

A Study of Texas Shrimp Populations

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A Study of Commercial Shrimp Populations in Coastal Bays of Texas,
1968

ABSTRACT

In spring, the growth of P. aztecus was delayed by cold water in early spring. Low salinity patterns of upper coastal bays confined the young to more saline lower regions of estuaries. The Gulfward migration began in late May. By July most had left the bays.

Heavy rainfall and runoff may have been beneficial to white shrimp (P. setiferus). They were abundant in samples and over 12 million pounds were landed commercially.

Juvenile brown and white shrimp were abundant in samples from Chocolate Bay.

INTRODUCTION

The success of the shrimp season depends on the well-being of juvenile shrimp populations in estuaries. Certain characteristics of each year-class must be known to develop a management plan. To get this knowledge, Parks and Wildlife Department personnel conduct annual surveys of shrimp populations in coastal bays from Sabine Lake to the Lower Laguna Madre (Leary and Compton 1960; Compton 1962; Pullen 1963; Moffett 1964, 1965, 1965, 1966 and 1967). The objectives are to study shrimp growth rates, seasonal abundance, emigration times, migrational patterns and habitat requirements. Another phase of the survey, not included in earlier work, is to determine the importance of Lower Chocolate Bay as habitat for small shrimp.

This report presents the results of the 1968 survey.

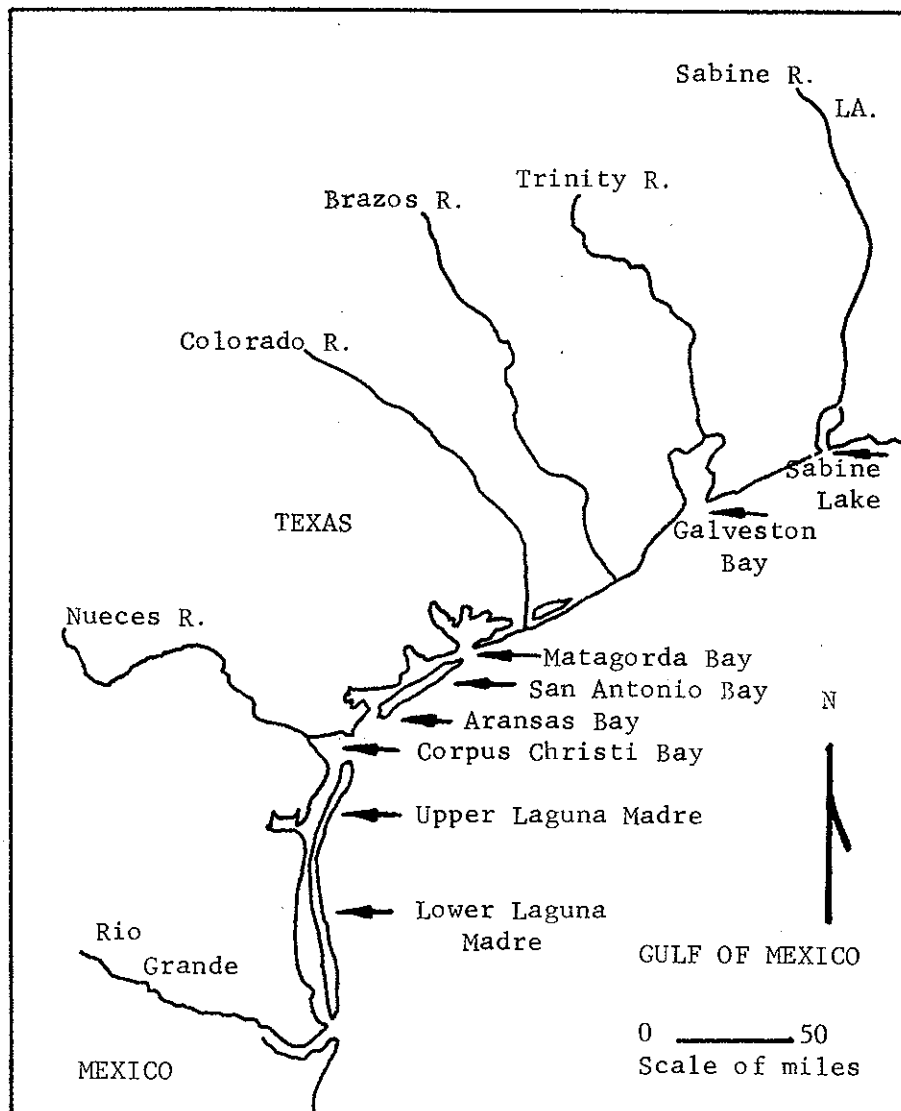
METHODS

Ten foot trawls (1 1/4 inch mesh, lined with 1/2 inch mesh webbing) were used in primary and secondary bays.* The sampling interval was 15 minutes. Six-foot bar-seines, 1/2 inch mesh webbing, were used in shallow areas. A standard sample was the catch in one 500 foot tow. Tertiary bays in the Corpus Christi Bay area were sampled with a 10 foot trawl. Shallows of the upper Laguna Madre were sampled with a 60 foot minnow seine.

Eight bay systems were sampled (Figure 1). In Sabine Lake samples were taken semi-monthly. Stations in Galveston, Matagorda, San Antonio, Aransas and Corpus Christi Bays were sampled weekly in spring then semi-monthly in other months. Laguna Madre stations were sampled semi-monthly from March 1 to June 15 and from September 1 to December 1.

* Mesh sizes are "stretch mesh"

Figure 1: Bay Systems Sampled



Shrimp were identified, measured in millimeters (tip of rostrum to end of telson), counted and weighed. Samples were equated to the standard when all shrimp caught were not measured and when short tows were made.

Pink shrimp in the upper Laguna Madre were sampled semi-monthly at night between September and June with a push net, (16 sq. ft., of 1/2 inch mesh webbing) and a 12 foot surface beam trawl, 1/2 inch mesh webbing. A standard 10-foot trawl was also used to sample pink shrimp on bottom.

Water temperature, salinity, wind velocity, wind direction and turbidity values were recorded.

Shrimp size distributions were plotted (data not presented) for each species by date, bay type and bay system. Size modes were selected from these graphs by the method of Leary and Compton (1960).

Growth rates, if measurable, were estimated by the method of Williams (1955) where growth was determined by using the difference between the largest shrimp in periodic samples.

ANALYSES OF SAMPLES

Brown Shrimp

Substantial numbers of postlarval brown shrimp entered coastal bays in February and March of 1968 (Baxter, personal communication*). This brood was exposed to relatively low water temperature in March (Table 1) that delayed shrimp growth. Consequently, the young were still less than one inch long and still confined to nursery areas in mid-April (Figure 2). In contrast, bait size shrimp were available in open bays by mid-April of 1967 (Moffett, 1967). Throughout spring low salinity levels (Table 1) restricted their distribution to the more saline regions in several bay systems.

In May, as the bays warmed, brown shrimp grew rapidly and began emigrating about May 28 when they were 75 to 110 mm long. To correspond with shrimp growth and time of emigration the Parks and Wildlife Commission closed the shallow Gulf to shrimping for 45 days starting on June 1.

Sabine Lake

Brown shrimp of the 1968 year-class (modal length, 33-43 mm), were caught first in samples on May 2 (Figure 2). The young were not found earlier because low spring water temperatures delayed growth (Table 1).

From May 2 to June 11 they were abundant in samples from the lower lake (Table 2). Values for catch per effort, however, declined sharply from 1967 at upper bay stations (Table 2).

The Gulfward migration began in mid-May and was nearly complete by July 1. On June 11, migrants (modal length, 48-78 mm) were abundant near the Cameron Causeway tidal outlet. Evidence of a second wave was not apparent.

The calculated growth rate between May 2 and June 11 (largest extreme sizes: 38 to 88 mm), was 1.25 mm per day.

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Table 1: Size of shrimp at first appearance (1966-1968)

BROWN SHRIMP						
Area	Date	Size Range	March Temp. °C	April Temp °C	March ppt	April ppt
<u>1966</u>						
Sabine Lake	April 22	13-33	18.0	20.0	1.7	10.8
Galveston Bay	April 1	13-23	18.0	21.8	9.2	17.5
Matagorda Bay	April 1	13-23	18.3	22.7	18.3	16.8
San Antonio Bay	April 1	18-28	16.6	21.4	15.8	17.1
Aransas Bay	April 1	13-23	18.5	22.7	20.9	22.5
Corpus Bay	April 8	13-28	18.9	24.6	30.7	31.2
Upper Laguna	May 1	48-83	20.5	23.5	38.4	42.5
Lower Laguna	April 1	18-78	20.5	22.0	35.4	35.3
<u>1967</u>						
Sabine Lake	April 4	23-43	21.0	26.0	17.6	10.0
Galveston Bay	March 15	18-28	21.7	26.5	24.7	27.1
Matagorda Bay	April 1	13-38	19.6	25.8	26.7	27.2
San Antonio Bay	April 8	23-78	17.2	25.1	20.8	24.2
Aransas Bay	March 15	13-18	20.5	26.7	25.2	27.9
Corpus Bay	March 15	23-108	21.7	25.6	34.8	36.7
Upper Laguna	March 15	18-78	22.8	25.5	44.0	46.0
Lower Laguna	March 15	13-28	23.5	25.9	37.7	38.3
<u>1968</u>						
Sabine Lake	May 2	28-68	19.5	22.3	12.2	1.5
Galveston Bay	April 1	13-18	14.7	19.9	13.3	8.2
Matagorda Bay	April 5	18-28	20.0	23.0	18.5	17.9
San Antonio Bay	May 1	28-83	15.1	21.9	8.9	9.5
Aransas Bay	March 15	28	17.6	23.6	11.8	17.5
Corpus Bay	April 23	38-48	16.3	25.1	21.9	26.6
Upper Laguna	April 1	23-33	18.7	21.4	22.6	24.9
Lower Laguna	April 1	28-38	-	22.7	-	31.4

Table 1: Contd.

WHITE SHRIMP

Area	Date	Size Range	June Temp. °C	July Temp. °C	June ppt	July ppt
<u>1966</u>						
Sabine Lake	July 1	38-93	27.5	31.0	2.9	6.8
Galveston Bay	July 1	13-58	29.1	31.3	19.3	13.8
Matagorda Bay	June 15	13-38	28.4	30.2	12.6	14.3
San Antonio Bay	July 1	23-58	28.3	29.5	11.8	11.7
Aransas Bay	August 1	58-113	28.2	29.5	13.1	16.5
Corpus Bay	July 25	28-113	28.3	30.7	21.5	29.6
Upper Laguna			30.0	30.8	32.0	34.2
Lower Laguna	June 15	13-48	29.6	29.9	29.6	28.9
<u>1967</u>						
Sabine Lake	July 5	33-78	31.0	29.0	8.9	14.0
Galveston Bay	June 15	33-53	28.2	30.6	18.5	18.2
Matagorda Bay	July 1	13-53	30.2	28.6	26.6	28.4
San Antonio Bay	June 15	23-58	27.1	29.2	23.5	29.1
Aransas Bay	July 1	18-88	ND	28.7	ND	27.8
Corpus Bay	June 15	33-83	28.4	29.2	39.2	42.6
Upper Laguna			29.2	30.2	48.5	51.4
Lower Laguna	June 1	23-68	29.1	29.4	41.7	41.8
<u>1968</u>						
Sabine Lake	June 26	43-68	29.0	31.0	2.3	2.8
Galveston Bay	June 4	23-33	28.8	28.1	6.4	3.5
Matagorda Bay	June 5	13-18	29.1	30.0	3.9	2.9
San Antonio Bay	June 14	33-98	29.1	29.1	1.3	1.2
Aransas Bay	May 31	13-38*	26.6	26.0	4.6	4.7
Corpus Bay	June 13	28-52	28.6	29.6	10.5	14.4
Upper Laguna	July 15	38-58	28.2	29.5	26.2	28.3
Lower Laguna	June 13	13-38	30.1	30.3	26.0	23.6

Figure 2: Modal lengths of brown shrimp by semi-monthly sampling periods (1968)

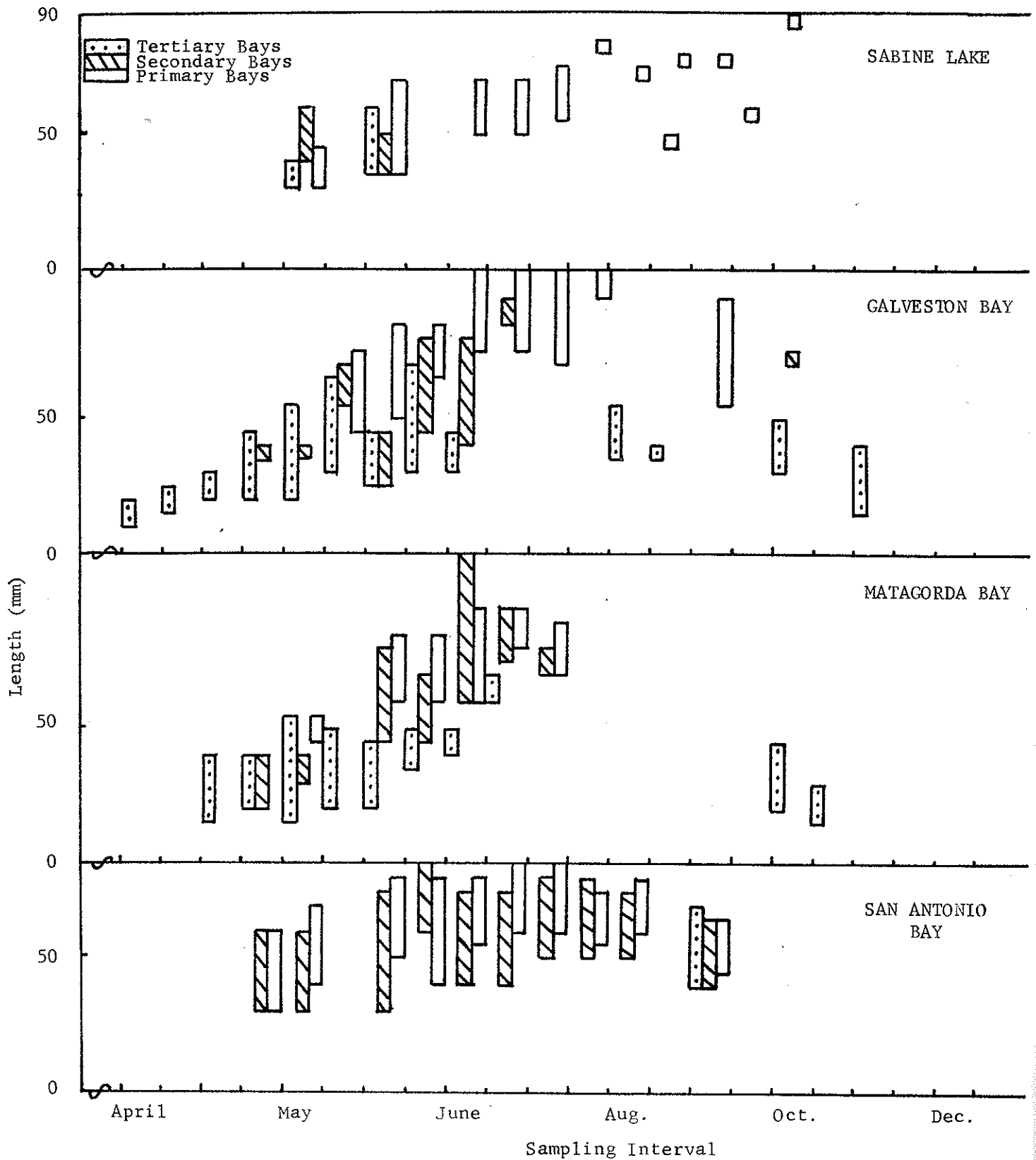
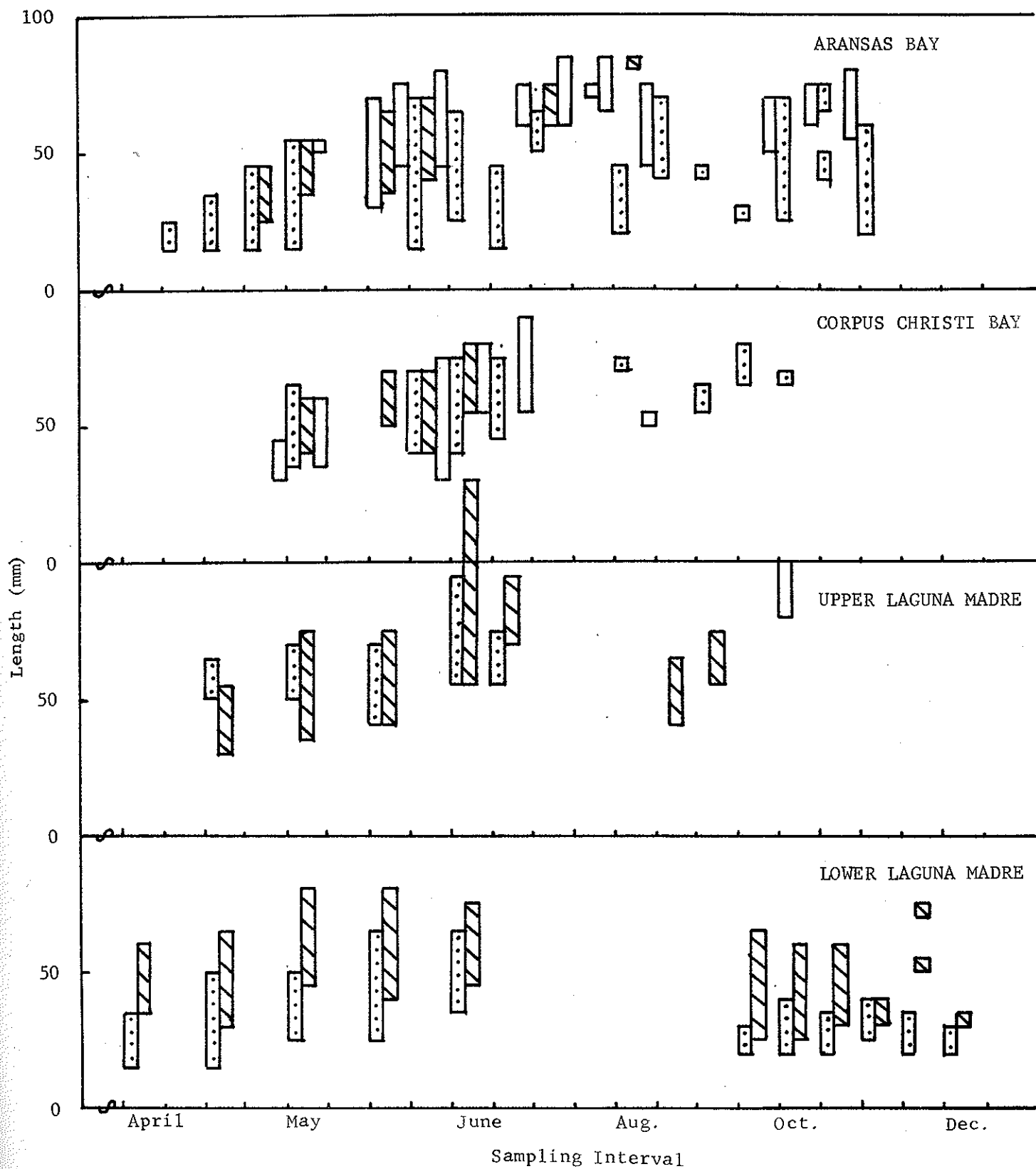


Table 2: Contd.



Galveston Bay

On March 19 postlarvae were found in Christmas Bay. By April 1 the young, 13-18 mm, were present on the nursery grounds of Jones Bay and Moses Lake. This brood increased in abundance throughout April, but none were caught in Galveston Bay or Clear Lake before April 25. Apparently low water temperatures in March (14.7°C) and early April (19.9°C) restricted the distribution of the young to nursery areas.

With salinity patterns greatly reduced in March (13.3 ppt) and April (8.2 ppt) brown shrimp were concentrated in the slightly more saline lower bay regions. Total rainfall (19.18 inches) increased 10.40 inches over the same period in 1967. This condition also prevailed in the 1966 spring.

Movement to the Gulf began in late May when the modal length of shrimp at primary bay stations was 83 to 88 mm (Figure 2). Most shrimp of the first wave had left by June 15.

Values for catch per effort declined sharply from values gotten in the 1967 spring (Table 2). Secondary waves were observed in samples on May 15 (size range, 29-43 mm), October 1 (size range, 33-48 mm) and November 1 (size range 18-38 mm).

Shrimp growth between April 1 and June 6 (largest extreme sizes, 18-103 mm) was 1.23 mm per day.

Matagorda Bay

Although salinities were reduced in spring, brown shrimp abundance increased in samples over 1967 (Table 2). The young (size range, 13-38 mm) were first detected on nursery grounds in early April (Table 1). Emigration was in progress by June 5 and most had left by mid-June. A second group (size range, 19-33 mm) were observed at nursery areas on October 1 (Figure 2).

Between April 15 and June 5 the calculated growth (largest extreme sizes, 38-128 mm) was 1.73 mm per day.

San Antonio Bay

Few brown shrimp were found before May. Early in May shrimp (modal length 38-58 mm) were abundant at secondary and primary stations (Table 2). Due to spring flood conditions there was a tendency for brown shrimp to avoid the upper portions of the estuary where salinities were less than 1.0 ppt (Table 1).

In May large concentrations of brown shrimp were found in the Intracoastal waterway. When emigration began, in late May, their modal length was 43 to 73 mm (Figure 2).

Most brown shrimp caught in June were concentrated in Espiritu Santo Bay, whereas few were found in the less saline San Antonio Bay. A second wave (size range 43 to 68 mm) was detected in samples on August 15 (Figure 2).

The estimated growth rate between April 29 and May 14 (largest extreme sizes, 63 to 93 mm) was 2 mm per day.

Aransas Bay

Young brown shrimp (28 mm) of the first wave appeared in samples on March 15 (Table 1). By mid-May their modal length at primary bay stations was 63 mm. When emigration began, about May 23, the modal size was 58 to 83 mm (Figure 2).

A second size group (modal length, 23 to 43 mm) was sampled in nursery areas in June. Emigrating began in early July at 68 mm. A sharp population drop-off followed. On August 1 evidence of a third wave (modal length, 23 to 43 mm) was apparent. These began emigrating on October 15 (68 mm).

The calculated growth rate from April 8 to May 23 (largest extreme sizes, 23 to 83 mm) was 1.3 mm.

Corpus Christi Bay

Bar seines are not used in this area; thus young brown shrimp were not detected until late April at back bay trawl stations. At first capture they were 27 to 50 mm long (Table 1). Throughout May they were abundant at most trawl stations (Table 2). The offshore migration started in late May (modal length, 58 to 83 mm) and state biologists observed juvenile brown shrimp moving through Packery and Corpus Christi Passes in early June. Few brown shrimp were found after June 15.

Values for catch per unit effort indicated an increased abundance in samples over 1967 (Table 2).

From April 23 to May 23 the calculated growth rate (largest extreme sizes, 48 to 93 mm) was 1.3 mm per day.

Upper Laguna Madre

Usually salinities in this area are high, however, in the spring of 1968 averaged salinity values were less than 30 ppt. Evidently this benefited the brown shrimp population since large samples were collected in spring (Table 2).

The young were first captured on April 1 (size range, 23-33 mm), but they were not found in abundance until mid-April (Table 1). On June 1, while emigration was in progress, many were over 100 mm long. A second but smaller wave was discovered on August 15 (modal length, 43 to 63 mm).

The calculated growth between April 15 and June 1 (largest extreme sizes, 68 to 128 mm) was 1.1 mm per day.

Lower Laguna

Spring rainfall reduced salinities to 31.5 ppt in April and May.

In 1967 and 1968 small brown shrimp (includes some pink shrimp) were abundant in spring (Table 2). The young of the 1968 year-class was 23 to 28 mm at first capture on April 1 (Table 1). Emigration started in early May when they were 63 mm. A population drop-off was noted on June 1, however, a small wave was detected on October 1 (23 to 43 mm).

The growth rate estimated from April 1 to May 1 (largest extreme sizes: 33 to 83 mm) was 1.7 mm per day.

Table 2: Average number of brown shrimp per sample (catch per effort by sampling date

		Tertiary			Secondary			Primary		
		<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>
SABINE LAKE										
April	1	0	-	0	0	69	0	0	11	-
	15	9	55	0	261	489	0	24	443	-
May	1	160	-	17	21	51	36	-	450	56
	15	0	514	58	0	615	108	194	257	660
June	1	4	13	2	0	660	0	872	286	601
	15	0	1	0	18	6408	-	211	305	58
July	1	3	1	-	78	1830	0	24	174	153
	15	5	1	0	60	3	0	12	14	4
Aug.	1	2	0	0	6	591	0	5	16	3
GALVESTON BAY										
March	15	0	31	0	0	0	0	0	0	0
April	1	33	71	5	0	6	0	0	0	0
	8	35	267	18	-	36	0	-	5	0
	15	47	439	15	8	92	0	0	23	0
	23	58	510	69	1	234	3	2	63	0
May	1	125	382	65	12	542	3	-	174	4
	8	115	135	71	7	435	13	16	548	147
	15	177	132	402	3	559	27	0	308	109
	23	101	385	70	3	712	32	5	131	23
June	1	118	94	42	74	273	238	100	199	134
	15	63	31	27	85	300	21	325	27	82
July	1	33	96	0	37	270	0	64	10	6
	15	12	19	9	12	45	0	39	5	24
MATAGORDA BAY										
April	1	28	13	3	0	20	-	0	0	-
	8	284	36	11	0	-	0	0	-	0
	15	141	92	63	0	57	6	2	9	0
	23	60	-	70	-	85	16	-	-	4
May	1	63	80	107	38	43	22	2	75	34
	8	-	53	175	-	75	-	-	17	-
	15	37	70	40	52	97	222	6	140	133
	23	52	21	14	23	-	69	27	-	121
June	1	112	51	40	91	26	81	58	18	76
	15	66	5	23	18	30	48	5	16	27
July	1	31	15	0	65	14	7	4	89	70
	15	38	2	0	74	21	1	18	7	5

Table 2: Contd.

		Tertiary			Secondary			Primary		
		<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>
SAN ANTONIO BAY										
March	15	-	-	0	0	26	0	0	29	-
April	1	-	-	0	3	-	0	0	-	-
	8	6	7	0	-	10	0	-	39	-
	15	6	8	0	4	10	0	-	72	0
	23	1	-	0	3	-	19	1	-	35
May	1	-	16	-	-	96	52	-	259	140
	8	59	-	-	17	201	-	7	131	-
	15	58	-	0	88	45	47	163	70	315
	23	21	-	0	-	-	51	-	-	249
June	1	28	17	1	100	164	51	183	185	85
	15	-	-	0	32	31	62	10	81	223
July	1	17	4	0	39	41	40	7	76	100
	15	-	-	0	35	13	36	4	6	20
ARANSAS BAY										
March	15	-	21	0	-	4	0	-	3	0
April	1	85	62	6	-	5	6	-	25	0
	8	-	281	0	-	-	0	-	-	0
	15	326	261	-	7	93	-	-	110	-
	23	-	205	19	-	-	19	-	-	0
May	1	197	189	16	47	257	16	2	827	10
	8	-	256	-	9	-	-	14	-	-
	15	124	101	69	217	-	69	23	-	190
	23	-	-	156	-	-	156	-	-	300
June	1	212	-	-	81	-	-	1149	-	-
	15	202	-	136	-	-	4	-	-	11
July	1	-	41	26	-	52	27	-	67	252
	15	-	72	6	-	49	13	-	161	216
CORPUS CHRISTI BAY										
April	1	0	-	-	0	-	-	0	-	-
	8	10	-	0	-	-	0	-	-	1
	15	22	145	-	-	0	0	-	54	0
	23	-	277	6	-	74	0	-	195	8
May	1	3	108	846	1	11	31	7	123	7
	8	126	172	-	8	744	600	44	128	-
	15	12	233	510	200	61	120	4	250	948
	23	10	293	561	950	155	211	61	89	403
June	1	149	161	621	2325	65	68	181	119	92
	15	-	193	205	-	27	3	-	105	266
July	1	-	134	-	-	59	4	-	27	1
	15	66	4	3	43	8	5	34	23	3

Table 2: Contd.

		Tertiary			Secondary		
		<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>
UPPER LAGUNA MADRE							
March	15	0	2	0	0	8	0
April	1	0	1	1	4	127	2
	15	0	48	16	0	60	179
May	1	29	106	31	59	355	792
	15	93	60	65	139	247	877
June	1	52	21	1332	38	165	1243
	15	-	11	-	35	201	-
LOWER LAGUNA MADRE							
March	15	6	50	0	4	6	0
April	1	103	74	137	56	77	112
	15	131	75	259	63	541	63
May	1	92	24	43	25	526	527
	15	37	14	71	41	121	617
June	1	39	33	30	165	305	93
	15	39	21	20	169	455	38
July	1	5	9	-	20	90	-
	15	-	0	-	-	1	31

Brown Shrimp, Emigration

The large Gulfward migration began in late May. Sampling aboard the Western Gulf showed that a few juvenile brown shrimp were present in the shallow Gulf between May 12 and May 18. The largest sample was taken ESE of Corpus Christi in 4 fathoms. This 30 minute tow produced 150 brown shrimp, 58 to 120 mm long. By May 28 large numbers of brown shrimp had moved into the shallow Gulf between Corpus Christi and Pass Cavallo. The smallest individuals were 60 mm. Time of emigration was verified by reports from commercial shrimpers who caught a few brown shrimp (78-80 mm) near Aransas Pass on May 23 (Farley, personal communication)*. They reported the capture of significant numbers along the Gulf beach from Corpus Christi to Galveston on May 28. Continued sampling in bays indicated that large numbers of juvenile brown shrimp continued to migrate Gulfward throughout June (Table 2).

White Shrimp

In 1967, commercial landings were low and the white shrimp population was at a low level. In 1968, commercial landings increased and white shrimp were abundant in samples from all bays. Heavy rainfall and run-off was excessive between April and August of 1968.

Sabine Lake

White shrimp (size range, 83 to 146 mm), which wintered-over, were common in May near Cameron Causeway.

Shrimp of the 1968 year-class (modal length, 53 to 78 mm) were first caught in samples on July 9 (Figure 3). The first wave was small, but a large wave was detected in the upper lake in late September. Between September 27 and November 18, juveniles were abundant at the upper bay trawl station when sample sizes ranged from 5,976 to 10,365 (Table 2).

Galveston Bay

Large white shrimp were fished by bait shrimpers throughout spring off Humble Camp (Upper Galveston Bay).

Members of the first 1968 year-class appeared at nursery areas on June 1 (modal length, 28 mm) and at trawl stations on June 15 (Table 1). The values for catch per unit effort were higher in July and August than values calculated in 1966 and 1967 (Table 2).

On July 15 a second wave of white shrimp (modal length; 28 mm) was detected at nursery areas. These shrimp developed rapidly into a large brood (Figure 2). From October 1 to mid-November, samples from the Clear Lake trawl station averaged 596 white shrimp per sample.

The estimated growth rate in June (largest extreme sizes, 28 to 88 mm) was 2 mm per day.

* Orman H. Farley, Supervisor Fishery Reporting Specialist, BFC Biological Laboratory, Galveston, Texas

Figure 3: Modal length of white shrimp by semi-monthly sampling \bar{x} (1968)

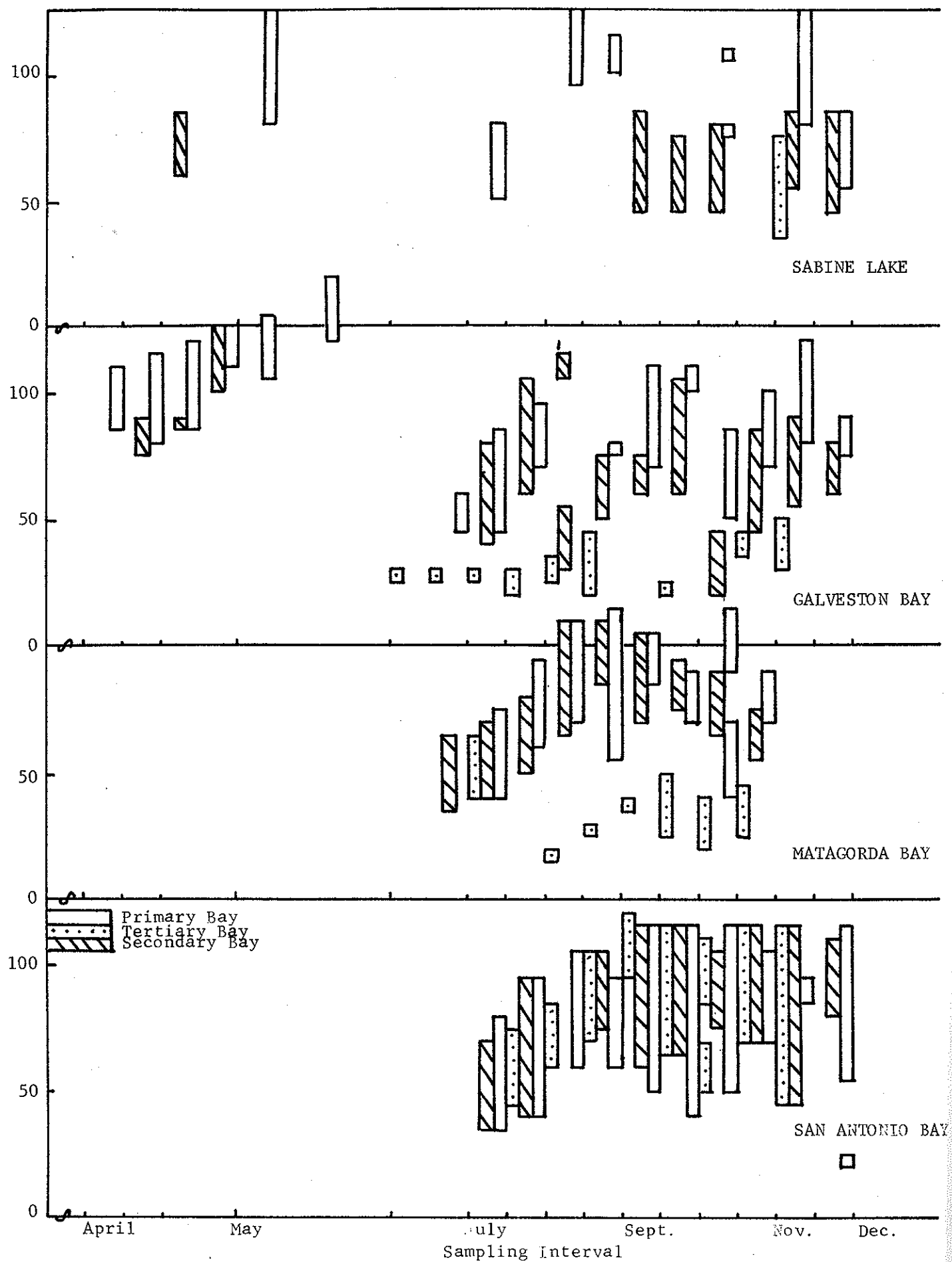
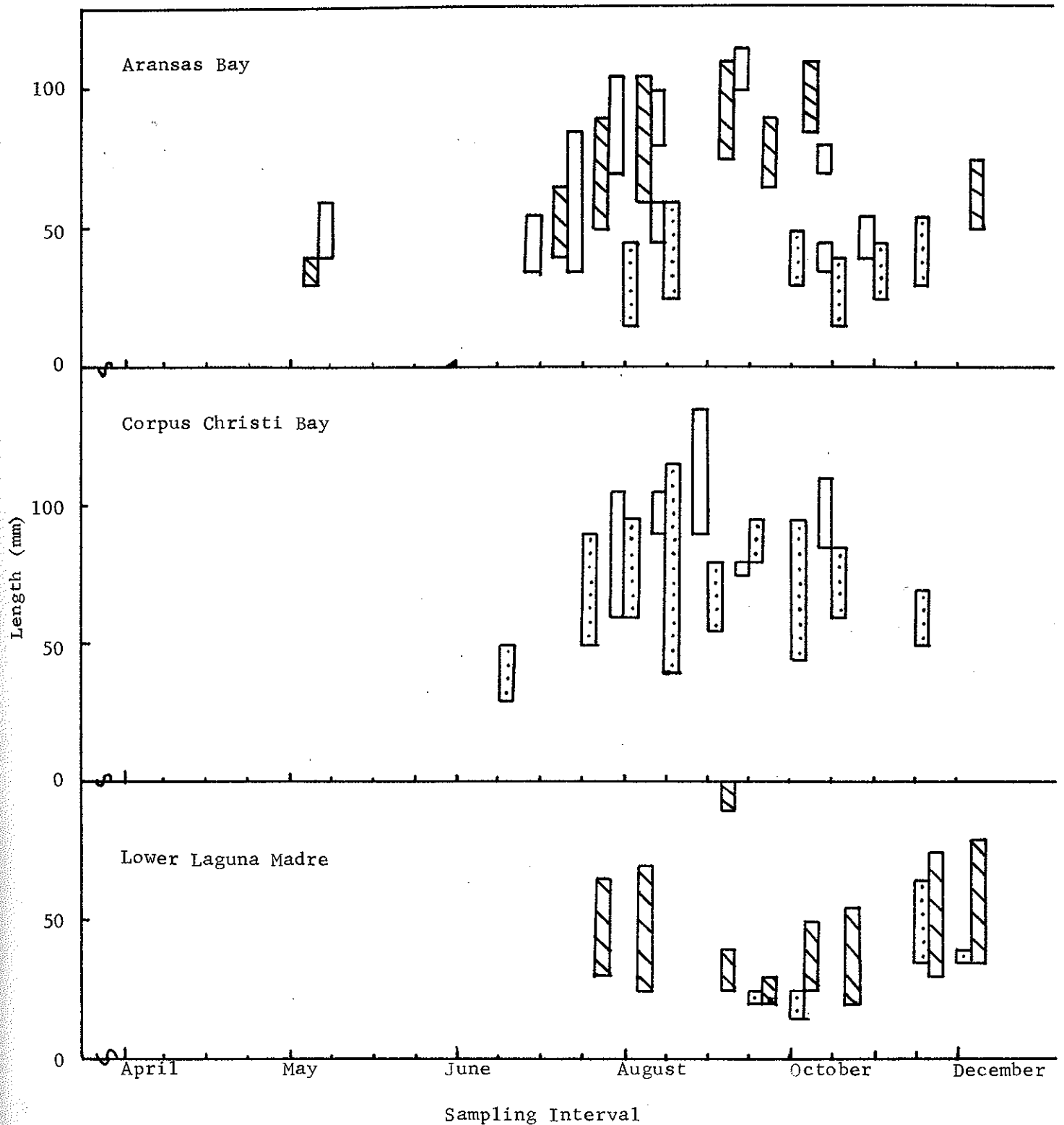


Figure 3: Contd.



Matagorda Bay

In summer, white shrimp were abundant in trawl samples (Table 2). They were first captured at nursery areas in late May and moved into secondary bays by late June. On August 15, when the fall bay shrimping season began, they were found in abundance but were too small to make the commercial count (65 tails per pound).

A second wave (Figure 3) appeared in samples from nursery areas on October 1 (18 to 43 mm).

San Antonio Bay

Young white shrimp (size range, 33 to 98 mm) were detected in the bay system on June 14. By mid-July they were abundant at secondary and primary bay stations (Table 2). From July 1 through November 15, values for catch per effort indicates a high abundance trend in San Antonio Bay (Table 2); but few were taken from near-by Espiritu Santo Bay during summer.

Aransas Bay

On April 30, 107 white shrimp, 33 to 78 mm long, were caught at trawl stations at Marker 19 and 43 in Aransas Bay, west of the Copano Bay Causeway, and near the mouth of Mission Bay. Although their sizes were unusually small, they probably belong to the 1967 year-class and had wintered-over. Small white shrimp were not captured again in samples until May 31 (size range, 13 to 38 mm). A second wave (size range, 18 to 38 mm) was detected at nursery areas on October 15 (Figure 3).

Sampling throughout summer and fall indicated a high abundance trend (Table 2). Despite this commercial bay landings in August were reduced from last year due to large numbers of illegal size shrimp.

The estimated growth rate between June 15 and July 15 (largest extreme sizes, 53 to 113 mm) was 2 mm per day.

Corpus Christi Bay

White shrimp, first detected in back bays (33 to 43 mm) in mid-June, were abundant in summer and fall, especially in Nueces Bay (Table 2). Few were found in Redfish Bay. A sharp population drop-off occurred by mid-November.

The estimated growth rate between June 13 and July 15 (largest extreme sizes; 43 to 113 mm) was 2.2 mm.

Laguna Madre

With salinity regimes low in summer a relatively large white shrimp population developed in the Lower Laguna Madre (Table 2). They were first detected (Table 1) on June 13 (13 to 38 mm). The young were most abundant in the Arroyo Colorado where a sample taken in August at Mile 13 contained 3,264 white shrimp (size range, 30 to 110 mm).

Chocolate Bay

The first 1968 year class brown shrimp (modal length, 23 to 33 mm) were caught on April 16 at the Nymph Point bar-seine station (Table 3). Their abundance increased gradually until a peak was reached on June 18 when 557 shrimp, modal length 63 to 88 mm, were caught in the Monsanto Channel (Figure 4). While in the area they grew about 1.4 mm per day. By July 1 most had left; however, limited recruitment continued through November.

Table 2: Contd. Average number of white shrimp per sample (catch per effort) by sampling date

		Tertiary			Secondary			Primary		
		1966	1967	1968	1966	1967	1968	1966	1967	1968
SABINE LAKE										
June	1	0	0	0	0	0	0	0	0	1
	15	0	0	0	0	0	-	0	0	3
July	1	0	0	-	0	357	-	1	0	20
	15	0	0	0	0	0	0	2	0	1
Aug.	1	1	0	0	0	69	0	0	1	15
	15	0	0	0	-	3	18	4	0	6
Sept.	1	-	0	0	-	0	291	-	0	14
	15	-	0	3	78	-	5976	1	2	35
Oct.	1	25	11	-	129	45	2748	0	0	25
	15	81	884	33	66	51	10365	96	193	68
Nov.	1	126	-	-	168	-	-	215	-	-
	15	142	1	-	825	852	2613	176	164	52
Dec.	1	1	3	-	327	3	-	1158	38	-
GALVESTON BAY										
June	1	0	0	2	0	0	0	1	1	4
	15	0	1	17	0	0	2	1	0	5
July	1	4	110	2	23	80	153	1	0	293
	15	8	35	10	60	71	117	2	0	30
Aug.	1	10	1	51	16	46	110	12	20	10
	15	7	50	129	7	20	139	3	15	17
Sept.	1	29	8	14	18	18	277	4	7	52
	15	63	137	24	69	33	364	6	1	28
Oct.	1	157	244	91	568	36	512	43	3	12
	15	47	49	26	428	174	1145	48	-	65
Nov.	1	193	126	145	565	172	725	15	3	46
	15	8	46	6	453	192	555	81	13	22
Dec.	1	5	22	1	224	387	354	51	8	-
MATAGORDA BAY										
June	1	0	0	4	0	1	1	1	1	0
	15	15	0	0	0	1	0	0	0	7
July	1	61	29	5	260	179	205	0	13	188
	15	46	9	1	95	48	206	1	0	152
Aug.	1	136	16	18	25	13	225	8	0	309
	15	73	7	16	92	-	312	1	0	99
Sept.	1	43	-	15	1	4	126	0	-	23
	15	108	65	50	0	23	24	0	0	43
Oct.	1	308	7	224	15		20	2	7	9
	15	-		80	3		79	2		169
Nov.	1	99		59	20		28	10		29
	15	35		1	4		16	2		22
Dec.	1	17		-	-		14	-		21

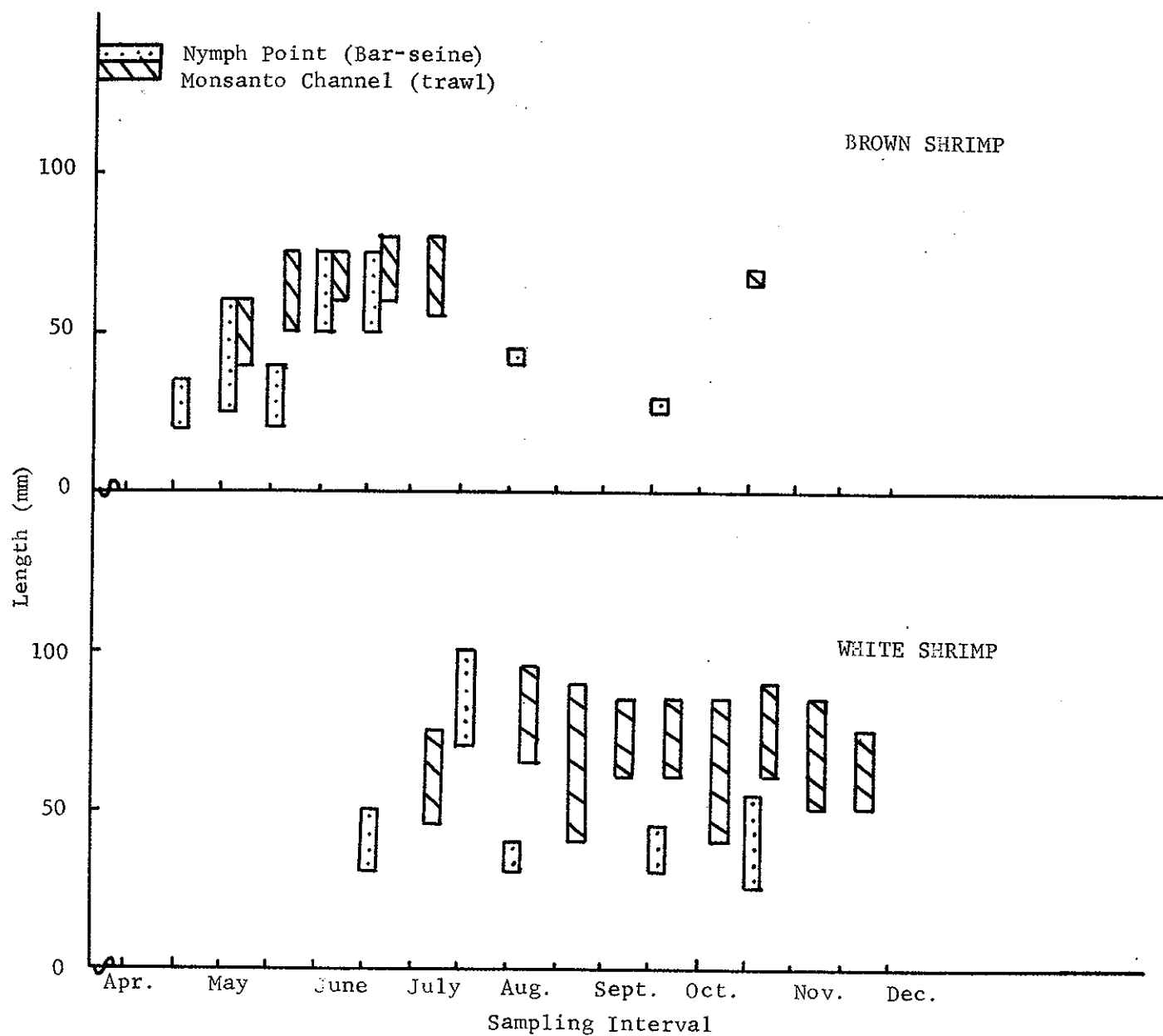
Table 2: Contd.

		Tertiary			Secondary			Primary		
		1966	1967	1968	1966	1967	1968	1966	1967	1968
SAN ANTONIO BAY										
June	1	0	0	0	0	0	0	0	0	0
	15	0	2	0	0	2	0	0	4	2
July	1	0	10	0	6	6	42	0	15	87
	15	29	27	214	10	32	72	4	12	212
Aug.	1	22	51	5	13	46	422	7	55	222
	15	37	1	272	21	4	330	18	16	147
Sept.	1	13	-	74	10	-	75	2	-	299
	15	9	141	196	1	1	131	1	3	240
Oct.	1	17	0	160	6	185	2	-	98	
	15	11	1	104	11	10	99	9	3	26
Nov.	1	0	-	342	12	106	147	9	69	42
	15	105	0	97	7	11	175	8	30	110
Dec.	1	3	-	0	7	-	16	1	-	186
ARANSAS BAY										
June	1	0	-	6	0	-	-	0	-	-
	15	0	-	0	-	-	4	-	-	11
July	1	-	27	3	-	18	101	-	2	188
	15	-	33	2	-	27	410	-	-	357
Aug.	1	4	3	50	41	-	184	432	87	28
	15	0	5	26	126	2	142	22	1	13
Sept.	1	0	8	6	4	-	75	0	-	2
	15	3	10	3	19	7	59	2	11	15
Oct.	1	39	8	110	-	-	151	39	-	58
	15	101	8	583	-	-	21	0	-	170
Nov.	1	-	31	167	-	77	-	-	220	-
	15	-	13	77	-	1	-	-	7	-
Dec.	1	15	0	3	0	173	54	0	224	5
CORPUS CHRISTI BAY										
June	1	0	2	0	0	0	0	4	1	5
	15	-	11	7	-	0	0	-	4	1
July	1	-	155	-	-	5	1	-	65	0
	15	183	114	393	0	0	0	26	1	315
Aug.	1	42	387	375	0	0	0	10	301	113
	15	102	68	1181	-	-	5	41	1	172
Sept.	1	197	27	120	35	0	0	34	2	7
	15	79	-	19	0	-	0	6	-	20
Oct.	1	73	56	230	-	0	0	69	182	28
	15	-	224	133	-	1	0	-	55	9
Nov.	1	-	83	-	-	27	0	-	267	1
	15	-	14	52	0	1	-	1	295	-
Dec.	1	67	-	-	0	-	0	15	-	0

Table 2: Contd.

		Tertiary			Secondary		
		<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>
LOWER LAGUNA							
June	1	0	3	0	0	31	0
	15	11	21	3	12	0	12
July	1	1	32	-	24	230	-
	15	-	-	-	-	103	105
Aug.	1	-	0	-	-	41	115
	15	-	0	-	-	76	-
Sept.	1	2	1	2	13	22	231
	15	16	-	11	6	-	165
Oct.	1	9	-	28	5	-	251
	15	3	-	2	5	-	53
Nov.	1	8	2	3	0	6	14
	15	5	1		7	1	
Dec.	1	42			3		

Figure 4: Modal lengths of shrimp caught, by sampling interval, in Chocolate Bay 1969



A few 1967 year-class white shrimp wintered-over and were legal size, over 115 mm, when sampling began in March (Table 3). Members of the 1968 year-class were captured first at Nymph Point on June 18 (33 to 53 mm). A second and much larger brood appeared on the nursery grounds on October 21 (modal length, 28 to 63 mm). From August through November, numerous juveniles probably migrating toward West Bay, were found in the Monsanto Channel (Table 3).

Pink Shrimp, Upper Laguna

Pink shrimp stocks, fished by bait shrimpers in the Upper Laguna Madre, have been sampled since October, 1966. Results show that the young appear at nursery areas in fall and early winter. They migrate to the Gulf in December and again in April and May.

In 1968 few were found in winter. By mid-March large numbers (modal length, 40 to 90 mm) were found on bottom (Figure 5). Nighttime sampling in April showed that a large migration to the Gulf was in progress (modal length, 60 to 100 mm). Emigration was not apparent in data collected in the fall of 1968, however, sampling was incomplete.

Sample Size-Commercial Yield Relationship

Shrimp sampling and commercial yield results for the years 1964 through 1968 are compared (Figure 6). To fit the sample catch curves, I divided the number of shrimp caught on the first of the month by the number of samples; fifteenth of the month data were treated the same. The monthly points of the curves are the total of the two average values. Monthly commercial production values were extracted from Texas Landings.*

The brown shrimp sample peak was relatively small in 1964 (about 150 in May and June) when the annual catch was 26 million pounds (headless). In 1965 the sample catch peak increased to 220 in May and 340 in June. There was also an 8 million pound increase in the commercial catch. Sample catch per effort values were reduced in 1966 to 160 in May and 290 in June. The commercial catch, however, was only slightly decreased from 1965. These 1966 data posed a problem because spring flooding along the upper coast caused young shrimp to leave areas of the back bays and enter saltier lower bay regions. As a result the abundance trend was difficult to determine because samples from tertiary and secondary bays decreased, while those from primary bays increased. In 1967, the record production year (55.4 million pounds), the catch per effort peaks were 200 in April, 310 in May and over 400 in June. The catch per effort peak in June 1968 was over 400, whereas the 1968 annual catch was the second largest of the 5 year period (40.3 million pounds).

Fall broods of small white shrimp do not seem to contribute greatly to total production. The white shrimp catch decreased each year from 12 million pounds in 1964 to 6.4 million pounds in 1967. In 1964 when production was high the July value for sample catch per effort was high. The same phenomenon occurred in the summer of 1968 (the record production year). Sample catch peaks, however, occurred later in 1965, 1966 and 1967.

* Texas Landings, BCF Washington, D.C. and Texas Parks & Wildlife Department, Austin, Texas

Table 3: Average number of shrimp per sample (Chocolate Bay, 1968)

Date	NYMPH POINT				MONSANTO CHANNEL			
	Brown Shrimp	White Shrimp	Temp. °C	Sal. ppt.	Brown Shrimp	White Shrimp	Temp. °C	Sal. ppt.
March 4	0	0	11.5	18.9	0	5	12.0	22.2
March 15	0	0	15.0	11.1	0	0	15.0	21.1
April 4	0	0	22.0	20.0	0	4	22.0	22.2
April 16	24	0	23.0	1.1	2	11	24.0	8.9
April 30	232	0	21.0	12.2	78	14	23.0	12.2
May 14	56	0	27.0	1.1	85	0	26.5	1.1
June 6	38	0	26.0	1.1	291	0	26.0	0.0
June 18	41	41	27.5	9.4	557	4	30.0	13.3
July 1	0	0	28.5	0.0	44	441	29.0	0.0
July 15	0	2	29.0	3.3	1	148	30.0	13.9
Aug. 1	8	34	30.0	7.8	2	962	31.0	15.5
Aug. 15	0	3	30.0	9.4	0	1,026	29.0	-
Sept. 1	0	4	27.5	23.3	3	1,345	24.0	23.9
Sept. 15	7	17	26.0	8.9	2	1,234	27.0	14.4
Oct. 1	0	8	27.0	17.7	21	3,735	28.0	17.8
Oct. 15	4	825	22.0	13.3	0	624	22.0	12.0
Nov. 1	0	4	23.0	15.5	3	753	23.0	17.8
Nov. 15	5	12	22.0	11.1	0	6,201	21.0	20.0
Dec. 1	4	10	13.0	16.7	0	1,314	12.0	10.5
Dec. 15	0	0	17.0	14.0	0	132	12.0	22.8

Figure 5: Size Distribution, Pink Shrimp, Upper Laguna Madre (1966-1968)

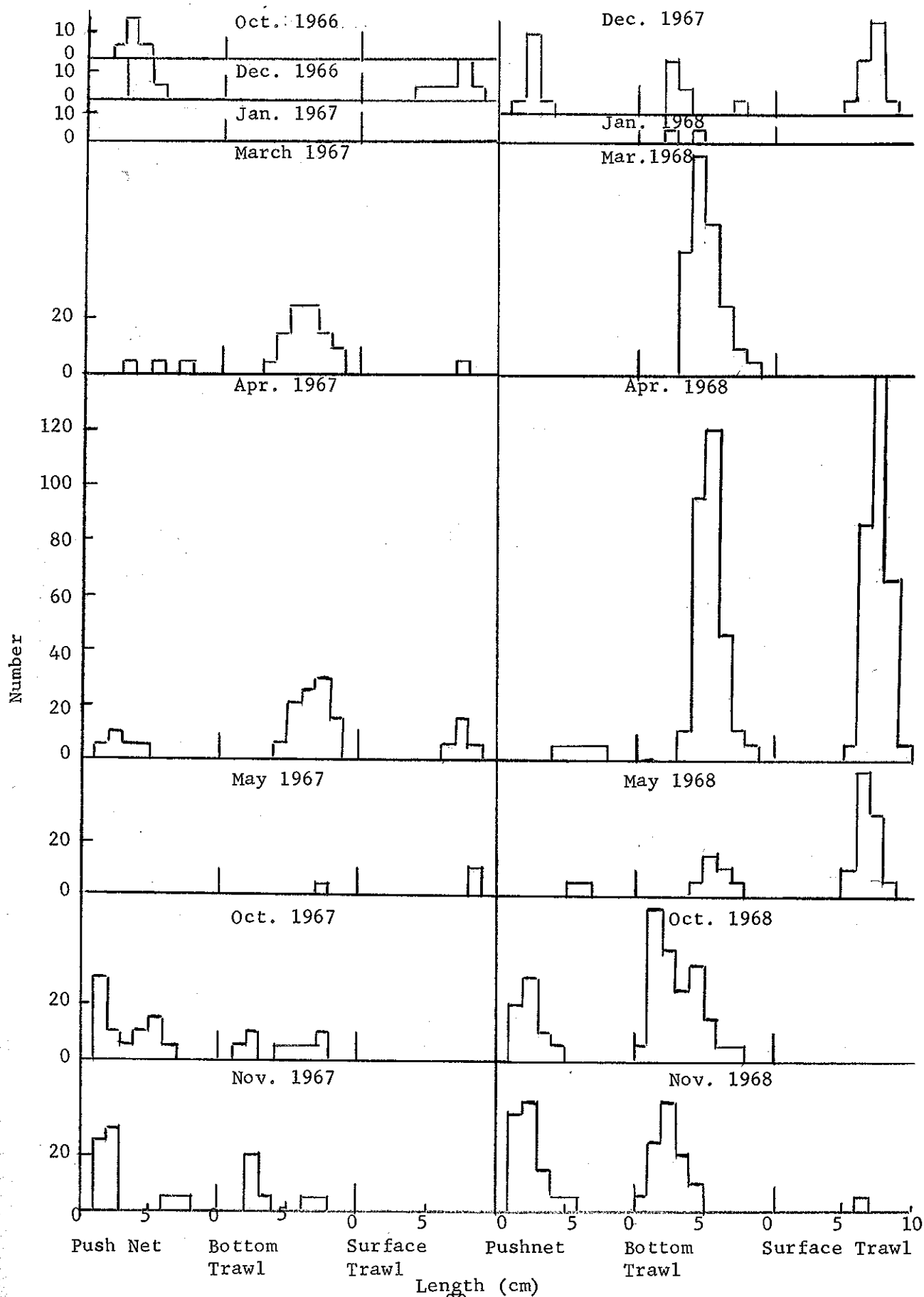
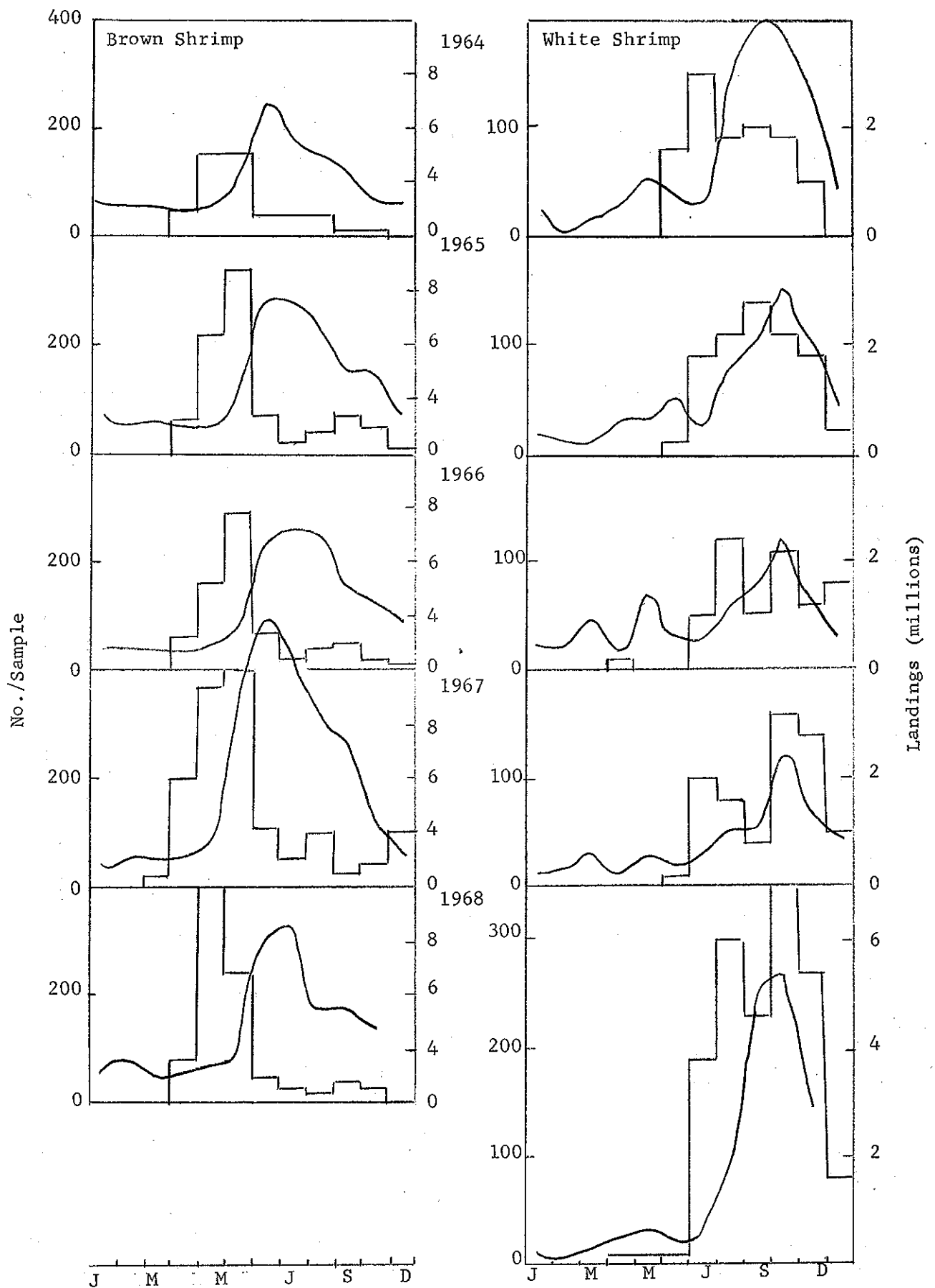


Figure 6: Relationship between commercial landings and catch per sample (1964-1968)



THE FISHERY AND SHRIMP PRODUCTION

Numerous vessels have been added to the Texas shrimp fleet since 1965. In 1968 approximately 230 trawlers made maiden voyages. The larger fleet and the abundance of shrimp were largely responsible for the excellent shrimp production in 1967 and 1968.

The 1968 shrimp catch totaled 52.4 million pounds (headless) and was valued at \$45 million to fishermen and/or shrimp boat owners. This was a decline of 11.8 million pounds in volume and \$1.4 million in value from 1967.

The brown shrimp catch, 40.3 million pounds (headless), decreased 10.3 million pounds in volume from 1967. Commercial and bait catches were poor in spring, because juvenile brown shrimp were confined to the lower, more saline, areas of several estuaries. The upper bays were, apparently, too fresh to support large numbers of brown shrimp. Catches in the Gulf, however, were excellent in July when landings at the Brownsville-Port Isabel areas were the highest for any year on record.

The white shrimp catch, over 12.1 million pounds (headless) was the largest since records have been kept. A production peak was reached in October when over 3.5 million pounds were reported. The presence of large white shrimp populations in all bays, except the upper Laguna Madre, was verified by biological sampling data. Consequently, commercial landings, 12.1 million pounds, increased 5.7 million pounds over 1967 and 44 thousand pounds over the previous record year of 1964. Despite this the fall bay season began slowly in some bays because shrimp did not make the commercial count (65 tails per pound). This was particularly evident in Matagorda Bay where local fishermen attempted to allow more shrimp to reach fishable size by abstaining from shrimping between August 15 and August 25.

DISCUSSION

Spring and summer bay salinity patterns were greatly reduced from the corresponding period in 1967, and water temperatures were unusually low in March. The low salinity level resulted in the concentration of large numbers of small brown shrimp in the lower and more saline regions of bays along the upper coast. The low water temperatures, especially along the upper coast, slowed shrimp growth rates in early spring. Their growth rates increased, however, in May as the bay waters warmed.

In summer brown shrimp were more abundant than they were in the 1967 summer. I conclude that this increase does not represent greater numbers in 1968. Instead, the 1967 brown shrimp year-class, which preceeded a record catch, left bays earlier.

Excessive rainfall and river discharge continued through June. The low salinity level, characteristic of bays in spring and summer, increased in fall. Evidently the fresher bays in summer were beneficial to young white shrimp because large populations were found in all bays sampled.

Values of catch per effort for white shrimp from some secondary bays increased remarkably over values obtained in previous years. Of particular interest was one sample from upper Sabine Lake that contained over 10 thousand shrimp. Apparently samples from secondary bays are valuable when making white shrimp catch predictions since 1968 was a record production year. Samples from nursery areas did not show a consistent relationship with commercial landings (probably due to annual changes in the environments). The samples from

primary bays cannot be used because the abundance of shrimp is greatly reduced by commercial shrimping activity.

Chocolate Bay

Findings of the survey, which may be biased due to low salinity patterns in spring and summer, begun in March 1968 to study the importance of lower Chocolate Bay as habitat for juvenile commercial shrimps revealed that the marsh shoreline areas served as important nursery grounds and that numerous under size shrimp were available to trawling gear from late April through early December. This indicates that commercial shrimping operations should not be permitted in lower Chocolate Bay from April 1 through December. To date, however, biologists do not know enough about winter mortality rates of small white shrimp and how this effects the commercial fishery. When more technical knowledge is available we may find that protection of small white shrimp from late broods is not required. There is evidence that the best seasons occur when the first white shrimp wave is relatively large.

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