An Ecological Evaluation of Some Tributaries of the Aransas Bay Area

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T. L. Heffernan

Abstract

Environmental conditions were surveyed in the Copano and St. Charles Bay tributary areas in 1969 and 1970.

The white shrimp (Penaeus setiferus) and blue crab (Callinectes sapidus) habitat in the vicinity of Chiltipin Creek and Mission River was found to be adversely affected by oilfield brine. Production of commercial crustacea in the Aransas River was found to be severely retarded by abnormal salinity and water quality conditions attributed to oilfield brine from Chiltipin Creek.

Tributaries of St. Charles Bay had water of very high quality and were normally very productive. The entire St. Charles Bay system appeared to be prime habitat for adult and juvenile food and game species.

Heavy rainfall alleviated poor conditions in Chiltipin Creek, the Aransas River and the Mission River, but this relief was short-lived.

Introduction

Biological studies of tributary streams in Copano and St. Charles Bays have been relatively few and have dealt primarily with finfish inventories and pollution surveys.

The Aransas River has been surveyed by Flury (1956) who noted salinities in the stream as high as 52.90 parts per thousand (ppt) and attributed the hypersaline condition of the river and the resulting damage of the fresh water habitat to oilfield brine from Chiltipin Creek.

Renfro (1958) reported salinities ranging as high as 58.00 ppt nine miles upstream from the mouth of the river and as high as 41.00 ppt 25 miles upstream. He noted that brine waters from Chiltipin Creek entered the river and influenced salinities.

Spears (1959) attributed salinity extremes in Aransas River to the influence of Chiltipin Creek and noted the loss of Chiltipin Creek as freshwater habitat because of brine disposal methods. Bioassay studies using the bluegill sunfish (Lepomis macrochirus) established a TLm of 11.2 per cent oilfield brine.

A second study by Spears (1960) noted excessive concentrations of oil in Chiltipin Creek and ionic imbalances between samples from Chiltipin Creek and Copano Bay with greatest variance in chloride, calcium, sodium,

and potassium. In this study pinfish suffered 100 per cent mortalities at 45.00 ppt salinity for oilfield brine and no mortalities at 41.00 ppt salinity for bay water.

Copeland and Moseley (1969) classified Chiltipin Creek as a brine dominated area and noted that a considerable amount of oil entered Copano Bay from the creek. Faunal communities consisted primarily of zooplankton and plankton-feeding fishes, typical of brine dominated systems, where the habitat is unusable for median tolerant marine species.

Mission River studies conducted by Flury (1958) and Spears (1959) (1960) described extensive environmental damage to the river waters, bed and populations from oilfield brine disposal and oil pollution in the river. Estimated flow of brine into the Mission River was 2.5 million gallons per 24 hours. Freshwater fish populations in the river proper were non-existent and the only marine fish found were euryhaline species.

This current study covered all tributaries of Copano and St. Charles Bays and was designed to evaluate the effects of brine on the habitat and on commercially important marine organisms.

Area Description

The Aransas Bay system (Figure 1) is a classic Texas marine ecosystem involving primary, secondary and tertiary bays. The predominant species utilizing this system for nursery areas are spawned in the Gulf of Mexico and migrate into the fresher waters of the bay generally during the post-larval stage.

The two primary bays, Aransas and Mesquite, are directly connected to open Gulf of Mexico waters by passes through Matagorda and Mustang Islands. These bay areas are influenced by tidal flow from the Gulf of Mexico and salinity approaches that of normal sea water.

The secondary areas, St. Charles, Copano, Redfish, and Dunham's Bays, represent major portions of available nursery grounds for white shrimp (Penaeus setiferus) and blue crabs (Callinectes sapidus). These areas are shallower than primary bays and are generally influenced by freshwater runoff from rivers and creeks as well as by tidal movements. They support extensive growths of algae and "grasses" which provide bottom cover and protection for juvenile fish and crustacea.

Copano Bay is the largest of these secondary bays with 39,526 acres of open water. The shoreline areas are generally shallow (less than 4 feet deep) from shore to five hundred feet bayward and comprise approximately 2,394 acres. This area is utilized as nursery grounds by juvenile fish and brown shrimp during the spring months (April-June) and to a lesser extent by white shrimp and blue crabs in the fall.

St. Charles Bay is the second largest area with 8,979 acres, all of which serves as nursery area to some extent. Brown shrimp are generally distributed throughout the 30 miles of shoreline in April, May and June. White shrimp are normally distributed about the shoreline but are concentrated

in the upper portion of the bay near the entrances of five creeks which provide freshwater to the area. This bay supports an extensive fish population and sports fishing pressure is greater than in any other portion of the Aransas Bay area.

Other secondary bay areas, Redfish and Dunham's, have the same general features as St. Charles Bay with the exception of freshwater flow directly from a stream. They are shallow, densely vegetated and provide prime nursery areas for marine organisms.

Tertiary areas of the Aransas Bay system are restricted to lower areas of creeks and streams which enter secondary systems. The largest tertiary area is Port Bay with 4,816 acres (Figure 1). It extends from Copano Bay southward for approximately 8 miles. Shoreline length is estimated as 19 miles. Freshwater is obtained from creek drainage in an area of marsh located northwest of the City of Aransas Pass and designated as McCambell Slough on the U. S. Geological Survey map of the area.

Mission Bay and the lower Mission River (Figure 1) are the major producing tertiary areas, totaling 3,938 acres. Mission Bay is located between Copano Bay and the mouth of the Mission River. It is very shallow, averaging less than two feet in depth at normal water levels. This bay has supported live oysters at intervals but not of commercial quantity or quality due to the taste of oil in the oyster meats.

Copano Creek, located in the northwest end of Copano Bay contains about 908 acres of tertiary nursery grounds.

Chiltipin Creek and the Aransas River system are classified as tertiary areas. The tidal area of the Aransas River area is estimated at 694 acres. This does not include the upper portion of the river or Chiltipin Creek which have a combined total of 617 acres.

Methods and Gear

Monthly sample procedures were initiated in June 1969 for Mission River; July 1969 for Aransas River; and September 1969 for Chiltipin Creek and the St. Charles Bay creeks. The monthly sample interval was maintained until September 1970 when, in order to obtain a better perspective of the influence of rainfall in Chiltipin Creek and the rapidity of brine-caused salinity increases, the interval was changed to weekly. This interval was maintained through September and October 1970 when the project terminated.

Faunal samples were obtained with an otter trawl pulled for 15 minutes at each station designated in Figures 2, 11, 13 and 15. The sample trawl was 12 feet (3.66 meters) wide at the mouth. Body and throat were constructed of 1.25 inch (3.18 cm) stretched mesh,(No. 12 nylon). The bag section was lined with 0.25 inch (6.3 mm) stretched mesh nylon webbing.

Each trawl sample was towed by an outboard motor skiff at a speed of approximately 1.3 miles per hour and covered approximately 20,600 square feet per drag. For comparison purposes a unit of effort is designated as a 15-minute standard drag. In Chiltipin Creek, Aransas River and Mission River at stations deeper than four feet the catches were increased significantly by trawling the upper slope of the banks. This method was utilized whenever possible.

Hydrographic samples were taken with a two-liter VanDorn type water sampler at bottom and surface during the survey period from September through October 1970. Prior to that period only bottom samples were collected. Bottom water samples obtained one foot above the bottom and surface samples from one foot beneath the surface were taken in conjunction with all trawl samples.

Field analysis were made for dissolved oxygen utilizing pre-prepared Hach chemical pillows for titration following the Winkler method. Oxygen determinations are presented in parts per million (ppm). Salinity determinations were made with an American Optical refractometer and by silver nitrate titration utilizing the Knudsen method of chlorinity analysis. Data is presented in parts per thousand (ppt). Turbidities were determined with a Jackson turbidimeter and expressed as parts per million suspended solids. A Corning double anode meter was used on all pH analyses. Temperatures were determined with mercury thermometers and presented in degrees centigrade.

Rainfall data were obtained from U. S. Weather Bureau Stations in Rockport, Sinton, Refugio, Woodsboro, and the Texas A&M Experimental Station near Beeville. River flow data for the Aransas and Mission Rivers were obtained from gauge recordings taken by the U. S. Department of the Interior Geological Survey - Water Resources Division. Flow data are presented in acre-feet per month.

Results

Chiltipin Creek Physical Characteristics - Chiltipin Creek is approximately 23 miles long and has an average width of 50 feet at normal levels. The creek heads approximately two miles northwest of the city of Sinton and joins the Aransas River approximately two and one-half miles west of the Bayside Causeway. The area and sample stations are shown in Figure 2. Stream depth is variable from 0.5 to 4 feet and averages 1.5 feet during normal conditions. Chiltipin Creek is not dependent on rainfall for flow. A Texas Railroad Commission special report in 1968 estimated the average daily flow of oilfield brine into Chiltipin Creek as 15 million gallons per day (357,000 barrels). The creek also receives about 0.5 million gallons of sewage effluent from the plants in the city of Sinton (personal communication with City of Sinton engineer).

The lower 1.5 miles of Chiltipin Creek physically resembles normal coastal creek habitat. The banks are vegetated with salt grass (Distichlis spicata) and no visible abnormalities are noticeable. The conditions upstream change rapidly with discolored water, bluegreen algae blooms, shoreline erosion and silted sand bars the predominant characteristcs of environmental damage.

Chiltipin Creek Hydrography - Station CC-1, located at the mouth of the Aransas River (Figure 2) was subject to salinity influences from Copano Bay and the downstream flow of Chiltipin Creek. Salinity at this station was moderate ranging from a low of 2.22 ppt in June 1970 to 16.10 ppt in March 1970. Average for the period of September 1969-September 1970, was 10.21 ppt.

The average at Station CC-2, located below the junction of Chiltipin Creek and the lower Aransas River, was 13.23 ppt. The low was 0.00 ppt in December 1969 and the high was 34.98 ppt in February 1970. The average at this station was 3.01 ppt higher than Station CC-1, an increase of 29.48 per cent.

Station CC-3 is located in the downstream vicinity of the confluence of the Aransas River bypass creek into Chiltipin Creek. This station receives the direct flow from the Aransas River system. Salinities averaged 18.92 ppt and ranged from the low of 0.00 ppt in October 1969 to a high of 49.96 ppt in March 1970. The station average of 18.92 ppt is an increase of 85.30 per cent over Station CC-1.

Station CC-4 was not regularly sampled until January 1970. The average for the seven months sampled was 28.85 ppt. The low occurred in June and August 1970 with 5.56 ppt. The high recorded was 61.07 ppt in March 1970. The average of 28.85 ppt represents an increase of 182.56 per cent over Station CC-1. Hydrographic data for each monthly sample for all stations are presented in Table 1.

Surface salinities were recorded in conjunction with each bottom sample beginning on September 9, 1970. Table 2 presents the station comparison data by week. Bottom salinity averages for the period of weekly samples through September and October ranged from a low of 3.43 ppt on October 15, 1970 to a high of 37.38 ppt recorded on September 15, 1970. Surface salinities on the same dates varied from a low of 1.86 ppt to a high of 26.03 ppt.

The highest salinities for the six stations were recorded on December 18, 1970 with a bottom average of 52.25 ppt and a surface average of 36.15 ppt (Figure 3). Bottom salinity averages by station ranged from 13.03 ppt at CC-2 to 35.65 ppt at Station CC-6 (Figure 2). Surface salinities ranged from 12.42 ppt at CC-1 to 35.34 ppt at CC-6. Figure 4 compares bottom-surface salinity ranges with rainfall for September-December 1970.

Station salinity averages from September, October, and December 1970 increased consecutively from CC-1 to CC-6. The average salinity for bottom and surface samples and the per cent of increase of each bottom salinity for each upstream station above CC-1 are shown in the following table.

Station	Bottom Salinity	%Increase	Surface Sal.(%)	%Increase
CC-1	13.79	Base	11.91	Base
CC-2	13.03	0	12.42	4.28
CC-3	26.26	90.42	13.46	13.01
CC-4	27.67	100.65	13.94	17.04
CC-5	31.61	129.22	22.10	85.55
CC-6	35.65	158.52	35.34	196.72

These data reflect the influence of Chiltipin Creek salinity on the Copano nursery area during a four-month period in which 16.35 inches of rainfall, well above normal, fell on the Chiltipin Creek watershed.

Rainfall data for the Chiltipin Creek area are presented in Table 3. The area average of 40.48 inches for 1969 and 40.12 inches for 1970 was derived from weather stations data at Rockport and Sinton. During the study period from August 1969 to December 1970 a total of 63.23 inches fell in the vicinity of Chiltipin Creek. The monthly average was 3.72 inches. The low recording was 0.63 inches in December 1970 and the high was 7.67 inches in September 1970.

Monthly hydrographic data for the Bayside Causeway station in Copano Bay are presented in Table 4. Included are salinity and the associated data for temperature, dissolved oxygen, pH and turbidity. In Figure 5 this station is compared with Stations CC-1 and CC-2 (Figure 2) located in the lower Aransas River-Chiltipin Creek area. This comparison clearly indicates the excessive salinity extremes are not derived from Copano Bay but are attributable to brine flow in Chiltipin Creek. Salinity fluctuations at Chiltipin Creek stations CC-1 and CC-2 coincide with fluctuations at the Bayside Causeway station and indicate the effect of Chiltipin Creek on Copano Bay. Major increases in salinities in Chiltipin Creek occurred in February, March and April 1970 correlated with a general increase of Copano Bay salinities.

Temperatures ranged from a low of 13.3° C. in February (CC-1) to a high of 34.0° C. (CC-1). Dissolved oxygen had a monthly average range of 3.25 ppm to 9.00 ppm. pH readings ranged from 6.10 to 8.65 and averaged 7.74. Turbidities ranged from 25 ppm to 430 ppm suspended solids and averaged 129.02 ppm. Copano Bay hydrographic data for the causeway averaged 12.56 ppt salinity, 22.35° C. temperature, 8.31 ppm dissolved oxygen, and 54.84 ppm suspended solids.

Chiltipin Creek Population Distribution and Abundance

A species listing and individual percentage of catch is presented in Table 5. The catch data is listed therein as "regular" and "special" to distinguish between the standard monthly samples and the weekly samples taken in September and October 1970. Thirty-two species of finfish and five species of crustacea were identified. Brevoortia patronis and Brevoortia gunteri catches are combined and presented as total catch of Brevoortia sp., and Palaemonetes pugio and Palaemonetes intermedius are combined under Palaemonetes sp. because of difficulty with field identification. B. patronis was the more numberous menhaden.

The dominant fish species and their percentage of total catch were common anchovy, Anchoa mitchilli (22.71%); spot croaker, Leiostomus xanthurus (9.66%); menhaden (8.63%); atlantic croaker, Micropogon undulatus (7.57%); and striped mullet, Mugil cephalus (2.74%). White shrimp, Penaeus setiferus, was the dominant crustacean and most numerous single species collected with 3,866 individuals taken in 95 samples comprising 30.21 per cent of the total catch.

Salinities and commercial crustacea catches are compared in Table 6 to show the effect of brine-based salinities in Chiltipin Creek upon white shrimp, brown shrimp and blue crabs. White shrimp population density peaked in October 1969 with a catch of 515 individuals following a radical decrease in salinity to 2.41 ppt from September when an average of 29.79 ppt and a catch of only 9 shrimp were recorded. White shrimp densities were influenced by seasonal migration and cool temperatures in December, when only two were caught, and the species did not reappear in significant numbers until August 1970.

Salinity averaged 5.84 ppt during the August 1970 sampling period when 231 white shrimp were collected (Table 6). These shrimp ranged in size from 57 to 82 mm and moved into the creek area to terminate their migration from the Gulf of Mexico to the tertiary nursery grounds, where they normally stay until emigrating to the Gulf as adults (Gunter 1950).

In September 1970, five weekly samplings (28 standard samples) yielded 1,185 individuals. Weekly salinity averages ranged from 18.18 ppt to 37.38 ppt. Only 5 shrimp were caught in salinities above 28.87 ppt. October 1970 catches totaled 1,910 individuals from 24 samples. Salinity averages ranged from 3.43 ppt to 14.25 ppt. Shrimp were caught at all six stations during the month. The highest weekly total was 1,051 individuals collected on October 20, 1970 when salinities ranged from 0.00 to 14.99 ppt, averaging 7.95 ppt. December 1970 catches totaled only 9 individuals. Salinities ranged from 28.05 ppt at station CC-1 to 72.70 ppt at CC-6. Salinity average for the six stations was 52.74 ppt. Catch per effort for the entire period was 40.69 (Table 7). The highest yield was at Station CC-1 with 63.30 individuals per effort followed by CC-2 with 57.45.. Stations CC-3, CC-4, CC-5 and CC-6 had declining yields of 22.50, 40.00, 31.11, and 4.55, respectively.

White shrimp sizes in 1969 ranged from 63 to 136 mm in September, 25-104 mm in October and 80-82 mm in December. Modal lengths in September and October were 76 and 69 mm, respectively. Scarcity of juvenile shrimp smaller than 30 mm was of some concern until the data from the other areas sampled reflected the same lack of these size shrimp in any significant abundance.

The brown shrimp, Penaeus aztecus, was a major species with 9.71 per cent of the total catch and 1,242 individuals. The species was present in September 1969 when 1 individual was taken at station CC-1 and in October when 14 were collected at CC-1 and 3 at CC-2. None were caught from December 1969 through March 1970. Significant numbers appeared in April with a catch of 102 at Station CC-1 (Table 6). Catches increased to 320 individuals in May and peaked in June with 778 individuals taken at Stations CC-1 through CC-4 when salinities ranged from 1.12 ppt to 5.56 ppt. Seasonal emigration lowered catches to 2 individuals in July, 0 in August, 5 in September and 16 in October. Salinity averages during this same period increased from 5.84 ppt in August to a weekly high of 37.38 ppt in September and dropped in October to a low weekly average of 3.43 ppt. Catch per effort for the entire period was 13.06. The most productive station was CC-1 with 32.60 per sample. There were declining catches per effort of 18.91, 6.64, 1.69, 0.44 and 0.11 for stations CC-2 through CC-6.

Blue crabs accounted for 0.80 per cent of the total catch with 102 individuals. The highest monthly catch was in December 1970 with 15 individuals. Only one crab was taken in salinities in excess of 29.00 ppt (Table 6). The catch per effort for 95 samples was 1.07 (Table 7). Station CC-1 contributed 50 per cent of the total blue crab catch and a catch per effort of 2.55 for 20 samples. At station CC-2, 26 crabs were caught in 22 drags for an average catch of 1.18 and for 25.29 per cent of the total crab catch. Stations CC-3 through CC-6 had individual catches per effort of 0.68, 0.54, 0.11 and 0.22 crabs, respectively.

Finfish catch per effort data are not presented. Catch totals and percentages are presented in Table 5 for each species collected.

Aransas River Physical Characteristics - The Aransas River drainage area extends into Bee, Refugio, and San Patricio Counties and covers approximately 247 square miles (Figure 6). The stream is basically dependent on local rainfall for flow. Flury (1956) found no flowing water except as the result of tidal changes and run-off from rains. The city of Beeville and Chase Field Naval Air Station discharge sewage effluents into Poesta Creek which enters the river northwest of the city of Sinton. The navigable portion of the river extends from a mile north of the U. S. Highway 77 bridge, near Sinton, downstream to Chiltipin Creek, a distance of approximately 27 miles (Figure 2).

Flury (op cit) made cross-sectional soundings of the lower 26 miles of the river and reported an average depth of 5.21 feet and an average width of 146 feet. The historic mouth of the river has been blocked by an earthen dam originally constructed by the Welder Ranch during the 1930's, and intended to prevent saltwater encroachment into the river from Copano Bay. Flood waters have since cut a narrow winding by-pass creek about a mile upstream of the dam. This by-pass allows river flow to enter Chiltipin Creek (Figure 2) thence into the lower portion of the natural river bed below the dam and into Copano Bay south of the Bayside Causeway. The area below the junction of Chiltipin Creek and the river bed is referred to as the Aransas River delta.

Aransas River Hydrography - The monthly discharge of the Aransas River during the study period averaged 979.00 acre-feet. The annual discharge for 1969 was 995.08 acre-feet. The monthly average for January through September 1970 was 1,326.44 acre-feet (Table 8). The influence of river flow on salinities is presented in Figures 7 and 8. Figure 7 presents a comparison of monthly flow and monthly salinity averages for the sampling area. Figure 8 compares salinities at Station AR-1 to the flow rate and shows the influence of Chiltipin Creek brine at that point. Salinity data from station CC-3 is also presented to show the definite correlations between salinities in Chiltipin Creek and those at the mouth of the Aransas River. The basic difference between the two stations is the dilution by Aransas River flow at AR-1. Figure 8 compares the monthly composite rainfall data to river flow for the survey period. Rainfall data is presented in Table 9 for the three stations in the Aransas River watershed.

Table 10 presents data obtained from water analyses for Stations AR-1 through AR-11. The data does not reflect any abnormal hydrographic conditions

other than excessive salinities. Temperature conditions were stable throughout the study period and no freeze kills or extremes were noted.

Dissolved oxygen levels averaged 5.35 ppm during the study. Two stations AR-5 and AR-7 presented fluctuating levels but had averages above 3.5 ppm. A comparison of trawl catch and hydrographic data in Table 6 and 8 does show low or negative catches where dissolved oxygen was below 3.0 ppm. This occurred in August 1969 at stations AR-1 through AR-5. Extremely high dissolved oxygen recordings were made in February 1970 at Station AR-2 with 20.0 ppm and AR-3 with 16.0 ppm. There was no evidence of a plankton bloom or other factors which could have created this condition; however, the condition did not exist when a recheck of the stations were made.

Each water sample was analyzed for pH and the average for all stations ranged from 7.36 to 8.15. Turbidity averages ranged from 80.6 to 181 ppm suspended solids.

Aransas River Population Distribution and Abundance - Populations of finfish and crustacea varied from species commonly found in freshwater habitat to marine organisms spawned in the Gulf of Mexico. During the course of this study 8,183 individual organisms were collected in 85 trawl samples in the Aransas River. Thirty-six species of finfish and seven species of crustacea were identified and are presented in Table 11 with the percentage of the total catch.

Eleven species of freshwater fish were collected in addition to two species of river shrimp, Macrobrachium ohione and Macrobrachium acanthurus. The river shrimp are listed under the genus Macrobrachium sp. because of difficulty in field identification. M. ohione was the more abundant species of river shrimp, Brevoortia patronis and Brevoortia gunteri are grouped under Brevoortia sp. and two species of grass shrimp, Palaemonetes pugio and Palaemonetes intermedius are combined as Palaemonetes sp.

The major finfish species of the Aransas River and associated percentage of the total catch are the common anchovy (12.24%), gizzard shad (10.20%), tidewater silverside (9.19%), Atlantic croaker (5.85%), channel catfish (5.41%) and menhaden (4.76%).

Crustacea species accounted for over a third of the total catch with white shrimp (24.97%) and the two species of grass shrimp (10.08%) as the major groups. White shrimp were the most abundant single species with 24.97% of the total catch and a total of 2,043 individuals. The catch per effort was 81.72 from 83 samples (Table 12). There were two seasonal occurrences with peaks in November 1969 and September 1970. The 1970 population peak possibly occurred after the Aransas River segment of the study was terminated.

Brown shrimp were collected at only two stations (Table 12) and produced a catch per effort of 1.38 from 85 samples. Scarcity of blue crabs in the Aransas River was notable although they were caught in 11 out of 15 months. A total of 85 samples produced only 23 individuals and a catch per effort of 0.27. The largest monthly catch was seven in June 1970.

White shrimp were not taken until September 1969, when 3 ranging from 80 to 89 mm were caught at AR-2. In October the catch increased significantly and white shrimp ranged from Stations AR-1 upstream to Station AR-5. Total catch was 241 with a size range of 47 to 130 mm. Salinities ranged from 5.56 to 8.89 ppt and averaged 7.00 for the 5 stations (Table 10).

Peak catches for the period were made in November 1969, with 1,100 white shrimp ranging in size from 58 to 125 mm. Mean size was approximately 85 mm. Bottom salinities increased to a range of 29.98 ppt. at AR-2 to 5.56 ppt upstream at AR-5 (Table 13). December catches fell sharply to a total of 45 shrimp ranging in size from 55 to 106 mm. Mean size was 80 mm. Temperatures had dropped to 13.9° C. and salinities were reduced to an average of 5.66 ppt by local rains.

The species did not appear again until July 1970, two months earlier than in 1969. Catches increased from 27 individuals in July to 130 in August, to 497 in September when the study segment was terminated. Salinities were low, averaging 3.70 ppt, 4.04 ppt and 6.35 ppt, for the three respective months.

Sizes ranged from 72-122 mm in July, 68-114 mm in August and 36-126 mm in September.

Aransas River Modification - Chiltipin Creek flow is pushed into the Aransas River by tidal action and during periods when flow from the creek is greater than that of the Aransas River. The result as shown in Table 11 is an abnormal increase of salinities in the river. The Refugio County Water Development District No. 2 constructed two permanent barrier dams at the junction of the creeks and the Aransas River (Figure 2). These dams were elevated to two feet above mean high tide so as to prevent any intrusion of saltwater, marine or brine, into the Aransas River. Both failed during heavy rains following termination of this study.

This type construction could make an elongated lake of the Aransas River and it could eventually become entirely freshwater habitat. The effect would be two-fold. The pollution of the Aransas River would cease and a stable freshwater recreation area could be developed. Flow of dilution water into the Chiltipin Creek area would be reduced and the effect of brine waters on Copano Bay nursery areas would be increased. There might be permanent loss of the nursery area provided by the Aransas River for crabs and shrimp, if and when the water quality of Chiltipin Creek is ever brought to satisfactory condition for faunal survival.

The loss would not be greater than that which is happening under present conditions, however. The Aransas River would be more valuable as a freshwater habitat until Chiltipin Creek conditions are changed.

Mission River Physical Characteristics - The Mission River drainage area (Figure 10) is 690 square miles. The river is formed at the junction of Medio and Blanco Creeks, approximately three miles northwest of the City of Refugio.

The stream is shallow (1.5 feet) at the mouth, deepens to 14 feet upstream, and averages 4.27 feet. Average width is estimated at 150 feet. The river is approximately 21 miles long from the confluence of Medio and Blanco Creeks to the mouth at Mission Bay.

Mission River receives drainage from several small creeks and the Refugio sewage plant. The river also receives approximately 1.5 million gallons of oilfield brine per day in addition to large quantities of crude oil and oilfield wastes. Portions of the stream from Dry Creek (Station 7) downstream to Station 5 were observed to be covered with oil on each sample visit. Station locations are shown in Figure 11. Brine discharges from separators on the banks are prevalent along this area. The river has many turns and horseshoe loops which restrict surface current from wind action. This condition aids in containing surface oil in specific areas and lessens downstream movement.

Mission River Hydrography - River flow, presented in Table 14, averaged 12,258.33 acre-feet per month in 1968 but decreased by over 50 per cent in 1969 to a monthly average of 5,023.33 acre-feet. A slight increase to 5,901.44 acre-feet per month was recorded for 1970. The peak flow rate of 21,900 acre-feet recorded in June 1970 followed a peak period of rainfall in May 1970. Rainfall at three locations, Rockport, Woodsboro, and Beeville averaged 3.44 inches per month (Table 15). The peak average was 6.30 inches in May 1970. Lowest recorded was 0.88 inches in July 1969. The lowest single reading was at Beeville with 0.05 inches recorded in October 1970. The highest was at Rockport with 10.17 inches during the same month.

Figure 12 shows a comparison of rainfall and river flow for the Mission River. A good correlation exists throughout the period from June 1969 to August 1970. River flow data was not available past September 1970, and the influence of September and October rainfall cannot be shown. The general trend is evident, however, during the previous months, particularly when monthly rainfall averages exceeded three inches. The increase in flow often lagged behind the rainfall because of the periodicity of precipitation and the use of monthly averages.

Salinity correlation with monthly rainfall averages is also presented in Figure 12. The figures coincide well from June 1969 through March 1970. In May 1970 the influence of precipitation increase to 6.30 inches was not reflected in the salinity data. Instead of the expected decrease in salinity an increase was recorded from 4.94 ppt in April to 10.82 in May. This is attributed to the influence of normal spring tides which pushed saline Copano Bay waters into the river area. Tide levels in May 1970 averaged 0.5 feet above those in April 1970. The denser saline water formed a strata on the bottom and the fresher water on occasion flowed downstream over an incoming tide. The effect is readily evident in the Chiltipin Creek and Aransas River salinity data presented in Tables 2 and 10 where additional surface data are available.

Salinity and rainfall data are available through October 1970 and the influence of September and October rainfall on salinity averages is presented in Figure 12. Salinities in October decreased to 0.00 ppt at all stations (Table 16) following 6.71 inches of rainfall in September 1970.

Table 16 shows hydrographic data obtained from water samples at stations MR-1 through MR-7. Salinity averages by station ranged from 4.70 ppt to 7.96 ppt. The highest station, MR-7, was the farthest upstream (Figure 11). Station MR-6 averaged 7.63 ppt on the bottom and 4.43 ppt at the surface. Station MR-5 ranged from an average of 5.12 ppt at the bottom to 3.25 ppt at the surface. Station MR-4 was 4.70 ppt at the bottom and 1.59 ppt at the surface. Temperature extremes for individual stations ranged from a low of 10.3° C. in January 1970 to a high of 33.3° C. in July 1970. Monthly averages for the study period ranged from 22.14° C. at MR-1 to 25.36° C. at MR-6. Dissolved oxygen was generally stable. The low station was MR-6 with an average of 4.12 ppm. The high average was recorded from Station MR-2 with 7.82 ppm. pH varied from a low of 6.55 at MR-7 to a high of 8.80 at MR-8. Averages ranged from 7.58 to 7.83. Turbidity recordings varied from 70.82 ppm to 174.64 ppm.

Mission River Species Abundance and Distribution - 19,737 individual organisms were collected and identified during the 15 months survey period (Table 18). The major species of finfish recorded were menhaden (14.46% of total catch), atlantic croaker (7.71%), spot croaker (6.27%), and common anchovy (4.92%). Major crustaces were white shrimp (47.14%) and brown shrimp (4.39%). Most of the fish were marine species. Only three freshwater fish were collected during the survey. Two white crappie and one black bass were taken in the vicinity of Melon Creek. Flury (1958) found several freshwater species in the extreme upper portion of the river north of Refugio, but none in the main water course of the river.

Species composition, numbers and size ranges for finfish and crustacea are presented in Table 17 for the 76 standard trawl samples taken during the survey. These data are presented for each station each month.

The relationship of the commercial crustacea (white shrimp, brown shrimp and blue crabs) to salinity and conditions is presented in Table 18. A notable difference between 1969 and1970 salinity conditions is presented. From August through November 1969 salinities averaged 13.32 ppt, 11.10 ppt, 14.10 ppt, and 11.55 ppt for each respective month. White shrimp catches were low to moderate until the peak catch of 3,282 individuals in November.

In 1970 salinity levels were much lower and white shrimp appeared in the area in June, two months earlier than 1969. Salinities ranged from 1.39 to 7.38 ppt during the population period. Peak catches in October 1970 corresponded with average salinities of 0.00 ppt.

White shrimp comprised 47.14 per cent of the total catch with 9,304 individuals in 76 standard samples. This figure includes two seasonal peaks in November 1969 and October 1970. Catch per unit effort was 118.62.

Catch varied with individual stations with Stations MR-1 (201.46 C/E) and MR-3 (293.47 C/E) the predominant areas of population concentration. Station MR-2 is at the mouth of the first inland lake on Melon Creek (Figure 11) and catches were variable (Table 18) with shrimp movement, tide fluctuations, and salinities. The most productive station was MR-3 at the junction of Melon Creek and the Mission River (Figure 11). White shrimp were consistently concentrated in this area in October and November 1969 with catches of 350 and 2,442 during the respective months. This condition was attributed to freshwater flow from Melon Creek.

Brown shrimp catch for the study period totaled 847 individuals obtained in 76 samples. Catch per effort was 11.14. Seasonal abundance, shown in Table 18, reached a major peak in May 1970 with 518 individuals. Salinity average for the area was 10.82 ppt. Salinities in June were reduced to 1.39 and the brown shrimp totals dropped accordingly to 239 individuals. July salinities remained low with an average of 1.11 ppt and the only brown shrimp taken were at MR-1 with a total of 34 individuals.

Blue crabs comprised 2.73 per cent of the total catch (Table 17). The catch per effort was 7.08 from a total catch of 538 individuals. Catches were made in 13 out of 15 months. Station MR-1 with a catch per effort of 14.85 and MR-3 with 10.33 were the dominant areas of population density. Station MR-2 at Melon Creek followed closely with 9.25. Upstream of Station MR-3, the catch decreased significantly at MR-4 with a catch per effort of 1.25. Station MR-6 averaged 1.80 individuals and Station MR-7 had 0.00 from 4 samples taken during the study period. Peak abundance was from January through March 1970 with corresponding salinities of 0.22, 3.55, and 0.64 ppt (Table 18). Sex ratio was 2.28 with 164 females and and 374 males.

Copano Creek Physical Characteristics - Copano Creek heads north of the city of Refugio and is approximately 23 miles long. The stream is entirely dependent upon localized rainfall for flow and is unique because it is relatively unaffected by man. The naturalness of the creek provides nesting areas for birds of many species. It has little erosion due to dense grass along the banks and is a biological opposite of Chiltipin Creek. The upper portion of the creek is located in the Tom O'Connor and Greta Oil Fields which are reputed to dispose of brine waters by injection methods.

The stream ranges in depth from 1 to 5 feet, averaging 2.4 feet in the navigable portion where Stations CO-1 through CO-5 were established (Figure 13). Average width is approximately 45 feet. The creek enters the northeast end of Copano Bay after widening to a shallow lake area approximately one mile in length and 0.4 miles in width constricting to a narrow channel. This shallow lake-like section of the creek contains extremely dense algae and "grasses" (primarily Rupia maritima) and supports live oysters near the exit into Copano Bay.

Nine miles of the creek are navigable from the mouth to a bridge which prevents further access but does permit circulation and flow.

Copano Creek Hydrography - Salinities during the sampling period from May 1969 through October 1970 (Table 20) averaged from 0.00 ppt to 13.70 ppt. Highest recordings were made in February 1970, with 14.44 ppt at Stations CO-1 and CO-2. Rainfall and salinity data are compared in Figure 14.

Temperature extremes ranged from a low of 16.1° C. in February 1970 to a high of 31.0° C. in August 1970. Low temperatures in other areas occurred in December 1969, when low tides prevented access into Copano Creek. Dissolved oxygen averages ranged from a low of 4.00 ppm in September 1969 to the high of 7.60 ppm in May 1970. pH ranges were from 6.80 in June 1970 to 8.59 in July 1970. Turbidities fluctuated from 77.60 in September 1969 to 124.00 in October 1970. Surface current velocities were variable ranging from a peak downstream flow of 2.5 miles per hour to upstream flow of incoming tides.

Copano Creek Population Density and Abundance - Copano Creek species diversification and percentages of total catch are shown in Table 21. The predominant finfish species caught and respective percentages of catch were menhaden (12.28%), common anchovy (9.16%), atlantic croaker (6.14%), and spot croaker (3.8%). White shrimp was the major single species with a catch of 3,753 individuals for 33.80 per cent of the total catch. Blue crabs (11.24%), brown shrimp (9.17%) and grass shrimp (5.35%) were abundant in the area and the crustacea outnumbered the finfish with 6,614 individuals out of a total catch of 11,104 individuals. River shrimp were a significant population group with 301 individuals taken to comprise 2.71 per cent of the total catch.

Random samplings in 1969 do not furnish valid comparison data over the survey period. Only one month, September 1969, was sampled during the period. It did, however, fall during the peak white shrimp period and the data are comparable to those of other areas for the same month.

Samples were taken on a monthly basis beginning in June 1970, continuing through October. These data are presented in Table 22. In September 1969, 965 white shrimp were taken from 4 stations, with Station CO-2 producing 845 individuals. Salinities averaged 0.28 ppt, ranging from 0.00 to 1.11 ppt. White shrimp appeared again in July 1970 when 902 were collected from 4 stations. Salinities averaged 2.04 ppt. Significant numbers were taken in August (564) and September (192) prior to the peak catch of 1,130 individuals in October 1970. Salinities dropped from 6.67 ppt. in September to 0.00 ppt in October. Catch per effort was 114.52 (Table 23). The high station was CO-2 with 2,233 individuals and a C/E of 279.12. Low station was CO-4 with 42 individuals and a C/E of 7.00.

Brown shrimp catches were highest in May 1970 with 1,018 individuals collected from 4 stations, representing a total catch per effort of 30.85. Station CO-1 with 434 individuals (catch per effort of 72.66) and CO-3 with 420 (catch per effort of 60.00) were the primary catch areas. None were caught at Station CO-5.

Blue crabs were well distributed and 1,240 were caught for a catch per effort of 37.58. Stations CO-2 through CO-5 produced catches of 52.25, 66.00, 24.00, and 41.66 per sample. The low stations were CO-1 with 46 individuals and a catch per effort of 7.66. There were three major peaks during the 1970 sampling. The first peak occurred in May with a total catch of 261 individuals from 5 stations. The population was distributed throughout the creek with catches ranging from 6 at Station CO-1, 39 at CO-2, 68 at CO-3, 90 at CO-4, and 58 at CO-5. Salinities averaged 4.78 ppt. July samples produced a catch of 369 with the concentration at Station CO-3 with 228 individuals. Salinities averaged 2.04 ppt. Catches fell to 60 in August and 42 in September but peaked again in October with 348 individuals collected at Stations CO-2 through CO-5. Salinity rises correspond with poor crab catches in August with 4.58 ppt and 6.67 ppt in September. In October the salinity decreased to 0.00 ppt.

St. Charles Bay Creeks Physical Characteristics - St. Charles Bay receives runoff waters from five creeks (Figure 5) which drain ranch and farm lands in the northern end of Aransas County and the southeast portion of Refugio County. Flow is dependent on local rainfall and tidal fluctuations.

Station StC-1, shown in Figure 15, is located in Burgentine Creek at the head of St. Charles Bay. This portion of the creek is 0.5 miles in length and is located below a dam which forms Burgentine Lake adjacent to the Aransas National Wildlife Refuge.

Twin Creek (Station StC-2) and Willow Creek (Station StC-3) also drain into the head of St. Charles Bay. Willow Creek is approximately 5 miles long, but is navigable for only a mile from the mouth. Twin Creek is a by-pass loop of Willow Creek and is navigable from the mouth of the bay to the junction with Willow Creek, a distance of approximately one mile.

Salt Creek (Station StC-5) is located on the west side of St. Charles Bay and is approximately 5 miles long. The creek forms a small shallow lake at the mouth, 5 miles in length by .2 miles in width, constricting to a narrow mouth 30 feet wide at St. Charles Bay.

Cavasso Creek (Station StC-4) is the southernmost creek in the bay and is the largest. The mouth is 1,200 feet wide at the junction with St. Charles Bay, but narrows to 100 feet at the Highway 35 bridge, 1.2 miles west of St. Charles Bay. Total length is approximately 6 miles with about 3 miles navigable. Average width is estimated at 40 feet. Depth varies from 1 to 4 feet and averages 2 feet.

St. Charles Bay Creeks Hydrographic Features - Hydrographic data were obtained in conjunction with trawl samples in each creek (Table 24). In addition a bi-monthly salinity survey was made of the entire bay area (Table 25). Salinity averages of the creek stations ranged from 0.37 to 12.77 ppt. Temperature extremes occurred in January 1970 with a low recording of 9.4° C. at Station StC-4. The high recording was at StC-2 in August 1970 with 31.0° C. Dissolved oxygen averages ranged from 4.41 ppm in September 1969 to 8.33 ppm in February 1970. Lowest recording was 3.2 ppm at StC-3 in September 1969 and highest was 10.0 ppm in January at Station StC-4. pH averages ranged from 7.48 to 8.63. Turbidities ranged from 63.00 ppm suspended solids to 293.50 ppm.

Rainfall data obtained from the weather station at Rockport (Table 26) are compared with salinity averages of the sample stations (StC-1 through StC-5) in Figure 16. Salinity fluctuations lagged behind rainfall but correlated well. Peak periods of salinity were preceded by rainfall monthly totals less than two inches. Increases in rainfall were followed by general decreases in salinities. One exception was noted in August 1970 when 2.34 inches of rain were recorded and salinity averages increased from 1.11 ppt to 8.32 ppt. This is attributed to above-normal tidal fluctuations associated with Hurricane Celia, which passed through the area on August 3, 1970.

Hydrographic data obtained from monthly samples of nine stations in St. Charles Bay are presented in Table 24. Stations are shown in Figure 5. Salinity averages varied between a low of 6.48 ppt in July 1970 and a high of 17.11 ppt in October 1969. Temperatures were lowest in January 1970 with an average of 9.64° C. and highest in September 1970 with 29.89° C. Dissolved oxygen levels ranged from 5.11 in August 1970 to 9.78 in January 1970. pH ranged from 7.68 to 8.41. Turbidities varied from 48.85 to 194.80.

St. Charles Bay Creeks Population Distribution and Abundance - 19,528 individuals were collected in 45 samples. 36 species were identified; 30 were finfish (Table 27). The major finfish species and associated percentage of the total catch were gizzard shad (9.06%), common anchovy (7.65%), Atlantic croaker (7.61%), menhaden (7.25%) and spot croaker (5.44 %). The speckled trout was an important species with 204 individuals comprising 1.04 per cent of the catch. Commercial crustaceans comprised 58.83 per cent.

The white shrimp was the most abundant species with 9,096 individuals and 46.58 per cent of the catch. In 1969, there was a stable population in the St. Charles Bay creeks with 2,371 caught in September followed by 1,660 in October, and 492 in November. None were caught in December (Table 28). White shrimp appeared again in August 1970 with a total catch of 1,400, followed by catches of 739 and 2,410 in October and November. Catch per effort for the entire study period was 202.13 for 45 samples. Station StC-2 in Twin Creek was the most productive with 350.25 for 12 samples. StC-5 in Salt Creek followed with 270.50. Stations StC-4 in Cavasso Creek and StC-3 in Willow Creek had catches per effort of 73.50 and 47.33, respectively (Table 29).

Salinity averaged 6.85 ppt in September, 9.79 ppt in October, and 8.32 ppt in November 1969.

The brown shrimp was the second most abundant species with 2,103 individuals and 10.77 per cent of the catch. Catches peaked in May 1970 with 1,094 individuals. A significant group of brown shrimp was present in September 1969 when 578 were caught. Small catches were recorded in October and November (15 and 18, respectively) and no more were caught until May 1970. Catch per effort for the study period was 46.73 in 45 samples. Station StC-2 yielded 858 shrimp for a catch per effort of 7.50. StC-3 yielded 473 individuals and had a catch per effort of 157.67. However, it was sampled only three times. The three remaining stations had even distribution of shrimp with catches per effort of 29.17 (StC-1), 23.67 (StC-4) and 23.00 (StC-5), respectively (Table 29).

Blue crabs comprised 1.48 per cent of the catch and were caught during each of the twelve months sampled. Catch per effort for 45 samples was 6.53 with a range of 3.17 to 11.67. Peak numbers occurred in December 1969 with 42 individuals and in May 1970 with 48 individuals. Table 28 presents catch by station for each month and the associated sizes for each group of crabs obtained. Juvenile groups appeared in December 1969 ranging from 5 to 115 mm. Mode size was 12-25 mm. The May 1970 size range was 10 to 34 mm with a mode size of 21 mm.

Discussion

The common crustacea are the more valuable species in the Aransas Bay area and are particularly important to the seafood and sport-fishing industries of Aransas County. Shrimp and crabs provide the main food source for finfish and also provide the primary source of livelihood for the commercial shrimp industry.

The area commercial shrimp industry is comprised of three basic fisheries; bait shrimping, commercial bay shrimping and Gulf of Mexico shrimping. The

bait and bay shrimp fishery depends on juvenile and sub-adult populations harvested prior to seasonal migration from the bay habitat to open Gulf waters. The average annual income to the commercial bay fishermen in Aransas County is $342,000. Peak years of value correspond with peak years of white shrimp landings. This figure does not include the bait shrimp industry, which is estimated to have an annual monetary value of $500,000 in retail bait sales.

Gulf shrimp landings for 1966-1969 averaged $40,594,570 per year to the fishermen. This figure is for all Gulf landings in Texas and is produced by shrimp primarily raised in nursery grounds in Texas bays.

The blue crab fishery produced record landings in 1969 following record rainfalls associated with Hurricane Beulah in 1967. Crab landings for the Aransas Bay area rose from 19,300 pounds in 1966 to 724,200 pounds in 1969. This increase is attributed to a reduction of salinities and to freshwater runoff which provided favorable environmental conditions for growth and survival.

Area Catch Comparison - White Shrimp - Catch per effort averaged for each habitat surveyed reflect the effect of stress placed on white shrimp nursery habitat in Chiltipin Creek that is not present in the Mission River area, Copano Creek or St. Charles Bay. Chiltipin Creek catch per effort averages of 40.69 shrimp were the lowest of the four major tertiary areas sampled (Table 30). Mission River produced 118.62 shrimp per sample, 191.52 per cent more than Chiltipin Creek. Copano Creek produced 114.52 per sample, an increase of 181.93 per cent, and St. Charles creeks had an average catch of 202.13 shrimp or 396.76 per cent more than Chiltipin Creek. The Aransas River produced a lower catch per effort average than Chiltipin Creek with only 24.04 shrimp per sample which establishes the effectiveness of Chiltipin Creek as a barrier to shrimp migration into the river. These shrimp must enter Chiltipin Creek to gain access to the river (Figure 2) because of the dam which prevents flow in the natural river bed.

The major areas of white shrimp production, because of proximity to stream flow, water depth and bottom compotition should be the Aransas River-Chiltipin Creek delta area and the Mission Bay-Mission River area. Production from these areas have been equaled and surpassed by smaller streams with smaller acreages and intermittant flow, but having in their favor one important criteria - no oilfield brine.

Brown shrimp catches per effort were largest in May 1970 when peak abundance occurred in all areas sampled except Chiltipin Creek which peaked in June. The total catches for Chiltipin Creek and Mission River of 13.06 and 11.14 shrimp per sample respectively, were based on data obtained the same period that catches of 30.85 shrimp per sample in Copano Creek and 46.73 shrimp per sample in St. Charles Bay Creek were made. Salinity averages in May and June 1970 and the respective catch per effort for each area are shown in the following table.

Catch Per Effort - Salinity Comparison
Brown Shrimp May-June 1970

Area	Month	Total Caught	Catch per Effort	Salinity (ppt)
Chiltipin Creek	May	320	106.66	16.84
	June	778	194.50	2.78
Mission River	May	518	129.50	10.82
	June	239	59.75	1.39
Copano Creek	May	968	193.40	4.78
	June	0	0	0.00
St. Charles Creeks	May	1,094	273.50	12.21
	June	296	74.00	1.11

The table reflects a generally distributed population of brown shrimp in all areas with a peak in May in Mission River, Copano Creek and St. Charles Creeks. Heavy rains in excess of six inches (Table 10) fell on the area in May resulting in a lowering of salinities in all areas and added impetus to the emigration of the small brown shrimp from the tertiary areas. Chiltipin Creek populations increased during this period and an upstream movement of shrimp was found as salinities were reduced (Table 6). These shrimp had moved out of the area by July.

Blue Crabs - Copano Creek was found to be a major nursery area for blue crabs as 1,240 individuals were collected representing a catch per effort of 37.58 crabs. The remaining areas presented moderate catches with averages of 7.08 (Mission River), 6.53 (St. Charles Creek), 1.07 (Chiltipin Creek), and 0.27 (Aransas River). Peak densities occurred in July 1970 in Copano Creek, in March 1970 in Mission River, in December 1969 through February 1970 in St. Charles Creeks,in December 1970 in Chiltipin Creek, and June 1970 in Aransas River.

Salinity - Salinity ranges from 0.00 ppt to 72.70 ppt were recorded during the survey. The following table shows the range and average for bottom salinities in each area of the study.

Station	Range (ppt)	Average (ppt)
Chiltipin Creek	0.00-72.70	22.56
Aransas River	0.00-45.52	7.52
Mission River	0.00-22.21	6.01
Copano Creek	0.00-14.44	3.11
St. Charles Creeks	0.00-15.55	6.97

Chiltipin Creek and Aransas River salinities are definitely influenced by daily brine flow. The influence of brine on the Mission River is more subtle and not as readily apparent. The catch data obtained from the Mission River and presented in Table 21 is probably the best available indicator of environmental damage in the area reflecting an absence of freshwater fish and poor crustacea catches in the upstream areas.

Salinity changes in Copano Creek and St. Charles Bay are attributed to natural tidal fluctuations and local rainfall.

Habitat Preference - Salinity range selectivity by white shrimp and blue crabs has been documented by Gunter (1950) who indicated the preference of white shrimp and blue crabs for areas of low salinity in Copano Bay. Pearse and Gunter (1957) reported the salinity requirements of white shrimp (P. setiferus) ranged from oceanic water to estuarine and stated that, ".....the older larvae must reach bay waters or perish." Gulf salinities are too high for survival of postlarval white shrimp. Increases in commercial landings of white shrimp and peak catches of blue crabs and white shrimp following Hurricane Beulah's record rainfalls substantiates this and indicates the rate of survival of the postlarval blue crabs and white shrimp can be correlated to rainfall and salinity decreases during the immigration period.

Salinity selectivity by white shrimp, brown shrimp and blue crabs is presented in Table 31. The total catch for each species is shown as the number of individuals taken within a given salinity range, in this case, five parts per thousand segments. Catch is shown for each study area.

Total white shrimp caught during the study was 28,287. Forty-seven per cent or 13,379 individuals were collected in salinities ranging from 0.00 to 5.00 ppt, 7,653 individuals or 27.0 per cent were in the 6-10 ppt range, 5,300 individuals or 18.7 per cent in the 11-15 ppt range, 1,087 or 3.8 per cent in thecent in the 16-20 ppt range, 460 or 1.63 in the 21-25 ppt range and 404 or 1.43 per cent in the 26-30 ppt range.

Brown shrimp were more evenly distributed in the salinity groups with 30.92 per cent taken in 0-5 ppt, 23.16 per cent in 6-10 ppt, and 39.53 per cent in 11-15 ppt. Blue crabs favored the fresher areas and a total catch of 2,091 individuals, 79.67 per cent were taken in 0-5 ppt salinity.

A checklist of all species collected and identified during this project is presented in Table 32.

Conclusions

White shrimp and blue crabs have used tertiary bay areas extensively during this survey and peak catches have occurred where hydrographic conditions have been within favorable ranges for each species. The discharge of oilfield brine into Chiltipin Creek influences the creek proper (approximately 121 acres), the lower Aransas River (240 acres), the Aransas River delta area (368 acres) and that portion of Copano Bay extending from the mouth of the Aransas River to the Bayside Causeway (563 acres). Included as nursery habitat are an estimated 1,100 acres of inundated tidal flats and marsh area north of the Aransas River mouth and south of the Bayside Causeway. The total nursery area is estimated to cover 2,392 acres. The extent of influence into Copano Bay can only be surmised until additional information of current patterns, flow data and long-term influence on the crustacea can be obtained. Damage to tertiary areas is more serious than to the open bay because of the tendency of crustacea to concentrate in these areas, particularly during period of below normal rainfall.

The degree of damage by oilfield brine to the Mission River has not been determined by this survey. The daily amount of brine entering Mission River

is only 10 per cent of that entering Chiltipin Creek and because of continued rains throughout the study period salinities never became excessive or reached what would be considered critical levels. The study did show that marine crustacea were not utilizing the river habitat further upstream than Station MR-4, about 4 miles from the mouth, although hydrographic conditions were well within tolerance limits for both shrimp and crabs. Several shoreline separators were seen discharging visible oil during each sample tour of the river. It is felt that this oil is detrimental, that it has created unstable habitat in the upstream portion of the river and that it does affect blue crab productivity in the downstream areas and Mission Bay.

The main cause of environmental damage in these areas is oilfield brine, associated oil and other by-products. These streams are polluted and the catches and salinity data presented herein substantiate the findings that the potential productivity of these areas is being reduced because of open-pit disposal of brine water. The problem is one of economics which affects the oil producers pumping marginal wells that, in some cases, produce 100 times more brine than oil. The solution to the habitat damage is subsurface injection of the brine.

Hydrographic and climatological conditions during the study period were ideal for white shrimp and crab production. Rainfall was above average and salinities were moderate throughout the survey except in polluted areas. At intervals Chiltipin Creek was flushed by rainfall and low salinities and substantial catches were recorded. These conditions will change with periodic climatic changes, primarily drought conditions which will escalate damage to the habitat that is shown herein to occur even during ideal conditions.

The production and perhaps survival of marine crustacea in the Aransas River delta area and upper Mission River is being seriously impeded. Reduction of rainfall together with the construction of the barrier dams on the Aransas River will increase the influence of oilfield brine on Copano Bay nursery areas.

It seems that the economic stability of the brine producing areas is not sufficient to allow the producers to inject their brine waters, with the exception of Humble Oil and Refining Company, which is responsible for only 10 per cent of the total discharge. Consideration must be given to the economy of Aransas County and the bay shrimping industries, the tourist industries, the bait industry, the crab industry and the Gulf shrimping industry, all of which are affected by the loss of available nursery grounds and environmental damage which reduces the production of the commercial marine crustacea.

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Table 1

Chiltipin Creek Monthly Hydrographic Data By Station
September 1969 through September 1970

Salinity data presented as parts per thousand (o/oo), Dissolved Oxygen and Turbidity as parts per million (ppm), Temperature in °C.

Station	Month	Bottom Salinity	Surface Salinity	Temp.	D.O.	pH	Turbidity	Station Depth (ft.)
CC-1	Sept. 1969	17.21		27.8	5.0	7.20	78	4
	Oct.	5.56		17.8	5.0	6.10	335	3
	Dec.	9.99		14.2	10.0	6.70	140	2
	Jan. 1970	4.45		18.6	9.0	8.20	165	2.5
	Feb.	13.88		13.3	9.0	8.30	77	3
	Mar.	16.10		15.6	8.0	7.60	38	2
	Apr.	17.76		19.4	10.0	8.40	110	3
	May	13.32		26.0	8.0	8.40	56	4
	June	2.22		26.0	6.0	7.85	150	2
	July	8.89		28.0	6.0	8.15	70	2
	Aug.	7.77		34.0	5.0	8.50	59	2
	Sept.	13.32		29.0	6.0	8.30	50	2.5
	Average	10.21		22.48	7.25	7.81	110.6	
CC-2	Aug. 1969	21.09		30.0		7.65	65	3
	Sept.	27.76		27.8	4.0	7.35	250	3
	Oct.	1.67		19.4	6.0	6.25	180	2
	Dec.	0.00		13.9	9.0	6.60	48	3
	Jan. 1970	6.62		17.0	8.0	7.90	95	2
	Feb.	34.98		13.9	7.0	7.70	350	5
	Mar.	30.53		16.7	8.0	7.70	65	2
	Apr.	21.09		20.0	9.0	8.25	106	2

Table 1 continued

Station	Month	Bottom Salinity	Surface Salinity	Temp.	D.O.	pH	Turbidity	Station Depth (ft.)
CC-2	May	18.88		25.5	9.0	8.15	72	3
	June	1.12		27.0	5.0	7.80	127	3
	July	8.89		29.5	6.0	8.20	55	3
	Aug.	5.56		29.5	5.0	8.65	58	2
	Sept.	12.77		29.0	6.0	8.30	84	3
	Average	13.23		23.02	6.83	7.73	111.5	
CC-3	Aug. 1969	13.88		30.6		7.70	55	3
	Sept.	44.41		29.4	4.0	7.70	76	4.5
	Oct.	0.00		19.1	5.0	6.85	350	4.5
	Dec.	3.89	2.22	13.6	8.0	6.50	36	5
	Jan. 1970	16.66	3.34	18.3	7.0	7.40	190	5
	Feb.	21.09		13.9	12.0	8.30	130	3.5
	Mar.	49.96	34.42	19.4	6.0	7.50	121	5
	Apr.	40.52		18.9	13.0	7.60	110	4
	May	18.32		25.5	8.0	7.70	37	5
	June	2.22		28.0	6.0	7.45	130	6
	July	12.77	11.10	30.0	5.0	8.12	84	4
	Aug.	4.45	3.89	30.5	5.0	8.55	195	5
	Sept.	17.77		30.0	5.0	8.00	160	5.5
	Average	18.92	10.99	23.63	7.00	7.64	128.8	
CC-4	Jan. 1970	17.77	17.77	18.9	6.0	7.40	34	3
	Feb.	57.62		20.6	8.0	7.20	25	3
	Mar.	61.07	32.20	18.3	7.0	7.45	65	3
	June	5.56		28.0	9.0	7.25	105	4
	July	25.54	20.54	29.5	4.0	7.79	77	3
	Aug.	5.56	3.33	30.0	4.0	8.60	280	2.5
	Sept.	28.87		29.0	5.0	7.65	135	4
	Average	28.85	18.53	24.88	6.14	7.62	93.7	

Table 2

Station Comparison of Chiltipin Creek
Weekly Hydrographic Data
September 9, 1970 through December 18, 1970

Associated hydrographic data obtained from bottom sample only. Salinities shown for bottom and surface samples.

Station	Date	Bottom Salinity	Surface Salinity	Temp.	D.O.	pH	Turb.	Station Depth (ft.)	Current Velocity
CC-1	9-9-70	14.44	14.44	30.0	5.0	7.70	78	1.5	0
CC-2		10.55	9.99	30.0	5.0	7.65	132	1.5	0
CC-3		27.20	9.99	30.5	1.0	7.20	67	6	0
CC-4		35.53	11.66	31.0	2.0	7.19	183	4.5	0
CC-5		29.98	13.32	29.0	3.0	7.21	98	3	.2
CC-6		39.97	39.97	28.0	2.0	7.20	105	6	.2
	Average	26.28	16.56	29.7	3.00	7.36	110.50		
CC-1	9-15-70	16.66	16.66	29.5	6.0	8.20	255	2	0
CC-2		19.43	19.43	30.0	5.0	8.20	112	2	0
CC-3		41.08	17.77	32.0	4.0	7.65	430	5	.2
CC-4		46.63	22.21	31.0	4.0	7.80	150	5	0
CC-5		48.29	27.36	30.0	5.0	7.80	108	4	0
CC-6		52.18	52.73	29.0	4.0	7.62	210	2	0
	Average	37.38	26.03	30.2	4.66	7.88	210.83		
CC-1	9-17-70	17.77	16.66	29.0	6.0	7.20	128	2	0
CC-2		18.88	17.77	29.0	5.0	8.20	105	2	0
CC-3		47.74	19.99	31.0	4.0	7.65	310	5	.2
CC-4		44.41	17.77	30.5	4.0	7.80	153	5	0
CC-5		43.30	21.09	29.5	5.0	7.80	122	4	0
CC-6		49.40	49.96	29.0	4.0	7.62	110	2	0
	Average	36.92	23.87	29.67	4.66	7.87	154.66		

Table 2 continued

Station	Date	Bottom Salinity	Surface Salinity	Temp.	D.O.	pH	Turb.	Station Depth (ft.)	Current Velocity
CC-1	9-21-70	15.55	15.55	29.0	7.0	8.20	132	2	0
CC-2		17.77	17.21	29.0	6.0	8.10	100	2	0
CC-3		25.54	21.09	29.0	4.0	7.90	82	5	Incoming tide
CC-4		26.70	23.32	29.5	4.0	7.75	145	4	.1
CC-5		45.52	27.76	29.0	1.2	7.40	130	4	.2
CC-6		49.96	49.96	29.0	3.0	7.10	74	3	.2
	Average	30.17	24.15	29.08	4.20	7.74	110.50		
CC-1	10-1-70	16.66	16.10	24.5	12.0	7.95	210	2	Incoming tide
CC-2		13.88	13.88	25.0	13.0	7.85	92	2	Incoming tide
CC-3		13.32	12.77	24.5	8.0	7.70	109	5	Incoming tide
CC-4		13.32	12.21	24.0	5.0	7.65	142	4.5	0
CC-5		12.27	12.21	25.0	5.0	7.62	125	4	0
CC-6		15.55	14.44	22.0	4.0	7.55	72	2.5	0
	Average	14.25	13.60	24.17	7.83	7.72	125.00		
CC-1	10-5-70	10.55	10.55	26.0	8.0	8.10	73	2	Incoming tide
CC-2		8.89	8.33	26.0	5.0	8.10	64	2	Incoming tide
CC-3		8.89	7.22	26.0	4.0	8.10	59	5	Incoming tide
CC-4		13.32	6.66	27.0	3.0	7.85	190	4.5	0
CC-5		15.55	14.44	26.0	3.0	7.70	93	4.5	0
CC-6		20.54	19.99	26.0	2.2	7.40	79	3	0
	Average	12.96	11.98	21.16	4.20	7.88	93.00		

Table 2 continued

Station	Date	Bottom Salinity	Surface Salinity	Temp.	D.O.	pH	Turb.	Station Depth (ft.)	Current Velocity
CC-1	10-15-70	0.00	0.00	22.5	7.0	8.60	175	2	Incoming tide
CC-2		0.00	0.00	23.5	8.0	8.23	310	2.5	Incoming tide
CC-3		4.45	0.00	24.0	6.0	8.00	114	5	Incoming tide
CC-4		3.89	1.11	24.5	6.0	7.80	370	4	Incoming tide
CC-5		6.66	4.48	23.0	6.0	7.75	108	4	0
CC-6		5.56	5.56	22.0	5.0	7.70	40	2.5	0
	Average	3.43	1.86	23.25	6.33	8.01	186.10		
CC-1	10-20-70	4.45	1.11	20.0	9.0	8.40	85	2	Incoming tide
CC-2		0.00	0.00	21.5	9.0	8.50	210	3.5	Incoming tide
CC-3		6.11	1.11	21.0	7.0	8.10	160	6.5	Incoming tide
CC-4		8.86	0.00	21.0	8.0	8.05	400	4.5	Incoming tide
CC-5		13.32	7.77	21.5	9.0	7.90	74	5	Incoming tide
CC-6		14.99	14.99	20.0	8.0	7.80	75	2	Incoming tide
	Average	7.95	4.16	20.83	8.33	8.12	167.33		
CC-1	12-18-70	28.05	28.05	19.0	8.0	7.90	182	2	0
CC-2		27.90	25.20	19.0	8.0	7.70	132	2	0
CC-3		62.00	31.20	17.0	5.0	7.10	77	4.5	0
CC-4		56.40	30.50	17.5	7.0	7.55	56	4	0
CC-5		69.60	31.44	18.0	4.0	7.00	65	4	0
CC-6		72.70	70.50	19.0	4.0	6.91	31	3	0
	Average	52.74	36.15	18.25	6.00	7.36	73.83		

Table 3

Rainfall for Chiltipin Creek Area

Month	Rockport	Sinton	Area Average
January 1969	1.04	0.74	0.89
February 1969	3.28	8.43	5.86
March 1969	1.14	1.42	1.28
April 1969	5.27	3.68	4.48
May 1969	2.66	2.87	2.77
June 1969	0.58	1.53	1.06
July 1969	0.45	1.68	1.07
August 1969	7.35	2.28	4.82
September 1969	1.41	7.70	4.56
October 1969	2.48	7.89	5.19
November 1969	6.12	6.00	6.06
December 1969	2.56	2.40	2.48
Total	34.34	46.62	40.48
January 1970	2.49	2.72	2.61
February 1970	1.12	1.50	1.31
March 1970	2.44	2.69	2.57
April 1970	0.65	2.18	1.42
May 1970	5.26	6.40	5.83
June 1970	1.51	6.44	3.98
July 1970	4.31	2.25	3.28
August 1970	2.54	3.06	2.80
September 1970	9.36	5.97	7.67
October 1970	10.17	2.70	6.44
November 1970	1.00	2.22	1.61
December 1970	0.60	0.65	0.63
Total	41.45	38.78	40.12

Table 4

Copano Bay Salinity
Bayside Causeway Station
August 1969 - December 1970

Date	Salinity	Temp. *	D.O.	pH	Turbidity
August 1969	13.60	30.0	6.5	7.95	201
September 1969	15.55	28.5	6.5	8.17	29.00
October 1969	15.27	24.4	8.7	8.30	31.50
November 1969	18.88	13.5	10.0	8.25	25.00
December 1969	14.43	16.5	9.0	8.51	29.50
January 1970	11.10	10.9	11.0	8.40	45.00
February 1970	12.76	15.2	8.5	8.35	49.50
March 1970	14.36	19.4	8.5	8.02	88.50
April 1970	16.10	22.5	7.0	8.15	172.50
May 1970	17.21	24.0	9.5	8.42	38.00
June 1970	8.88	27.5	8.0	8.20	38.70
July 1970	7.77	29.5	7.0	8.37	31.50
August 1970	11.10	30.5	8.0	8.35	25.00
September 1970	8.86	30.0	8.0	8.30	39.00
October 1970	7.72	23.0	8.0	8.40	25.00
November 1970	9.99	20.5	8.0	7.90	30.00
December 1970	9.99	14.0	9.0	8.30	25.00
	12.56	22.35	8.31	8.26	54.84

* °C.

Table 5

Chiltipin Creek - Trawl Catch
Species Comparison by Percentage

	No. Caught		Percent	
	Regular Samples	Special Samples	of Catch	Total of Each Species
A. fasciatus	5	3	.06	8
A. mitchilli	756	2,150	22.71	2,906
A. probatocephalus	0	1	.01	1
B. marinus	39	29	.53	68
B. chrysura	2	19	.16	21
Brevoortia sp.	718	386	8.63	1,104
C. faber	1	0	.01	1
C. hippos	0	1	.01	1
C. nebulosus	4	4	.06	8
C. nothus	32	33	.51	65
C. variegatus	136	34	1.33	170
D. olisthostomus	7	0	.05	7
D. cepedianum	110	18	1.00	128
F. grandis	34	0	.27	34
G. felis	60	137	1.54	197
G. cinereus	9	32	.32	41
I. furcatus	0	2	.02	2
I. punctatus	4	0	.03	4
L. humilis	0	1	.03	1
L. rhomboides	2	0	.02	2
L. xanthurus	1,150	86	9.66	1,236
L. osseus	2	1	.02	3
L. spatula	3	4	.06	7
M. beryllina	17	28	.35	45
M. vagrans	139	1	1.09	140
M. undulatus	828	141	7.57	969
M. cephalus	110	241	2.74	351
P. lethostigma	6	0	.05	6
P. cromis	5	8	.10	13
S. ocellata	22	1	.18	23
S. spengleri	0	11	.09	11
Crustacea				
C. sapidus	67	35	.80	102
Palaemonetes sp.	14	0	.11	14
P. aztecus	1,223	18	9.71	1,241
P. setiferus	809	3,057	30.21	3,866
	6,314	6,483	100.01	12,797

Table 6

Chiltipin Creek
Commercial Crustacea Monthly Catch
and Salinity Comparison by Station

Station	Date	White Shrimp (P. setiferus)	Brown Shrimp (P. aztecus)	Blue Crabs (C. sapidus)	Bottom Salinity (o/oo)
CC-2	Aug. 1969	0	0	0	21.09
CC-3	Aug. 1969	0	0	0	13.88
	Total	0	0	0	17.49 (Avg.)
CC-1	Sept. 1969	9	1	2	17.21
CC-2	Sept. 1969	0	0	0	27.76
CC-3	Sept. 1969	0	0	1	44.41
	Total	9	1	3	29.79 (Avg.)
CC-1	Oct. 1969	226	14	2	5.56
CC-2	Oct. 1969	284	3	6	1.67
CC-3	Oct. 1969	5	0	2	0.00
	Total	515	17	10	2.41 (Avg.)
CC-1	Dec. 1969	2	0	2	9.99
CC-2	Dec. 1969	0	0	0	0.00
CC-3	Dec. 1969	0	0	0	3.89
	Total	2	0	2	4.63 (Avg.)

Table 6 continued

Station	Date	White Shrimp (P. setiferus)	Brown Shrimp (P. aztecus)	Blue Crabs (C. sapidus)	Bottom Salinity (o/oo)
CC-2	Jan. 1970	0	0	1	6.62
CC-3	Jan. 1970	0	0	1	16.66
CC-4	Jan. 1970	0	0	0	17.77
	Total	0	0	2	13.68 (Avg.)
CC-1	Feb. 1970	0	0	4	13.88
CC-2	Feb. 1970	0	0	5	34.98
CC-3	Feb. 1970	0	0	4	21.09
	Total	0	0	13	23.32 (Avg.)
CC-1	Mar. 1970	0	0	1	16.10
CC-2	Mar. 1970	0	0	0	30.53
CC-3	Mar. 1970	0	0	0	49.96
	Total	0	0	1	32.19 (Avg.)
CC-1	Apr. 1970	0	102	12	17.76
CC-2	Apr. 1970	0	0	0	21.09
CC-3	Apr. 1970	0	0	0	40.52
	Total	0	102	12	26.46 (Avg.)
CC-1	May 1970	0	306	4	13.32
CC-2	May 1970	0	14	0	18.88
CC-3	May 1970	0	0	0	18.32
	Total	0	320	4	16.84 (Avg.)

Table 6 continued

Station	Date	White Shrimp (P. setiferus)	Brown Shrimp (P. aztecus)	Blue Crabs (C. sapidus)	Bottom Salinity (o/oo)
CC-1	June 1970	0	222	4	2.22
CC-2	June 1970	0	398	0	1.12
CC-3	June 1970	0	138	0	2.22
CC-4	June 1970	0	20	2	5.56
	Total	0	778	6	2.78 (Avg.)
CC-1	July 1970	0	2	1	8.89
CC-2	July 1970	0	0	0	8.89
CC-3	July 1970	3	0	2	12.77
CC-4	July 1970	2	0	0	25.54
	Total	5	2	3	14.02 (Avg.)
CC-1	Aug. 1970	44	0	1	7.77
CC-2	Aug. 1970	16	0	4	5.56
CC-3	Aug. 1970	111	0	0	4.45
CC-4	Aug. 1970	60	0	2	5.56
	Total	231	0	7	5.84 (Avg.)
CC-1	Sept. 1970	14	2	0	13.32
CC-2	Sept. 1970	0	0	2	12.77
CC-3	Sept. 1970	15	0	1	17.71
CC-4	Sept. 1970	18	0	1	28.87
	Total	47	2	4	18.18 (Avg.)

Table 6 continued

Station	Date	White Shrimp (P. setiferus)	Brown Shrimp (P. aztecus)	Blue Crabs (C. sapidus)	Bottom Salinity (o/oo)
		Special Samples			
CC-1	Sept. 9, 1970	48	0	0	14.44
CC-2	Sept. 9, 1970	39	0	0	10.55
CC-3	Sept. 9, 1970	0	0	0	27.20
CC-4	Sept. 9, 1970	0	0	0	35.53
CC-5	Sept. 9, 1970	2	0	0	29.98
CC-6	Sept. 9, 1970	1	0	0	39.97
	Total	90	0	0	26.28 (Avg.)
CC-1	Sept. 15, 1970	85	1	2	16.66
CC-2	Sept. 15, 1970	88	0	1	19.43
CC-3	Sept. 15, 1970	0	1	0	41.08
CC-4	Sept. 15, 1970	0	0	0	46.63
CC-5	Sept. 15, 1970	0	0	0	48.29
CC-6	Sept. 15, 1970	0	0	0	52.18
	Total	173	2	3	37.38 (Avg.)
CC-1	Sept. 17, 1970	117	0	1	17.77
CC-2	Sept. 17, 1970	451	1	2	18.88
CC-3	Sept. 17, 1970	0	0	0	47.74
CC-4	Sept. 17, 1970	1	0	0	44.41
CC-5	Sept. 17, 1970	1	0	0	43.30
CC-6	Sept. 17, 1970	0	0	0	49.40
	Total	570	1	3	36.99 (Avg.)

Table 6 continued

Station	Date	White Shrimp (P. setiferus)	Brown Shrimp (P. aztecus)	Blue Crabs (C. sapidus)	Bottom Salinity (o/oo)
CC-1	Sept. 21, 1970	180	0	1	15.55
CC-2	Sept. 21, 1970	92	0	0	17.77
CC-3	Sept. 21, 1970	33	0	1	25.54
CC-4	Sept. 21, 1970	0	0	0	26.70
CC-5	Sept. 21, 1970	0	0	0	45.52
CC-6	Sept. 21, 1970	0	0	0	49.96
	Total	305	0	2	30.17 (Avg.)
CC-1	Oct. 1, 1970	31	0	0	16.66
CC-2	Oct. 1, 1970	92	0	0	13.88
CC-3	Oct. 1, 1970	44	0	1	13.32
CC-4	Oct. 1, 1970	2	0	1	13.32
CC-5	Oct. 1, 1970	24	0	0	12.27
CC-6	Oct. 1, 1970	3	0	0	15.55
	Total	196	0	2	14.25 (Avg.)
CC-1	Oct. 5, 1970	15	0	0	10.55
CC-2	Oct. 5, 1970	18	0	3	8.89
CC-3	Oct. 5, 1970	81	0	0	8.89
CC-4	Oct. 5, 1970	70	0	0	13.32
CC-5	Oct. 5, 1970	29	0	0	15.55
CC-6	Oct. 5, 1970	0	0	0	20.54
	Total	213	0	3	12.96 (Avg.)
CC-1	Oct. 15, 1970	100	1	0	0.00
CC-2	Oct. 15, 1970	67	0	1	0.00
CC-3	Oct. 15, 1970	67	7	1	4.45

Table 6 continued

Station	Date	White Shrimp (P. setiferus)	Brown Shrimp (P. aztecus)	Blue Crabs (C. sapidus)	Bottom Salinity (o/oo)
CC-4	Oct. 15, 1970	110	2	0	3.89
CC-5	Oct. 15, 1970	84	0	0	6.66
CC-6	Oct. 15, 1970	22	0	2	5.56
	Total	450	10	4	3.43 (Avg.)
CC-1	Oct. 20, 1970	387	1	0	4.45
CC-2	Oct. 20, 1970	117	0	0	0.00
CC-3	Oct. 20, 1970	136	0	1	6.11
CC-4	Oct. 20, 1970	257	0	1	8.86
CC-5	Oct. 20, 1970	139	4	1	13.32
CC-6	Oct. 20, 1970	15	1	0	14.99
	Total	1,051	6	3	7.95 (Avg.)
CC-1	Dec. 18, 1970	8	0	14	28.05
CC-2	Dec. 18, 1970	0	0	1	27.90
CC-3	Dec. 18, 1970	0	0	0	62.00
CC-4	Dec. 18, 1970	0	0	0	56.40
CC-5	Dec. 18, 1970	1	0	0	69.60
CC-6	Dec. 18, 1970	0	0	0	72.70
	Total	9	0	15	52.74 (Avg.)

Table 7

Chiltipin Creek Catch Per Effort
of Commercial Crustacea by Station

Station	Total No. Samples	Total Catch	Positive C/E	No. Positive Samples	Total C/E
White Shrimp (*P. setiferus*)					
CC-1	20	1,266	90.43	14	63.30
CC-2	22	1,264	126.40	10	57.45
CC-3	22	495	55.00	9	22.50
CC-4	13	520	65.00	8	40.00
CC-5	9	280	40.00	7	31.11
CC-6	9	41	10.25	4	4.55
Total	95	3,866	74.34	52	40.69
Brown Shrimp (*P. aztecus*)					
CC-1	20	652	65.20	10	32.60
CC-2	22	416	104.00	4	18.90
CC-3	22	146	48.67	3	6.64
CC-4	13	22	2.20	1	1.69
CC-5	9	4	4.00	1	.44
CC-6	9	1	1.00	1	.11
Total	95	1,241	62.05	20	13.06
Blue Crab (*C. sapidus*)					
CC-1	20	51	3.40	15	2.55
CC-2	22	26	2.60	10	1.18
CC-3	22	15	1.55	9	.68
CC-4	13	7	1.25	4	.54
CC-5	9	1	1.00	1	.11
CC-6	9	2	2.00	1	.22
Total	95	102	2.55	40	1.07

Table 8

Aransas River
Monthly Flow Data
October 1968 - September 1970

Month		Flow Rate in Acre Feet	Annual Total	Average Flow Per Month (acre feet)
1968	October	775		
	November	65		
	December	102	15,050	1,254
1969	January	91		
	February	6,590		
	March	316		
	April	200		
	May	1,900		
	June	97		
	July	1,520		
	August	123		
	September	62		
	October	419		
	November	236		
	December	387	11,941	995.08
1970	January	176		
	February	97		
	March	486		
	April	80		
	May	6,500		
	June	3,800		
	July	570		
	August	139		
	September	90	11,938	1,326.44

Table 9

Rainfall for Aransas River Watershed

Month	Rockport	Sinton	Beeville	Area Average
January 1969	1.04	.74	1.41	1.06
February	3.28	8.43	3.88	5.20
March	1.14	1.42	1.43	1.33
April	5.27	3.68	1.89	3.61
May	2.66	2.87	3.58	3.04
June	.58	1.53	2.70	1.60
July	.45	1.68	1.30	1.14
August	7.35	2.28	3.32	4.32
September	1.41	7.70	2.56	3.89
October	2.48	7.89	3.30	4.56
November	6.12	6.00	3.92	5.34
December	2.56	2.40	2.19	2.38
Total	34.34	46.62	31.48	37.48
January 1970	2.49	2.72	1.71	2.31
February	1.12	1.50	1.78	1.47
March	2.44	2.69	1.88	2.34
April	.65	2.18	2.41	1.75
May	5.26	6.40	3.67	5.11
June	1.51	6.44	3.08	3.68
July	4.31	2.25	2.36	2.97
August	2.54	3.06	2.16	2.59
September	9.36	5.97	3.86	6.40
October	10.17	2.70	2.64	5.17
November	1.00	2.22	2.03	1.75
December	.60	.65	2.19	1.15
Total	41.45	38.78	29.77	36.67

Table 10

Aransas River Hydrographic Data By Station
July 1969 through September 1970

Salinity data presented as parts per thousand (o/oo), Dissolved Oxygen and Turbidity as parts per million (ppm), Temperature in ^{o}C.

Station	Month	Bottom Salinity	Surface Salinity	Temp.	D.O.	pH	Turbidity	Station Depth (ft.)
AR-1	July 1969	17.77		29.4	5.0	7.60	45	6
	Aug.	13.88		30.6		7.70	55	3
	Sept.	17.77		28.6	5.0	7.70	58	8
	Oct.	5.56		20.0	6.0	6.60	113	3
	Dec.	0.00		13.9	7.0	7.10	126	4
	Jan. 1970	3.34	0.00	16.7	7.0	7.90	102	8
	Feb.	21.09		13.3	9.0	8.00	84	7
	Mar.	45.52	14.44	19.4	4.0	7.55	65	8
	April	29.42		20.0	8.0	7.55	82	6
	May	12.77		26.0	7.5	8.10	55	4
	June	1.12	0.00	26.0	5.0	7.90	147	6
	July	3.89	2.24	29.9	5.0	8.19	72	5
	Aug.	4.45	4.45	30.0	5.0	8.68	65	5
	Sept.	7.77		30.0	6.0	8.40	60	4
	Average	13.16	4.22	23.8	6.42	7.78	80.6	
AR-2	May 1969	.56		27.5	5.0	7.50	210	3
	June	1.67	.56	27.8	8.0	8.30	74	3
	July	12.77		29.7	6.0	7.90	97	3
	Aug.	18.88		28.9	4.0	6.40	68	3
	Sept.	17.77		27.8	6.0	6.20	50	3
	Oct.	8.89		23.3	6.0	8.50	74	2.5
	Nov.	29.98		21.1	7.0	7.65	75	3.5
	Dec.	0.00	0.00	13.9	7.0	7.15	49	4

Table 10 continued

Station	Month	Salinity	Salinity	Temp.	D.O.	pH	Turbidity	Station Depth (ft.)
AR-2	Jan. 1970	0.00		10.3	9.0	6.75	44	3
	Feb.	4.45		16.1	20.0	9.20	90	3
	Mar.	36.09	28.27	19.4	6.0	7.60	160	5
	Apr.	6.66		17.5	9.0	8.10	90	2.5
	May	25.54		26.0	6.0	8.20	56	3
	June	1.11	0.00	26.0	5.0	6.85	124	4
	July	8.33	6.66	28.0	5.0	7.90	47	4
	Aug.	5.56	3.34	31.0	5.0	8.65	76	3
	Sept.	8.89	7.77	29.0	6.0	7.70	65	3.5
	Average	11.04	6.65	22.2	7.05	7.67	85.2	
AR-3	June 1969	2.78		27.8	4.0	7.55	85	5
	July	6.66		30.6	5.0	8.15	200	4
	Aug.	17.77		30.9	1.0	7.00	52	5
	Sept.	12.21		28.6	5.0	7.05	157	5
	Oct.	8.89		25.6	5.0	8.50	190	5
	Nov.	22.76		21.1	8.0	7.65	187	4
	Dec.	5.56	0.00	15.6	1.0	6.90	250	5
	Jan. 1970	2.22	0.00	11.6	6.0	6.50	375	5
	Feb.	5.56	2.22	17.8	16.0	9.00	75	5.5
	Mar.	27.76	14.44	20.0	4.0	8.10	280	5
	Apr.	6.11		20.0	9.0	8.50	117	5
	May	19.99	9.99	26.0	5.0	8.35	142	4.5
	June	0.00	0.00	25.0	4.0	7.00	162	5
	July	2.22	1.11	30.0	5.0	8.10	109	4
	Aug.	3.36	2.78	32.0	6.0	8.70	126	4
	Sept.	8.89	5.56	30.5	.8	7.65	390	5
	Average	9.54	4.01	22.8	5.3	7.83	181	

Table 10 continued

Station	Month	Bottom Salinity	Surface Salinity	Temp.	D.O.	pH	Turbidity	Station Depth (ft.)
AR-4	May 1969	0.00		26.0	3.0	7.30	240	7
	June	6.66	1.67	26.7	.8	7.50	42	6
	July	6.66		31.1	6.0	8.15	200	6
	Aug.	34.42	4.45	31.1	0.0	7.20	50	8
	Sept.	12.77		29.4	6.0	7.40	120	8
	Oct.	5.56		25.0	7.0	8.60	133	8
	Nov.	17.77		18.9	7.0	7.75	82	6
	Dec.	10.55		16.7	2.0	7.10	59	7
	Jan. 1970	5.00	0.00	12.5	8.0	6.65	90	6
	Feb.	6.66	4.45	17.2	10.0	8.80	62	7.5
	Mar.	17.21	12.21	20.6	5.0	8.35	110	6
	Apr.	4.45	5.56	19.0	9.0	8.60	100	6
	May	19.99	8.88	26.0	3.0	8.40	165	6.5
	June	0.00	0.00	27.0	5.0	7.15	100	7.5
	July	.56	.56	30.0	5.0	8.00	195	6.5
	Aug.	4.45	2.22	31.0	5.0	8.60	92	6
	Sept.	7.77	4.45	30.0	4.0	7.75	46	8
	Average	9.44	4.04	24.6	5.05	7.84	110.9	
AR-5	June 1969	0.00		27.5	7.0	8.20	82	6
	July	1.67		31.7	6.0	8.00	425	5
	Aug.	16.66	2.78	30.6	0.0	6.70	135	5
	Sept.	21.09	8.33	30.0	0.6	7.20	78	6
	Oct.	6.11		25.6	0.2	8.40	204	6
	Nov.	5.56		20.6	8.0	8.30	98	7
	Dec.	12.21	0.00	17.8	0.0	7.20	210	6
	Jan. 1970	9.99	0.00	13.1	3.0	6.60	280	7
	Feb.	5.56	3.34	16.7	9.0	8.65	57	7.5
	Mar.	32.20	8.89	18.6	0.0	8.05	305	7
	Apr.	4.45	2.22	19.0	11.0	8.72	90	6
	May	7.77	5.56	26.0	3.0	8.55	62	7
	June	1.11	0.00	27.0	5.0	7.10	82	7

Table 10 continued

Station	Month	Bottom Salinity	Surface Salinity	Temp.	D.O.	pH	Turbidity	Station Depth (ft.)
AR-5	July 1970	1.12	.56	30.0	5.0	7.90	36	7
	Aug.	6.11	2.22	31.0	2.0	8.45	47	7
	Sept.	9.99	2.22	30.0	0.6	7.65	50	7
	Average	8.85	3.01	24.7	3.77	7.85	115	
AR-6	May 1969	0.00		30.0	4.5	7.70	169	5
	June	0.00		28.0	5.0	7.20	107	5
	July	0.00		30.6	3.0	8.10	210	7
	Aug.	27.70	1.67	29.7	5.0	7.50	54	6
	Oct.	4.45		24.4	8.0	8.50	26	5
	Nov.	5.00		20.6	3.0	8.20	112	7
	Feb. 1970	4.45	0.00	16.7	6.0	8.40	57	5
	Mar.	5.56	4.45	20.0	10.0	8.71	82	6
	Apr.	0.00	0.00	19.5	9.0	8.90	180	6
	Aug.	2.22	1.11	30.0	2.5	8.90	95	6
	Sept.	6.66	2.22	29.5	0.0	7.55	310	6
	Average	5.10	1.57	25.4	5.09	8.15	127	
AR-7	June 1969	0.00		27.8	5.0	7.50	67	6
	July	0.00		30.6	7.0	7.90	41	5
	Aug.	3.89	0.00	30.2	.3	7.80	39	5
	Nov.	16.66		23.3	0.0	7.40	180	8
	April 1970	1.11	0.00	20.0	8.0	8.55	95	6
	Sept.	1.11	.56	31.0	.4	8.20	83	8
	Average	3.79	.18	27.15	3.95	7.84	84.2	
AR-8	June 1969	0.00		29.0	5.0	7.70	142	5
	July	0.00		31.7	1.8	8.00	125	12
	Aug.	0.00		30.3	6.0	7.95	53	6.5
	Nov.	0.00		20.0	7.0	8.30	98	8

Table 10 continued

Station	Month	Bottom Salinity	Surface Salinity	Temp.	D.O.	pH	Turbidity	Station Depth (ft.)
AR-8	April 1970	0.00		22.0	9.0	8.02	130	5
	Sept.	1.11	___	31.0	6.0	8.40	90	7
	Average	0.18		27.33	5.80	8.06	106.3	
AR 9-11	June 1969	0.00		28.0	5.8	7.36	78	5.25

Table 11

Aransas River
Trawl Catch - Species Comparison by Percentage

Species	No. Caught	% of Catch
Pisces		
A. fasciatus	4	.05
A. mitchilli	1,002	12.24
A. probatocephalus	1	.01
B. marinus	3	.04
B. chysura	2	.02
Brevoortia sp.	390	4.76
C. cyanoguttatum	16	.20
C. nothus	2	.02
C. variegatus	73	.89
D. cepedianum	835	10.20
E. saurus	1	.01
F. grandis	8	.10
G. felis	3	.04
I. furcatus	139	1.70
I. punctatus	443	5.41
I. bubalus	2	.02
L. sicculus	10	.12
L. xanthurus	133	1.62
L. osseus	16	.20
L. spatula	9	.11
L. cyanellis	1	.01
L. humilis	8	.10
L. macrochirus	203	2.48
L. megalotis	82	1.00
L. microlophus	129	1.58
M. beryllina	752	9.19
M. vagrans	14	.17
M. undulatus	479	5.85
M. salmoides	17	.21
M. cephalus	171	2.09
P. lethostigma	7	.08
P. cromis	15	.18
P. octonemus	1	.01
P. annularis	60	.73
S. ocellata	13	.16

Table 11 continued

Species	No. Caught	% of Catch
Crustacea		
C. sapidus	41	.50
Macrobrachium sp.	113	1.38
Palaemontes sp.	825	10.08
P. aztecus	117	1.43
P. setiferus	2,043	24.97
	8,183	99.95

Table 12

Aransas River Catch Per Effort
of Commercial Crustacea by Station

Station	Total No. Samples	Total Catch	Positive C/E	Total Positive Samples	Total C/E
White Shrimp (*P. setiferus*)					
AR-1	10	3	3.00	1	3.00
AR-2	14	709	118.17	6	50.64
AR-3	15	616	123.29	5	41.07
AR-4	14	387	64.50	6	27.64
AR-5	13	67	16.75	4	5.15
AR-6	8	14	14.00*	1	1.75
AR-7	4	234	234.00*	1	58.50
AR-8	3	13	13.00*	1	4.33
AR-9	1	0	0.00	0	0.00
AR-10	2	0	0.00	0	0.00
AR-11	1	0	0.00	0	0.00
Total	85	2,043	81.72	25	24.04
Brown Shrimp (*P. aztecus*)					
AR-1	10	0	0.00	0	0.00
AR-2	14	97	32.33	3	6.93
AR-3	15	20	5.00	4	1.33
AR-4	14	0	0.00	0	0.00
AR-5	13	0	0.00	0	0.00
AR-6	8	0	0.00	0	0.00
AR-7	4	0	0.00	0	0.00
AR-8	3	0	0.00	0	0.00
AR-9	1	0	0.00	0	0.00
AR-10	2	0	0.00	0	0.00
AR-11	1	0	0.00	0	0.00
Total	85	117	16.71	7	1.38
Blue Crab (*C. sapidus*)					
AR-1	10	0	0.00	0	0.00
AR-2	14	9	1.28	7	.64
AR-3	15	8	1.33	6	.53
AR-4	14	1	1.00	1	.07
AR-5	13	5	5.00	1	.38
AR-6	8	0	0.00	0	0.00
AR-7	4	0	0.00	0	0.00
AR-8	3	0	0.00	0	0.00

Table 12 continued

Station	Total No. Samples	Total Catch	Positive C/E	Total Positive Samples	Total C/E
Blue Crab (*C. sapidus*)					
AR-9	1	0	0.00	0	0.00
AR-10	2	0	0.00	0	0.00
AR-11	1	0	0.00	0	0.00
Total	85	23	1.53	15	.27

*All caught September 1970.

Table 13

Aransas River
Monthly Commercial Crustacea Catch
and Salinity Comparison by Station

Station	Date	White Shrimp (P. setiferus)	Brown Shrimp (P. aztecus)	Blue Crabs (C. sapidus)	Bottom Salinity (o/oo)
AR-2	July 1969	0	0	0	12.77
AR-3		0	3	1	6.66
AR-4		0	0	0	6.66
AR-5		0	0	0	1.67
AR-6		0	0	0	0.00
AR-8		0	0	0	0.00
AR-10		0	0	0	0.00
AR-11		0	0	0	0.00
	Total	0	3	1	3.47 (Avg.)
AR-1	Aug. 1969	0	0	0	13.88
AR-2		0	0	0	18.88
AR-3		0	0	0	17.77
AR-4		0	0	0	34.42
AR-5		0	0	2	16.66
AR-6		0	0	4	27.70
AR-7		0	0	0	3.89
	Total	0	0	6	19.52 (Avg.)
AR-1	Sept. 1969	0	0	0	17.77
AR-2		3	0	0	18.88
AR-3		0	0	0	12.21
	Total	3	0	0	16.29 (Avg.)

Table 13 continued

Station	Date	White Shrimp (P. setiferus)	Brown Shrimp (P. aztecus)	Blue Crabs (C. sapidus)	Bottom Salinity (o/oo)
AR-1	Oct. 1969	3	0	0	5.56
AR-2		91	0	1	8.89
AR-3		63	0	0	8.89
AR-4		82	0	0	5.56
AR-5		2	0	0	6.11
	Total	241	0	1	7.00 (Avg.)
AR-2	Nov. 1969	376	0	3	29.98
AR-3		425	0	1	22.76
AR-4		242	0	0	17.77
AR-5		57	0	0	5.56
AR-6		0	0	0	5.00
AR-7		0	0	0	16.66
	Total	1,100	0	4	15.54 (Avg.)
AR-1	Dec. 1969	0	0	0	0.00
AR-2		13	0	0	0.00
AR-3		29	1	1	5.56
AR-4		3	0	0	10.55
AR-5		0	0	0	12.21
	Total	45	1	1	5.66 (Avg.)
AR-1	Jan. 1970	0	0	0	3.34
AR-2		0	0	1	0.00
AR-3		0	0	0	2.22
AR-4		0	0	1	5.00
AR-5		0	0	0	9.99
	Total	0	0	2	4.11 (Avg.)

Table 13 continues

Station	Date	White Shrimp (P. setiferus)	Brown Shrimp (P. aztecus)	Blue Crabs (C. sapidus)	Bottom Salinity (o/oo)
AR-1	Feb. 1970	0	0	0	21.09
AR-2		0	0	1	4.45
AR-3		0	0	0	5.56
AR-4		0	0	0	6.66
AR-5		0	0	0	5.56
AR-6		0	0	0	4.45
	Total	0	0	1	7.96 (Avg.)
AR-1	Mar. 1970	0	0	0	45.52
AR-2		0	0	0	36.09
AR-3		0	0	0	27.76
AR-4		0	0	0	17.21
AR-5		0	0	0	32.20
AR-6		0	0	0	5.56
	Total	0	0	0	27.39 (Avg.)
AR-1	April 1970	0	0	0	29.42
AR-2		0	0	1	6.66
AR-3		0	0	3	6.11
AR-4		0	0	0	4.45
AR-5		0	0	0	4.45
AR-6		0	0	0	0.00
AR-7		0	0	0	1.11
AR-8		0	0	0	0.00
AR-9		0	0	0	0.00
AR-10		0	0	0	0.00
	Total	0	0	4	5.22 (Avg.)

Table 13 continued

Station	Date	White Shrimp (P. setiferus)	Brown Shrimp (P. aztecus)	Blue Crabs (C. sapidus)	Bottom Salinity (o/oo)
AR-1	May 1970	0	0	0	12.77
AR-2		0	91	0	25.54
AR-3		0	12	0	19.99
AR-4		0	0	0	19.99
AR-5		0	0	0	7.77
	Total	0	103	0	17.21 (Avg.)
AR-1	June 1970	0	0	0	1.12
AR-2		0	4	1	1.11
AR-3		0	4	1	0.00
AR-4		0	0	0	0.00
AR-5		0	0	5	1.11
	Total	0	8	7	.67 (Avg.)
AR-2	July 1970	1	2	0	8.33
AR-3		0	0	1	2.22
AR-4		26	0	1	.56
	Total	27	2	2	3.70 (Avg.)
AR-3	Aug. 1970	96	0	0	3.36
AR-4		28	0	0	4.45
AR-5		6	0	0	6.11
AR-6		0	0	0	2.22
	Total	130	0	0	4.04 (Avg.)

Table 13 continued

Station	Date	White Shrimp (P. setiferus)	Brown Shrimp (P. aztecus)	Blue Crabs (C. sapidus)	Bottom Salinity (o/oo)
AR-2	Sept. 1970	225	0	0	8.89
AR-3		3	0	0	8.89
AR-4		6	0	0	7.77
AR-5		2	0	0	9.99
AR-6		14	0	0	6.66
AR-7		234	0	0	1.11
AR-8		13	0	1	1.11
	Total	497	0	1	6.35 (Avg.)

Table 14

Mission River
Monthly Flow Data
October 1968 - September 1970

Month		Flow Rate in Acre Feet	Annual Total	Average Flow Per Month (acre feet)
1968	October	3,570		
	November	738		
	December	741	147,100	12,258.33
1969	January	584		
	February	27,599		
	March	7,360		
	April	4,170		
	May	9,850		
	June	3,560		
	July	611		
	August	499		
	September	471		
	October	376		
	November	1,430		
	December	3,770	60,280	5,023.33
1970	January	3,780		
	February	565		
	March	5,310		
	April	6,090		
	May	10,910		
	June	21,900		
	July	1,360		
	August	1,660		
	September	638	52,213	5,801.44

Table 15

Rainfall Data for Mission River Watershed

Month	Rockport	Woodsboro	Beeville	Area Average
June 1969	.58		2.70	1.64
July 1969	.45		1.30	.88
August 1969	7.35		3.32	5.34
September 1969	1.41		2.56	1.98
October 1969	2.48	3.71	3.30	3.16
November 1969	6.12	3.68	3.92	4.57
December 1969	2.56	4.81	2.19	3.19
January 1970	2.49	1.84	2.09	2.14
February 1970	1.12	1.14	1.61	1.29
March 1970	2.44	2.98	2.50	2.64
April 1970	.65	4.61	.67	1.97
May 1970	5.26	6.52	7.11	6.30
June 1970	1.51	6.85	4.32	4.23
July 1970	4.31	3.85	1.99	3.38
August 1970	2.54	3.55	2.97	3.02
September 1970	9.36	6.56	4.21	6.71
October 1970	10.17	2.81	.05	4.34
Total	60.80	52.91	46.81	56.78
Average	3.58	4.07	2.75	3.41

Table 16

Mission River Hydrographic Data By Station
June 1969-October 1970

Salinity data presented as parts per thousand (o/oo), Dissolved Oxygen and Turbidity as parts per million (ppm), Temperature in ^{o}C.

Station	Month	Bottom Salinity	Surface Salinity	Temp.	D.O.	pH	Turb.	Station Depth(ft.)	Current Velocity(mph)
MR-1	June 1969	3.34		28.9	8.0	8.05	350	2	
	July	5.56		33.9	9.0	8.80	59	1.5	.5
	Aug.	12.77		31.1	9.0	8.60	91	4	.2
	Sept.	11.10		28.9	6.0	6.10	165	2.5	.2
	Oct.	18.32		26.0	9.0	7.00	66	2	0
	Nov.	11.10		13.3	8.0	7.00	72	2	.5
	Dec.	0.00		15.0	7.0	6.70	122	2	0
	Jan. 1970	1.11		10.0	10.0	8.20	71	4.5	0
	Feb.	7.74		15.0	8.0	7.65	94	2	0
	Mar.	0.00		17.8	8.0	7.40	185	2	0
	Apr.	5.56		20.0	7.0	8.10	72	2	Incoming tide
	May	13.32		24.0	6.0	8.30	25	2	Incoming tide
	June	1.11	2.22	26.0	6.0	7.10	121	4	.6
	July	.55		30.0	4.0	7.10	98	2	1.0
	Aug.	6.66		28.0	4.5	8.32	75	4	.3
	Sept.	9.44		28.0	5.0	8.30	47	3.5	0
	Oct.	0.00	____	18.0	7.0	8.00	325	4	.2
	Average	6.33	2.22	23.17	7.64	7.69	119.88		
MR-2	June 1969	0.00		27.8	8.0	8.49	220	3	
	July	6.62		33.1	9.0	8.50	450	1	.5
	Aug.	12.77		30.6	8.0	8.60	127	1	.1

Table 16 continued

Station	Month	Bottom Salinity	Surface Salinity	Temp.	D.O.	pH	Turb.	Station Depth(ft.)	Current Velocity(mph)
MR-2	Sept.	8.33		27.0	5.5	6.50	228	1.5	.3
	Oct.	15.55		19.4	8.0	7.90	175	4	0
	Nov.	13.22		6.7	7.0	7.35	104	4	.4
	Dec.	0.00		14.4	7.0	6.60	210	2	0
	Jan. 1970	0.00		10.6	10.5	8.80	215	2	.8
	Feb.	0.00		15.0	9.0	8.45	310	3	0
	Mar.	4.45		17.8	10.0	7.75	80	2	.5
	Apr.	7.77		19.0	6.0	8.05	89	2	Incoming tide
	May	11.10		25.0	6.5	8.35	165	2	Incoming tide
	June	1.12		26.0	6.0	7.10	121	4	.6
	July	.56		30.0	3.0	7.20	47	2	.5
	Aug.	1.12		28.0	6.0	8.60	132	1.5	0
	Sept.	5.56		28.0	6.0	8.50	61	2	0
	Oct.	0.00		18.0	9.0	8.50	235	2	.1
	Average	5.19		22.14	7.82	7.46	174.64		
MR-3	June 1969	2.78		28.3	9.0	8.19	60	4	
	July	5.56		33.3	9.0	8.60	235	5	.5
	Aug.	12.21		30.6	7.0	8.25	140	4	.7
	Sept.	11.66		29.4	7.0	7.00	96	4	.1
	Oct.	15.55		20.0	9.0	7.50	167	5	0
	Nov.	11.10		13.3	8.0	7.20	55	4	.4
	Dec.	0.00		14.7	7.0	6.70	160	4.5	0
	Jan. 1970	0.00		10.3	9.0	8.40	265	6	0
	Feb.	1.11		14.4	8.0	7.90	245	5	0
	Mar.	0.00		16.7	7.0	8.20	210	4	0
	Apr.	2.78		20.5	8.0	8.32	109	5	Incoming tide

Table 16 continued

Station	Month	Bottom Salinity	Surface Salinity	Temp.	D.O.	pH	Turb.	Station Depth(ft.)	Current Velocity(mph)
MR-3	May	11.10		25.0	6.0	8.35	57	4	Incoming tide
	June	1.67	2.22	26.0	5.0	7.10	150	4	.5
	July	.56		32.0	3.0	6.75	70	6	.6
	Aug.	3.34		30.0	5.0	8.00	109	4.5	.1
	Sept.	7.77		29.0	5.0	8.30	180	3.5	0
	Oct.	0.00	0.00	18.0	7.0	8.10	250	5	.1
	Average	5.13	2.22	23.03	7.11	7.82	150.47		
MR-4	June 1969	4.45		26.7	8.0	7.90	86	5	
	July	4.45		32.2	8.0	8.40	96	3.5	.5
	Aug.	12.77		31.4	7.0	7.90	47	7	0
	Sept.	13.88		33.3	10.0	7.30	45	4	.1
	Oct.	12.21		19.4	9.0	8.30	62	5	0
	Nov.	10.55		15.6	7.0	7.60	53	4	.2
	Dec.	0.00	0.00	15.3	6.0	6.70	75	6	0
	Jan. 1970	0.00	0.00	11.6	8.0	8.00	83	6	0
	Feb.	0.00	0.00	14.4	8.0	8.00	64	6	0
	Mar.	0.00		16.7	7.0	8.00	132	6	0
	Apr.	2.22	2.22	20.0	8.0	8.32	109	5	Incoming tide
	May	7.74		25.0	6.5	8.50	55	5	Incoming tide
	June	1.67	2.22	28.0	5.0	7.00	51	4	.5
	July	.56		32.0	4.0	6.65	52	5	.1
	Aug.	2.78		32.0	5.0	8.20	47	3.5	0
	Sept.	6.66	6.66	31.0	6.0	8.32	85	4.5	0
	Oct.	0.00	0.00	24.0	7.0	7.95	62	5.5	.1
	Average	4.70	1.59	23.45	7.41	7.83	70.82		

Table 16 continued

Station	Month	Bottom Salinity	Surface Salinity	Temp.	D.O.	pH	Turb.	Station Depth(ft.)	Current Velocity(mph)
MR-5	June 1969	2.22		25.0	3.5	7.15	370	5	
	July	7.77		32.2	7.0	8.00	115	8	.5
	Aug.	12.77	12.77	31.9	0.0	7.95	26	9	.1
	Sept.	13.88		30.0	.9	7.35	125	11	.1
	Oct.	8.89		23.3	7.0	7.45	71	5	0
	Nov.	11.66		16.7	6.5	7.70	88	7	.1
	Dec.	0.00	0.00	15.6	6.0	6.80	84	6	0
	Jan. 1970	0.00	0.00	12.2	8.0	7.80	90	8	.3
	Feb.	2.22	1.11	14.7	9.0	7.70	65	8	0
	Mar.	0.00		16.7	7.0	7.75	150	6.5	0
	Apr.	4.45	4.45	20.5	8.0	8.15	280	7	Incoming tide
	Aug.	2.22		32.0	8.0	8.30	42	7	0
	Sept.	5.56	4.45	31.5	5.0	8.30	42	5	0
	Oct.	0.00	0.00	23.0	3.0	7.70	115	7	0
	Average	5.12	3.25	23.24	5.64	7.72	118.78		
MR-6	June 1969	0.00		23.3	6.0	7.20	350	7	
	July	9.94		33.3	6.0	7.90	100	7	.5
	Aug.	15.55	9.94	31.9	0.0	7.00	46	6	0
	Sept.	7.77		30.6	9.0	7.55	57	8	.1
	Nov.	13.32		20.0	0.0	7.80	63	8	.4
	Feb. 1970	6.66	3.34	16.7	4.0	7.40	92	10	0
	Mar.	0.00	0.00	16.1	8.0	7.75	150	6	0
	Sept.	7.77	4.45	31.0	0.0	8.00	110	8	0
	Average	7.63	4.43	25.36	4.12	7.58	121.00		
MR-7	June 1969	0.00		23.7	5.0	7.30	390	6	
	July	22.21		31.7	5.0	7.80	65	5	.5
	Aug.	13.32		31.1	10.0	6.55	70	1	0

Table 16 continued

Station	Month	Bottom Salinity	Surface Salinity	Temp.	D.O.	pH	Turb.	Station Depth(ft.)	Current Velocity(mph)
MR-7	Sept.	1.11		30.9	9.0	8.50	46	1.5	.1
	Mar. 1970	0.00		16.7	7.0	7.60	120	4	0
	Sept.	11.10	5.56	31.0	6.0	7.80	108	4	0
	Average	7.96	5.56	25.0	7.0	7.59	133.16		

Table 17
Mission River
Trawl Catch - Species Comparison by Percentage

Species	No. Caught	% of Catch
Pisces		
A. fasciatus	48	.24
A. mitchilli	971	4.92
A. probatocephalus	1	.005
B. chrysura	21	.11
B. marinus	84	.43
Brevoortia sp.	2,855	14.46
C. hippos	1	.005
C. nebulosus	45	.23
C. nothus	78	.40
C. variegatus	62	.31
D. cepedianum	506	2.56
E. gula	4	.02
F. grandis	10	.05
G. felis	114	.58
G. bosci	1	.005
G. ionthus	1	.005
L. sicculus	1	.005
L. rhomboides	2	.01
L. xanthurus	1,237	6.27
L. osseus	3	.015
L. spatula	4	.02
M. beryllina	41	.21
M. vagrans	1	.005
M. undulatus	1,522	7.71
M. salmoides	1	.005
M. cephalus	496	2.51
P. tribulus	1	.005
P. lethostigma	26	.13
P. annularis	2	.01
P. cromis	14	.07
S. ocellata	125	.63
Crustacea		
C. sapidus	538	2.73
Macrobrochium sp.	47	.24
Palaemontes sp.	703	3.56
P. aztecus	867	4.39
P. setiferus	9,304	47.14
	19,737	99.995

Table 18

Mission River
Monthly Commercial Crustacea Catch
and Salinity Comparison by Station

Station	Date	White Shrimp (P. setiferus)	Brown Shrimp (P. aztecus)	Blue Crabs (C. sapidus)	Bottom Salinity (o/oo)
MR-3	Aug. 1969	79	1	0	12.21
MR-4		0	0	2	12.77
MR-5		0	0	0	12.77
MR-6		0	0	0	15.55
MR-7		0	0	0	13.32
	Total	79	1	2	13.32 (Avg.)
MR-2	Sept. 1969	21	0	0	8.33
MR-3		9	0	0	11.66
MR-4		0	0	0	13.88
MR-5		0	0	0	13.88
MR-6		0	0	0	7.77
MR-7		0	0	0	1.12
	Total	30	0	0	11.10 (Avg.)
MR-1	Oct. 1969	46	0	0	18.32
MR-2		120	0	0	15.55
MR-3		350	1	0	15.55
MR-4		30	0	0	12.21
MR-5		12	0	0	8.89
	Total	558	1	0	14.10 (Avg.)
MR-1	Nov. 1969	297	12	3	11.10

Table 18 continued

Station	Date	White Shrimp (P. setiferus)	Brown Shrimp (P. aztecus)	Blue Crabs (C. sapidus)	Bottom Salinity (o/oo)
MR-3	Nov. 1969	2,442	0	12	11.10
MR-4		396	0	6	10.55
MR-5		147	0	0	11.66
MR-6		0	0	0	13.32
	Total	3,282	12	21	11.55 (Avg.)
MR-1	Dec. 1960	31	4	13	0.00
MR-2		3	0	37	0.00
MR-3		3	0	2	0.00
MR-4		10	0	0	0.00
MR-5		1	0	1	0.00
	Total	48	4	53	0.00 (Avg.)
MR-1	Jan. 1970	0	0	48	1.11
MR-2		0	0	24	0.00
MR-3		0	0	45	0.00
MR-4		0	0	10	0.00
MR-5		0	0	1	0.00
	Total	0	0	128	.22 (Avg.)
MR-1	Feb. 1970	0	0	5	7.74
MR-3		0	0	11	1.11
MR-4		0	0	1	0.00
MR-5		0	0	0	2.22
MR-6		0	0	0	6.66
	Total	0	0	17	3.55 (Avg.)

Table 18 continued

Station	Date	White Shrimp (P. setiferus)	Brown Shrimp (P. aztecus)	Blue Crabs (C. sapidus)	Bottom Salinity (o/oo)
MR-1	Mar. 1970	0	0	73	0.00
MR-2		0	0	24	4.45
MR-3		0	0	55	0.00
MR-4		0	0	27	0.00
MR-5		0	0	5	0.00
MR-6		0	0	9	0.00
MR-7		0	0	0	0.00
	Total	0	0	193	.64 (Avg.)
MR-1	April 1970	0	9	5	5.56
MR-2		0	0	12	7.77
MR-3		0	0	2	2.78
MR-4		0	0	0	2.22
MR-5		0	0	0	4.45
	Total	0	9	19	4.94 (Avg.)
MR-1	May 1970	0	280	9	13.32
MR-2		0	76	4	11.10
MR-3		0	116	0	11.10
MR-4		0	46	4	7.74
	Total	0	518	17	10.82 (Avg.)
MR-1	June 1970	59	225	5	1.11
MR-2		0	0	7	1.12
MR-3		0	12	1	1.67
MR-4		0	2	1	1.67
	Total	59	239	14	1.39 (Avg.)

Table 18 continued

Station	Date	White Shrimp (P. setiferus)	Brown Shrimp (P. aztecus)	Blue Crabs (C. sapidus)	Bottom Salinity (o/oo)
MR-1	July 1970	52	34	6	.55
MR-2		0	0	2	.56
MR-3		18	0	10	1.67
MR-4		4	0	2	1.67
	Total	74	34	20	1.11 (Avg.)
MR-1	Aug. 1970	780	6	24	6.66
MR-2		113	6	0	1.12
MR-3		455	8	13	3.34
MR-4		47	1	1	2.78
MR-5		0	0	0	0.00
	Total	1,395	21	38	3.48 (Avg.)
MR-1	Sept. 1970	81	0	0	9.44
MR-2		144	0	1	5.56
MR-3		352	0	2	7.77
MR-4		158	0	0	6.66
MR-5		0	0	0	5.56
MR-6		0	0	0	7.74
MR-7		0	0	0	11.10
	Total	735	0	3	7.69 (Avg.)
MR-1	Oct. 1970	1,252	2	1	0.00
MR-2		578	0	0	0.00
MR-3		694	6	2	0.00
MR-4		382	0	0	0.00
MR-5		138	0	0	0.00
	Total	3,044	8	3	0.00 (Avg.)

Table 19

Mission River Catch Per Effort
of Commercial Crustacea by Station

Station	Total No. Samples	Total Catch	Positive C/E	Total Positive Samples	Total C/E
White Shrimp (*P. setiferus*)					
MR-1	13	2,619	261.90	10	201.46
MR-2	12	967	161.17	6	80.58
MR-3	15	4,402	489.11	9	293.47
MR-4	14	1,027	146.71	7	73.36
MR-5	12	298	74.50	4	24.83
MR-6	6	0	0.00	0	0.00
MR-7	4	0	0.00	0	0.00
Total	76	9,015	161.91	36	67.75
Brown Shrimp (*P. aztecus*)					
MR-1	13	572	71.50	8	44.00
MR-2	12	82	41.00	2	6.83
MR-3	15	144	24.00	6	9.60
MR-4	14	49	16.33	3	3.50
MR-5	12	0	0.00	0	0.00
MR-6	6	0	0.00	0	0.00
MR-7	4	0	0.00	0	0.00
Total	76	847	16.03	19	9.13
Blue Crabs (*C. sapidus*)					
MR-1	13	193	17.45	11	14.85
MR-2	12	111	13.88	8	9.25
MR-3	15	155	14.09	11	10.33
MR-4	14	55	6.88	8	3.92
MR-5	12	15	5.00	3	1.25
MR-6	5	9	9.00	1	1.80
MR-7	4	0	0.00	0	0.00
Total	76	538	9.08	42	6.07

Table 20

Copano Creek Hydrographic Data By Station
May 1969-October 1970

Salinity data presented as parts per thousand (o/oo), Dissolved Oxygen and Turbidity as parts per million (ppm), Temperature in ^{o}C. All data obtained from sample taken one foot from bottom.

Station	Month	Salinity	Temp.	D.O.	pH	Turb.	Station Depth(ft.)	Current Velocity(mph)
CO-1	May 1969	0.00	30.0	7.0			1.5	
CO-2		0.00	29.0	5.5	7.20	112	1.5	
CO-3		0.00	29.0	5.0	7.25	100	3	
CO-4		0.00	28.0	4.5	7.15	115	3	
CO-5		0.00	28.0	4.0	7.20	125	3.5	
	Average	0.00	28.80	4.2	7.20	113.0		
CO-1	Sept. 1969	0.00	29.4	4.0	6.95	68	2.5	0
CO-2		1.11	29.4	4.0	6.80	92	2	.2
CO-3		0.00	28.3	3.5	6.95	75	3.5	.1
CO-4		0.00	27.5	4.0	6.90	72	2.5	.2
CO-5		0.00	27.8	4.5	7.00	81		
	Average	.27	28.48	4.00	6.92	77.60		
CO-1	Feb. 1970	14.44	16.1	7.0	6.90	90	1.5	Incoming tide
		14.44	16.7	7.0	6.65	240	2	Incoming tide
		12.21	16.7	7.0	7.20	65	1.5	Incoming tide
	Average	13.70	16.50	7.0	6.92	131.66		

Table 20 continued

Station	Month	Salinity	Temp.	D.O.	ph	Turb.	Station Depth(ft.)	Current Velocity(mph)
CO-1	May 1970	8.89	18.5	7.0	8.00	90	2	Incoming tide
CO-2		6.66	19.0	7.0	8.20	125	1	Incoming tide
CO-3		2.22	21.0	8.0	8.30	100	3	Incoming tide
CO-4		3.34	23.0	8.0	8.15	95	4	Incoming tide
CO-5		2.78	23.0	8.0	8.00	120	2	Incoming tide
	Average	4.78	20.9	7.6	8.13	106		
CO-1	June 1970	0.00	24.0	4.0	6.75	82	2	.2
CO-2		0.00	25.0	4.0	6.75	25	3	.8
CO-3		0.00	25.0	5.0	6.80	90	2	.2
CO-4		0.00	26.0	6.0	6.80	95	3	1.0
CO-5		0.00	26.0	6.0	6.90	105	3	2.5
	Average	0.00	25.20	5.0	6.80	79.40		
CO-1	July 1970	4.45	27.0	5.0	7.96	60	21	Incoming tide
CO-2		2.21	27.0	5.0	8.20	106	2	Incoming tide
CO-3		1.11	29.5	5.0	8.30	199	3	Incoming tide
CO-4		.56	30.0	4.0	8.10	127	3	Incoming tide
CO-5		1.89	30.0	5.0	7.90	107	1.5	Incoming tide
	Average	2.04	28.70	4.80	8.09	119		

Table 20 continued

Station	Month	Salinity	Temp.	D.O.	pH	Turb.	Station Depth(ft.)	Current Velocity(mph)
CO-1	Aug. 1970	11.10	28.0	5.0	8.40	83	1.5	0
CO-2		5.56	29.0	4.5	8.60	118	2	0
CO-3		1.11	30.0	5.0	8.95	111	3	0
CO-4		.56	31.0	4.0	8.65	73	2	0
CO-5		1.12	31.0	2.5	8.35	58	2	0
	Average	3.89	29.80	4.20	8.59	88.60		
CO-1	Sept. 1970	8.89	30.0	7.0	7.91	91	2.5	Incoming tide
CO-2		4.45	30.5	6.0	7.60	103	2.5	Incoming tide
CO-3		1.11	30.0	5.0	7.20	82	5	0
CO-4		1.11	30.0	4.0	7.00	90	2	0
CO-5		1.11	30.0	3.0	7.05	102	1.5	0
	Average	3.33	30.10	5.0	7.35	93.60		
CO-1	Oct. 1970	0.00	19.0	6.0	7.40	125	2	.1
CO-2		0.00	19.0	6.0	7.40	140	4	0
CO-3		0.00	19.0	7.0	7.20	118	4	0
CO-4		0.00	18.0	8.0	7.00	140	2	0
CO-5		0.00	19.0	8.0	6.90	97	3	0
	Average	0.00	18.8	7.0	7.18	124.00		

Table 21

Copano Creek
Trawl Catch - Species Comparison by Percentage

Species	No. Caught	% of Catch
Pisces		
A. fasciatus	137	1.23
A. mitchilli	1,017	9.16
A. probatocephalus	6	.05
B. chrysura	15	.14
B. marinus	4	.04
Brevoortia sp.	1,364	12.28
C. nebulosus	66	.59
C. nothus	5	.04
C. spilopterus	6	.05
C. variegatus	3	.03
D. cepedianum	105	.94
E. saurus	13	.12
G. grandis	3	.03
F. felis	1	.01
G. bosci	10	.09
I. furcatus	1	.01
I. natalis	13	.12
L. cyanellus	8	.07
L. rhomboides	92	.83
L. osseus	7	.06
L. spatula	7	.06
L. xanthurus	430	3.87
M. beryllina	56	.50
M. undulatus	682	6.14
M. cephalus	9	.08
N. octurus	1	.01
P. annularis	31	.28
P. lethostigma	50	.45
P. cromis	22	.20
S. ocellata	25	.22
S. foetens	1	.01
Crustacea		
C. sapidus	1,248	11.24
Macrobrochium sp.	301	2.71

Table 21 continued

Species	No. Caught	% of Catch
Crustacea		
Palaemontes sp.	594	5.35
P. aztecus	1,018	9.17
P. setiferus	3,753	33.80
	11,104	99.98

Table 22

Copano Creek
Monthly Commercial Crustacea Catch
and Salinity Comparison by Station

Station	Date	White Shrimp (P. setiferus)	Brown Shrimp (P. aztecus)	Blue Crabs (C. sapidus)	Bottom Salinity (o/oo)
CO-2	Sept. 1969	845	30	46	1.11
CO-3		114	0	0	0.00
CO-4		0	0	24	0.00
CO-5		6	0	0	0.00
	Total	965	30	70	.28 (Avg.)
CO-1	Feb. 1970	0	0	24	14.44
CO-2		0	0	64	12.21
	Total	0	0	88	13.32 (Avg.)
CO-1	May 1970	0	434	6	8.89
CO-2		0	93	39	6.66
CO-3		0	420	68	2.22
CO-4		0	21	90	3.34
CO-5		0	0	58	2.78
	Total	0	968	261	4.78 (Avg.)
CO-1	June 1970	0	0	2	0.00
CO-2		0	0	0	0.00
CO-3		0	0	0	0.00
CO-4		0	0	0	0.00
CO-5		0	0	0	0.00
	Total	0	0	2	0.00 (Avg.)

Table 22 continued

Station	Date	White Shrimp (P. setiferus)	Brown Shrimp (P. aztecus)	Blue Crabs (C. sapidus)	Bottom Salinity (o/oo)
CO-1	July 1970	62	2	6	4.45
CO-2		582	0	75	2.21
CO-3		252	0	228	1.11
CO-4		0	0	18	.56
CO-5		6	0	42	1.89
	Total	902	2	369	2.04 (Avg.)
CO-1	Aug. 1970	116	0	8	11.10
CO-2		276	12	32	5.56
CO-3		130	0	20	1.11
CO-4		42	0	0	.56
	Total	564	12	60	4.58 (Avg.)
CO-2	Sept. 1970	26	6	4	4.45
CO-3		36	0	8	1.11
CO-5		130	0	30	1.11
	Total	192	6	42	6.67 (Avg.)
CO-1	Oct. 1970	224	0	0	0.00
CO-2		504	0	78	0.00
CO-3		402	0	138	0.00
CO-4		0	0	12	0.00
CO-5		0	0	120	0.00
	Total	1,130	0	348	0.00 (Avg.)

Table 23

Copano Creek Catch Per Effort
of Commercial Crustacea by Station

Station	Total No. Samples	Total Catch	Positive C/E	Total Positive Samples	Total C/E
White Shrimp (*P. setiferus*)					
CO-1	6	428	107.00	4	71.33
CO-2	8	2,233	446.60	5	279.12
CO-3	7	934	186.80	5	133.42
CO-4	6	42	42.00	1	7.00
CO-5	6	142	47.33	3	23.66
Total	33	3,779	165.94	18	102.91
Brown Shrimp (*P. aztecus*)					
CO-1	6	436	218.00	2	72.66
CO-2	8	141	35.25	4	17.62
CO-3	7	420	420.00	1	60.00
CO-4	6	21	21.00	1	3.50
CO-5	6	0	0.00	0	0.00
Total	33	1,018	138.85	8	30.76
Blue Crabs (*C. sapidus*)					
CO-1	6	46	9.20	5	7.66
CO-2	8	338	48.28	7	42.25
CO-3	7	462	92.40	5	66.00
CO-4	6	144	36.00	4	24.00
CO-5	6	250	62.50	4	41.66
Total	33	1,240	49.68	25	36.31

Table 24

St. Charles Bay Creeks Hydrographic Data By Station
September 1969-November 1970

Salinity data presented as parts per thousand (o/oo), Dissolved Oxygen and Turbidity shown as parts per million (ppm), Temperature in ^{o}C.

Station	Month	Salinity	Temp.	D.O.	pH	Turb.	Station Depth(ft.)	Current Velocity(mph)
StC-2	Sept. 1969	8.33	28.3	8.0	7.20	80	3	.2
StC-3		10.55	28.3	3.2	7.20	25	2	.1
StC-4		1.67	28.3	5.0	8.30	84	3	.1
	Average	6.85	28.3	4.40	7.57	63.00		
StC-2	Oct. 1969	13.88	26.5	7.0	8.30	105	1.5	0
StC-3		13.32	27.0	7.0	8.30	59	1	Incoming tide
StC-4		11.10	26.0	5.0	8.80	45	2	Incoming tide
	Average	12.77	26.5	7.33	8.47	69.67		
StC-1	Nov. 1969	6.66	24.4	6.0	8.45	260	2	.2
StC-2		9.99	25.0	8.0	8.05	54		
	Average	8.32	24.7	7.0	8.25	157.00		
StC-1	Dec. 1969	0.00	13.9	9.0	8.70	133	2	.4
StC-2		1.11	13.9	9.0	8.70	133	2	.4
StC-4		0.00	15.0	7.0	8.50	106	3	0
	Average	.37	14.27	5.33	8.63	124.00		

Table 24 continued

Station	Month	Salinity	Temp.	D.O.	pH	Turb.	Station Depth(ft.)	Current Velocity(mph)
StC-4	Jan. 1970	1.11	9.4	10.0	8.10	98	2	Incoming tide
	Average	1.11	9.4	10.0	8.10	98		
StC-1	Feb. 1970	8.33	13.9	9.0	8.30	170	1.5	0
StC-2		9.99	15.0	9.0	8.20	149	3	Incoming tide
StC-4		6.66	13.9	7.0	8.10	135	2	Incoming tide
	Average	8.33	14.27	8.33	8.20	151.33		
StC-1	Mar. 1970	4.45	18.1	7.0	8.05	222	2	Incoming tide
StC-2		1.11	17.5	7.0	8.20	215	3.5	Incoming tide
StC-4		2.22	16.7	7.0	8.05	113	2	Incoming tide
	Average	2.59	17.43	7.0	8.10	183.33		
StC-1	Apr. 1970	11.10	18.0	9.0	8.40	210	2	0
StC-2		8.33	16.5	8.5	8.40	46	2	.1
StC-4		8.33	16.0	8.0	8.38	49	3	0
	Average	9.25	16.83	8.5	8.39	101.67		
StC-1	May 1970	11.10	26.0	5.5	8.20	97	2	Incoming tide
StC-2		11.10	25.0	6.0	8.20	390	2.5	Incoming tide
StC-4		15.55	25.0	5.5	8.20	160	2	Incoming tide

Table 24 continued

Station	Month	Salinity	Temp.	D.O.	pH	Turb.	Station Depth(ft.)	Current Velocity(mph)
StC-5	May 1970	11.10	26.0	6.0	8.20	62	2	Incoming tide
	Average	12.21	25.50	5.75	8.20	177.25		
StC-1	June 1970	1.11	23.0	5.0	7.40	260	2	0
StC-2		1.11	23.0	5.0	7.10	124	2	0
StC-4		1.11	23.0	4.0	8.00	44	3	0
StC-5		1.11	23.0	5.0	7.42	42	2	0
	Average	1.11	23.0	4.75	7.48	117.50		
StC-1	July 1970	0.00	27.7	4.7	8.30	155	2	.2
StC-4		2.22	29.5	5.5	8.40	37	2	.2
	Average	1.11	28.6	5.1	8.35	96.00		
StC-1	Aug. 1970	6.66	30.0	5.0	8.60	95	2	0
StC-2		6.66	31.0	5.0	8.80	120	2	0
StC-3		8.88	29.5	4.0	8.60	115	2	0
StC-5		11.10	29.0	4.0	8.60	170	2	0
	Average	8.32	29.88	4.50	8.50	125.00		
StC-1	Oct. 1970	0.00	27.0	6.0	8.70	220	2.5	0
StC-2		13.32	26.5	7.0	8.65	140	3	0
StC-4		3.34	25.0	4.0	8.50	52	3	0
StC-5		4.45	26.0	6.0	8.50	215	3.5	0
	Average	5.28	26.12	5.75	8.58	156.75		

Table 24 continued

Station	Month	Salinity	Temp.	D.O.	pH	Turb.	Station Depth(ft.)	Current Velocity(mph)
StC-1	Nov. 1970	0.00	21.0	7.0	7.80	87	2.5	0
StC-2		2.24	21.0	6.0	7.70	62	2	0
StC-4		0.00	18.0	6.0	7.60	300	3	0
StC-5		2.24	20.0	7.0	7.75	225	3	0
	Average	1.12	20.0	6.50	7.71	293.50		

Table 25

St. Charles Bay Hydrographic Data
September 1969-November 1970

Salinity data presented as parts per thousand (o/oo), Dissolved Oxygen and Turbidity as parts per million (ppm), Temperature in °C. All data obtained from sample taken one foot from bottom.

Month	Salinity	Temp.	D.O.	pH	Turbidity
September 1969	13.05	28.09	5.16	7.68	73.63
October 1969	17.11	24.26	6.88	7.88	48.45
November 1969	15.96	26.66	7.13	8.16	80.44
December 1969	7.84	17.14	8.20	8.08	61.31
January 1970	8.70	9.64	9.78	8.04	66.06
February 1970	12.34	14.29	8.57	8.08	53.54
March 1970	10.12	13.70	8.03	8.09	95.60
April 1970	15.67	21.86	7.67	8.17	56.08
May 1970	14.62	24.86	6.42	8.08	52.31
June 1970	10.10	26.28	6.11	7.95	69.27
July 1970	6.48	29.15	5.60	8.19	68.75
August 1970	15.54	29.67	5.11	8.32	53.28
September 1970	9.87	29.89	7.00	8.21	89.33
October 1970	7.10	26.39	6.11	8.41	114.67
November 1970	4.88	19.67	6.33	7.82	194.80

Table 26

Rainfall Data for Rockport

Month	Rockport
January 1969	1.04
February 1969	3.28
March 1969	1.14
April 1969	5.27
May 1969	2.66
June 1969	.58
July 1969	.45
August 1969	7.35
September 1969	1.40
October 1969	2.48
November 1969	6.12
December 1969	2.56
Total	34.34
January 1970	2.49
February 1970	1.12
March 1970	2.44
April 1970	.65
May 1970	5.26
June 1970	1.51
July 1970	4.31
August 1970	2.54
September 1970	9.36
October 1970	10.17
November 1970	1.00
December 1970	.60
Total	41.45

Table 27

St. Charles Bay Creeks
Trawl Catch - Species Comparison by Percentage

Species	No. Caught	% of Catch
Pisces		
A. fasciatus	18	.09
A. mitchilli	1,492	7.64
A. probatocephalus	21	.11
B. marinus	6	.03
B. chrysura	43	.22
Brevoortia sp.	1,416	7.25
C. nebulosus	204	1.04
C. nothus	5	.03
C. variegatus	3	.02
D. cepedianum	1,769	9.06
E. saurus	3	.02
F. grandis	12	.06
F. similis	3	.02
G. felis	13	.07
G. cinereus	3	.02
H. ionthus	1	.01
L. sicculus	21	.11
L. rhomboides	3	.02
L. xanthurus	1,062	5.44
L. osseus	3	.02
L. spatula	9	.05
M. vagrans	1	.01
M. beryllina	112	.57
M. undulatus	1,487	7.61
M. cephalus	43	.22
P. lethostigma	46	.24
P. cromis	156	.80
S. ocellata	45	.23
Crustacea		
C. sapidus	290	1.48
Macrobrochium sp.	2	.01
Palaemontes sp.	37	.19
P. aztecus	2,103	10.77
P. setiferus	9,096	46.58
	19,528	100.04

Table 28

St. Charles Bay Creeks
Monthly Commercial Crustacea Catch
and Salinity Comparison by Station

Station	Date	White Shrimp (P. setiferus)	Brown Shrimp (P. aztecus)	Blue Crabs (C. sapidus)	Bottom Salinity (o/oo)
StC-2	9-8-69	2,160	84	6	8.33
StC-3		7	434	0	10.55
StC-4		204	60	0	1.67
	Total	2,371	578	6	6.85 (Avg.)
StC-2	10-2-69	12	0	6	13.88
StC-3		3	15	15	13.32
StC-4		0	0	0	11.10
	Total	15	15	21	12.77 (Avg.)
StC-1	10-17-69	175	0	1	12.21
StC-2		720	0	2	9.44
StC-5		750	0	0	7.74
	Total	1,645	0	3	9.79 (Avg.)
StC-1	11-13-69	276	0	12	6.66
StC-4		216	18	5	9.99
	Total	492	18	17	8.32 (Avg.)

Table 28 continued

Station	Date	White Shrimp (P. setiferus)	Brown Shrimp (P. aztecus)	Blue Crab (C. sapidus)	Bottom Salinity (o/oo)
StC-4	1-15-70	0	0	46	1.11
	Total	0	0	46	1.11 (Avg.)
StC-1	2-2-70	0	0	22	8.33
StC-2	2-11-70	0	0	0	9.99
StC-4		0	0	14	6.66
	Total	0	0	36	8.33 (Avg.)
StC-1	3-24-70	0	0	4	4.45
StC-2		0	0	14	1.11
StC-4		0	0	2	2.22
	Total	0	0	20	2.59 (Avg.)
StC-1	4-6-70	0	0	0	11.10
StC-2		0	0	4	8.33
StC-4		0	0	1	8.33
	Total	0	0	5	9.25 (Avg.)
StC-1	5-21-70	0	318	0	11.10
StC-2		0	480	0	11.10
StC-4		0	206	0	15.55
StC-5		0	90	48	11.10
	Total	0	1,094	48	12.21 (Avg.)

Table 28 continued

Station	Date	White Shrimp (P. setiferus)	Brown Shrimp (P. aztecus)	Blue Crabs (C. sapidus)	Bottom Salinity (o/oo)
StC-1	6-4-70	0	6	10	1.11
StC-2		0	290	2	1.11
StC-4		0	0	0	1.11
StC-5		0	0	0	1.11
	Total	0	296	12	1.11 (Avg.)
StC-1	7-1-70	24	26	2	0.00
	Total	24	26	2	0.00 (Avg.)
StC-1	8-14-70	464	0	0	6.66
StC-2		36	4	4	6.66
StC-3		132	24	3	8.88
StC-5		768	48	18	11.10
	Total	1,400	76	25	8.32 (Avg.)
StC-1	10-27-70	37	0	1	0.00
StC-2		189	0	0	13.32
StC-4		411	0	3	3.34
StC-5		102	0	0	4.45
	Total	739	0	4	5.28 (Avg.)
StC-1	11-10-70	1,270	0	3	0.00
StC-2		1,086	0	0	2.24
StC-4		51	0	0	0.00
StC-5		3	0	4	2.24
	Total	2,140	0	7	1.12 (Avg.)

Table 29

St. Charles Bay Creeks Catch Per Effort
of Commercial Crustacea by Station

Station	Total No. Samples	Total Catch	Positive C/E	Total Positive Samples	Total C/E
White Shrimp (*P. setiferus*)					
StC-1	12	2,246	374.33	6	187.17
StC-2	12	4,203	700.50	6	350.25
StC-3	3	142	47.33	3	47.33
StC-4	12	882	220.50	4	73.50
StC-5	6	1,623	405.75	4	270.50
Total	45	9,096	395.48	23	202.13
Brown Shrimp (*P. aztecus*)					
StC-1	12	350	116.67	3	29.17
StC-2	12	858	214.50	4	71.50
StC-3	3	473	157.67	3	157.67
StC-4	12	284	94.67	3	23.67
StC-5	6	138	69.00	2	23.00
Total	45	2,103	140.20	15	46.73
Blue Crab (*C. sapidus*)					
StC-1	12	57	6.33	9	4.75
StC-2	12	38	5.43	7	3.17
StC-3	3	18	9.00	2	6.00
StC-4	12	111	15.86	7	9.25
StC-5	6	70	11.67	3	11.67
Total	45	294	10.50	28	6.53

Table 30

Comparisons of Area Catch Per Effort
1969-1970

Area	Total No. Samples	Total Catch	Total C/E
White Shrimp (*P. setiferus*)			
Chiltipin Creek	95	3,866	40.69
Aransas River	85	2,043	24.04
Mission River	76	9,015	118.62
Copano Creek	33	3,779	114.52
St. Charles Creeks	45	9,096	202.13
Brown Shrimp (*P. aztecus*)			
Chiltipin Creek	95	1,241	13.06
Aransas River	85	117	1.38
Mission River	76	847	11.14
Copano Creek	33	1,018	30.85
St. Charles Creeks	45	2,103	46.73
Blue Crab (*C. sapidus*)			
Chiltipin Creek	95	102	1.07
Aransas River	85	23	.27
Mission River	76	538	7.08
Copano Creek	33	1,240	37.58
St. Charles Creeks	45	294	6.53

Table 31

Salinity Selectivity By Area and Species
(5 ppt Groups)

	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70
White Shrimp (P. setiferus)														
Copano	4,078		116											
St. Charles	3,164	4,761	1,147											
Mission	3,984	1,800	3,374	46										
Aransas	581	416		245	425	376								
Chiltipin	1,572	676	663	796	35	28		1	2					1
Total	13,379	7,653	5,300	1,087	460	404		1	2					1
Brown Shrimp (P. aztecus)														
Copano	50	527												
St. Charles	356	560	1,157											
Mission	309	52	486											
Aransas	9	5		12	91									
Chiltipin	806	2	313	211					1					
Total	1,530	1,146	1,956	223	91				1					
Blue Crab (C. sapidus)														
Copano	1,099	45	96											
St. Charles	82	69	40											
Mission	445	53	30											
Aransas	14	6		2	1	7								
Chiltipin	26	10	16	23	5	16	5		1					
Total	1,666	183	182	25	6	23	5		1					

Table 32

Checklist of Fin Fish and Crustacea of the
Aransas Bay Area Taken During Project CE 1-1

Scientific Name	Common Name
Anchoa mitchilli (Valenciennes)	Common anchovie (Bay anchovie)
Archosargus probatocephalus (Walbaum)	Sheepshead
Arius felis (Linnaeus)	Hardhead catfish
Bagre marinus (Mitchill)	Gafftopsail catfish
Bairdiella chrysura (Lacèpède)	Silver perch
Brevoortia gunteri Hildebrand	Finescale menhaden
Brevoortia patronis Goode	Largescale menhaden (Gulf)
Caranx hippos (Linnaeus)	Crevelle jack
Chaetodipterus faber (Broussonet)	Atlantic spadefish
Cichlasoma cyanoguttatum (Baird & Girard)	Rio Grande perch
Citharichthys spilopterus Günther	Bay whiff
Cynoscion nebulosus (Cuvier)	Speckled trout (Spotted sea trout)
Cynoscion nothus (Holbrook)	Sand trout (Silver sea trout)
Cyprinodon variegatus Lacèpède	Broad killifish (Speepshead minnow)
Diapterus olisthostomus (Goode & Bean)	Irish pompano
Dorosoma cepedianum(LeSueur)	Gizzard shad
Elops saurus Linnaeus	Skipjack (Lady fish)
Eucinostomus gula (Quoy & Giamard)	Silver jenny
Fundulus grandis Baird & Girard	Gulf killifish
Fundulus similis (Baird & Girard)	Longnose killifish
Gerres cinereus (Walbaum)	Yellowfin mojarra
Gobiosoma bosci (Lacèpède)	Naked goby
Hypsoblennius ionthos (Jordan & Gilbert)	Freckled blenny
Ictalurus furcatus	Blue catfish
Ictalurus natalis (LeSueur)	Yellow bullhead
Ictalurus punctatus (Rafinesque)	Channel catfish
Ictiobus bubalus (Rafinesque)	Smallmouth buffalo
Labidesthes sicculus (Cope	Brook silverside
Lagodon rhomboides (Linnaeus)	Pinfish
Leiostomus xanthurus Lacèpède	Spot croaker
Lepisosteus spatula Lacèpède	Alligator gar
Lepisosteus osseus (Linnaeus)	Longnose gar
Lepomis cyanellus Rafinesque	Green sunfish
Lepomis humilis (Girard)	Orange spotted sunfish
Lepomis macrohirus Rafinesque	Bluegill sunfish
Lepomis megalotis (Rafinesque)	Longear sunfish

Table 32 continued

Scientific Name	Common Name
Lepomis microlophus (Günther)	Redear sunfish
Menidia beryllina (Cope)	Tidewater silverside
Membras martinica (Valenciennes)	Rough silverside
Micropogon undulatus (Linnaeus)	Atlantic croaker
Micropterus salmoides (Lacèpède)	Largemouth bass
Mugil cephalus Linnaeus	Striped mullet
Notutus nocturnus Jordan & Gilbert	Freckled madtom
Paralichthys lethostigma Jordan & Gilbert	Southern flounder
Pogonias cromis (Linnaeus)	Black drum
Polydactylus octonemus (Girard)	Eight-fingered threadfin (Atlantic)
Pomoxis annularis Rafinesque	White crappie
Sciaenops ocellata (Linnaeus)	Redfish
Sphoeroides spengleri (Bloch)	Bandtail puffer
Synodus foetens (Linnaeus)	Inshore lizardfish
Trinectes maculatus (Bloch & Schneider)	Hog choker
Crustacea	
Callinectes sapidus Rathbun	Blue crab
Macrobrachium acanthurus (Weigmann)	River shrimp
Macrobrachium ohione (Smith)	River shrimp
Palaemonetes palaemonetes intermedius Holthius	Grass shrimp
Palaemonetes palaemonetes pugio Holthuis	Grass shrimp
Penaeus aztecus (Ives)	Brown shrimp
Penaeus setiferus (Linnaeus)	White shrimp

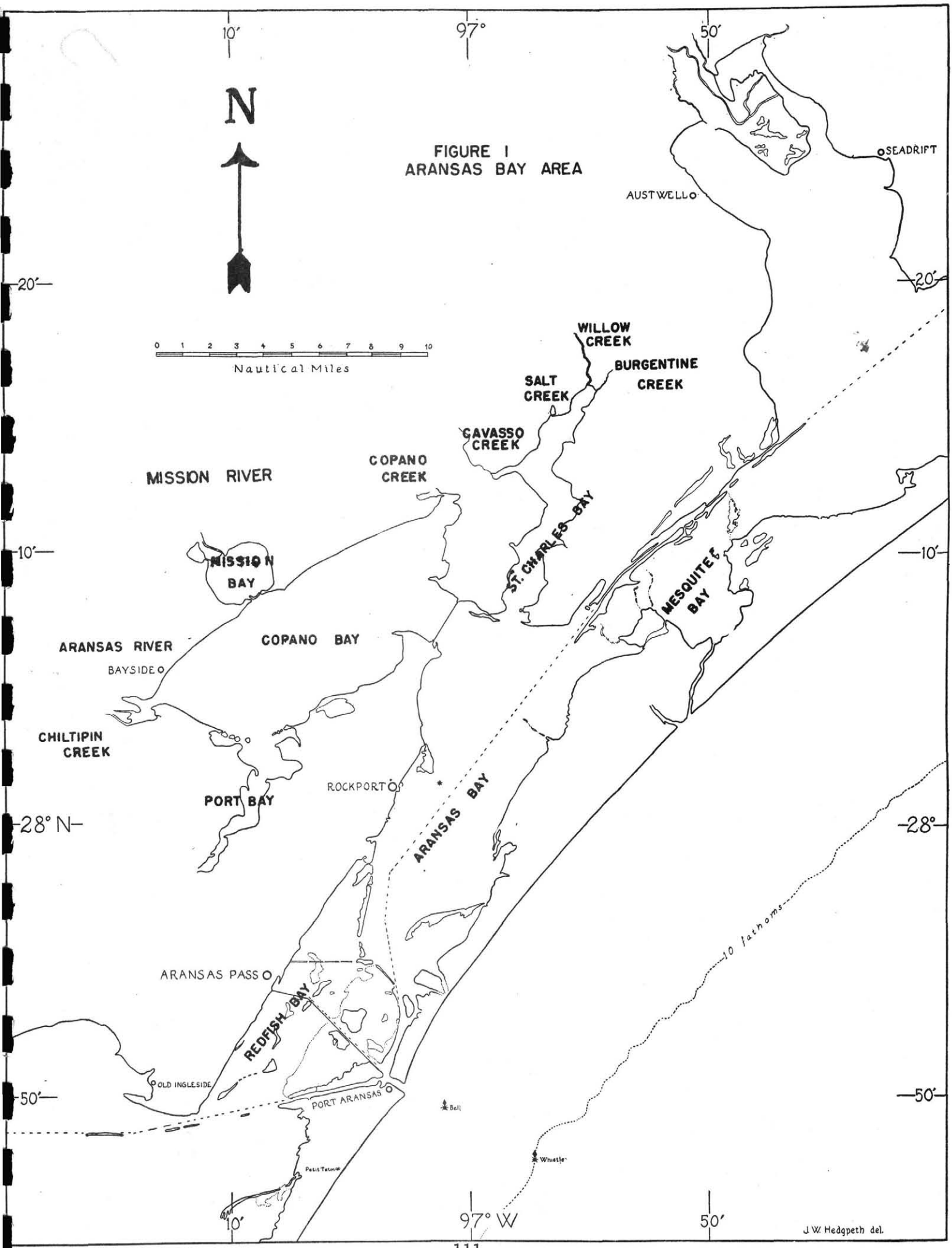
FIGURE I
ARANSAS BAY AREA
N
0 1 2 3 4 5 6 7 8 9 10
Nautical Miles
10'
97°
50'
20'
10'
28° N
50'
97° W
SEADRIFT
AUSTWELL
WILLOW CREEK
BURGENTINE CREEK
SALT CREEK
CAVASSO CREEK
COPANO CREEK
MISSION RIVER
ST. CHARLES BAY
MESQUITE BAY
MISSION BAY
ARANSAS RIVER
COPANO BAY
BAYSIDE
CHILTIPIN CREEK
PORT BAY
ROCKPORT
ARANSAS BAY
ARANSAS PASS
REDFISH BAY
OLD INGLESIDE
PORT ARANSAS
Bell
Whistle
10 fathoms
J.W. Hedgpeth del.

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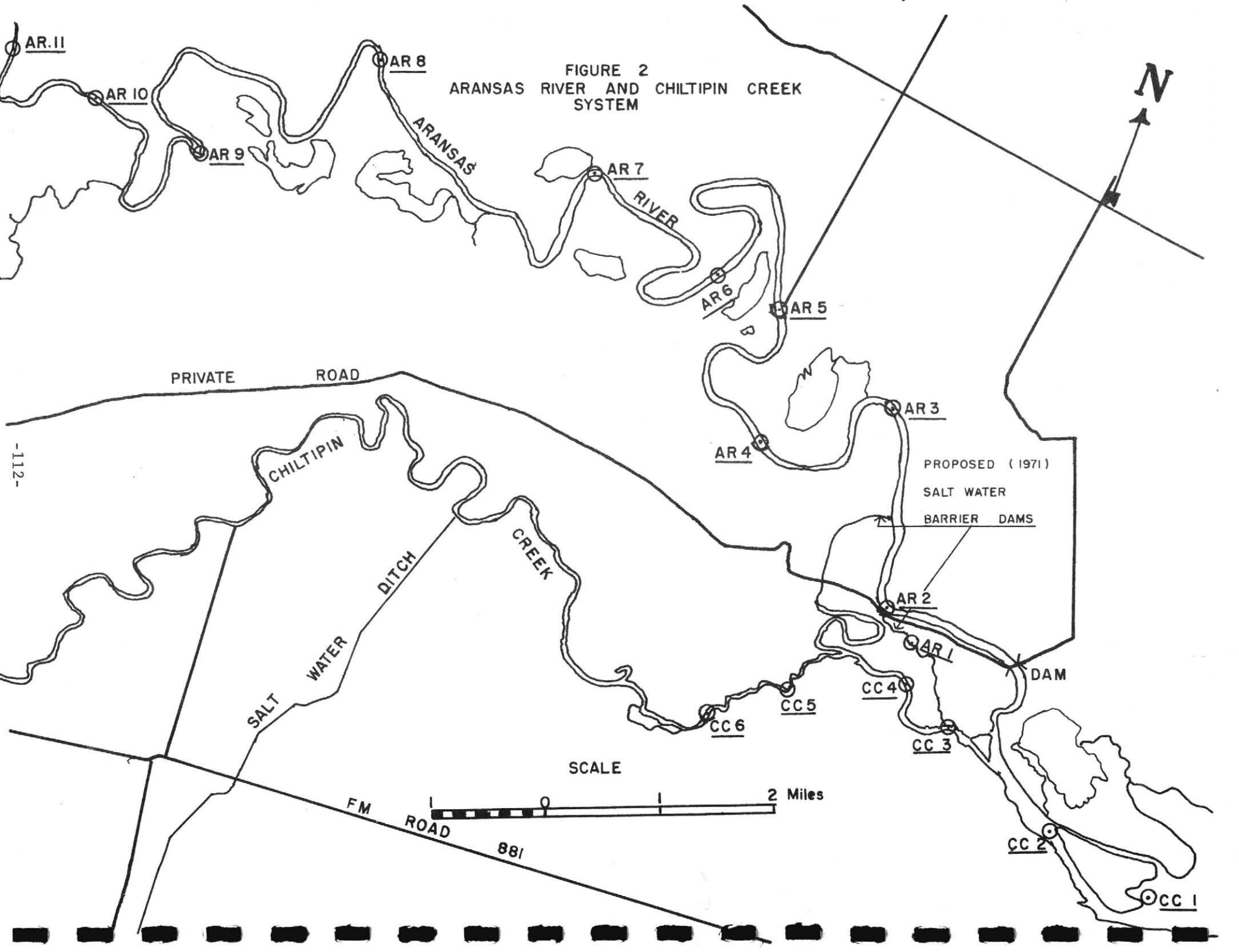


FIGURE 2
ARANSAS RIVER AND CHILTIPIN CREEK SYSTEM

FIGURE 3

CHILTIPIN CREEK – ALL STATIONS

BOTTOM SALINITY RANGE AND AVERAGE

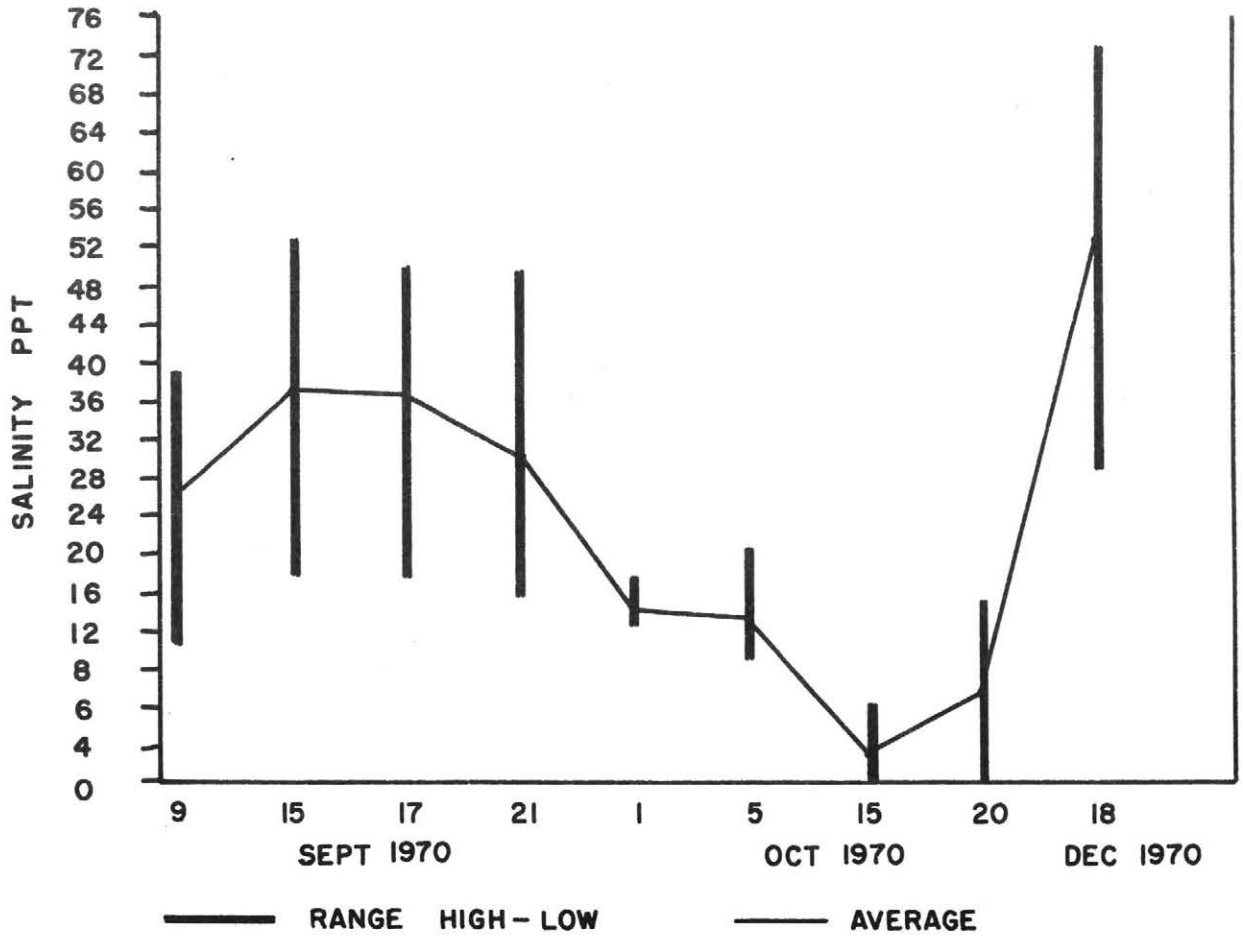


FIGURE 4

CHILTIPIN CREEK – ALL STATIONS

SPECIAL SAMPLES – BOTTOM TO SURFACE

SALINITY RANGES AND RAINFALL AVERAGES

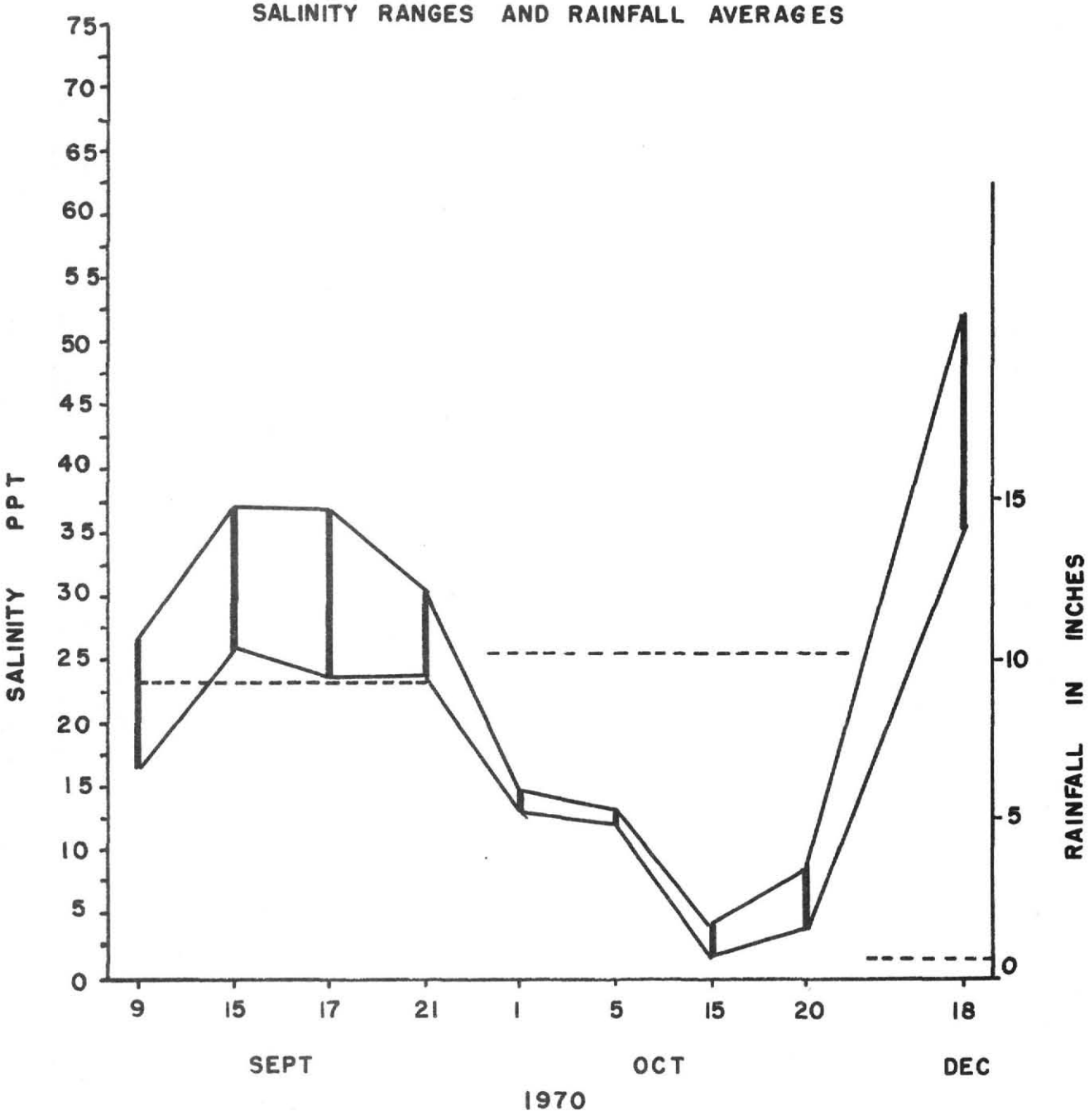


FIGURE 5

CHILTIPIN CREEK STATIONS CC-1 AND CC-2

COMPARED TO BAYSIDE CAUSEWAY STATION SALINITY

AUGUST 1969 — DEC 1970

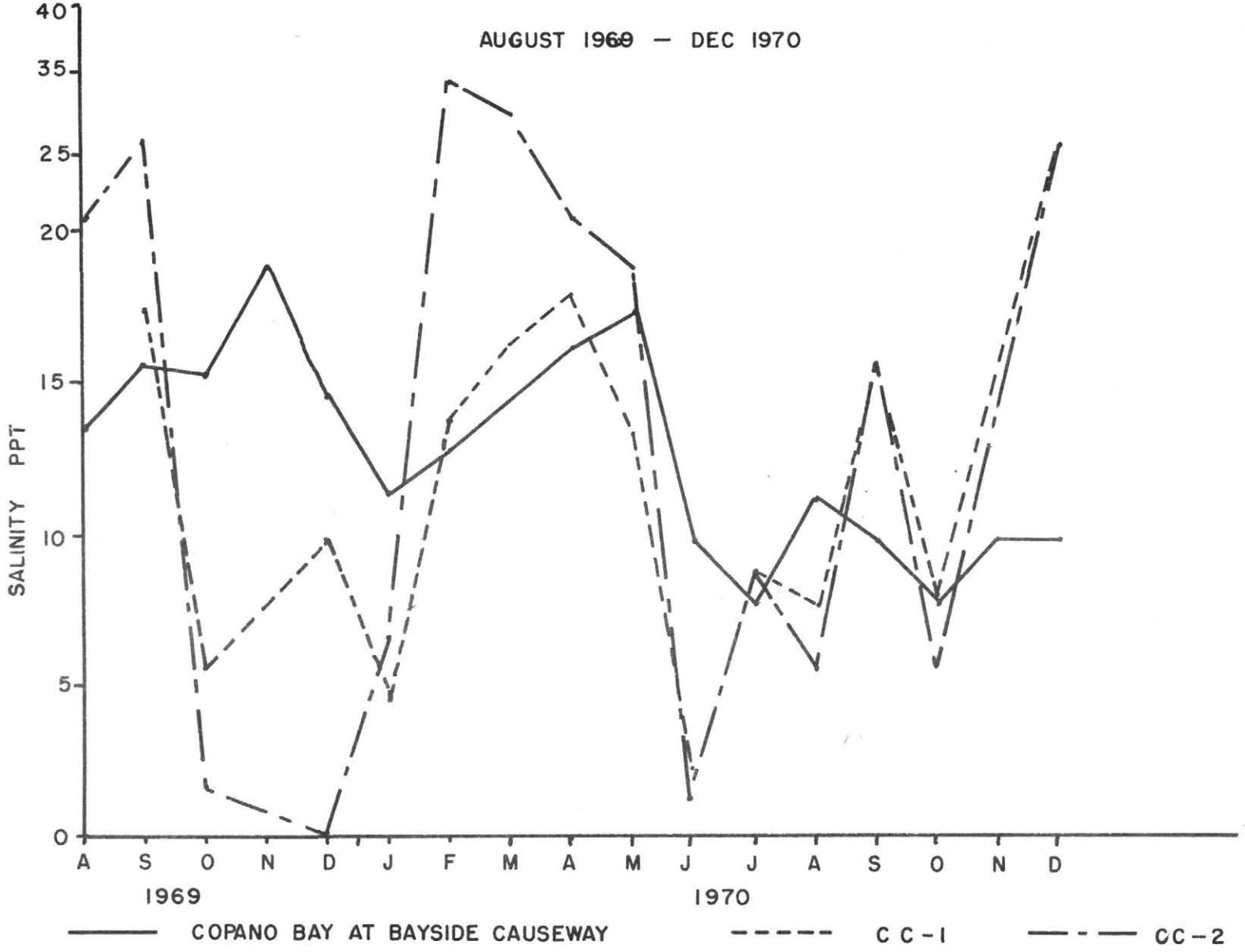
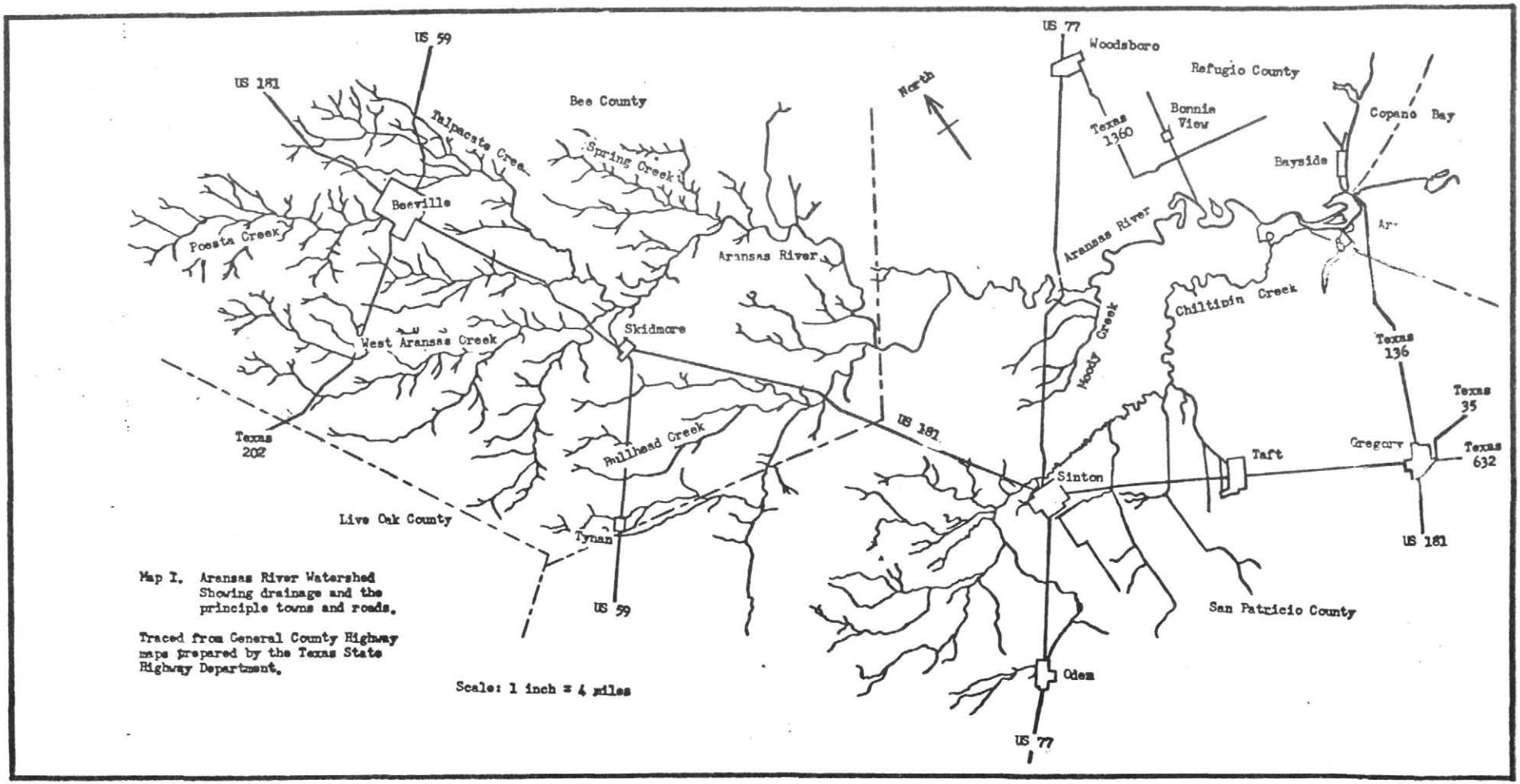


Figure 6

ARANSAS RIVER WATERSHED



Map I. Aransas River Watershed Showing drainage and the principle towns and roads.

Traced from General County Highway maps prepared by the Texas State Highway Department.

Scale: 1 inch = 4 miles

Figure 7

ARANSAS RIVER

MONTHLY FLOW DATA
AND
MONTHLY SALINITY DATA
COMPARISON

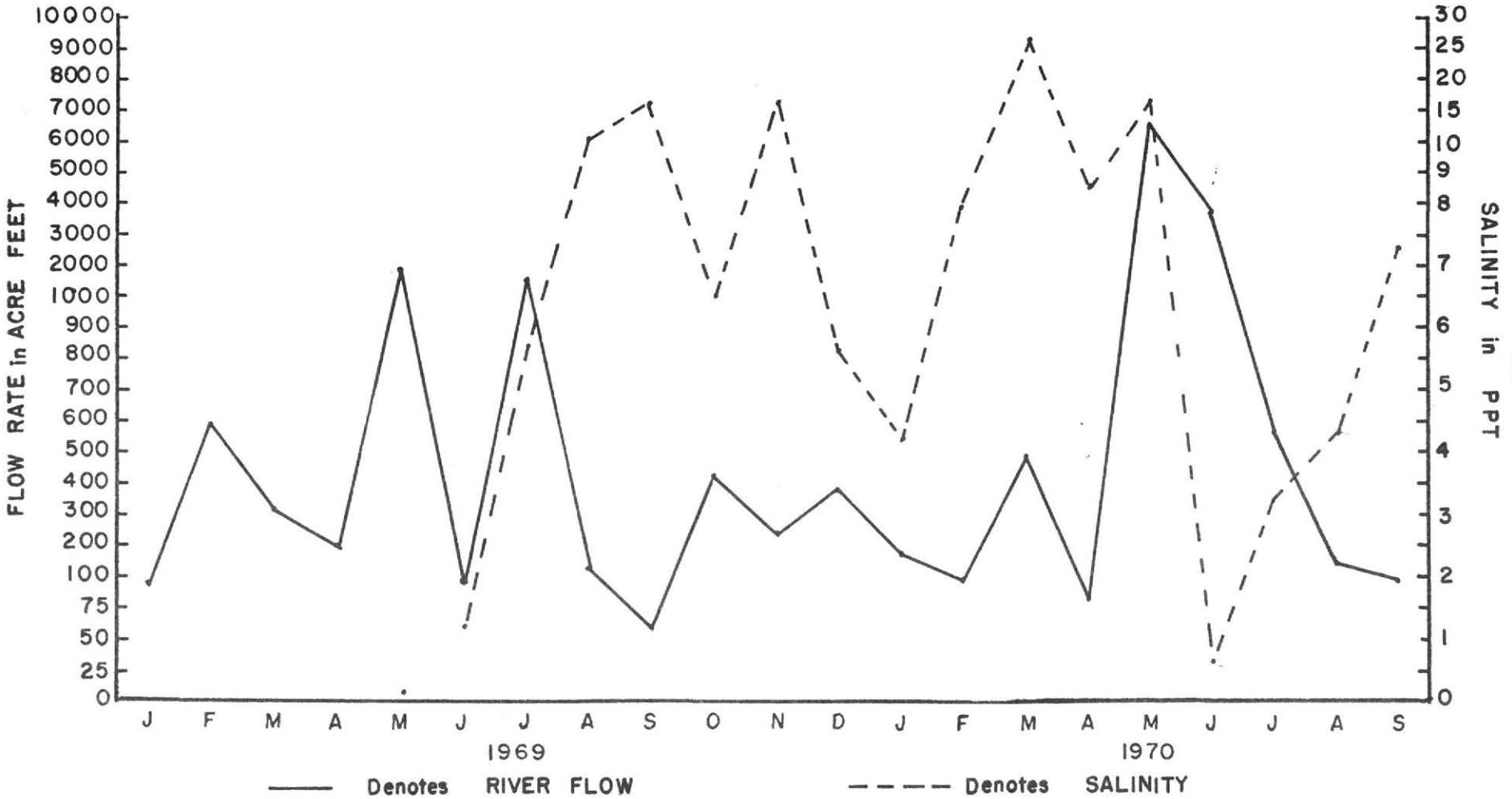


FIGURE 8

ARANSAS RIVER

COMPARISON OF RIVER FLOW WITH SALINITY AT STATIONS AR-1 AND CC-3

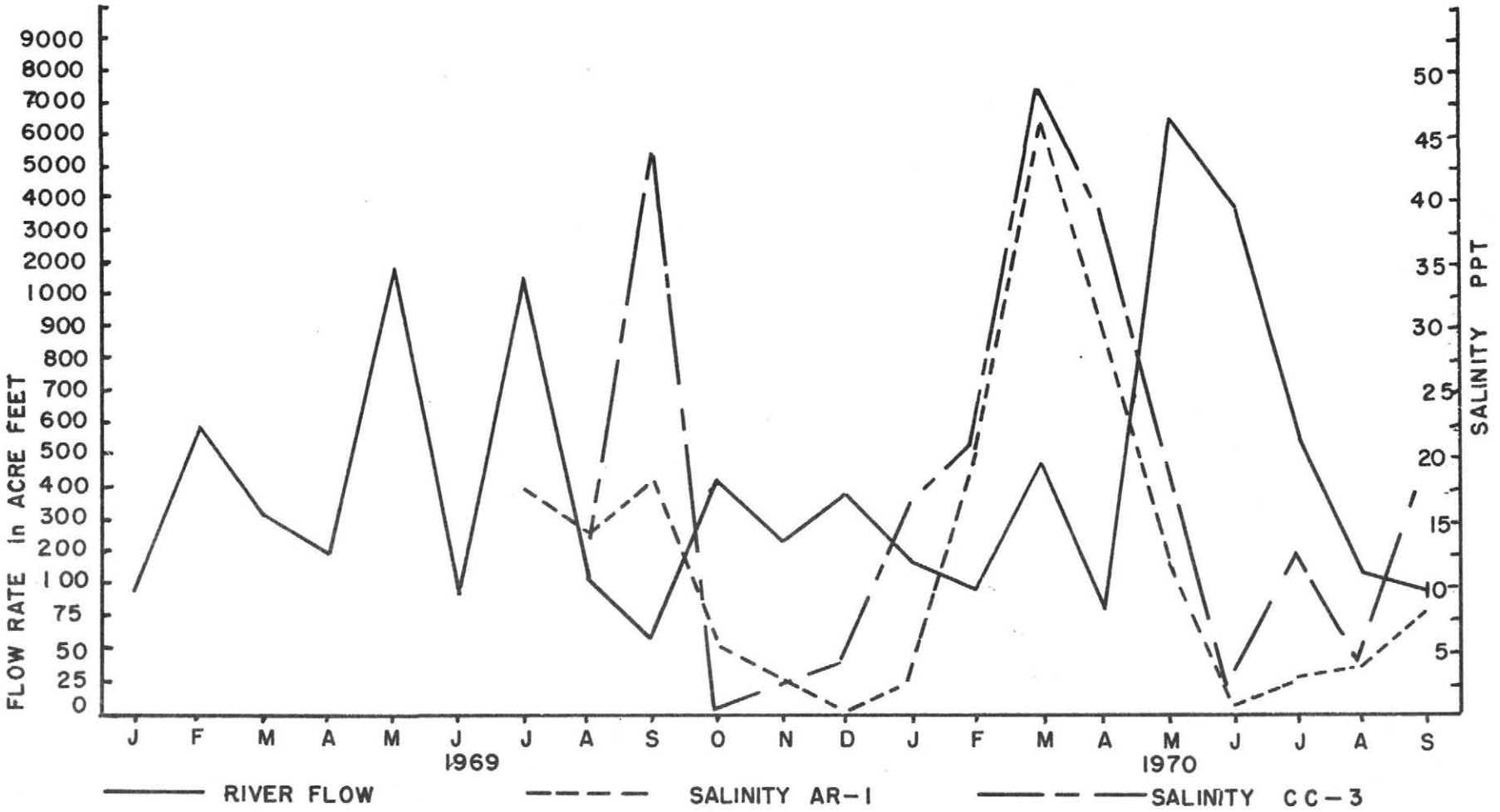


FIGURE 9

ARANSAS RIVER

COMPARISON OF RIVER FLOW AND RAINFALL DATA

MONTHLY AVERAGE

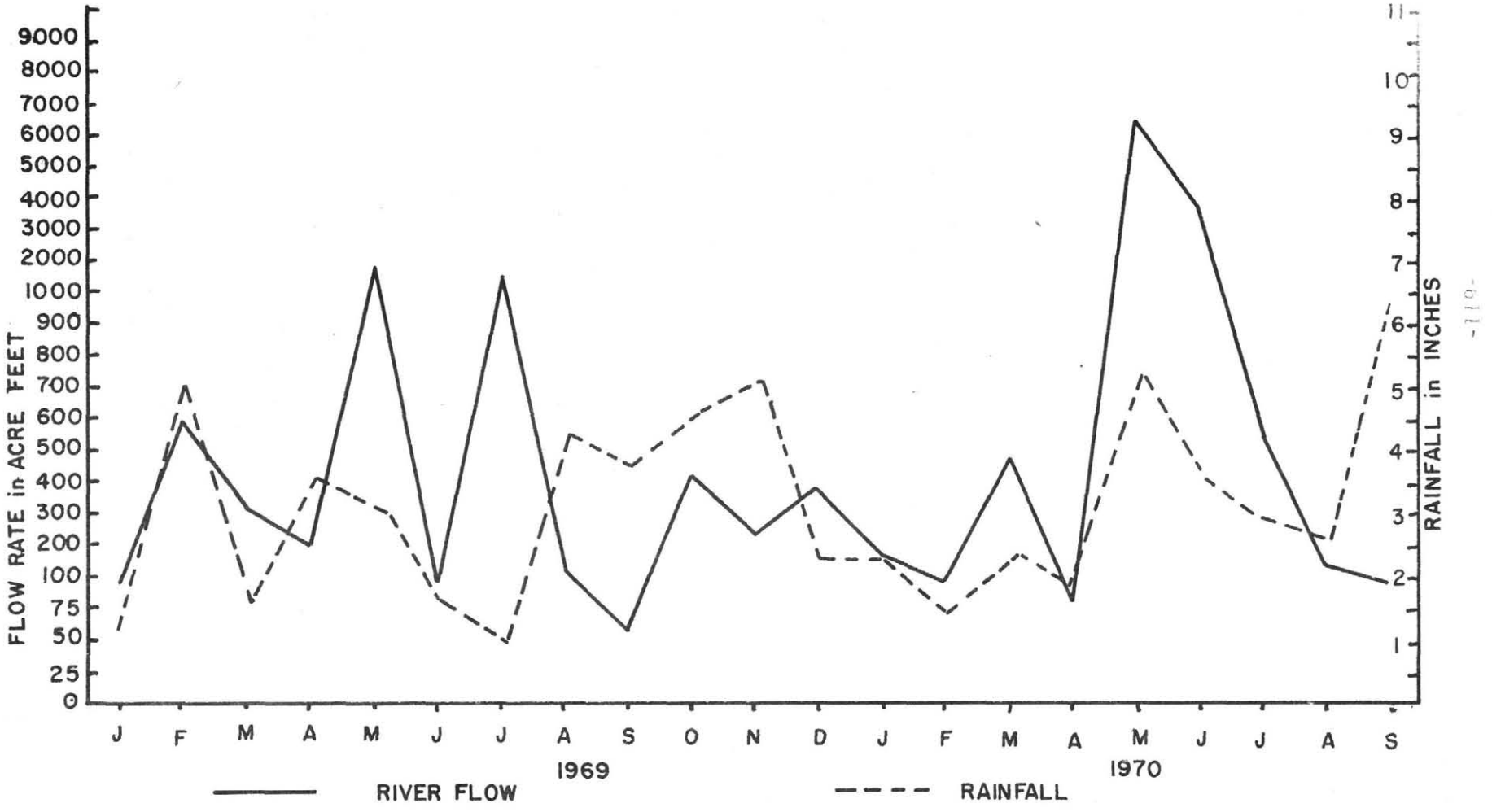


Figure 10

MISSION RIVER WATERSHED

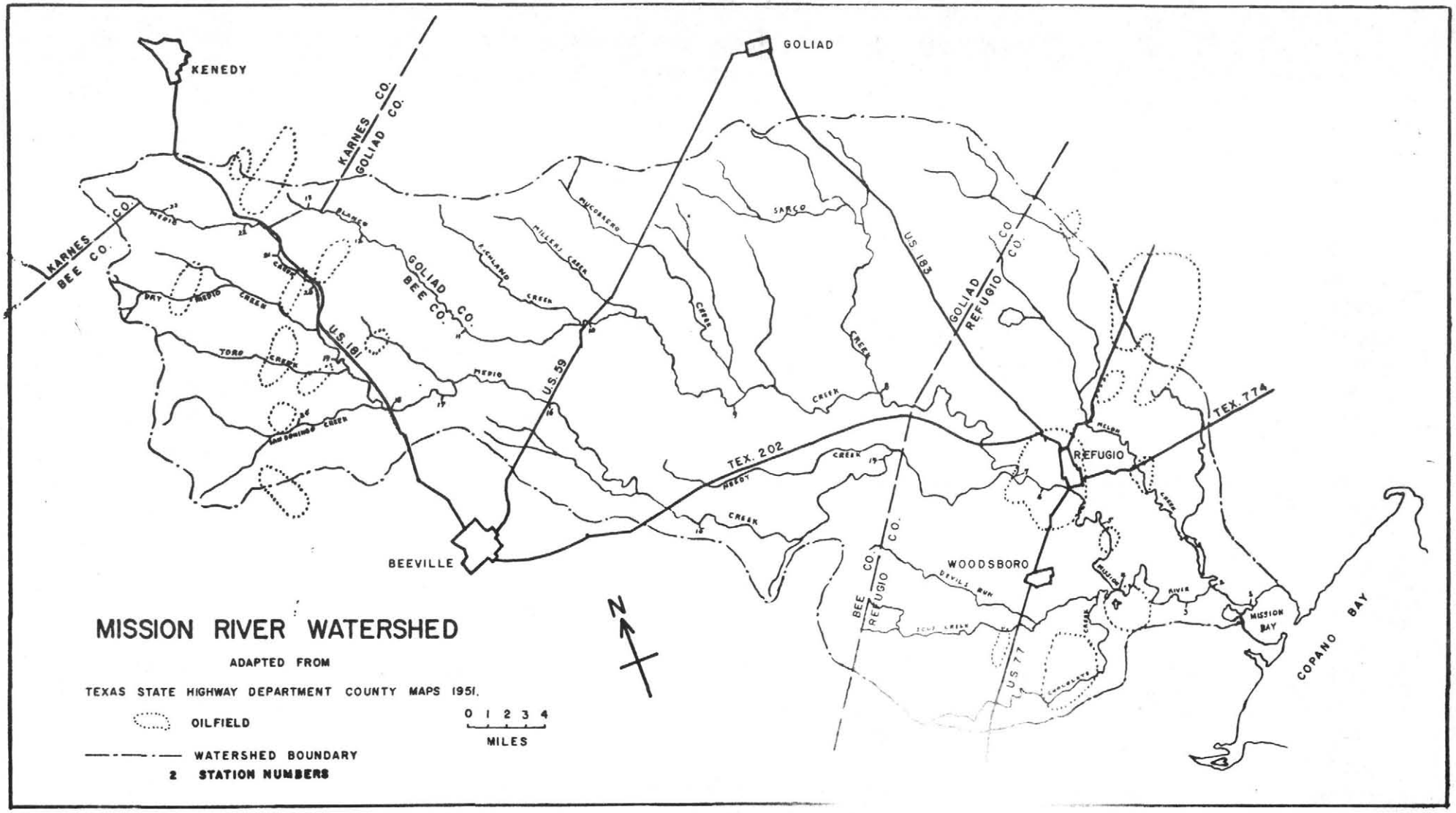


FIGURE 11

MISSION RIVER SYSTEM

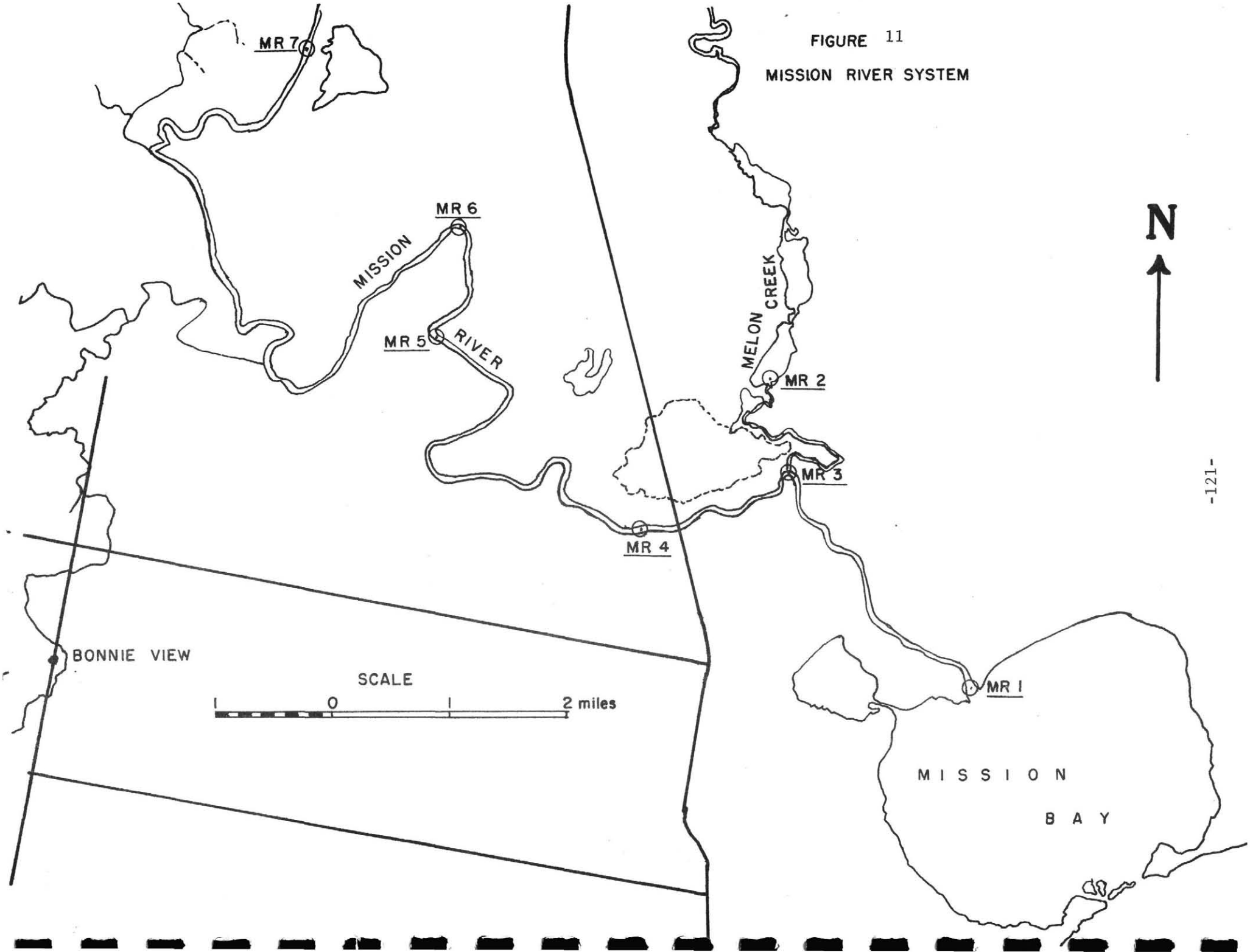


FIGURE 12
MISSION RIVER

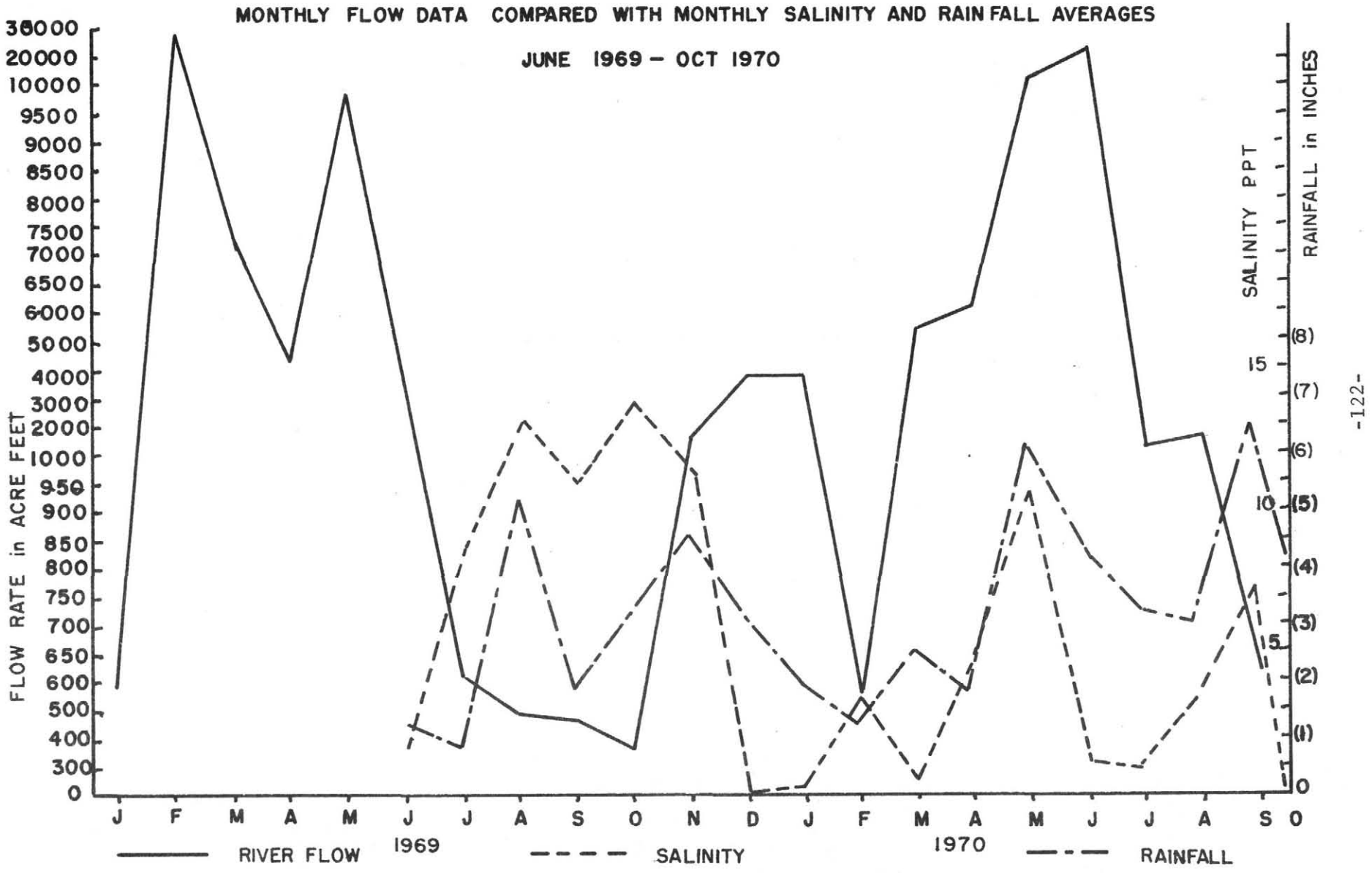


FIGURE 13
COPANO CREEK

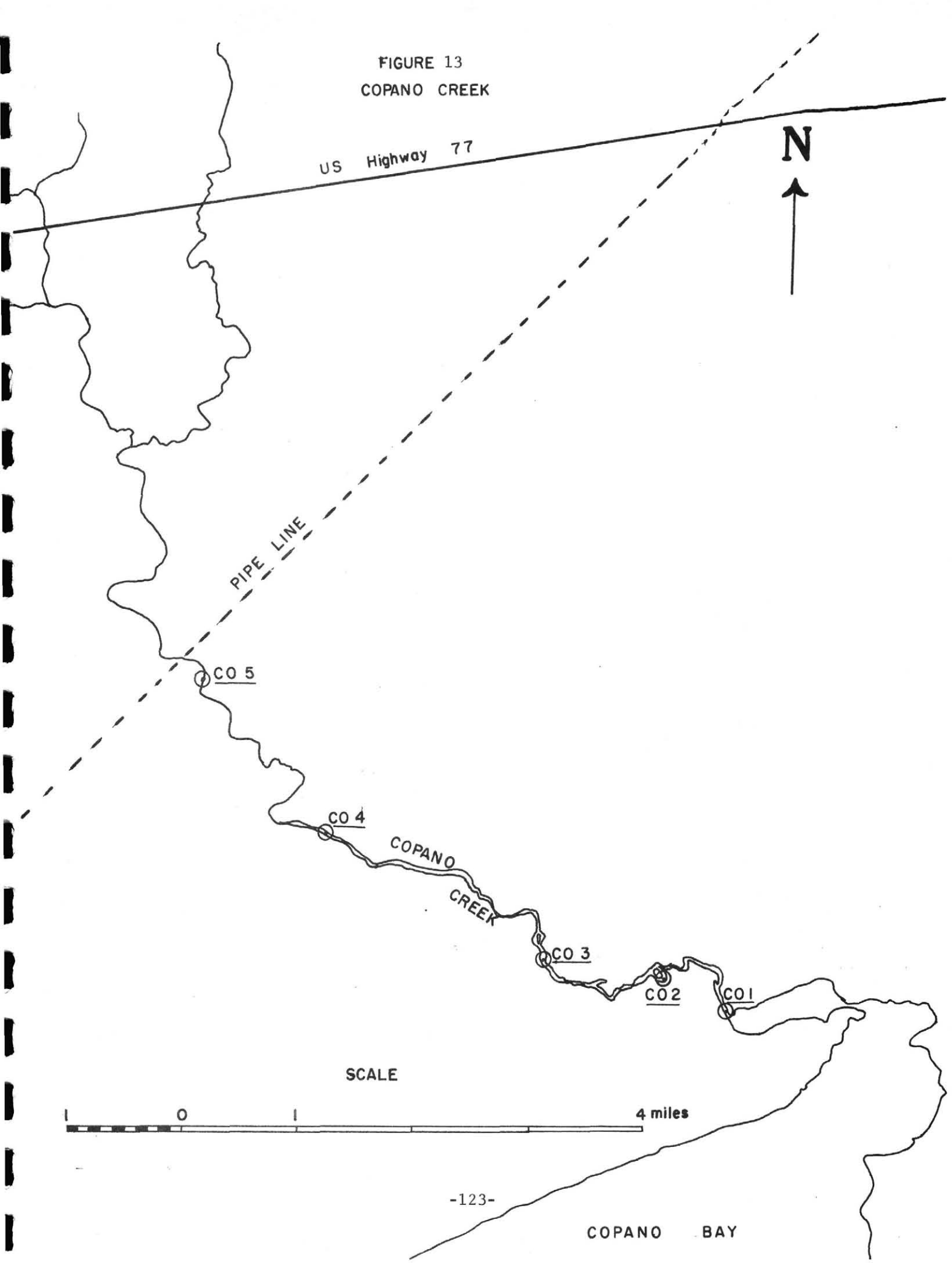


FIGURE 14

COPANO CREEK

SALINITY AND RAINFALL COMPARISON

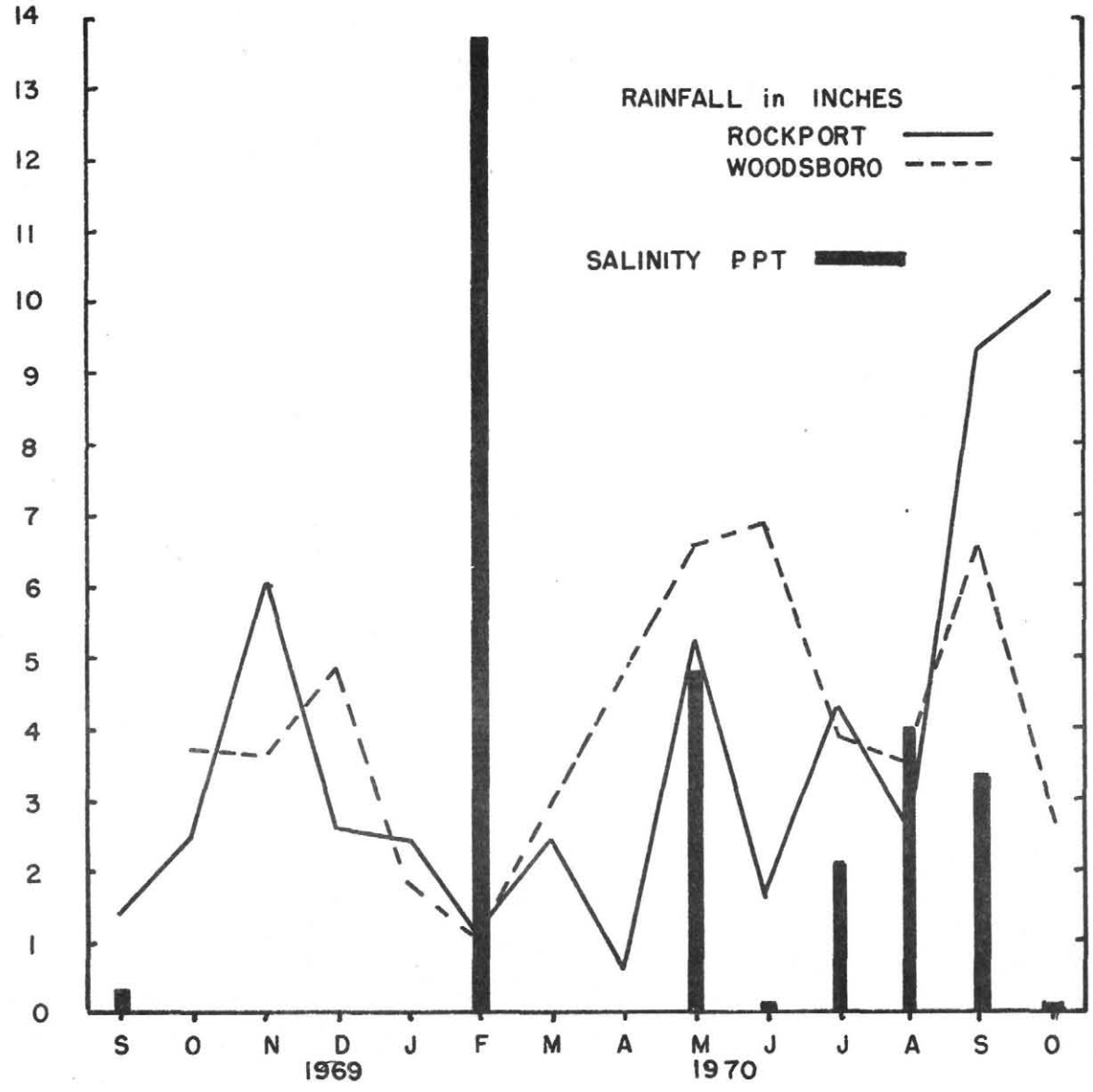


FIGURE 15

ST. CHARLES BAY AND

CREEKS

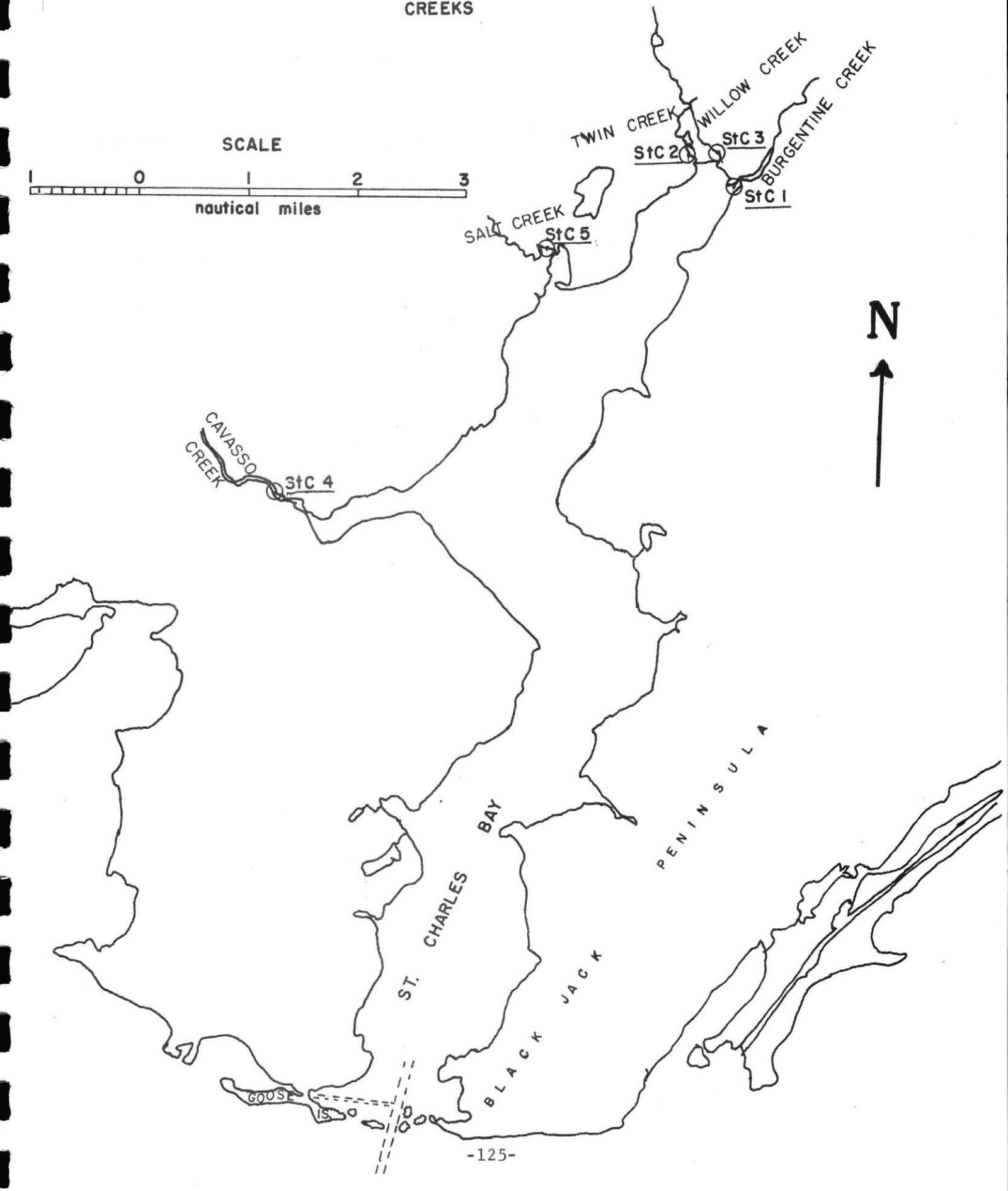


FIGURE 16

ST. CHARLES BAY

CREEKS

RAINFALL AND

SALINITY COMPARISON