

# Job Report

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Project Name: A Study of the Texas Shrimp Populations

Period Covered: January 1, 1963 to December 31, 1963

Job No. 2

## A Study of the Juvenile Shrimp Populations of the Galveston Bay System

Abstract: Seasonal abundance and sizes of juvenile brown shrimp, Penaeus aztecus, and white shrimp, P. setiferus, in the Galveston Bay and Sabine Lake areas were studied using samples taken semi-monthly in tertiary, secondary and primary bays. The first and largest wave of brown shrimp appeared in mid-April. Two smaller waves followed. White shrimp were detected in June. The first wave was small, but was followed by two larger waves. Most brown shrimp emigrated to the Gulf before they were 100 mm long, while white shrimp attained a larger size in the bay. Both species of Penaeus were more abundant in samples taken in 1963 than in 1962.

The abundance of shrimp in replica samples indicated poor agreement, but sizes and seasonality trends indicated fair agreement.

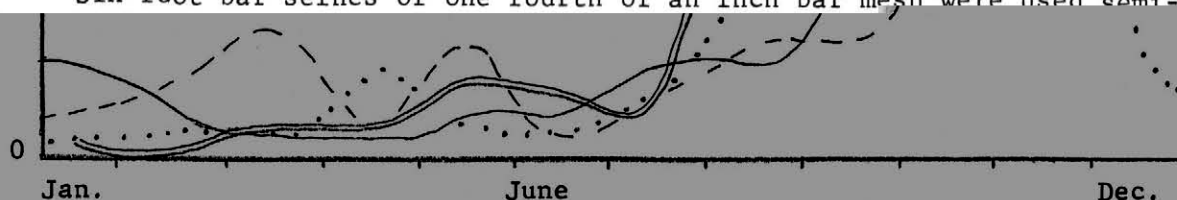
Commercial shrimp landings in 1963 exceeded 1962 landings in all months but January and February.

Objective: To determine the seasonal abundance, growth rates and size of juvenile shrimp in the Galveston Bay system.

Procedures: Shrimp were identified and measured in total length (from tip of rostrum to tip of telson) to the nearest millimeter. Total sample weights, in ounces, were recorded by species. Occasionally lack of time and broken shrimp prevented measuring all individuals of the samples. But all unmeasured shrimp were identified and counted.

Sampling stations were established in tertiary (Mud and Taylor Lakes), secondary (Clear Lake) and primary (Galveston) bays (Figure 1). Sampling began in Sabine Lake late in the season at one secondary and three primary stations (Figure 2).

Six-foot bar seines of one fourth of an inch bar mesh were used semi-monthly



Salinity samples collected at sampling time were determined by Mohr's titration method. Water temperatures were recorded in degrees centigrade.

#### Stations:

Tertiary: Taylor and Mud Lake are small tertiary bays (2-3 feet deep) on the west side of upper Galveston Bay (Figure 1). These lakes are surrounded by marsh grasses and receive an influx of fresh water from a complicated network of small tributaries and marshes. The lake bottoms are soft mud. These areas serve as important nurseries for sub-adult blue crabs and juvenile game fishes as well as shrimp. Mud Lake salinities varied from 1.5 (March) to 21.1 ppt (October). Salinities in Taylor Lake ranged from 4.7 (March) to 22.1 ppt (October). Water temperatures ranged from 25°C in April to 13.5°C in December (Table 1). In August water temperature reached a peak of 31.5°C.

Secondary: Both tertiary bays are connected to Clear Lake (Figure 1). This bay is deeper and provides a nursery area for juvenile shrimps that enter, mainly, via Mud Lake, Taylor Lake and Clear Creek. The mud bottom is firmer than the tertiary bays described above. The depth at the station was 4.5 feet. A channel (6 to 9 feet deep) runs down the center of the lake. Salinity ranged from 9.2 ppt in July to 23.7 ppt in September. Water temperatures ranged from 25.5°C in April to 23.2°C in November. Water temperatures as high as 31.5°C were recorded in August (Table 2).

Primary: Primary stations were at Humble Camp in upper Galveston Bay and Texas City Dike in lower Galveston Bay (Figure 1). Humble Camp is off Baccliff along the northwest bank of upper Galveston Bay. The water depth averaged eight feet. The bottom is a mixture of mud and clay. Texas City Dike is about four nautical miles northwest of Bolivar Roads (Figure 1). The bottom is mud, but a mixture of sand and clay was found near shore. The water depth averaged about nine feet. Humble Camp salinities varied from 16 (April) to 25.6 ppt (September). Salinities at Texas City Dike varied from 18.7 (April) to 35.1 ppt. (August). Water temperatures ranged from 23.9°C in April to 14.6°C in December. The highest water temperature (30.57°C) was recorded in August (Table 3).

Sabine Lake: Primary stations were off the south and center of Pleasure Island in 4-7 feet of water (Figure 2). The lake bottom was firm mud mixed with rangia shell. Salinities varied from 8.3 ppt. in October to 18.2 ppt in September (Table 5). Water temperatures ranged from 30.8°C in July to 14.2°C in December (Table 5).

A secondary station was in the north end of Sabine Lake in a channel near Stewts Island (Figure 2). The depth averaged 10 feet. The channel bottom was soft mud mixed with rangia shell. Salinities ranged from 7.9 ppt (October) to 19.4 ppt (September). Water temperatures varied from 31.0°C in July to 15.9°C in December.

#### Findings & Discussion:

##### Seasonal Occurrence

Galveston Bay: Postlarval (less than 25 mm long) and early juvenile stages of brown shrimp (*Penaeus aztecus*) were detected in tertiary bays (Mud and Taylor Lakes) in mid-April when water temperatures were over 20°C (Table 1). This agrees with St. Amant, et. al. (1963) who state:

Metamorphosis of postlarvae into rapidly growing juveniles occurs suddenly after water temperatures exceed 20°C and continues upward to summer levels.

Brown shrimp were abundant in samples from the adjacent secondary bay (Clear Lake) in May and June (Table 2). Most shrimp, of this first wave, left the primary bay (Galveston Bay) before July when they were 90 mm long (Table 3).

The abundance of brown shrimp in samples from tertiary and secondary bays declined in July when salinities reached a low level (Table 1 and 2) following a month of heavy rainfall (about 6 inches). These reduced catches may reflect normal shrimp emigration instead of habitat change because shrimp samples from primary stations also declined but salinity remained fairly stable (Table 3).

The first wave of brown shrimp was numerically larger than two succeeding waves found in tertiary bays in July and October. The July group was detected at a modal length of 20-30 mm (Table 1) and reached a peak of abundance in samples from the secondary bay in August at a modal length of 70-80 mm. (Table 2). Sample catches in the primary bay indicated that this group left the bay by early September when most shrimp were about 90 mm long (Table 3). The third wave was detected in October at a modal length of 20-30 mm, and left the bay before December.

White shrimp (*P. setiferus*) were detected in samples from tertiary bays in June at a modal length of 30-40 mm (Table 1). This species was abundant in samples from the primary bay in August and apparently left at a modal length of 118 mm (Table 3). At that time white shrimp were subjected to heavy fishing pressure that may have altered the estimated time and size of emigration.

The first wave was smaller than waves detected in tertiary bays (Table 1) in August (modal length 20-30 mm) and October (modal length 20-30 mm). White shrimp were abundant in samples from secondary bays (Table 2) in August (modal length 90-100 mm). Apparently this represented the second wave that left the primary bay (Table 3) in November (modal length 120 mm). Another abundance increase occurred in samples from the secondary bay in November when white shrimp were 60-80 mm long. (Table 2). Samples collected in the primary bay in December after water temperatures dropped to 14.6°C contained few shrimp. Thus it was assumed that the third white shrimp "brood" left the bay at a small size to seek warmer waters.

Sabine Lake: Brown shrimp data from Sabine Lake were incomplete and shrimp waves were hard to separate. Those caught in June probably represented individuals of an earlier wave (Table 4). A second wave was found in August (Table 4) when the abundance of shrimp in the samples increased sharply (modal length 50-80 mm). Apparently these shrimp left the bay before the mid-September hurricane (Table 5). Samples taken after the hurricane contained few brown shrimp (Table 4 and 5).

White shrimp were found in Sabine Lake in July at a modal length of 70-80 mm (Table 4). By August this species was abundant in trawl catches at a modal length of 120-130 mm (Table 5). Apparently, the bulk of this wave left the lake before September. A second, larger, wave was detected in October (after the hurricane) at a modal length of 50-70 mm (Table 4). A third (large) group appeared in samples taken in December (modal length 50-60 mm). Attempts were made to follow growth and movement of this wave, but samples collected in January, when the water temperature was below 11°C, were negative.

The sampling indicated that the two latter white shrimp waves were very large. Salinities in October were 8 ppt at secondary and 8.3 ppt at primary stations. The total rainfall in the preceding month was 20.75 inches at Port Arthur. Because samples were not collected from September 1 - October 1 any attempt to relate the relative size of the second and third wave to habitat change, resulting from the hurricane, would be open to criticism. The size of

shrimp caught in October suggests that the shrimp were in the area before the hurricane. Flooding, caused by the hurricane, may have increased survival rates by providing more nursery space and reducing competition. Larger shrimp in the area apparently left through Sabine Pass with receding flood waters since local fishermen reported large commercial catches (for a short duration) in this area after the hurricane.

#### Comparison of 1962 and 1963 Trawl Data

Shrimp samples collected in Clear Lake in 1963 were compared to samples collected in 1962. The solid or baselines represent 1962 data, while, broken lines represent 1963 average monthly catch deviations from the 1962 data. This station was used because Clear Lake shrimp samples are relatively large (Figure 3).

In 9 of 16 sample periods, 1963 catches (numbers) were well above 1962 data indicating a relatively large year-class of both species.

#### Validity of Samples

The abundance of shrimp in replica samples (Figure 4) collected by 10 foot trawl in Clear Lake show poor agreement. This could result from sampling twice in the same general area. Excluding the first replica white shrimp sample, the length-frequency curves appear comparable. The brown shrimp curves show poor agreement, but this species was not abundant in the fall samples; thus one would expect greater variation. The white shrimp samples indicate that seasonality trends as well as lengths available, are well represented (at least in secondary bays) in trawl samples. Continued replica sampling in the spring should strengthen the brown shrimp data.

#### The Fishery:

##### Bay Fishery

Over two million pounds of white shrimp and about 270,000 pounds of brown shrimp were taken commercially from Galveston and Trinity Bays in 1963 (Table 6). The bay production figures in Table 6 are based on statistics collected by the U. S. Fish and Wildlife Service. Data collected after June were preliminary and may be subjected to slight changes. About 12 per cent of the white shrimp landings after August probably were brown shrimp. (Farley - personal communication.)

The bulk of the brown shrimp production was from Upper Galveston Bay where a production peak was reached in June during the limited bay season (300 pounds of shrimp per day per boat). A small percentage of the total brown shrimp catch came from Trinity Bay (Table 6).

Most of the white shrimp catch was from Upper and Lower Galveston Bay. Landings reached a peak in August when nearly one million pounds were caught.

In Sabine Lake about 750,000 pounds of white shrimp and about 105,000 pounds of brown shrimp were reported. White shrimp production reached a peak in October after hurricane "Cindy".

## Gulf and Bay Landings

In 1963 commercial landings (both gulf and bay) at Galveston, Port Arthur and Sabine Pass exceeded landings of the previous year in all months but January and February (Figure 5).<sup>\*</sup> Both production curves shown in Figure 5 reached peaks in October. The 1963 production data are preliminary. Port Arthur and Sabine Lake were not combined with Galveston Landings before July, 1962.

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\* Source: Gulf of Mexico Monthly Landings, Production and Shipments of Fishery Products. U. S. Dept. Interior, Bur. Comm. Fish. Market News Service. New Orleans, La. (1962-1963).

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## Literature Cited

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1963 Studies on the Growth Dynamics of the Brown Shrimp, Penaeus aztecus,  
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(56) Table 1. Monthly length-frequency tables of shrimp caught by bar-seine in tertiary bays. (Galveston Bay, (1963).

Brown Shrimp

Total length (MM)	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1.0-1.9	3				2	1	6			12
2	18	9		11	20	14	20			92
3	21	20	1	4	11	13	4	1		75
4	8	12	6	1	3	12	8	0	2	52
5.0-5.9	1	4	4		1	6	5	1	2	24
6		2	2		1	1	2	0	1	9
7		1	3			3	0	1	1	9
8		1					2	2		5
9.0-9.9		1								1
No. Measured	51	50	16	16	38	50	47	5	6	279
Total	51	54	17	16	44	50	47	5	6	295
No. Samples	2	4	4	4	4	4	4	4	2	32
Avg. per Sample	25.5	13.5	4.2	4.2	11.0	12.5	11.7	1.2	3.0	9.2

White Shrimp

Total length (MM)	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1.0-1.9			1		3					4
2			2	2	14		16	1	4	39
3			4	0	6		23	6	6	45
4			1	1	4		20	17	8	51
5.0-5.9			1	0	2	1	3	3	3	13
6				2	1	0	4	3	1	11
7					1	1	0			2
8					1		0			1
9							1			1
10.0-10.9							1			1
No. Measured	-	-	9	5	32	2	68	30	22	168
Total	-	-	9	5	32	2	68	31	22	169
Avg. per Sample	-	-	2.2	1.2	8.0	0.5	17.0	7.7	11.0	6.5
Avg. Salinity ‰	15.3	15.6	15.82	6.40	13.35	18.17	20.37	21.5	18.55	-
Avg. Temp. °C	25.0	25.8	29.6	-	31.0	30.5	24.0	18.2	13.5	-



Table 2. Monthly length-frequency tables of shrimp caught by ten-foot trawl in a secondary bay (Galveston Bay, 1963).

## BROWN SHRIMP

Total Length (MM)	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1.0-1.9										
2						2				2
3	14	2			1	6	3			26
4	44	16	20	4	12	13	4			113
5.0-5.9	4	44	26	12	20	21	20	1	1	139
6		49	35	9	24	8	12	5	2	144
7		40	64	5	28	21	4	20	5	187
8		53	88	21	20	26	16	27	2	253
9		48	71	9	31	13	11	10		193
10		20	18		27	5	2	2		74
11		2	1		3					6
12.0-12.9					1					1
No. Measured	62	274	323	60	167	115	62	65	10	1138
Total	72	296	369	60	167	119	66	65	10	
No. Samples	1	2	2	2	2	2	2	2	1	16
Avg. per Sample	72	148	184.5	30.0	84.5	59.5	33.0	32.5	10	

## WHITE SHRIMP

Total Length (MM)	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1.0-1.9										
2										
3				2		3	7	7	1	20
4			1	10	4	4	23	21	14	77
5.0-5.9			1	22	16	11	21	80	27	178
6				27	28	16	9	167	26	273
7				16	54	11	8	114	17	220
8				10	72	9	6	56	12	165
9	1			6	105	6	10	22	7	157
10	0			5	91	10	24	19		149
11	1				74	10	14	12		110
12	1				17	15	8	5		46
13					2	12	5	1		20
14.0-14.9						5	1			6
No. Measured	2	-	2	98	463	112	136	504	104	1421
Total	3	-	2	98	514	113	143	563	104	1539
Avg. per Sample	2		1	49.0	257.0	56.5	71.5	281.5	104	109.9
Avg. Salinity ‰	16.5	16.7	18.45	9.20	17.4	23.70	23.5	21.1	21.2	
Avg. Temp. °C	23.5	28.0	30.6	31.0	31.5	31.3	27.0	23.2	-	

Table 3. Monthly length-frequency tables of shrimp caught by ten-foot trawl in a primary bay (Galveston Bay, 1963).

## BROWN SHRIMP

Total length (MM)	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1.0-1.9	1									1
2	4	1								5
3	1	5								6
4		12			5					17
5.0-5.9		10	3		3	3				19
6		16	2	2	14	5		1		40
7		15	9	0	10	1	1	1		37
8		7	12	1	7	0	1	5	1	34
9		5	20	0	14	3	5	2		49
10		1	10	5	2	0	1	1		20
11		1	3	5	4	1		1		15
12		0		5	1	1				7
13		1			1					2
14.0-14.9										
No. Measured	6	74	59	18	61	14	8	11	1	252
Total	10	102	59	18	61	14	8	12	1	285
No. Samples	1	4	4	4	4	4	4	4	2	31
Avg. per Sample	10	39.2	14.7	4.5	15.2	3.5	2.0	3.0	0.5	9.2



Table 3. (Continued) Monthly length-frequency tables of shrimp caught by ten-foot trawl in a primary bay  
(Galveston Bay, 1963)

WHITE SHRIMP

Total Length (mm)	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
4.0-4.9								1		1
5					1			2		3
6					3			2		5
7					0	1		2		3
8				1	8	1		5		15
9				0	9	0		16		25
10.0-10.9				0	12	0	1	20	2	35
11				1	13	0	1	33	2	51
12					18	0	0	29		47
13					14	1	1	9		25
14					2	4	2	2		10
15					1	1	1			3
16	1				1	1				3
17.0-17.9					1					1
No. Measured	1	1	1	2	83	9	6	121	5	227
Total	1	-	-	2	84	9	6	121	5	228
Avg. per Sample	1	-	-	0.5	21.0	2.25	1.15	30.25	2.5	10.36
Avg. Salinity ‰	17.9	21.70	23.15	24.00	25.32	29.57	26.75	24.95	24.90	-
Avg. Temp °C	23.8	25.50	26.2	29.7	30.57	30.10	24.95	20.95	14.6	-

Table 4. Length-frequency table of shrimp caught by 10-foot trawl at secondary stations (Sabine Lake, 1963).

BROWN SHRIMP								
Total Length (MM)	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
20-29								0
30			6					6
40	2	3	33	6	1	3		48
50-59	0	3	74	12	1	3	1	94
60	0	13	79	15	1			108
70	2	28	47	16		1		94
80	0	15	36	6				57
90	1	4	34					39
100-109		1	19					20
No. Measured	5	67	328	55	3	7	1	467
Total	7	95	549	55	5	9	3	723
No. Samples	2	2	2	1	2	2	1	12
Avg./Sample	2.5	47	274	55	2.5	4.5	3	60
WHITE SHRIMP								
Total Length (mm)								
20-29								0
30					1	1	3	5
40		1	1		29	10	42	83
50-59		4			83	34	117	238
60		7	3	1	85	76	82	254
70		11	5		77	92	61	246
80		5	5	3	48	81	18	160
90		2	21	1	64	63	3	154
100-109		1	22	4	23	33	3	86
110			20	8	8	6		42
120			13	2		7		21
130			4	1				5
140-500				1				1
No. Measured		31	94	21	418	402	329	1295
Total		31	280	29	1298	1335	969	3942
Avg. Salinity ‰		13.0	14.9	19.4	7.9	14.3	12.2	-
Avg. Temperature °C		31.0	29.9	31.5	26.0	22.0	15.9	-
Avg./Sample		15.5	140	29	649	667.5	969	328

Table 5. Length-frequency table of shrimp caught by 10-foot trawl at primary stations (Sabine Lake, 1963)

BROWN SHRIMP								
Total Length (MM)	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
2.0-2.9								0
3					3			3
4	1	1	3		9	2		16
5	2	3	34	6	14	4		63
6	11	2	6	25	7	2		53
7	15	4	14	27	5	2		67
8	23	25	21	3	3			75
9	16	16	5		6			43
10	1	4	11		1			17
11			4					4
12.0-12.9			1					1
No. Measured	69	55	99	61	48	10	0	342
Total	73	59	109	60	49	23	0	373
No. Samples	6	6	6	3	6	6	3	36
Avg./Sample	12.2	9.8	18	20	8.2	3.8	0	10.4
WHITE SHRIMP								
Total Length (MM)								
2.0-2.9					3			3
3					32	6		38
4			1		78	17	4	100
5					78	69	15	162
6					148	119	15	282
7			1		213	166	26	406
8		1		1	119	169	16	306
9			2	4	43	110	6	165
10		5		1	20	56	6	88
11		1	16	6	8	25		56
12		1	22	2		2		27
13		2	14	5				21
14			8	1				9
15								0
16.0-16.9			1	1				2
No. Measured	0	10	65	21	742	739	88	1665
Total	0	10	195	27	1642	1335	95	3304
Avg. Salinity ‰		14.8	16.3	18.2	8.3	14.0	12.5	-
Avg. Temp. °C		30.8	29.8	30.7	24.5	21.9	14.2	-
Avg./Sample		1.7	32.5	9.0	273	222	31.6	91.7

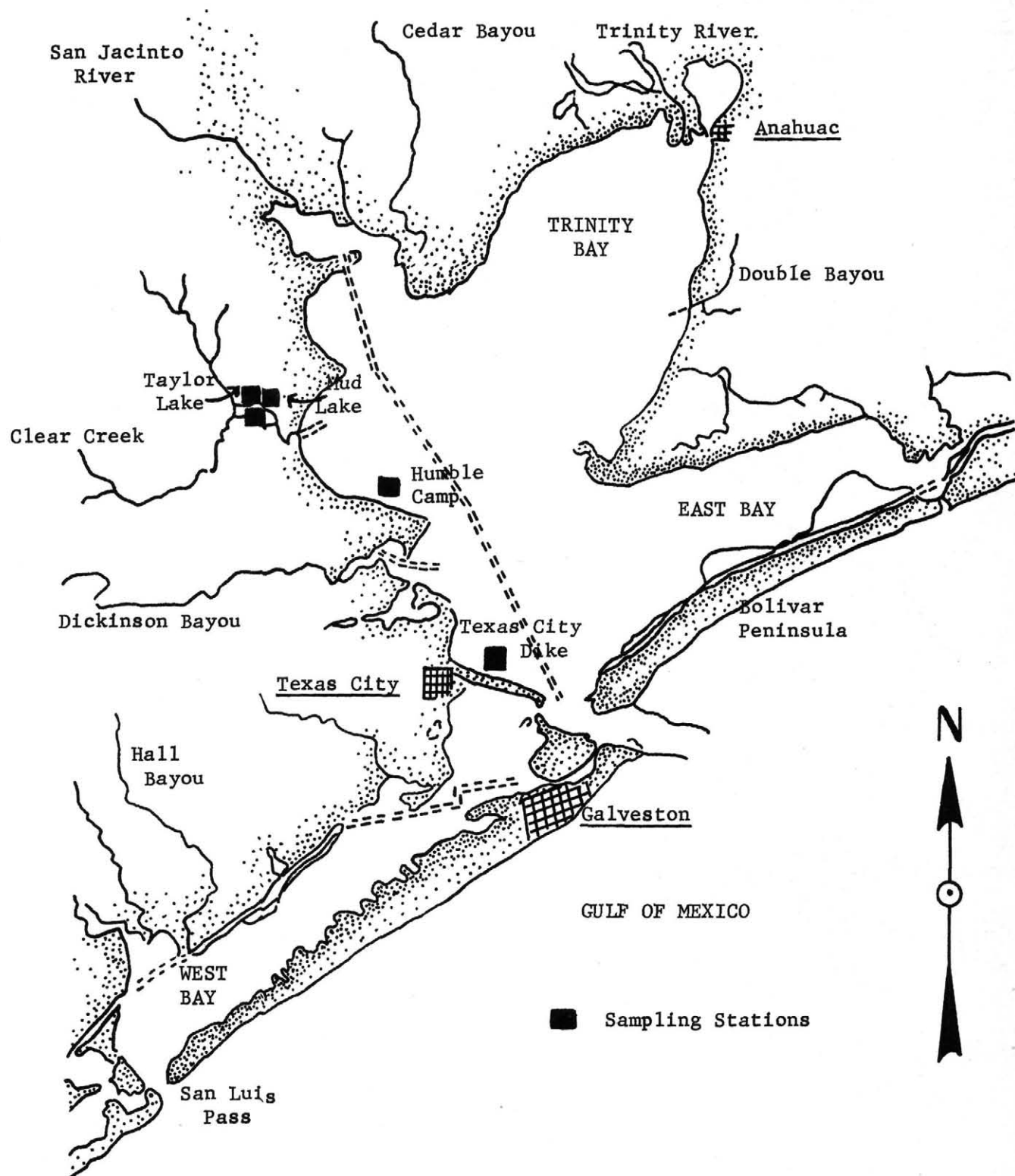
Table 6. 1963 Bay Shrimp Production in Pounds (heads-off).

Brown Shrimp	Month	Sabine Lake	Trinity Bay	Upper Galveston	Lower Galveston	Total
	April	-	-	-	-	-
	May	7,100	-	52,572	41,572	101,571
	June	2,237	13,372	109,784	62,667	188,060
	July	86,691	-	57,952	29,154	173,797
	Aug.	9,575	-	2,697	103	12,375
	Sept.	-	-	-	-	-
	Oct.	-	-	-	-	-
	Nov.	-	-	-	-	-
	Dec.	-	-	-	-	-
TOTAL		105,603	13,372	223,005	133,823	475,830

White Shrimp	April	129	-	430	-	559
	May	21,010	-	262	4,929	26,201
	June	9,733	19	925	221	10,898
	July	987	-	463	14,752	16,202
	Aug.	85,631	143,143	388,168	462,346	1,079,288
	Sept.	194,958	163,626	191,731	186,074	736,389
	Oct.	229,207	153,865	227,948	188,058	799,078
	Nov.	150,754	6,000	12,443	41,567	210,764
	Dec.	53,088	-	-	-	53,088
TOTAL		745,497	466,653	822,370	897,947	2,932,467

Figure 1. Map of Galveston Bay System



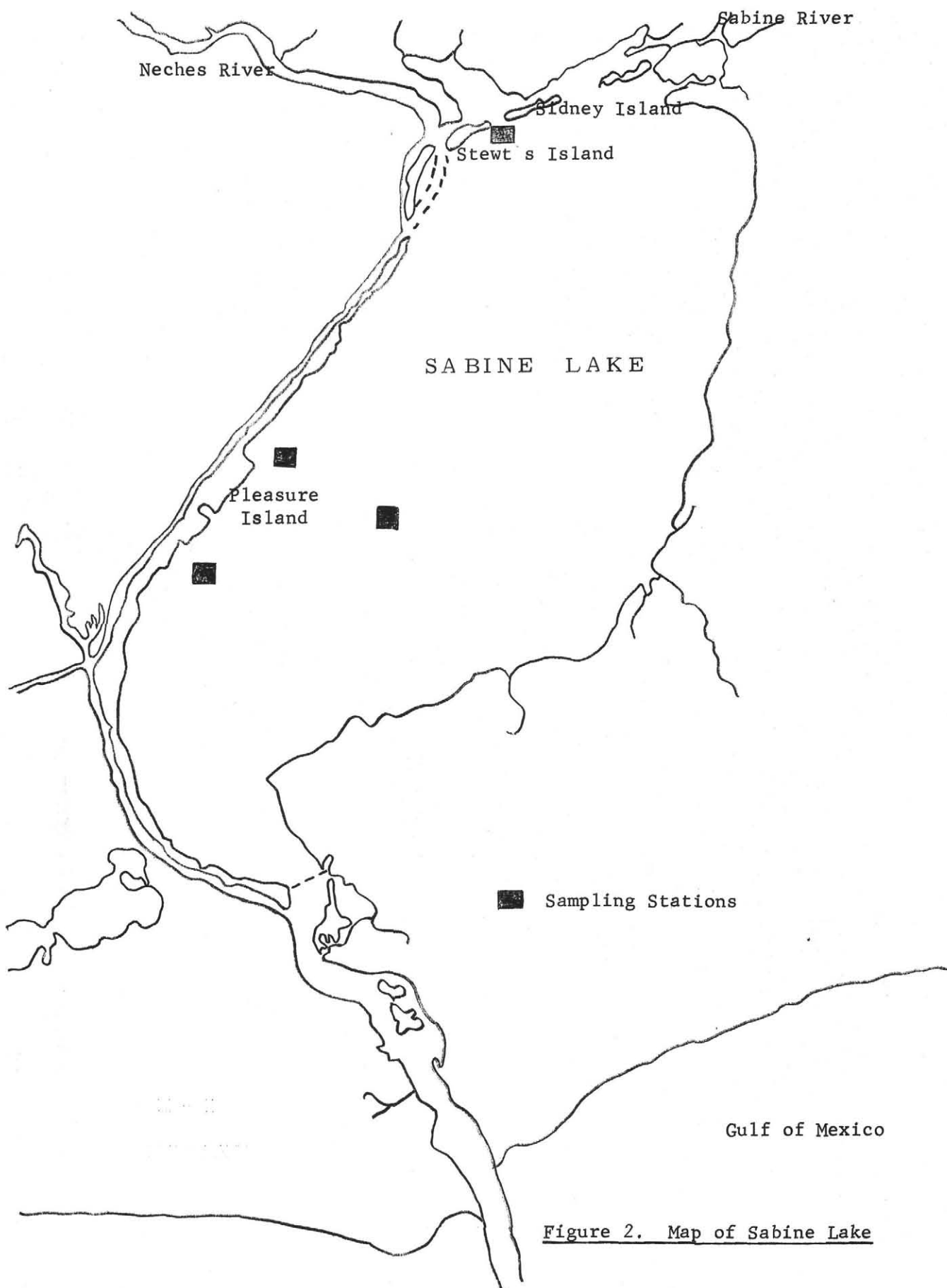


Figure 2. Map of Sabine Lake

Figure 3. Semi-monthly catch per effort deviations based on shrimp trawl samples collected in Clear Lake in 1963 from corresponding data collected in 1962.

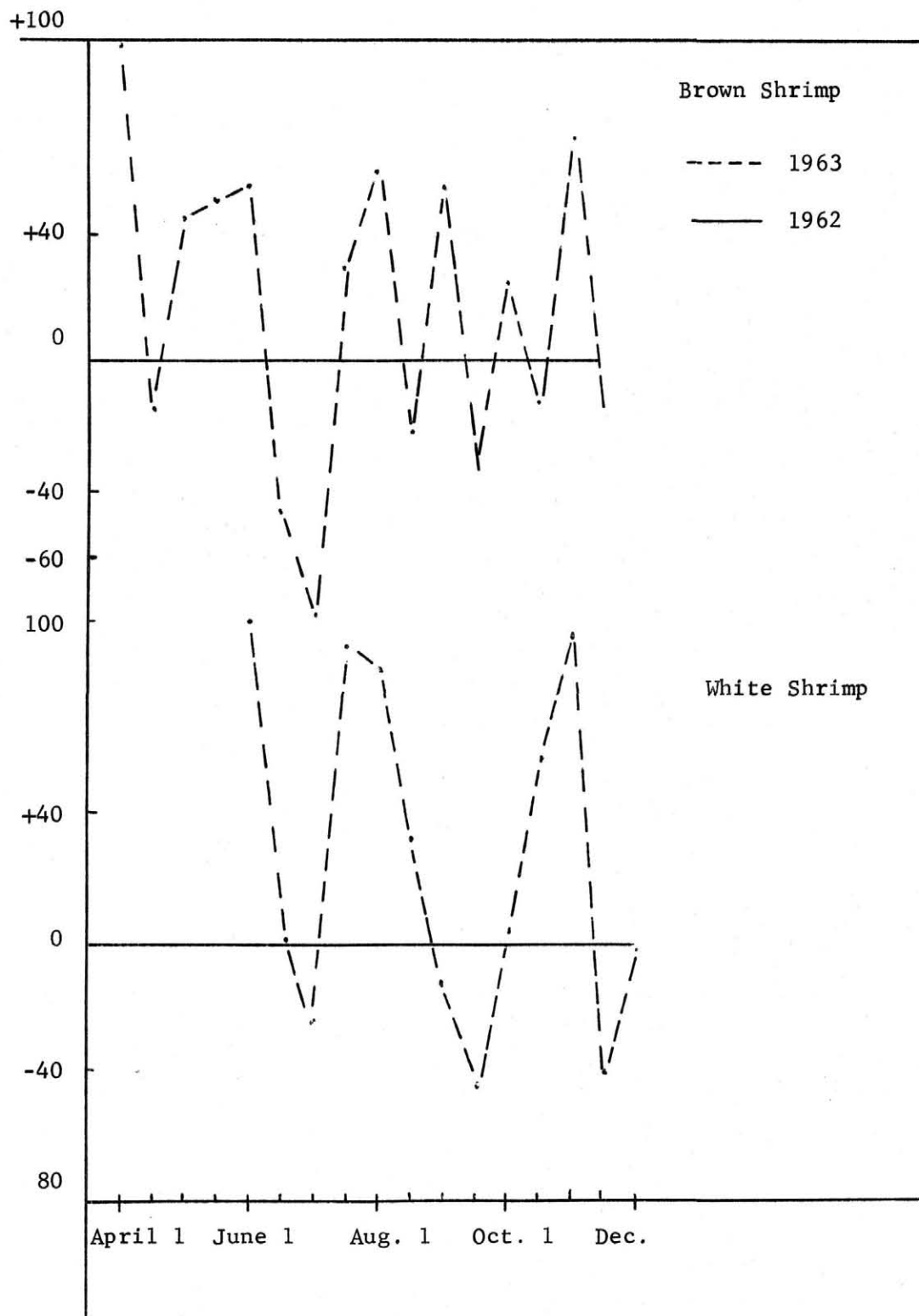




Figure 4. Comparison of sizes of shrimp caught by ten foot trawl in Clear Lake. Broken lines represent a second sample collected immediately after the routine (solid line) sample.

August 29, 1963

White Shrimp

— N = 42  
- - N = 99

Brown Shrimp

— N = 47  
- - N = 29

September 13, 1963

— N = 71  
- - N = 1--

— N = 72  
- - N = 34

October 2, 1963

— N = 78  
- - N = 57

— N = 36  
- - N = 21

October 29, 1963

— N = 270  
- -

— N = 12  
- - N = 10

No of Shrimp

Total Length (CM)

Figure 5. Commercial shrimp landings (spp. combined) reported from Galveston, Port Arthur and Sabine Pass.

