A Study of the Texas Shrimp Populations

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A Study of Commercial Shrimps in Coastal Bays of Texas

ABSTRACT

In spring, many brown shrimp, Penaeus aztecus, nursery grounds were adversely affected when fresh water inflow lowered salinities. Brown shrimp abundance trends were relatively high in Aransas and Corpus Christi bays, but low in other bays.

White shrimp, P. setiferus, were scarce in summer. In fall they were abundant in Sabine Lake and Galveston Bay.

Commercial brown shrimp production was high; white shrimp production was low. Total production (43.1 million pounds, headless) decreased 4.6 million pounds from 1965.

Factors which influence brown shrimp survival, growth, and average emigration size are discussed.

INTRODUCTION

In 1966 about 43.7 million pounds of shrimp tails were landed in Texas. Brown (Penaeus aztecus), white (P. setiferus) and pink shrimp (P. duorarum) were the principal species.

For management purposes, surveys are conducted in coastal bays to determine migrational patterns, growth rates, seasonal abundance and the habitat of each commercial shrimp year class. These factors vary with changes in bay environments; therefore, the survey findings are needed to make recommendations that will improve annual production.

Results of each survey are published (Leary and Compton 1960; Compton 1962; Pullen 1963; Moffett 1964; 1965; 1966). The present program was expanded to include studies of shrimp habitat near the Aransas Wildlife Refuge Area and winter-spring pink shrimp stocks in the upper Laguna Madre. This report reviews the 1966 survey.

MATERIALS and METHODS

Shrimp nursery grounds were sampled with 6-foot bar-seines (1/2 inch stretch mesh). A standard sample was the catch in one 500 foot drag. Nursery areas of Corpus Christi Bay were sampled with a 10-foot trawl. Those of the upper Laguna Madre were sampled with a 60-foot minnow seine.

Shrimp in open bay areas were sampled with 10-foot trawls of 1/4 inch stretch mesh, lined with 1/2 inch stretch mesh webbing. The standard sample interval was 15 minutes.

intensity at stations used in past surveys. Therefore data collected in 1966 were comparable to data from earlier surveys. Stations added in 1966 were not used in the analyses; however, reference is made to these data when appropriate.

In Sabine Lake, samples were collected semi-monthly. Samples in Galveston, Matagorda, San Antonio, Aransas and Corpus Christi Bays were taken weekly in spring, then semi-monthly in other months. Collections in the Laguna Madre were made semi-monthly from March 1 through June 15 and from September 1 through December 1.

Captured shrimp were identified, measured to the nearest millimeter (tip of rostrum to tip of telson), counted and weighed. If all shrimp caught could not be measured or if short tows were made, the number of shrimp was equated to the standard sample.

In fall, state biologists boarded commercial bay trawlers to sample unculled shrimp catches. The shrimp were identified, measured and weighed. Pounds of shrimp aboard, time spent fishing, and catch composition were recorded. Shrimp available to the fishery in San Antonio and Aransas Bays were sampled with 20-foot trawls (1 1/2 inch stretch mesh).

Records of water temperature, salinity, wind velocity, wind direction and turbidity were kept.

Size distribution graphs* were drawn for each species by date, bay type and bay system. Size modes selected from the graphs by the method of Leary and Compton (1960) are presented (Figures 2 through 5).

Growth rates, when measurable, were determined by the method of Williams (1955), where growth was estimated by using the differences between the largest shrimp in periodic samples. The estimates refer to growth before emigration.

Catch per effort values (averaged number of shrimp per sample) by date, bay type, bay system and species (1964 through 1966) are tabulated (Tables 1 through 4). Data collected in seasons when shrimp were scarce are not included.

Reference to shrimp lengths are modal lengths unless otherwise stated.

RESULTS

Biological Samples

Figure 6 and 7 presents average monthly sample catches for the year 1964 through 1966. The 1966 brown shrimp data indicate a downward abundance trend in upper coastal bays (Sabine Lake through San Antonio Bay). Samples from the lower coast (Aransas Bay through the Laguna Madre) suggest increased abundance.** White shrimp catch rates were low along the entire coast in summer, but increased on the upper coast in fall.

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* Size distribution graphs not included to save space.

** The abundance increase was evident in Aransas and Corpus Christi Bay only. Samples from the Laguna Madre were low.

Sabine Lake: One major shrimp wave was observed. The young (13 to 33 mm) were plentiful in the upper lake when first captured on April 22 (Figure 2). In May when floods and rainfall reduced cumulative salinities below 1 ppt, shrimp avoided the upper lake. By June 20, salinities were 11.7 ppt near the Cameron Causeway where migrant shrimp (53 to 83 mm) were abundant. They grew about 1.2 mm per day and most had left before August 1.

Another group of shrimp (28 to 38 mm) was present at nursery areas on July 18, but they were not abundant.

The seasonal abundance trend, although difficult to determine due to abnormal distribution, indicated a decline from 1965 (Table 1). Juvenile shrimp were more widely distributed in 1965.

Galveston Bay: Shrimp (19 to 33 mm) appeared at nursery areas on April 1 (Figure 2). In April higher than normal tides flooded peripheral marshes and increased nursery space. The young shrimp became scattered throughout the flooded areas. Results of bar-seine sampling were, therefore, a poor measure of abundance.

Trinity River flooding began in late April. Samples from Trinity Bay on May 2 indicated that shrimp (28 to 38 mm) were leaving the affected nursery areas. Upper bays, including important nursery grounds of Trinity Bay and Clear Lake, remained nearly fresh throughout May. Few shrimp were found in these areas, but dense concentrations became established in saltier lower bays. Shrimp in East Bay ranged from 32 to 95 mm long on May 27. Growth was estimated at 1.0 mm per day.

An offshore shrimp movement (size range 60 to 80 mm) began shortly after mid-May, but lasted only two days (Chapman, personal communication). The first 1966 year-class brown shrimp appeared in commercial catches from the shallow Gulf on May 27 and were abundant in catches during the last two days of May (Farley, personal communication). Bureau of Commercial Fisheries Biologists detected a steady offshore emigration on June 1.

A second shrimp group (18 mm) appeared at nursery areas in early May. A third (23 to 38 mm) was found in mid-September (Figure 2).

Catch per effort values were reduced from those of 1964 and 1965. The greatest decline was observed in Clear Lake (Table 1).

Matagorda Bay: Postlarvae (13 to 23 mm) were abundant at nursery areas on April 1 (Figure 2). Sample catch rates were greatly reduced in late April (Table 1) when rainfall lowered salinities near shore. The young, apparently, moved to deeper water. They appeared at secondary bay stations on May 1 (23 to 42 mm) and at primary bay stations in late May (73 to 83 mm). Their growth was estimated at 1.4 mm per day.

Emigration began on May 27 when shrimpers first caught juvenile brown shrimp outside Pass Cavallo (Farley, personal communication). Juveniles were common in samples from the bay through July 15.

Other shrimp waves were not found, but recruitment was continuous and new groups appeared in late May (23 mm) and in fall (18 to 43 mm).

San Antonio Bay: Juvenile shrimp grew approximately 1.5 mm per day. They appeared in early April, but were not taken in abundance before May (Table 1). Specimens (53 to 93 mm) were plentiful at primary bay stations on May 20 and

and June 1 (Figure 2). Emigration was in progress by June 1 and continued, at least, through mid-July. Other shrimp groups were not evident in succeeding samples but recruitment was continuous.

During spring Guadalupe Bay was not suitable brown shrimp habitat. Low salinities resulted when excessive fresh water entered from the Guadalupe River and rainfall was heavy.

Aransas Bay: In 1966 juvenile shrimp were abundant. They grew about 1.4 mm per day.

The young (13 to 20 mm) were plentiful at nursery areas in April and May (Table 2). They were found consistently on flats along the east shore of Live Oak Peninsula and from Fulton to South Beach. Those captured in smaller bays, e.g., Port Mission and St. Charles, were slightly larger.

Emigration began on May 27 when the first 1966 year-class brown shrimp (about 80 mm long) were caught by Gulf shrimpers just outside Cedar Bayou Cut and Port Aransas (Farley, personal communication). At the same time, shrimp (53 to 93 mm) were abundant at primary bay stations (Figure 3). The sample from Marker #19 contained 1,414 shrimp.

Heavy recruitment continued and another shrimp wave (23 mm) was found in September. Apparently these grew 2 mm per day and began leaving in early October.

The Aransas Wildlife Refuge Area shore is excellent nursery habitat. Small brown shrimp were present through December 15. Abundance peaks were observed on April 28 (23 to 43 mm), June 19 (19 mm) and September 1 (18 mm).

Corpus Christi Bay: Although brown shrimp catch per effort values were moderate in April, samples in May indicated an abundance increase over 1964 and 1965.

The shrimp (12 to 30 mm long at detection) grew about 1.2 mm per day (Figure 3). During spring, rains (14.74 inches) reduced salinities to 5.6 ppt in back bays. Salinities in Corpus Christi Bay ranged from 26 to 28.6 ppt.

Late in May, when the offshore movement began, shrimp (23 to 78 mm) were abundant in Redfish Bay (Table 2).

Upper Laguna Madre: Juvenile shrimp grew approximately 1.3 mm per day and by mid-May many were 70 to 80 mm long, especially near the Land Cut. Emigration probably began in late May before they were 98 mm long. By mid-June sample catch rates were reduced (Table 2).

Although rains, 12.7 inches, reduced salinities in this usually hypersaline area to about 32.2 ppt in May, brown shrimp catch per effort values declined from those of 1965 (Table 2).

Lower Laguna Madre: Catch per effort values, based on sampling data, were low in 1965 (Table 2).

Shrimp (23 to 25 mm) appeared in early April and grew about 1.0 mm per day (Figure 3). Sampling near Port Mansfield and Three Islands indicated that postlarvae had entered at Mansfield and Brazos Santiago Passes. Heavy spring run-off and high tides apparently affected the distribution of shrimp since sample sizes were greatly reduced by mid-May. In late May the only

dense shrimp concentration found was near Port Mansfield.

Shrimpers first caught small brown shrimp in the nearby Gulf on May 27, but some (33 to 58 mm) were caught in biological samples in 4 fathoms on May 20.

White Shrimp

Sabine Lake: Shrimp were abundant near Cameron Causeway in April. Thes may have been members of a large group fished commerically in December, 1965 (Moffett 1966). Their size (63 to 83 mm) indicated that winter growth had been inhibited.

The first 1966 year-class shrimp (73 to 83 mm) were captured on July 6 (Figure 4). Like 1965, sample catch per effort values were low in summer (Table 3). In October, a large wave (28 to 68 mm) was detected. These grew about 1.1 mm per day.

Emigration was evident in fall when the lake cooled. Apparently the rat of migration was heaviest in early December (following a late November "north when the catch per effort at primary stations was 1,158 shrimp (58 to 98 mm). They were still abundant on December 15, but few were caught in January, 196 when the water temperature was 10°C (Table 3).

Galveston Bay: Postlarvae were found entering the bay in late May (Baxt personal communication). Consequently, young shrimp were not found at bay stations until July 1.

Their seasonal abundance pattern was similar to that in Sabine Lake. Th were scarce in summer (Table 3) although some large concentrations were fou (one sample of 2,203 shrimp, 24 to 30 mm, was taken in July in Jones Lake). In September a second wave was detected at bar-seine stations (23 mm). They grew about 1.2 mm per day. Small juveniles of this group were abundant in Jones and Moses Lake. Larger juveniles (53 to 93 mm) were numerous in Clear Lake during fall (Figure 4) and moved off-shore in late fall.

On October 9, when the area was under hurricane warning, the Moses Lake-Galveston Bay tidal pass was intentionally closed. Numerous white shrimp we land-locked. The pass was reopened to 36 feet on October 15 and will remain this way until hurricane locks are built. Apparently the shrimp in Moses Lak were not greatly affected.

Shrimp mortality occurred during a mid-December cold spell. State Biologist W. R. More found stunned and dead shrimp along the Moses Lake shor on December 13. The water temperature, probably lower when shrimp died, was 7°C at 11 AM. He counted 3 dead brown shrimp (size range, 40 to 53 mm) and 12 dead white shrimp (size range, 62 to 93 mm) in one 50 foot section of sho line. Other shrimp kills due to cold have been reported by Gunter (1941). Gunter and Hildebrand (1951), Lunz (1959), and Joyce (1965).

Matagorda Bay: In 1966 catch per effort values were below those of 196 and 1965. Two shrimp groups were found. Both appeared to be small. The first was detected in early June, (13 to 38 mm) and their growth was estimat at 1.6 mm per day. The second appeared at tertiary bay stations in August, (18 to 33 mm) and reached a peak of abundance on October 1, (23 to 43 mm). Recruitment was continuous during fall but few were caught at trawl stations after the start of the bay shrimping season on August 15 (Table 3).

San Antonio Bay: Catch per effort values were reduced from those of 19

at the Swan Point trawl station on July 1. In July and August they grew about 1.3 mm per day (Figure 4).

Aransas Bay: The Aransas Wildlife Refuge Area shoreline also served as an important white shrimp nursery ground. Abundance peaks were observed on June 16 (8 to 28 mm), September 1 (8 to 33 mm), and October 19 (29 to 33 mm).

Although sampling was interrupted, catch per effort values indicated increased abundance over 1964 and 1965 (Table 4). Shrimp (60 to 80 mm) were common in Copano Bay in August (Figure 5).

Corpus Christi Bay: Shrimp (65 to 163 mm) were present in the spring. 1966 year-class shrimp (43 to 53 mm) were fairly common in Oso and Nueces Bays by late July (Figure 5). On August 15 a large shrimp wave (38 to 98 mm) was detected in Neuces Bay when samples contained, on the average, 1,019 shrimp (Table 4). Few were caught in September.

Sampling was also interrupted in this bay, but the available catch per effort values indicated decreased abundance from 1964 and 1965 (Table 4).

Lower Laguna Madre: White shrimp were captured at Arroyo Colorado stations in the spring, but they were not abundant.

In the fall white shrimp (13 to 53 mm) were present, but catch per effort values were below those of 1964 and 1965 (Table 4).

Pink shrimp

Sampling at night in the upper Laguna Madre produced small catches of pink shrimp in April. This phase of the project began late (due to lack of personnel) after most of the fall-winter pink shrimp had migrated. In October small grooved shrimp, probably pink shrimp, were present (40 to 50 mm). By mid-November they were 60 to 65 mm long.

In the lower Laguna Madre pink shrimp (70 to 90 mm) were abundant at Mansfield Pass on March 21. Not many were taken after mid-May.

Gulf of Mexico

Brown shrimp (68 to 123 mm) were caught in samples from the shallow Gulf in early May, but were not found in abundance until late May (63 to 133 mm). On May 27, shrimpers first caught 1966 year-class brown shrimp near most Gulf passes. Brown shrimp remained abundant in the shallow Gulf through June (63 to 133 mm), but were scarce by August.

In winter, white shrimp (83 to 133 mm) were fairly common out to 10 fathoms off Port Aransas and were present in 18 to 20 fathoms in fall.

Size of shrimp caught commercially in bays

White shrimp sizes, based on limited data, available to fishermen are shown in Figure 8. In Galveston Bay they were below legal size (65 tail count) when the season began on August 15. Shrimp 130 to 150 mm were dominant in August catches. A large portion of shrimp sampled in Matagorda and Corpus Christi Bays were legal size in August.

White shrimp dominated fall catches. The data from Aransas Bay in September, when brown shrimp outnumbered white shrimp, were exceptions (Table 5).

Commercial Fishery

Shrimp production statistics were not complete, therefore, references to 1966 landings are preliminary (Table 6).

The 1966 shrimp catch of 43.7 million pounds, heads-off, dropped 4.6 million pounds from 1965 and 0.3 million pounds from 1963. There was, however a 2.1 million pound increase over 1964.

Bay shrimping was poor. Brown shrimp catches were low at the start of the spring season (May 15) but increased in late May. Landings decreased in Matagorda and Galveston Bays from 1965, while those from San Antonio and Aransas Bay showed an increase.

Gulf shrimp landings through August were low. This was attributed to sub-par brown shrimp production from upper coastal bays, low white shrimp production from all bays and a drop in pink shrimp landings from Campeche.

Due to poor white shrimp catches in bays, the number of Gulf fishing units increased. Brown shrimp landings rose in September and (excluding October when unsettled weather hampered fishing) remained high during fall. Best catches were made SE of Galveston to Port Isabel.

Commercial - sample shrimp catch relationships

Results of shrimp sampling and Texas shrimp production for 1964, 1965 and 1966 are presented (Figure 9). To fit the sample catch curves, I divided the total number of shrimp caught on the first of the month by the number of samples (bar seine and 10 foot trawl samples combined); the fifteenth of the month data were treated in the same way. The first and fifteenth averaged values were totaled, but not divided. Commercial landings were extracted from Shrimp Landings.*

The sample-commercial production relationship for brown shrimp agrees. In 1964 samples and landings were relatively small. In contrast, shrimp were abundant in samples and production was excellent in 1965. The production catch curve for 1966 is incomplete.

The 1965 and 1966 white shrimp abundance peaks in biological samples occurred in the fall. This, apparently, had an adverse affect on landings. In 1964, when shrimp were abundant in summer, the catch was large.

DISCUSSION

Brown shrimp

As a result of spring floods and heavy rainfall, important brown shrimp nursery areas were not fully utilized in spring. This was especially appare in upper coastal estuaries where countless small brown shrimp left low

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* Shrimp Landings, South Atlantic and Gulf States, 1964-1966. U.S. Department of Interior, Fish and Wildlife Service, Bureau of Commercial Fisheri Washington, D.C.

emigration did not start until late May. The abundance of small brown shrimp in Aransas and Redfish Bays (on the lower coast) in late May and in Sabine Lake and Galveston Bay in late June were indicative of a long migration time interval.

Commercial shrimp production, which was low in summer, increased in fall. This trend was not evident in data from upper coastal bays nor in the Laguna Madre where brown shrimp samples were relatively small. Those from Aransas and Corpus Christi Bays were indicative of high abundance. I believe this production increase in fall resulted from greater fishing pressure in the Gulf, good fishing weather, and continuous recruitment to the fished population. A large portion of the fishable stock probably emerged from Aransas and Corpus Bays where large concentrations of juveniles had been found earlier.

White shrimp

Low white shrimp production from bays was probably the primary factor that prevented the total 1966 shrimp catch from surpassing that of 1965. Samples from all bays in summer were indicative of low abundance. The large waves of small white shrimp that appeared in Sabine Lake and Galveston Bay late in the season will contribute to the 1967 catch if conditions are suitable for survival and growth.

Management Implications

Postlarvae ingression: A good brown shrimp season is likely if postlarvae are abundant and the ingression peak is late. Differences in the timing of shrimp cycles are common and probably caused by ecological changes. St. Amant, Broom and Ford (1966) report that in Louisiana a small postlarval brown shrimp peak may develop into a maximum population if they enter estuaries when water temperatures are 18 to 20°C or higher; whereas a small year-class may result from a large postlarval peak if they enter when temperatures are low. Postlarvae growth and survival rates are low when water temperatures are below 18°C. Slow growing shrimp that enter early are exposed to larger predators for a longer time than those that enter when bays are warmer. St. Amant, Broom and Ford (1966) offer this as a possible explanation for low 1964 shrimp production in Louisiana and Mississippi.

Growth rate variation: Brown shrimp growth rate variation poses a problem when adjusting the 45 day closed Gulf season in the spring. The Shrimp Research Committee (1966) report:

"Water temperatures below 20°C (68°F) greatly inhibit the rate of growth to a point where it becomes practically nil at 16°C. Conversely, growth rates are extremely rapid above 20°C and that of juveniles may exceed 1.5 mm per day at 25°C."

Usually brown shrimp growth rates will be slow in Texas bays in April and rapid in May. In the cold spring of 1964, this was evident in Galveston Bay when brown shrimp growth was delayed in April. However, the bays warmed in May and they reached "emigration" size by June (Moffett, 1965).

Emigration: Shrimp have a tendency to emigrate at a smaller average size if juvenile abundance is high (Shrimp Biological Research Committee, 1966). The reason for this is not known. Overcrowding, which results in keener competition, may cause them to leave at a small size. If crowding

occurs in nursery areas and bays, the possibility of large numbers of small shrimp appearing in the Gulf should be an important management consideration.

Excessive flooding may force small brown shrimp from nursery areas, but will not necessarily cause premature offshore migrations. I do not know how normal emigration patterns would have changed if the amount of fresh wate inflow exceeded that of the 1966 spring. For the past three years, however, brown shrimp migration has begun in late May-early June regardless of shrimp size, position of shrimp in bays and bay ecology.

First harvest size: There is no apparent relationship between the numbe of adult shrimp and resultant year-class abundance. Therefore, the present amount of fishing is not endangering shrimp populations. Annual yields, however, may be reduced if shrimp below optimum (first harvest size) size are harvested.

Preliminary findings at the Bureau of Commercial Fisheries, Galveston, Texas show that fishing to get maximum yield should begin when brown shrimp a 100 to 45 tail count. Highest value will be reached if fishing starts when they are 100 to 28 tail count. Fishing should begin on white shrimp when the are 40 to 25 or 65 to 30 tail count depending on fishing intensity. Work is progress at Galveston to refine these sizes and usable information should be available soon (Shrimp Biological Committee, 1966).

COMMENTS

(1) Flexible seasons are needed to use new research findings. Discarding small shrimp at sea can be greatly reduced if shrimping can be restricte to seasons and areas (depths) where a large portion of the fished population is utilizable.

(2) Keeping the shoreline of the Aransas Wildlife Refuge Area in it's natura state will benefit the fishery. This area's importance as a nursery ground for penaeid shrimp is obvious. Continued sampling should produce comparable information for management purposes, including catch-predict

(3) Some information is now available on the winter-spring pink shrimp stocl important to the bait fishery of the upper Laguna Madre. Continued samp through winter months is needed before findings can be adequately discu This work is in progress.

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Table 1: Average number brown shrimp per sample (catch per effort) by sampling date (Sabine Lake through Matagorda Bay).

Date		Tertiary Bays 1964	1965	1966	Secondary Bays 1964	1965	1966	Primary Bays 1964	1965	1966
					SABINE LAKE					
April	1	0	0	0	0	0	0	0	0	0
	15	0	0	9	0	15	261	0	24	0
May	1	2	61	160	0	234	21	0	-	51
	15	4	21	0	0	51	0	25	194	178
June	1	6	36	4	303	624	0	133	872	18
	15	40	-	0	519	51	18	59	211	439
July	1	5	0	3	60	33	78	51	24	145
	15	7	0	5	21	9	60	13	12	44
					GALVESTON BAY					
April	1	0	24	33	0	0	0	0	0	0
	8	55	15	35						
	15	132	109	47	0	7	8	0	42	0
	23	133	184	58	0	15	1	-	9	2
May	1	104	186	125	139	137	12			
	8	-	218	115	-	138	7	-	-	16
	15	114	219	177	187	210	3			
	23	-	37	101	-	179	3	-	340	5
June	1	22	14	118	431	230	74	242	107	100
	15	10	17	63	107	290	85	34	92	325
July	1	15	29	33	54	51	37	24	166	64
	15	18	9	12	27	56	12	27	35	39
					MATAGORDA BAY					
April	1	0	0	28	0	2	0	0	0	0
	8	69	2	284	0	0	0	0	0	0
	15	96	44	141	1	8	0	0	0	2
	23	126	107	60						
May	1	171	238	63	63	14	38	5	7	2
	8									
	15	133	173	37	54	-	52	8	-	6
	23	-	123	52	-	121	23	-	43	27
June	1	76	50	112	22	362	91	19	388	58
	15	25	37	66	15	347	18	38	221	35
July	1	12	13	31	36	187	65	110	7	4
	15	9	30	38	11	33	74	22	5	18

Table 2: Average number of brown shrimp per sample (catch per effort) by sampling date (San Antonio Bay through Lower Laguna Madre).

		Tertiary Bays			Secondary Bays			Primary Bays		
		1964	1965	1966	1964	1965	1966	1964	1965	1966
SAN ANTONIO BAY										
April	1				2	1	3	2	8	0
	8	-	0	6						
	15	10	2	6	0	1	4			
	23	-	40	1	-	-	3	-	-	1
May	8	-	36	59	-	-	17	-	-	7
	15	16	26	58	66	120	88	128	98	163
	23	-	-	21						
June	1	7	49	28	92	168	100	384	143	183
	15				125	13	32	118	183	10
July	1	8	55	17	69	37	39	12	29	7
	15				31	24	35	47	10	4
ARANSAS PASS										
April	1	11	1	85	-	-	0	-	-	0
	15	94	47	326	1	-	6			
May	1	186	19	197	6	58	47	2	25	2
	8				-	-	9	-	-	14
	15	150	67	214	10	191	217	2	101	23
June	1	104	65	212	5	27	81	41	55	1149
	15	45	28	201						
CORPUS CHRISTI BAY										
April	1	15	-	0	15	-	0	7	-	0
	8	1	29	10						
	15	0	8	22						
May	1	12	15	3	12	15	1	11	23	7
	8	-	94	127	-	150	8	-	41	44
	15	90	17	12	105	10	200	67	20	5
	23	-	27	10	-	15	950	-	27	61
June	1	57	84	149	15	24	2325	153	51	181
	15	4	7	66	0	316	43	4	235	34
UPPER LAGUNA MADRE										
April	15	1	5	0	0	194	0			
May	1	55	5	29	2	96	59			
	15	43	96	93	1	842	139			
June	1	57	279	52						
LOWER LAGUNA MADRE										
April	1	758	123	103	0	5	56			
	15	121	331	131	14	340	63			
May	1	222	473	92	-	116	25			
	15	184	208	37	350	1300	41			
June	1	91	172	38	147	367	165			
	15	86	295	39	113	201	167			

Table 3: Average number of white shrimp per sample (catch per effort) by sampling date (Sabine Lake through Matagorda Bay).

Date		Tertiary Bays 1964	1965	1966	Secondary Bays 1964	1965	1966	Primary Bays 1964	1965	1966
					SABINE LAKE					
June	1	0	0	0	0	3	0	0	11	0
	15	18	-	0	480	9	0	0	2	0
July	1	10	0	0	609	4	0	2	0	1
	15	3	0	0	12	0	0	1	0	2
Aug.	1	12	0	1	-	0	0	1	0	0
	15	0	0	0				1	0	4
Sept.	15				3	12	78	50	24	1
Oct.	1	283	47	25	-	24	129	56	181	1
	15	7	1	81	105	66	66	1	49	98
Nov.	1	24	127	126	30	18	168	87	75	215
	15	29	35	142	33	192	825	72	382	176
Dec.	1	0	0	1	96	27	327	1	12	1158
	15				-	-	390	-	-	181
					GALVESTON BAY					
June	1	5	0	0	12	0	0	1	1	1
	15	12	3	0	38	7	0	0	0	1
July	1	87	11	4	88	31	23	12	8	1
	15	85	24	8	120	43	60	28	18	2
Aug.	1	64	9	10	63	15	16	19	27	12
	15	56	29	7	54	10	7	9	0	3
Sept.	1	32	408	29	33	16	18	4	1	4
	15	74	369	63	34	6	69	3	0	6
Oct.	1	36	128	157	27	38	568	2	5	43
	15	4	283	46	6	111	428	0	7	38
Nov.	1	17	283	193	32	111	565	1	0	15
	15	26	95	8	70	127	453	2	3	81
Dec.	1	5	52	5	76	137	224	6	15	51
	15	-	8	1	-	-	185	-	-	27
					MATAGORDA BAY					
June	1	280	2	0	0	0	0	0	0	1
	15	143	24	3	38	231	1	0	0	0
July	1	478	43	61	23	68	260	5	0	0
	15	292	118	46	77	284	94	7	0	1
Aug.	1	148	64	136	34	280	25	10	0	8
	15	119	28	73	430	317	92	3	0	2
Sept.	1	65	17	43	27	61	1	0	-	0
	15	384	26	108	16	-	0	0	0	0
Oct.	1	-	64	308	-	3	15	-	0	2
	15				10	2	3			
Nov.	1	20	13	99	7	2	20	0	0	10
	15	73	11	35	20	3	4	3	0	2
Dec.	1	7	14	41						

Table 4: Average number of white shrimp per sample (catch per effort) by sampling date (San Antonio Bay through Lower Laguna Madre).

Date		Tertiary Bays 1964	1965	1966	Secondary Bays 1964	1965	1966	Primary Bays 1964	1965	196
					SAN ANTONIO BAY					
June	15	8	0	0	0	0	0	0	3	
July	1	41	7	0	16	79	6	3	57	
	15	62	55	29	27	34	10	53	41	
Aug.	1	33	8	22	25	28	13	51	26	
	15	376	16	37	24	66	21	66	24	1
Sept.	1	10	94	13	1	153	10	19	24	
	15	10	59	9	1	53	1	17	30	
Oct.	1	6	258	17	1	74	6	4	30	
	15	-	45	11	-	12	11	-	3	
Nov.	1	41	127	0	3	5	12	4	3	
	15	9	3	105	9	9	7	15	1	
					ARANSAS BAY					
Aug.	1	11	6	4	51	-	41	0	0	4
	15	0	1	0	40	0	126	0	0	
Sept.	1	9	7	0	0	1	4	0	-	
	15	4	0	3	0	-	19	1	0	
Oct.	1	1	-	39				1	0	
	15	3	0	101				0	1	
					CORPUS CHRISTI BAY					
July	15	7	146	183	5	0	0	112	0	
Aug.	1	106	226	63	5	270	0	146	140	
	15	92	279	1019	0	278	0	140	215	
Sept.	1	126	107	197	6	142	35	176	121	
	15	172	32	79	3	45	0	114	33	
Oct.	1	236	27	73				5	31	
Nov.	15				3	10	0	1	3	
Dec.	1	2	2	67	1	5	0	1	2	
					LOWER LAGUNA MADRE					
June	1	4	6	0	0	0	0			
	15	474	28	11	20	23	12			
July	1	564	173	1	20	63	24			
Sept.	1	159	96	2	8	1	13			
	15	138	124	16	1	0	6			
Oct.	1	128	26	9	0	-	5			
	15	41	28	3	-	0	5			
Nov.	1	119	11	8	3	1	0			
	15	23	10	5	0	-	7			
Dec.	1	0	-	42	0	-	3			

Table 4: Pounds (X1000) and Value X1000 dollars) of headless brown and white shrimp landed in Texas Ports (1964-1966).

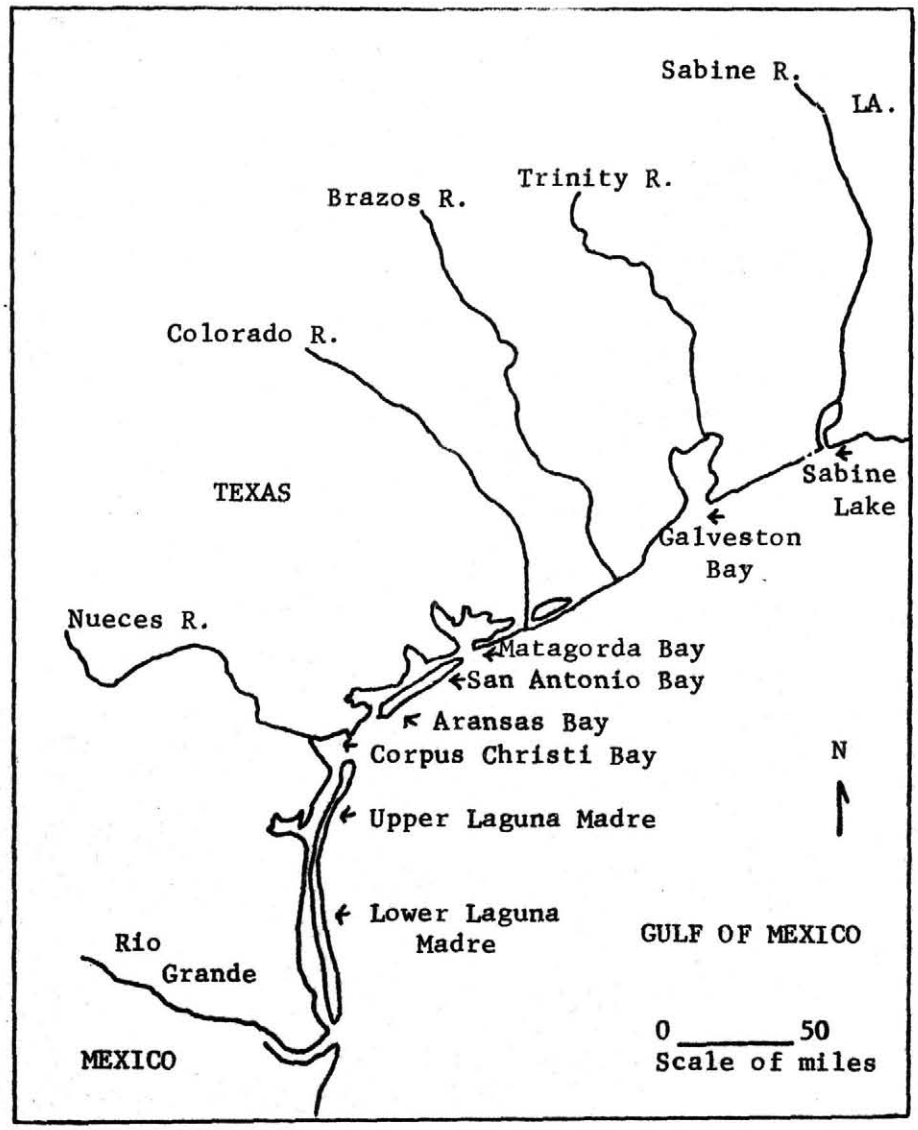
	BROWN SHRIMP						WHITE SHRIMP					
	1964		1965		1966		1964		1965		1966	
Month	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
Jan.	1,000	705	729	601	1,108	904	358	239	169	127	284	158
Feb.	751	510	394	302	700	600	45	26	289	160	288	149
Mar.	868	613	553	449	742	703	219	95	281	170	587	407
Apr.	763	571	711	592	875	881	366	189	375	282	245	207
May	1,103	722	1,036	663	1,013	913	756	538	390	310	937	942
June	2,094	1,033	2,132	956	2,007	1,546	518	413	693	564	474	491
July	5,570	2,868	6,816	3,482	5,851	4,477	382	256	394	305	339	361
Aug.	4,673	2,988	7,024	4,323	6,369	5,682	1,968	226	1,065	504	746	538
Sept.	3,757	2,526	5,392	3,626	6,455	6,254	2,625	1,457	1,421	781	1,027	873
Oct.	2,834	2,163	3,782	2,758	3,834	3,742	2,521	1,549	2,117	1,393	1,559	1,347
Nov.	1,631	1,313	3,687	2,825	2,834	2,618	1,807	1,127	1,555	858	935	655
Dec.	884	726	2,077	1,650	2,161	1,997	522	358	491	238	431	253
TOTAL	25,928	16,739	34,336	22,227	33,948	30,316	12,089	7,173	9,240	5,693	7,852	6,383

Source: Shrimp Landings, U. S. Department of Interior, Fish and Wildlife Service, Bureau Comm. Fish., Washington, D. C.

Table 5: Shrimp catch composition in Texas Bays based on samples from unculled commercial catches, 1966 (data from San Antonio and Aransas Bays from 20-foot trawl data).

Bay	Brown Shrimp (August)	White Shrimp (August)	Brown Shrimp (September)	White Shrimp (September)	Brown Shrimp (October)	White Shrimp (October)	Brown Shrimp (November)	White Shrimp (November)
Galveston	30	70	33	67	5	95	2	98
Matagorda	3	97	4	96	-	-	-	-
San Antonio	16	84	5	95	0	100	-	-
Aransas	-	-	68	32	-	-	-	-
Corpus Christi	3	97	-	-	-	-	-	-

Figure 1: Bay systems sampled



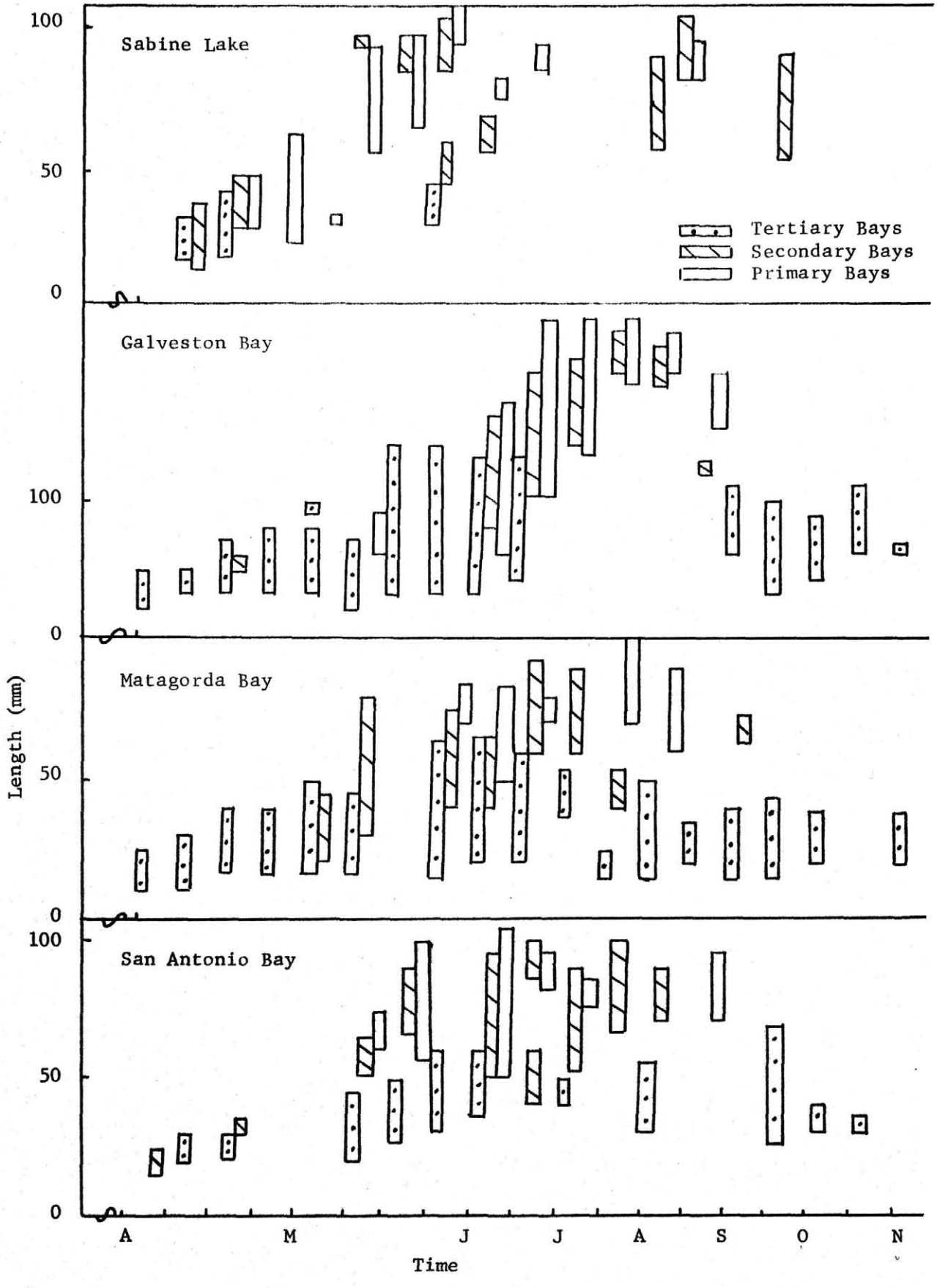
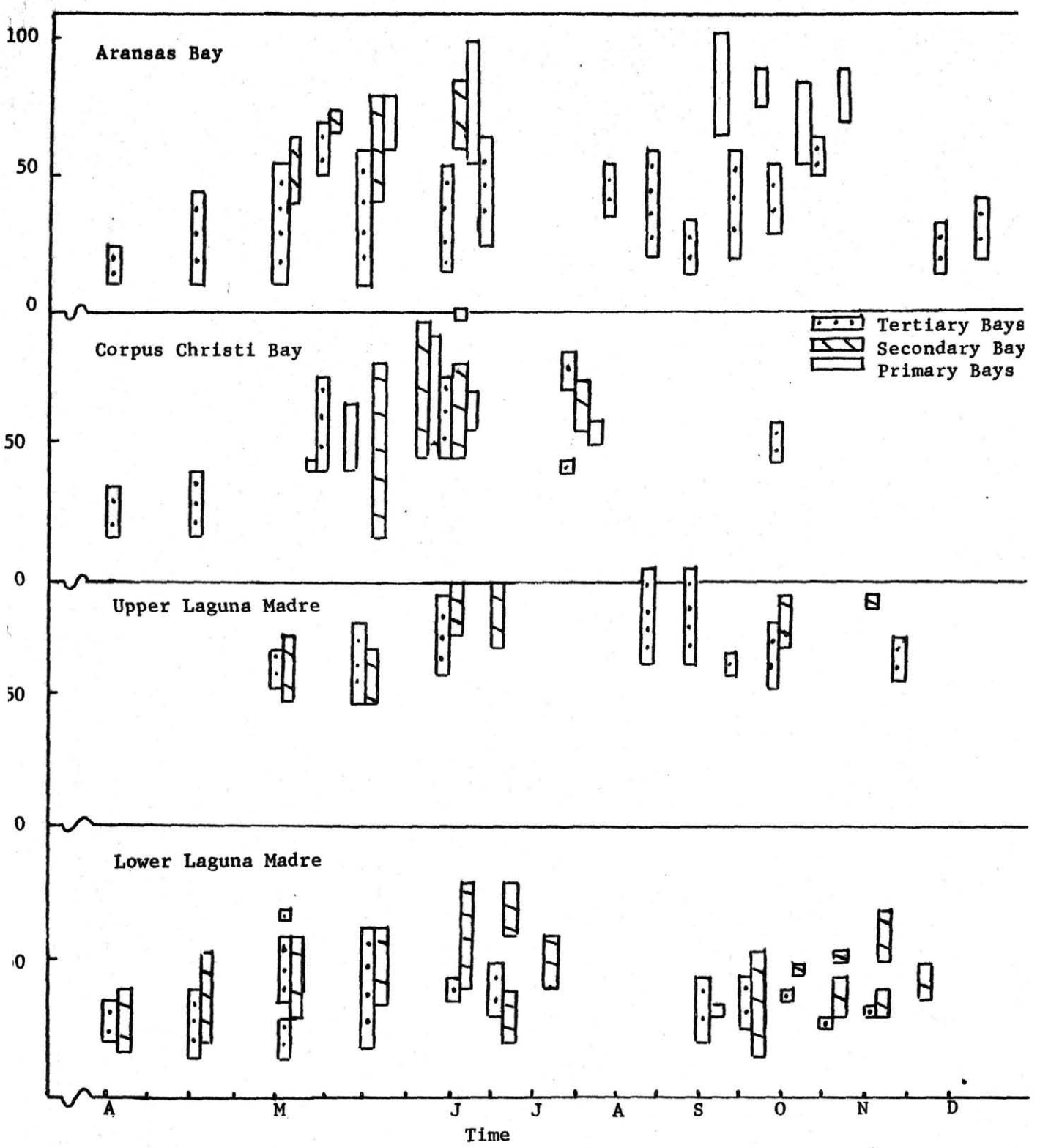


Figure 2: Brown shrimp modal lengths vrs time, based on 1966 samples (Sabine Lake through San Antonio Bay).



igure 3: Brown shrimp modal lengths vrs time, based on 1966 samples (Aransas Bay through Lower Laguna Madre).

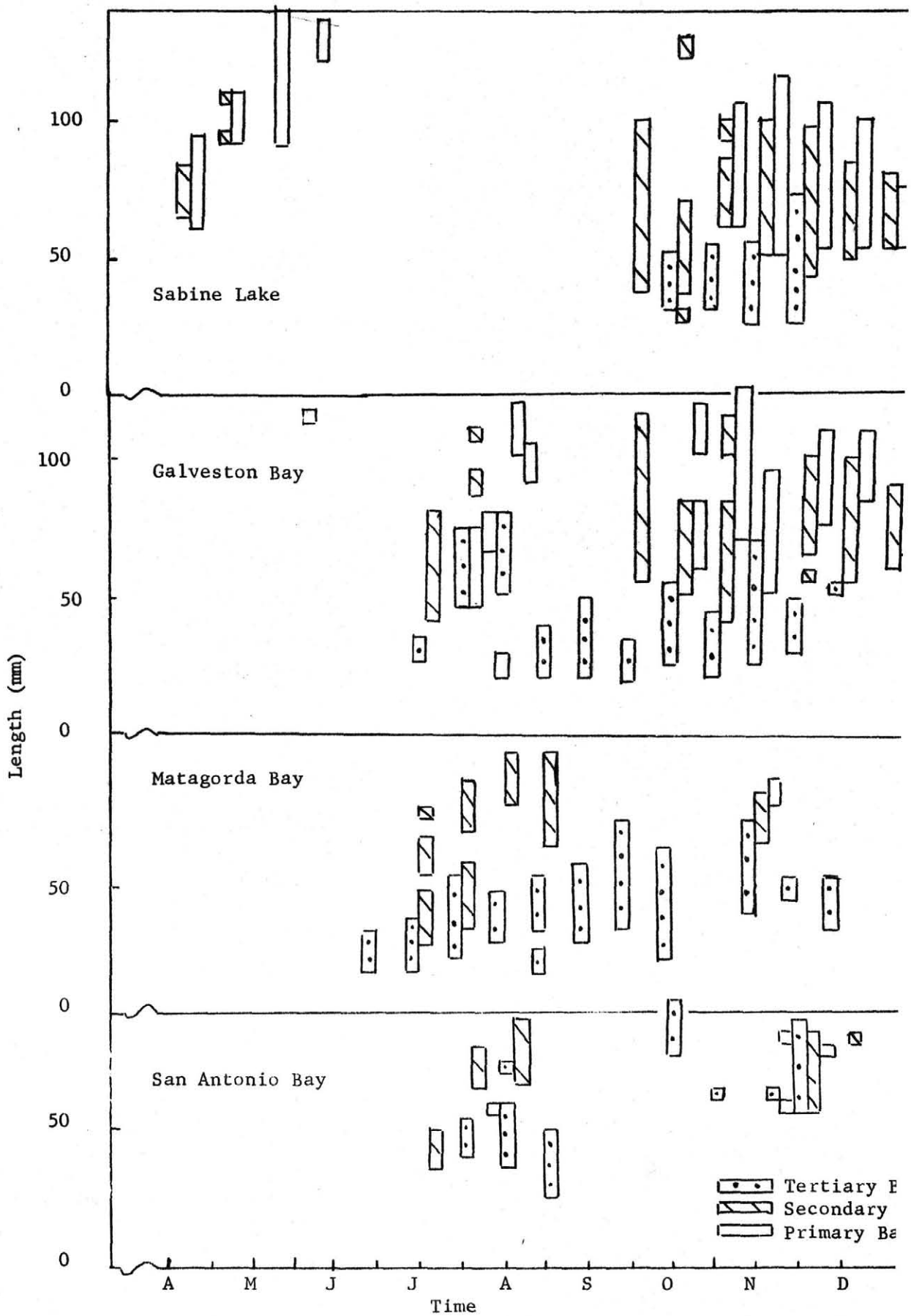


Figure 4: White shrimp modal lengths, based on 1966 samples (Sabine Lake through San Antinia Bay).

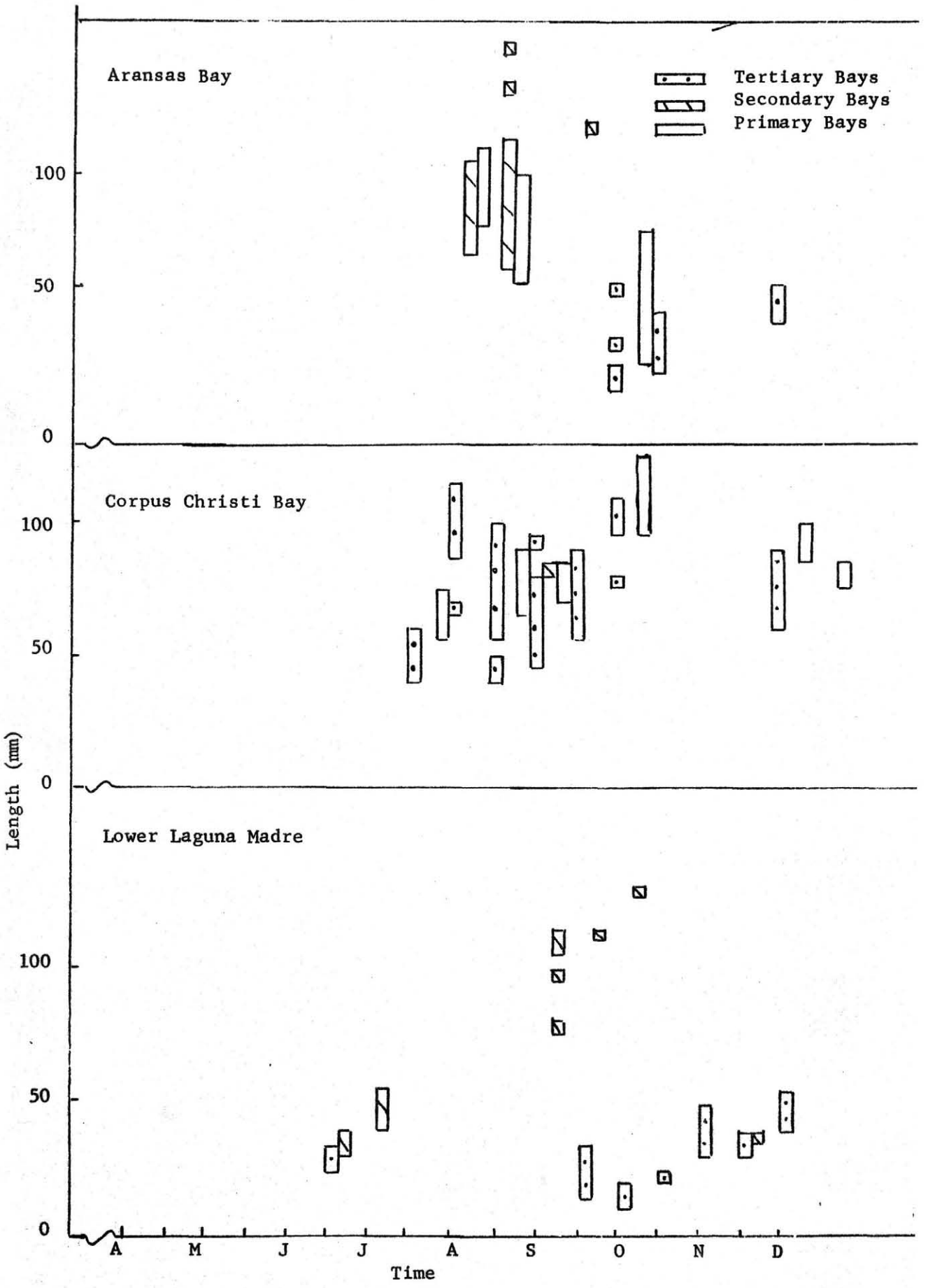


Figure 5: White shrimp modal lengths, based on 1966 samples (Aransas Ba through Lower Laguna Madre).

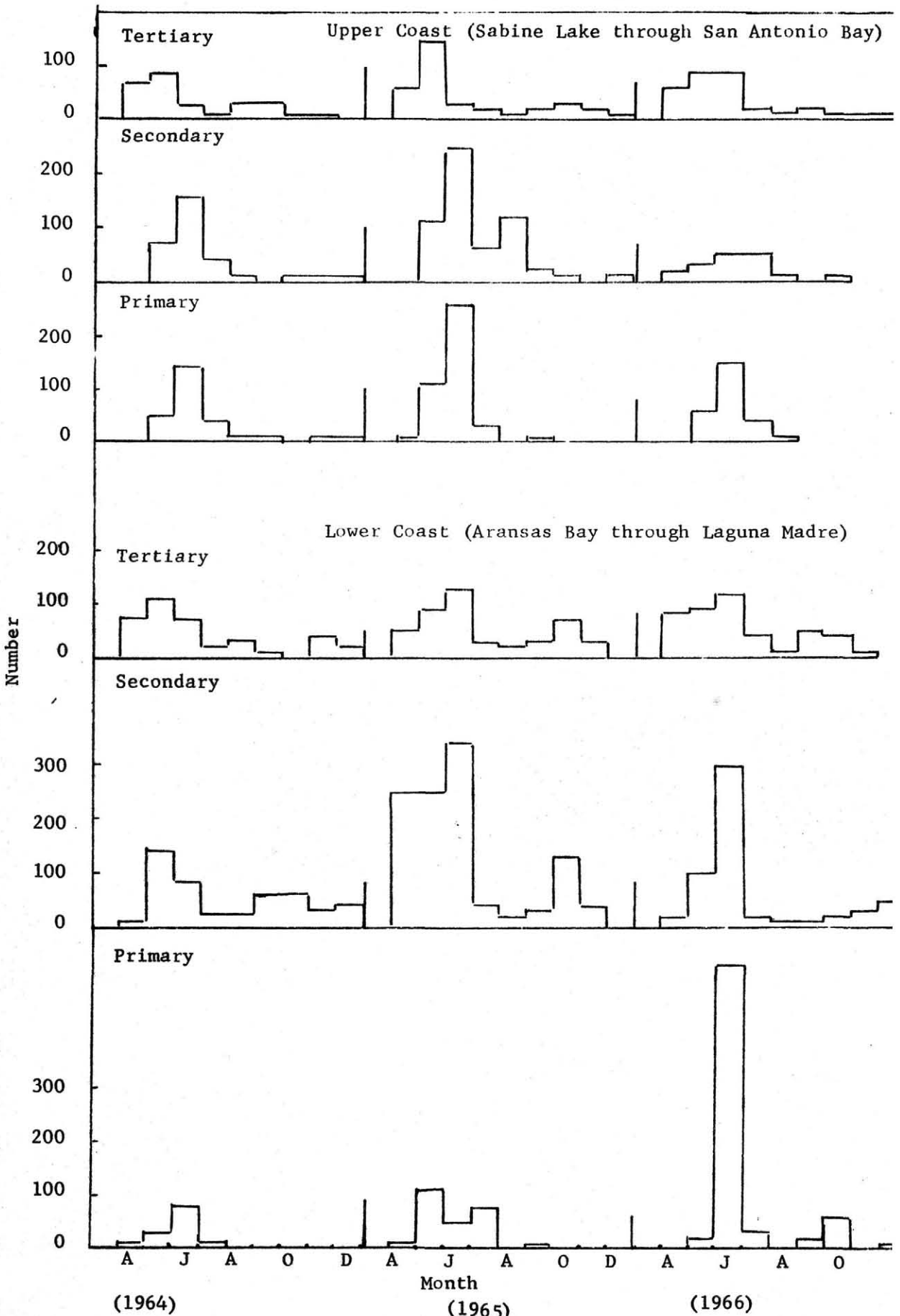


Figure 6: Brown shrimp catch per effort, based on sampling data (1964, 1965, 1966).

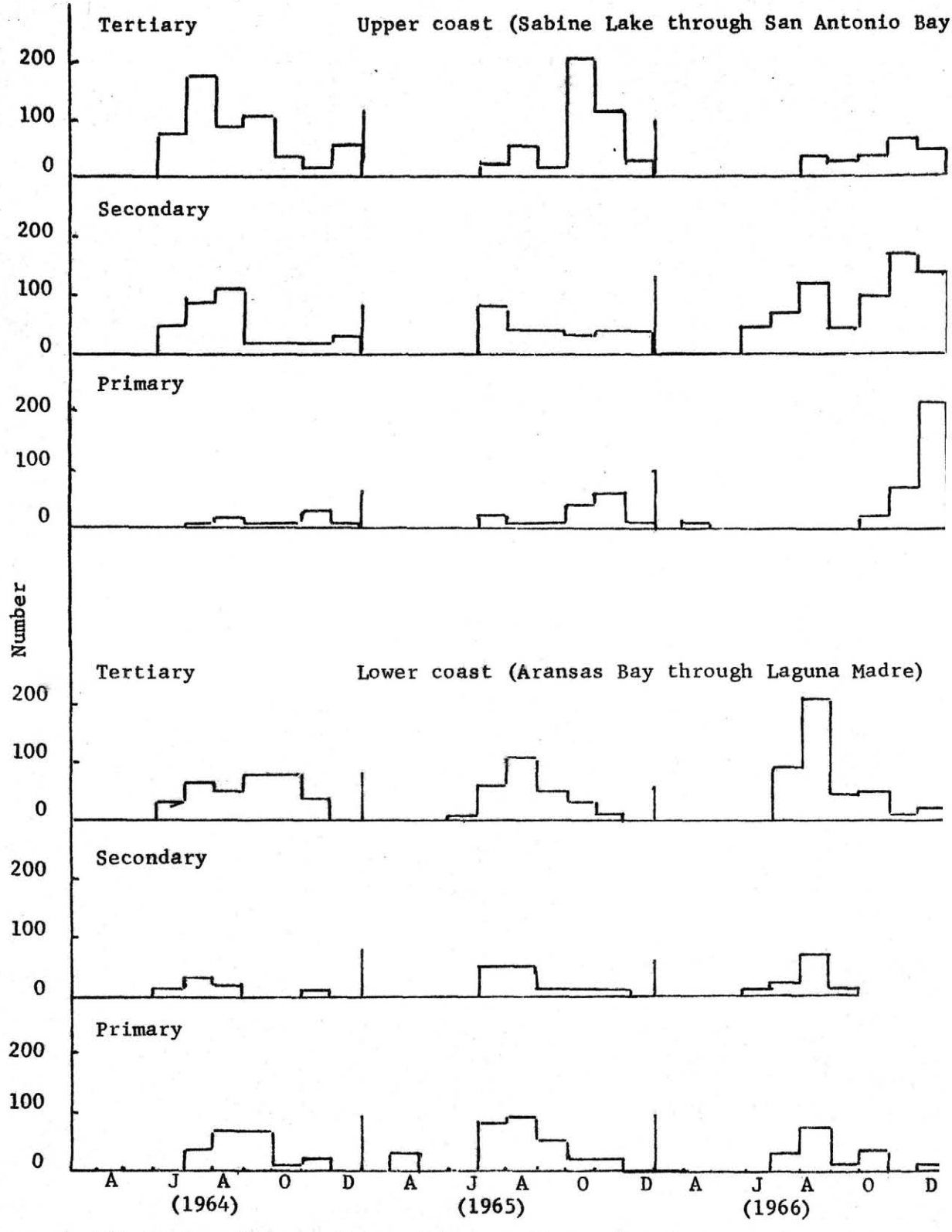
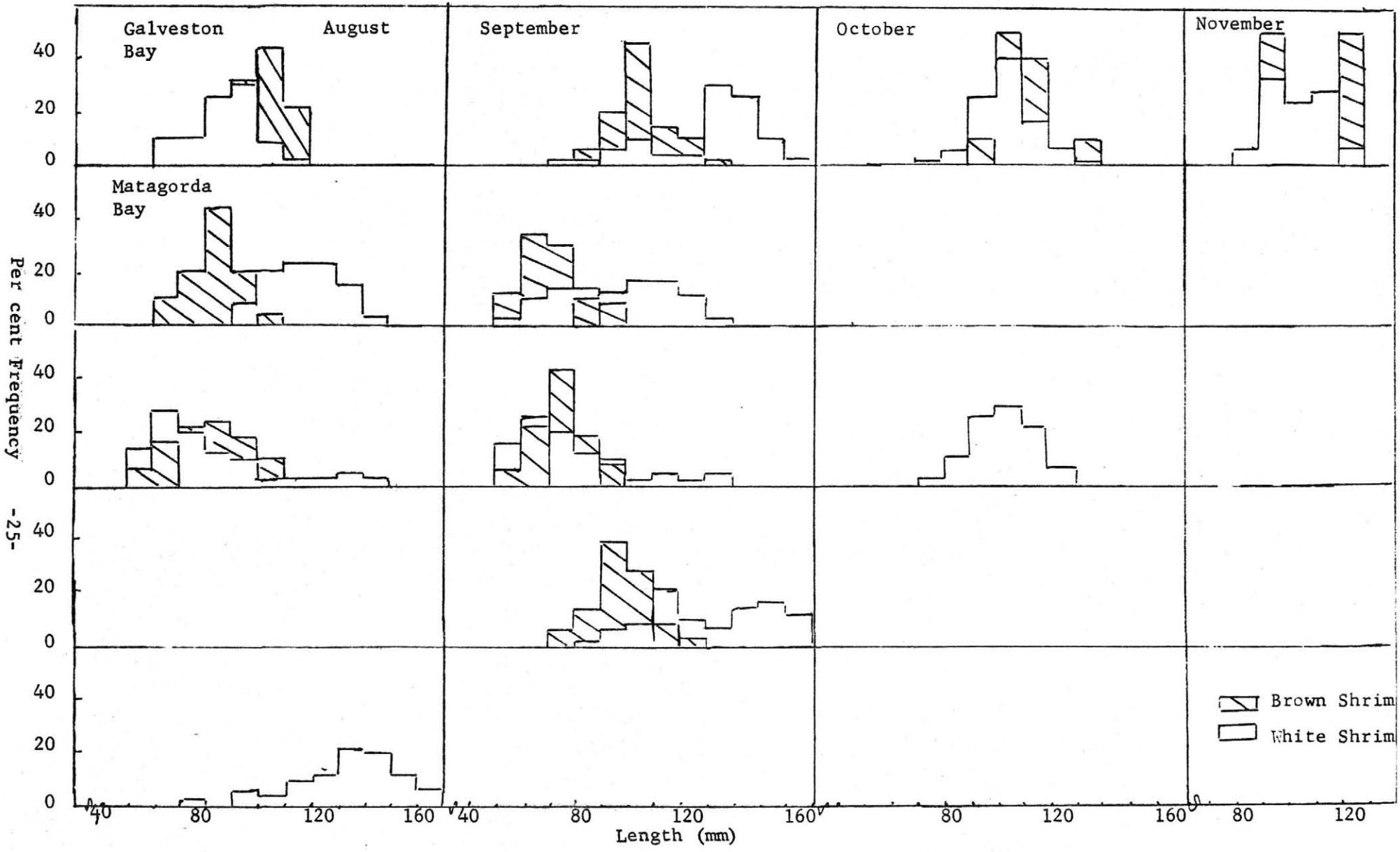


Figure 7: White shrimp catch per effort, based on sampling data (1964, 1965, 1966).

Figure 8: Per cent length frequencies of shrimp caught commercially in Texas Bays (1966).



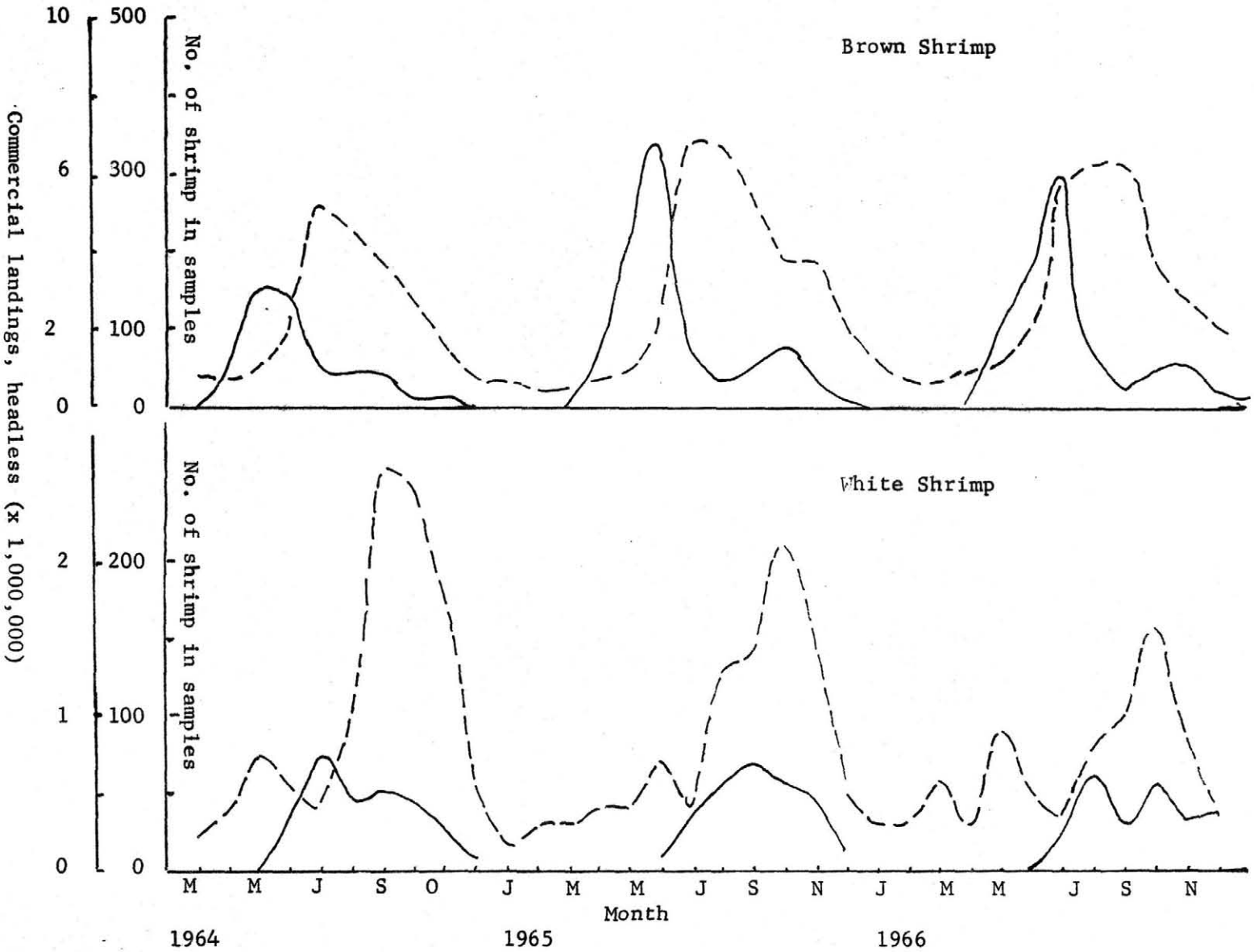


Figure 9: Commercial - sample shrimp catch relationships. Solid line represents sample catch, Broken line represents commerical catch