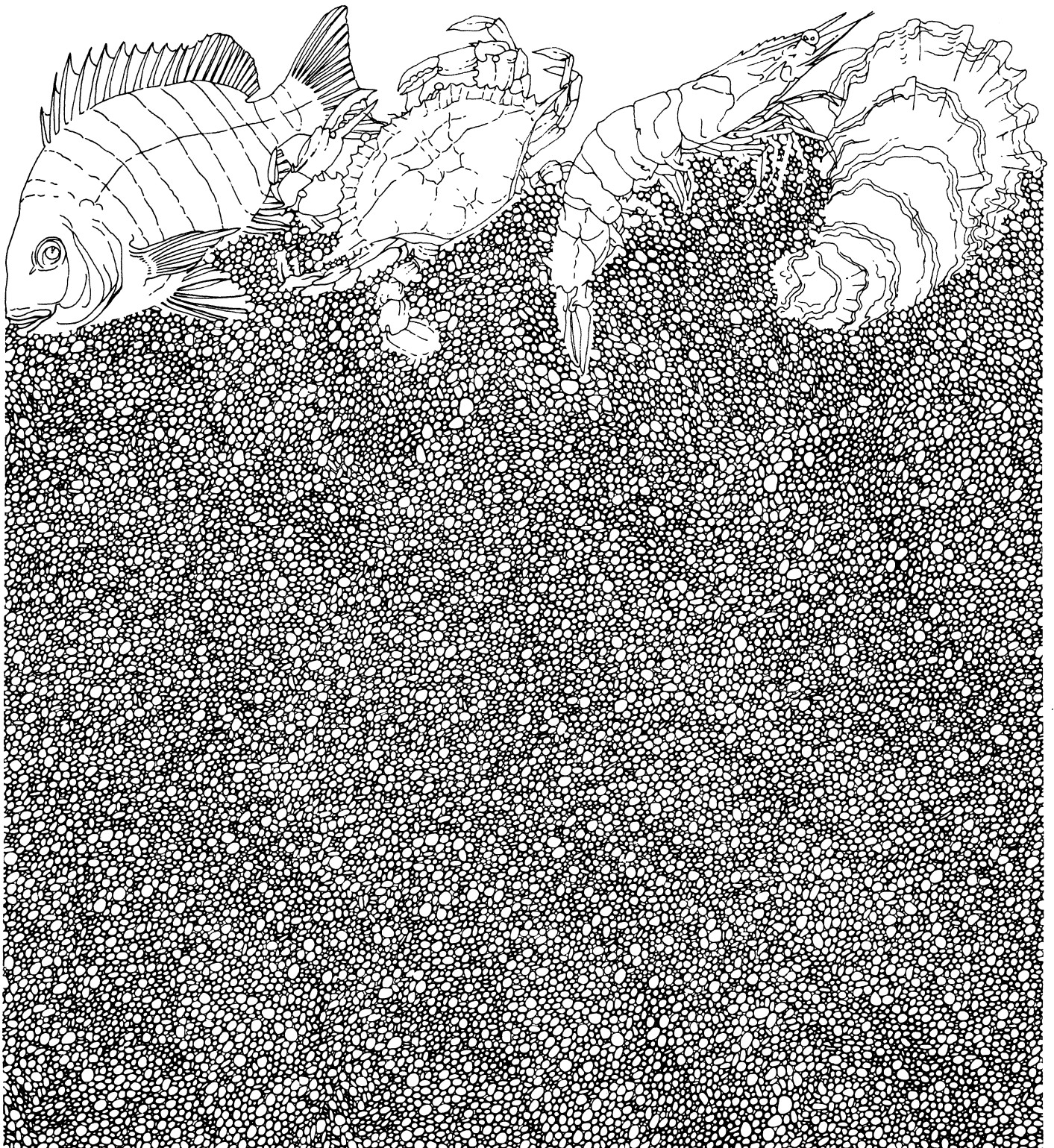


Closure Dates For The 1985 Texas Gulf Shrimping Season

by C.E. Bryan

Management Data Series Number 127
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Texas Parks and Wildlife Department
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ABSTRACT

Brown shrimp (Penaeus aztecus) were collected with bag seines along shorelines and with trawls in deeper ($\geq 1m$) bay waters, bay to Gulf passes and Texas gulf waters to determine closing and opening dates of the 1985 shrimping season in the Texas Territorial Sea. The purpose of the closed season was to protect small shrimp from fishing pressure until they reached a larger, more valuable size and to minimize waste caused by discarding smaller shrimp during harvest. The closed season date was set for 30 minutes after sunset 20 May to 30 minutes after sunset 15 July 1985 based on biological sampling along shorelines in April. Bay and Gulf samples collected in June indicated that substantial numbers of shrimp would be ≥ 112 mm before 15 July; therefore the closed season was shortened to 8 July. Pass sampling verified that closure dates and the mean length (90 mm) used to predict size at emigration were appropriate to accomplish the purpose of the closure.

ACKNOWLEDGMENTS

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INTRODUCTION

Shrimp have the highest total exvessel value of all seafood products landed in the United States. There were 136.9 million kg (heads-on) with an exvessel value of \$488 million reported landed in 1984 (U.S. Department of Commerce 1985). Texas shrimp landings in 1984 amounted to 40.9 million kg valued at \$180 million (Osburn et al. 1985). This is 30% of the weight and 37% of the value of the U.S. shrimp fishery. Shrimp are the most important commercial seafood product in Texas, annually accounting for over 90% of the value and 80% of the weight of all seafood landings. Brown shrimp (Penaeus aztecus) is the most economically valuable species, comprising about 70% of both weight and value of the annual reported landings.

Brown shrimp spawn in the Gulf of Mexico, go through several larval stages and enter bays during February-April as post-larvae (Baxter and Renfro 1967, King 1971). They initially seek shallow nursery areas in the bays where they grow rapidly, migrate to the deeper portions of bays and then return to the Gulf in late May or early June at a mean size of about 90 mm total length (Copeland 1965, Trent 1967, Parker 1970, King 1971). Movement to the Gulf through passes occurs mainly at night near the surface in association with ebb tides during the period of maximum tide duration (Copeland 1965, King 1971). Movement ceases during daylight and periods of flood tides. During these periods, shrimp remain on the bottom until the next nocturnal ebb tide. Diurnal tides are mixed, with one low and one high per 24-h period of maximum range and two highs and two lows per 24-h period with a minimum range (Collier and Hedgpeth 1950). During the period of maximum range, tides are also at maximum duration.

Brown shrimp management in Texas is designed to accommodate all users (bait, small food shrimp and large food shrimp fishermen) while protecting the resource and minimizing waste. The supply of large shrimp is ensured by regulating harvest in bays and simultaneously delaying harvest in the Gulf until emigrants reach a larger, more valuable size. Shrimp are managed by the Texas Legislature through the Shrimp Conservation Act of 1959 (State of Texas 1986). This Act established a closed season in the Texas Territorial Sea (TTS) waters (<16.7 km) from 1 June-15 July each year, but authorized the Texas Parks and Wildlife Commission (TPWC) or Executive Director to adjust closing and opening dates as long as the total closure was ≤60 d.

The purpose of the annual closure is to protect small shrimp from fishing pressure until they reach a larger, more valuable size (>112mm mean TL) and to minimize waste caused by discarding smaller shrimp during the harvest. Texas has closed its TTS for over 20 years, and the statutory 1 June-15 July season has been adjusted seven times (Table 1). The rationale for adjusting closure dates was detailed by Moffett (1967, 1972), Johnson (1982), Benefield (in preparation) and Bryan (1983, 1985 and 1986). Small shrimp were protected in the TTS by closures prior to 1981, but large numbers of small shrimp were still captured and discarded in waters beyond the state's jurisdiction (Berry and Benton 1969, Baxter 1973, Bryan et al. 1982).

The Gulf of Mexico Fishery Management Council Shrimp Fishery Management Plan was adopted in 1980 and implemented in 1981 (Center for Wetland Resources 1980). Among other options, the plan called for closure of U.S. waters (>16.7

to 370.6 km) off Texas to complement the traditional Texas closed season. The combined closure of Texas and U.S. waters resulted in an estimated increase of \$59.5 million in the exvessel value in 1981, \$46.2 million in 1982 and \$31.7 million in 1983 (Klima and Nichols 1985). This report documents the means by which the 1985 dates of closing and opening the TTS to shrimping were recommended.

MATERIALS AND METHODS

Shoreline samples were collected with bag seines to capture post-larval and juvenile shrimp as they were first recruited to the gear. Otter trawls were used in deeper (>1 m) portions of bays. Trawls were also used in passes and in the Gulf of Mexico to determine the time and at what sizes shrimp emigrated from the bays.

Bag seines were 18.3 m long and 1.8 m deep with 19-mm stretched nylon multifilament mesh in the wings and 13-mm stretched nylon multifilament mesh in the 1.8-m square bag in the middle. Trawls were 6.1 m wide at the mouth measured along the cork line between the rear margins of the trawl doors. The net was constructed of #9 nylon multifilament thread with a stretched mesh of 38 mm. Trawls doors were 1.2 m long and 0.6 m high.

Samples were collected with bag seines in Galveston, East Matagorda, Matagorda, San Antonio, Aransas and Corpus Christi Bays and upper and lower Laguna Madre. Ten different shoreline stations were sampled each month in each bay system. Stations were randomly selected from a list of grids established for each bay system on National Oceanic and Atmospheric Administration (NOAA) nautical charts. Grids were based on 1-minute longitude-latitude lines and were designated as bag seine stations if any part of the bay shoreline (mainland, peninsula, island or exposed reef) fell within the grid. The actual sampling location of the bag seine sample in each station grid was randomly selected from the 144 5-second longitude-latitude blocks (gridlets) within the grid, provided the selected gridlet fulfilled the criteria for grid station designation. If a preselected station could not be sampled, an alternate randomly selected station was substituted. A bag seine sample was collected by pulling an extended seine parallel to shore for a distance of 15.2 m which covered a rectangular surface area of 0.03 ha.

Samples were collected with trawls in Galveston, Matagorda, San Antonio, Aransas, Corpus Christi Bays and upper and lower Laguna Madre. Trawl stations were based on grids as for bag seining. A sample station was established in a grid if at least 1/3 of the grid's surface area was covered by >1 m of water and had no known obstruction, snags or reefs that would hinder sampling.

Bay systems were divided into three sampling zones: Zone I (upper bay, Zone II (lower bay) and Zone III (passes). Galveston, Matagorda, Aransas and Corpus Christi Bays were divided into Zones I, II and III; San Antonio into Zones I and II; upper Laguna Madre into Zone II; and lower Laguna Madre into Zones II and III. Zone I contained upper bay stations nearest the mouths of rivers and bayous while Zone II contained lower bay stations farthest from river and bayou influence. Zone III contained pass stations including Bolivar Roads (Galveston Bay), Pass Cavallo and Matagorda Ship Channel (Matagorda Bay), Lydia Ann Channel (Aransas Bay), Corpus Christi Ship Channel (Corpus Christi Bay) and Brazos Santiago Pass (lower Laguna Madre).

Five stations in Zone I and five in Zone II were sampled during each of the first (1st-15th) and latter half (16th-end of month) of the month. Data collected in Zones I and II were combined and reported on a monthly basis. Two stations were sampled in Zone III each week. All sampling stations were selected at random for each zone and each sample period. The sampling week extended from sunrise Monday through sunset the following Sunday. Samples were collected during daylight hours.

Trawls were towed in Zones I and II in a circular fashion near the center of each sample grid. They were towed linearly in Zone III (Gulfward or bayward); one sample with the current and one sample against the current. Direction of tow was randomly selected at each station on each sample date. Tow duration was 15 minutes in all bay systems except in the upper Laguna Madre where heavy vegetation necessitated reducing tow duration to 7.5 minutes. Catches in upper Laguna Madre were doubled to be comparable with all other catches. If a particular scheduled station could not be sampled, an alternate station was selected at random from stations immediately adjacent to that which could not be sampled.

All brown shrimp captured in a sample were counted. Total lengths (tip of rostrum to tip of telson) were obtained from a minimum of 19 shrimp (if available) in bag seine samples and 50 in trawl samples.

Catches were expressed as No./ha (bag seines) and No./h (trawls). The coastwide mean catch (number and length) in bag seines was weighted by the shoreline distance in each bay system (Matlock and Ferguson 1982). Trawl data were weighted according to the percentage each bay system's surface area in water ≥ 1.2 m deep contributed to the coastwide area. Mean shrimp lengths were weighted by the total number caught in each sample. Projected growth rates for combined bays were based on the von Bertalanffy model from Parrack (1979). Sexes were assumed equal since shrimp were not sexed.

Trawls (12.2 m wide at mouth) were used at night in the Gulf off Galveston, Port O'Connor, Port Aransas and Port Mansfield-Port Isabel during 16-30 June 1985 in conjunction with the Southeast Area Monitoring and Assessment Program (SEAMAP). Detailed descriptions of the gear, sample stations and procedures are reported by Stuntz et al. (1984).

The following criteria, procedures and assumptions were used to recommend the 1985 closing of the TTS:

1. The mean number of brown shrimp captured in bag seines during April 1985 was compared to the mean number caught during 1978, 1979 and 1980 when the season was closed 1 June. Relatively large numbers (April mean for 1978-1980 plus 2 SE) of shrimp captured in April were interpreted as indicating good survival and/or early recruitment of post-larvae and therefore a probable earlier than 1 June emigration from bays to the Gulf.
2. The percentage of samples in which brown shrimp occurred was compared to that observed in previous years. A relatively high percentage of samples containing shrimp was interpreted that shrimp were well distributed along the coast.

3. The mean length of shrimp collected during April was determined. When the number of shrimp in samples indicated early emigration, the von Bertalanffy growth model from Parrack (1979) was used to estimate the date that shrimp captured in April would reach a mean length of 90 mm. Growth rate was calculated from 15 April.
4. The periods of maximum duration of ebb tides were determined from NOAA nautical charts for Galveston Bay. The date of the period nearest to the date shrimp were projected to reach 90 mm was recommended as the closure date.

The following criteria, procedures and assumptions were used to recommend the 1985 opening of the TTS to shrimping:

1. The mean number of shrimp caught in bag seines during June was compared to previous years' means. The season could be set for the 60 days authorized if substantial numbers (a mean 2 SE greater than average) of small shrimp were still found along shorelines. This would indicate additional recruitment of small shrimp into the bays, thus later movement toward the Gulf. The season could be shortened if the mean number of shrimp were 2 SE less than average for 1979-84. This would indicate less recruitment of small shrimp into the bays, thus earlier movement toward the Gulf.
2. The mean number of shrimp caught with trawls in the deeper (≥ 1 m) portion of bays in June was compared to previous years' means. These samples reflect those shrimp that will most likely move to the Gulf during June-July. If catch rates are similar to or greater than in past years, the date when shrimp are projected to reach a mean length of 112 mm is recommended to be the reopening date.
3. Samples in the Gulf of Mexico in depths of 5.5-40.3 m during 15-30 June were collected to determine if recruitment into the Gulf shrimping grounds had occurred. If recruitment to the Gulf shrimping grounds has occurred, the mean lengths are obtained and growth rates projected to determine the recommendation for the opening date. The criterion is that a substantial portion of brown shrimp on the fishing grounds would average ≥ 112 mm when the season was opened (Center for Wetland Resources 1980).

RESULTS

Closing Date

Mean catch rates and sizes indicated an early emigration of brown shrimp to the Gulf of Mexico in 1985 was probable. The mean number of shrimp captured in April bag seines was similar ($1.4 \pm 0.5/\text{ha}$) to that in 1981, 1982, 1983 and 1984 (1.4/ha to 2.0/ha), but was 2 SE greater than the mean catch rate (0.5/ha) for 1978, 1979, and 1980 (Table 2). The percentage of samples containing shrimp in 1985 was 44% compared to a mean of 28% for 1978-80, indicating shrimp exhibited a wider than normal distribution.

Mean length of shrimp from bag seines was 50 ± 3 mm in April 1985 (Table 2). Growth calculated from 15 April indicated the mean length would be 90 mm on 19 May. The periods of maximum ebb tide duration for Galveston Bay were 7-12 May, 20-27 May, 3-9 June and 16-23 June. The period of maximum ebb tide duration nearest the date that shrimp were projected to reach a mean length of 90 mm began on 20 May. Therefore, the recommended Gulf closure extended from 30 minutes after sunset on 20 May to 30 minutes after sunset on 15 July.

Opening Date

The season was reopened 8 July because most shrimp on the fishing grounds would be >112 mm by that date. Bag seine catch rates of shrimp during June 1985 ($2.4 \pm 0.4/\text{ha}$) were similar to the average ($2.2 \pm 0.2/\text{ha}$) of previous years (Table 2). The mean length of 63 ± 4 mm indicated the shrimp on shorelines would not reach 112 mm until the end of July or much longer than the authorized closure period.

There was no difference in the mean number of shrimp in the deeper portion of bays (Table 3) in June 1985 ($1.4 \pm 0.2/\text{h}$) compared to Junes 1982-84 ($1.4 \pm 0.1/\text{h}$). The mean length of 91 mm calculated from 15 June indicated they would be 112 mm on 8 July.

Catch rates and mean lengths of shrimp in the Gulf of Mexico also indicated a need for a shorter season based on the criterion that a substantial portion of the shrimp on the fishing grounds average >112 mm when the season was opened. Mean catch rates (423/h) in the Gulf revealed that recruitment into the Gulf had occurred (Table 4). The mean length of 109 mm on 30 June indicated they would attain 112 mm on 3 July.

Since brown shrimp remaining in the deeper portion of the bays would be 112 mm on 8 July and those already in the Gulf would be 112 mm on 3 July the recommended reopening date was 8 July.

Verification of Closure Date

Trawl samples collected in passes indicated the 20 May closure date was appropriate (Table 5). Movement of shrimp began as early as April from the Laguna Madre (30/h). By May shrimp were collected in all five passes. Highest catch rates occurred in June (95/h) with most coming from Aransas Bay (421/h). By July, catch rates declined to an average of 2/h with no more than 4/h in any of the passes.

The 90 mm mean length used to determine the closure also was appropriate. Mean lengths of shrimp collected in passes ranged from 53 to 114 mm (Table 5). Mean lengths for shrimp collected in all passes combined during May-July ranged from 89-92 mm.

DISCUSSION

Techniques used to establish a closed season should be straight forward because they must be employed in a timely manner. The last possible dates for collection of bag seine samples are 30 April and 30 June, respectively.

Calculations must be made and results presented to supervisors and approved by the TPWD Executive Director who has delegated authority by the TPWC to set season dates. The law requires 72 and 24 h, respectively, for public notice for closing and opening dates (State of Texas 1986). The approved season dates must be published in the Texas Register and public notice and news releases prepared. The NMFS is notified so that public notice can be provided concerning the closing and opening of U.S. waters. The NMFS must go through their in-house procedure and they require a minimum of three days notice prior to the effective opening/closing date.

Fishery managers do not always have the luxury of an extensive data analysis. The time lapse from the last day of data collection through approval and public notice is only a few days. Since sample data are often required to be transmitted by telephone to expedite the analysis, there is a possibility of error. Data in this report are considered preliminary and may change with up-dating of the data base.

This was the fourth year in which the described technique was used to determine season dates and the data indicate it has been successful. Adjustments may be made as more data are collected and analyzed.

The 1985 trawl samples collected in deeper portions of the bays during June were used to determine the reopening date. The bay trawl data provide a more immediate estimate of size before the shrimp emigrate to the Gulf. In 1982, 1983 and 1984, bag seine collections along shorelines were a major determinant (Bryan 1983, 1985 and 1986). The rationale behind this change was that the size of shrimp on shorelines is such that they would not reach the desired size (112 mm) until late July or early August. The latter dates extend beyond the closure limit authorized by law.

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Table 1. Modifications to the 1 June-15 July closed Gulf shrimping season by year.

Year ^a	Date ^b		Duration (days)
	Closing	Opening	
1967	17 May	1 July	45
1972	17 May	1 July	45
1976	17 May	16 July	60
1981	22 May	16 July	55
1982	25 May	14 July	50
1983	27 May	15 July	49
1984	16 May	6 July	51

^aIn 1975 the maximum length of the closed season was increased from 45 to 60 days.

^bThrough 1981 the season closing and opening times were 12:01 a.m. During 1982-84 the closing and opening times were 30 minutes after sunset.

Table 2. Coastwide mean catch rate (No./ha + 1 transformed to $\text{Log}_{10} \pm 1 \text{ SE}$) and mean length (mm $\pm 1 \text{ SE}$) of brown shrimp (*Penaeus aztecus*) collected with 18.3-m wide bag seines along shorelines during April and June 1978-1985. ND = no data.

Year	Samples/mo.	April			June		
		Mean catch rate (No./ha) ^a	Samples containing shrimp (%) ^b	Mean length	Mean catch rate (No./ha) ^c	Samples containing shrimp (%)	Mean length ^d
1978	42	0.7 \pm 0.4	31	46 \pm 4	ND	ND	ND
1979	42	0.6 \pm 0.4	31	43 \pm 4	2.0 \pm 0.5	74	62 \pm 4
1980	42	0.4 \pm 0.2	21	47 \pm 10	2.4 \pm 0.3	83	63 \pm 3
1981	42	2.0 \pm 0.5	76	52 \pm 4	1.9 \pm 0.5	69	60 \pm 3
1982	70	1.8 \pm 0.4	64	47 \pm 2	2.3 \pm 0.4	79	66 \pm 2
1983	70	1.4 \pm 0.4	56	41 \pm 2	2.3 \pm 0.3	82	62 \pm 4
1984	70	1.7 \pm 0.4	66	50 \pm 3	2.2 \pm 0.3	81	68 \pm 4
1985	80	1.4 \pm 0.5	44	50 \pm 3	2.4 \pm 0.4	84	63 \pm 4

^aMean No./ha +2 S.E. for 1978-1980 = 1.17

^bPercentage of samples containing shrimp 1978-1980 = 28

^cMean No./ha \pm 1 S.E. 1979-1984 = 2.2 \pm 0.2

^dMean length (mm) \pm 1 S.E. 1979-1984 = 63 \pm 4

Table 3. Mean catch rate (No./h + 1 transformed to $\log 10 \pm 1$ S.E.) and mean length (mm ± 1 S.E.) of brown shrimp (Penaeus aztecus) collected with 6.1-m wide otter trawls in the deeper (>1 m) water of Galveston, Matagorda, San Antonio, Aransas, Corpus Christi Bays and the Laguna Madre (upper and lower) during June 1982-85.

Year	No./h ^a	Mean length (mm)
1982	1.4 \pm 0.2	94 \pm 3
1983	1.3 \pm 0.2	96 \pm 2
1984	1.4 \pm 0.2	101 \pm 3
1985	1.4 \pm 0.2	91 \pm 3

^aMean No./h + 1 S.E. 1982-1984 = 1.4 \pm 0.1.

Table 4. No./h and mean length (mm) of brown shrimp (Penaeus aztecus) collected in four areas of the Gulf of Mexico (5.5 to 40.3 m depths) by TPWD vessels using one 12.2-m trawl during 15-30 June 1985.^a

Area	Date	n	Depth range (m)	Mean No./h	Mean length (mm)	Mean length (mm) adjusted to 6/30
Galveston-Freeport	25 June	10	5.5-20.1	350	98	103
Matagorda	16 June	10	16.5-40.3	67	104	116
Port Aransas	27 June	10	16.5-40.3	340	109	112
Pt. Isabel/ Pt. Mansfield	30 June	10	5.5-23.4	935	109	109
MEAN				423	106	109

^a Samples collected in conjunction with Southeast Area Monitoring and Assessment Program (SEAMAP).

Table 5. Monthly mean catch rate (No./h) and mean total lengths (mm) of brown shrimp (Penaeus aztecus) caught with 6.1-m trawls in passes by bay system during January-July 1985. Blank indicates no measurement taken.

Month	Galveston		Matagorda		Aransas		Corpus Christi		Laguna Madre		Total	
	No./h	Length	No./h	Length	No./h	Length	No./h	Length	No./h	Length	No./h	Length
Jan	2	73	0		0		<1	75	<1	75	<1	74
Feb	1	85	0		0		0		5	87	1	87
Mar	<1	76	0		0		0		2	105	<1	95
Apr	2	103	0		0		0		30	74	6	76
May	14	76	2	100	30	101	2	60	4	67	10	90
Jun	7	101	<1	112	421	92	<1	68	45	64	95	89
Jul	4	105	<1	101	2	114	1	87	2	53	2	92

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