freshwater inflow into the Corpus Christi Bay system are Oso Creek and the Nueces River. Prior to the construction of Wesley Seale Dam at Mathis, Texas, in 1958, the Nueces River averaged 200 billion gal of discharge per year. The reservoir furnishes the industrial and municipal freshwater needs for the city of Corpus Christi and surrounding towns. Freshwater inflow to Nueces and Corpus Christi Bays is now limited to periods of dam overflow and heavy land runoffs (Stevens 1959).

Prior to 1972, the primary source for water exchange between Corpus Christi Bay and the Gulf of Mexico was the Corpus Christi Channel. This ship channel extends approximately 18 miles from the Port of Corpus Christi to its intersection with the Aransas Ship Channel, which continues for approximately 1 mile to the Gulf of Mexico. The two channels are maintained at an average depth of 40.0 ft (U. S. Dept. Commerce 1974). Since its completion in 1972, the Corpus Christi Fish Pass has provided intermittent water exchange through the upper Laguna Madre, but in recent years this has only accurred in association with hurricane winds and tides. Water exchange for Corpus Christi Bay with lower Redfish Bay and the upper Laguna Madre takes place primarily through the Intracoastal Waterway and on a limited basis across the shallow flats during high tides.

The climate for the area is intermediate between the semi-arid regions to the west and southwest and the humid subtropical region to the northeast. For the period 1936-1975 the mean annual air temperature was 71.2 F and the mean annual rainfall was 28.5 inches (NOAA 1975).

The general water circulation pattern for the Corpus Christi Bay system is a counterclockwise movement along the shoreline (Stevens 1959). The predominant winds, generally from the southeast year-round with occasional "northers" in the winter, and the irregular lunar tides, have the greatest overall influence on the bay water movement. For the period 1968-1972, the mean salinity and the mean water temperature for the entire Corpus Christi Bay system was 26.1 o/oo and 73.4 F, respectively (Martinez 1968, 1969, 1970, 1971 and 1972). The mean turbidity for the same period was 43 JTU, although the mean for Nueces Bay during 1971 and 1972 was 107 JTU.

The entire system lies within Nueces County, Texas. The county, with an area of 536,301 acres, had a population of 237,544 persons as of the 1970 census. The City of Corpus Christi had a population estimate of 204,525 (Diener 1975). Extensive oil and gas exploration has resulted in numerous well platforms and submerged pipelines throughout Nueces and lower Redfish Bays and along the western shore of Corpus Christi Bay. Heavy industrialization has occurred along the south shore of Nueces Bay and the north shore of Corpus Christi Bay in the area of La Quinta Channel.

Upper Laguna Madre

Located on the lower Texas coast between latitudes 27° 10' and 27° 41' the upper Laguna Madre system consists of the upper Laguna Madre and the Baffin Bay system (Fig. 7). The upper Laguna Madre is a long (approximately 41 miles), narrow (9.8 miles) and shallow (average depth 3.3 ft) lagoon extending from the Kenedy Land Cut to Corpus Christi Bay (Simmons 1957; Diener 1975; U. S. Dept. Commerce 1976b). Bordered on the east by Padre Island and on the west by the city of Corpus Christi and the King and Kenedy Ranches, the upper Laguna Madre covers approximately 47,228 acres at MLW (Diener 1975).

This long, narrow coastal lagoon is bisected imperfectly by the Intracoastal Waterway, which is 124.7 ft wide and 12.1 ft deep. Spoil banks from this canal form a dike 13 miles long effectively dividing the northern part of the bay. Beyond this point, spoil banks are staggered and the division is less effective (Simmons 1957). The northern end of the lagoon is restricted by a land fill causeway which has three openings totaling about 899 ft in width at MLW. The southern end is restricted by a land fill through which the Intracoastal Waterway extends.

The upper Laguna Madre is joined in the southern portion by the equally large Baffin Bay system--consisting of Baffin Bay, Alazan Bay, Laguna Salada, Cayo del Grullo and Cayo del Infernillo--which covers an estimated 54,117 acres. Baffin Bay, the central and largest bay of the group, is a narrow body of water, 19 miles long and 5 miles wide, bisected laterally by the demarcation line of Kleberg-Kenedy Counties (Breuer 1957). The average depth in Baffin Bay is 7.9 ft at MLW, with a maximum depth (MLW) of 12.1 ft near the entrance to the Laguna Madre (Breuer 1957, Diener 1975). There are approximately 31,861 acres of surface area (MLW) in Baffin Bay.

Alazan Bay, entirely within Kleberg County and the King Ranch, extends approximately 15 miles northeasterly to the mouth of Petronilla Creek (Breuer 1957, Diener 1975). The average water depth (MLW) in Alazan Bay is approximately 3.0 ft. The surface area of Alazan Bay is approximately 13,867 acres.

Cayo del Infernillo is a shallow slough (0.7 ft) extending westward from the west shore of Alazan Bay whose water surface at MLW covers 699 acres (Breuer 1957, Diener 1975).

Baffin Bay is joined by two small tertiary bays--Laguna Salada entering from the west and Cayo del Grullo from the northwest. Both bays have an average water depth (MLW) of 3.0 ft. Laguna Salada covers approximately 3227 acres and Cayo del Grullo about 4470 acres.

The upper Laguna Madre, with restricted openings at either end, no constant openings into the Gulf of Mexico and limited freshwater inflow, has been characterized as a hypersaline estuary (Simmons 1957, Breuer 1962a), with salinities of 50-60 o/oo common. The Intracoastal Waterway provides for limited water exchange at both ends of the lagoon. Since the dredging of the Intracoastal Waterway salinity "has neither risen above 80 o/oo in the lagoon nor in Baffin Bay (where 100 o/oo was formerly not uncommon), nor have waters of very low salinity remained in the area any length of time" (Simmons 1957).

The only substantial source of freshwater is runoff from the Kenedy, Kleberg, Jim Wells and Nueces County watersheds into the Baffin Bay system (Breuer 1957). The dry sand on Padre Island absorbs rain very rapidly and the very gradual slope of the lagoon's western shore makes these areas poor watersheds (Simmons 1957).

The upper Laguna Madre system lies in two climatic zones--north of Baffin Bay is sub-humid; south of that point is semi-arid (Simmons 1957). Rainfall in the area is highly variable but averages 27.0-29.1 inches annually (NOAA, Env. Data Svs., Natl. Climatological Center, Ashville, N. C. 1976). Annual average surface water temperatures for the period 1969-1972 ranged from 73.6 to 76.3 F in the upper lagoon (Martinez 1969, 1970, 1971 and 1972). No data concerning water temperature from Baffin Bay is available. Southeast or south-southeast winds are prevalent during most of the year and are directly responsible for the water circulation in the system (Simmons 1957). Water in the upper lagoon is generally clear (annual average turbidity during 1969-1972 ranged from 36.8 to 45.6 JTU) (Martinez 1969, 1970, 1971 and 1972); while water in Baffin Bay is often turbid and at times becomes a dark brown (Breuer 1957).

The bottom in the upper lagoon consists primarily of quartzose sand, silt and shell with come calcareous sand or mud in isolated areas (Simmons 1957). In the Baffin Bay system bottom types of soft mud, soft and hard clay, sand and concentrated shell (mostly _Mulinia lateralis_) can be found. Also, in Baffin Bay and near the junction of Baffin Bay and the upper Laguna Madre are extensive rock formations consisting of serpulid worm tubes, calcareous and quartzose material.

Simmons (1957) and Breuer (1957) reported dense vegetation--shoalgrass and widgeon grass--restricted to the northern one-third of the lagoon. They indicated that the remainder of the system has only sparse to moderate vegetation, with the exception of the area near the entrance to Baffin Bay and areas around spoil islands.

The only substantially populated center adjacent to the upper Laguna Madre is Corpus Christi, Texas, with a population of 204,525 (U. S. Dept. Commerce 1970a). An additional 33,166 people in Kleberg County (U. S. Dept. Commerce 1970b) are located near the Baffin Bay system.

Industrialization in the area has been held to a minimum because of limited access to the surrounding land. The only major industry in the system is a public utility (Central Power and Light Co.) which displaces approximately 3.3 million gal of water/min from the upper Laguna to Oso Bay (Mr. M. L. Sheperd, Central Power and Light Co., June 1976, Personal Communication). Most of the area surrounding Baffin Bay is private ranchland and consequently there is little urban development. There is considerable oil and gas development on these ranches, resulting in large quantities of oilfield brine production. In most cases the brine has been discharged into the bay or a creek which leads to the bay. Mackin (1971) reported that approximately 2,728,897 gal of oilfield brine is discharged each day into Petronilla Creek and thence into Alazan and Baffin Bays.

Lower Laguna Madre

The lower Laguna Madre is a long shallow bay that extends 55 miles northward from Port Isabel to the Kenedy Land Cut (Fig. 8). It varies from 3 miles to 7.8 miles wide and is imperfectly bisected by the Intracoastal Waterway. The bay is bounded on the west by the Texas mainland and on the east by Padre Island and contains approximately 182,809 acres (Stokes 1974). Passes to the Gulf of Mexico are located near Port Isabel and east of Port Mansfield. Limited amounts of fresh water (average of 818.9 gal/s) enter lower Laguna Madre from the Arroyo Colorado and North Floodway (Bryan 1971).

Except for the Intracoastal Waterway with an average depth of 12.0 ft, the deepest areas are found in the northern and southern portions of the bay (Breuer 1962a). In the northern section, which extends from Port Mansfield to the Kenedy Land Cut, water depth is as much as 7.9 ft. From Port Mansfield south to Three Islands the water is shallow with most locations being $<$ 3.0 ft deep. South of Three Islands the maximum water depth is 5.9 ft and water depths of 3.9-4.9 ft are prevalent.

Bottom types consist of sand, silty sand or a combination of sand, silt and clay (Shepard and Rusnak 1957). Shell is not commonly found in lower Laguna Madre. In general, sediments are coarser along the eastern or Padre Island side of the bay than along the western or mainland side of the bay.

Shoalgrass is the most common type of vegetation found in lower Laguna Madre (Stokes 1974). Dense stands of shoalgrass can be found in shallow water along most of the shoreline as well as in the entire middle portion (Port Mansfield to Three Island) of the bay. Light to dense stands of manatee grass (*Cymodocea filiforme*), turtle grass, widgeon grass, *Halophila engelmannii* and *Acetabularia crenulata* can be found scattered throughout the bay.

Hydrological parameters have been described by Stokes (1974). Average monthly salinities range from 16.0 to 41.0 o/oo. Excluding the Arroyo Colorado and North Floodway, salinities as low as 10.5 o/oo and as high as 44.9 o/oo are sometimes encountered. Average monthly bottom water temperatures range from 62.6 F during some winter months to 81.5 F in August. Turbidity values are generally highest from Port Mansfield to Three Islands (the shallowest portion of the bay). The average annual turbidity value in this region is 45 JTU. North of Port Mansfield the average turbidity is 28 JTU and south of Three Islands the average is 32 JTU.

The total population for the counties bordering lower Laguna Madre is 162,608 (Harlingen Chamber of Commerce). In 1973, 1,278,000 out-of-state residents visited the lower Rio Grande Valley. Although there are no figures available, it is probable that many of these people visited this area because of water related activities in lower Laguna Madre. Farming and ranching are the main industries along the bay. The only area of heavy industry is the Brownsville Ship Channel where several shrimp processing plants, a Union Carbide plant, a grain elevator, three ship dismanteling plants, two oil loading docks and an oil rig construction company are located.

Appendix D: Summary of three-way analysis of variance of weekend and weekday mean daily catch rates.

Table 1. Mean daily catch rates (spotted seatrout/man-hour) weekend and weekday.

Strata	Bay system[a]	Weekend	Weekday	Pooled
Boat	Galveston	0.08 (7)[b]	0.15 (9)	0.11 (16)
	Matagorda	0.08 (6)	0.08 (4)	0.08 (10)
	Aransas	0.11 (5)	0.43 (5)	0.27 (10)
	Corpus Christi	0.37 (7)	0.61 (6)	0.49 (13)
	Upper Laguna Madre	0.44 (5)	0.45 (8)	0.44 (13)
	Lower Laguna Madre	0.60 (6)	0.47 (7)	0.54 (13)
	Pooled	0.38 (36)	0.36 (39)	0.32 (75)
Wade/bank	Galveston	0.04 (9)	0.09 (5)	0.06 (14)
	Matagorda	0.10 (7)	0.01 (7)	0.05 (14)
	Aransas	0.07 (9)	0.27 (7)	0.17 (16)
	Corpus Christi	0.07 (8)	0.08 (7)	0.08 (15)
	Upper Laguna Madre	0.08 (6)	0.00 (5)	0.04 (11)
	Lower Laguna Madre	0.02 (7)	0.06 (4)	0.04 (11)
	Pooled	0.06 (46)	0.08 (35)	0.07 (81)
Pier	Galveston	0.07 (7)	0.02 (8)	0.04 (15)
	Matagorda	0.04 (6)	0.02 (8)	0.03 (14)
	Aransas	0.06 (8)	0.26 (8)	0.16 (16)
	Corpus Christi	0.18 (5)	0.13 (7)	0.15 (12)
	Upper Laguna Madre	0.57 (7)	0.08 (4)	0.32 (11)
	Lower Laguna Madre	0.17 (7)	0.34 (5)	0.26 (12)
	Pooled	0.18 (40)	0.14 (40)	0.16 (80)

[a]San Antonio Bay data were not used in order to accomplish a design that would permit the analysis.
[b]Sample size (no. of days).

Note: The data in this analysis consisted of 2353 separate interviews.

Table 2. Mean daily catch rates for spotted seatrout compared by day type, fishing method and bay system.

Source of var.	Sum of sq.	DF	Mean sq.	FS
Day type (A)	0.004	1	0.0036	0.3980
Fishing method (B)	0.209	2	0.1046	11.4520***
Bay system (C)	0.152	5	0.0305	3.3344**
A x B	0.003	2	0.0016	0.1767
A x C	0.066	5	0.0132	1.4455
B x C	0.112	10	0.0112	1.2306
A x B x C	0.300	10	0.0030	0.3331
Error	1.827	200	0.0091	
Total	2.417	236		

Table 3. Mean daily catch rates for red drum compared by day type, fishing method and bay system.

Source of var.	Sum of sq.	DF	Mean sq.	FS
Day type (A)	0.001	1	0.0008	0.9412
Fishing method (B)	0.010	2	0.0048	5.6916**
Bay system (C)	0.004	5	0.0007	0.8699
A x B	0.000	2	0.0000	0.0185
A x C	0.004	5	0.0008	0.9134
B x C	0.013	10	0.0013	1.5695
A x B x C	0.006	10	0.0006	0.7735
Error	0.168	200	0.0008	
Total	0.204	236		

Table 4. Mean daily catch rates for black drum compared by day type, fishing method and bay system.

Source of var.	Sum of sq.	DF	Mean sq.	FS
Day type (A)	0.000	1	0.0002	0.2937
Fishing method (B)	0.003	2	0.0013	1.7225
Bay system (C)	0.005	5	0.0009	1.1769
A x B	0.004	2	0.0021	2.7093
A x C	0.001	5	0.0002	0.2373
B x C	0.005	10	0.0005	0.6647
A x B x C	0.008	10	0.0008	1.0467
Error	0.156	200	0.0008	
Total	0.182	236		

Table 5 . Mean daily catch rates for Atlantic croaker compared by day type, fishing method and bay system.

Source of var.	Sum of sq.	DF	Mean sq.	FS
Day type (A)	0.003	1	0.0028	0.7359
Fishing method (B)	0.000	2	0.0001	0.0132
Bay system (C)	0.136	5	0.0271	7.0520**
A x B	0.001	2	0.0006	0.1535
A x C	0.009	5	0.0018	0.4776
B x C	0.022	10	0.0022	0.5795
A x B x C	0.048	10	0.0048	1.2361
Error	0.770	200	0.0038	
Total	0.992	236		

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