GEOGRAPHIC ORIGINS OF RECREATIONAL ANGLERS USING TEXAS BAYS

by

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ABSTRACT

Few studies have been conducted on the social and behavioral aspects of marine recreational anglers. It has generally been assumed that anglers represent a homogeneous group when using catch data obtained from recreational anglers. Anglers were interviewed at boat ramps, wade/bank areas and commercial lighted piers in each of seven Texas bay systems during 1974 through 1976. Anglers were asked their country, state (if in the United States) and county (if in Texas) of residence. Differences in patterns of geographic origin and distance of residence from each bay system were determined for anglers interviewed during each season at each type of fishing platform (strata) in each bay system. Most (94.2%) of the anglers resided in Texas with 1.4% from states adjacent to Texas, 4.1% from other states in the United States and 0.4% from two foreign countries. Anglers in each bay system except the Aransas Bay and the lower Laguna Madre systems generally exhibited this same pattern of geographic origin. In these two systems the geographic origin of recreational anglers changed dramatically between seasons and fishing strata. Out-of-state residents comprised a large proportion (about 20-50%) of the wade/bank and lighted pier anglers in the winter and spring in the Aransas Bay system and in the winter in the lower Laguna Madre system. These "winter Texans" also comprised over 40% of the winter boat anglers in the Aransas Bay system. The localization of "winter Texans" to the south Texas area may have been related to available facilities, population adjacent to each bay system and climate. Patterns of anglers' geographic origin were not consistent among bay systems. The pattern for zone of origin was also dependent on either season, fishing strata or both. Anglers traveled from the Galveston area to fish in other bays, but the reverse did not occur. Distance, population, facilities and climate probably affected each angler's selection of the bay system in which to fish.

INTRODUCTION

The importance of obtaining information on fisheries resource users, especially recreational anglers, has increased dramatically in recent years. It is essential that the characteristics of anglers be determined for the development of effective management strategies. The concept of optimum sustainable yield requires that harvest limits be a function of some biologically allowable catch as modified by pertinent sociologic, economic and political factors. Few studies have been conducted on the social and behavioral aspects of marine recreational anglers and it is assumed that they represent a homogenous group (Bryan 1976). It seems unlikely that the diversity of fishing experiences available in Texas' coastal zone would be utilized by one group homogeneous in their social, economic, and political characteristics. It is imperative, therefore, that the constituency of marine recreational anglers be defined to establish a known population from which statistically reliable and meaningful socioeconomic data can be obtained for establishing levels of optimum sustainable yield.

Data on the characteristics of recreational anglers using Texas bays were almost completely non-existent until 1974 when the Coastal Fisheries Branch of the Texas Parks and Wildlife Department initiated a survey to estimate the minimum harvest of finfish by recreational anglers. Demographic data were also collected, and a cursory analysis of the data was provided in Heffernan et al. (1977) and Breuer et al. (1977). This study examines the geographic origins of recreational anglers fishing in each of seven major Texas bay systems. The origin, with respect to distance from the "target" bay system for anglers using three types of fishing platforms (strata) during each season in each bay system was determined and compared.

MATERIALS AND METHODS

Anglers in the Galveston, San Antonio, Aransas and upper Laguna Madre Bay systems were surveyed during September 1974 through August 1975; those in the Matagorda, Corpus Christi and lower Laguna Madre Bay systems during September 1975 through August 1976 (Heffernan et al. 1977, Breuer et al. 1977). Anglers using three fishing strata--boat ramps, wade/bank areas and commercial lighted piers--were interviewed on 104 different days in each bay system during the sample year. Eight randomly selected days (4 weekdays and 4 weekend days) each were spent sampling randomly selected lighted piers and wade/bank areas per season; randomly selected boat ramps were sampled on 10 days (4 weekdays and 6 weekend days). Each season consisted of 3 months; September, October and November comprised the fall; December, January and February the winter; March, April and May the spring; and June, July and August made up the summer. Anglers leaving boat ramps and wade/bank areas were interviewed between 6:00 a.m. and 2:00 p.m. or between 2:00 p.m. and 10:00 p.m.; those at lighted piers between 2:00 p.m. and 10:00 p.m. or between 10:00 p.m. and 6:00 a.m. The time period was randomly selected for each day. One angler (the apparent "leader") from each party was interviewed about the harvest and asked

his country, state (if in the United States) and county (if in Texas) of residence.

The percent of anglers interviewed in each bay system who resided in Texas, states adjacent to Texas, all other states in the United States (U.S.) and foreign countries was calculated for each season and each fishing strata. Significant (P<0.01) differences in the pattern of geographic origin of interviewed anglers between season and fishing strata within each bay system were determined using the log likelihood ratio test (Sokal and Rohlf 1969). The test is similar to χ^2 but involves the transformation of the raw data to natural logarithms prior to the calculation of the test statistic G. Prior to the analysis, the number of anglers in each geographic origin category interviewed during each season at boat ramps was multiplied by 0.8 to adjust for differences in the number of sampling days at each strata. For each bay system where geographic origin was independent of season and strata, all data were used to calculate one percentage value for each origin category in that bay system. Differences in origin pattern among bay systems were determined using the log likelihood ratio test when origin was independent of season and fishing strata.

A series of concentric zones was constructed around each bay system (Fig. 1). Texas counties included in each zone surrounding each bay system were determined by constructing arcs around each bay system on a Texas highway map (Anonymous 1975). The center of each arc surrounding a bay system was the midpoint of the Gulfward boundary of that bay system. Arcs with radii of 100, 200, 400, 600, 800, 1000 and 1200 km enclosed zones 1, 2, 3, 4, 5, 6 and 7, respectively. The boundary of each arc was modified to coincide with county lines. Counties with at least 50% of their area within a zone were included in that zone (Appendix A). Total population in each zone (Appendix B) was determined by summing the 1970 populations of those counties within each zone (Anonymous 1979). Significant (P<0.01) differences in the pattern of zone of residence within Texas for interviewed anglers between season and fishing strata within each bay system were determined using the log likelihood ratio test.

RESULTS

Texas residents comprised the majority of the recreational anglers using Texas bays. Most (94.2%) of the 7,478 recreational anglers who were interviewed during the study resided in Texas with 1.4% from states adjacent to Texas and 4.1% from other states in the U.S. Thirty residents (0.4%) of two foreign countries, Mexico (27 anglers) and Canada (3 anglers), were interviewed. At least 46% of the anglers interviewed in each bay system at each strata during each season were Texas residents, with the percentage in this category usually approximating 100% (Table 1). In the Galveston and San Antonio Bay systems, >98% of the anglers interviewed at each strata during each season were Texas residents; the percentage of anglers residing in each geographic category was independent of season and strata (Table 2). In addition, the percentage of anglers within each geographic origin category was the same in Galveston and San Antonio Bay systems (G = 2.376, d.f. = 3, P>0.05). For these two systems combined, 99.5% of all fishermen interviewed

were Texas residents, 0.1% were from states adjacent to Texas, and 0.4% were from all other states in the U.S. and 0.0% were from foreign countries.

In each of the other five bay systems, the pattern of geographic origin varied with either season, strata or both (Table 2). In the Corpus Christi Bay system, the percentage of anglers within each geographic category was dependent on season only. Texas residents comprised 91.1% of the fall and winter anglers and 95.1% and 98.8% of the spring and summer fishermen, respectively. In the upper Laguna Madre system, the percentage of anglers within each geographic category was dependent on strata only. Texas residents comprised 99.3% of the boat anglers, 94.1% of the wade/bank anglers and 93.1% of the lighted pier anglers. In the Matagorda Bay, Aransas Bay and lower Laguna Madre systems, the percentage of anglers within each geographic category was dependent on both season and strata. In the Matagorda Bay system, Texas residents comprised >90% of the anglers in each season and strata except in the winter at wade/bank areas (86.1%) and lighted piers (46.2%). In the Aransas Bay and lower Laguna Madre systems, the geographic origins of recreational fishermen changed dramatically between seasons and fishing strata (Table 1). The proportion of out-of-country residents exceeded 3% only in the lower Laguna Madre. In this system, out-of-country residents comprised 2% of all anglers and were encountered at boat ramps in the summer; wade/bank areas in the winter, spring and summer; and lighted piers in each season.

The percentage of interviewed anglers residing in each distance zone within Texas was not consistent among bay systems (Fig. 2). The pattern for zone of origin depicted in Figure 2 was the same (P>0.01) in all seasons and at all fishing strata in the San Antonio Bay, Corpus Christi Bay and upper Laguna Madre systems (Table 3). In the Galveston and Matagorda Bay systems, the pattern of origin was independent of season but not fishing strata; in the lower Laguna Madre system the pattern of origin was independent of strata but not season (Fig. 3). In the Aransas Bay system, the pattern of origin was not independent of season or strata (Fig. 4).

The distribution of the state's 11,196,730 population around each bay system varied substantially among bay systems. There was no apparent relationship between the zone of origin of anglers and each zone's population for any of the bay systems (Fig. 3).

DISCUSSION

Texas residents comprised over 80% of the anglers interviewed in each bay system during each season at each strata except in the winter in the Matagorda Bay, Aransas Bay and lower Laguna Madre systems and in the spring in the Aransas Bay system. The low percentage of Texas residents interviewed in the Matagorda Bay system at lighted piers during the winter (46.2%) may have been due to the small number of anglers interviewed (13). The use of the Aransas Bay and lower Laguna Madre system by out-of-state anglers in the winter probably reflects the annual migration of residents of "northern" states who spend their winters in south Texas. These so called "winter Texans" are apparently centralized in the Rockport and Aransas Pass area (located on the Aransas Bay system) and the Rio Grande Valley (adjacent to the lower Laguna

Madre system) perhaps because of the availability of facilities (mobile trailer parks, motels and winter homes) or the warm climate. In addition, the "winter Texans" using the Aransas Bay area apparently stay longer (through spring) and use more fishing strata (all three) than those in the lower Laguna Madre. Perhaps they occur in greater numbers or they fish more extensively in the Aransas Bay system than in the lower Laguna Madre. Unfortunately, no data are available on the number of "winter Texans" annually visiting each of these two areas or on their fishing habits. However, as seasonal residents of these two areas, "winter Texans" comprise a substantial portion of the recreational anglers using two of the seven bay systems. If these anglers have different expectations of their fishing experience from those of Texas residents, then the management strategies imposed by the fisheries agency should consider those different expectations.

Generally, Texas residents fishing in Texas bays lived within 100 km of the bay in which they fished, with the proportion coming from each distance zone decreasing as distance increased. In the San Antonio and Aransas Bay systems, however, 40-50% of the Texas anglers resided in zone 3 where about 45% of the state's population also resided. Anglers selection of the bay system in which to fish is probably a function of distance and population. However, these are not the only factors involved in the selection process. The population immediately adjacent to a bay system may act to reduce the number of anglers travelling to that system. Over 99% of the Texas anglers interviewed in the Galveston Bay system resided within 100 km of the system. Anglers did not travel over about 100 km to fish in the Galveston Bay system. However, anglers from the Galveston area travelled to all other Texas bays, including the most remote--the lower Laguna Madre. Season and available fishing platforms in each strata also apparently influenced the selection process; the anglers' residence was dependent on one or both of these factors in four of the seven bay systems.

The patterns of geographic origins of recreational anglers presented in this study were determined for wade, bank and private boat strata during the day and for pier strata during the night. Those using bank areas and private boats during the night and those using piers during the day were not surveyed. Anglers who store their boats on the water, fish from private boats not launched at public boat ramps or fish from charter or party boats were not surveyed. In addition, only the apparent "leader" of each party was interviewed. The residence of anglers in each party may not have been the same as that of the party's "leader." Therefore, care should be taken when extrapolating results presented herein to the total population of recreational anglers.

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Table 1. Percent of recreational anglers interviewd in each bay system who used each strata type in each season who resided in Texas (A), states adjacent to Texas (B), all other states in the United States (C) and foreign countries (D) during 1974-1976[a].

Bay System	Strata[b]	Number of Interviews	Fall A	Fall B	Fall C	Fall D	Winter A	Winter B	Winter C	Winter D	Spring A	Spring B	Spring C	Spring D	Summer A	Summer B	Summer C	Summer D	Annual A	Annual B	Annual C	Annual D
Galveston	BR	589	100	0	0	0	99	0	1	0	100	0	0	0	99	0	1	0	99	0	1	0
	WB	1152	99	0	1	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
	LP	288	100	0	0	0	100	0	0	0	99	1	0	0	99	0	1	0	99	1	1	0
	All[c]	2029	99	0	1	0	99	0	1	0	100	0	0	0	99	0	0	0	99	0	1	0
Matagorda	BR	181	100	0	0	0	100	0	0	0	100	0	0	0	98	2	0	0	99	1	0	0
	WB	197	100	0	0	0	86	6	6	3	98	0	2	0	100	0	0	0	97	1	2	0
	LP	245	97	3	0	0	46	8	46	0	90	0	10	0	96	1	3	0	93	2	6	0
	All[c]	623	99	1	0	0	86	4	9	1	96	0	4	0	97	1	2	0	96	1	3	0
San Antonio	BR	925	100	0	0	0	100	0	0	0	100	0	0	0	99	0	1	0	100	0	0	0
	WB	51	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
	All[c]	976	100	0	0	0	100	0	0	0	100	0	0	0	99	0	1	0	100	0	0	0
Aransas	BR	269	92	2	6	0	59	18	23	0	100	0	0	0	97	3	0	0	84	7	9	0
	WB	280	83	9	9	0	47	14	40	0	66	4	30	0	100	0	0	0	74	6	20	0
	LP	417	85	4	11	0	65	5	30	0	72	5	21	2	97	1	2	0	83	3	13	1
	All[c]	966	86	5	9	0	56	13	31	0	76	3	19	1	98	1	1	0	80	5	14	0
Corpus Christi	BR	310	99	0	1	0	83	4	13	0	92	1	7	0	100	0	0	0	94	1	5	0
	WB	239	82	10	6	2	92	0	8	0	98	0	2	0	100	0	0	0	92	3	5	0
	LP	187	94	3	3	0	100	0	0	0	93	4	4	0	97	0	2	2	96	2	2	0
	All[c]	736	91	5	4	0	91	1	8	0	95	1	4	0	99	0	1	1	94	2	4	0
Upper Laguna Madre	BR	451	100	0	0	0	97	0	3	0	100	0	0	0	100	0	0	0	99	0	0	0
	WB	256	97	2	2	0	94	1	4	0	89	5	7	0	97	0	3	0	94	2	4	0
	LP	262	93	0	6	1	96	0	4	0	86	0	14	0	99	0	1	0	93	0	7	0
	All[c]	969	96	0	3	0	95	1	4	0	92	1	6	0	99	0	1	0	96	1	3	0

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Table 1. Cont'd.

Bay System	Strata[b]	Number of Interviews	Fall				Winter				Spring				Summer				Annual			
			A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Lower Laguna Madre																						
	BR	395	100	0	0	0	94	0	6	0	98	0	2	0	96	2	2	1	97	1	2	0
	WB	341	96	2	2	0	51	1	46	2	87	3	9	1	91	0	1	8	79	2	17	3
	LP	443	89	2	4	4	78	6	14	2	94	2	2	1	96	0	1	4	91	2	4	3
	All[c]	1179	96	1	2	1	69	3	26	2	93	2	5	1	95	1	1	4	89	2	8	3

[a]Percentages may not sum to 100 due to rounding error.
[b]BR--Boat ramp; WB--Wade/bank areas; LB--Lighted pier.
[c]Percentages are based on adjusted number of anglers interviewed at boat ramps (adjusted number = number interviewed X 0.8).
[d]No lighted piers existed in San Antonio Bay system.

Table 2. Results of log likelihood ratio test comparing geographic origin (country and state) of recreational anglers in Texas bays by season (fall, winter, spring and summer) and fishing strata (boat ramps, wade/bank areas and commercial lighted piers).

Bay system	Hypothesis tested	Degrees of freedom	G-statistic	
Galveston	Season x Geographic origin	9	2.702	NS
	Fishing strata x Geographic origin	6	2.640	NS
	Interaction (Season x Fishing strata x Origin)	18	11.464	NS
Matagorda	Season x Geographic origin	9	30.034	**
	Fishing strata x Geographic origin	6	44.004	**
	Interaction (Season x Fishing strata x Origin)	18	22.504	NS
San Antonio	Season x Geographic origin	9	2.098	NS
	Fishing strata x Geographic origin	3	0.400	NS
	Interaction (Season x Fishing strata x Origin)	9	0.000	NS
Aransas	Season x Geographic origin	9	189.672	**
	Fishing strata x Geographic origin	6	55.082	**
	Interaction (Season x Fishing strata x Origin)	18	16.960	NS
Corpus Christi	Season x Geographic origin	9	40.232	**
	Fishing strata x Geographic origin	6	6.526	NS
	Interaction (Season x Fishing strata x Origin)	18	25.442	NS
Upper Laguna Madre	Season x Geographic origin	9	17.330	*
	Fishing strata x Geographic origin	6	31.060	**
	Interaction (Season x Fishing strata x Origin)	18	11.932	NS
Lower Laguna Madre	Season x Geographic origin	9	154.120	**
	Fishing strata x Geographic origin	6	75.544	**
	Interaction (Season x Fishing strata x Origin)	18	7.350	NS

NS--Not Significant
 *--P<0.05
**--P<0.01

Table 3. Results of log likelihood ratio test comparing zone of residence within Texas of recreational anglers in Texas bays by season (fall, winter, spring and summer) and fishing strata (boat ramps, wade/bank areas and commercial lighted piers).

Bay system	Hypothesis tested	Degrees of freedom	G-statistic	
Galveston	Season x Zone of residence	18	9.246	NS
	Fishing strata x Zone of residence	18	32.122	**
	Interaction (Season x Fishing strata x Zone)	54	16.350	NS
Matagorda	Season x Zone of residence	18	32.648	*
	Fishing strata x Zone of residence	18	54.346	**
	Interaction (Season x Fishing strata x Zone)	54	25.556	NS
San Antonio	Season x Zone of residence	18	25.796	NS
	Fishing strata x Zone of residence	6	13.342	*
	Interaction (Season x Fishing strata x Zone)	18	14.924	NS
Aransas	Season x Zone of residence	18	65.994	**
	Fishing strata x Zone of residence	18	49.044	**
	Interaction (Season x Fishing strata x Zone)	54	36.826	NS
Corpus Christi	Season x Zone of residence	18	32.080	*
	Fishing strata x Zone of residence	18	19.260	NS
	Interaction (Season x Fishing strata x Zone)	54	63.702	NS
Upper Laguna Madre	Season x Zone of residence	18	20.532	NS
	Fishing strata x Zone of residence	18	10.116	NS
	Interaction (Season x Fishing strata x Zone)	54	44.848	NS
Lower Laguna Madre	Season x Zone of residence	18	36.606	**
	Fishing strata x Zone of residence	18	21.834	NS
	Interaction (Season x Fishing strata x Zone)	54	69.642	NS

NS--Not Significant
*--P<0.05
**--P<0.01

Figure 1. Map of Texas showing the concentric zones constructed around each of seven Texas bay systems.
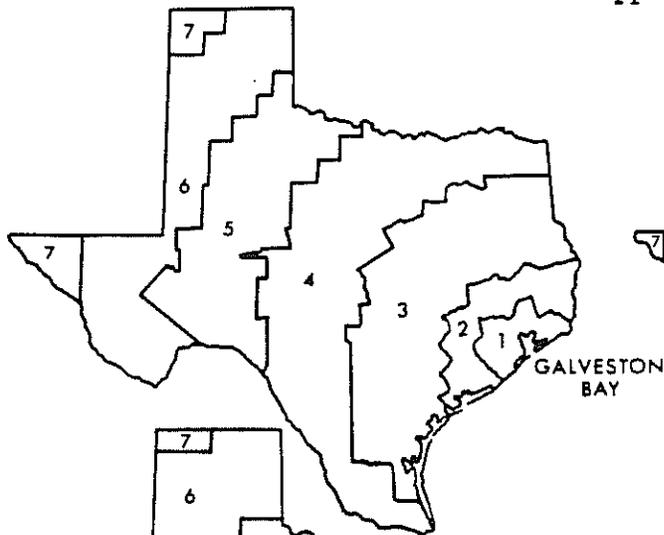
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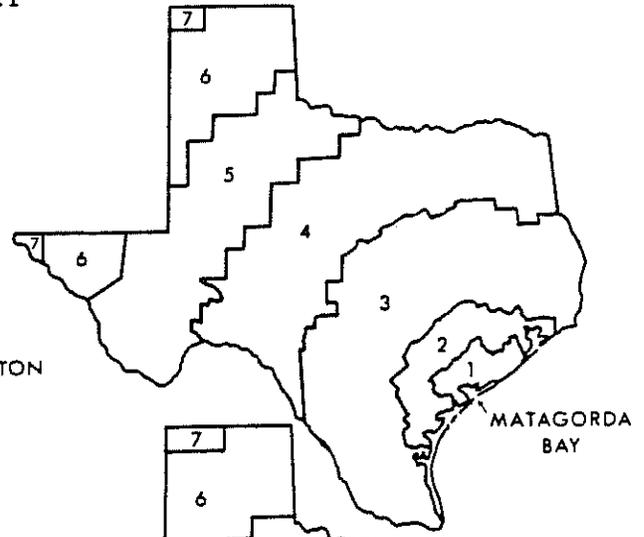
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SAN ANTONIO BAY
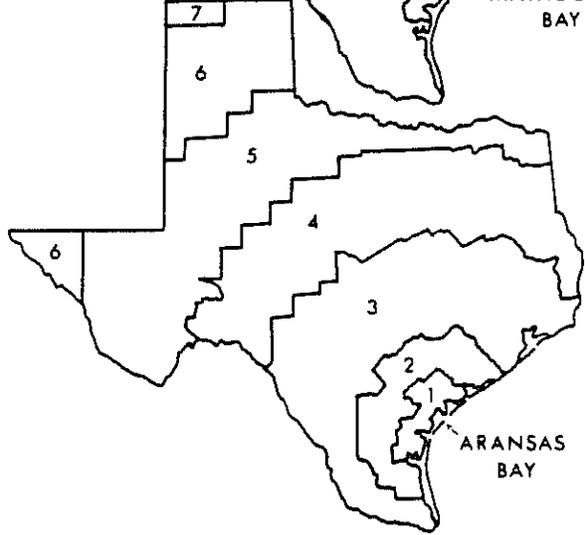
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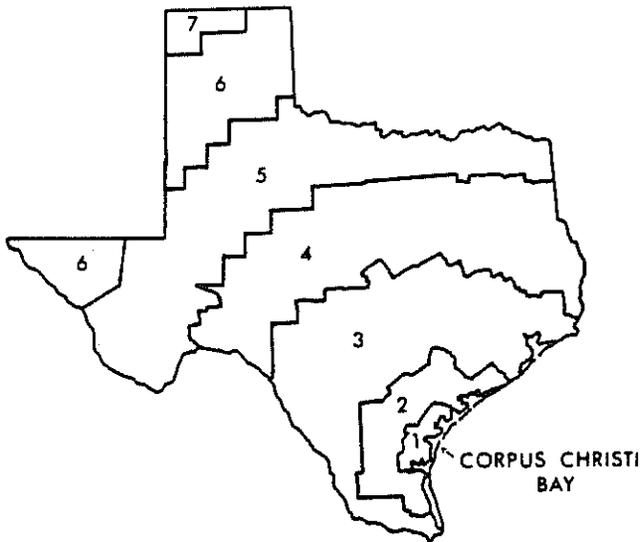
CORPUS CHRISTI BAY
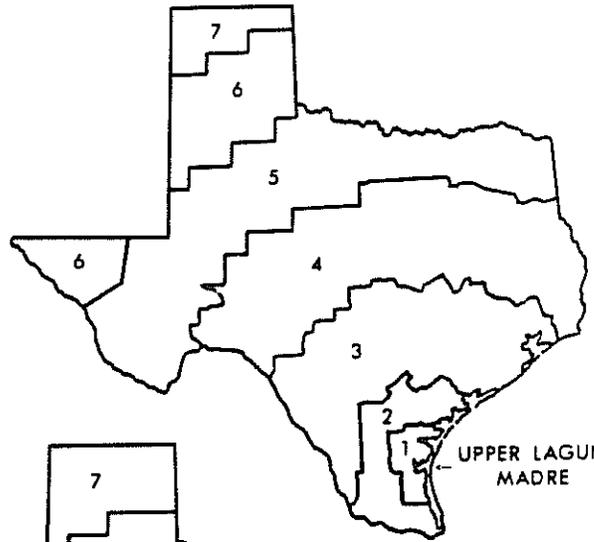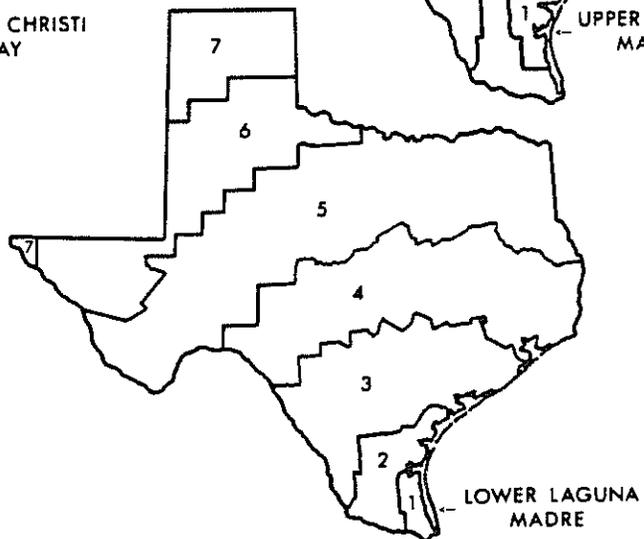
UPPER LAGUNA MADRE

LOWER LAGUNA MADRE

Figure 2. Percent of all interviewed recreational anglers (solid line) and of Texas' 1970 population (dashed line) residing within each distance zone surrounding each Texas bay system.

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GALVESTON BAY

MATAGORDA BAY

SAN ANTONIO BAY

ARANSAS BAY

CORPUS CHRISTI BAY

UPPER LAGUNA MADRE

LOWER LAGUNA MADRE

DISTANCE   (KM × 10²)

DISTANCE   (KM × 10²)
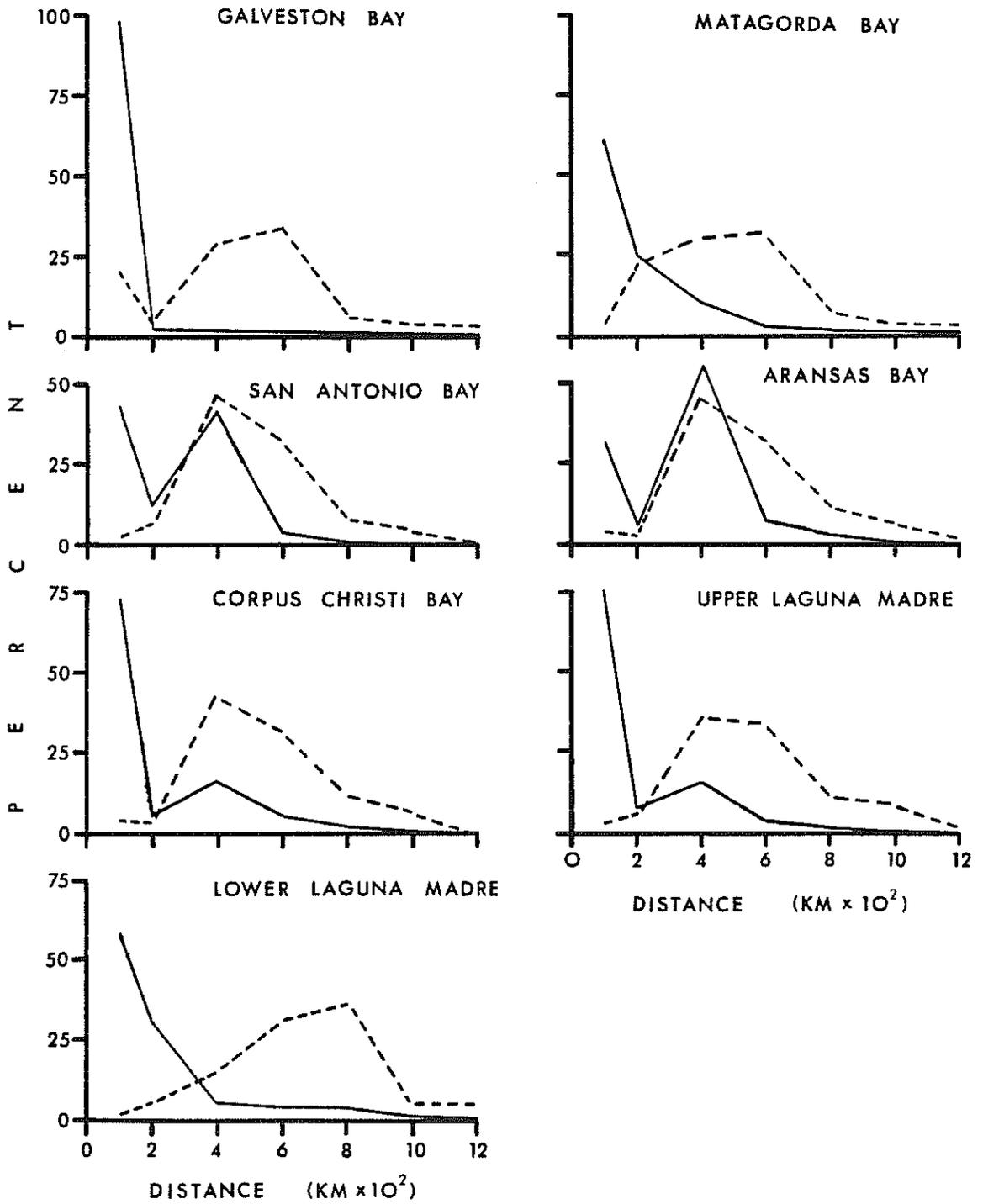
Figure 3. Percent of recreational anglers interviewed at each strata in the Galveston and Matagorda Bay systems and during each season in the lower Laguna Madre residing in each distance zone surrounding each of the three bay systems. (BR--Boat ramps, WB--Wade/bank areas, LP--Lighted piers).
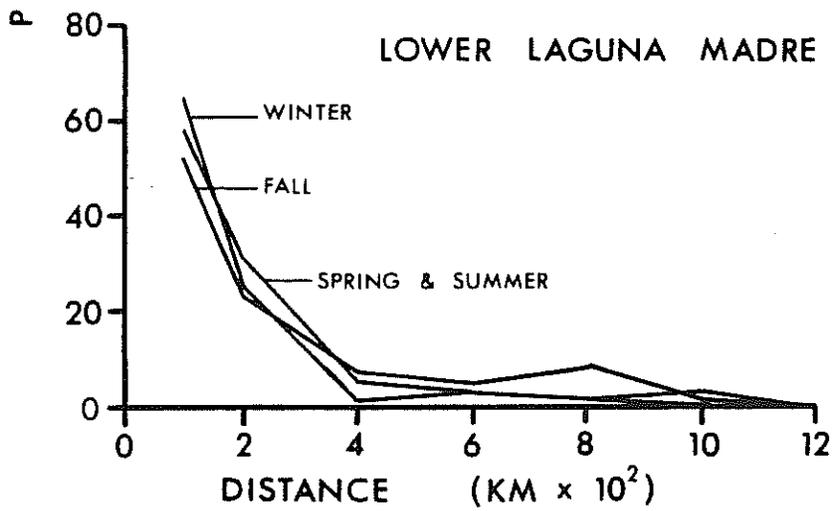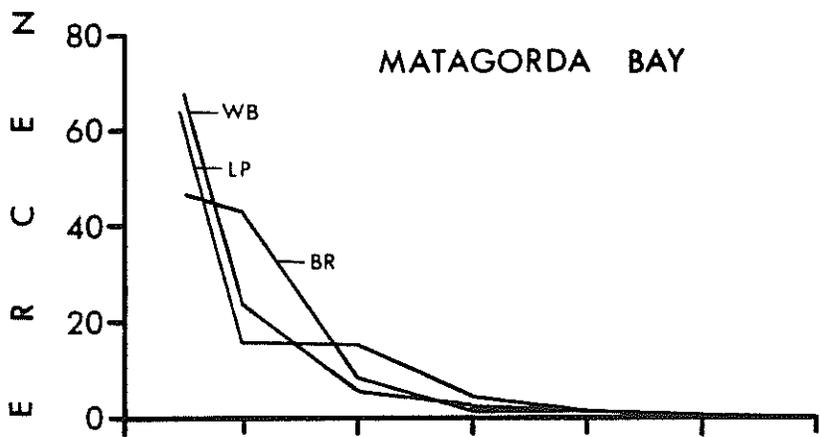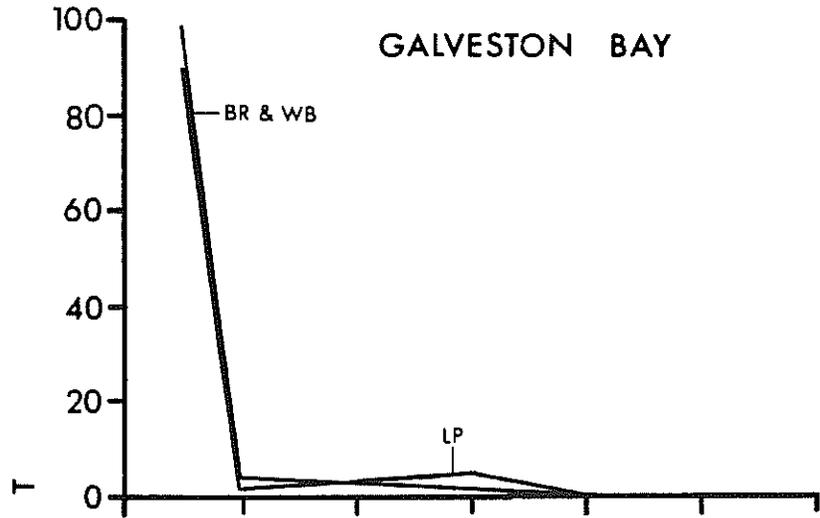
Figure 4. Percent of recreational anglers interviewed at each strata during each season who resided in each distance zone around the Aransas Bay system. (BR--Boat ramps, WB--Wade/bank areas, LP--Lighted piers).

ARANSAS BAY
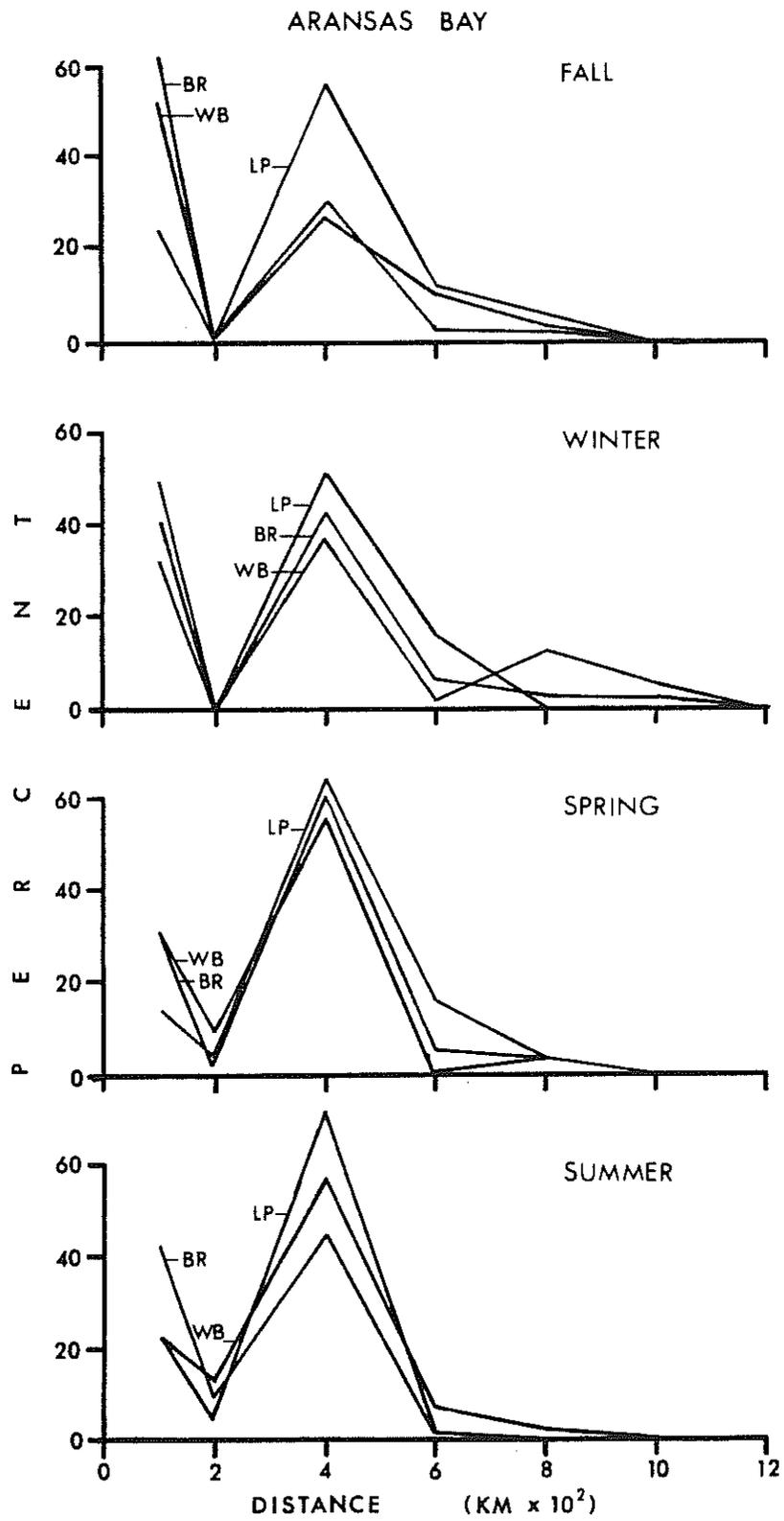
APPENDIX A--Texas counties included in each zone surrounding each bay system.

Table 1. Number of the 254 Texas counties included in each zone surrounding each bay system.

Bay system	Zone						
	1	2	3	4	5	6	7
Galveston	7	18	69	76	42	37	5
Matagorda	6	19	81	74	44	28	2
San Antonio	7	15	79	71	52	28	2
Aransas	8	16	70	70	60	28	2
Corpus Christi	5	17	62	69	67	30	4
Upper Laguna Madre	5	16	51	72	72	29	9
Lower Laguna Madre	3	11	38	56	90	37	19

Table 2. Texas counties included in each zone surrounding the Galveston Bay system.

			Zone			
1	2	3	4	5	6	7
Brazoria	Calhoun	Kenedy	Kinney	Terrell	Brewster	Dallam
Fort Bend	Jackson	Kleberg	Edwards	Pecos	Presidio	Sherman
Harris	Colorado	Jim Wells	Sutton	Crane	Jeff Davis	Hartley
Liberty	Austin	Live Oak	Schleicher	Ector	Culberson	El Paso
Chambers	Washington	Atascosa	Tom Green	Martin	Reeves	Hudspeth
Jefferson	Grimes	McMullen	Runnels	Dawson	Ward	
Galveston	Walker	Bexar	Taylor	Lynn	Loving	
	San Jacinto	Kendall	Shackelford	Garza	Winkler	
	Polk	Blanco	Throckmorton	Crosby	Andrews	
	Tyler	Burnet	Archer	Dickens	Gaines	
	Jasper	Lampasas	Clay	Motley	Yoakum	
	Newton	Coryell	Montague	Hall	Terry	
	Matagorda	Bosque	Cooke	Childress	Cochran	
	Wharton	Hill	Grayson	Hardeman	Hockley	
	Waller	Ellis	Fannin	Val Verde	Bailey	
	Montgomery	Kaufman	Lamar	Crockett	Lamb	
	Hardin	Van Zandt	Red River	Upton	Hale	
	Orange	Wood	Bowie	Reagan	Parmer	
		Upshur	Cass	Irion	Castro	
		Marion	Cameron	Midland	Swisher	
		Nueces	Willacy	Glasscock	Briscoe	
		San Patricio	Hidalgo	Sterling	Deaf Smith	
		Refugio	Starr	Coke	Randall	
		Aransas	Zapata	Howard	Armstrong	
		Bee	Webb	Mitchell	Donley	
		Goliad	Dimmit	Nolan	Oldham	
		Victoria	Maverick	Borden	Potter	
		Karnes	Morris	Scurry	Carson	
		DeWitt	Camp	Fisher	Gray	
		Wilson	Titus	Kent	Wheeler	
		Gonzales	Franklin	Stonewall	Moore	
		Fayette	Hopkins	Haskell	Hutchinson	
		Guadalupe	Delta	King	Roberts	
		Caldwell	Rains	Knox	Hemphill	
		Bastrop	Rockwood	Baylor	Hansford	
		Lee	Hunt	Cottle	Ochiltree	
		Burleson	Collin	Foard	Lipscomb	
		Brazos	Denton	Wilbarger		
		Madison	Wise	Wichita		
		Houston	Jack	Lubbock		
		Trinity	Young	Floyd		
		Angelina	Stephens	Collingsworth		
		San Augustine	Palo Pinto	Jones		
		Sabine	Parker			
		Shelby	Tarrant			
		Nacogdoches	Dallas			

Table 2. Cont'd.

			Zone			
1	2	3	4	5	6	7
		Cherokee	Johnson			
		Anderson	Hood			
		Freestone	Somervell			
		Limestone	Erath			
		Falls	Eastland			
		McLennan	Callahan			
		Bell	Coleman			
		Williamson	Brown			
		Travis	Comanche			
		Hays	Hamilton			
		Comal	Mills			
		Navarro	San Saba			
		Henderson	McCulloch			
		Smith	Concho			
		Gregg	Menard			
		Rusk	Mason			
		Panola	Llano			
		Harrison	Gillespie			
		Leon	Kimble			
		Robertson	Kerr			
		Milam	Bandera			
		Duval	Real			
		Lavaca	Uvalde			
			Medina			
			Zavala			
			Frio			
			LaSalle			
			Jim Hogg			
			Brooks			

Table 3. Texas counties included in each zone surrounding the Matagorda Bay system.

			Zone			
1	2	3	4	5	6	7
Brazoria	Nueces	Webb	Terrell	Presidio	Hudspeth	Dallam
Matagorda	San Patricio	Dimmit	Crockett	Brewster	Culberson	El Paso
Wharton	Bee	Zavala	Reagan	Jeff Davis	Yoakum	
Jackson	Karnes	Uvalde	Sterling	Reeves	Cochran	
Victoria	Gonzales	Bandera	Nolan	Pecos	Bailey	
Calhoun	Fayette	Kerr	Fisher	Loving	Lamb	
	Washington	Gillespie	Haskell	Winkler	Parmer	
	Waller	Mason	Throckmorton	Ward	Castro	
	Chambers	San Saba	Archer	Crane	Swisher	
	Harris	Lampasas	Clay	Upton	Briscoe	
	Aransas	Coryell	Val Verde	Ector	Deaf Smith	
	Refugio	McLennan	Kinney	Midland	Randall	
	Goliad	Hill	Maverick	Glasscock	Armstrong	
	DeWitt	Navarro	Edwards	Andrews	Donley	
	Lavaca	Henderson	Kimble	Martin	Oldham	
	Colorado	Cherokee	Menard	Howard	Potter	
	Austin	Nacogdoches	McCulloch	Mitchell	Carson	
	Fort Bend	Shelby	Brown	Gaines	Gray	
	Galveston	Cameron	Comanche	Dawson	Wheeler	
		Hidalgo	Erath	Borden	Hartley	
		Starr	Somervell	Scurry	Moore	
		Zapata	Johnson	Terry	Hutchinson	
		Sabine	Ellis	Lynn	Roberts	
		Newton	Kaufman	Garza	Hemphill	
		Orange	Van Zandt	Kent	Sherman	
		Jefferson	Smith	Stonewall	Hansford	
		Montgomery	Rusk	Hockley	Ochiltree	
		Real	Panola	Lubbock	Lipscomb	
		Mills	Harrison	Crosby		
		Hamilton	Marion	Dickens		
		Bosque	Cass	King		
		Liberty	Bowie	Knox		
		San Jacinto	Red River	Baylor		
		Grimes	Lamar	Hale		
		Brazos	Fannin	Floyd		
		Burleson	Grayson	Motley		
		Lee	cooke	Cottle		
		Bastrop	Montague	foard		
		Caldwell	Sutton	Wilbarger		
		Guadalupe	Schleicher	Wichita		
		Wilson	Irion	Hall		
		Atascosa	Tom Green	Childress		
		Live Oak	Concho	Hardeman		
		Jim Wells	Coleman	Collingsworth		
		Kleberg	Runnels			
		Kenedy	Taylor			

Table 3. Cont'd.

		Zone				
1	2	3	4	5	6	7
		Willacy	Callahan			
		Brooks	Eastland			
		Jim Hogg	Hood			
		Duval	Rockwall			
		McMullen	Dallas			
		LaSalle	Tarrant			
		Frio	Parker			
		Medina	Palo Pinto			
		Bexar	Stephens			
		Kendall	Shackelford			
		Comal	Young			
		Blanco	Jack			
		Hays	Wise			
		Travis	Denton			
		Llano	Collin			
		Burnet	Hunt			
		Williamson	Gregg			
		Milam	Hopkins			
		Bell	Rains			
		Falls	Wood			
		Robertson	Franklin			
		Limestone	Titus			
		Freestone	Morris			
		Leon	Camp			
		Madison	Upshur			
		Walker	Delta			
		Polk	Jones			
		Trinity	Coke			
		Houston				
		Anderson				
		Angelina				
		Tyler				
		Jasper				
		San Augustine				
		Hardin				

Table 4. Texas counties included in each zone surrounding the San Antonio Bay system.

Zone						
1	2	3	4	5	6	7
San Patricio	Kleberg	Cameron	Terrell	Presidio	El Paso	Dallam
Aransas	Nueces	Hidalgo	Val Verde	Brewster	Hudspeth	Sherman
Refugio	Jim Wells	Starr	Sutton	Jeff Davis	Culberson	
Goliad	Live Oak	Zapata	Menard	Reeves	Cochran	
Victoria	Bee	Webb	McCulloch	Pecos	Bailey	
Jackson	Wilson	Maverick	Brown	Ward	Lamb	
Calhoun	Karnes	Kinney	Comanche	Crane	Parmer	
	DeWitt	Edwards	Erath	Upton	Castro	
	Gonzales	Kimble	Somervell	Loving	Swisher	
	Lavaca	mason	Bosque	Winkler	Briscoe	
	Colorado	San Saba	Hill	Ector	Deaf Smith	
	Wharton	Mills	Navarro	Midland	Randall	
	Fort Bend	hamilton	Henderson	Glasscock	Armstrong	
	Brazoria	Coryell	Cherokee	Andrews	Donley	
	Matagorda	McLennan	Nacogdoches	Martin	Collingsworth	
		Limestone	San Augustine	Howard	Oldham	
		Freestone	Sabine	Mitchell	Potter	
		Anderson	Shelby	Gaines	Carson	
		Houston	Panola	Dawson	Gray	
		Trinity	Harrison	Borden	Wheeler	
		Angelina	Marion	Scurry	Hartley	
		Tyler	Cass	Fisher	Moore	
		Jasper	Morris	Yoakum	Hutchinson	
		Newton	Titus	Terry	Roberts	
		Orange	Franklin	Lynn	Hemphill	
		Jefferson	Hopkins	Garza	Hansford	
		Chambers	Delta	Kent	Ochiltree	
		Galveston	Hunt	Stonewall	Lipscomb	
		Harris	Fannin	Haskell		
		Waller	Grayson	Hockley		
		Austin	Cooke	Lubbock		
		Fayette	Wise	Crosby		
		Bastrop	Jack	Dickens		
		Caldwell	Young	King		
		Guadalupe	Throckmorton	Knox		
		Bexar	Shackelford	Baylor		
		Atascosa	Jones	Archer		
		NcMullen	Nolan	Clay		
		Duval	Taylor	Montague		
		Brooks	Coke	Hale		
		Kenedy	Sterling	Floyd		
		Willacy	Reagan	Motley		
		Jim Hogg	Crockett	Cottle		
		LaSalle	Irion	Foard		
		Dimmit	Tom Green	Wilbarger		
		Zavala	Concho	Wichita		

Table 4. Cont'd.

			Zone			
1	2	3	4	5	6	7
		Frio	Runnels	Hall		
		Uvalde	Coleman	Childress		
		Medina	Callahan	Hardeman		
		Real	Eastland	Lamar		
		Bandera	Stephens	Red River		
		Kerr	Palo Pinto	Bowie		
		Kendall	Parker			
		Comal	Tarrant			
		Gillespie	Dallas			
		Blanco	Hood			
		Hays	Johnson			
		Llano	Ellis			
		Burnet	Denton			
		Travis	Collin			
		Lee	Schleicher			
		Williamson	Rockwall			
		Lampasas	Kaufman			
		Bell	Van Zandt			
		Falls	Rains			
		Milam	Smith			
		Robertson	Rusk			
		Leon	Gregg			
		Burleson	Upshur			
		Brazos	Camp			
		Madison	Wood			
		Washington				
		Grimes				
		Walker				
		Montgomery				
		San Jacinto				
		Polk				
		Liberty				
		Hardin				

Table 5. Texas counties included in each zone surrounding the Aransas Bay system.

Zone						
1	2	3	4	5	6	7
Kleberg	Kenedy	Willacy	Val Verde	Culberson	El Paso	Dallam
Nueces	Brooks	Cameron	Terrell	Jeff Davis	Hudspeth	Sherman
San Patricio	Duval	Hidalgo	Crockett	Presidio	Cochran	
Refugio	Jim Wells	Starr	Reagan	Brewster	Bailey	
Aransas	McMullen	Jim Hogg	Sterling	Reeves	Lamb	
Goliad	Live Oak	Zapata	Coke	Pecos	Hale	
Victoria	Bee	Webb	Nolan	Ward	Parmer	
Calhoun	Karnes	LaSalle	Jones	Crane	Castro	
	Wilson	Frio	Shackelford	Upton	Swisher	
	Gonzales	Atascosa	Stephens	Loving	Briscoe	
	DeWitt	Bexar	Young	Winkler	Deaf Smith	
	Lavaca	Guadalupe	Jack	Ector	Randall	
	Jackson	Caldwell	Wise	Midland	Armstrong	
	Colorado	Bastrop	Denton	Glasscock	Donley	
	Wharton	Fayette	Collin	Andrews	Collingsworth	
	Matagorda	Austin	Hunt	Martin	Oldham	
		Fort Bend	Hopkins	Howard	Potter	
		Brazoria	Franklin	Mitchell	Carson	
		Galveston	Camp	Gaines	Gray	
		Chambers	Upshur	Dawson	Wheeler	
		Jefferson	Marion	Borden	Hartley	
		Orange	Harrison	Scurry	Moore	
		Hardin	Panola	Fisher	Hutchinson	
		Tyler	Shelby	Yoakum	Roberts	
		Polk	Sabine	Terry	Hemphill	
		Trinity	Newton	Lynn	Hansford	
		Houston	Jasper	Garza	Ochiltree	
		Leon	San Augustine	Kent	Lipscomb	
		Limestone	Angelina	Stonewall		
		McLennan	Cherokee	Haskell		
		Coryell	Anderson	Throckmorton		
		Lampasas	Freestone	Hockley		
		San Saba	Navarro	Lubbock		
		Mason	Hill	Crosby		
		Kimble	Bosque	Dickens		
		Edwards	Hamilton	King		
		Kinney	Mills	Knox		
		Maverick	Brown McCulloch	Baylor		
		Dimmit	Menard	Archer		
		Zavala	Schleicher	Clay		
		Uvalde	Sutton	Montague		
		Medina	Irion	Cooke		
		Real	Tom Green	Grayson		
		Bandera	Concho	Fannin		
		Kerr	Runnels	Lamar		
		Kendall		Delta		

Table 5. Cont'd.

			Zone			
1	2	3	4	5	6	7
		Comal	Coleman	Red River		
		Gillespie	Taylor	Bowie		
		Blanco	Callahan	Titus		
		Hays	Eastland	Morris		
		Llano	Erath	Cass		
		Burnet	Comanche	Floyd		
		Travis	Palo Pinto	Motley		
		Williamson	Parker	Cottle		
		Lee	Hood	Foard		
		Bell	Somervell	Wilbarger		
		Milam	Tarrant	Wichita		
		Burleson	Dallas	Hall		
		Washington	Johnson	Childress		
		Waller	Ellis	Hardeman		
		Harris	Rockwall			
		Montgomery	Kaufman			
		San Jacinto	Van Zandt			
		Liberty	Henderson			
		Grimes	Rains			
		Walker	Wood			
		Brazos	Smith			
		Madison	Gregg			
		Robertson	Rusk			
		Falls	Nacogdoches			

Table 6. Texas counties included in each zone surrounding the Corpus Christi Bay system.

Zone						
1	2	3	4	5	6	7
Kleberg	Willacy	Cameron	Val Verde	Presidio	El Paso	Hartley
Nueces	Kenedy	Hidalgo	Sutton	Brewster	Hudspeth	Dallam
San Patricio	Brooks	Starr	Schleicher	Jeff Davis	Culberson	Sherman
Refugio	Jim Hogg	Zapata	Menard	Reeves	Yoakum	Hansford
Aransas	Duval	Webb	McCulloch	Pecos	Cochran	
	Jim Wells	LaSalle	San Saba	Ward	Hockley	
	McMullen	Atascosa	Mills	Crane	Bailey	
	Live Oak	Wilson	Hamilton	Upton	Lamb	
	Bee	Gonzales	Coryell	Loving	Hale	
	Karnes	Fayette	McLennan	Winkler	Parmer	
	Goliad	Colorado	Limestone	Ector	Castro	
	DeWitt	Wharton	Leon	Midland	Swisher	
	Victoria	Brazoria	Houston	Glasscock	Briscoe	
	Calhoun	Galveston	Trinity	Andrews	Hall	
	Lavaca	Chambers	Polk	Martin	Deaf Smith	
	Jackson	Jefferson	Tyler	Howard	Randall	
	Matagorda	Hardin	Jasper	Mitchell	Armstrong	
		Liberty	Orange	Gaines	Donley	
		San Jacinto	Newton	Dawson	Collingsworth	
		Walker	Sabine	Borden	Oldham	
		Madison	Shelby	Scurry	Potter	
		Brazos	Panola	Fisher	Carson	
		Robertson	Harrison	Jones	Gray	
		Falls	Upshur	Terry	Wheeler	
		Bell	Wood	Lynn	Moore	
		Lampasas	Rains	Garza	Hutchinson	
		Burnet	Van Zandt	Kent	Roberts	
		Llano	Kaufman	Stonewall	Hemphill	
		Mason	Rockwall	Haskell	Ochiltree	
		Kimble	Dallas	Throckmorton	Lipscomb	
		Edwards	Tarrant	Young		
		Kinney	Parker	Jack		
		Maverick	Palo Pinto	Wise		
		Dimmit	Stephens	Denton		
		Zavala	Shackelford	Collin		
		Frio	Callahan	Hunt		
		Uvalde	Taylor	Delta		
		Medina	Nolan	Hopkins		
		Bexar	Coke	Franklin		
		Real	Sterling	Camp		
		Bandera	Reagan	Titus		
		Kerr	Crockett	Morris		
		Gillespie	Terrell	Marion		
		Kendall	Irion	Cass		
		Blanco	Tom Green	Lubbock		

Table 6. Cont'd.

	Zone						
1	2	3	4	5	6	7
		Comal	Concho	Crosby		
		Hays	Runnels	Dickens		
		Travis	Coleman	King		
		Williamson	Brown	Knox		
		Milam	Eastland	Baylor		
		Guadalupe	Comanche	Archer		
		Caldwell	Erath	Clay		
		Bastrop	Hood	Montague		
		Lee	Somervell	Cooke		
		Burleson	Bosque	Grayson		
		Washington	Johnson	Fannin		
		Austin	Hill	Lamar		
		Fort Bend	Ellis	Red River		
		Waller	Navarro	Bowie		
		Grimes	Freestone	Floyd		
		Harris	Henderson	Motley		
		Montgomery	Anderson	Cottle		
			Smith	Foard		
			Cherokee	Wilbarger		
			Angelina	Wichita		
			San Augustine	Childress		
			Nacogdoches	Hardeman		
			Rusk			
			Gregg			

Table 7. Texas counties included in each zone surrounding the upper Laguna Madre system.

Zone						
1	2	3	4	5	6	7
Kenedy	Willacy	Zapata	Val Verde	Presidio	El Paso	Oldham
Kleberg	Cameron	Webb	Edwards	Brewster	Hudspeth	Hartley
Jim Wells	Hidalgo	LaSalle	Kimble	Jeff Davis	Culberson	Moore
Nueces	Starr	Frio	Mason	Reeves	Yoakum	Hutchinson
San Patricio	Jim Hogg	Wilson	San Saba	Pecos	Cochran	Dallam
	Brooks	Atascosa	Lampasas	Ward	Hockley	Sherman
	Duval	Gonzales	Bell	Crane	Lubbock	Hansford
	McMullen	DeWitt	Falls	Upton	Bailey	Ochiltree
	Live Oak	Lavaca	Robertson	Loving	Lamb	Lipscomb
	Bee	Jackson	Leon	Winkler	Hale	
	Karnes	Matagorda	Madison	Ector	Floyd	
	Goliad	Brazoria	Walker	Midland	Motley	
	Refugio	Galveston	San Jacinto	Glasscock	Parmer	
	Victoria	Chambers	Polk	Andrews	Castro	
	Aransas	Liberty	Hardin	Martin	Swisher	
	Calhoun	Montgomery	Jefferson	Howard	Briscoe	
		Grimes	Orange	Mitchell	Hall	
		Brazos	Newton	Nolan	Childress	
		Burleson	Sabine	Gaines	Deaf Smith	
		Milam	Shelby	Dawson	Randall	
		Williamson	Panola	Borden	Armstrong	
		Burnet	Rusk	Scurry	Donley	
		Llano	Smith	Fisher	Collingsworth	
		Gillespie	Van Zandt	Jones	Potter	
		Kerr	Kaufman	Shackelford	Carson	
		Real	Dallas	Stephens	Gray	
		Kinney	Tarrant	Terry	Wheeler	
		Maverick	Parker	Lynn	Roberts	
		Dimmit	Palo Pinto	Garza	Hemphill	
		Zavala	Eastland	Kent		
		Uvalde	Callahan	Stonewall		
		Medina	Taylor	Haskell		
		Bexar	Runnels	Throckmorton		
		Bandera	Coke	Young		
		Kendall	Sterling	Jack		
		Comal	Reagan	Wise		
		Guadalupe	Crockett	Denton		
		Blanco	Terrell	Collin		
		Hays	Sutton	Rockwall		
		Travis	Schleicher	Hunt		
		Caldwell	Menard	Delta		
		Bastrop	Irion	Hopkins		
		Lee	Tom Green	Rains		
		Fayette	Concho	Wood		
		Washington	McCulloch	Franklin		

Table 7. Cont'd.

		Zone				
1	2	3	4	5	6	7
		Colorado	Coleman	Titus		
		Austin	Brown	Morris		
		Waller	Mills	Camp		
		Wharton	Comanche	Upshur		
		Fort Bend	Hamilton	Gregg		
		Harris	Coryell	Cass		
			Erath	Marion		
			Hood	Harrison		
			Somervell	Crosby		
			Bosque	Dickens		
			McLennan	King		
			Johnson	Knox		
			Hill	Baylor		
			Limestone	Archer		
			Ellis	Clay		
			Navarro	Montague		
			Freestone	Cooke		
			Henderson	Grayson		
			Anderson	Fannin		
			Houston	Lamar		
			Trinity	Red River		
			Cherokee	Bowie		
			Angelina	Cottle		
			Tyler	Foard		
			Jasper	Hardeman		
			Nacogdoches	Wilbarger		
			San Augustine	Wichita		

Table 8. Texas counties included in each zone surrounding the lower Laguna Madre system.

			Zone			
1	2	3	4	5	6	7
Cameron	Hidalgo	Zapata	Kinney	Presidio	Hudspeth	El Paso
Willacy	Starr	Webb	Edwards	Brewster	Culberson	Parmer
Kenedy	Jim Hogg	LaSalle	Real	Pecos	Jeff Davis	Deaf Smith
	Brooks	McMullen	Kerr	Terrell	Reeves	Randall
	Duval	Live Oak	Gillespie	Crockett	Loving	Oldham
	Jim Wells	Bee	Blanco	Ward	Winkler	Potter
	Kleberg	Goliad	Travis	Crane	Andrews	Carson
	Nueces	Victoria	Williamson	Upton	Gaines	Gray
	San Patricio	Calhoun	Lee	Reagan	Dawson	Wheeler
	Refugio	Matagorda	Washington	Irion	Yoakum	Hartley
	Aransas	Brazoria	Grimes	Tom Green	Terry	Moore
		Fort Bend	Montgomery	Ector	Lynn	Hutchinson
		Waller	Harris	Midland	Garza	Roberts
		Austin	Galveston	Glasscock	Cochran	Hemphill
		Fayette	Chambers	Sterling	Hockley	Dallam
		Bastrop	Jefferson	Coke	Lubbock	Sherman
		Caldwell	Orange	Runnels	Crosby	Hansford
		Hays	Jasper	Coleman	Dickens	Ochiltree
		Comal	Newton	Brown	King	Lipscomb
		Kendall	Tyler	Comanche	Bailey	
		Bandera	Angelina	Martin	Lamb	
		Uvalde	Trinity	Howard	Hale	
		Zavala	Houston	Mitchell	Floyd	
		Maverick	Anderson	Nolan	Motley	
		Dimmit	Freestone	Taylor	Cottle	
		Frio	Limestone	Callahan	Foard	
		Atascosa	McLennan	Eastland	Wilbarger	
		Medina	Bosque	Erath	Wichita	
		Bexar	Hamilton	Hood	Castro	
		Guadalupe	Mills	Somervell	Swisher	
		Wilson	San Saba	Johnson	Briscoe	
		Karnes	McCulloch	Hill	Hall	
		DeWitt	Concho	Ellis	Childress	
		Gonzales	Menard	Navarro	Hardeman	
		Lavaca	Schleicher	Borden	Armstrong	
		Jackson	Sutton	Scurry	Donley	
		Colorado	Val Verde	Fisher	Collingsworth	
		Wharton	Kimble	Jones		
			Mason	Shackelford		
			Llano	Stephens		
			Burnet	Palo Pinto		
			Lampasas	Parker		
			Coryell	Tarrant		
			Bell	Dallas		
			Milam	Kent		

Table 8. Cont'd.

			Zone			
1	2	3	4	5	6	7
			Burleson	Stonewall		
			Falls	Haskell		
			Robertson	Throckmorton		
			Brazos	Young		
			Leon	Jack		
			Madison	Wise		
			Walker	Denton		
			San Jacinto	Collin		
			Polk	Knox		
			Liberty	Baylor		
			Hardin	Archer		
				Clay		
				Montague		
				Cooke		
				Grayson		
				Fannin		
				Lamar		
				Red River		
				Bowie		
				Rockwall		
				Kaufman		
				Henderson		
				Hunt		
				Van Zandt		
				Delta		
				Hopkins		
				Rains		
				Wood		
				Smith		
				Cherokee		
				Franklin		
				Titus		
				Morris		
				Camp		
				Cass		
				Upshur		
				Gregg		
				Rusk		
				Nacogdoches		
				Marion		
				Harrison		
				Panola		
				Shelby		
				San Augustine		
				Sabine		

APPENDIX B--Population in Texas counties included in each zone surrounding each bay system

Table 1. Population in Texas counties included in each zone surrounding each bay system (based on 1970 data (Anonymous 1975)).

Bay system	Zone						
	1	2	3	4	5	6	7
Galveston	2,362,324	420,149	3,099,919	3,707,234	739,405	493,565	374,134
Matagorda	257,526	2,455,705	3,335,313	3,618,856	805,745	358,282	365,303
San Antonio	155,125	655,523	5,071,090	3,618,519	975,477	711,327	9,669
Aransas	412,860	258,662	5,074,203	3,564,854	1,134,447	742,035	9,669
Corpus Christi	336,394	271,569	4,798,943	3,612,695	1,388,241	770,086	18,802
Upper Laguna Madre	351,708	518,414	4,045,128	3,905,311	1,388,159	915,257	72,753
Lower Laguna Madre	156,616	593,049	1,642,269	3,546,498	4,013,984	594,574	649,740