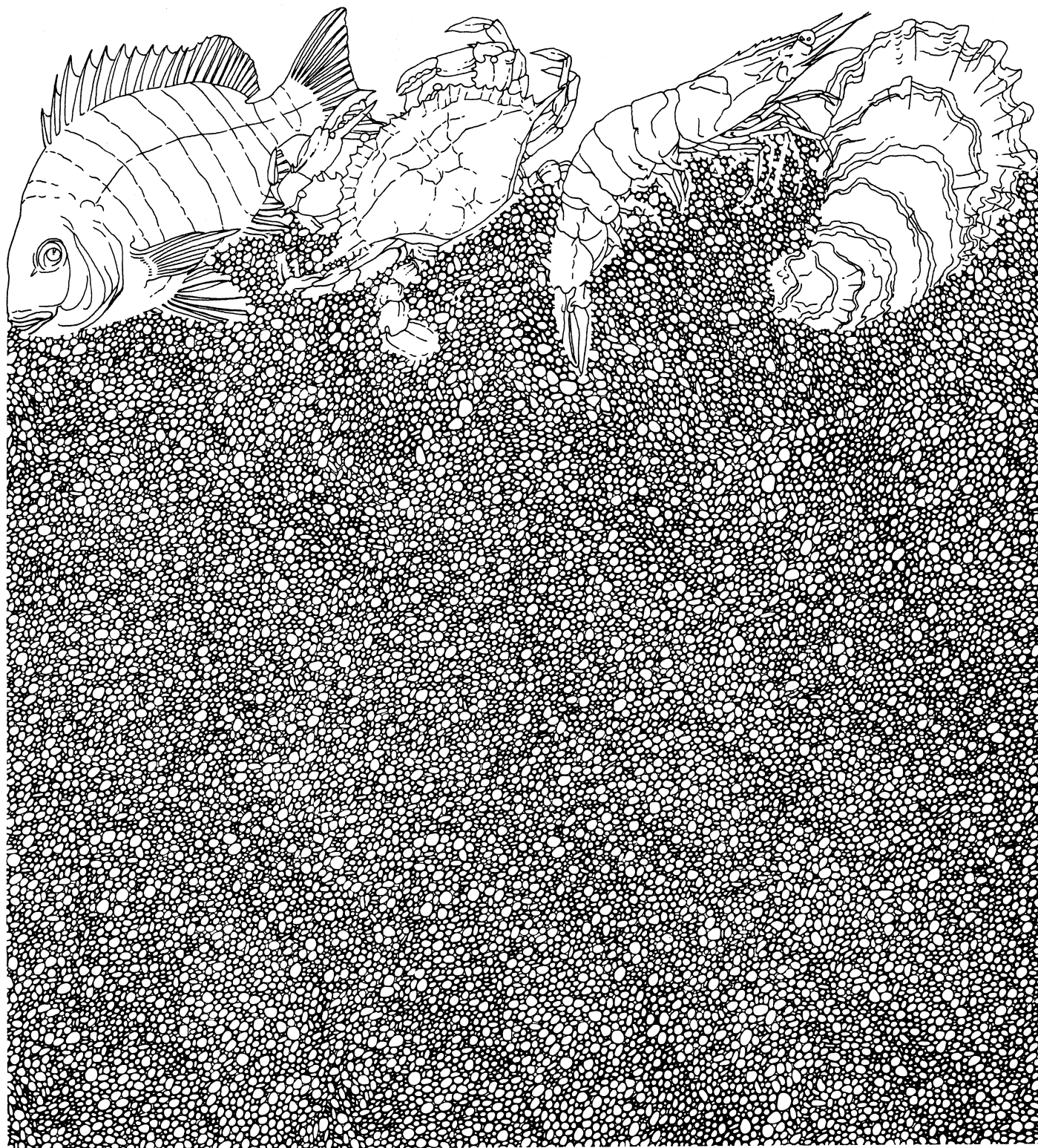


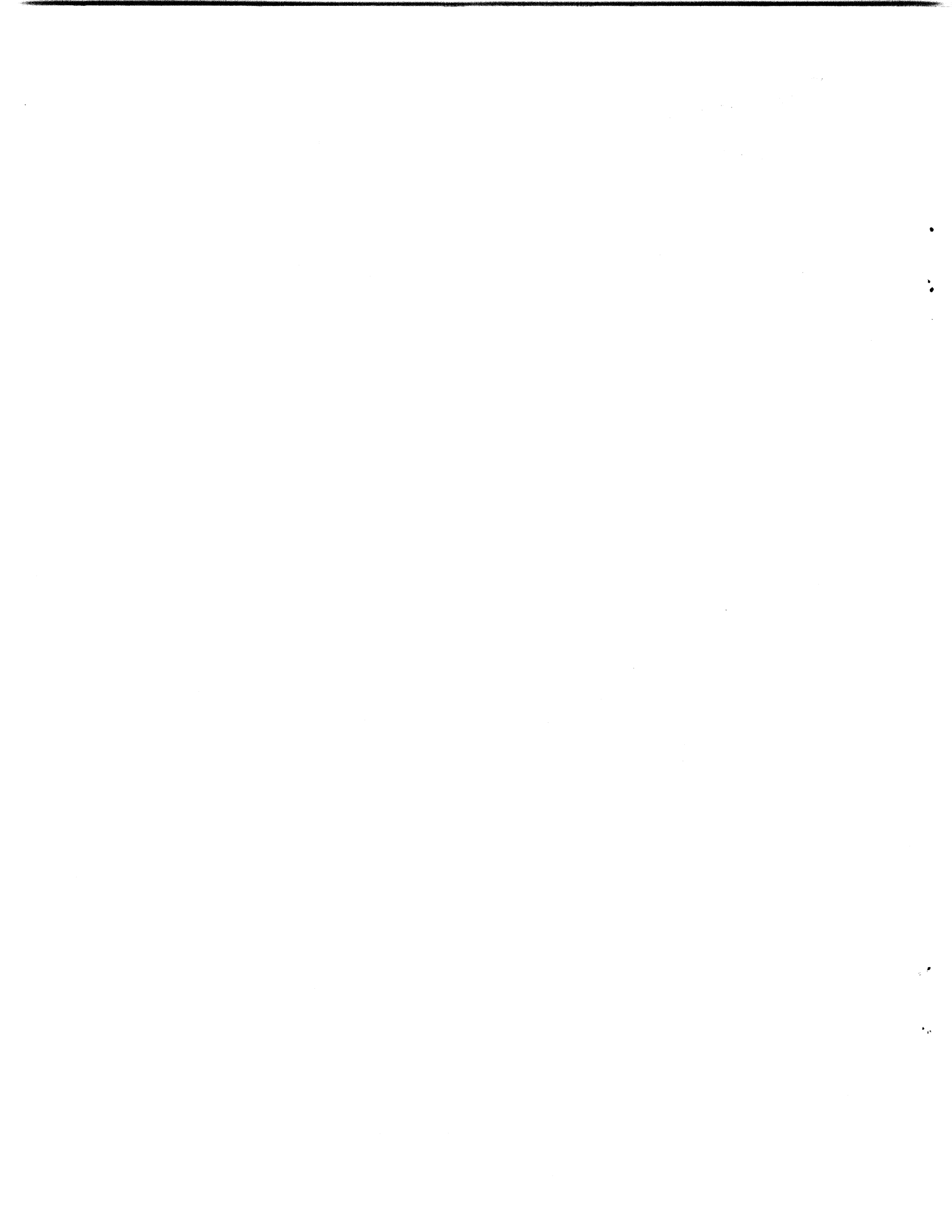
Closure Dates for the 1984 Texas Gulf Shrimping Season

by C.E. Bryan

Management Data Series Number 82
1985

Texas Parks and Wildlife Department
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ABSTRACT

Brown shrimp (Penaeus aztecus) were collected with 18.3-m (60.0 ft) bag seines along shorelines of seven bay systems; with 6.1-m (20.0 ft) trawls in five passes leading from the bays to the Gulf of Mexico and with 12.2-m (40.0 ft) trawls in Gulf waters off the central Texas coast to determine closing and opening dates of the 1984 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 (at least 65 count, heads off) and to minimize waste caused by discarding smaller shrimp during harvest. The closed season was set from 30 minutes after sunset 16 May to 30 minutes after sunset 14 July 1984 based on biological sampling along shorelines in April. Data collected in the bays and Gulf in June indicated that shrimp were larger than average and the 14 July opening date was changed to 6 July. Sampling in passes verified that closure dates and the mean length (90 mm) chosen to predict size at emigration were appropriate to accomplish the purpose of the closure.

INTRODUCTION

Shrimp are the most valuable commercial seafood product landed in the United States. There were 113.3 million kg (heads-on) with an ex-vessel value of \$503 million reportedly landed in 1983 (U. S. Department of Commerce 1984). The value was even greater when the total economic impact is considered. The Gulf of Mexico fishery accounted for 90.0 million kg (79%) and \$417 million (83%) of total U.S. landings. Texas landings in 1983 amounted to 32.7 million kg valued at \$171 million (Hamilton and Saul 1984). This is 29% of the weight and 34% 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 important species, comprising over 75% 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 the bays during February-April as post-larvae (Baxter and Renfro 1967, King 1971). They seek the shallow peripheral areas (nursery areas) in the bays where they grow rapidly, migrate to the deeper portions of bays and 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, Benefield [in press]). Movement back to the Gulf through passes occurs mainly at night near the surface in association with ebb tide currents during the period of maximum duration (Copeland 1965, King 1971). Movement ceases during daylight and periods of incoming tides. During those periods, shrimp remain on the bottom until the next nocturnal ebb tide. Diurnal tides are mixed, with one low and one high per 24-hour period of maximum range and two highs and two lows per 24-hour period with a minimum range (Collier and Hedgpeth 1950). During the period of maximum range, tides are also at their 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. 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 (Parks and Wildlife Laws 1981). This Act established a closed season in the state's territorial waters (≤ 16.7 km) during 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 days.

The purpose of this annual closure is to protect small shrimp from fishing pressure until they reach a larger, more valuable size (≥ 112 mm) and to minimize waste caused by discarding smaller shrimp during the harvest. Texas has closed its territorial waters for over 20 years, and the statutory 1 June-15 July season was changed in 1967, 1972, 1976, 1981, 1982 and 1983 (Table 1). The rationale for adjusting closure dates was detailed by Moffett (1967, 1972), Johnson (1982), Benefield (in press) and Bryan (1983, in press). While small shrimp were protected in state waters by closures prior to 1981, 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 has resulted in an estimated increase in the ex-vessel value of \$59.5 million in 1981, \$46.2 million in 1982 and \$31.7 million in 1983 (Klima and Nichols 1985). This report documents the recommended 1984 dates of closing and opening the Texas territorial sea to shrimping.

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, while otter trawls were used in passes to determine the time and at what sizes shrimp emigrated to the Gulf of Mexico. All samples were collected during daylight.

Bag seines (18.3m) with 19.0-mm stretched mesh in the wings and 12.7-mm stretched mesh in the 1.8-m wide bag were pulled parallel to shore between 15.2 m and 30.5 m at randomly selected stations. Ten samples were collected monthly in each of the following bay systems: Galveston, Matagorda, San Antonio, Aransas, Corpus Christi and the upper and lower Laguna Madre. Five samples were collected during the first 2 fullest weeks of each month and five during the last 2 fullest weeks each month. Additional sampling details are provided in Hegen (1982).

Otter Trawls (6.1 m) with 39.1-mm stretched mesh and spread by 0.5 x 1.2-m doors were pulled for 15 minutes. Weekly samples were collected in passes in Bolivar Roads (Galveston Bay), Pass Cavallo (Matagorda Bay), Lydia Ann Channel (Aransas Bay), Corpus Christi Ship Channel (Corpus Christi Bay) and Brazos Santiago Pass (lower Laguna Madre). Two samples per week were collected in each location parallel with the orientation of the pass. Tow direction (bayward or Gulfward) was alternated with each sample. Additional sampling details are provided in Benefield et al. (1983).

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./tow (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). 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.

Samples in the Gulf of Mexico were collected along the central coast (NMFS statistical shrimp grid zone 20) between depths of 11.9 m and 36.6 m during 15-30 June by the NMFS vessel Oregon II using a 12.2-m wide trawl. Stratified random samples were collected perpendicular to shore for the length of each depth stratum sampled. Catch rates were adjusted to No./h.

Mean length was derived from the No./weight reported using weight/length conversion from Fontaine (1971). Sampling was carried out as part of the Southeastern Monitoring Assessment Program (SEAMAP). Additional sampling details may be found in Stuntz et al. (1984).

The following criteria, procedures and assumptions were used to recommend the 1984 closing of the Texas territorial sea:

1. The mean number of shrimp captured in bag seines during April 1984 was compared to the mean number caught during 1978, 1979 and 1980, when the season was closed on 1 June. Relatively large numbers (April mean for 1978-1979 and 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 to mean 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 National Oceanic and Atmospheric Administration (NOAA) nautical charts for Galveston Bay. The date of the period nearest to the date shrimp were projected to reach 90 mm was determined and recommended as the closure date.

The following criteria, procedures and assumptions were used to recommend the 1984 opening of the Texas Territorial Sea 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 of 2 SE greater than average) of small shrimp were still found along shorelines indicating 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 was 2 SE less than average for 1979-83 indicating less recruitment of small shrimp into the bays, thus earlier movement toward the Gulf.
2. The mean length of shrimp caught in bag seines during June was compared to previous years' means. The season could be lengthened or shortened if mean lengths were 2 SE greater or less than the average during all previous years (1979-83).

3. Catch rates in the Gulf of Mexico in depths of 11.0-36.6 m during 15-30 June were compared to previous years' means to determine relative abundance. Similar catch rates among years indicated that recruitment into the Gulf shrimping grounds had occurred.
4. 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 criteria 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

An early emigration of shrimp to the Gulf of Mexico in 1984 was probable. The mean number of shrimp captured in April bag seines was similar ($1.71 \pm 0.37/\text{ha}$) to that in 1981, 1982 and 1983 ($1.45/\text{ha}$ to $2.03/\text{ha}$), but was 2 SE greater than the mean catch rate ($0.53/\text{ha}$) for 1978, 1979 and 1980 (Table 1). The percentage of samples containing shrimp in 1984 was 65.71% compared to a mean of 28.00% for 1978-80, indicating shrimp exhibited a wider than normal distribution.

Mean length of shrimp, in bag seines, was 49.24 ± 3.59 mm in April 1984 (Table 2). Growth calculated from 15 April indicated that the mean length would be 90 mm on 18 May. The periods of maximum ebb tide duration as predicted for Galveston Bay were 3-8 May, 16-22 May, 30 May-5 June and 12-19 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 16 May. Therefore, the recommended Gulf closure extended from 30 minutes after sunset on 16 May to 30 minutes after sunset on 14 July for the maximum 60 days authorized.

Opening Date

The season was reopened on 6 July 1984 because shrimp were larger than normal in both the bays and Gulf in June. Bag seine catch rates during June 1984 ($2.18 \pm 0.35/\text{ha}$) were similar to the average ($2.19 \pm 0.21/\text{ha}$) of previous years, but the mean length of 68.41 ± 3.75 mm in 1983 was 2 SE $>$ mean of 62.38 ± 2.33 mm for 1979-83 (Table 2).

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. Catch rates in the Gulf ($684 \pm 215/\text{h}$) were similar to the average ($1621 \pm 1025/\text{h}$) for 1978-1983 indicating that recruitment into the Gulf had occurred (Table 3). The mean length of 119 ± 4 mm was 2 SE $>$ 103 ± 8 mm mean for 1979-1983 and >112 mm criterion.

Verification of Closure Date

Trawl samples collected in passes indicated the closure date of 16 May was appropriate (Table 4). Major movements (154.0/tow) of shrimp were detected during 30 April-6 May in lower Laguna Madre and during the following 2 weeks from Corpus Christi (18.5/tow) and Aransas (62.0/tow) Bays.

Little movement was detected from the bays along the upper coast until 4-10 June when 30.0/tow were collected in Galveston Bay. Highest coastwide catches (99.6/tow) occurred during 25 June-1 July mainly from the Aransas (454.0/tow) and lower Laguna Madre (39.5/tow) areas. After 1 July, little movement was detected as coastwide trawl catch rates in passes remained < 2.0/tow.

The 90-mm mean length used to determine the closure date was appropriate. Coastwide mean lengths of shrimp collected in passes ranged from 55 to 121 mm (Table 4). During the major emigration period (1 May-1 July) mean lengths ranged from 78 to 98 mm.

DISCUSSION

Techniques used to establish a closed season should be simple, 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 Executive Director who has delegated authority by the TPWC to set season dates. The law requires 72 and 24 hours, respectively, for public notice for closing and opening dates (Parks and Wildlife Laws 1981). The approved season dates must be published in the Texas Register and public notice and news releases prepared. The National Marine Fisheries Service (NMFS) is notified so that public notice can be provided concerning the closing and opening of U.S. waters. NMFS must go through their in-house procedure and they require a minimum of 3 days notice prior to the effective opening/closing date.

Fishery managers do not always have the luxury of a detailed 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 by many persons 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 third year in which the current technique was used to determine season dates and the data indicate it has been a successful method. Since the technique is relatively new, adjustments may be made as more data are collected and analysed.

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Table 1. Modifications to the normal 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	50

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

^bThrough 1981 the season closing and opening times were 12:01 a.m. During 1982-83 the closing and opening times were 30 minutes after sunset.

Table 2. Coastwide mean catch rate (No./ha + 1 transformed to $\log_{10} \pm 1$ SE) and mean length (mm ± 1 SE) of brown shrimp (Penaeus aztecus) collected with 18.3-m wide bag seines along shorelines during April and June 1978-1984. ND = no data.

Year	Samples/month (No.)	April			June		
		Mean catch rate (No./ha) ^a	Samples containing shrimp (%) ^b	Mean length	Mean catch rate (No./ha) ^c	Samples containing shrimp (%)	Mean ^d length
1978	42	0.64 \pm 0.40	30.95	43.93 \pm 2.06	ND	ND	ND
1979	42	0.58 \pm 0.38	30.95	41.42 \pm 3.87	2.01 \pm 0.53	73.81	61.80 \pm 3.37
1980	42	0.37 \pm 0.25	21.43	47.48 \pm 9.58	2.43 \pm 0.26	83.33	63.07 \pm 3.28
1981	42	2.03 \pm 0.50	76.19	51.83 \pm 3.51	1.93 \pm 0.52	69.05	59.60 \pm 2.61
1982	70	1.77 \pm 0.35	64.29	47.50 \pm 2.20	2.26 \pm 0.38	78.57	65.91 \pm 2.48
1983	70	1.45 \pm 0.37	55.71	40.73 \pm 2.67	2.32 \pm 0.33	82.05	61.54 \pm 3.51 ^o
1984	70	1.71 \pm 0.37	65.71	49.24 \pm 3.59	2.18 \pm 0.35	81.23	68.41 \pm 3.75

^a Mean No./ha 1978-1980 = 0.53 \pm 0.34

^b Mean percentage 1978-1980 = 28.00

^c Mean No./ha 1979-1983 = 2.19 \pm 0.21

^d Mean length (mm) 1979-1983 = 62.38 \pm 2.33

Table 3. Mean catch rates (No./h \pm 1 SE) and mean total length (mm \pm 1 SE) of brown shrimp (Penaeus aztecus) collected with 12.2-13.7-m wide otter trawls in Gulf of Mexico waters off the central Texas coast during 15-30 June 1978-84.

Year	Samples (No.)	No./h ^a	Mean (mm) ^b length
1978	5	2564 \pm 577	95 \pm 3
1979	3	152 \pm 106	120 \pm 1
1980	3	2359 \pm 1389	105 \pm 1
1981	4	2006 \pm 822	105 \pm 3
1982	15	2145 \pm 538	104 \pm 0
1983	13	504 \pm 180	109 \pm 8
1984	8	684 \pm 215	119 \pm 4

^a Mean No./h 1978-1983 = 1621 \pm 1025.

^b Mean length 1978-1983 = 103 \pm 8 mm.

Table 4. Weekly mean catch rate (No./tow) and mean length (mm) of brown shrimp (Penaeus aztecus) caught at 6.1-m trawl pass stations in selected Texas bay systems during April-July 1984 (Blank = no measurement taken).

Month	Date	Sample (No.) ^a	Bolívar Roads		Pass Cavallo/Matagorda Channel		Lydia Ann Channel		Corpus Christi Channel		Brazos Santiago		Coastwide	
			No./tow	Length	No./tow	Length	No./tow	Length	No./tow	Length	No./tow	Length	No./tow	Length
Apr	02-08	2	0.0		0.0		0.5	121	0.0		0.0		0.1	121
	09-15	2	0.0		0.0		1.0	108	0.0		1.5	79	0.5	91
	16-22	2	0.5	141	0.0		0.5	99	0.0		12.0	72	2.6	76
	23-29	2	0.0		0.0		0.0		0.0		1.0	86	0.5	86
	30-06 May	2	0.0		0.5	79	3.5	84	0.5	78	154.0	82	31.7	82
May	07-13	2	2.5	66	0.0		62.0	78	18.5	76	5.5	94	17.7	78
	14-20	2	0.0		0.0		39.0	80	1.5	70	0.0		8.1	80
	21-27	2	0.5	99	0.0		1.0	58	1.0	56	6.0	89	1.7	82
	28-03 Jun	2	1.5	108	0.0		0.0		0.5	75	22.0	92	4.8	86
Jun	04-10	2	30.0	94	0.0		0.0		0.5	72	0.0		3.8	94
	11-17	2	0.0		0.5	77	0.0		0.0		29.0	80	5.9	80
	18-24	2	0.0		1.0	96	0.0		0.0		0.0		0.2	96
	25-01 Jul	2	0.0		2.5	107	454.0	101	2.0	90	39.5	65	99.6	98
	02-08 Jul	2	0.0		8.0	103	0.0		0.5	90	0.0		1.7	102
Jul	09-12	2	0.0		4.0	96	1.0	129	1.0	86	0.0		1.2	100
	16-22	2	0.0		0.0		0.5	93	0.0		4.0	65	0.9	68
	23-29	2	0.0		0.0		0.0		0.0		2.0	55	0.4	55
	30-08 Aug	2	0.0		0.0		3.5	110	0.0		0.5	75	0.8	106

^aNo. of samples each week in each pass.





