

## JOB REPORT

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A Study of the Texas Bay Populations of Juvenile Shrimp, Penaeus aztecus, Penaeus setiferus, and Penaeus duorarum.

Abstract: Plankton samples from the Aransas Bay area indicated that the postlarvae brown shrimp (Penaeus aztecus) immigration peak was reached in March.

Sampling in the bays revealed the presence of a large wave of brown shrimp in the spring. In the shallow tertiary bays and along the shore of large bays brown shrimp grew slowly in April and movement to the open waters of larger bays was delayed. As the waters warmed growth was rapid and the shrimp began their gulfward movement on schedule.

Samples taken in the inshore Gulf off the Lower Laguna Madre contained large numbers of brown shrimp in May. The samples from the Gulf off Port Aransas indicated that the majority of this species left the Aransas Bay area in June.

Shrimp samples from the bays indicated the presence of a large 1964 white shrimp year class. This was confirmed by large commercial catches in the late summer and early fall. Small white shrimp were found in the Gulf in September off the lower coast. In January this species was found in abundance off Port Aransas, but not off Galveston.

Brown shrimp commercial landings were somewhat disappointing, however, white shrimp landings were greater than landings reported in 1963

Objective: To analyze data collected during the year in nine bay areas along the Texas Coast and to compile an annual coastal shrimp report.

Introduction: The shrimp industry is the most valuable fishery of the Gulf states and a large percentage of the total landings are caught in Texas waters. Because of the importance of this fishery to the economy of the state, the Texas Parks and Wildlife Department has conducted investigations, annually, to determine sound management methods.

The investigations include shrimp sampling programs in all major bay systems on the Texas coast, and in the shallow Gulf of Mexico off the lower coast. In addition, postlarval shrimp are monitored as they enter some bays of the lower coast. The sampling results are used to estimate growth, seasonal abundance, emigration sizes, sizes of shrimp available to the fishery, and to predict abundance.

This report discusses the results of the 1964 sampling program.

Procedures: Postlarval penaeid shrimp were sampled weekly in the Aransas Bay area and monthly in the Port Mansfield/Port Isable area. The plankton samplers included a beam trawl with a 1 by 3 foot opening (a 6 foot bag of one mm mesh was attached), and a meter plankton net or "hoop net" of one mm mesh. The "hoop net" was used to collect "vertical" plankton samples by adjusting cable lengths to permit the net to fish 2 minutes on bottom, at mid-depth and near the surface. Beam trawl plankton samples were collected by towing the trawl on the bottom for 6 minutes. A flow meter, to measure the volume of water strained in cubic meters was mounted on the "hoop net". The plankton bar seine employed in the 1963 study (Moffett 1964) was not used. Postlarval shrimp in the samples were identified to genus, counted, and measured. The postlarval sampling methods were described in greater detail by Compton (1965).

Six foot bar-seines were used to sample shrimp in the shallow water tertiary bays and shoreline areas of larger bays. These nets could not be used in Corpus Christi Bay or the Upper Laguna Madre. The bar-seine consisted of a 6 foot wide bag-shaped net of 1/4 inch mesh. Usually samples were collected by pulling the net by hand, but, at some stations the net was pulled by skiff. The seine was towed for 500 feet to collect one sample. Secondary and primary bay stations were sampled with a 10-foot trawl of 1 1/4 inch stretched mesh lined with a 1/4 inch bar mesh liner. The duration of each drag was 15 minutes. All bay stations were sampled weekly in April and semi-monthly during the rest of the study period. Shrimp (in the bay samples) were identified, measured in mm (tip of rostrum to end of telson), counted and weighed. Occasionally, lack of time prevented measuring all shrimp in the samples and at times rough water and dense vegetation reduced trawling time. In such cases the number of shrimp caught were equated to the standard sample.

Shrimp in the shallow Gulf off Port Aransas, Texas and the lower coast were sampled with a 42 foot flat trawl of 2-inch stretched mesh. The duration of each Gulf trawl was 30 minutes. Gulf samples were taken weekly off Port Aransas and monthly off Port Mansfield and Port Isabel. Compton (1965) described the sampling materials and methods used in the Gulf study.

A 20-foot trawl was used to sample shrimp during the commercial bay shrimp season. The stretched mesh of the trawl was 1 1/2 inches. After sampling, a biologist boarded a commercial trawler in the area and measured a sub-sample of the catch. That night a second shrimp trawl sample was taken in the same area. Samples were collected by dragging the trawl for 15 minutes.\*

Bottom water temperatures, salinities, wind velocity, wind direction and turbidity were recorded for each sample.

Charts showing sampling stations in each area are shown in Figures 1 through 9.

Shrimp growth rates in this report were determined by following the progression of modal groups. These modes were selected from shrimp length frequency distributions. Waves of shrimp were selected by the inspection of the sample catch curves (Figures 10 through 24). Starting in the spring of 1963, bar-seine sampling time was changed to 500 feet. Since it takes about 5 minutes to cover this distance the number of shrimp in each sample was adjusted to equal the 15 minute time interval used in the 1962 investigation (Pullen 1963).

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\* These data have been covered well in the 1964 area reports. Due to the nature of the fishery sampling was not complete in all major bays and could not be discussed adequately on a coastwide basis. For this reason the data are not included.

### Findings:

Ingress of Postlarval Shrimp: Postlarval shrimp sampling was limited to the lower Texas Coast. In the Port Aransas area postlarval penaeids (probably brown shrimp, Penaeus aztecus) were first caught entering Aransas Bay on February 17 (12 mm long). Apparently the immigration peak was passed before April. In the Port Mansfield/Port Isabel area sampling was interrupted in March, however, large numbers of postlarvae were found in mid-April (Table 1). Brown shrimp postlarvae were reported in some areas of Galveston Bay on March 11, but the immigration peak was probably reached after mid-March (Commercial Fisheries Review, 1964).

A second group of postlarval shrimp was detected in early June in the Port Aransas Channel samples. These were presumed to be small white shrimp (P. setiferus).

The present investigation indicated an increased abundance of postlarvae in relation to samples collected during corresponding periods in 1962 and 1963 (Table 1). This change may reflect better sampling techniques instead of increased abundance.

### Bay Studies:

Figure 25 shows the 1963 and 1964 catch per unit of effort of brown and white shrimp based on biological samples taken from the bays. The monthly points were fitted using a method described by Pullen (1963) where: "The first of the month average samples for all bays were totaled and divided by the number of samples; the fifteenth of the month data were handled in the same manner. The first and the fifteenth figures were totaled, but not divided." In general the overall trend of the 1964 brown shrimp sample curve was similar to the 1963 curve in the spring, however, the 1964 catches dropped off sharply after May. The 1963 curve showed a more gradual downward trend.

The white shrimp sample curves indicated a large year-class in 1964 that reached a peak of abundance in the July samples.

#### Brown Shrimp (Penaeus aztecus)

Sabine Lake: Small juvenile brown shrimp were not found until early May. These shrimp were members of the single major wave, or group, that reached a peak of abundance in June (Figure 10). At that time the seaward movement began when the shrimp were about 83 mm long. After June, this species was not found in abundance, but limited recruitment took place throughout the sampling program.

Shrimp of the major wave grew an estimated 1.0 mm per day (May 1 - June 1). This estimate is rough since small shrimp continued to enter the samples population.

The 1963 shrimp data were not comparable to present data because sampling began late in the 1963 season.

Galveston Bay: Of the three waves of brown shrimp, that appeared in the bay system, the first was the largest and most valuable to the industry (Figure 4). Individuals of the first wave arrived at the tertiary bay stations before mid-April (less than 30 mm long). The small shrimp remained in the back bays and marshes throughout most of April and did not appear in the secondary bay samples until May 1.

Shrimp growth in April was abnormally slow. In May growth was rapid and

emigration to the Gulf began in early June when the shrimp were about 88 mm long. Shrimp growth (April 15 - June 1) was estimated at 1.4 mm per day. A large percentage of this growth took place in late April and May.

Two minor waves were detected in the fall at tertiary stations, however, these shrimp appeared in small numbers in the trawl samples and growth could not be estimated.

The number of shrimp taken in the spring samples was greater than those taken during the previous spring. After June the 1964 samples were smaller than the 1963 samples.

Matagorda Bay: Small brown shrimp appeared at the tertiary bay stations before mid-April (modal size 18 mm). Movement from the bay probably began about the 1st of June when the shrimp were 83-93 mm long. The seaward movement continued on a large scale through July 1 since this species was abundant in the samples from the primary bay in early July (Figure 12).

The growth of shrimp was slow in the early spring and fast in May. Shrimp growth was estimated at 1.0 mm per day (April 15 - June 15).

After July 1 samples indicated that the bay portion of the population remained at a low level.

During the past two years the spring shrimp samples have indicated a high brown shrimp abundance. In 1963 the tertiary samples remained high after June. This was not the case in 1964.

San Antonio Bay: A large wave of brown shrimp was observed in the spring, but after June sample catches were small (Figure 13). Although some may have left the bay before June the major movement began in early June when the shrimp were about 88 mm long.

The bar-seine was used in the spring to sample shoreline stations and shrimp were detected in mid-April at a modal length of 23 mm. Thus growth from mid-April to June 1 was estimated at 1.4 mm per day.

Aransas Bay: Small penaeid shrimp were found as early as April 1 at a modal size of 18 mm (Figure 14). There was some doubt concerning identification, however, the size of the shrimp and time of year strongly suggests that they were P. aztecus. Although this species was abundant in samples from tertiary bays the catch rates at the trawl stations were low. Apparently these shrimp began leaving the bay system in small numbers in May, but the majority left in June at a modal length of 73 mm. Growth was slow in April and rapid in May. A rough growth rate of 0.9 mm per day (April 1 - June 1) was estimated.

A second wave of shrimp appeared in the fall. These were reported as grooved shrimp and were probably a mixture of brown and pink shrimp (P. duorarum). For this reason the fall data were not used.

Gulf of Mexico: It was evident from samples taken off Port Mansfield and Port Isabel that many small brown shrimp had left the lower Laguna Madre in May and were available to the commercial fleet (Figure 26). Shrimp sampling off Port Aransas showed that undersized shrimp were present in the Gulf in May (Figure 27), however, the majority left Aransas and adjacent bays in June (Table 2).

Corpus Christi Bay: In March some large juvenile brown shrimp were reported, but it is doubtful that they belonged to the 1964 year-class. On April 15 small brown shrimp (modal length 53 mm) were taken in the back bays (Figure 15). Movement from the bay seemed to start in June (when shrimp were about 63 mm long) and shrimp were still leaving in mid-June when at a length of 93 mm. After this the samples indicated a sharp population drop off.



Upper Laguna: There is a lack of adequate nursery space that meets the habitat requirements of postlarval and juvenile shrimp in this region, therefore, proper samples for an investigation of this type are hard to collect. Dense vegetation prevents use of the bar seine (a 60 foot seine was used instead) and trawling is limited to selected areas.

Young brown shrimp appeared in the samples in April and recruitment to the population was continuous throughout the sampling period (Figure 16). Growth (although hard to trace) was estimated at 0.8 mm per day (May 1 through June 1).

Lower Laguna: This area served as an important nursery for brown and pink shrimp. Pink shrimp appeared in the samples (in relatively large numbers) in the spring and fall. Apparently, the large wave of shrimp detected in April were brown shrimp (Figure 17). A second group appeared in the August samples.

The estimated growth of shrimp of the first wave was 0.8 mm per day (April 1 through May 15). Evidently, emigration from the bay began in May when the shrimp were about 60 mm long since large concentrations of small brown shrimp (Table 2) were found in the shallow Gulf samples (Figure 26).

Small grooved shrimp (probably pink shrimp) were plentiful in samples taken during late fall.

#### White Shrimp (P. setiferus)

White shrimp remain in the bays longer than brown shrimp and the larger individuals are fished heavily. The fishing mortality in the major bays may tend to distort the actual size at emigration, however, most are well over 100 mm long when they leave the upper coastal bays and perhaps slightly smaller when they leave the southern bays. Marked white shrimp released in Galveston Bay in August 1963 did not demonstrate a seaward movement although returns were received through October and some had reached a size of 134 mm (Commercial Fisheries Review, 1964). During the colder months of late fall and winter there may be some emigration of small white shrimp from the bays.

Sabine Lake: There were two waves of white shrimp present in Sabine Lake (Figure 18). The first appeared in mid-June samples (20 to 60 mm long). There was a decline in the sample catch rates in mid-July, therefore, I assumed that some emigration took place earlier.

The shrimp grew about 1.3 mm per day before leaving the secondary station.

A second wave of shrimp, was detected during a "norther" in October at a modal length of 33 mm. These shrimp grew about 1.5 mm per day before leaving the bay in November when they were about 78 mm long. The magnitude of this fall wave was smaller than the fall white shrimp wave reported in 1963 by Moffett (1964).

Galveston Bay: There were at least three waves present. The first and largest appeared in early June when the shrimp were about 30 mm long (Figure 19). By mid-August these shrimp had reached legal size (65 tails per pound) and were ready to support the bay shrimp fishery.

Growth of these shrimp was estimated at 1.3 mm per day (June 1 - July 15).

A smaller group of shrimp was observed at tertiary stations in August (modal length 30 mm) and a third appeared in October (modal length 23 mm). Growth of the second group could not be traced. Some members of the third group were still present at the secondary station in December. Growth of shrimp in the third wave was estimated at 1.0 to 1.1 mm per day.

Matagorda Bay: The first of the 1964 white shrimp appeared in June at a modal length of 18 mm. This group was most abundant at trawl stations in mid-August (Figure 20). Growth of these shrimp (June 1 - July 1) was estimated at 1.3 mm per day.

A second, and apparently smaller, wave arrived in September. This was followed by a smaller group in November. In the fall few shrimp were taken at the trawl stations and growth of shrimp in the later waves could not be traced.

San Antonio Bay: Shrimp data from this area indicated that a small wave of white shrimp arrived in June at a modal length of 48 mm (Figure 21). This was followed by a larger wave that appeared in mid-August samples (modal length 43 mm).

Growth of shrimp of the first wave could not be traced. Shrimp of the second wave grew about 1.2 mm per day (August 15 - September 15).

Aransas Bay: Few white shrimp appeared in the samples; thus the data did not warrant lengthy comment (Figure 22). They appeared at tertiary bay stations on July 1 and were fairly abundant at secondary bay stations in August.

Emigration from the bay probably began sometime in September since the shallow Gulf trawl data included white shrimp less than 100 mm in length (Figure 27).

Gulf of Mexico: Excluding January samples, the numbers of white shrimp caught in the shallow Gulf samples off the lower coast were relatively small (Table 2), therefore, the data were weak. Most white shrimp (Figures 26 and 27) taken during spring and summer were well over legal size (65 tails per pound). In September undersized white shrimp were present in the inshore Gulf and movement from the bay systems was apparent. Small white shrimp were fairly abundant off Port Aransas in January, but not off Galveston (Figure 27). This suggested that the low water temperatures of the winter may have forced small white shrimp, in the Aransas Bay area, to seek warmer Gulf waters.

Corpus Christi Bay: The first wave of white shrimp appeared in the June 1 tertiary bay samples at a modal length of 48 mm (Figure 23). On August 15 this species was most abundant (modal length 113 mm) at primary bay stations. By October most of these shrimp had left.

Growth of shrimp of the first wave (June 15 - July 15) was estimated at 1.5 mm per day.

A second group appeared at the tertiary bay stations on September 15 (33-38 mm long) and left in November at 108 mm.

Upper Laguna Madre: Rounsefell (1964) reports that in the estuaries near the mouth of the Mississippi River the salinity preference of small juvenile white shrimp is somewhat obscure since they tend to avoid open waters. Despite this, the high salinities of the Upper Laguna Madre do not appear suitable for the survival of the young of this species. The few white shrimp caught in the samples may have immigrated from other bays.

Lower Laguna Madre: The first and largest white shrimp wave (Figure 24) was observed in early June (modal length 18 mm). These shrimp grew about 1.3 mm per day (June 15 - July 15). The data indicated that shrimp started moving out of the bay in mid-July, however, small white shrimp did not appear in the shallow Gulf trawl samples until September (Figure 26).

A second but smaller group appeared in the tertiary bays in September at a modal length of 58 mm and a trace of a third group appeared in late fall. Shrimp from these waves did not appear in abundance in trawl samples and most had left by December.

### Commercial Landings

The major portion of the Texas shrimp catch is composed of brown and white shrimp. Both catches and prices tend to fluctuate widely. Brown shrimp is the principle species and is fished heavily in the Gulf in depths of 15-25 fathoms. Most white shrimp are caught in 10 fathoms of water or less.

In the spring juvenile brown shrimp support a limited commercial bay fishery. During the past two years the largest catches have been made in Galveston Bay (Table 3). The total spring brown shrimp catch from the bays in 1964 exceeded the 1963 catch by 19 per cent, however, landings from San Antonio and Corpus Christi Bays declined (Table 3).

Although data on white shrimp caught in the bays in 1964 are preliminary the landings through October show a substantial increase over 1963 in all bays except Sabine Lake (Table 4). The largest catches (probably due to intensive fishing) were reported from Galveston Bay.

Tables 5, 6, and 7 show the monthly landings of brown, white and pink shrimp from 1960 through 1964 in pounds (heads off) and the value (in dollars) to the fisherman. These data represent total commercial landings in Texas regardless of where caught.

In 1963 over 31 million pounds of brown shrimp were landed (Table 5). This was the most successful catch since 1960 when nearly 38 million pounds were reported. In 1964, monthly landings through June exceeded those of the same period in 1963. After June the 1964 monthly landings were below the level set in 1963.

The large 1963 harvest did not increase the value of the catch to the fishermen (Table 5). Instead prices began dropping in August and reached a low ebb in October. Barry (1964) reports that the 1963 price drop may, in part, be due to the large catch of small shrimp in the spring off Louisiana.

The total 1964 white shrimp catch increased 35 per cent over 1963 (Table 6). The largest catches, during both years, (especially in 1963) were from the Galveston Bay area.

A large percentage of pink shrimp landed in Texas are caught off the Campeche Banks (M. Johnson, Personal Communication). This species does form an important part of the commercial catch and monthly landings from 1960 through 1964 are shown (Table 7).

The average catch per day fished by month, species and area is shown in Table 8 for the period 1960 through 1964. These data represent the apparent abundance of shrimp, however, local weather conditions and changes in fishing intensity may cause some bias. The increase in brown shrimp catch per day during summer months reflect the recruitment of a new year-class to the fishery and (in July) the end of the closed inshore Gulf season. The high brown shrimp landings along the coast indicates that the species and fishing pressure are well distributed. As a general rule the catch rates in the late fall tend to decline, off the upper coast, but remain high off the lower coast. Pullen (1963) suggested that this may represent a southward drift of the brown shrimp population along the Texas coast.

The white shrimp catch rates (Table 8) are greater off the upper coast where the less saline estuaries are found. When the fall bay season opens there is a sharp increase in the catch rates (at least off the upper coast).

### Discussion

The frequency of sampling postlarval penaeids was increased in 1964 in the Aransas Bay area, and more intensive sampling was conducted in the Port Mansfield/Port Isabel area. The results indicated the number of postlarval shrimp entering Aransas Bay exceeded the number found during the previous year. Caution should be used when interpreting these results since the ingress of postlarvae to the bays may be controlled by spring weather cycles (St. Amant, et al, 1963) and many other factors. In future investigations postlarval samples will be collected at several other Gulf passes. This should offer a more reliable understanding of changes in postlarvae abundance.

Each biologist increased the number of back bay and shoreline stations in 1964. These additional data were extremely valuable in determining the seasonal abundance and sizes of prerecruited shrimp groups. The tertiary bays seem to act as essential nursery grounds for the smaller juvenile white shrimp, while, small brown shrimp, apparently, use the shoreline of larger bays as well as tertiary bays (Commercial Fisheries Review, 1964). Shrimp of the first 1964 brown shrimp wave grew slowly in April and movement to open waters of large bays was delayed. Apparently this slow growth was the result of the slow spring warming of the bay waters. Similar results were reported from Mississippi and Alabama. \*This led biologists to believe that the slow growing brown shrimp would enter the Gulf after June 1 and the starting date of the closed inshore Gulf season was moved to mid-June. As the waters warmed in late April and May, shrimp growth in the bays was abnormally fast and emigration from the bays began on schedule. Thus the dates of the closed Gulf season, a mandatory 45 day period, were readjusted.

The shrimp growth rate estimates in this report are preliminary since they are based on length frequency data. The continuous recruitment of small shrimp to the population and the movement of larger juveniles from the bays may tend to present modes in the length-frequency data at a small size. This would result in underestimated growth rates. However, if the data are used in the same manner each year changes in growth rates from year to year should be apparent. Usually brown shrimp grow about 1.0 mm per day while in the bays. Several growth rates presented in this report may appear slightly faster than usual but growth had to be fast in May for the small shrimp to reach normal emigration size by June 1.

Brown shrimp usually leave the bays before they are 100 mm long. In the lower Laguna Madre shrimp apparently start leaving in May (possibly at a smaller size than shrimp of the upper coast) since large samples were collected in the shallow Gulf. A few browns were taken in the Gulf off Port Aransas in May, but did not appear in abundance until June.

White shrimp grow faster and leave the bays at a larger size. Groups of white shrimp (at least in Galveston) may remain in the bay until late winter and apparently leave or die when water temperatures reach certain limits. Chapman (1964) found a scarcity of white shrimp in Galveston Bay in late February of 1963 although small white shrimp were plentiful in mid-January. He believed that the shrimp either left the bay to escape low water temperatures or suffered heavy mortality. He suspected the latter since shrimp were observed stunned and apparently dying during a severe cold spell in January. His preliminary conclusion was that water temperatures as low as 9.0°C will affect the general physiology of these white shrimp and a sustained low of 4.0°C may be fatal.

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\* State Activities Summaries - May 1964. A report to the Commissioners of the Gulf States Marine Fisheries Commission.



Federal Biologist presented important management considerations, based on parameters of the shrimp populations (growth, natural mortality and fishing mortality) and the nature of the market that may provide a shrimp harvest close to the maximum sustaining yield. This information was offered at the October 1964 session of the Gulf States Marine Fisheries Commission at Brownsville, Texas. The count estimates (although preliminary and should be tested) indicate that the protection of small, but marketable shrimp is not biologically sound. The suggested headless count size were 45 to 100 for brown shrimp, 40 to 75 for white shrimp and 50 to 100 for pink shrimp. Brown shrimp can be harvested at 28 to 100 plus (tails per pound) without decreasing the value of the catch. This creates an economic problem since one phase of the industry may desire small shrimp and another, larger shrimp. Perhaps the solution is to select minimum legal sizes, within the optimum count ranges, that would satisfy all phases of the industry. Future management regulations of the shrimp stocks should be concentrated inside the bay systems and fishing season dates should be highly flexible, to allow bay shrimping when most shrimp sizes are within the optimum ranges.

#### Suggestions for Future Work

Twenty-foot trawls have been used in past studies to sample sizes of shrimp caught commercially by the bay shrimp fleet. These trawls tend to catch smaller shrimp than those of the commercial nets (Moffett, 1964). I suggest that sampling with the 20-foot trawl should be discontinued and shrimp should be measured directly from the commercial catches.

The 10-foot trawl does not catch adequate sample sizes of shrimp in several of the primary bays. When shrimp reach the major bays they are larger and faster swimmers and not as vulnerable to the small trawl. These small samples do not offer good growth information. One solution is to use larger trawls.

#### Summary:

1. Post-larval shrimp were sampled with a plankton "hoop-net" and beam trawl as they entered Aransas Bay and the Laguna Madre. The samples taken in 1964 produced more post-larvae than samples taken during the previous year. Apparently, peaks of brown shrimp immigration were reached in March.
2. Early samples of juvenile brown shrimp, collected with bar-seines and trawls, indicated the presence of a large group of shrimp in the bays, however, the catch rates dropped off sharply after May. White shrimp samples indicated the presence of a large year-class that reached a peak of abundance in July.
3. The growth of brown shrimp in April was relatively slow (probably due to low water temperatures) and movement for the back bays was delayed. As the waters warmed growth accelerated and emigration from the bays began on schedule.
4. Brown shrimp were found in the shallow Gulf off the lower Laguna Madre, in abundance, in May and off Port Aransas, in abundance, in June.
5. Small white shrimp were plentiful at bay sample stations in June.
6. The commercial production of brown shrimp caught in the bays was 19 per cent greater than the 1963 catch. The monthly white shrimp landings were higher in 1964 in all major bays except Sabine Lake.
7. Total brown shrimp landings were disappointing in 1964. White shrimp landings increased.

8. Preliminary studies on the dynamics of shrimp stocks by the U. S. Bureau of Commercial Fisheries show that brown shrimp as small as 100 tails per pound and white shrimp as small as 75 tails per pound may be harvested without decreasing total production or value.

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Table 1: Post-larval Penaeid shrimp caught off Port Aransas and Port Isabel/Mansfield (1962-64).

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Month	Type Net	No. Samples 1962	No. Postlarval 1962	No. Samples 1963	No. Postlarval 1963	No. Samples 1964	No. Postlarval 1964
January	Meter Plankton Net	0	-	1	0	0	-
February	Meter Plankton Net	0	-	1	0	3	254
	Beam Trawl	1	72	2	6	0	-
	Bar Seine	0	-	3	0	3	1
March	Meter Plankton Net	0	-	3	9	4	887
	Beam Trawl	1	140	2	28	7	144
	Bar Seine	2	165	4	22	-	-
April	Meter Plankton Net	0	-	3	414	4	1866
	Beam Trawl	2	9	3	23	5	281
	Bar Seine	1	0	4	11	-	-
May	Meter Plankton Net	0	-	2	11	-	-
	Beam Trawl	3	30	2	30	-	-
	Bar Seine	2	3	4	0	-	-
June	Meter Plankton Net	0	-	3	90	2	230
	Beam Trawl	0	-	3	2	2	5
	Bar Seine	0	-	3	1	-	-
July	Meter Plankton Net	0	-	0	-	4	230
	Beam Trawl	0	-	0	-	2	5
	Bar Seine	2	1	2	0	-	-
August	Meter Plankton Net	0	-	0	-	2	17
	Beam Trawl	0	-	0	-	-	-
	Bar Seine	0	-	4	0	-	-
September	Meter Plankton Net	2	24	0	-	5	466
	Beam Trawl	1	0	0	-	4	392
	Bar Seine	1	0	2	0	-	-
October	Meter Plankton Net	1	3	5	0	-	-
	Beam Trawl	2	9	4	0	-	-
	Bar Seine	1	1	0	-	-	-
November	Meter Plankton Net	1	80	3	0	-	-
	Beam Trawl	1	5	1	0	-	-
	Bar Seine	0	-	0	-	-	-
	TOTAL	24	64	542	647		



Table 2: Seasonal abundances of commercial shrimp based on biological samples collected in the inshore Gulf.

GULF OFF PORT ARANSAS

<u>Month</u>	<u>Brown Shrimp</u>	<u>White Shrimp</u>	<u>Pink Shrimp</u>	<u>No. Samples</u>
January	0	644	13	8
February	-	-	-	-
March	0	17	1	2
April	0	11	0	1
May	424	10	30	2
June	4,157	26	7	9
July	210	4	0	3
August	147	2	0	4
September	50	63	1	6
October	51	180	41	6
November	16	0	0	1
December	-	-	-	-

GULF OFF PORT MANSFIELD\_PORT ISABEL

May	1,287	2	472	2
July	7	9	10	8
August	119	4	2	5
September	0	14	77	4
October	215	18	63	6
December	0	32	7	6

GULF OFF GALVESTON

January	0	61	0	7
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Table 3: Pounds of brown shrimp (heads-off) caught commercially in Texas bays (1963-1964).

Month	Sabine Lake		Galveston Bay		Matagorda Bay	
	1963	1964	1963	1964	1963	1964
April	-	-	-	-	-	-
May	7,100	-	54,471	18,567	7,325	26,413
June	2,237	-	225,787	280,778	74,317	87,161
July	86,691	-	87,106	143,166	23,472	4,772
August	9,575	-	4,404	2,854	-	-
TOTAL	105,603	-	371,768	445,365	105,114	118,346

Month	San Antonio Bay		Aransas Bay		Corpus Christi Bay	
	1963	1964	1963	1964	1963	1964
April	-	-	-	-	-	-
May	36,000	12,000	35,041	90,491	35,000	27,955
June	1,173	35,302	3,216	11,183	19,719	1,313
July	18,795	6,951	7,321	2,013	4,518	2,890
August	-	-	40	3,276	-	283
TOTAL	55,968	54,253	45,618	106,963	59,237	32,441

Bay	1963	1964	Deviation	% Change
Galveston Bay	371,768	445,365	+73,597	+19.8
Matagorda Bay	105,114	118,364	+13,250	+12.6
San Antonio Bay	55,968	54,253	- 1,715	- 3.0
Aransas Bay	45,618	106,963	+61,319	+134.5
Corpus Christi Bay	59,237	32,441	-26,796	-45.2
*TOTAL	637,705	757,386	+119,681	+18.8

\*Sabine Lake not included.

Source: Orman H. Farley, Branch of Statistics, Bureau of Commercial Fisheries, Biological Laboratory, Galveston, Texas (preliminary data).

Note: Landings from East Bay and West Bay, in the Galveston Bay system, and East Matagorda Bay not included.

Table 4: Pounds of white shrimp (heads-off) caught commercially in Texas bays (1963 & 1964)

Month	Sabine Lake		Galveston Bay		Matagorda Bay	
	1963	1964	1963	1964	1963	1964
April	129	-	430	1,841	-	-
May	21,010	-	5,191	3,402	1,007	12,848
June	9,733	-	1,165	606	99	8,730
July	978	-	15,215	66,313	-	34,694
August	85,631	38,509	762,484	961,102	294,824	504,101
September	194,958	31,284	541,431	892,896	347,992	555,776
October	231,343	34,713	568,718	677,439	243,354	301,169
November	150,924	56,000	60,018	400,941	92,830	159,053
December	53,088	-	-	3,142	10,619	4,032
TOTAL	747,794	160,506	1,954,652	3,007,682	990,725	1,580,403

Month	San Antonio Bay		Aransas Bay		Corpus Christi Bay	
	1963	1964	1963	1964	1963	1964
April	-	-	-	-	-	-
May	-	2,000	35	3,594	-	640
June	-	-	-	31	-	45
July	-	32,457	151	1,178	60	-
August	61,443	158,694	50,443	58,261	4,127	20,004
September	93,808	365,635	27,178	85,667	20,409	53,044
October	42,712	235,483	52,119	142,022	11,024	49,415
November	16,669	102,039	33,839	87,206	9,871	34,523
December	18,593	515	17,614	7,558	16,756	31
TOTAL	233,225	896,823	181,379	385,517	62,247	157,702

Source: Orman H. Farley, Branch of Statistics, Bureau of Commercial Fisheries, Biological Laboratory, Galveston, Texas (preliminary data).

Note: Landings from East Bay and West Bay in the Galveston Bay system and East Matagorda Bay not included.

Table 5: Total pounds (heads off) of brown shrimp landed in Texas and value (dollars) to the fishermen (1960-1964).

Month	*Pounds	**Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
January	1,025	564	1,439	826	590	470	825	741	1,000	705
February	509	297	860	514	1,139	935	693	615	749	509
March	676	411	874	522	935	775	621	540	868	613
April	745	479	801	476	837	692	620	532	761	568
May	1,143	766	1,085	646	864	628	1,009	729	1,097	718
June	1,093	750	2,400	1,167	1,792	1,143	1,675	813	2,072	1,021
July	9,428	4,207	4,350	2,026	4,111	2,578	6,119	3,109	5,569	2,867
August	9,155	4,293	4,877	3,102	3,892	2,909	7,172	4,167	4,673	2,988
September	6,412	3,373	3,466	2,481	3,980	3,739	5,099	3,297	3,755	2,526
October	4,200	2,497	2,644	1,909	3,003	2,835	4,572	2,797	2,829	2,159
November	2,298	1,362	735	571	1,540	1,413	1,695	1,073	1,631	1,313
December	1,236	712	802	632	1,793	1,599	1,205	847	884	726
TOTAL	37,922	19,712	24,334	14,877	24,479	19,719	31,306	19,234	25,888	16,713

\* in 1000 lbs.

\*\* in 1000 dollars

\*\*\* 1964 landings preliminary

Source: Orman H. Farley, Branch of Statistics, Bureau of Commercial Fisheries, Biological Laboratory, Galveston, Texas (Landings 1960-1963).

Shrimp Landings, U. S. Dep. of the Interior, Fish and Wildlife Services, Bureau of Commercial Fisheries, Washington, D. C. (1964 Landings).



Table 6: Total pounds (heads off) of white shrimp landed in Texas and value (dollars) to the fisherman (1960-1964)

Month	1960		1961		1962		1963		1964	
	*Pounds	**Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
January	26	15	139	65	212	165	52	24	358	239
February	54	35	202	88	126	100	9	7	45	26
March	69	38	352	160	96	70	124	80	219	95
April	257	137	134	70	70	58	79	62	366	189
May	97	67	372	218	123	110	217	199	753	535
June	89	61	81	47	157	146	165	156	505	403
July	213	140	203	132	271	238	134	117	380	255
August	910	353	584	300	1,032	559	1,489	697	1,939	911
September	2,268	955	669	387	1,276	1,051	1,783	915	2,579	1,431
October	2,355	1,064	1,972	1,269	1,782	1,312	2,488	1,286	2,521	1,548
November	1,662	707	1,420	890	1,569	976	1,487	748	1,807	1,127
December	314	144	733	509	307	108	881	514	522	358
TOTAL	8,315	3,716	6,863	4,136	7,022	4,894	8,909	4,806	11,994	7,117

\* in 1000 pounds

\*\* in 1000 dollars

\*\*\* 1964 landings preliminary

Source: Orman H. Farley, Branch of Statistics, Bureau of Commercial Fisheries, Biological Laboratory, Galveston, Texas (Landings 1960-1963).

Shrimp Landings, U. S. Dept. of the Interior, Fish and Wildlife Service, Bureau of Commercial Fisheries, Washington, D. C. (1964 Landings).

Table 7: Total pounds (heads off) of pink shrimp landed in Texas and value (dollars) to the fisherman (1960-1964).

Month	1960		1961		1962		1963		1964***	
	*Pounds	**Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
January	129	71	157	90	288	232	362	309	414	266
February	365	199	428	244	570	472	756	620	587	366
March	235	125	434	234	244	194	552	390	467	287
April	333	189	178	91	281	214	580	416	470	249
May	187	109	212	101	285	222	367	263	216	119
June	39	24	130	59	221	178	224	175	165	96
July	36	22	12	66	74	60	89	65	29	15
August	40	13	89	61	94	79	6	4	7	5
September	-	-	148	100	239	195	-	-	76	46
October	177	105	355	234	184	151	28	16	132	87
November	381	215	667	475	212	171	94	56	275	188
December	172	97	602	461	333	283	321	178	693	492
TOTAL	2,094	1,171	3,416	2,156	3,025	2,437	3,380	2,492	3,477	2,216

\* in 1000 pounds

\*\* in 1000 dollars

\*\*\* 1964 landings preliminary

Source: Orman H. Farley, Branch of Statistics, Bureau of Commercial Fisheries, Galveston, Texas (Landings 1960-1963)

Shrimp Landings, U. S. Dept. of the Interior, Fish &amp; Wildlife Service, Bureau of Commercial Fisheries, Washington D. C. (1964 landings).

Table 8: Average catch per days fishing effort (1960-1964).

White Shrimp

Month	Galveston Bay					Matagorda Bay to Aransas Bay					Corpus Christi to Upper Laguna					Lower Laguna				
	1960	1961	1962	1963	1964	1960	1961	1962	1963	1964	1960	1961	1962	1963	1964	1960	1961	1962	1963	1964
1	0	256	113	0	252	9	136	154	16	238	6	85	111	0	2	0	29	218	0	-
2	10	4	14	3	27	1	213	75	3	88	0	36	63	0	-	0	130	75	0	-
3	291	251	154	228	485	22	248	140	200	250	4	249	23	7	0	0	105	33	0	-
4	365	90	33	168	446	157	81	22	93	183	34	51	52	0	27	0	33	29	0	11
5	83	69	54	112	366	46	99	44	48	231	14	166	83	84	-	1	78	46	6	12
6	51	23	30	7	79	21	19	8	4	59	2	8	4	31	17	1	3	0	0	18
7	34	35	61	29	17	35	31	56	15	35	3	16	6	0	9	1	8	1	0	5
8	57	10	13	10	21	28	25	59	8	13	3	2	0	0	1	1	5	0	1	1
9	263	256	118	40	463	134	71	63	18	41	24	3	0	-	2	1	2	0	-	-
10	398	365	455	292	269	171	355	38	96	142	35	274	3	11	140	0	28	0	1	7
11	549	388	476	747	407	301	397	236	291	228	150	526	68	113	143	22	71	1	-	-
12	267	226	19	791	452	291	315	27	471	263	72	333	0	242	113	43	153	0	1	-

Brown Shrimp

1	602	205	383	413	69	508	290	366	365	90	364	280	374	404	453	390	450	229	430	468
2	578	279	480	343	336	445	247	345	323	25	298	326	330	297	-	276	337	242	294	-
3	112	136	181	233	116	515	196	115	119	288	361	180	301	174	411	275	321	285	165	209
4	23	256	279	46	34	246	282	212	183	194	244	232	51	261	327	320	393	276	225	271
5	276	247	178	138	10	295	287	184	237	160	333	250	138	205	268	364	357	215	343	355
6	237	291	415	838	439	254	407	327	554	398	307	797	509	520	927	278	732	372	250	292
7	1520	460	355	829	762	1460	516	371	828	658	1358	662	597	979	962	1145	599	605	967	655
8	1019	550	448	786	591	1060	524	411	763	529	1064	571	578	775	535	970	535	516	698	517
9	643	217	556	665	463	753	483	583	704	505	870	484	657	747	530	818	711	643	700	559
10	414	55	203	450	257	659	207	516	599	451	749	235	479	655	439	782	667	590	786	539
11	195	138	120	74	213	399	138	357	305	295	519	9	405	515	348	700	362	559	780	643
12	209	261	495	27	76	244	156	521	138	186	450	158	546	301	371	556	283	591	868	471

Source: Gulf Coast Shrimp Data. United States Department of the Interior, Bureau Comm. Fish., Washington 25, D. C..

Figure 1: Postlarval Shrimp Stations (Aransas Bay Area)

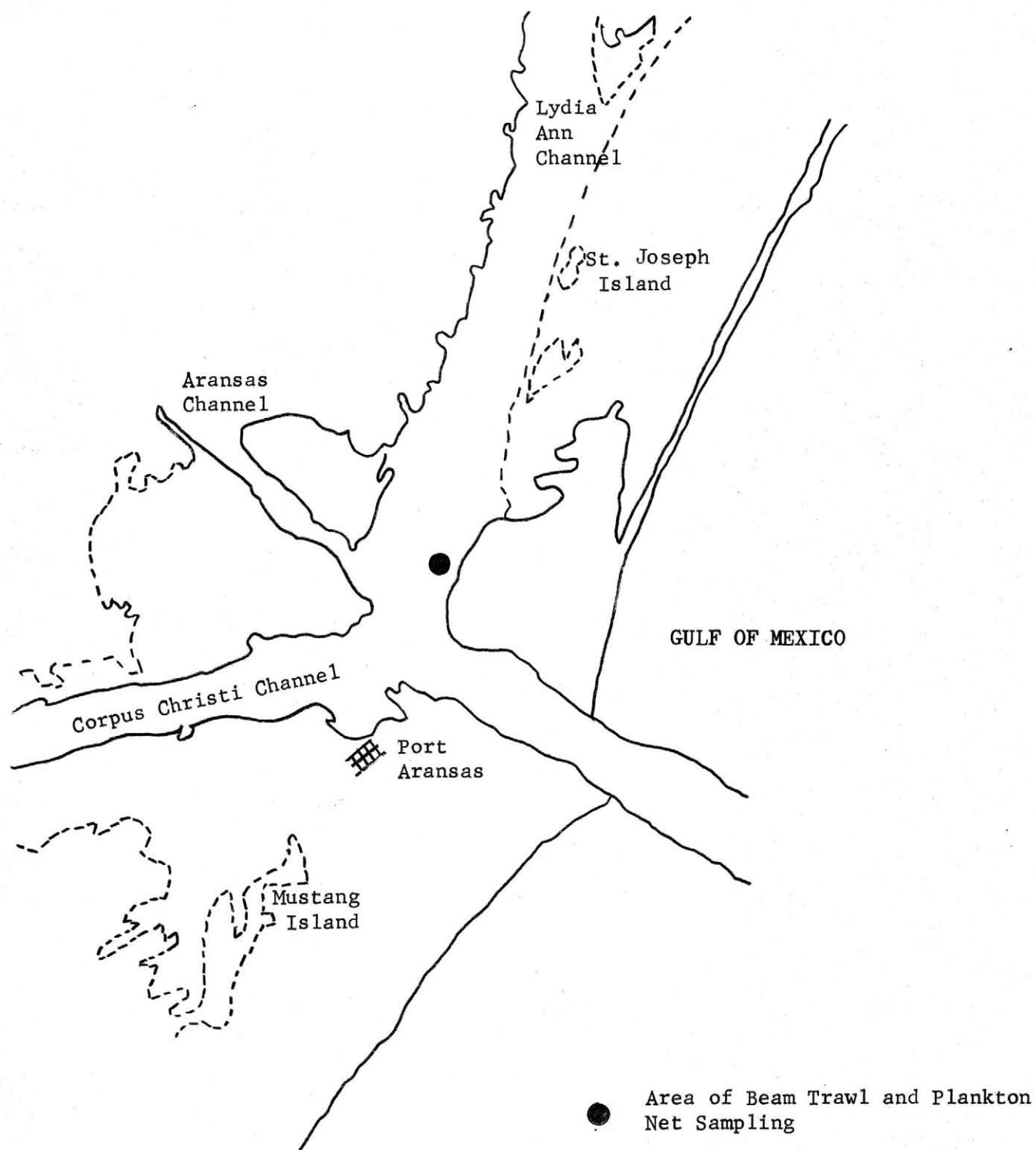




Figure 2: Map of Sabine Lake

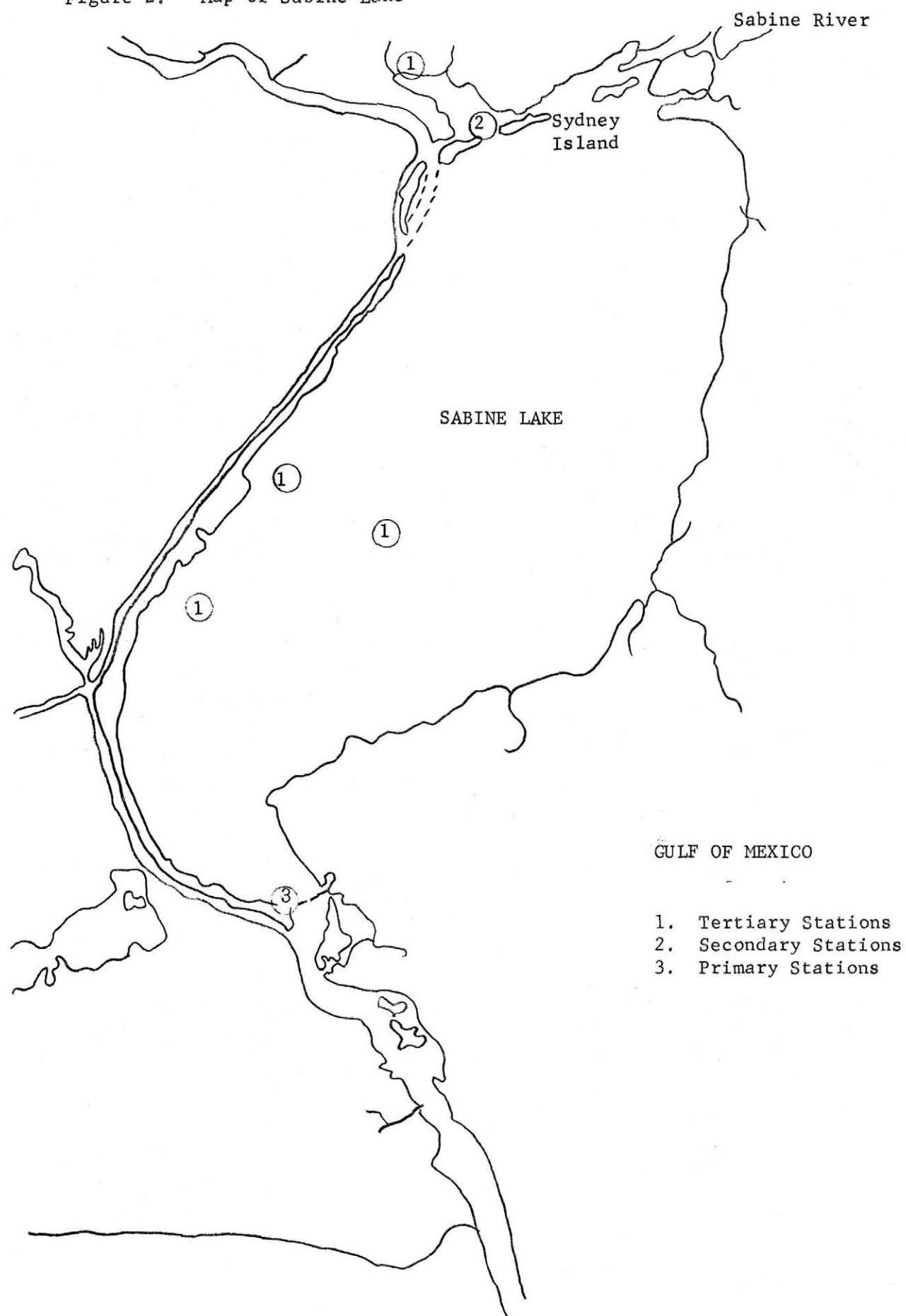


Figure 3: Galveston Bay Station Locations

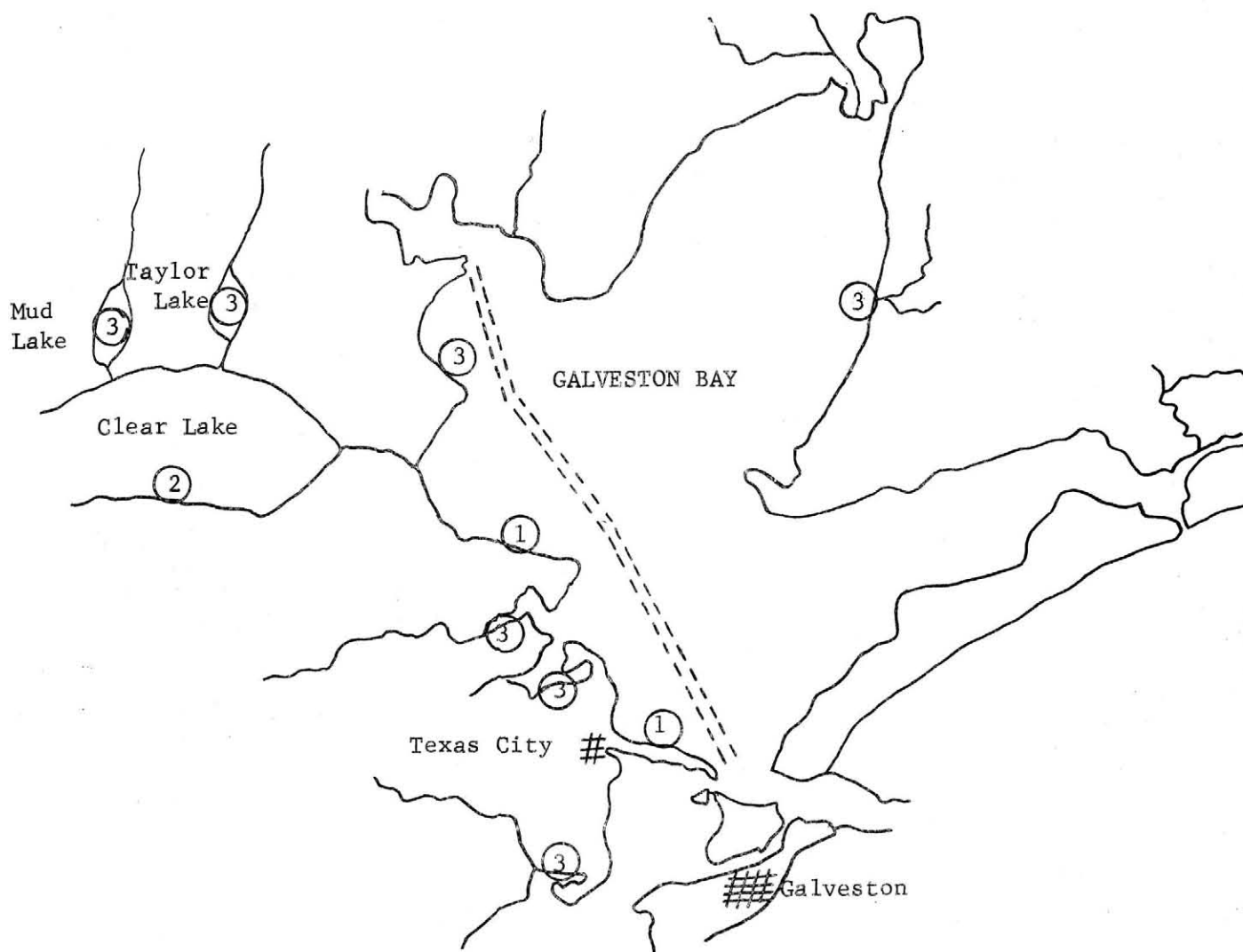


Figure 4: Matagorda Bay Station Locations

1. Primary Bay Stations
2. Secondary Bay Stations
3. Tertiary Bay Stations

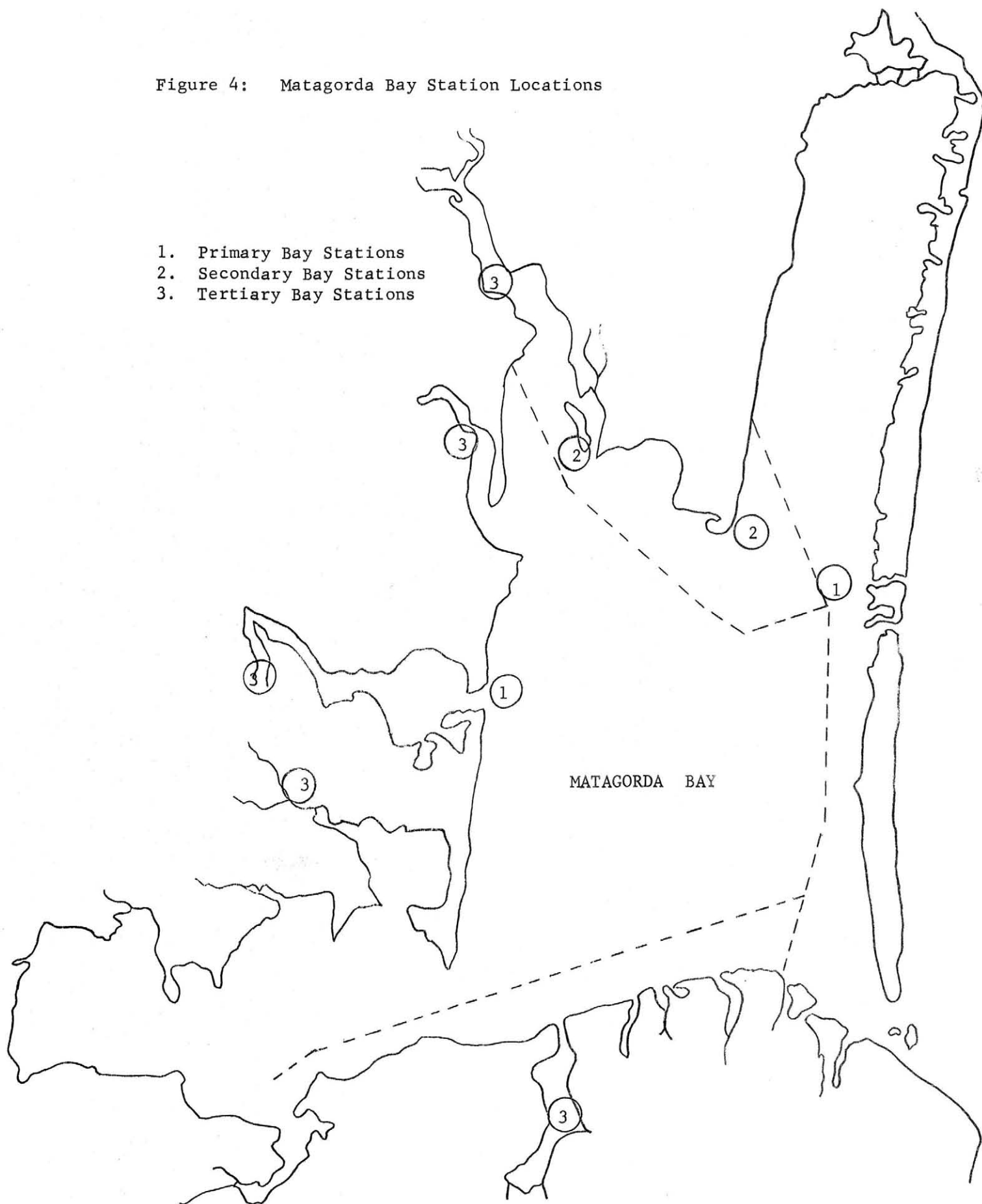
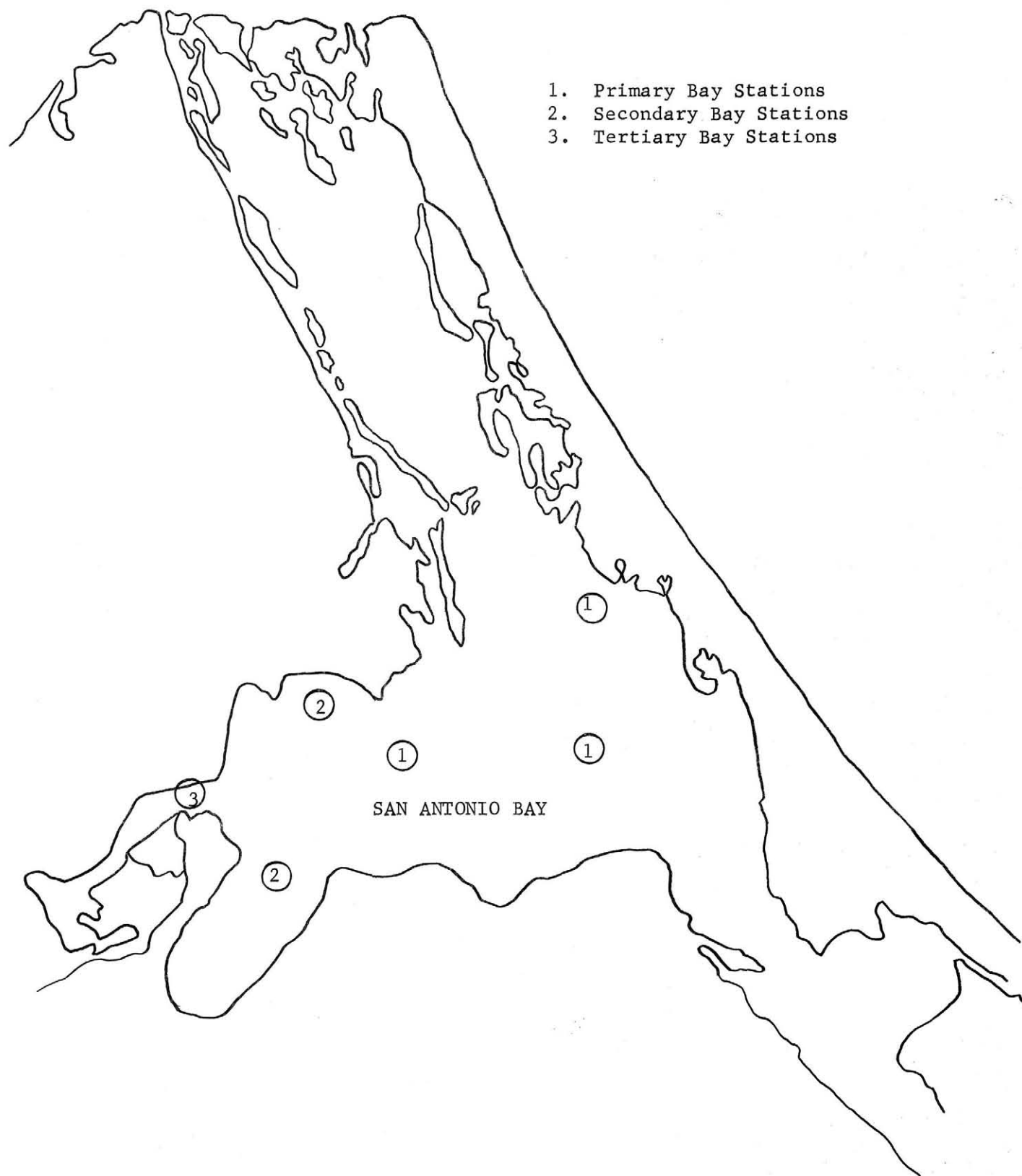


Figure 5: San Antonio Bay Station Locations





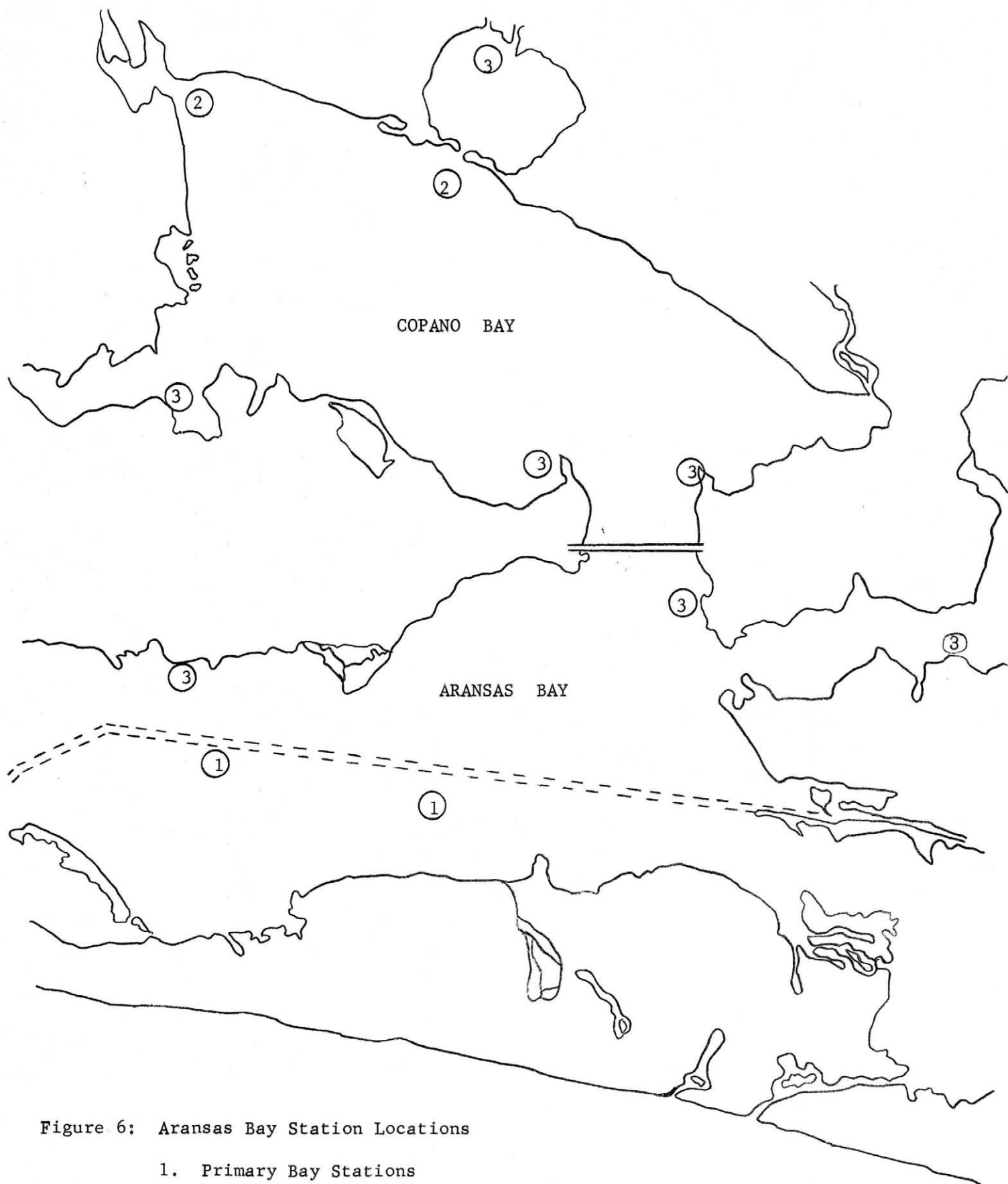
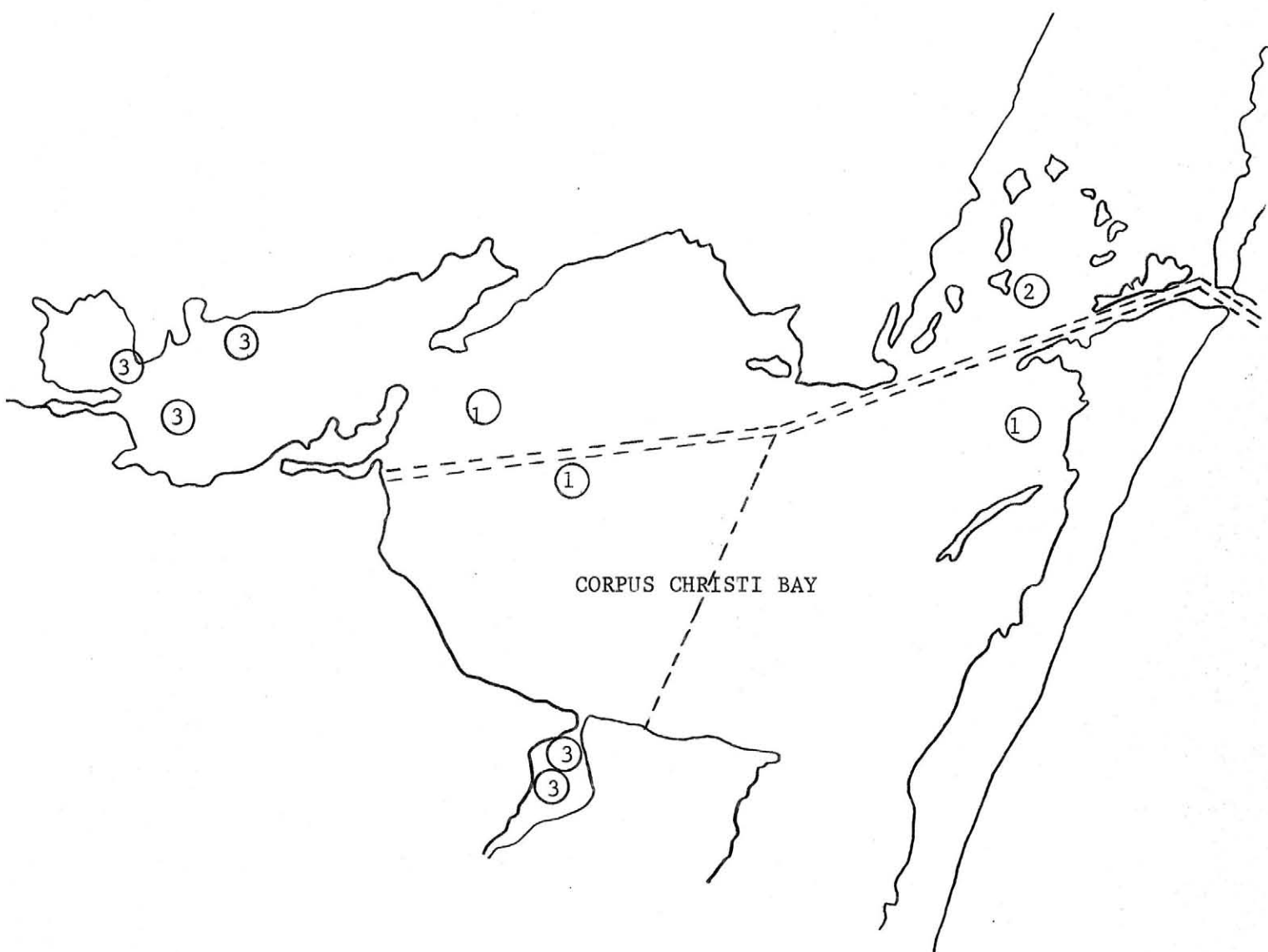


Figure 6: Aransas Bay Station Locations

1. Primary Bay Stations
2. Secondary Bay Stations
3. Tertiary Bay Stations

Figure 7: Map of Corpus Christi Bay



- 1. Primary Bay Stations
- 2. Secondary Bay Stations
- 3. Tertiary Bay Stations

UPPER LAGUNA  
MADRE

Corpus Christi Bay

Baffin Bay

LOWER  
LAGUNA  
MADRE

Mansfield  
Pass

Figure 8: Map of Laguna Madre

1. Bar Seine Stations
2. 60-foot Seine Stations
3. Trawl Stations

Figure 9: Map of inshore Gulf sampling area off Port Aransas, Texas

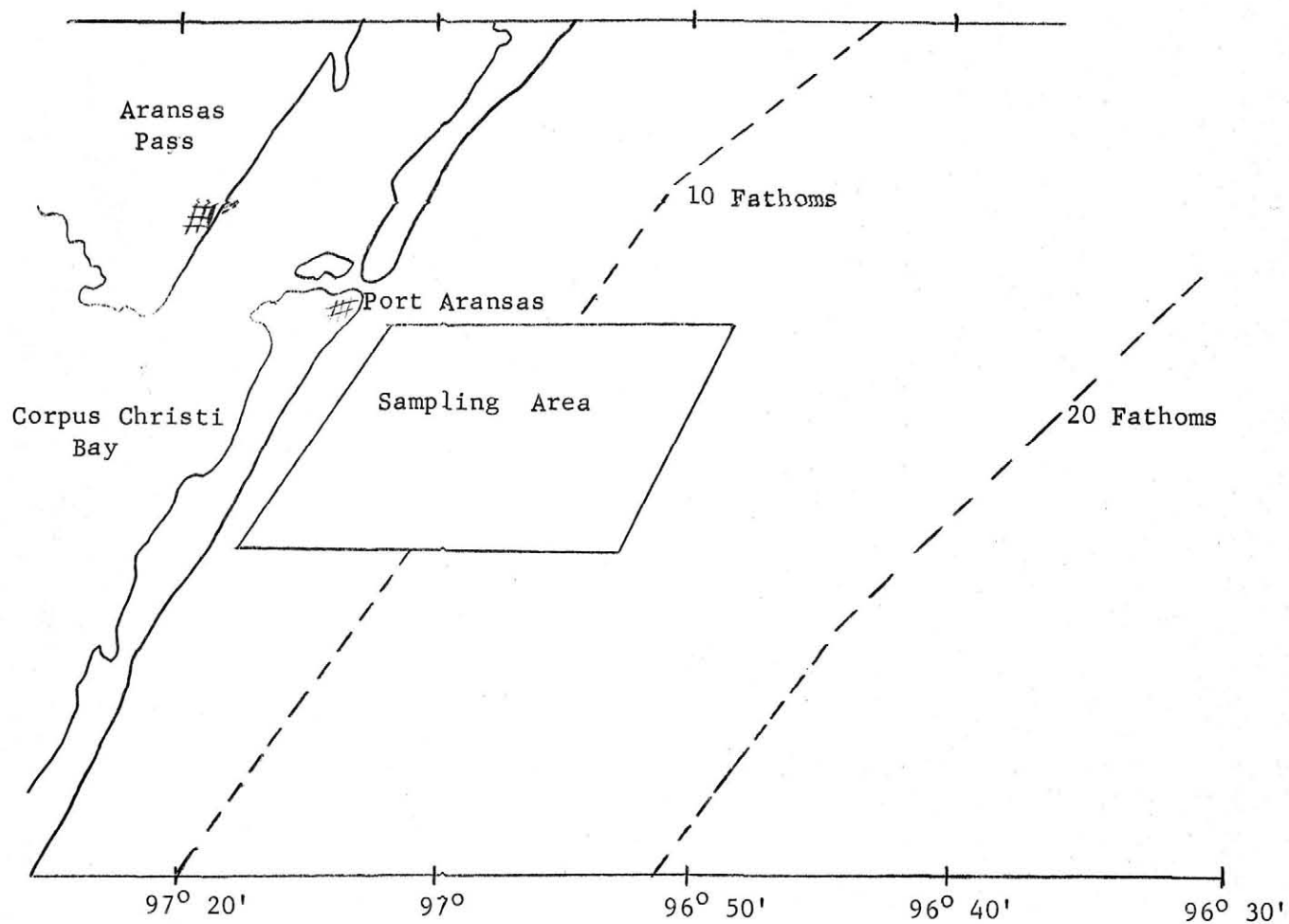


Figure 10: Average number of brown shrimp per sample (top).  
Monthly progression of modal brown shrimp lengths  
(bottom). Sabine Lake (1964).

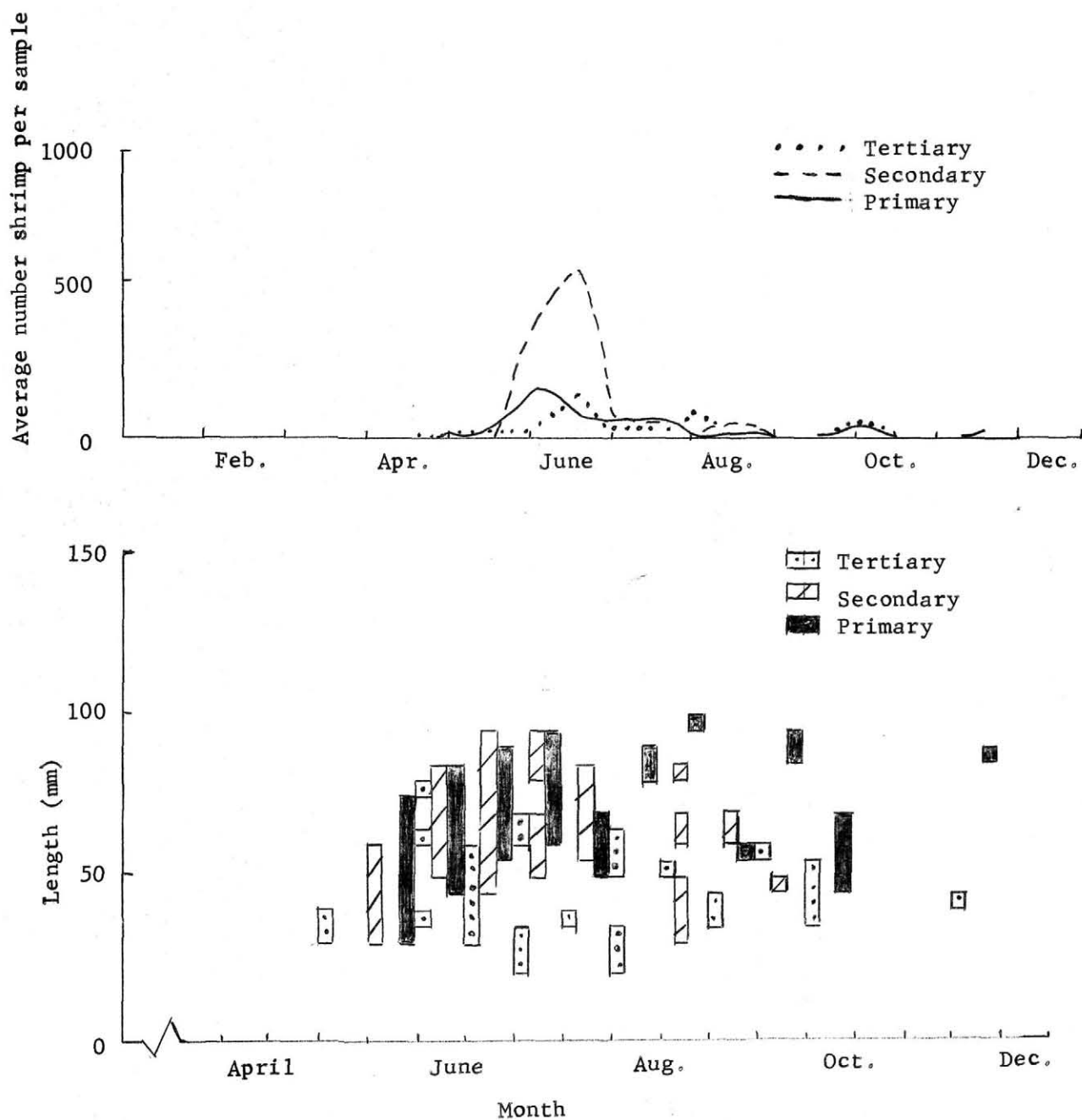


Figure 11: Average number of brown shrimp per sample (top).  
Monthly progression of modal brown shrimp lengths  
(bottom). Galveston Bay (1964).

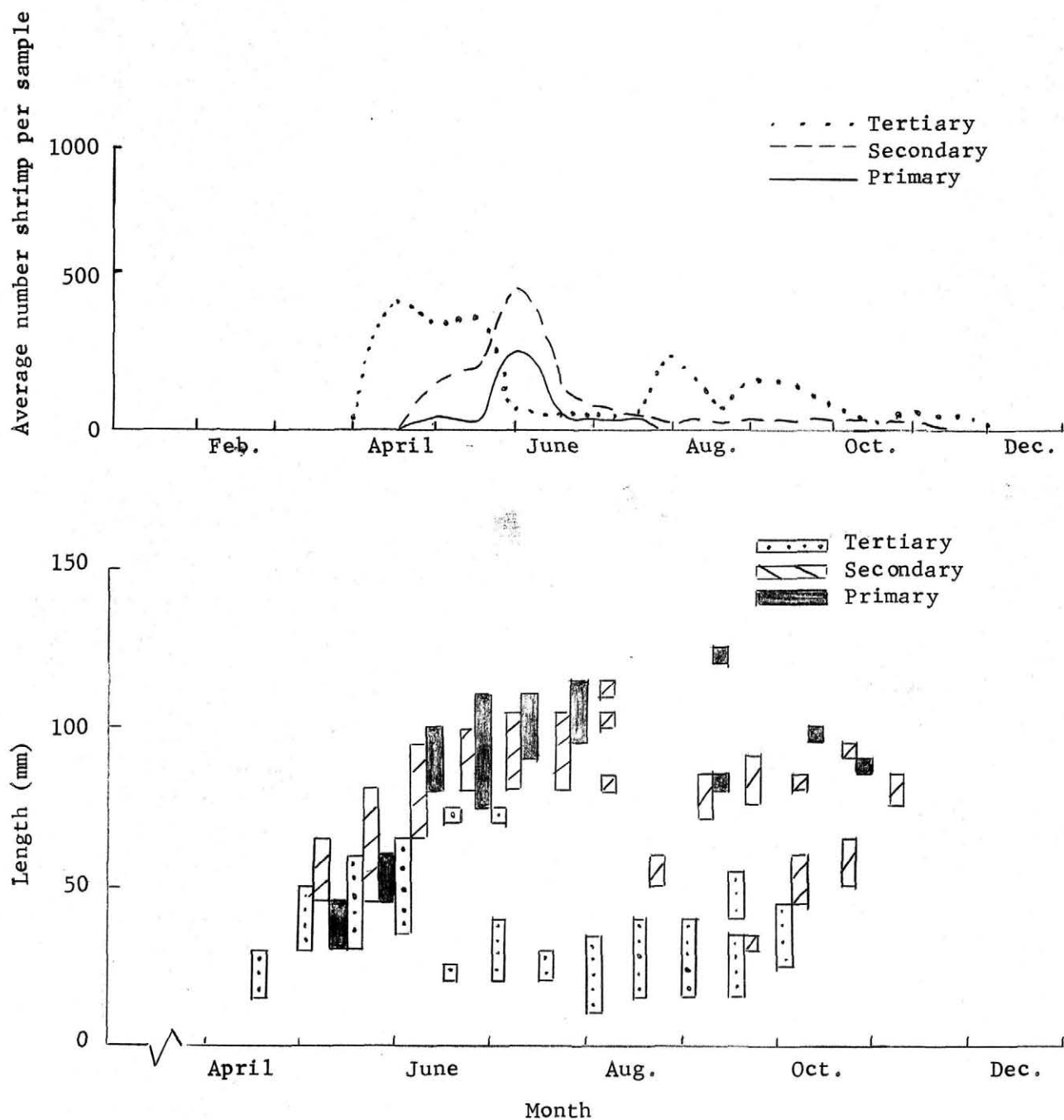




Figure 12: Average number of brown shrimp per sample (top).  
Monthly progression of modal brown shrimp lengths  
(bottom). Matagorda Bay (1964).

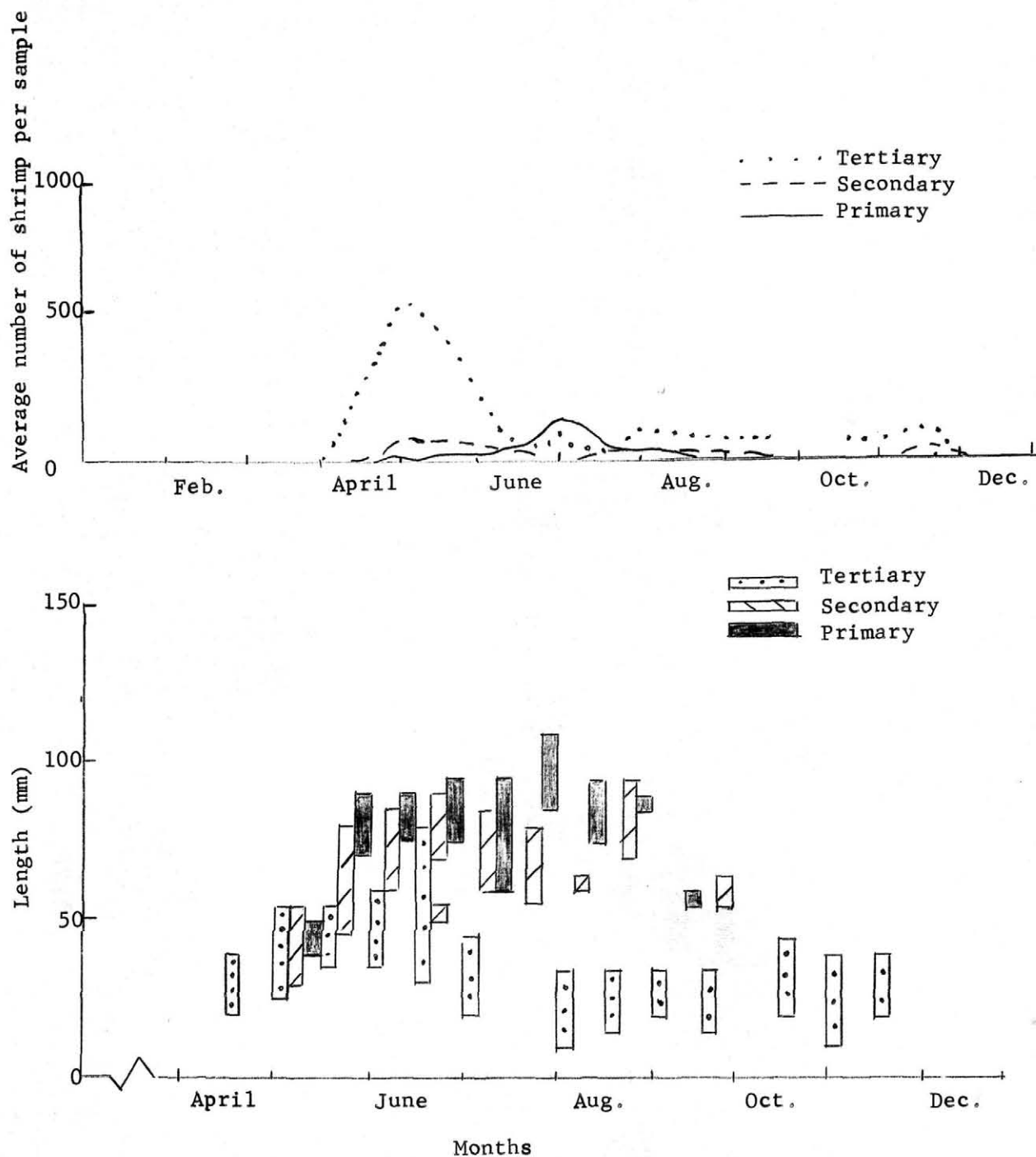


Figure 13: Average number of brown shrimp per sample (top).  
Monthly progression of modal brown shrimp lengths  
(bottom) San Antonio Bay (1964).

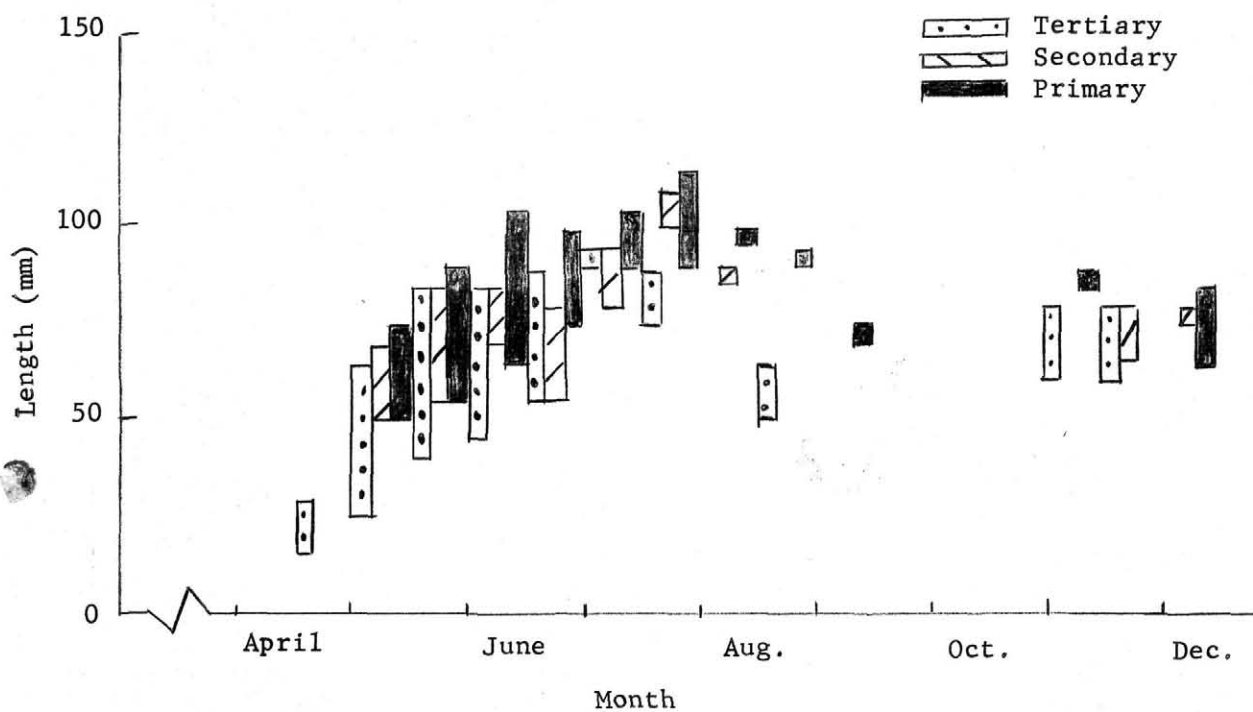
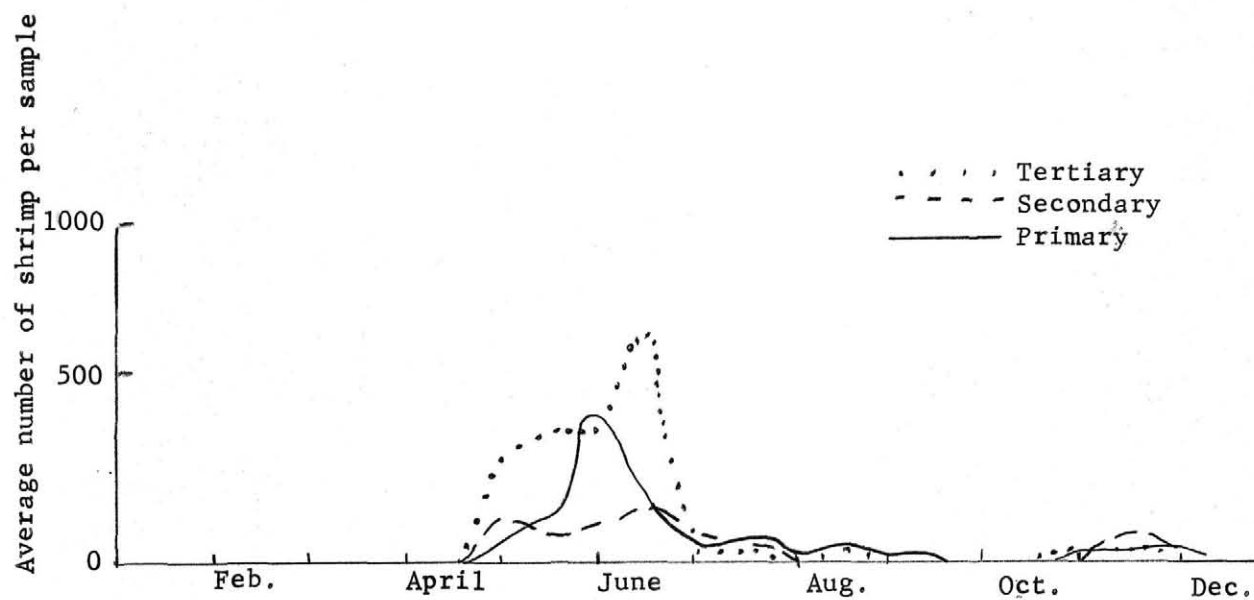


Figure 14: Average number of brown shrimp per sample (top).  
Monthly progression of modal brown shrimp lengths  
(bottom). Aransas Bay (1964).

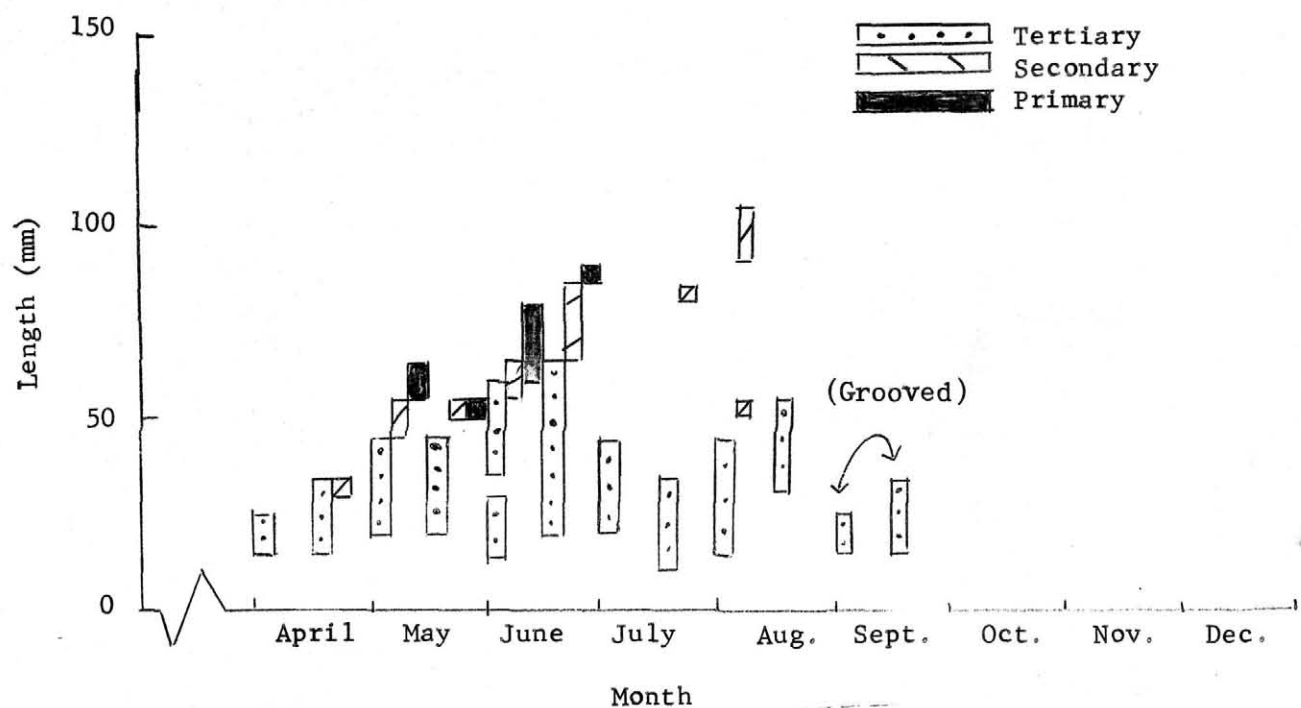
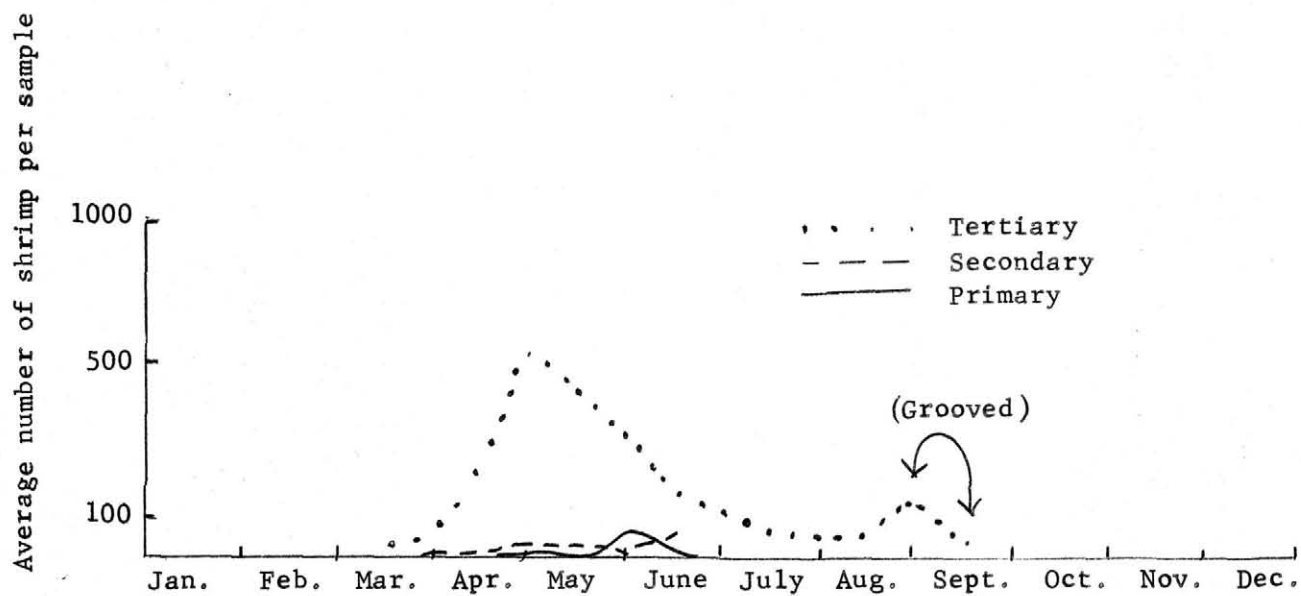


Figure 15: Average number of brown shrimp per sample (top). Monthly progression of modal shrimp lengths (bottom). Corpus Christi Bay (1964)

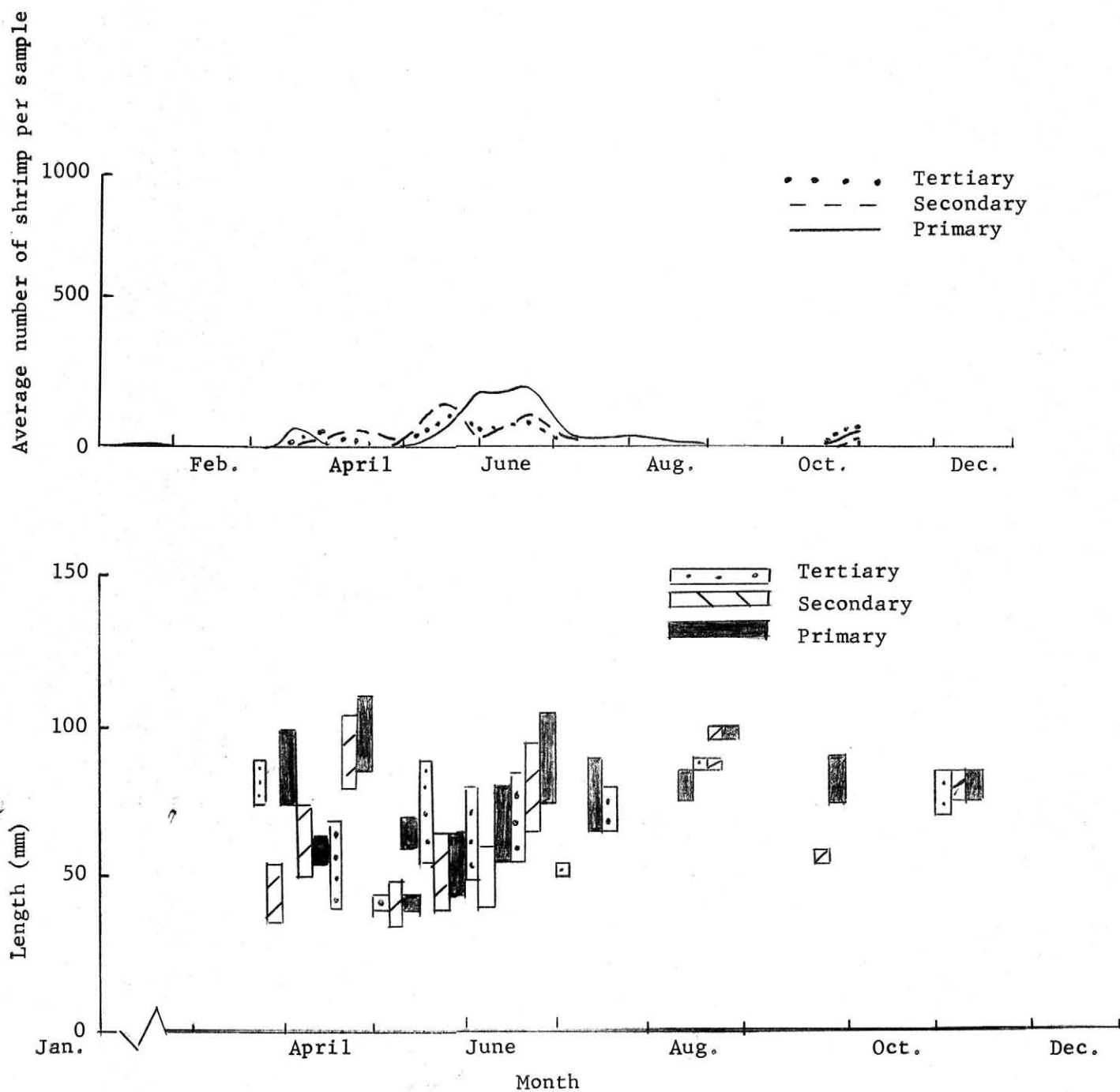


Figure 16: Average number of brown shrimp per sample (top). Monthly progression of modal shrimp sizes (bottom). Upper Laguna (1964)

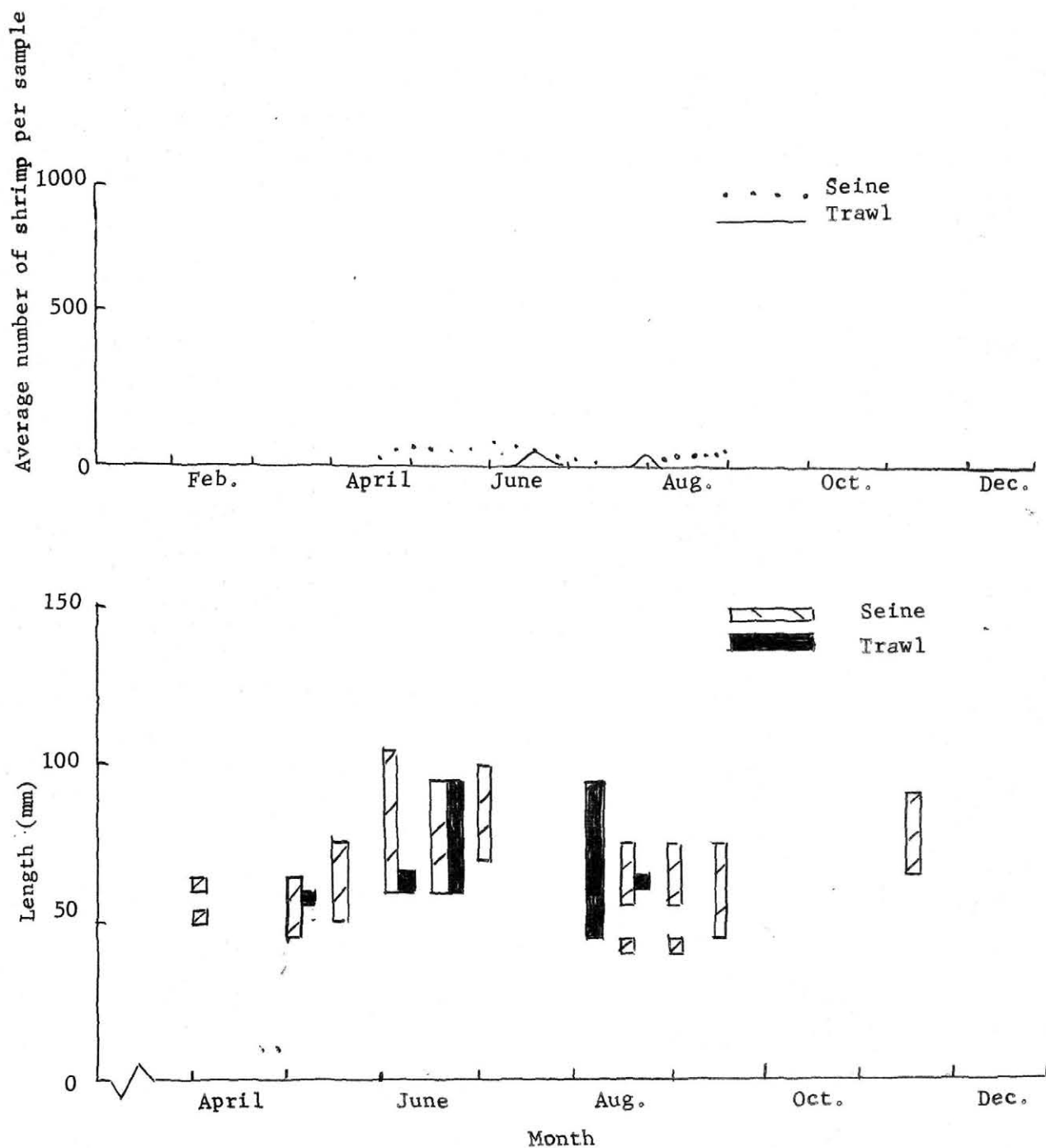


Figure 17: Average number of brown shrimp per sample (top). Monthly progression of modal brown shrimp sizes (bottom) Lower Laguna (1964)

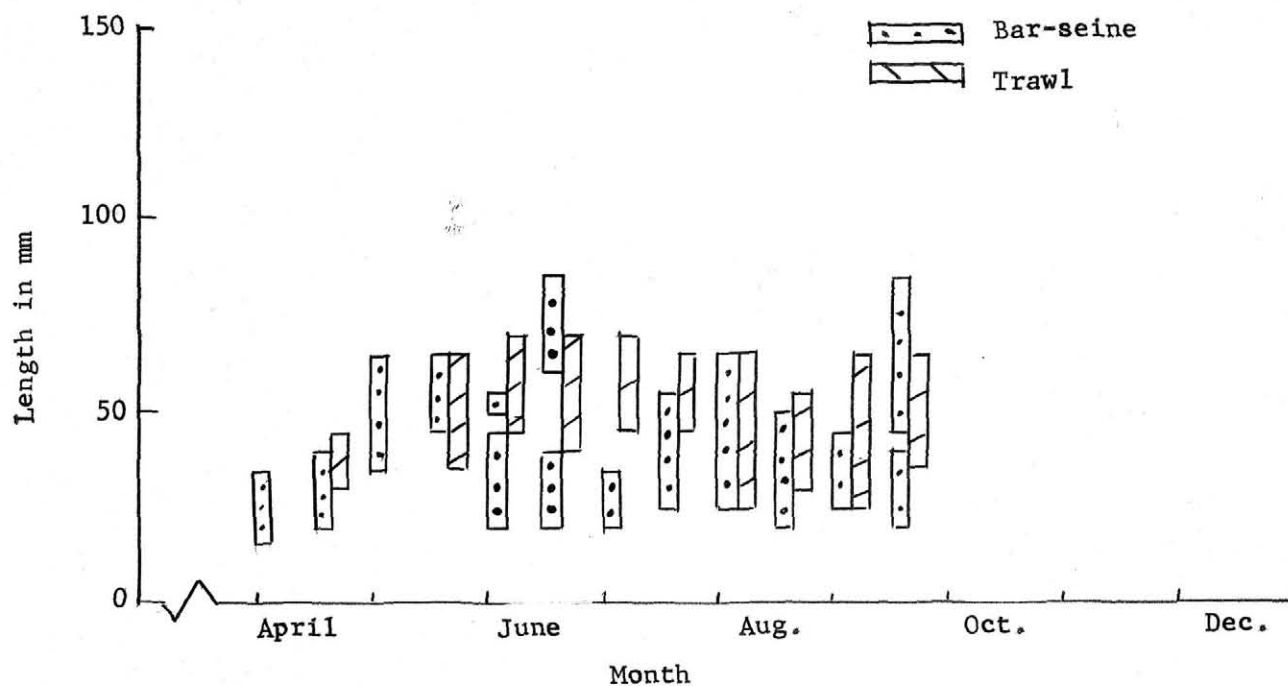
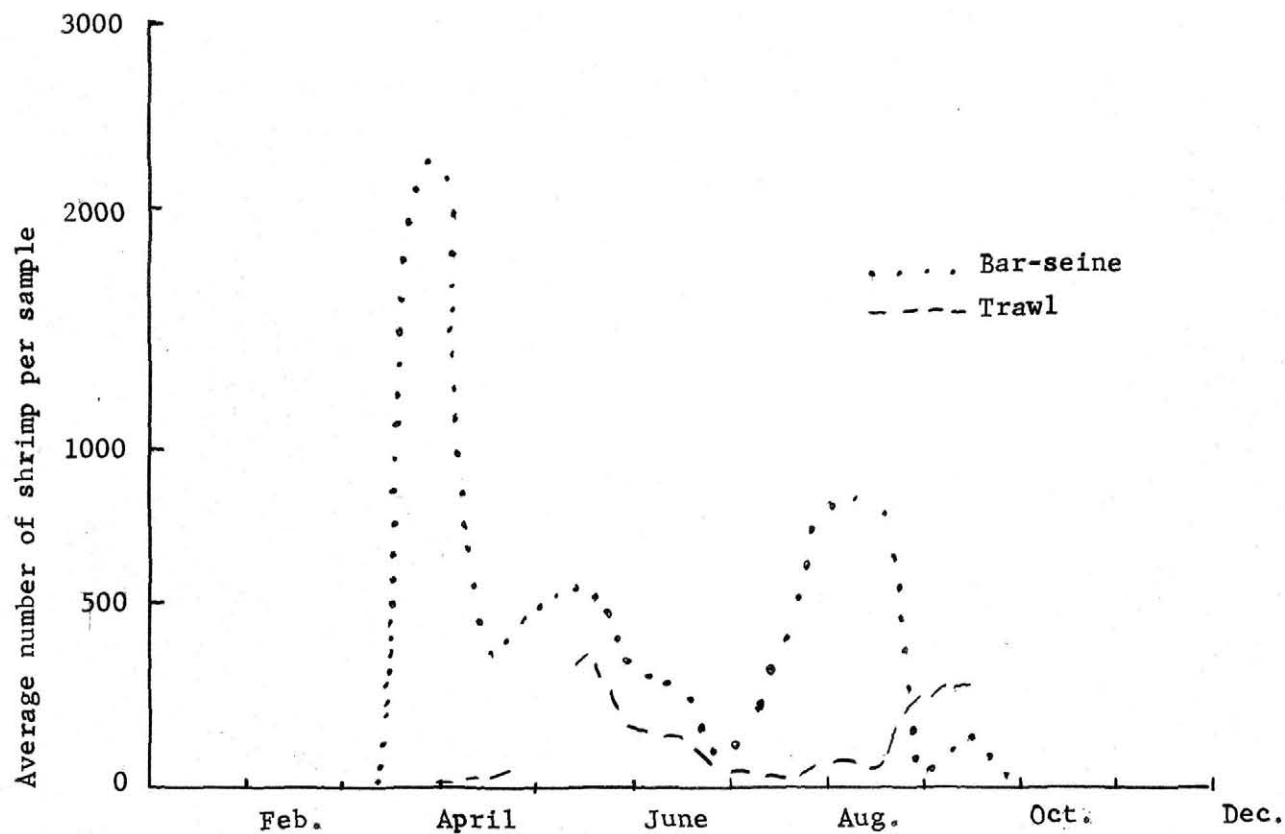


Figure 18: Average number of white shrimp per sample (top). Monthly progression of modal white shrimp sizes (bottom). Sabine Lake (1964)

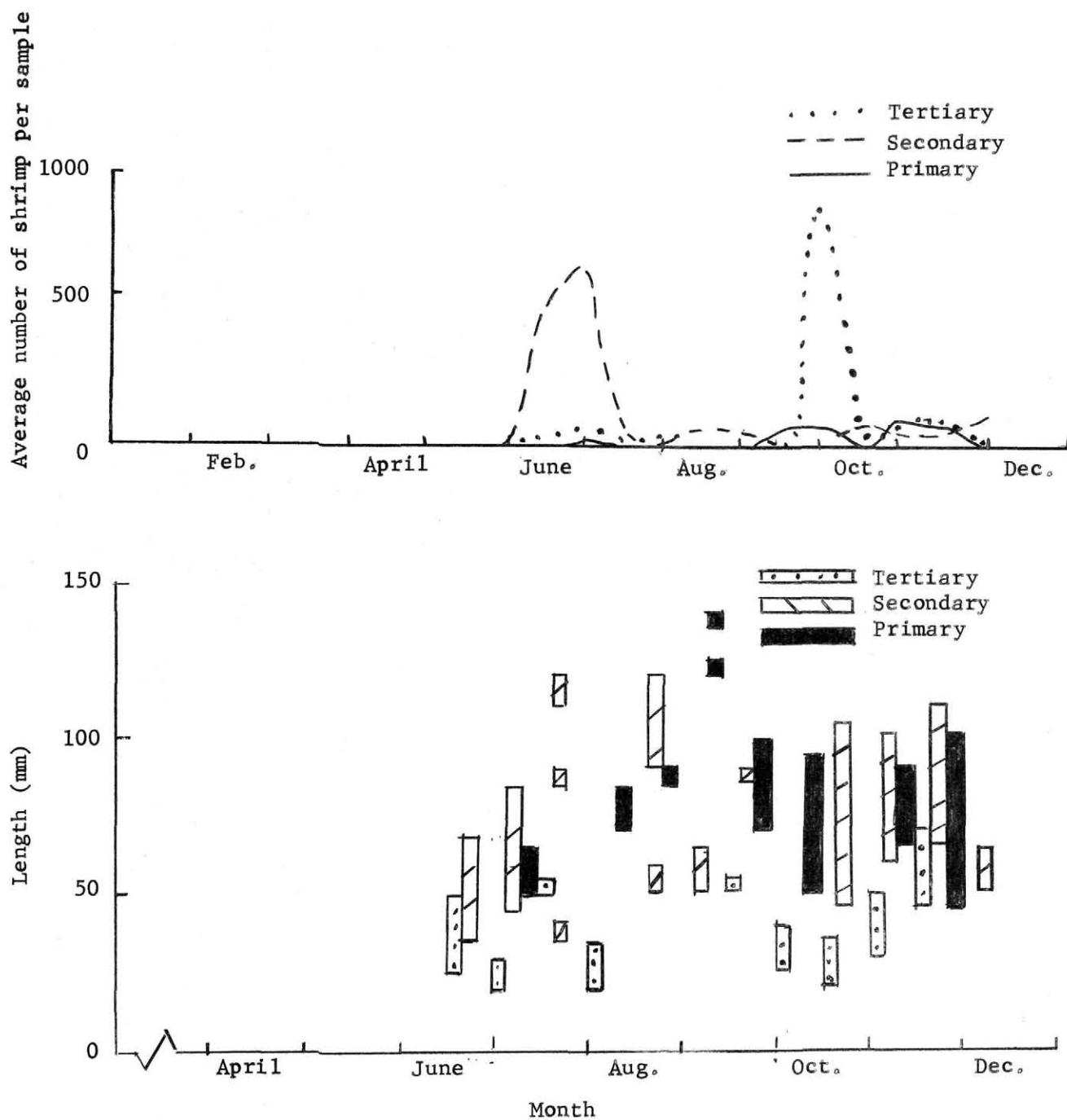




Figure 19: Average number of white shrimp per sample (top). Monthly progression of modal white shrimp lengths (bottom). Galveston Bay (1964)

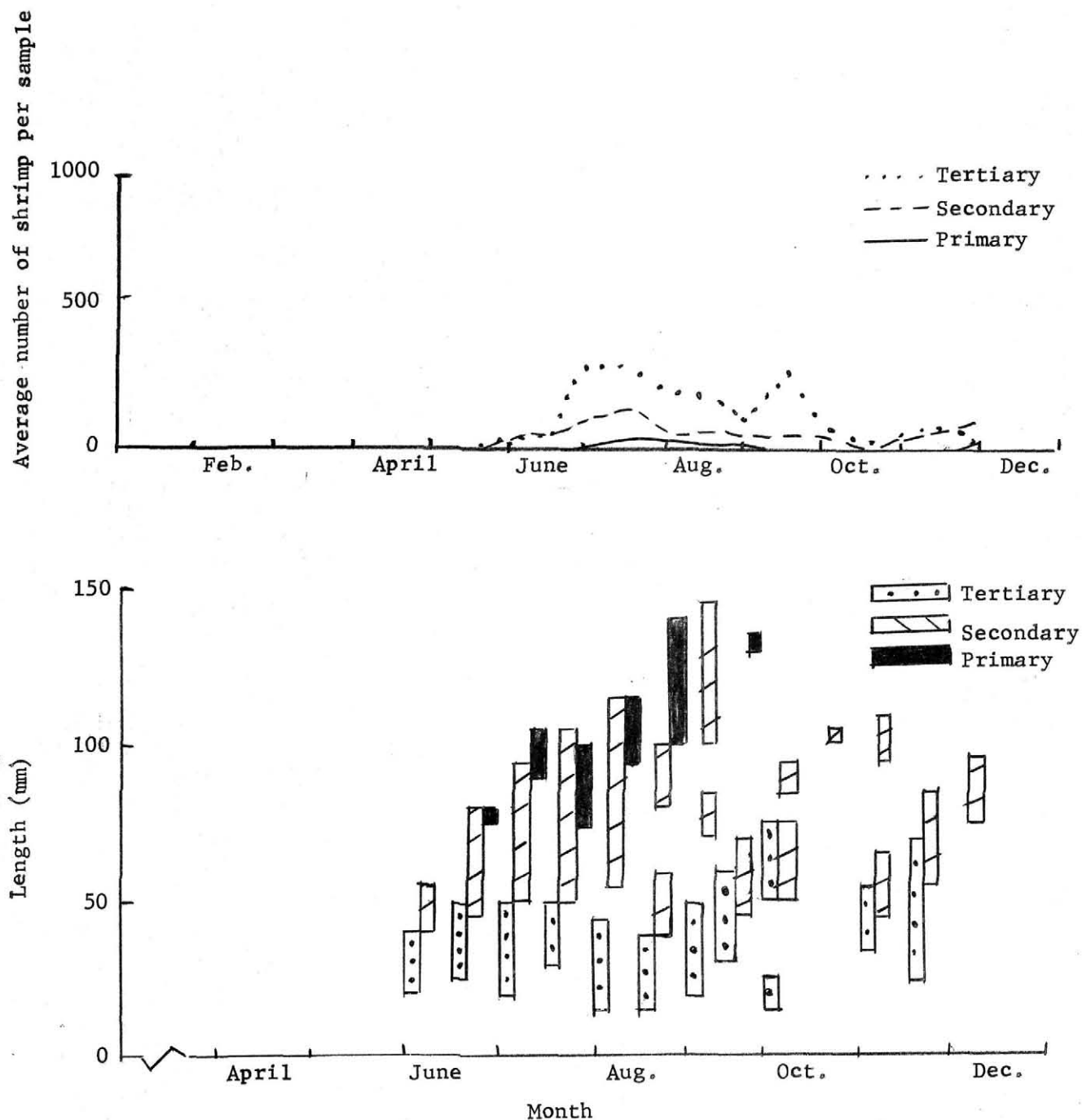


Figure 20: Average number of white shrimp per sample (top). Monthly progression of modal white shrimp sizes (bottom). Matagorda Bay (1964).

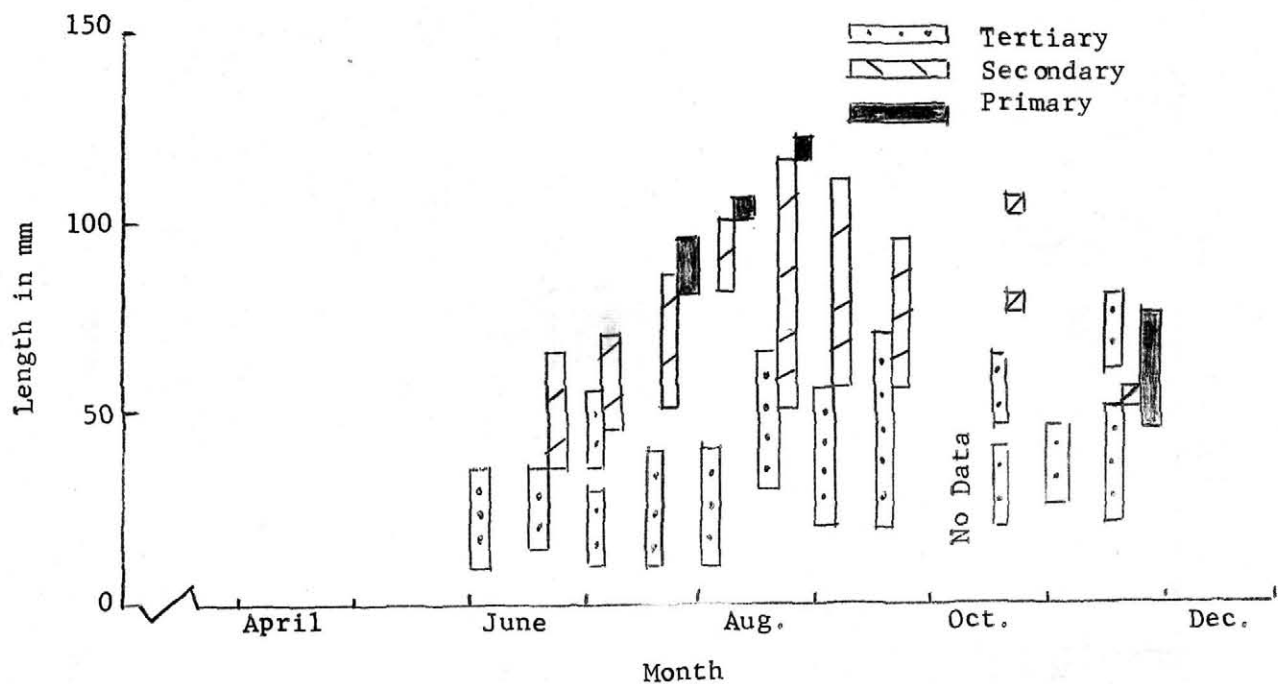
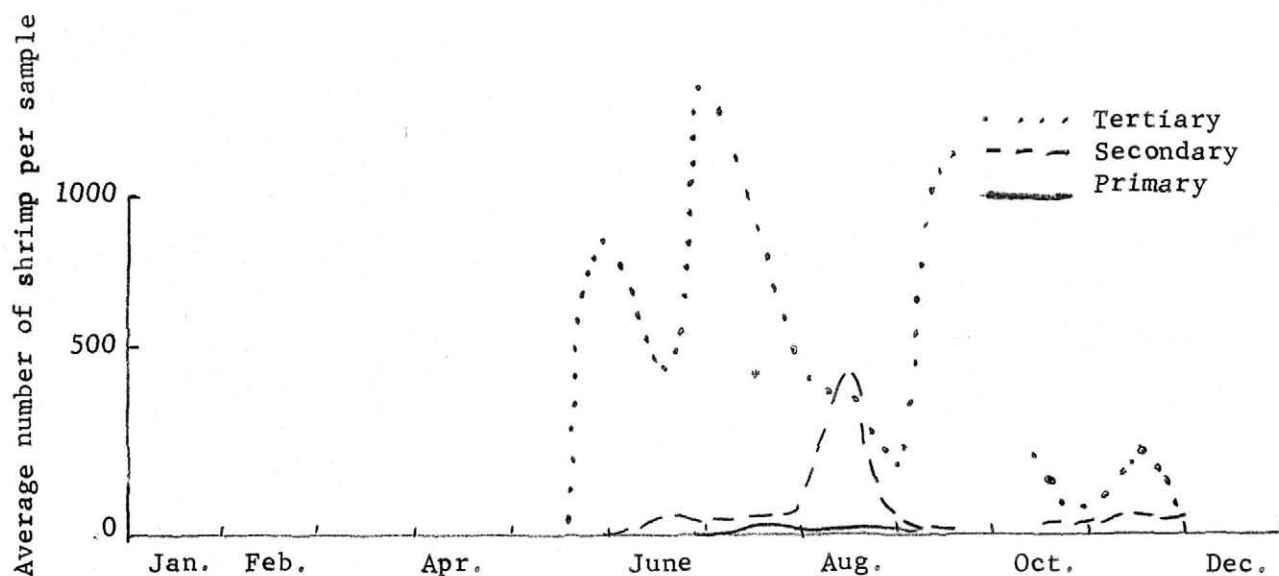


Figure 21: Average number of white shrimp per sample (top). Monthly progression of modal white shrimp lengths (bottom). San Antonio Bay (1964)

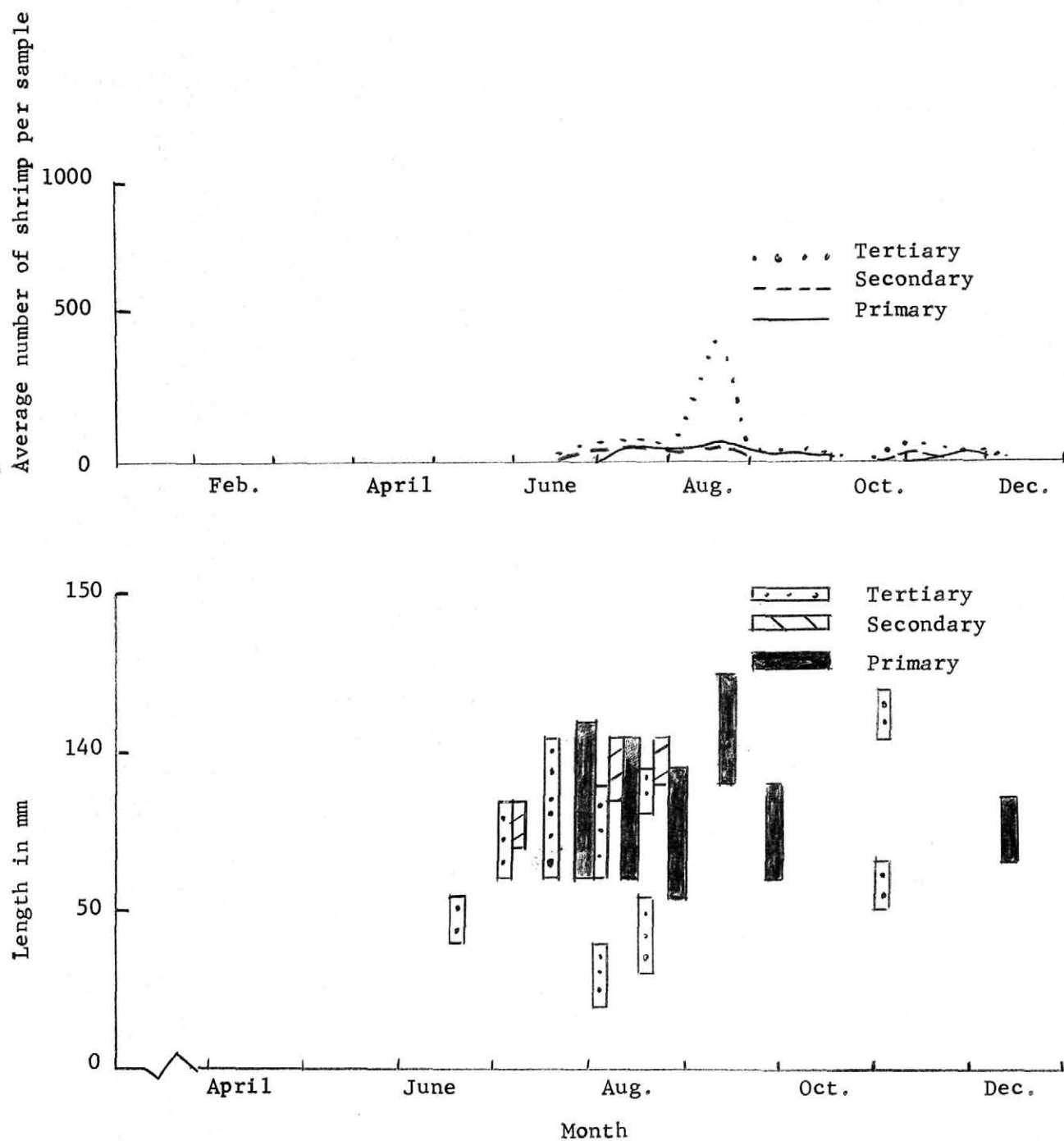


Figure 22: Average number of white shrimp per sample (top). Monthly progression of modal white shrimp lengths (bottom) Aransas Bay (1964)

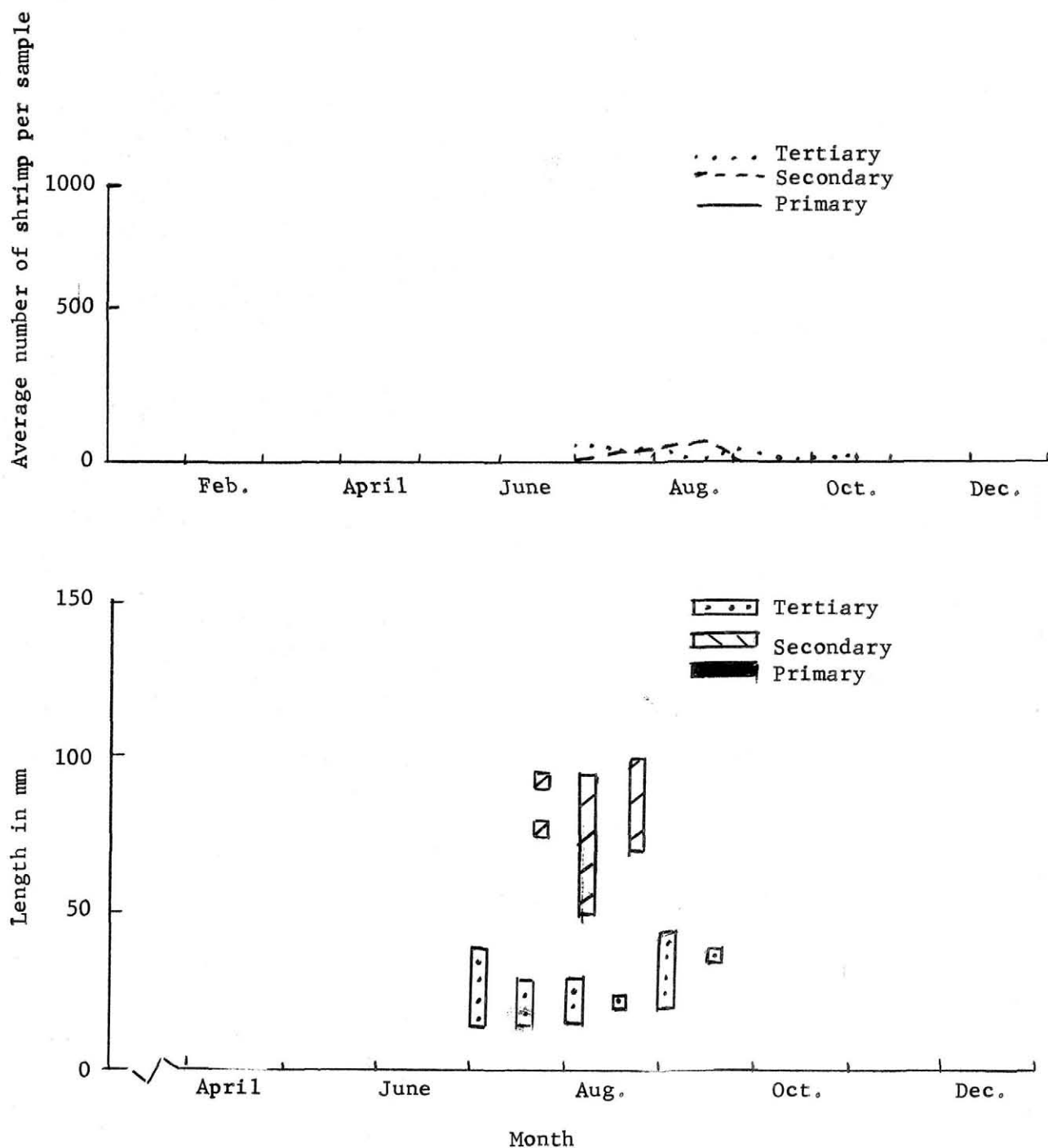


Figure 13: Average number of white shrimp per sample (top). Monthly progression of modal white shrimp sizes (bottom) Corpus Christi Bay (1964)

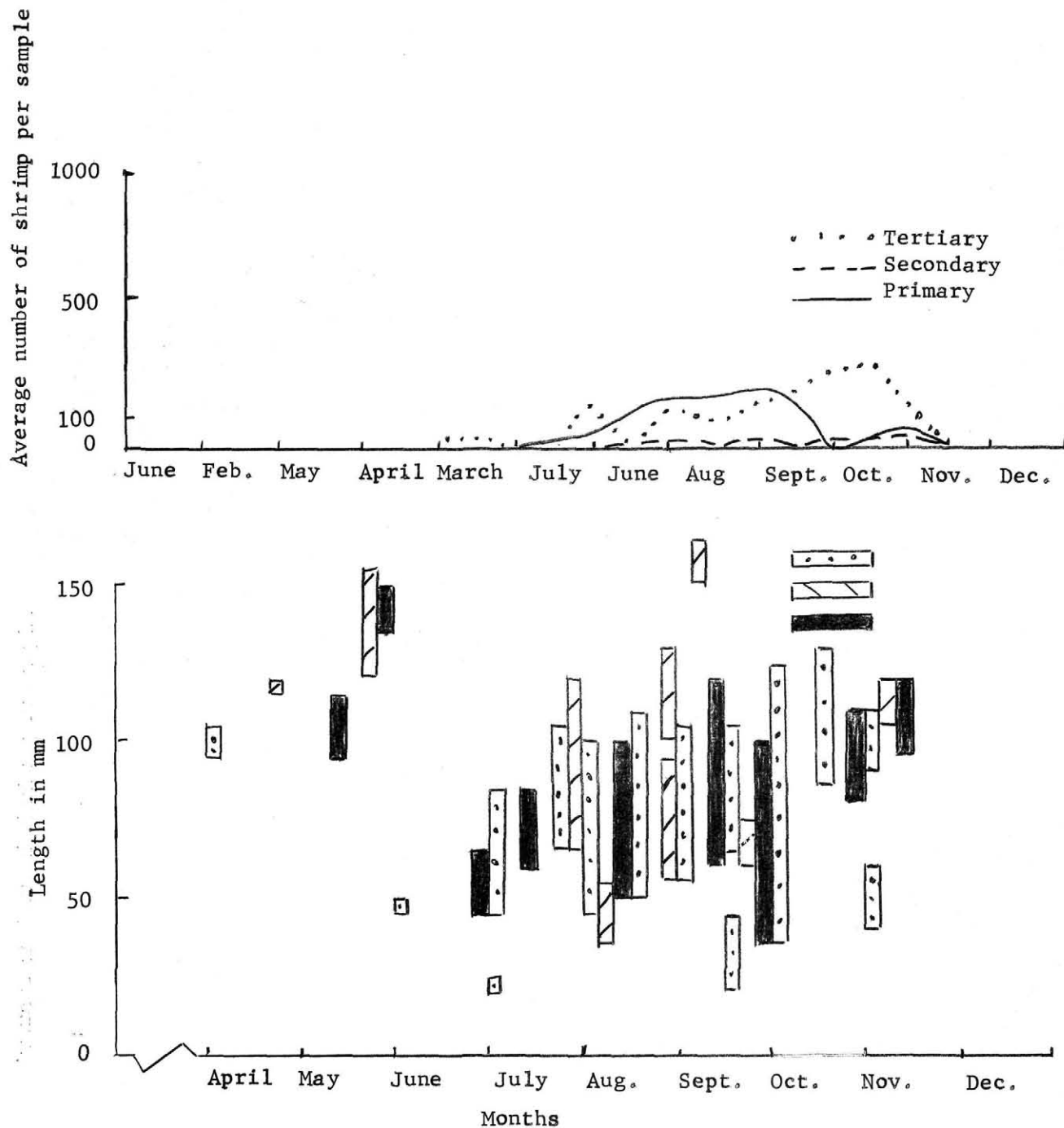


Figure 24: Average number of white shrimp per sample (top). Monthly progression of modal white shrimp lengths (bottom). Lower Laguna (1964).

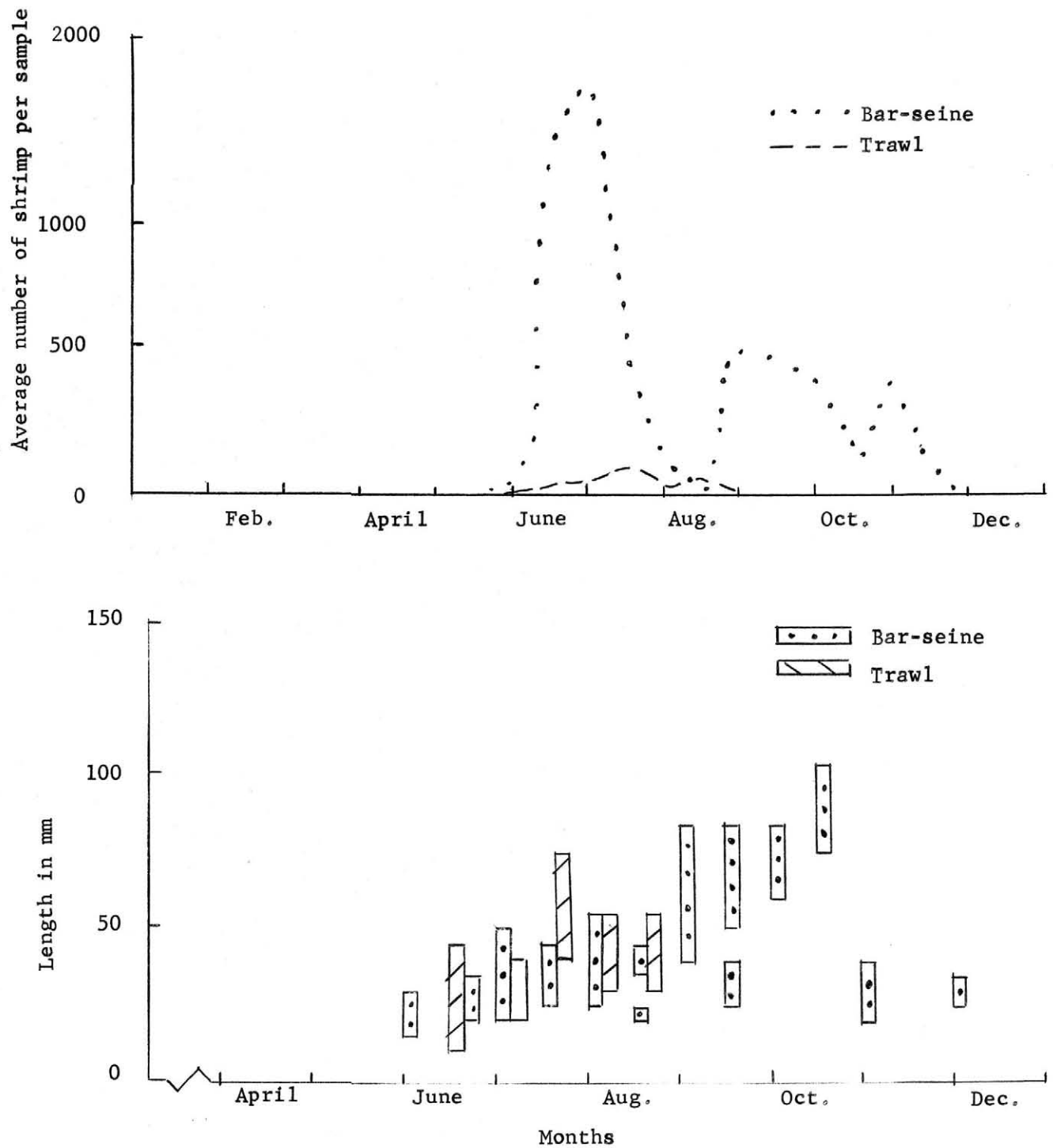


Figure 25: Brown and white shrimp catch curves based on samples collected inside Texas coastal bay (1963-1964)

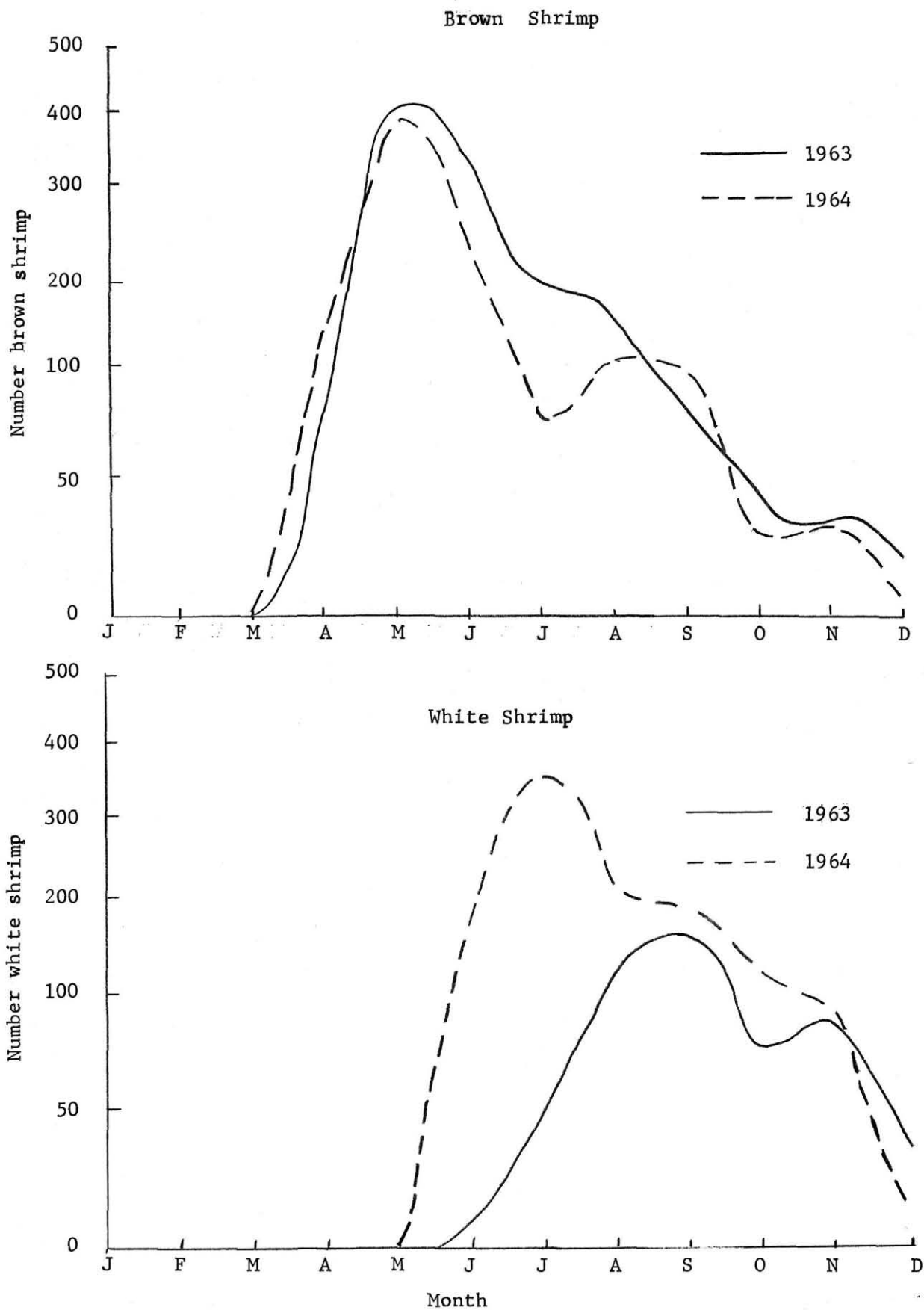




Figure 26: Modal sizes of shrimp by species based on samples from the shallow Gulf off Port Mansfield and Port Isabel (1964)

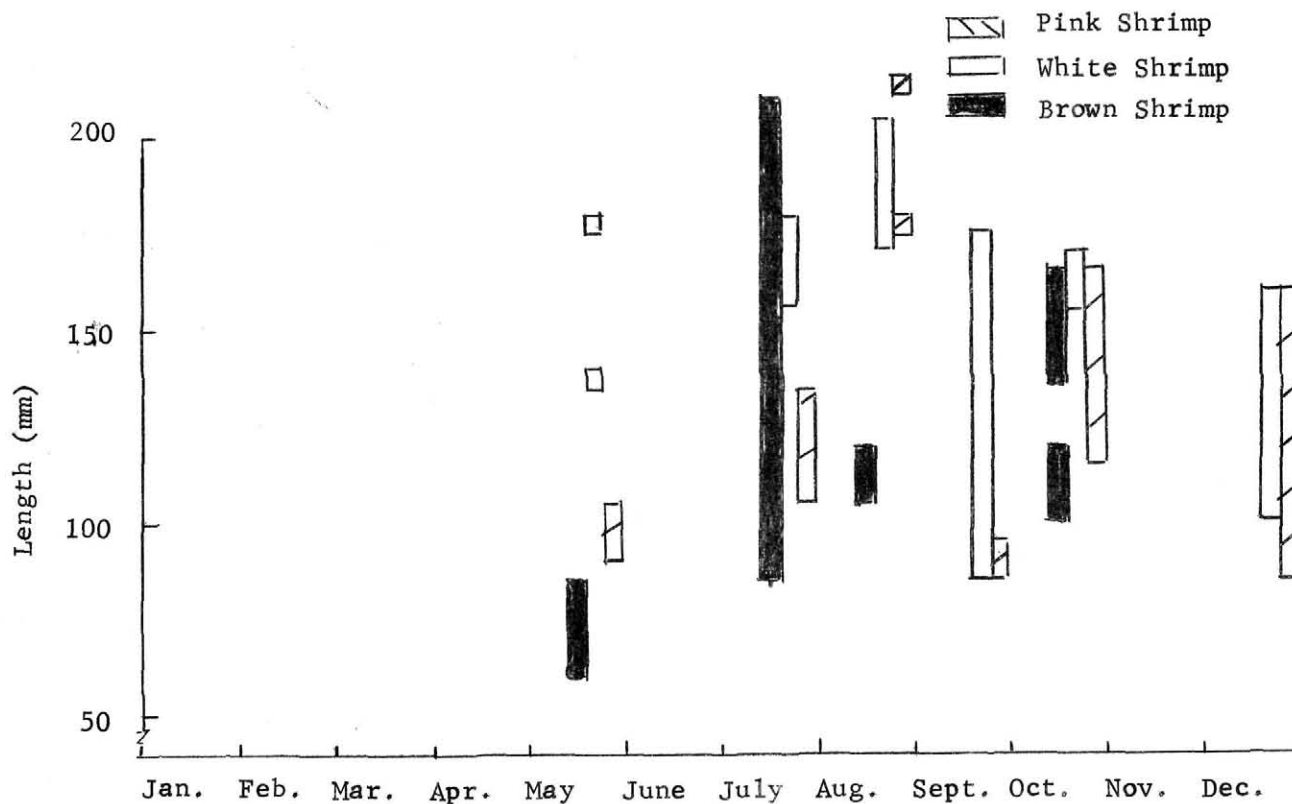


Figure 27: Modal sizes of shrimp by species based on samples from the shallow Gulf off Port Aransas (1964)

