

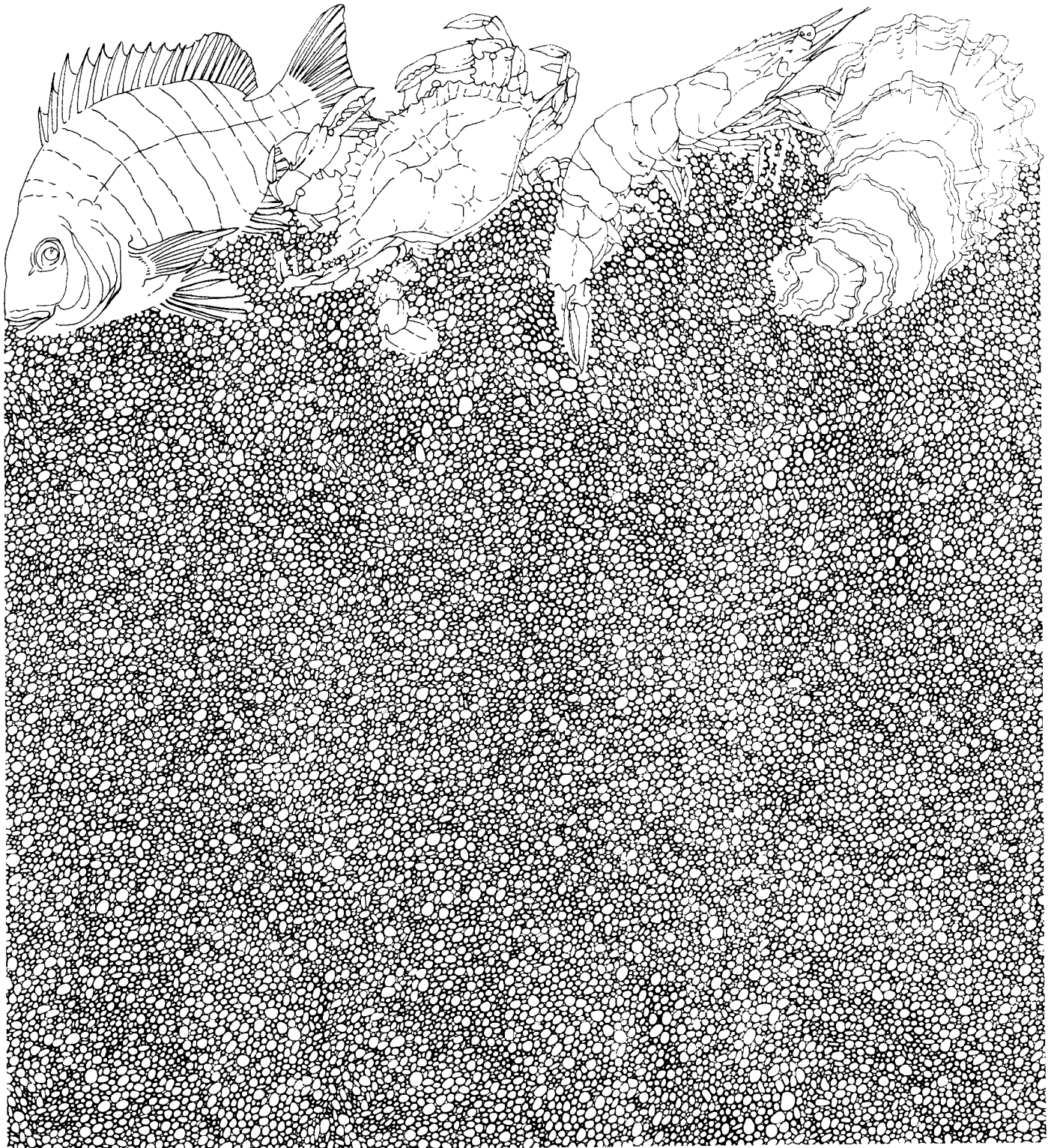
Paul Hammerschmidt

**BY-CATCH OF SOUTHERN FLOUNDER AND GULF
FLOUNDER BY COMMERCIAL SHRIMP TRAWLERS IN
TEXAS BAYS**

by Gary C. Matlock

Management Data Series, Number 31
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Texas Parks & Wildlife
Coastal Fisheries Branch



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ABSTRACT

The by-catch of southern flounder (Paralichthys lethostigma) by commercial shrimp trawlers in Texas bays during April-November 1978 was an estimated $9,740,800 \pm 552,860$ fish; $195,686 \pm 73,350$ gulf flounder (P. albigutta) were caught. The mean catch rate of southern flounder was 5.3 ± 1.0 fish/h with no significant differences among the eight monthly mean catch rates. Total length of southern flounder ranged from 82 mm (3.2 inches) to 385 mm (15.2 inches); mean of 176 ± 2 mm (6.9 ± 0.1 inches). Mean monthly catch rates of gulf flounder exceeded 0.1 fish/h only once (May); total length range was 94-311 mm (3.7-12.2 inches).

INTRODUCTION

Southern flounder (Paralichthys lethostigma) and gulf flounder (P. albigutta) are important in both the commercial and recreational fisheries of Texas. During 1974-76 commercial finfish fishermen reported harvesting 97,250 kg of flounder while recreational fishermen harvested an estimated 237,410 kg (Heffernan and Green 1977). In recent years fishermen who direct their efforts to harvesting flounder have expressed concerns that other fisheries harvesting flounder indirectly may be adversely affecting flounder populations. This study was undertaken to provide a preliminary estimate of the by-catch and size of southern flounder and gulf flounder by commercial shrimp trawlers along the Texas coast during the period when most bay shrimping activity occurs.

MATERIALS AND METHODS

One commercial shrimp trawler in each of Galveston, Matagorda, San Antonio, Aransas and Corpus Christi Bays and upper and lower Laguna Madre was accompanied 1 day each month from April through November 1978. Each trawler was selected at random from those trawlers whose captain agreed to allow Texas Parks and Wildlife Department (TPWD) personnel aboard. Each species of flatfish caught was identified to species (Gallaway et al. 1971, Bailey et al. 1970). Southern flounder and gulf flounder were counted and individual total lengths (to the nearest 1 mm) determined. On each day, the duration of each drag (to the nearest 0.1 h), total number of drags, stretched mesh size (to the nearest 0.1 mm), net width (to the nearest 0.1 m), type of trawler (bait or food) and bay shrimped were recorded. In addition, each

captain was asked the number of days shrimped per week. Total catch (C_T) of each species in all bays during the 8-mo sampling period was estimated by the following:

$$C_T = \bar{C}_t \times T \times D$$

where \bar{C}_t = mean catch per trawler per day, T = total number of trawlers, and D = total number of days of trawling. D was estimated using the mean number of days trawled per week times the total number of weeks. The standard error of \bar{C}_t was calculated according to Goodman (1960). Because of dual licensing, the total number of commercial shrimp trawlers in Texas bays was 4,458 in fiscal year 1979 (Warren and Bryan 1981); 6,196 bay and bait licenses were sold (Texas Parks and Wildlife Department, unpublished data). This proportion (4,458/6,196) and the number of bay and bait licenses sold in fiscal year 1978 were used to estimate the number of commercial shrimp trawlers in fiscal year 1978 (4,458/6,196 x 5,289 = 3,805).

Mean catch rates (C as no/h) and standard errors for each of southern flounder and gulf flounder were calculated for each month in each bay system and all bays combined using the ratio estimator (Cochran 1967):

$$C = \frac{\sum_{i=1}^n N_i}{\sum_{i=1}^n t_i}$$

where N = number of fish caught each day, n = total number of days sampled and t = total drag time (hours) on each day. Mean total length (+ 1 SE) was calculated for each species caught each day in each bay system. Analysis of variance (Sokal and Rohlf 1969) was used to determine significant (P = 0.01) differences among the monthly mean catch rates and the monthly mean total lengths of southern flounder. Each catch rate was transformed to common logarithm before analysis. Duncan's multiple range test was used to determine

which mean lengths were different (Ott 1977). No statistical analyses were conducted on the gulf flounder data; only 18 fish were caught in 8 months.

RESULTS

The total catch of southern flounder by the estimated 3,805 commercial shrimp trawlers in Texas bays (see Materials and Methods) was $9,740,800 \pm 552,860$ fish. The catch of gulf flounder was $195,686 \pm 73,350$ fish. During April-November 1978, 898 southern flounder (176 ± 2 mm) and 18 gulf flounder (166 ± 18 mm) were caught by commercial shrimp trawlers in the eight Texas bay systems (Table 1) during 168.5 h of trawling (Table 2). The mean catch rate of southern flounder was 5.3 ± 1.0 fish/h with no significant differences among the eight monthly mean catch rates (Table 3). The mean size of southern flounder was significantly different among months (Table 4). The mean length of fish caught in April (233 ± 10 mm) was significantly larger than that of fish caught in any other month ($P < 0.01$). Catches of southern flounder were consistently lower in upper Laguna Madre than in any other bay system. Gulf flounder catches were consistently low ($< 0.1/h$) except in May when they reached 0.5 ± 0.0 fish/h. No trend in mean size of gulf flounder was evident.

Ten species of flatfishes were caught during the sampling period, including: southern flounder, gulf flounder, bay whiff (Citharichthys spilopterus), hogchoker (Trinectes maculatus), ocellated flounder (Ancylosetta quadrocellata), blackcheek tonguefish (Symphurus plagiusa), lined sole (Achirus lineatus), spiny flounder (Engyophrys senta), fringed flounder (Etropus crossotus) and shoal flounder (Syacium gunteri) (Table 5). Southern flounder, bay whiff, ocellated flounder and blackcheek tonguefish only were

caught in every bay system at least once during the sampling periods with southern flounder caught more often (78.7% of the time) than any other species. The Corpus Christi Bay system yielded the greatest number of species (nine) and the upper Laguna Madre the fewest (five).

DISCUSSION

Of the southern flounder caught by commercial shrimp trawlers in Texas bays, most were juveniles. Few gulf flounder were caught during the shrimping season. The estimated mean catch rates and mean sizes for flounder were based on seven samples per month for the entire coast and on the assumption that the sampled boats were representative of the entire commercial shrimp fleet in Texas bays. The calculated catch rates and mean sizes were also based on the assumption that all flounder along the coast were part of a single population. No literature is available to support or refute this assumption. However, if the assumption is not valid then additional samples should be collected in each bay system each month and the data analysis should be conducted on a bay system basis. Additional samples would probably improve the precision of the estimates.

Using the length-weight regression for southern flounder (Harrington et al. 1979), the weight of the 10 million southern and gulf flounder caught by shrimpers was about 563,000 kg. It is unknown what proportion of these fish actually died since no studies have been conducted on this topic. However, if 50% of the catch had died, the weight harvested by trawlers would have been about 281,000 kg which would have approximated the weight harvested by commercial and recreational fishermen. During 1974-76 commercial fishermen reported landing approximately 96,300 kg of southern flounder annually and recreational fishermen landed an estimated 235,350 kg of flounder for a total of 331,650 kg of flounder (Heffernan and Green 1977). By number,

the southern flounder catch by trawlers (9,740,800 \pm 552,860) was about 13 times greater than that of the directed fishery (737,000 fish), assuming 0.45 kg for the mean weight of flounder caught in the directed fishery.

Only two southern flounder were caught during the 8 mo in upper Laguna Madre. Either flounder populations in this system were very low or they were unavailable to the gear which is predominantly push net type trawl. Since limited data are available on the status of flounder populations in the upper Laguna Madre it is difficult to assess the impact of each factor on the catches during this study. However, bait trawlers in this system use a frame from which the trawl is suspended, and only bait shrimpers were surveyed in the upper Laguna Madre. If trawl construction rather than low flounder populations proves to be a key element, perhaps this modification could be used in other systems to reduce southern flounder catches.

Very few ($<0.1/h$) gulf flounder were caught by either gear. Either very few fish were available for capture or the trawls used were ineffective in capturing gulf flounder. The mean catch rate of gulf flounder in dredge seines, minnow seines, flounder nets, gigs and trawls in 1974-1975 never exceeded 0.5/sample whereas mean southern flounder catches in each gear reached 1.5, 2.3, 10.2, 6.4 and 9.0 per sample (Stokes 1977). Apparently the commercial catches reflected the low abundance of gulf flounder as compared to southern flounder.

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Table 1. Catch data for southern flounder and gulf flounder caught by commercial bay shrimp trawlers during April-November 1978 (ND = no data).

Month	Bay system	Southern flounder				Gulf flounder				
		Number caught	No/h \pm 1 SE	Total length range (mm)	Mean total length (mm) \pm 1 SE	Number caught	No/h \pm 1 SE	Total length range (mm)	Mean total length (mm) \pm 1 SE	
April	Galveston	2	1.0 \pm 1.0	ND	ND	0	0.0 \pm 0.0	ND	ND	
	Matagorda	0	0.0 \pm 0.0	ND	ND	0	0.0 \pm 0.0	ND	ND	
	San Antonio	2	0.8 \pm 0.4	225-255	240 \pm 15	0	0.0 \pm 0.0	ND	ND	
	Aransas	1	0.3 \pm 0.2	153	153	0	0.0 \pm 0.0	ND	ND	
	Corpus Christi	1	0.7 \pm 0.7	311	311	0	0.0 \pm 0.0	ND	ND	
	Upper Laguna Madre	0	0.0 \pm 0.0	ND	ND	0	0.0 \pm 0.0	ND	ND	
	Lower Laguna Madre	31	23.8 \pm 0.8	105-348	232 \pm 11	0	0.0 \pm 0.0	ND	ND	
	Texas Coast	37	2.0 \pm 1.8 ^a	105-348	233 \pm 10	0	0.0 \pm 0.0 ^a	ND	ND	
	May	Galveston	3	0.7 \pm 0.5	96-103	100 \pm 2	0	0.0 \pm 0.0	ND	ND
		Matagorda	14	1.5 \pm 0.6	213-362	253 \pm 12	0	0.0 \pm 0.0	ND	ND
San Antonio		7	4.1 \pm 3.1	101-261	162 \pm 24	0	0.0 \pm 0.0	ND	ND	
Aransas		0	0.0 \pm 0.0	ND	ND	0	0.0 \pm 0.0	ND	ND	
Corpus Christi		5	1.7 ^b	220-301	257 \pm 16	6	2.0 ^b	103-140	123 \pm 6	
Upper Laguna Madre		2	1.4 \pm 1.0	105-136	120 \pm 85	2	1.4 \pm 0.0	94-115	104 \pm 10	
Lower Laguna Madre		6	6.0 \pm 2.6	87-240	141 \pm 21	3	3.0 \pm 0.0	95-260	155 \pm 53	
Texas Coast		37	1.6 \pm 0.4 ^a	87-362	199 \pm 12	11	0.5 \pm 0.0	94-260	128 \pm 14	
June		Galveston	27	19.3 \pm 5.4	118-255	150 \pm 8	0	0.0 \pm 0.0	ND	ND
		Matagorda	10	5.6 \pm 0.7	110-268	158 \pm 18	0	0.0 \pm 0.0	ND	ND
	San Antonio	86	26.1 \pm 2.3	100-345	144 \pm 5	0	0.0 \pm 0.0	ND	ND	
	Aransas	17	4.0 ^b	87-207	145 \pm 7	0	0.0 ^b	ND	ND	
	Corpus Christi	6	2.0 ^b	143-261	210 \pm 21	2	0.7 ^b	130-243	186 \pm 56	
	Upper Laguna Madre	0	0.0 \pm 0.0	ND	ND	0	0.0 \pm 0.0	ND	ND	
	Lower Laguna Madre	3	1.9 \pm 1.9	150-249	204 \pm 29	0	0.0 \pm 0.0	ND	ND	
	Texas Coast	149	9.2 \pm 4.5 ^a	87-345	150 \pm 4	2	0.1 \pm 0.0 ^a	130-243	186 \pm 56	

Table 1. (Cont'd).

Month	Bay system	Southern flounder				Gulf flounder				
		Number caught	No/h \pm 1 SE	Total length range (mm)	Mean total length (mm) \pm 1 SE	Number caught	No/h \pm 1 SE	Total length range (mm)	Mean total length (mm) \pm 1 SE	
July	Galveston	0	0.0 + 0.0	ND	ND	0	0.0 + 0.0	ND	ND	
	Matagorda	9	4.7 + 3.2	95-135	112 + 4	0	0.0 + 0.0	ND	ND	
	San Antonio	23	7.7 + 4.9	108-232	136 + 7	0	0.0 + 0.0	ND	ND	
	Aransas	59	45.4 ^b	88-278	114 + 5	0	0.0 ^b	ND	ND	
	Corpus Christi	5	2.3 ^b	135-308	222 + 32	1	0.4 ^b	118	118	
	Upper Laguna Madre	0	0.0 + 0.0	ND	ND	0	0.0 + 0.0	ND	ND	
	Lower Laguna Madre	5	10.0 + 0.0	243-358	282 + 21	0	0.0 + 0.0	ND	ND	
	Texas Coast	101	8.7 + 5.0 ^a	88-358	133 + 6	1	0.1 + 0.0 ^a	118	118	
August	Galveston	5	1.2 + 0.9	124-280	236 + 29	0	0.0 + 0.0	ND	ND	
	Matagorda	42	4.5 ^b	120-300	205 + 8	0	0.0 ^b	ND	ND	
	San Antonio	88	12.6 + 6.7	112-266	159 + 3	0	0.0 + 0.0	ND	ND	
	Aransas	16	4.6 ^b	145-216	195 + 5	0	0.0 ^b	ND	ND	
	Corpus Christi	7	2.3 ^b	160-220	186 + 8	2	0.7 ^b	223-252	238 + 14	
	Upper Laguna Madre	0	0.0 + 0.0	ND	ND	0	0.0 + 0.0	ND	ND	
	Lower Laguna Madre	1	3.3 + 2.6 ^a	241	241	0	0.0 + 0.0	ND	ND	
	Texas Coast	159	5.4 + 2.0 ^a	112-300	179 + 3	2	0.1 + 0.0 ^a	223-252	238 + 14	
	September	Galveston	0	0.0 + 0.0	ND	ND	0	0.0 + 0.0	ND	ND
		Matagorda	14	1.5 ^b	162-355	240 + 16	0	0.0 ^b	ND	ND
San Antonio		21	3.2 + 0.5	82-307	170 + 16	0	0.0 + 0.0	ND	ND	
Aransas		43	14.3 ^b	129-288	200 + 5	0	0.0 ^b	ND	ND	
Corpus Christi		49	40.8 ^b	120-385	172 + 5	0	0.0 ^b	ND	ND	
Upper Laguna Madre		0	0.0 + 0.0	ND	ND	0	0.0 + 0.0	ND	ND	
Lower Laguna Madre		6	7.5 + 3.2	140-235	174 + 15	0	0.0 + 0.0	ND	ND	
Texas Coast		133	5.5 + 3.0 ^a	82-385	189 + 4	0	0.0 + 0.0 ^a	ND	ND	

Table 1. (Cont'd).

Month	Bay system	Southern flounder				Gulf flounder			
		Number caught	No/h \pm 1 SE	Total length range (mm)	Mean total length (mm) \pm 1 SE	Number caught	No/h \pm 1 SE	Total length range (mm)	Mean total length (mm) \pm 1 SE
October	Galveston	2	0.4 + 0.5	224-232	228 + 4	0	0.0 + 0.0	ND	ND
	Matagorda	5	1.0 ^b	200-380	259 + 34	1	0.2 ^b	305	305
	San Antonio	63	9.0 + 0.7	112-337	159 + 6	0	0.0 + 0.0	ND	ND
	Aransas	40	8.0 ^b	115-294	212 + 6	0	0.0 ^b	ND	ND
	Corpus Christi	9	3.0 ^b	232-295	266 + 6	1	0.3 ^b	311	311
	Upper Laguna Madre	0	0.0 + 0.0	ND	ND	0	0.0 + 0.0	ND	ND
	Lower Laguna Madre	7	4.7 + 3.1 ^a	164-231	199 + 9	0	0.0 + 0.0	ND	ND
Texas Coast	126	4.7 + 1.8 ^a	112-380	190 + 5	2	0.1 + 0.0	305-311	308 + 3	
November	Galveston	0	0.0 + 0.0	ND	ND	0	0.0 + 0.0	ND	ND
	Matagorda	3	2.5 ^b	280-350	307 + 22	0	0.0 ^b	ND	ND
	San Antonio	32	4.6 + 1.7	148-250	205 + 4	0	0.0 + 0.0	ND	ND
	Aransas	94	29.4 ^b	121-259	170 + 4	0	0.0 ^b	ND	ND
	Corpus Christi	24	12.0 ^b	175-314	223 + 8	0	0.0 ^b	ND	ND
	Upper Laguna Madre	0	0.0 + 0.0	ND	ND	0	0.0 + 0.0	ND	ND
	Lower Laguna Madre	3	3.0 + 2.0 ^a	196-285	238 + 26	0	0.0 + 0.0	ND	ND
Texas Coast	156	8.3 + 4.6 ^a	121-350	188 + 3	0	0.0 + 0.0 ^a	ND	ND	
April - November	Galveston	39	1.7 + 1.2 ^a	96-350	162 + 9	0	0.0 + 0.0 ^a	ND	ND
	Matagorda	97	2.3 + 0.7 ^a	95-380	209 + 7	0	0.0 + 0.0 ^a	305	305
	San Antonio	322	8.5 + 2.3 ^a	82-345	159 + 2	0	0.0 + 0.0 ^a	ND	ND
	Aransas	270	10.2 + 3.9 ^a	87-294	169 + 3	0	0.0 + 0.0 ^a	ND	ND
	Corpus Christi	106	5.7 + 2.8 ^a	120-385	201 + 5	12	0.6 + 0.3 ^a	103-311	168 + 20
	Upper Laguna Madre	2	0.2 + 0.2 ^a	105-136	120 + 16	2	0.2 + 0.0 ^a	94-115	104 + 10
	Lower Laguna Madre	62	7.4 + 2.7 ^a	87-358	218 + 8	3	0.4 + 0.0 ^a	95-260	155 + 53
Texas Coast	898	5.3 + 1.0 ^a	82-385	176 + 2	18	0.1 + 0.1	94-311	166 + 18	

^aStandard error of mean catch rate calculated for separate bays, not separate trawls (i.e., April n=7, n#37).

^bStandard error not available; data from each trawl not kept separate.

Table 2. Effort data for each commercial bay shrimp trawler observed during April-November 1978 (ND = no data).

Month	Bay system	Bay	Net width (m)	Stretched mesh (mm)	Mean number of drags made on sample day \pm 1 SE	Total drag time (h)	Mean time per drag (h) \pm 1 SE	Days shrimped per week	Type of trawler ^a	
April	Galveston	Bastrop Bayou	7.6	38.1	9	2.1	0.2 \pm 0.0	ND	B	
	Matagorda	Matagorda	7.6	38.1	6	2.6	0.4 \pm 0.1	7	B	
	San Antonio	Espiritu Santo	8.2	38.1	4	2.5	0.6 \pm 0.0	6	B	
	Aransas	Aransas	7.6	41.4	2	4.0	2.0 \pm 0.0	6	B	
	Corpus Christi	Corpus Christi	7.6	38.1	3	1.4	0.5 \pm 0.0	4	B	
	Upper Laguna Madre	Upper Laguna Madre	4.9	35.0	5	4.1	0.8 \pm 0.1	7	B	
	Lower Laguna Madre	Lower Laguna Madre	7.6	27.9	10	1.7	0.1 \pm 0.0	7	B	
	Texas Coast				6 \pm 1	18.4	0.5 \pm 0.1	6 \pm 0 ^b	B	
	May	Galveston	Moses Lake;Galveston	7.6	38.1	6	4.4	0.7 \pm 0.2	4 ^c	B
		Matagorda	ND	7.6	41.4	6	9.5	1.6 \pm 0.1	6	ND
San Antonio		Espiritu Santo	8.2	38.1	3	1.7	0.6 \pm 0.0	6	B	
Aransas		Aransas	7.6	38.1	3	2.2	0.8 \pm 0.0	4	ND	
Corpus Christi		Corpus Christi	7.6	35.0	3	3.0	1.0 \pm 0.3	5	B	
Upper Laguna Madre		Upper Laguna Madre	7.6	38.1	2	1.4	0.7 \pm 0.0	4 ^d	B	
Lower Laguna Madre		Lower Laguna Madre	7.6	38.1	4	1.0	0.2 \pm 0.0	ND	B	
Texas Coast					4 \pm 1	23.2	0.9 \pm 0.1	5 \pm 0 ^b	B	
June		Galveston	Trinity	7.6	35.0	4	1.4	0.4 \pm 0.1	4 ^e	B
		Matagorda	ND	7.6	35.0	3	1.8	0.6 \pm 0.1	3	ND
	San Antonio	San Antonio	7.6	41.4	2	3.3	1.6 \pm 0.4	2	B	
	Aransas	ND	7.6	34.9	3	4.2	1.4 \pm 0.0	7	ND	
	Corpus Christi	Corpus Christi	7.6	38.1	2	3.0	1.5 \pm 0.5	6	F	
	Upper Laguna Madre	Upper Laguna Madre	7.6	38.1	2	0.9	0.4 \pm 0.0	5	B	
	Lower Laguna Madre	Lower Laguna Madre	6.7	27.9	8	1.6	0.2 \pm 0.0	5	B	
	Texas Coast				3 \pm 1	16.2	0.7 \pm 0.1	5 \pm 1 ^b	B	

Table 2. (Cont'd).

Month	Bay system	Bay	Net width (m)	Stretched mesh (mm)	Mean number of drags made on sample day \pm 1 SE	Total drag time (h)	Mean time per drag (h)		Days shrimped per week	Type of trawler ^a
								\pm 1 SE		
July	Galveston	Galveston	7.6	41.4	2	1.8	0.9 \pm 0.1	6	B	
	Matagorda	Tres Palacios	7.6	38.1	5	1.9	0.4 \pm 0.1	7	B	
	San Antonio	San Antonio	7.6	41.4	3	3.0	1.0 \pm 0.3	2	B	
	Aransas	St. Charles	7.6	34.9	4	1.3	0.3 \pm 0.0	4	B	
	Corpus Christi	Corpus Christi	7.6	41.4	3	2.2	0.8 \pm 0.0	1	B	
	Upper Laguna Madre	Upper Laguna Madre	5.5	38.1	2	0.9	0.5 \pm 0.0	7	B	
	Lower Laguna Madre	Arroyo Colorado	4.9	33.0	3	0.5	0.2 \pm 0.0	4	B	
	Texas Coast				3 \pm 0	11.6	0.5 \pm 0.1	4 + 1 ^b		
	August	Galveston	Clear Lake	7.6	38.1	3	4.0	1.3 \pm 0.1	6	B
		Matagorda	Matagorda	16.8	44.4	5	9.4	1.9 \pm 0.0	4	F
San Antonio		San Antonio	17.1	41.4	2	7.0	3.5 \pm 0.5	6	F	
Aransas		Copano	7.6	38.1	3	3.5	1.2 \pm 0.0	6	B	
Corpus Christi		Corpus Christi	7.6	38.1	3	3.0	1.0 \pm 0.2	4	F	
Upper Laguna Madre		Upper Laguna Madre	6.1	35.1	2	2.3	1.2 \pm 0.0	1	F	
Lower Laguna Madre		Lower Laguna Madre	4.9	33.0	2	0.3	0.2 \pm 0.0	4	B	
Texas Coast					3 \pm 0	29.5	1.5 \pm 0.2	4 + 1 ^b		
September		Galveston	Galveston	7.6	38.1	3	1.5	0.5 \pm 0.0	5	F
		Matagorda	Matagorda	15.9	44.4	5	9.6	1.9 \pm 0.0	7	F
	San Antonio	San Antonio	12.2	41.4	3	6.5	2.2 \pm 0.2	6	F	
	Aransas	Aransas	7.6	41.4	2	3.0	1.5 \pm 0.0	5	F	
	Corpus Christi	Corpus Christi	16.8	44.4	1	1.2	1.2	6	F	
	Upper Laguna Madre	Upper Laguna Madre	6.1	38.1	2	1.5	0.8 \pm 0.0	7	B	
	Lower Laguna Madre	Arroyo Colorado	6.7	38.1	4	0.8	0.2 \pm 0.0	5	B	
	Texas Coast				3 + 1	24.1	1.2 \pm 0.2	6 + 0 ^b		

Table 2. (Cont'd).

Month	Bay system	Bay	Net width (m)	Stretched mesh (mm)	Mean number of drags made on sample day \pm 1 SE	Total drag time (h)	Mean time per drag (h) \pm 1 SE	Days shrimped per week	Type of trawler ^a	
October	Galveston	Trinity	10.1	44.4	4	4.5	1.1 \pm 0.3	3	F	
	Matagorda	Matagorda; Turtle	18.6	44.4	7	5.0	0.7 \pm 0.0	7	F	
	San Antonio	San Antonio	17.1	44.4	2	7.0	3.5 \pm 0.5	6	F	
	Aransas	Aransas	16.8	44.4	2	5.0	2.5 \pm 0.0	6	F	
	Corpus Christi	Corpus Christi	15.2	44.4	2	3.0	1.5 \pm 0.0	7	F	
	Upper Laguna Madre	Upper Laguna Madre	6.1	38.1	1	0.8	0.8	7	B	
	Lower Laguna Madre	Arroyo Colorado	7.6	40.6	5	1.5	0.3 \pm 0.0	4	B	
	Texas Coast				3 \pm 1	26.8	1.2 \pm 0.2	6 \pm 1 ^b	B	
	November	Galveston	Clear Lake	7.6	38.1	3	3.6	1.2 \pm 0.1	7	B
		Matagorda	Matagorda; Tres Palacios	7.6	38.1	5	1.2	0.2 \pm 0.0	7	B
San Antonio		San Antonio;	15.2	41.4	3	7.0	2.3 \pm 0.2	6	F	
Aransas		Espiritu Santo	7.6	34.9	4	3.2	0.8 \pm 0.0	5	B	
Corpus Christi		Aransas	16.8	38.1	4	2.0	0.5 \pm 0.0	6	F	
Upper Laguna Madre		Corpus Christi	5.5	38.1	1	0.7	0.7	7	B	
Lower Laguna Madre		Upper Laguna Madre	6.7	38.1	3	1.0	0.3 \pm 0.0	5	B	
Texas Coast		Lower Laguna Madre			3 \pm 1	18.7	0.8 \pm 0.1	6 \pm 0 ^b	B	
April -		Galveston			4 \pm 1	23.3	0.7 \pm 0.1	5 \pm 1 ^b		
November		Matagorda			5 \pm 0	43.0	1.0 \pm 0.1	6 \pm 1 ^b		
	San Antonio			3 \pm 0	38.0	1.7 \pm 0.2	5 \pm 1 ^b			
	Aransas			3 \pm 0	26.4	1.1 \pm 0.1	5 \pm 0 ^b			
	Corpus Christi			3 \pm 0	18.8	0.9 \pm 0.1	5 \pm 1 ^b			
	Upper Laguna Madre			2 \pm 0	12.6	0.6 \pm 0.0	6 \pm 1 ^b			
	Lower Laguna Madre			5 \pm 1	8.4	0.2 \pm 0.0	5 \pm 0 ^b			
	Texas Coast			4 \pm 0	168.5	0.8 \pm 0.0	5 \pm 0 ^b			

^aB = Bait shrimper; F = Food shrimper.

^bStandard error of mean catch rate calculated for separate bays, not separate trawls (i.e., in April n=7, n#37).

^cBased on 100 drags/mo and 6 drags/day.

^dBased on response of 3-4 days/week by shrimper.

^eBased on 18 drags/week and 4 drags/day.

^fBased on 3 trips/mo and 3 trawls/trip.

Table 3. Results of analysis of variance of monthly mean catch rates (no/h) of southern flounder by commercial shrimp trawlers in Texas bays.

Source	Degrees of freedom	Sum of squares	Mean square	F
Total	55	12.2115		
Months	7	1.0082	0.1440	0.6170 NS
Error	48	11.2033	0.2334	

NS = not significant at $P = 0.05$.

Table 4. Results of analysis of variance of mean total length of southern flounder caught by commercial shrimp trawlers in Texas bays.

Source	Degrees of freedom	Sum of squares	Mean square	F
Total	897	2,657,749		
Months	7	497,946	71135.14	29.310**
Error	890	2,159,803	2426.74	

** $P < 0.01$.

Table 5. (Cont'd).

Month	Bay system	Southern flounder	Gulf flounder	Bay whiff	Hogchoker	Ocellated flounder	Blackcheek tonguefish	Lined sole	Spring flounder	Fringed flounder	Shoal flounder
July	Galveston			X							
	Matagorda	X		X							
	San Antonio	X		X							
	Aransas	X		X	X		X				
	Corpus Christi	X	X	X		X		X		X	
	Upper Laguna Madre	X		X			X				
	Lower Laguna Madre Texas Coast	X	X	X	X	X	X	X		X	
August	Galveston	X		X			X	X			
	Matagorda	X		X	X					X	
	San Antonio	X		X	X	X					X
	Aransas	X		X	X						
	Corpus Christi	X	X	X	X		X				
	Upper Laguna Madre	X		X					X		
	Lower Laguna Madre Texas Coast	X	X	X	X	X	X	X	X	X	X
September	Galveston										
	Matagorda	X		X		X	X	X			
	San Antonio	X		X	X		X	X		X	
	Aransas	X		X	X	X	X	X			
	Corpus Christi	X		X	X						
	Upper Laguna Madre	X		X			X				
	Lower Laguna Madre Texas Coast	X	X	X	X	X	X	X		X	

Table 5. (Cont'd).

Month	Bay system	Southern flounder	Gulf flounder	Bay whiff	Hogchoker	Ocellated flounder	Blackcheek tonguefish	Lined sole	Spring flounder	Fringed flounder	Shoal flounder
October	Galveston	X		X		X					
	Matagorda	X	X	X			X	X			
	San Antonio	X		X			X			X	
	Aransas	X			X		X			X	
	Corpus Christi	X	X	X		X	X				
	Upper Laguna Madre	X						X			
	Lower Laguna Madre	X						X			
November	Galveston		X	X		X	X	X			
	Matagorda	X		X			X				
	San Antonio	X			X	X	X	X		X	
	Aransas	X		X			X			X	
	Corpus Christi	X				X	X			X	
	Upper Laguna Madre	X					X	X			
	Lower Laguna Madre	X					X	X			
April - November	Galveston	X		X		X	X	X			
	Matagorda	X	X	X		X	X	X		X	
	San Antonio	X		X		X	X	X		X	
	Aransas	X		X		X	X	X		X	
	Corpus Christi	X	X	X		X	X	X	X		
	Upper Laguna Madre	X		X		X	X	X	X		
	Lower Laguna Madre	X		X		X	X	X			
Texas Coast	X	X	X		X	X	X	X		X	

^aData collected for species other than southern flounder and gulf flounder in upper and lower Laguna Madre only.

^bData collected for species other than southern flounder and gulf flounder in lower Laguna Madre only.

^cData collected for southern flounder and gulf flounder only.

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