JOB COMPLETION REPORT

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Project No. M-2-R-1 Date: June 25, 1959.

Project Name: Basic Ecological Survey of Area M-2. Job No. E-2

Period Covered: May 1958 to June 1959.

Hydrographic and Climatological Data for Area M-2.

Objectives: To collect hydrographic and climatological data in the area and determine their effects upon the biological components.

Procedure: Information on hydrographic and climatological phenomena were obtained by use of various instruments and by direct observation. Various publications were consulted. Observations were made in conjunction with Jobs A-2, C-2, D-2 and F-2.

Findings: Climate.

Mean annual temperature in Area M-2 is about 20.5° C and average annual rainfall is around 50 inches. It is considered to be a wet, humid region. Records of the U.S. Weather Bureau as reported in the 1959 Texas Almanac show that the sun reaches the surface of the earth during all the hours of daylight 58% of the time at Houston and 63% of the time at Galveston. Since Corpus Christi and Brownsville both have more sunshine per year than does Houston, the waters of Area M-2 are restricted in this respect in their productivity. In-solation (the amount of sunshine reaching the earth's surface) is an important factor in determining the productivity of an area. Productivity is also influenced by turbidity, temperature and the availability of nutrient materials.

Collier and Hedgepth (1950, Introduction to the Hydrography of the Tidal Waters of Texas, Publ. Inst. Mar. Sci., Vol. I, No. 2) discussed the effects of seasonal rainfall on the watersheds of the Aransas Hydrographic System. They showed that season peaks of rain fell during September and stated that from November until well into March there were pronounced winter droughts in that area. This is not the case in area M-2. Table I (with graph) shows precipitation on the Trinity and San Jacinto River watersheds over a long period of years has reached a peak in May and is well distributed throughout the rest of the year. The late summer months experience the least rainfall on the watersheds. Coupled with high temperatures and high evaporation, the late summer period is thus most likely to be the time of highest salinities in Area M-2.

Figure I indicates the streams and watersheds which influence the area. Upon examination of the precipitation records for Corsicana (Figure II) (about halfway up the Trinity River watershed) and for Huntsville (Figure III) (at the head of the San Jacinto watershed) and for Alvin (Figure IV) (near the

TABLE I

Precipitation Records of Cities on the Galveston Bay - Trinity Bay Watershed

City	County	Years of Record	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Bowie	Montague	28	4.79	3.42	3.84	4.13	5.42	4.49	3.90	3.62	3.00	2.96	4.46	5.14	49.47
Gainesville	Cook	55	1.86	2.15	2.84	4.17	4.78	3.36	3.25	2.51	3.20	3.29	2.23	2.30	35.94
Waxachie	Ellis	49	2.19	2.38	2.85	4.02	4.84	3.26	2.45	1.80	2.81	2.67	2.84	2.92	35.05
Corsicanna	Navarro	70	2.58	2.60	3.06	4.04	4.92	3.22	2.44	2.09	2.75	2.81	3.07	3.33	36.91
Palestine	Anderson	71	3.74	3.12	3.78	3.66	4.69	3.12	2.67	1.76	2.81	2.92	4.01	4.26	40.54
Crockett	Houston	35	3.80	3.53	3.66	4.74	5.68	2.95	3.08	2.23	2.85	3.22	4.51	5.14	45.39
Huntsville	Walker	63	3.73	3.48	3.52	4.44	4.91	4.11	3.18	2.66	2.76	3.20	4.13	4.27	44.40
Conroe	Montgomery	28	4.79	3.42	3.84	4.13	5.42	4.49	3.90	3.62	3.00	2.96	4.46	5.14	49.17
Houston	Harris	63	3.98	2.81	3.10	3.40	4.84	4.08	4.45	3.09	3.65	3.39	3.95	4.63	45.37
		Avg.	3.50	2.99	3.39	4.41	5.05	3.68	3.26	2.60	2.98	3.05	3.74	4.13	42.44

Nine City
Precipitation Average

- inches -

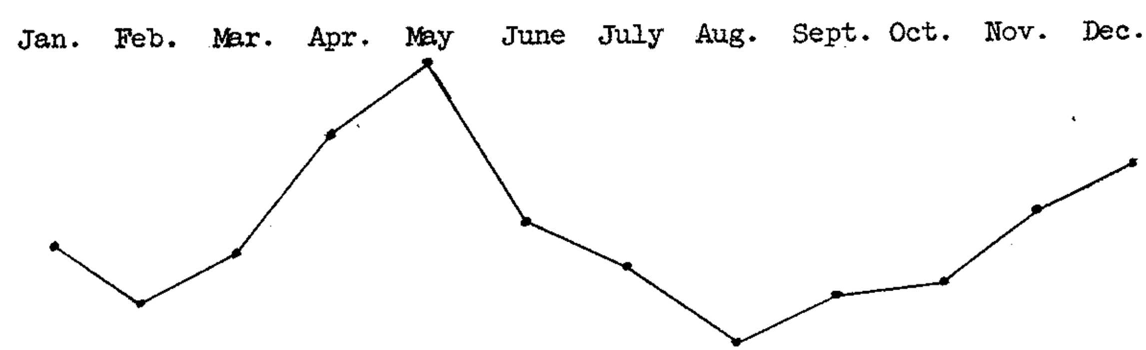
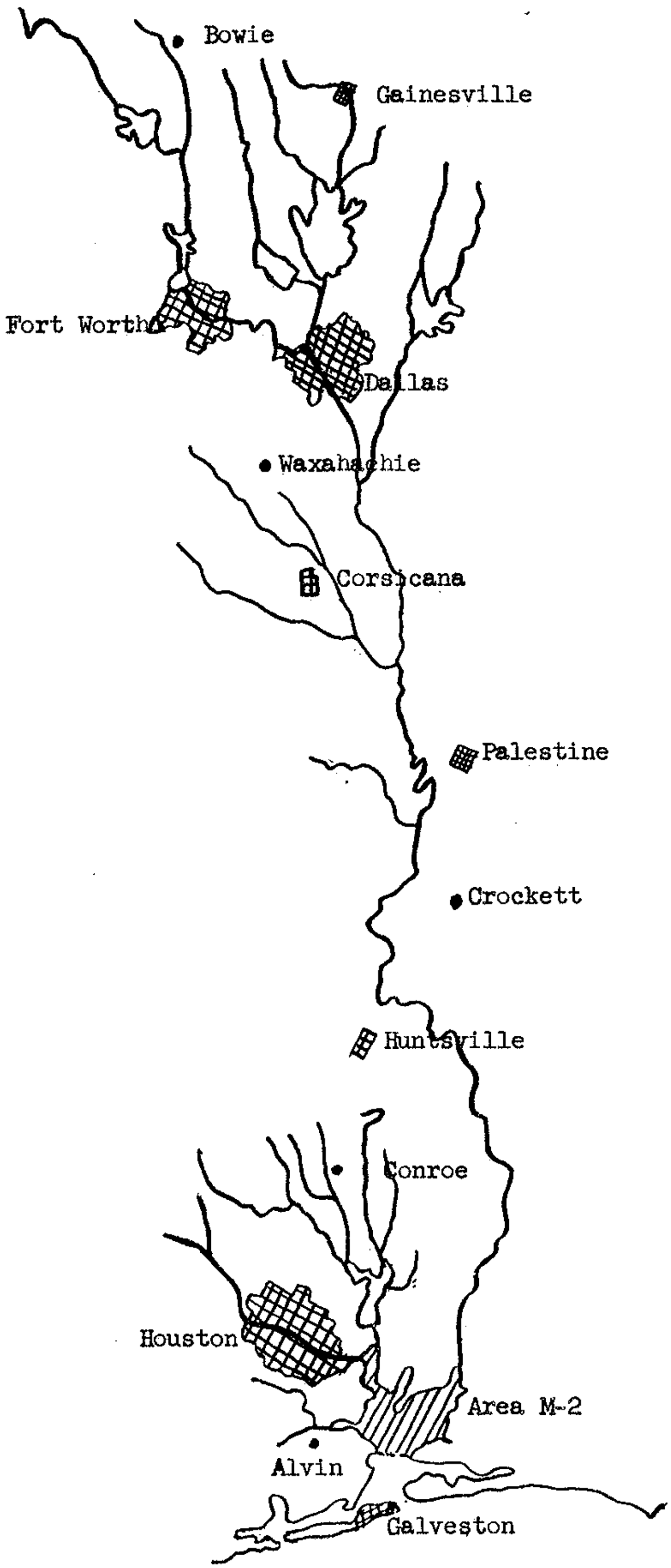
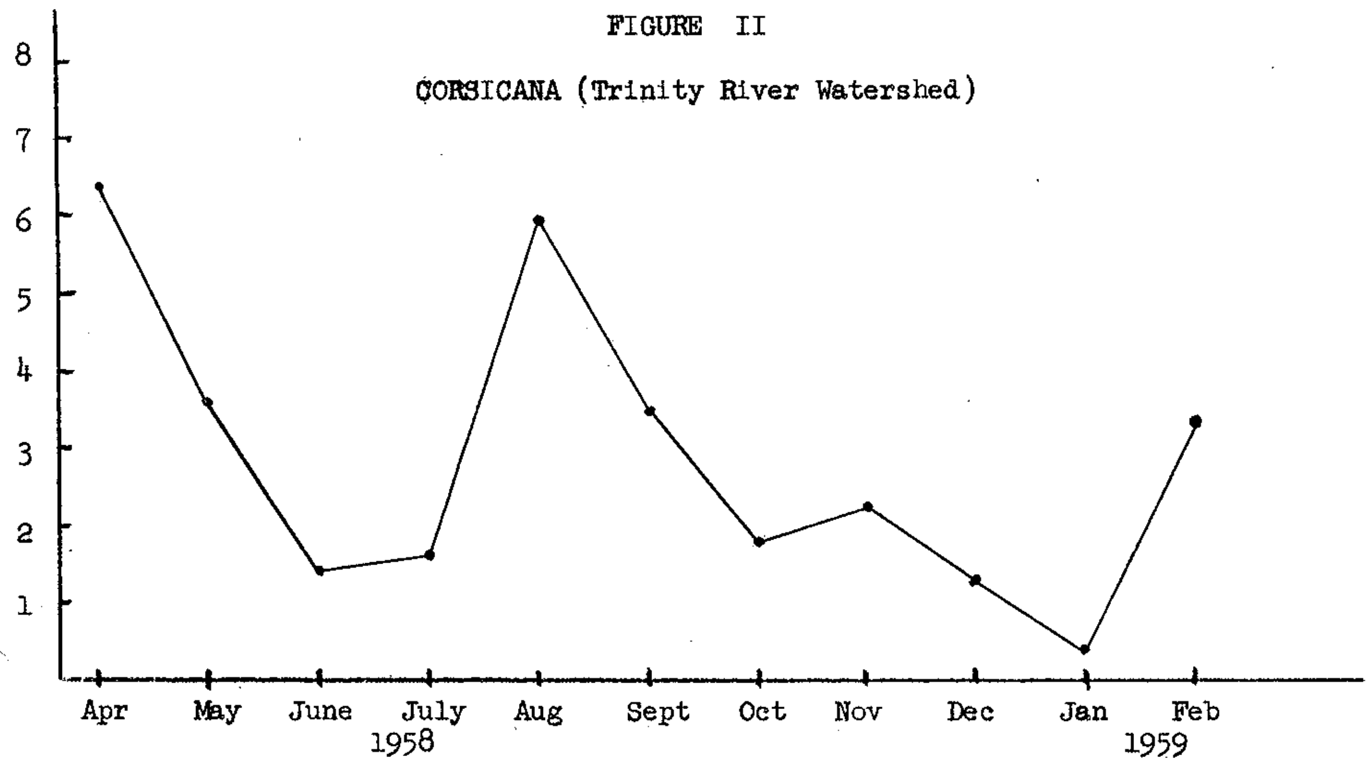
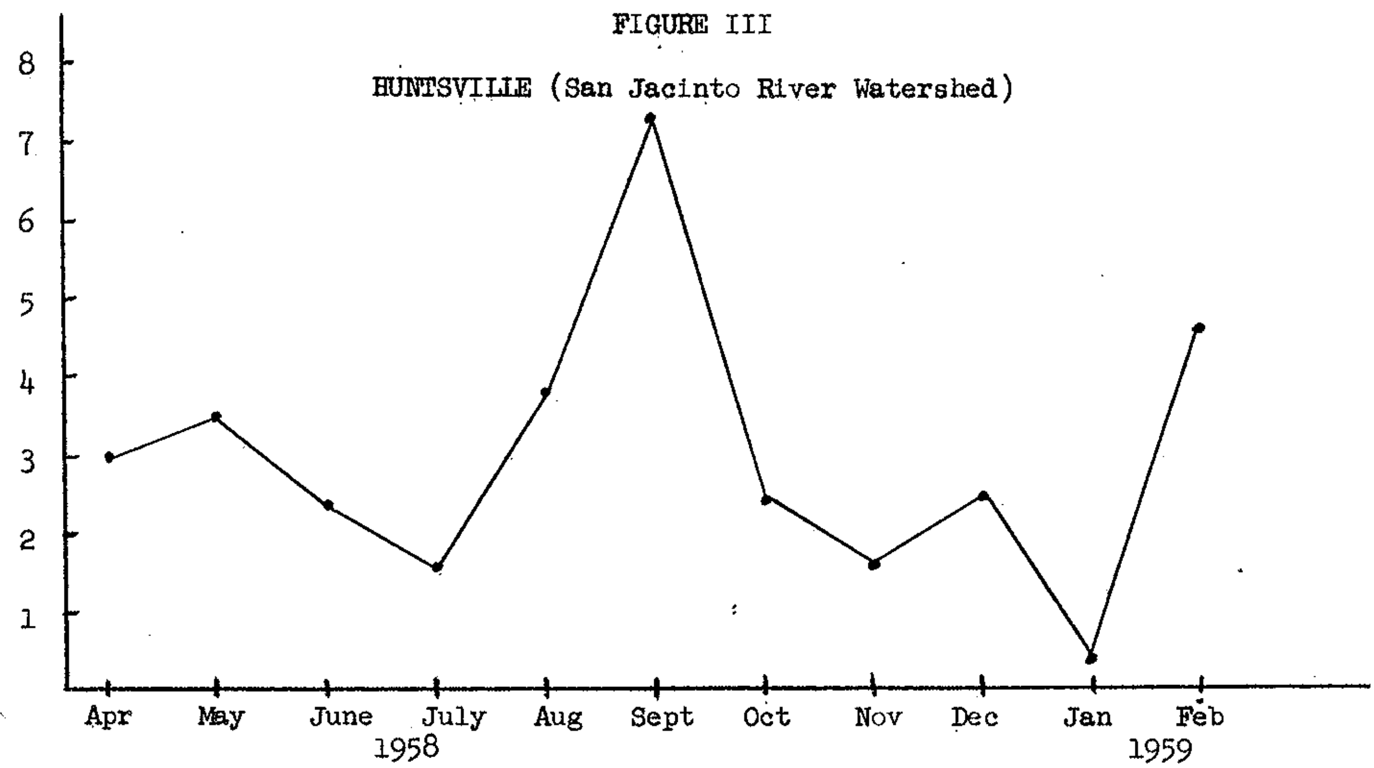


FIGURE I


Bowie
Gainesville
Fort Worth
Dallas
Waxahachie
Corsicana
Palestine
Crockett
Huntsville
Conroe
Houston
Area M-2
Alvin
Galveston

Precipitation records of stations on Area M-2 watershed.
(Taken from Climatological Data - Texas Section)





PRECIPITATION IN INCHES

watershed of Clear Creek), it becomes obvious that precipitation during the preceding year was not average. Much rainfall was experienced during September as a result of tropical disturbances and during the middle of September there was an abnormal amount of rain throughout the area.

<u>Salinity</u>.
The waters of Area M-2 present an interesting hydrographic arrangement. The positions of the major streams emptying into the bays, the shape of the basins, and the position of channels and spoil banks divide the area roughly into five separate but related hydrographic systems. The following map (Figure V) illustrates these systems.

Clear Creek System -
In Clear Lake and the adjacent bay west of the Houston Ship Channel, south of Red Bluff, and north of Eagle Point, salinity is largely determined by the discharge of fresh water from Clear Creek and its adjacent bayous. During periods of high precipitation a definite line of muddy water and debris can be seen pouring out of the Seabrook Channel and pushing the more saline water from the area. The ship channel and its spoil banks delimit this area on the east and often the water in the bay to the east of the channel is quite clear while muddy fresh water can be found only a few yards across the channel to the west.

San Jacinto System -
Above Red Bluff and west of the ship channel is an area primarily influenced by water coming out of the Houston Ship Channel as a result of discharge of the San Jacinto River and the numerous bayous in and about Houston. This area often has the typical foul odor and taste of the ship channel north of Morgan's Point.

Tabbs Bay System -
Near Mesquite Point and east of the ship channel is a small area which, at times, becomes brackish with brine waters from the numerous oil wells in the Baytown area.

Trinity River System -
Salinities in this area are controlled by fresh water discharge from the Trinity River. During periods of much rainfall on the watershed of the Trinity River the entire bay becomes fresh and muddy. During November, December and January of last year there was little rain. As a result salty water from lower Galveston Bay invaded and mixed with fresh water in the bay and salinities increased steadily during these months.

Lower Galveston Bay System -
In the southern part of Area M-2 more saline water from lower Galveston Bay is pushed over the sill of oyster reefs and spoil banks between Eagle Point and Smith's Point with tidal changes and causes salinities to be higher in this area. Discharge of fresh water from all the other systems passes through this bottleneck and causes salinities to fluctuate.

FIGURE IV

Precipitation records of stations on Area M-2 Watershed
(Average of the monthly totals recorded for Houston and Alvin)
(Taken from Climatological Data - Texas Section)

HOUSTON-ALVIN (Clear Creek Watershed)

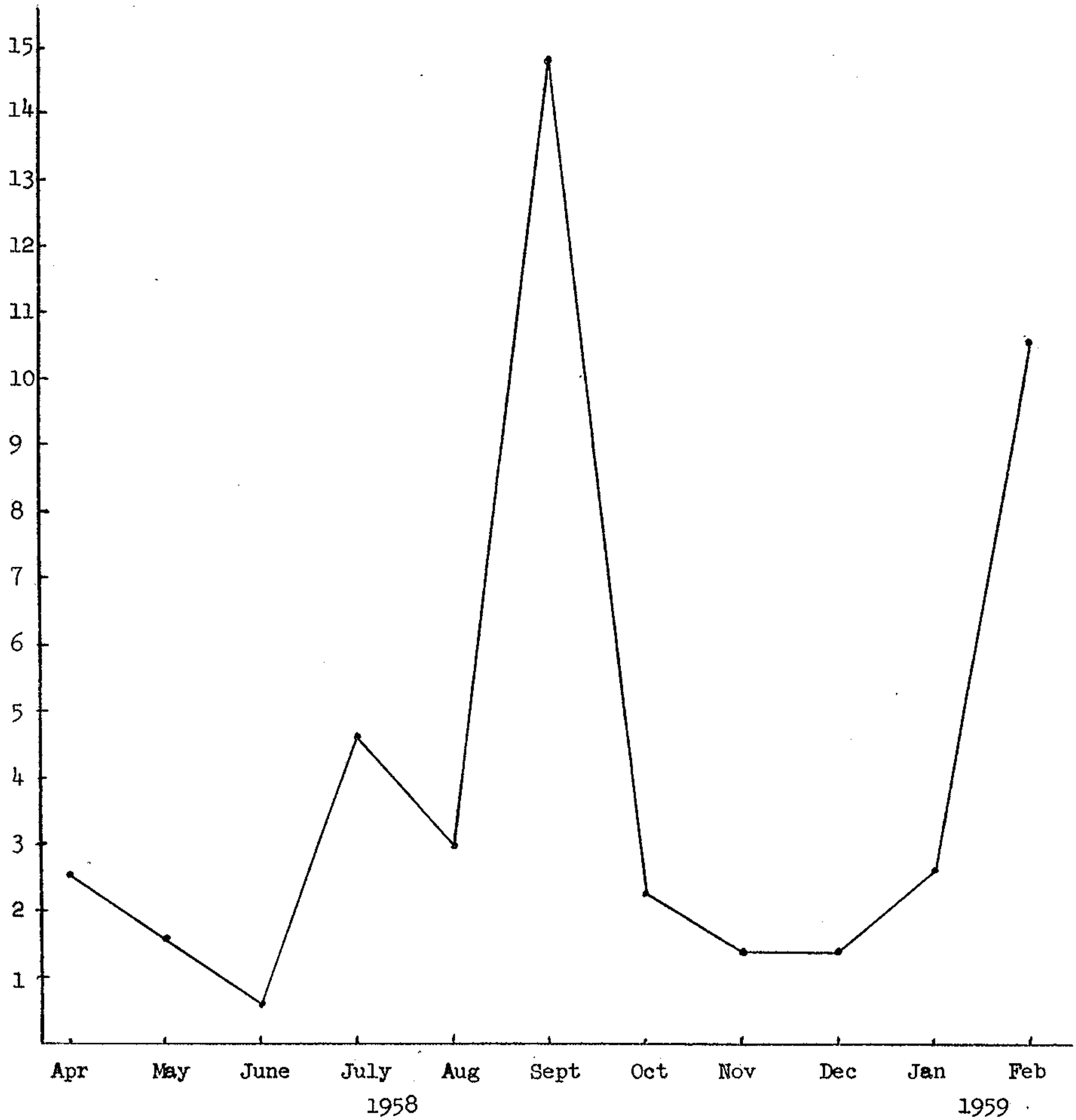
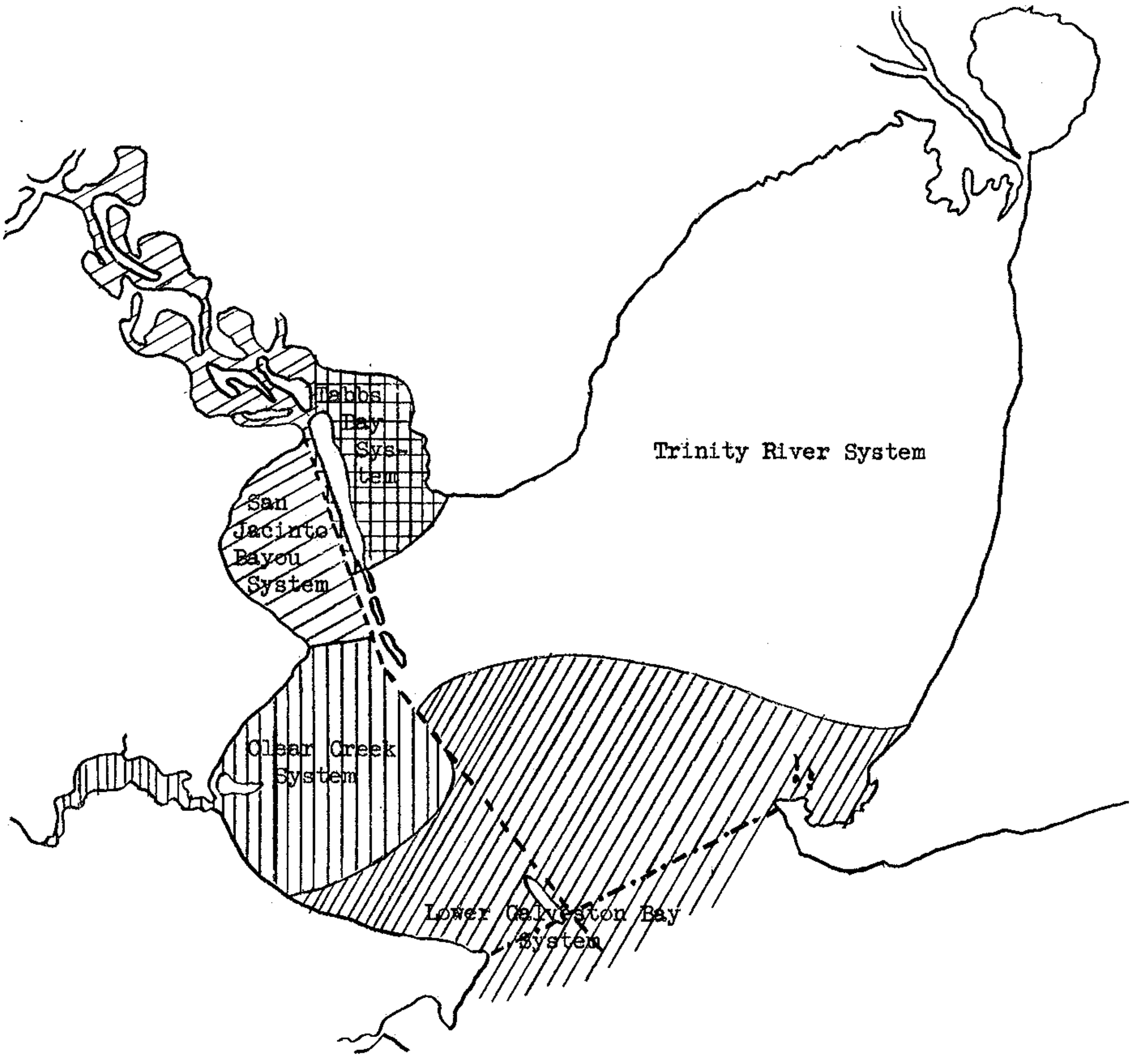


FIGURE V

Hydrographic Systems

Area M-2



During September 1958 after Tropical Storm "Ella" the salinity picture changed radically. There was a disproportionate amount of rain on the Clear Creek and San Jacinto River watersheds and fresh water pushing out on the west side of the ship channel kept this area relatively fresh under the circumstances while the high tides resulting from the storm pushed into the Trinity River System making for higher salinities than usual here (Figure X).

Tides

Several complicating factors make the study of tides in Area M-2 a subjective matter at best. One cause for difficulty in studying water level changes at different locations within the area is the fact that the elevation of the land surrounding the bays is constantly changing. Shepard (1953, Sedimentation Rates in Texas Estuaries and Lagoons - Bull. Amer. Assoc. Petrol. Geol., Vol. 37, No. 8) states that "it seems likely that the Gulf Coast is subsiding and Galveston is subsiding at an exceptionally rapid rate. Between 1909 and 1950 the sea has changed in relation to the land at Galveston to the amount of approximately 1.0 feet (or a rate of 2.4 feet per century)." In the region within a radius of 125 miles around Galveston and Houston the rate of subsidence of the land is abnormally rapid (but also extremely confused - that is, the rate of sinking from one location to another within the area varies greatly). In conversation with Mr. Joe Hicks, a surveyor with offices in the Electric Building in Houston the following point was brought out: one tide gauge occupied by the U.S. Coast and Geodetic Survey on the Houston Ship Channel above Morgan's Point sank 1.6 feet in the ten years between 1943 and 1953. From the above it becomes apparent that a considerable amount of information is needed before water levels recorded at the various stations around the bay could be correlated. In the absence of an accurate standard datum plane with which tide gauges in the area could be adjusted, the recorded ranges in water level fluctuations at the different gauges would appear to be the only valid figures available at present.

Another factor to be taken into consideration is the elevation to which the tide gauge is referred. The various agencies maintaining tide gauges in the area use different reference planes. The U.S. Coast and Geodetic Survey uses Mean Sea Level. The U.S. Corps of Engineers relate their elevations to Mean Low Tide. Most of the concern maintaining gauges relate their water levels to Mean Sea Level. Mean Sea Level is defined as: "the plane about which the tide oscillates". It is determined from tidal observations by averaging the tabulated hourly heights of the tide over a period of several years. According to personnel at the Corps of Engineers Fort Point Station, Mean Low Tide is 1.41 feet below Mean Sea Level at Galveston.

Another factor in the study of celestial tides in the bays is the effect of winds. Table II shows that the prevailing winds at Galveston and Houston during most months of the year blow from 90° quadrant south to east. Under these conditions there is a tendency for water to be pushed up and held in the area. During the fall and winter months, when cold fronts pass the area and winds blow from either of the two northern quadrants, drastic changes in water levels in the area may occur. The bays are so aligned (northwest to southeast axis) that north and northwest winds push water from the area causing low water levels. In the winter during particularly intense frontal passages, it is not unusual for the water level to drop four feet in a matter of hours. It is also common for cold fronts to become stationary over the area causing northerly winds to remain in force for considerable periods and causing water levels to remain low. At times the winds blow from the northeast causing water from Trinity Bay to be pushed across the bay and pile up on the southwest shores. This results in abnormally high water levels on the west shore and low water levels in Trinity Bay.

Tables III, IV, and V consist of data collected from continuously recording tide gauges maintained in Area M-2. The tide level data for Clear Creek was in tabular form. The data presented for Fort Point and the Sam Berton plant on the Houston Ship Channel were taken directly from the graph papers taken from the gauges. In collecting the data the lowest level and the highest level recorded during the month were noted and then a visual averaging of all the daily low and high levels during the month was performed. The courtesy and cooperation of personnel at the Fort Point station of the U.S. Corps of Engineers and of numerous people connected with the Houston Lighting and Power Company is greatly appreciated. Without their help this data could not have been assimilated. Table VI is a comparison of the ranges of fluctuations between the average monthly high and low water levels for the three tide gauge stations. It appears that there is little difference in water level range among the stations. It must be added that the stations on Clear Creek and the Ship Channel are influenced by flood stages at times.

Figures VI through XVIII show general hydrographic and climatic conditions in the area during each month of the study. Prevailing winds are an average of the vectors between Galveston and Houston. Air temperatures are the averages of all the hourly temperatures during each month. Water temperatures at noon were determined from field data. Salinity patterns represent the average conditions which occured during the month.

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Approved by: Howard T. Lee (signed) Howard T. Lee

Date Approved: 21 July 1959

TABLE II

Prevailing Winds

(Airport Reports From Climatological Data - Texas Section)

Date		Prevailing Direction Galveston	Velocity MPH	Prevailing Direction Houston	Velocity MPH
1957	April	ESE	14	SE	13
	May	SSE	14	SSE	12
	June	SSE	13	SSE	10
	July	S	10	S	7
	August	S	11	SSE	8
	September	N	12	ENE	9
	October	N	12	NNW	10
	November	SSE	14	SSE	11
	December	SE	13	SSE	10
1958	January	ESE	11	WNW	13
	February	E	16	ENE	14
	March	N	14	N	12
	April	ESE	13	SSE	12
	May	S	13	S	11
	June	S	14	SSE	11
	July	S	14	SSE	10
	August	S	12	SSE	8
	September	ESE	11	ENE	11
	October	NE	10	NE	22
	November	E	9	ESE	10
	December	N	11	N	11
1959	January	ESE	13	NNW	13
	February	N	14	ENE	13
	March	SE	13	SE	14
	April	SE	14	SE	16

TABLE III

Data obtained from Fort Point Station,
U.S. Corps of Engineers, Galveston, Texas

GALVESTON TIDE LEVELS
(Feet above Mean Sea Level)

1958	HIGHEST	LOWEST	AVERAGE MAXIMUM	AVERAGE MINIMUM
January	2.5	-2.2	0.6	-0.4
February	1.8	-2.2	0.5	-0.1
March	1.7	-1.2	0.5	-0.3
April	1.8	-0.9	0.5	-0.2
May	1.7	-1.4	1.1	0.2
June	1.8	-0.6	1.1	-0.1
July	1.7	-0.9	0.8	-0.2
August	1.9	-0.9	0.7	-0.4
September	3.3	-0.1	1.6	0.7
October	2.6	0.3	1.8	0.9
November	2.1	-1.0	1.4	0.4
December	1.5	-1.1	0.8	-0.4
1959				
January	1.7	-1.5	0.7	-0.6
February	1.4	-1.1	0.9	-0.1
March	1.4	-2.3	0.9	-0.2
April	1.8	-1.3	0.9	-0.1

TABLE IV
Data obtained from the Webster Station
of the Houston Lighting and Power Company

CLEAR CREEK TIDE LEVELS
(Feet above Mean Sea Level)

1958	HIGHEST	LOWEST	AVERAGE MAXIMUM	AVERAGE MINIMUM
January	4.0	-0.5	2.0	0.7
February	3.7	-0.7	2.3	0.8
March	3.0	-0.1	1.8	0.7
April	3.7	0.3	2.5	1.2
May	3.3	-0.1	2.5	1.4
June	3.0	0.8	2.6	1.4
July	2.7	0.7	2.5	1.5
August	2.7	0.6	2.0	1.0
September	5.0	1.3	3.0	2.0
October				
November	3.3	0.5	2.7	1.6
December	3.5	-0.1	2.3	1.9
1959				
January	3.4	-1.5	2.3	1.1
February	4.9	1.4	3.2	2.1
March	3.3	-0.4	2.5	1.4

TABLE V

Data obtained from Sam Berton Plant,
Houston Lighting and Power Company

HOUSTON SHIP CHANNEL TIDE LEVELS
(Feet above Mean Sea Level)

1958	HIGHEST	LOWEST	AVERAGE MAXIMUM	AVERAGE MINIMUM
January	5.7	1.0	3.5	2.0
February	4.8	1.0	3.5	2.0
March	4.5	1.8	3.7	2.5
April	5.3	1.8	4.0	2.8
May	4.7	1.5	4.0	2.5
June	4.9	2.0	4.3	3.0
July	4.6	2.3	4.0	2.9
August	4.6	2.1	3.7	2.6
September	6.5	2.7	4.6	3.8
October	5.3	2.7	4.5	3.8
November	5.1	1.8	3.9	3.0
December	4.4	1.2	3.5	2.4
1959				
January	4.8	0.0	3.5	2.4
February	4.9	1.7	3.8	2.6
March	4.8	1.5	3.7	2.5
April	5.0	1.2	4.3	2.8
May	6.0	2.8	4.6	3.5

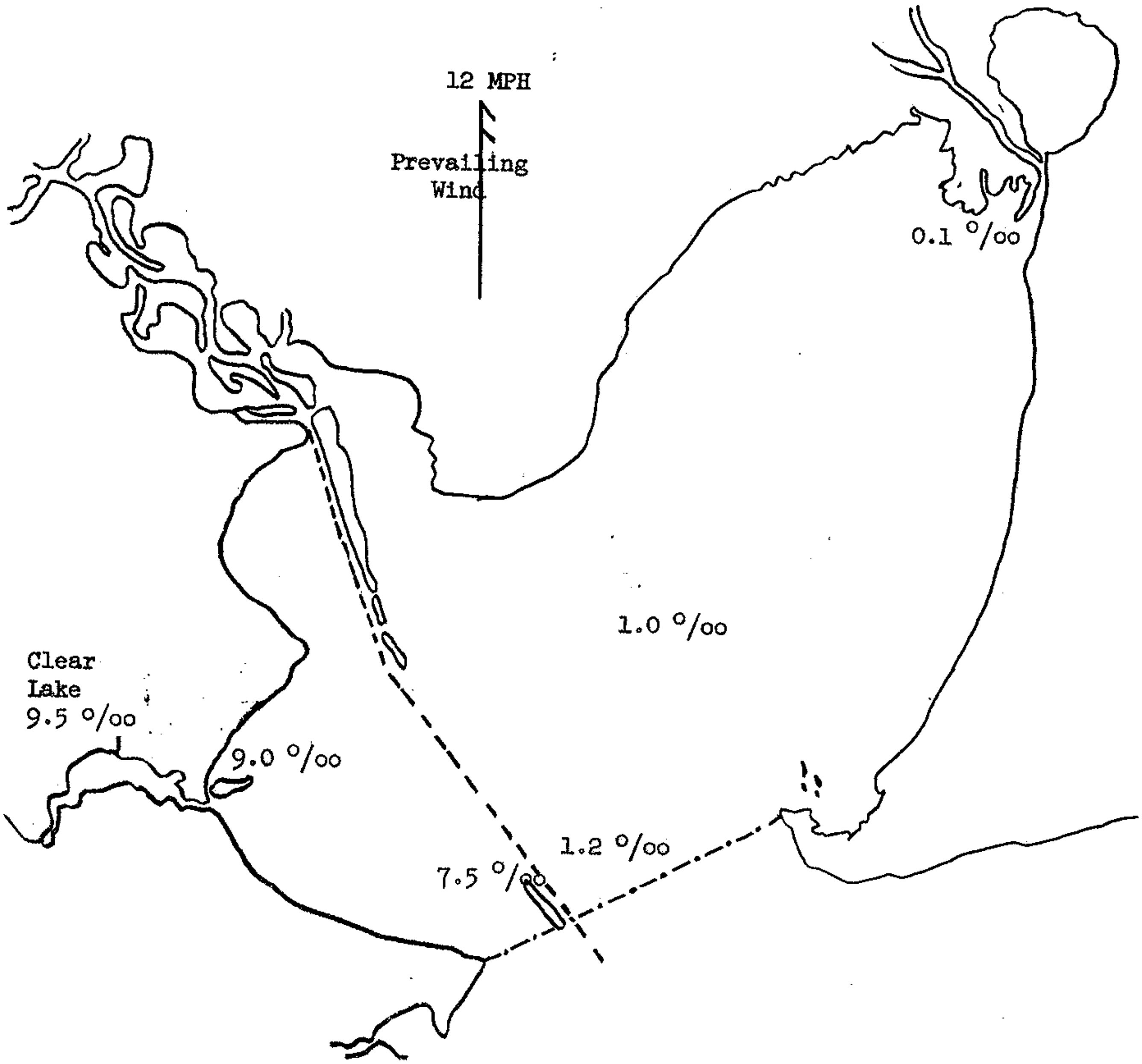
TABLE VI
Comparison of tide ranges between three stations in Area M-2.

Average Monthly Range

1958	FORT POINT	CLEAR CREEK	SHIP CHANNEL	THREE STATION AVERAGE
January	1.0	1.3	1.5	1.3
February	0.6	1.5	1.5	1.2
March	0.8	1.1	1.2	1.0
April	0.7	1.3	1.2	1.1
May	0.9	1.1	1.5	1.2
June	1.2	1.2	1.3	1.2
July	1.0	1.0	1.1	1.0
August	1.1	1.0	1.1	1.0
September	0.9	1.0	0.8	0.9
October	0.9		0.7	
November	1.0	1.1	0.9	1.0
December	1.2	0.4	1.1	0.9
1959				
January	1.3	1.2	1.1	1.2
February	1.0	0.9	1.2	1.0
March	1.1	1.1	1.2	1.1
Annual Average	1.0	1.1	1.2	

FIGURE VI

Hydrographic and Climatic Conditions May 1958.



Air Temperature: 25.0° C
(24 hr. average Houston-Galveston)

Water Temperature: 28° C
(noon)

Cynoscion arenarius

(Standard Length in mm)

	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100-109	110-119	120-129	129+	Total	Number Per Collection
1958															
May								1		1	2	1	8	13	1.6
June		1	3	5	4	3				2	1	1	7	27	1.3
July	4	27	24	27	15	6	3	1	1	3	4	2	7	124	6.2
August			1	4	8	18	9	6	2	2			2	52	3.1
September	4	24	37	10	15	20	6	6	4	3	3	1	3	136	5.4
October		4	13	12	7	7		2	2	1	3	4	3	58	3.2
November				10	2	8	1	3	3			1	4	32	1.7
December				2	5	7	6	4	1		1	3	17	46	3.0
1959															
January				3		3		1		2	3		3	15	1.1
February														0	0
March					1	1	1		1				1	5	0.3
April	4	6				1	3	10	8	6	6	1	2	47	2.8
May	2	54	32	8	7	7	1		1		5	8	11	136	12.4
June		3	15	77	114	104	50	43	8	10	3	4	5	436	39.6
														1,127	5.0