

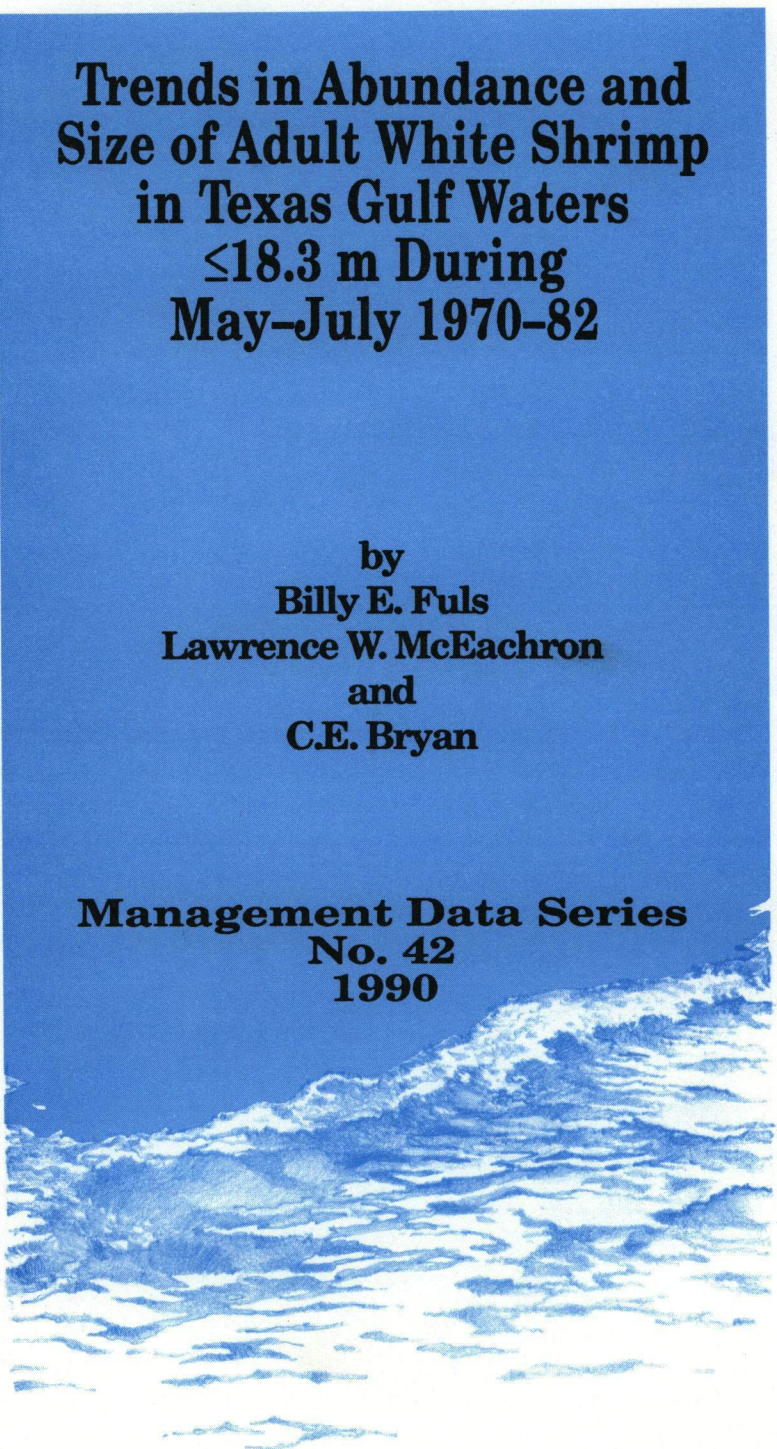
**Trends in Abundance and
Size of Adult White Shrimp
in Texas Gulf Waters
≤18.3 m During
May-July 1970-82**

by
**Billy E. Fuls
Lawrence W. McEachron
and
C.E. Bryan**

**Management Data Series
No. 42
1990**



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TRENDS IN ABUNDANCE AND SIZE OF ADULT WHITE
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DURING MAY-JULY 1970-82

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ABSTRACT

Analysis of catch rates (no./h) and mean length of white shrimp (Penaeus setiferus) collected in gulf waters (≤ 18.3 m deep) off the central Texas coast during May-July 1970-82 revealed a significant difference among years in mean length but not in catch rate. Linear regression analysis revealed a negative linear trend in mean length among years, depicting a decrease in size of white shrimp through time.

INTRODUCTION

Penaeid shrimp constitute Texas' most valuable commercial fishery. White shrimp (*Penaeus setiferus*) comprised 25% (by weight) of the annual mean (37.4 million Kg) combined reported commercial shrimp landings from Texas bays and the gulf during 1977-86 (Osburn et al. 1987). White shrimp comprised 53% of the reported landings from bays and 22% from the gulf. During 1986, reported commercial gulf landings of white shrimp were greatest (62%) during August-November; 21% were landed during May-July.

In 1981, implementation of the Gulf of Mexico Fishery Management Council's (GMFMC) shrimp management plan (Van Lopik et al. 1980) closed the Exclusive Economic Zone (EEZ) off Texas to shrimping in conjunction with the annual closure (typically 1 June-15 July) of the Texas Territorial Sea (TTS). However, it remained legal to catch white shrimp during daylight hours in the TTS during the Texas closure in water ≤ 7.3 -m deep.

The major white shrimp fishing grounds within the Texas gulf are at depths ≤ 18.3 m (Hildebrand 1954, Griffin et al. 1974). Overall mean length of white shrimp within the TTS is greatest from May-August then declines from September through December as emigrating young shrimp enter the gulf from Texas bays (Bryan et al. 1978). Mature white shrimp are found within shallow gulf waters mainly from April through August with peak spawning during June (Lindner and Anderson 1956, Perez-Farfante 1969, Bryan and Cody 1975, Chamberlain and Lawrence 1983), which parallels the annual closure of Texas gulf waters.

There has been concern whether historical to present-day white shrimp stock abundance and average shrimp size has remained relatively stable through time. Caillouet et al. (1980) observed that reported commercial white shrimp catches in Texas revealed a trend of decreasing size from 1959 to 1976. Rothschild and Brunenmeister (1984) and Brunenmeister (1984) observed that shrimp stocks, as indicated by CPUE (abundance and weight) of commercial shrimpers in the Gulf, were decreasing through time. The Texas Parks and Wildlife Department (TPWD) has monitored relative abundance and size of white shrimp since 1970 in gulf waters ≤ 18.3 m deep. The objective of the present study was to determine if there were differences and trends through time in relative abundance (no./h) and size (TL) of adult white shrimp off the central Texas gulf coast during May-July, 1970-82.

MATERIALS AND METHODS

White shrimp were collected with trawls aboard the R/V WESTERN GULF (a double-rigged, 21.9-m steel hull trawler) in gulf waters (≤ 18.3 m deep) off the central Texas coast (Figure 1) during May-July 1970-82. Samples were collected with trawls ranging in width from 12.2 to 14.3 m with stretched mesh ranging from 4.4 to 5.7 cm (Appendix A). Trawls were equipped with a tickler chain and spread by 0.9 x 2.1-m wooden doors. Day and night trawl samples were pooled because no significant differences have been found between day and night catches (Cody and Fuls 1986). Tow durations ranged from 5-60 minutes. All white shrimp were weighed en masse. Up to 50 randomly selected individuals were measured (TL to nearest mm).

Total number of shrimp in catches with >50 individuals was estimated using the following formula:

$$N = (T/S)(n)$$

where: N = total number of white shrimp in sample,
 T = total weight of white shrimp in sample,
 S = weight of white shrimp measured,
 n = number of white shrimp measured.

Catch rate (weighted to no./h) and total length data for white shrimp, associated with TPWD gulf trawl samples, were compiled by year (May-July) for analysis (Appendix A). Individual lengths were weighted for analysis by no./h for samples with all shrimp measured, and by number in sample not measured and no./h for samples with >50 shrimp. Data for 1975 were excluded from the analysis because of the small sampling effort and because samples were collected only in May.

SAS software programs (SAS Institute Inc. 1985) were used for all analyses. Using the SAS UNIVARIATE procedure, catch rates and lengths of white shrimp were found not to be normally distributed. Therefore, data were analyzed non-parametrically by ranking the data and testing for significant differences ($P \leq 0.05$) among years using the SAS procedure GLM, for a one-way analysis of variance (AOV) with unequal sample sizes (Sokal and Rohlf 1981). The GT2-method for a one-way AOV with unequal sample size was used to determine which years were different (Sokal and Rohlf 1981).

Linear regression analysis involving multiple y at each x was performed regressing length on year to determine if a significant ($P \leq 0.05$) linear trend existed (Sokal and Rohlf 1981).

Because only 1% of all white shrimp caught were <140 mm in total length it was assumed that white shrimp collected were maturing parental stock (Burkenroad 1939, Lindner and Anderson 1956). It was also assumed TPWD catches were proportional to shrimp populations throughout the sampling period and area despite various trawl sizes and tow durations.

RESULTS

The mean size of adult white shrimp off the central Texas coast decreased during 1970-82, but abundance remained relatively stable (Figures 2 and 3). Linear regression analysis revealed length was a significant function of year, however, the regression explained only 3% of the variation in mean length (Table 1). The regression further indicated a decrease in size through time ($r = -0.18$); overall size of adult white shrimp decreased about 5 mm from the period 1970-78 to 1979-82 (Figure 2). There was a significant difference in mean length (Figure 2, Table 1) but not in mean catch rate (Figure 3, Table 2) of white shrimp among years. Further analysis revealed mean length of white shrimp for 1971 significantly differed from all other years, whereas mean

length within grouped years of 70/72/74/76/77/78, 73/80/82, and 79/80/81 were similar among years within each group but differed among groups (Table 3).

DISCUSSION

Abundance of parental white shrimp in the gulf is dependent upon escapement from the bays. Results of this study indicated the magnitude of escapement (i.e. number of shrimp) remained constant during 1970-82. This was in spite of the fact number of white shrimp commercially caught in bays and number of bay and gulf licensed shrimp vessels increased during the same period (Cody et al. 1989). Reasons for this disparity would include: 1) recruitment to the parent stock came from other areas, or 2) fishing and natural mortality combined must have gone down, or 3) recruitment to the bays increased. The apparent reason is an increase in recruitment to bays since TPWD bag seine samples during 1978-82 indicated an overall increase in juvenile white shrimp catch rates (Cody et al. 1989). This finding conflicts with that of Rothschild and Brunenmeister (1984) who reported a decrease in Gulf-wide white shrimp stocks (in relation to abundance) through time.

If white shrimp mean length has decreased, as indicated by this study of parental stocks in the gulf and by TPWD bag seine samples of juveniles in bays (Cody et al. 1989), then the catch by weight off the central coast of Texas would show a decline if overall numbers of shrimp remained constant. The decrease of white shrimp length through time off the central Texas coast and in bays is supported by observations of Caillouet et al. (1980), and the decrease in weight is supported by Brunenmeister (1984) who reported a decrease in gulf-wide CPUE by weight.

It is documented that decrease in length of organisms in a fishery through time can be a function of increased fishing pressure (Cushing 1968, Gulland 1978, Ricker 1945, Royce 1972). However, it is not entirely clear why the length of white shrimp has decreased or why the numbers of recruits to the bays has increased. Perhaps the parental white shrimp stock has compensated for the increased fishing pressure on the overall shrimp population. If length of shrimp continues to decrease the minimum effect will be a decrease in the ex-vessel value of the catch because larger shrimp are more valuable. A more critical effect, however, would be an eventual collapse of the fishery since smaller shrimp produce fewer eggs (Chamberlain and Lawrence 1983).

Information presented in the present report on relative abundance and size of white shrimp should assist managers in constructing population models to manage the fishery. Additional analyses on white shrimp stocks coastwide within the Texas gulf during periods of major gulf recruitment and throughout the year should also give greater insight into abundance and size composition of white shrimp stocks within Texas waters. In 1985, the TPWD instituted a coastwide monthly gulf shrimp monitoring program, which will provide needed information to formulate more precise population models. To refine such models, and analyze long term effects on relative abundance and size of shrimp it is important that standardized gulf monitoring programs be maintained.

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Table 1. Summary of AOV table with regression for more than one value of Y [ranked TL (mm)] for each value of X (year) for white shrimp in TPWD gulf trawl collections within the 18.3-m depth zone during May-July 1970-82.

| Source of variation | df | Sum of squares | F |
|----------------------------|-------|----------------|-----------|
| Total | 11452 | 12507365902 | |
| Among years | 11 | 7988589742 | 70.96*** |
| Linear regression | 1 | 4125572956 | 106.80*** |
| Deviations from regression | 10 | 386301786 | 3.77*** |
| Error | 11441 | 117085067160 | |

***P \leq 0.001

Table 2. Summary of AOV of ranked catch rates (no./h) for white shrimp in TPWD gulf trawl collections within the 18.3-m depth zone during May-July 1970-82. NS = not significant.

| Source of variation | df | Sum of squares | F |
|---------------------|-----|----------------|---------|
| Total | 196 | 629010 | |
| Among years | 11 | 53988 | 1.58 NS |
| Error | 185 | 575022 | |

Table 3. Ranked mean TL (mm) by year for white shrimp in TPWD gulf trawl collections within the 18.3-m depth zone during May-July 1970-82. Means followed by the same letter in a column are similar ($P > 0.05$).

| Year | Unranked mean TL | Ranked mean TL |
|------|------------------|----------------|
| 1971 | 174.5 | 7,731.7 A |
| 1974 | 171.9 | 6,887.0 B |
| 1972 | 171.0 | 6,791.8 B |
| 1978 | 171.9 | 6,783.8 B |
| 1977 | 170.9 | 6,507.1 B |
| 1976 | 170.6 | 6,394.8 B |
| 1970 | 170.2 | 6,278.6 B |
| 1973 | 165.8 | 5,397.9 C |
| 1982 | 167.1 | 5,314.8 C |
| 1980 | 166.2 | 5,142.2 CD |
| 1981 | 165.1 | 4,957.5 CD |
| 1979 | 162.6 | 4,699.2 D |

Figure 1. TPWD gulf trawl sample areas off the central Texas gulf coast during May-July 1970-82.

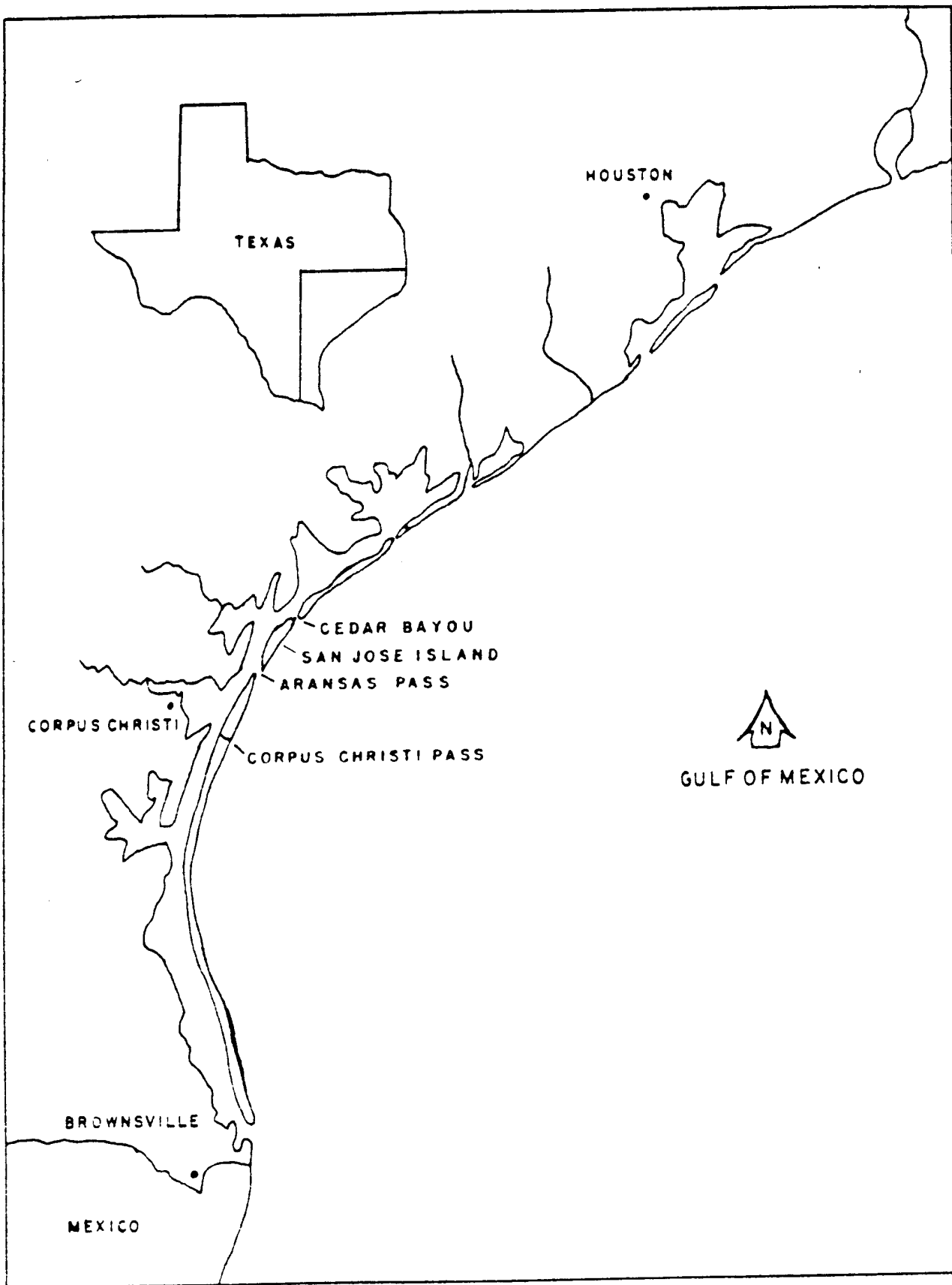


Figure 2. Mean length ($\pm 2SE$) of white shrimp in TPWD gulf trawl collections within the 18.3-m depth zone during May-July 1970-82.

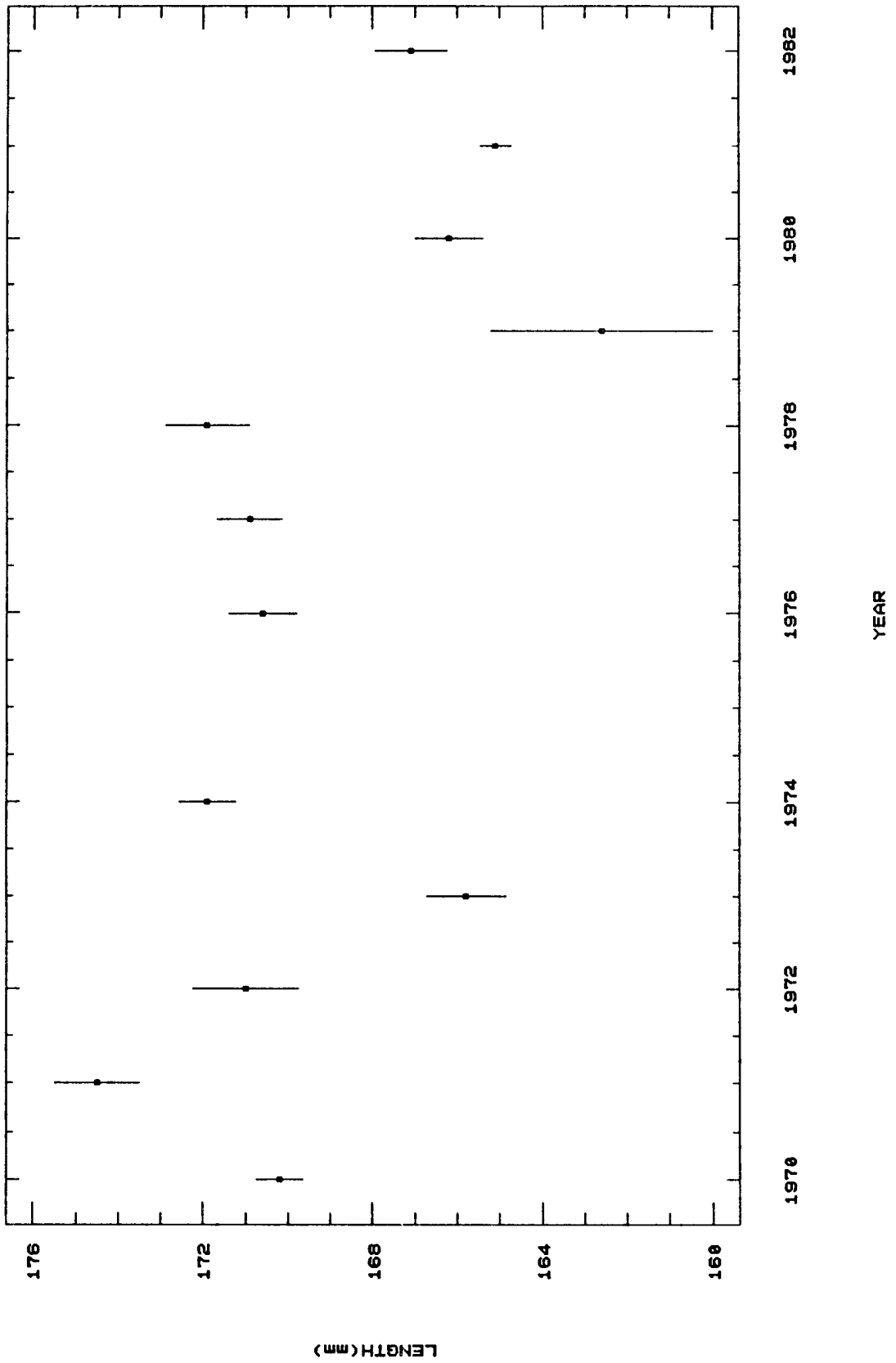
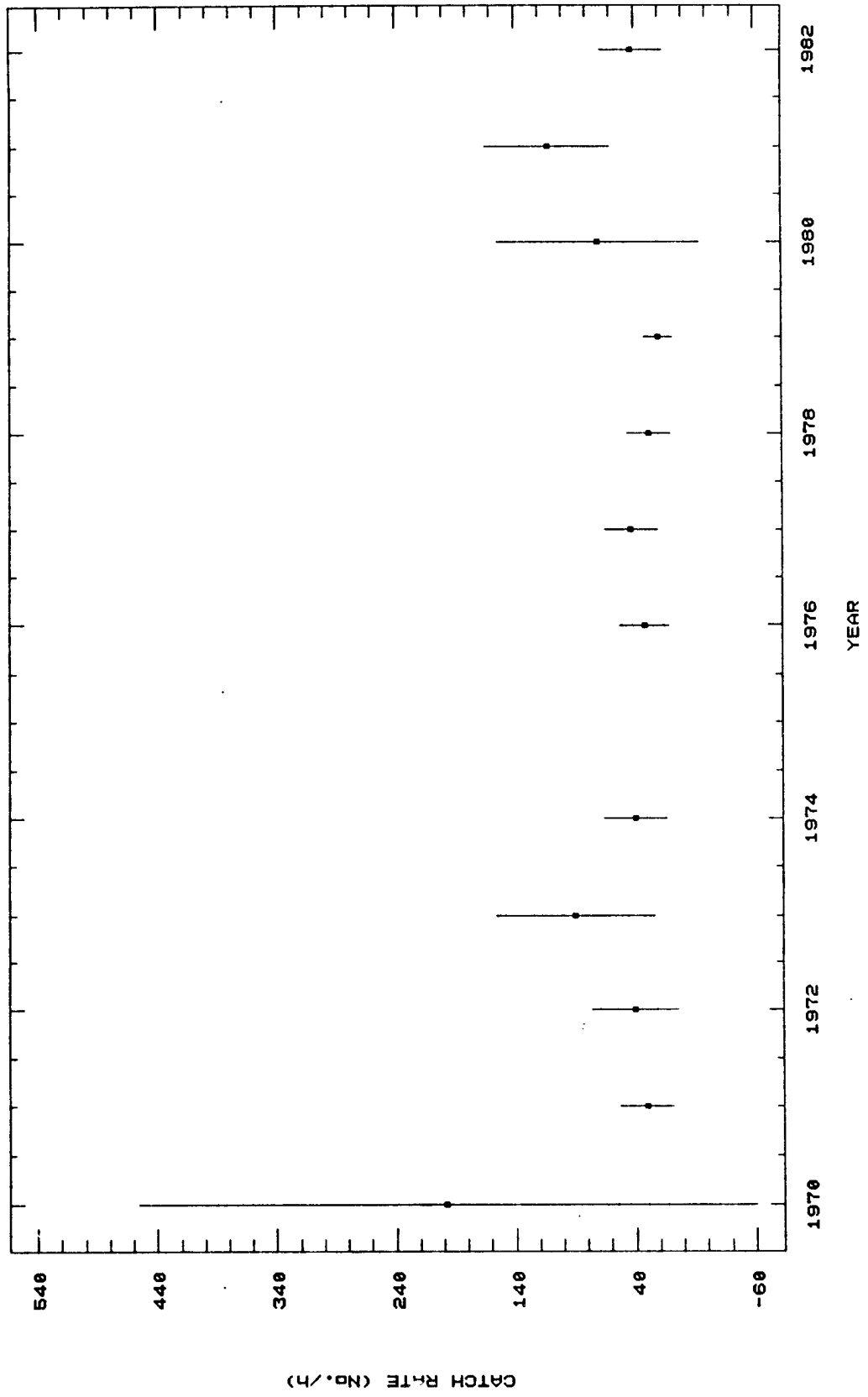


Figure 3. Mean catch rate ($\pm 2SE$) of white shrimp in TPWD gulf trawl collections within the 18.3-m depth zone during May-July 1970-82.



Appendix A. TPWD trawl catches within the gulf during May-July 1970-82.

Table A.1. Date, location, day or night sample, trawl size, mesh size, tow duration, depth, tow duration, no./h and mean total length for individual sample collections of white shrimp caught within 18.3 m off the central Texas gulf coast by the TPWD during May-July 1970-82. ND = No data.

| Year | Date | Location | Day (D) or night (N) | Trawl size (m) | Mesh size (mm) | Water depth (m) | Tow duration (min) | No./h | Mean length (mm) |
|-------------|--------|--------------|----------------------|----------------|----------------|-----------------|--------------------|-------|------------------|
| 1970 | | | | | | | | | |
| | 25 May | Cedar Bayou | D | 14.0 | 44 | 6.4 | 15 | 0 | 170 |
| | | Cedar Bayou | D | 14.0 | 44 | 14.6 | 60 | 31 | 171 |
| | 08 Jun | Aransas Pass | D | 14.0 | 44 | 7.3 | 15 | 380 | 171 |
| | | Aransas Pass | D | 14.0 | 38 | 12.8 | 5 | 0 | |
| | 08 Jul | Aransas Pass | N | 13.7 | 51 | 14.6 | 30 | 6 | 183 |
| | | Aransas Pass | N | 13.7 | 51 | 7.3 | 15 | 768 | 170 |
| 1971 | | | | | | | | | |
| | 25 May | Aransas Pass | D | 13.7 | 57 | 5.5 | 15 | 12 | 156 |
| | | Aransas Pass | N | 13.7 | 57 | 11.0 | 15 | 8 | 175 |
| | | Aransas Pass | N | 13.7 | 57 | 16.4 | 15 | 16 | 174 |
| | 08 Jun | Aransas Pass | D | 13.7 | 57 | 6.4 | 15 | 0 | 171 |
| | | Aransas Pass | N | 13.7 | 57 | 14.6 | 15 | 84 | 174 |
| | 21 | Aransas Pass | N | 13.7 | 57 | 7.3 | 15 | 76 | 168 |
| | | Aransas Pass | N | 13.7 | 57 | 17.4 | 15 | 12 | |
| | 06 Jul | Aransas Pass | D | 13.7 | 57 | 12.8 | 15 | 0 | 175 |
| | 09 | Aransas Pass | N | 13.7 | 57 | 14.6 | 15 | 8 | 174 |
| | | Aransas Pass | N | 13.7 | 57 | 7.3 | 15 | 8 | 196 |
| | 14 | Cedar Bayou | N | 13.7 | 57 | 14.6 | 15 | 4 | 178 |
| | | Cedar Bayou | N | 13.7 | 57 | 7.3 | 15 | 120 | |
| | 29 | Aransas Pass | D | 13.7 | 57 | 11.9 | 15 | 56 | 174 |

Table A.1. (Cont'd.)

| Year Date | Location | Day (D) or night (N) | Trawl size (m) | Mesh size (mm) | Water depth (m) | Tow duration (min) | No./h | Mean length (mm) |
|--------------|--------------|-------------------------|----------------------|----------------------|-----------------------|--------------------------|-------|------------------------|
| 1972 | | | | | | | | |
| 03 May | Aransas Pass | D | 13.7 | 51 | 18.3 | 15 | 32 | 165 |
| 19 | Aransas Pass | N | 13.7 | 51 | 16.4 | 30 | 2 | 163 |
| | Aransas Pass | N | 13.7 | 51 | 7.3 | 15 | 8 | 178 |
| 01 Jun | Aransas Pass | N | 13.7 | 51 | 16.4 | 15 | 8 | 186 |
| | Aransas Pass | N | 13.7 | 51 | 7.3 | 5 | 0 | |
| 09 | Aransas Pass | N | 13.7 | 51 | 14.6 | 10 | 120 | 170 |
| | Aransas Pass | N | 13.7 | 51 | 9.1 | 10 | 138 | 173 |
| 27 Jul | Aransas Pass | N | 13.7 | 51 | 14.6 | 15 | 0 | |
| 28 | Aransas Pass | N | 13.7 | 51 | 9.1 | 10 | 60 | 171 |
| 1973 | | | | | | | | |
| 09 May | Cedar Bayou | D | 13.7 | 51 | 14.6 | 15 | 8 | 167 |
| | Cedar Bayou | D | 13.7 | 51 | 7.3 | 10 | 282 | 149 |
| 30 | Aransas Pass | D | 13.7 | 51 | 7.3 | 15 | 16 | 166 |
| | Aransas Pass | D | 13.7 | 51 | 14.6 | 15 | 8 | 176 |
| 31 | Aransas Pass | D | 13.7 | 51 | 7.3 | 15 | 0 | |
| | Aransas Pass | D | 13.7 | 51 | 14.6 | 15 | 0 | |
| 25 Jun | Aransas Pass | D | 13.7 | 51 | 7.3 | 15 | 136 | 169 |
| | Aransas Pass | D | 13.7 | 51 | 14.6 | 15 | 264 | 174 |
| 17 Jul | Aransas Pass | D | 13.7 | 54 | 11.9 | 15 | 188 | 173 |
| | Aransas Pass | D | 13.7 | 54 | 13.7 | 15 | 32 | 175 |
| | Aransas Pass | D | 13.7 | 54 | 7.3 | 15 | 52 | 175 |
| 1974 | | | | | | | | |
| 11 Jun | Aransas Pass | D | 13.7 | 51 | 7.3 | 15 | 4 | 150 |
| | Aransas Pass | D | 13.7 | 51 | 11.0 | 15 | 44 | 169 |
| | Aransas Pass | D | 13.7 | 51 | 14.6 | 15 | 76 | 172 |

Table A.1. (Cont'd.)

| Year Date | Location | Day (D) or night (N) | Trawl size (m) | Mesh size (mm) | Water depth (m) | Tow duration (min) | No./h | Mean length (mm) |
|----------------|--------------|-------------------------|----------------------|----------------------|-----------------------|--------------------------|-------|------------------------|
| 1974 (Cont'd.) | | | | | | | | |
| 18 Jun | Aransas Pass | D | 13.7 | 51 | 7.3 | 15 | 212 | 171 |
| | Aransas Pass | D | 13.7 | 51 | 11.0 | 15 | 4 | 181 |
| | Aransas Pass | D | 13.7 | 51 | 14.6 | 15 | 0 | |
| | Aransas Pass | N | 13.7 | 51 | 14.6 | 15 | 0 | |
| | Aransas Pass | N | 13.7 | 51 | 7.3 | 15 | 44 | 169 |
| 21 | Aransas Pass | D | 13.7 | 51 | 14.6 | 15 | 8 | 176 |
| | Aransas Pass | D | 13.7 | 51 | 11.0 | 15 | 64 | 174 |
| | Aransas Pass | D | 13.7 | 51 | 7.3 | 15 | 48 | 171 |
| 27 | Cedar Bayou | D | 13.7 | 51 | 7.3 | 15 | 28 | 178 |
| | Cedar Bayou | D | 13.7 | 51 | 11.0 | 15 | 116 | 174 |
| | Cedar Bayou | D | 13.7 | 51 | 14.6 | 15 | 140 | 170 |
| 15 Jul | Aransas Pass | D | 13.7 | 51 | 7.3 | 15 | 0 | |
| | Aransas Pass | D | 13.7 | 51 | 11.0 | 15 | 0 | |
| | Aransas Pass | D | 13.7 | 51 | 14.6 | 15 | 0 | |
| 22 | Cedar Bayou | D | 13.7 | 51 | 14.6 | 15 | 0 | |
| | Cedar Bayou | D | 13.7 | 51 | 11.0 | 15 | 0 | |
| | Cedar Bayou | D | 13.7 | 51 | 7.3 | 15 | 4 | 181 |
| 1975 | | | | | | | | |
| 27 May | Aransas Pass | D | 13.7 | 51 | 7.3 | 15 | 0 | |
| | Aransas Pass | D | 13.7 | 51 | 11.0 | 15 | 84 | 160 |
| | Aransas Pass | D | 13.7 | 51 | 14.6 | 15 | 156 | 168 |
| | Aransas Pass | N | 13.7 | 51 | 14.6 | 15 | 16 | 160 |
| Jun | ND | | | | | | | |
| Jul | ND | | | | | | | |

Table A.1. (Cont'd.)

| Year Date | Location | Day (D) or night (N) | Trawl size (m) | Mesh size (mm) | Water depth (m) | Tow duration (min) | No./h | Mean length (mm) |
|--------------|--------------|-------------------------|----------------------|----------------------|-----------------------|--------------------------|-------|------------------------|
| 1976 | 10 May | Aransas Pass | N | 13.7 | 44 | 14.6 | 26 | 164 |
| | 11 | Aransas Pass | D | 13.7 | 44 | 7.3 | 0 | |
| | | Aransas Pass | D | 13.7 | 44 | 14.6 | 2 | 165 |
| | 23 | Corpus Christi Pass | N | 13.7 | 44 | 11.0 | 26 | 163 |
| | 24 | Aransas Pass | N | 13.7 | 44 | 16.4 | 12 | 179 |
| | | Aransas Pass | N | 13.7 | 44 | 11.0 | 32 | 170 |
| | 09 Jun | Aransas Pass | N | 13.7 | 44 | 12.8 | 88 | 167 |
| | 14 | Aransas Pass | D | 13.7 | 44 | 7.3 | 8 | 185 |
| | | Aransas Pass | D | 13.7 | 44 | 14.6 | 96 | 169 |
| | 16 | Corpus Christi Pass | N | 13.7 | 44 | 14.6 | 12 | 178 |
| | 21 | Corpus Christi Pass | N | 13.7 | 44 | 14.6 | 16 | 180 |
| | | Corpus Christi Pass | N | 13.7 | 44 | 11.0 | 56 | 176 |
| | 22 | Corpus Christi Pass | D | 13.7 | 44 | 11.0 | 24 | 173 |
| | 07 Jul | Aransas Pass | N | 13.7 | 51 | 12.8 | 204 | 167 |
| | 08 | Corpus Christi Pass | N | 13.7 | 51 | 12.8 | 24 | 178 |
| | 20 | Aransas Pass | D | 13.7 | 51 | 7.3 | 28 | 177 |
| | 21 | Aransas Pass | D | 13.7 | 51 | 14.6 | 40 | 177 |
| | 27 | Aransas Pass | N | 13.7 | 51 | 18.3 | 0 | |
| | | Aransas Pass | D | 13.7 | 51 | 7.3 | 0 | |
| | | Aransas Pass | D | 13.7 | 51 | 12.8 | 8 | 180 |
| | Aransas Pass | D | 13.7 | 51 | 14.6 | 12 | 187 | |
| | Aransas Pass | D | 13.7 | 51 | 14.6 | 0 | | |
| 1977 | 22 May | Aransas Pass | D | 13.7 | 51 | 7.3 | 2 | 170 |
| | 25 | Aransas Pass | D | 13.7 | 51 | 14.6 | 124 | 173 |

Table A.1. (Cont'd.)

| Year | Date | Location | Day (D) or night (N) | Trawl size (m) | Mesh size (mm) | Water depth (m) | Tow duration (min) | No./h | Mean length (mm) |
|----------------|--------|---------------------|-------------------------|----------------------|----------------------|-----------------------|--------------------------|-------|------------------------|
| 1977 (Cont'd.) | | | | | | | | | |
| | 26 May | Aransas Pass | N | 13.7 | 51 | 14.6 | 30 | 68 | 170 |
| | 27 | Corpus Christi Pass | N | 13.7 | 51 | 14.6 | 15 | 16 | 158 |
| | 31 | Aransas Pass | N | 13.7 | 51 | 11.0 | 15 | 120 | 165 |
| | 06 Jun | Aransas Pass | N | 13.7 | 51 | 11.0 | 30 | 48 | 170 |
| | | Aransas Pass | D | 13.7 | 51 | 14.6 | 15 | 12 | 170 |
| | 29 | Corpus Christi Pass | N | 13.7 | 51 | 12.8 | 30 | 8 | 171 |
| | | Aransas Pass | D | 13.7 | 51 | 7.3 | 30 | 51 | 174 |
| | 30 | Aransas Pass | D | 13.7 | 51 | 14.6 | 15 | 0 | 178 |
| | | Aransas Pass | N | 13.7 | 51 | 14.6 | 15 | 20 | 173 |
| | 13 Jul | Aransas Pass | N | 13.7 | 51 | 11.0 | 15 | 44 | 174 |
| | | Aransas Pass | D | 13.7 | 51 | 7.3 | 30 | 112 | |
| | 14 | Aransas Pass | D | 13.7 | 51 | 12.8 | 30 | 0 | |
| | | Aransas Pass | N | 13.7 | 51 | 16.4 | 30 | 0 | |
| | 15 | Aransas Pass | N | 13.7 | 51 | 12.8 | 30 | 14 | 167 |
| | 19 | Corpus Christi Pass | N | 13.7 | 51 | 11.0 | 15 | 0 | |
| | | Aransas Pass | N | 13.7 | 51 | 11.0 | 15 | 128 | 171 |
| 1978 | | | | | | | | | |
| | 30 May | Aransas Pass | D | 13.7 | 51 | 7.3 | 30 | 0 | |
| | | Aransas Pass | D | 13.7 | 51 | 11.0 | 15 | 8 | 170 |
| | | Aransas Pass | D | 13.7 | 51 | 14.6 | 30 | 10 | 167 |
| | | Aransas Pass | D | 13.7 | 51 | 18.3 | 30 | 2 | 146 |
| | 31 | Aransas Pass | N | 13.7 | 51 | 14.6 | 15 | 48 | 170 |
| | | Aransas Pass | N | 13.7 | 51 | 11.0 | 15 | 52 | 163 |
| | 13 Jun | Aransas Pass | N | 13.7 | 51 | 14.6 | 30 | 6 | 176 |
| | 14 | Aransas Pass | N | 13.7 | 51 | 11.0 | 30 | 76 | 172 |
| | | Aransas Pass | D | 13.7 | 51 | 7.3 | 15 | 0 | |

Table A.1. (Cont'd.)

| Year | Date | Location | Day (D) or night (N) | Trawl size (m) | Mesh size (mm) | Water depth (m) | Tow duration (min) | No./h | Mean length (mm) |
|----------------|--------|--------------|-------------------------|----------------------|----------------------|-----------------------|--------------------------|-------|------------------------|
| 1978 (Cont'd.) | | | | | | | | | |
| | 14 Jun | Aransas Pass | D | 13.7 | 51 | 14.6 | 15 | 0 | |
| | 29 | Aransas Pass | N | 13.7 | 51 | 11.0 | 15 | 156 | 171 |
| | 28 | Aransas Pass | N | 13.7 | 51 | 14.6 | 15 | 72 | 173 |
| | | Aransas Pass | D | 13.7 | 51 | 7.3 | 15 | 16 | 184 |
| | | Aransas Pass | D | 13.7 | 51 | 14.6 | 15 | 44 | 166 |
| | 14 Jul | Aransas Pass | N | 13.7 | 51 | 14.6 | 15 | 12 | 188 |
| | | Aransas Pass | D | 13.7 | 51 | 7.3 | 15 | 0 | |
| | | Aransas Pass | D | 13.7 | 51 | 14.6 | 15 | 4 | 181 |
| | 15 | Aransas Pass | N | 13.7 | 51 | 11.0 | 15 | 56 | 181 |
| | 19 | Aransas Pass | D | 13.7 | 51 | 7.3 | 15 | 0 | |
| | | Aransas Pass | D | 13.7 | 51 | 14.6 | 15 | 0 | |
| 1979 | | | | | | | | | |
| | 15 May | Aransas Pass | D | 13.7 | 51 | 7.3 | 30 | 0 | |
| | 16 | Aransas Pass | D | 13.7 | 51 | 9.1 | 30 | 0 | |
| | | Aransas Pass | D | 13.7 | 51 | 12.8 | 30 | 0 | |
| | | Aransas Pass | N | 13.7 | 51 | 11.0 | 30 | 0 | |
| | | Aransas Pass | N | 13.7 | 51 | 14.6 | 30 | 8 | 162 |
| | 17 | Aransas Pass | N | 13.7 | 51 | 7.3 | 30 | 0 | |
| | 23 | Aransas Pass | D | 13.7 | 51 | 16.4 | 30 | 14 | 167 |
| | 24 | Aransas Pass | N | 13.7 | 51 | 11.0 | 30 | 42 | 159 |
| | | Aransas Pass | N | 13.7 | 51 | 16.4 | 30 | 54 | 166 |
| | | Aransas Pass | D | 13.7 | 51 | 7.3 | 30 | 44 | 160 |
| | | Aransas Pass | D | 13.7 | 51 | 11.0 | 30 | 54 | 163 |
| | 22 Jun | Aransas Pass | N | 13.7 | 51 | 14.6 | 30 | 0 | |

Table A.1. (Cont'd.)

| Year Date | Location | Day (D) or night (N) | Trawl size (m) | Mesh size (mm) | Water depth (m) | Tow duration (min) | No./h | Mean length (mm) |
|----------------|--------------|-------------------------|----------------------|----------------------|-----------------------|--------------------------|-------|------------------------|
| 1979 (Cont'd.) | | | | | | | | |
| 30 Jul | Aransas Pass | D | 13.7 | 51 | 7.3 | 30 | 46 | 154 |
| | Aransas Pass | D | 13.7 | 51 | 12.8 | 30 | 20 | 184 |
| 1980 | | | | | | | | |
| 20 May | Aransas Pass | N | 13.7 | 51 | 12.8 | 30 | 14 | 157 |
| 05 Jun | Aransas Pass | D | 13.7 | 51 | 7.3 | 15 | 44 | 161 |
| | Aransas Pass | D | 13.7 | 51 | 7.3 | 15 | 0 | |
| | Aransas Pass | N | 13.7 | 51 | 14.6 | 30 | 222 | 164 |
| 25 | Aransas Pass | D | 13.7 | 51 | 7.3 | 15 | 444 | 168 |
| | Aransas Pass | N | 13.7 | 51 | 12.8 | 30 | 18 | 168 |
| 08 Jul | Aransas Pass | N | 13.7 | 51 | 16.4 | 15 | 0 | |
| 09 | Aransas Pass | D | 13.7 | 51 | 7.3 | 15 | 4 | 183 |
| | Aransas Pass | D | 13.7 | 51 | 7.3 | 15 | 4 | 158 |
| 24 | Aransas Pass | N | 13.7 | 51 | 11.0 | 15 | 0 | |
| 25 | Aransas Pass | N | 13.7 | 51 | 11.0 | 15 | 16 | 174 |
| 1981 | | | | | | | | |
| 06 May | Aransas Pass | D | 13.7 | 51 | 7.3 | 10 | 66 | 164 |
| | Aransas Pass | D | 13.7 | 51 | 11.0 | 10 | 0 | |
| | Aransas Pass | D | 13.7 | 51 | 11.0 | 10 | 48 | 155 |
| | Aransas Pass | D | 13.7 | 51 | 7.3 | 10 | 12 | 146 |
| 12 | Aransas Pass | D | 13.7 | 51 | 7.3 | 10 | 6 | 185 |
| | Aransas Pass | D | 13.7 | 51 | 11.0 | 10 | 6 | 142 |
| | Aransas Pass | D | 13.7 | 51 | 11.0 | 10 | 6 | 146 |
| | Aransas Pass | D | 13.7 | 51 | 7.3 | 10 | 0 | |

Table A.1. (Cont'd.)

| Year | Date | Location | Day (D) or night (N) | Trawl size (m) | Mesh size (mm) | Water depth (m) | Tow duration (min) | No./h | Mean length (mm) |
|----------------|--------|--------------|-------------------------|----------------------|----------------------|-----------------------|--------------------------|-------|------------------------|
| 1981 (Cont'd.) | | | | | | | | | |
| | 19 May | Aransas Pass | D | 14.3 | 51 | 7.3 | 10 | 810 | 162 |
| | | Aransas Pass | D | 14.3 | 51 | 11.0 | 10 | 348 | 163 |
| | | Aransas Pass | D | 14.3 | 51 | 11.0 | 10 | 78 | 161 |
| | | Aransas Pass | D | 14.3 | 51 | 7.3 | 10 | 0 | |
| | 21 | Aransas Pass | N | 14.3 | 51 | 12.8 | 10 | 72 | 162 |
| | | Aransas Pass | D | 14.3 | 51 | 7.3 | 10 | 102 | 163 |
| | | Aransas Pass | D | 14.3 | 51 | 11.0 | 10 | 348 | 166 |
| | | Aransas Pass | D | 14.3 | 51 | 11.0 | 10 | 138 | 158 |
| | | Aransas Pass | D | 14.3 | 51 | 7.3 | 10 | 192 | 167 |
| | 26 | Aransas Pass | D | 14.3 | 51 | 7.3 | 10 | 168 | 170 |
| | | Aransas Pass | D | 14.3 | 51 | 11.0 | 10 | 198 | 165 |
| | | Aransas Pass | D | 14.3 | 51 | 11.0 | 10 | 258 | 165 |
| | | Aransas Pass | D | 14.3 | 51 | 7.3 | 10 | 36 | 173 |
| | 27 | Aransas Pass | N | 14.3 | 51 | 11.0 | 10 | 240 | 162 |
| | 05 Jun | Aransas Pass | D | 14.3 | 51 | 7.3 | 10 | 66 | 168 |
| | | Aransas Pass | D | 14.3 | 51 | 11.0 | 10 | 48 | 164 |
| | | Aransas Pass | D | 14.3 | 51 | 11.0 | 10 | 18 | 169 |
| | | Aransas Pass | D | 14.3 | 51 | 7.3 | 10 | 72 | 168 |
| | 16 | Aransas Pass | D | 14.3 | 51 | 7.3 | 10 | 12 | 176 |
| | 17 | Aransas Pass | D | 14.3 | 51 | 11.0 | 10 | 12 | 184 |
| | | Aransas Pass | D | 12.2 | 51 | 7.3 | 10 | 42 | 176 |
| | 26 | Aransas Pass | D | 12.2 | 51 | 11.0 | 10 | 168 | 175 |
| | | Aransas Pass | D | 12.2 | 51 | 7.3 | 10 | 60 | 169 |
| | 08 Jul | Aransas Pass | D | 12.2 | 51 | 11.0 | 10 | 282 | 170 |
| | 09 | Aransas Pass | N | 12.2 | 51 | 7.3 | 10 | 30 | 165 |
| | | Aransas Pass | D | 12.2 | 51 | 7.3 | 10 | 30 | 147 |
| | | Aransas Pass | D | 12.2 | 51 | 11.0 | 10 | 36 | 174 |
| | 30 | Aransas Pass | N | 13.7 | 51 | 14.6 | 30 | 6 | 181 |

Table A.1. (Cont'd.)

| Year Date | Location | Day (D) or night (N) | Trawl size (m) | Mesh size (mm) | Water depth (m) | Tow duration (min) | No./h | Mean length (mm) |
|--------------|------------------------------|-------------------------|----------------------|----------------------|-----------------------|--------------------------|-------|------------------------|
| 1982 | | | | | | | | |
| 18 May | San Jose Island | D | 12.2 | 51 | 9.1 | 15 | 28 | 166 |
| | San Jose Island | D | 12.2 | 51 | 9.1 | 15 | 44 | 160 |
| | San Jose Island | D | 12.2 | 51 | 17.4 | 15 | 36 | 165 |
| | San Jose Island | D | 12.2 | 51 | 18.3 | 15 | 88 | 173 |
| | San Jose Island | D | 12.2 | 51 | 17.9 | 15 | 152 | 165 |
| 19 | Aransas Pass | D | 12.2 | 51 | 17.9 | 15 | 72 | 167 |
| | Aransas Pass | D | 12.2 | 51 | 14.6 | 15 | 48 | 160 |
| | Aransas Pass | D | 12.2 | 51 | 16.4 | 15 | 4 | 167 |
| | S. of Corpus Christi Pass | D | 12.2 | 51 | 18.3 | 15 | 40 | 164 |
| 25 | Cedar Bayou | D | 12.2 | 51 | 7.3 | 15 | 0 | |
| | San Jose Island | D | 12.2 | 51 | 14.6 | 15 | 4 | 161 |
| | San Jose Island | D | 12.2 | 51 | 12.8 | 15 | 0 | |
| | San Jose Island | D | 12.2 | 51 | 14.6 | 15 | 4 | 176 |
| 25 Jun | San Jose Island | D | 12.2 | 51 | 7.3 | 15 | 0 | |
| | Aransas Pass | D | 12.2 | 51 | 16.4 | 15 | 0 | |
| 30 | S. of Aransas Pass | D | 12.2 | 51 | 9.1 | 15 | 184 | 169 |
| | S. of Corpus Christi Pass | D | 12.2 | 51 | 14.6 | 15 | 12 | 186 |
| Jul | ND | | | | | | | |

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