Acc# 2076

Job Report

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Field Assistant

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Project Name: Oyster Investigations

Period Covered: July 1, 1959 to June 30, 1960 Job No. E-2

Hydrographic and Climatological Data

Objectives: To maintain records of hydrographic and climatological data as an aid in evaluating changes in bay fauna. To summarize these records in a form which makes their interpretation as components of the biotic environment more convenient.

Procedure: Hydrographic and climatological data were recorded at the Seabrook Field Laboratory by various staff members. Hydrographic data, including water temperatures, salinities, and sometimes turbidity and tidal data were recorded from stations established in Galveston, Trinity, East and West Bays and their tributaries, the Intracoastal Waterway, and the Gulf beach. These data have been compiled in various ways and interpreted as follows:

Findings: I. Data from the Field Laboratory Bulkhead

Previous to January 1959 regular water samples were sometimes taken at the Field Laboratory bulkhead by various workers and checked for temperature, salinity, etc. But beginning January, 1959, a regular weather observation and water analysis schedule was set up at the Field Laboratory with daily observations at 8:00 AM and 4:00 PM on work days. Water levels, air temperature, amount of precipitation, visibility, cloud coverage, wind direction and velocity, and barometric pressure are recorded and determinations of the temperature, salinity, turbidity, pH, and dissolved oxygen content of the water are made. Weather station entries have been made by the following persons: H.D. Hoese, R.P. Hofstetter, R. Marek, E.J. Pullen, W.C. Renfro, J.K. Shidler, and J.R. Stevens.

The data are recorded on monthly log sheets which are kept at the Field Laboratory. Also on field at the laboratory are monthly compilations giving maxima, minima, averages, and other summarizations of the monthly data.

A. Water Temperature and Salinity: The "Hydrographic Climate"

Water temperatures were recorded from a maximum-minimum thermometer kept suspended in the laboratory boat basin. Salinity was determined by Mohr chloride titration.

Using the method of Hedgepeth (1951) of plotting salinity against temperature, the "hydrographic climate" has been graphed for the Field Laboratory boat basin for the period January 1959 to April 1960 (Figure 1). About 1 May 1960 the maximum-minimum thermometer was appropriated by persons unknown and salinity data only are recorded since that time.

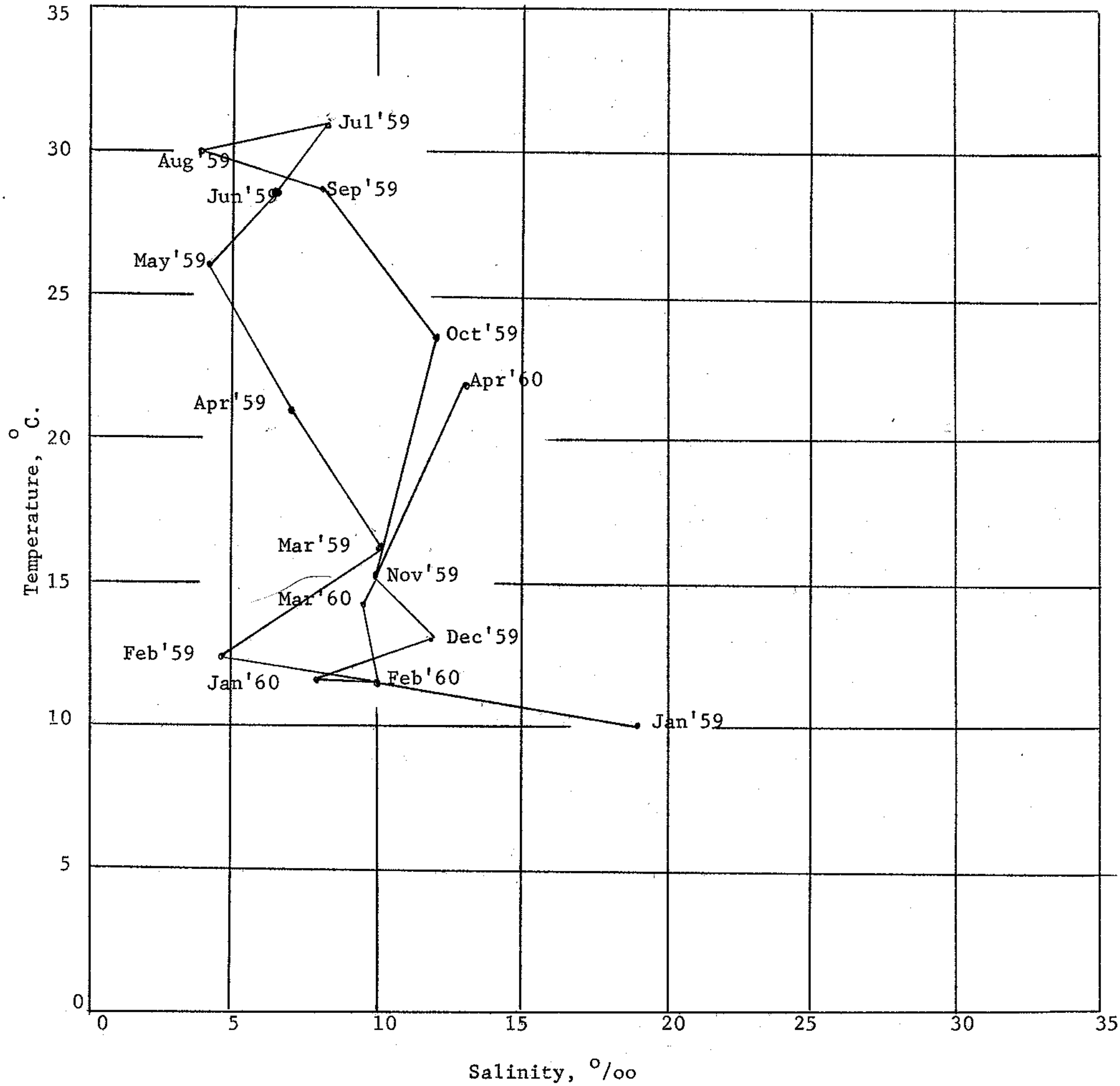

Figure 1

THE HYDROGRAPHIC CLIMATE AT THE

FIELD LABORATORY BULKHEAD

1959-60

The salinity was rather high (19.9 °/oo) when the weather station was set up; by the next month, however, the average had declined sharply to 4.7 °/oo --- since that time, the normal range of average salinity has been 4-14 °/oo. At the beginning of the summer of 1960, the salinity was again on the rise and had reached 16.0 °/oo (8:00 AM, 24 June) when the heavy rains of the 25-26 June reduced it to a tenth of that figure. The average salinity for May, 1960, was 13.9 °/oo, for June (including some low salinities after the rainfall), 12.1 °/oo.

The water temperature varies according to a fairly regular yearly cycle, but the averages for the various months frequently differ from those of the same months in other years. In Figure 2 the averages and extreme ranges of the air and water temperatures are compared. The two averages corresponded rather closely, but the range of the air temperature was often considerably greater.

B. Turbidity

The turbidity was determined with a spectrophotometer and read in percentage of light transmitted. Note that a high reading indicates a low turbidity and vice versa.

The turbidity at the Field Laboratory averaged just above 90% transmittance (Figure 3). The monthly minima usually fell just below 100% transmittance. The maximum turbidities, however, were irregular, ranging 53-91%. The pattern of the figure suggests that "normal" turbidity at the laboratory bulkhead ranges 80-100% transmittance, but occasional high turbidities (low percentage transmittance) occur. These occurrences probably result from heavy wave action, dredging operations, heavy river discharge, and other factors.

C. Dissolved Oxygen and pH

Dissolved oxygen was determined by the Winkler method and pH was read from a Beckman Model N pH meter.

In Figure 4 the average monthly dissolved oxygen and pH determinations from samples taken in the laboratory boat basin are compared. Both these phenomena undergo a diurnal cycle of varying concentrations in the water, dependent upon the metabolic activities of the aquatic organisms. In the usual pattern there is an early morning low and a late afternoon peak. To better show the nature of these daily cycles, the morning and afternoon dissolved oxygen (DO) and pH have been averaged separately.

There is also a yearly cycle, apparent at least in the DO graph. The lower summer readings are probably ascribable to a combination of factors, including decreased solubility of oxygen in warmer water, a greater population of respiring organisms in summer, and more wind-aeration of the water in winter.

D. Wind Patterns by Months

Figures 5a and 5b show the changes of wind prevalence from month to month during the first year and a half of Field Laboratory weather station records. The wind rosettes in these figures were constructed in the following manner: The twice daily wind direction and velocity observations were summarized for each month. The percentage of observations that the wind was from each eighth of the compass was determined, and each of these percentages was multiplied by the average velocity in miles per hour of the wind from that direction. The magnitude of the resulting "wind index" is indicated by the lenghths of the radiating lines in the wind rosettes. For example -- If two percent of the observed winds were from the Northeast, and their average velocity was five miles per hour, the monthly wind index for that direction would be ten. A northeast wind index of ten could also mean that five percent of the wind came from that direction, averaging two miles per hour, or several other combinations. The wind index would be valid as a measure of the

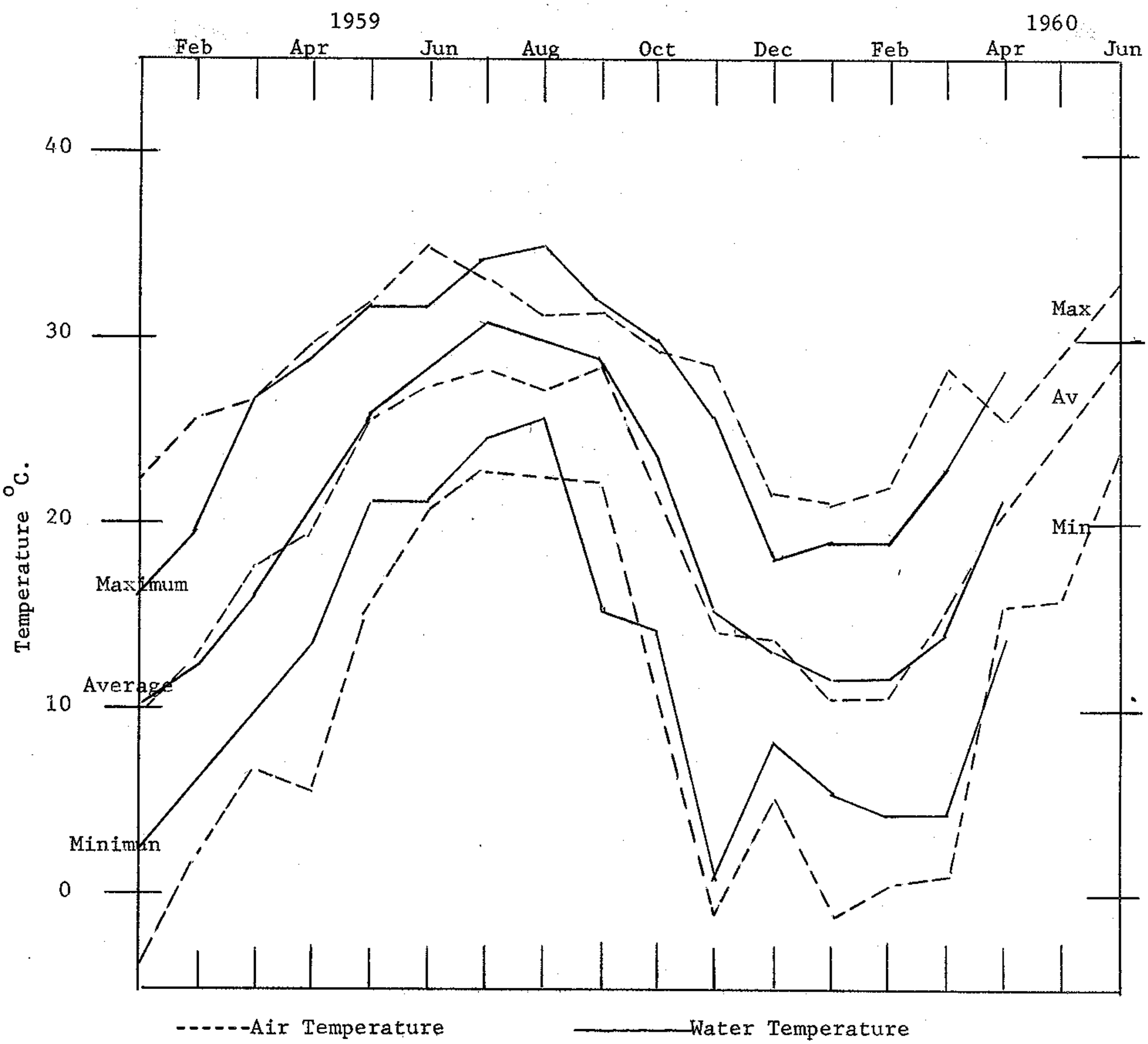

Figure 2

AIR AND WATER TEMPERATURE

FIELD LABORATORY WEATHER STATION

1959-60

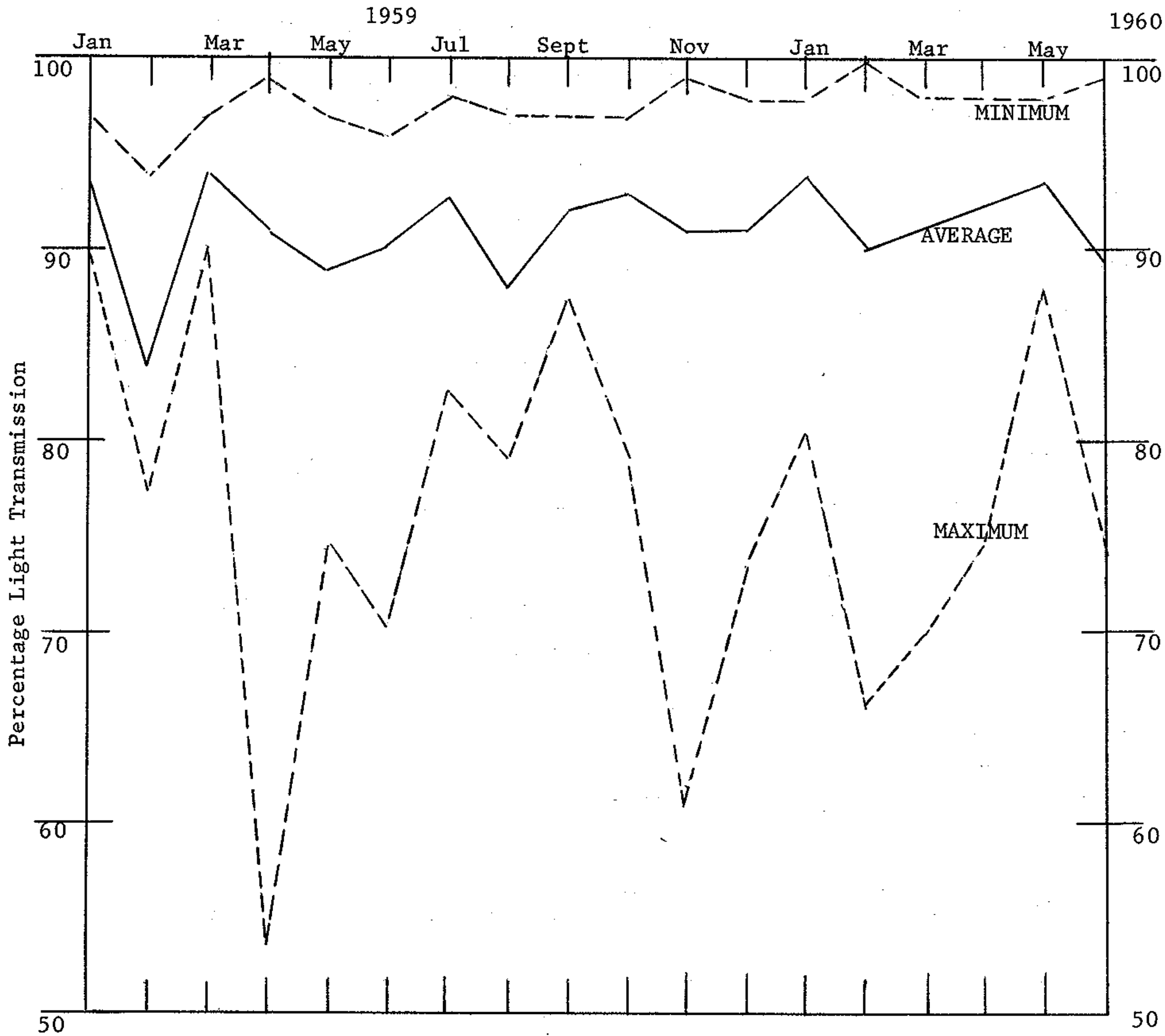

FIGURE 3

TURBIDITY

FIELD LABORATORY BULKHEAD

1959-60

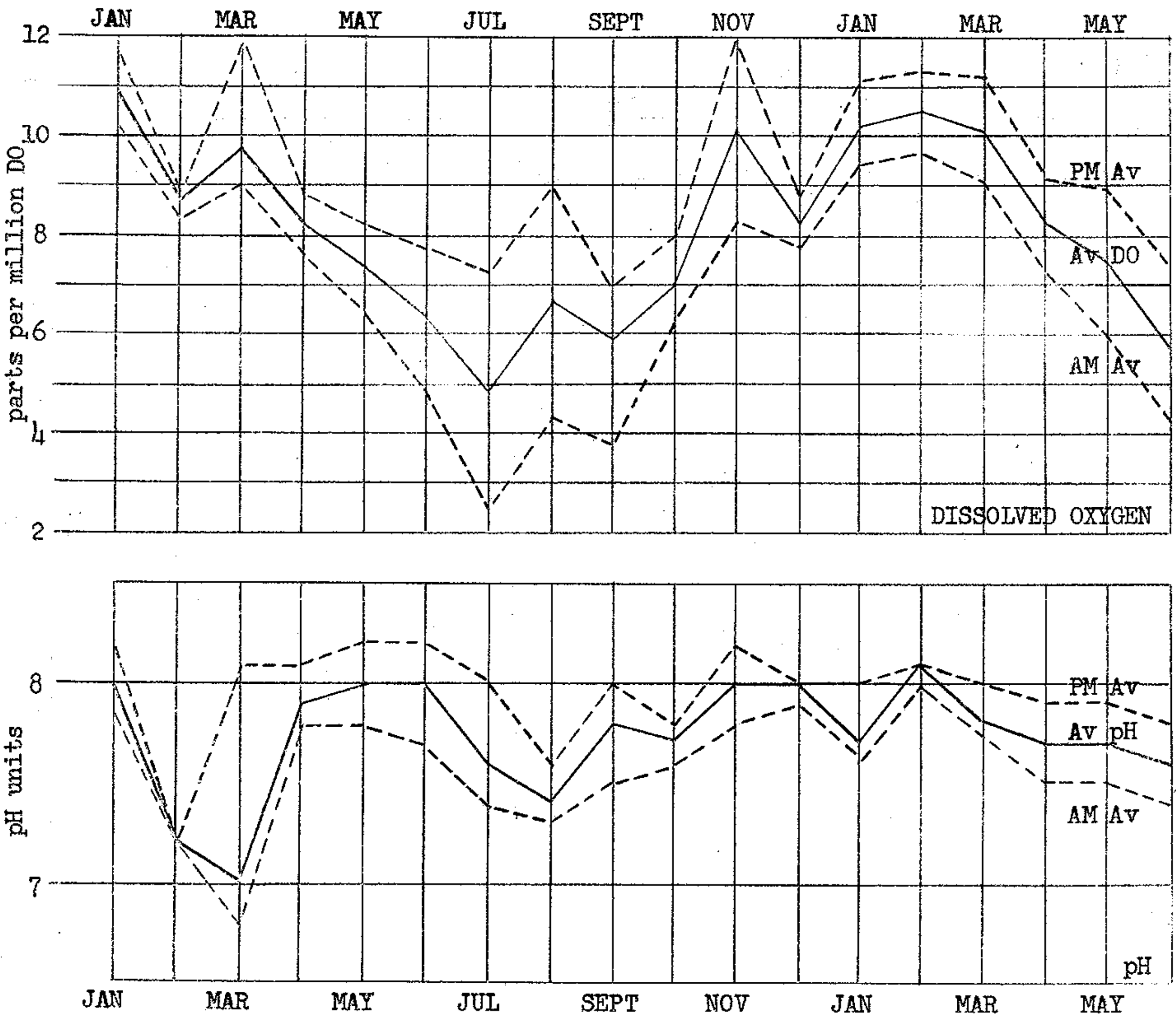

Figure 4

DISSOLVED OXYGEN AND pH

FIELD LABORATORY BULKHEAD

(January 1959 to June 1960)

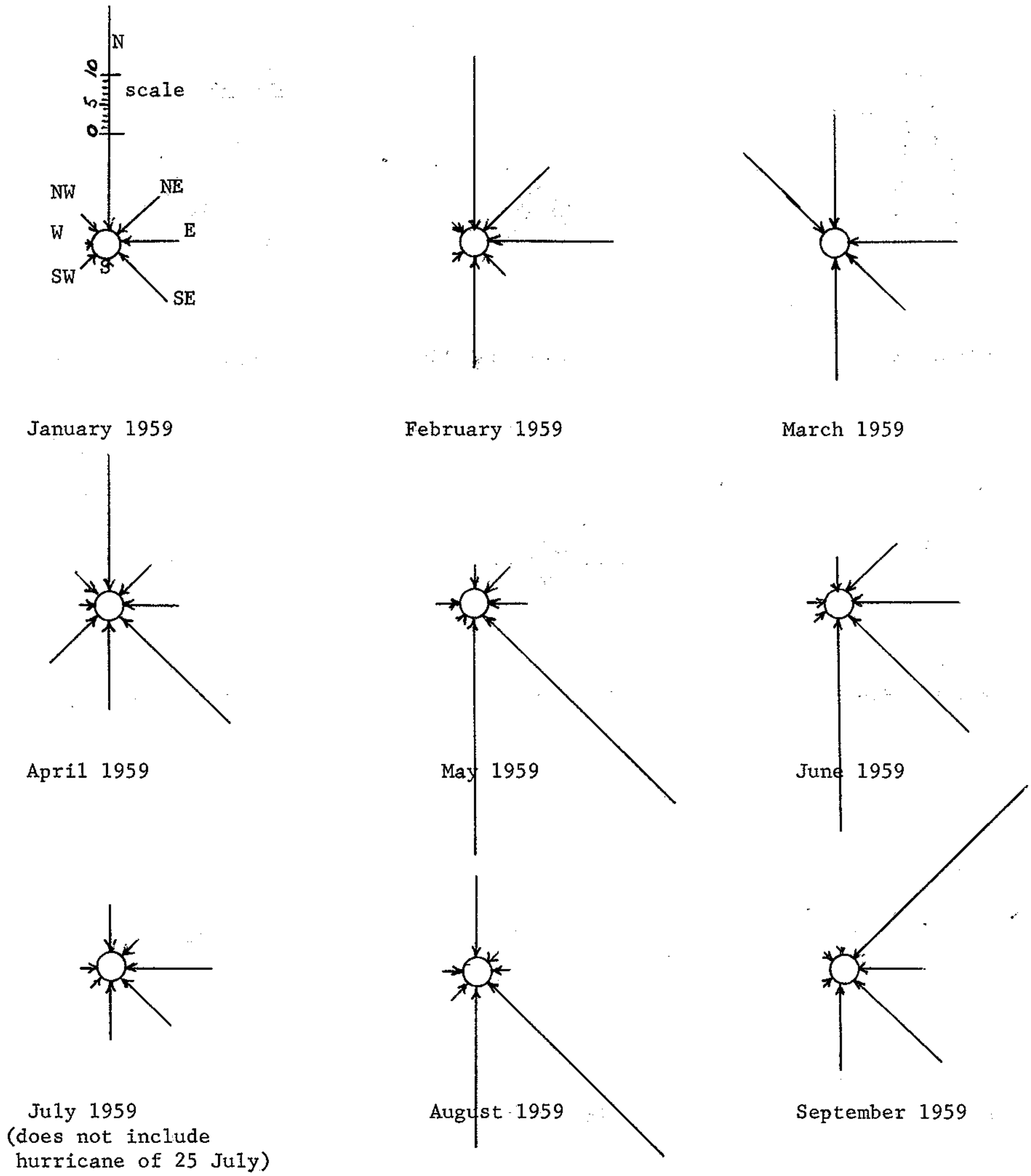

Figure 5a

MONTHLY WIND PATTERN

FIELD LABORATORY

January - September 1959

(see text for explanation)

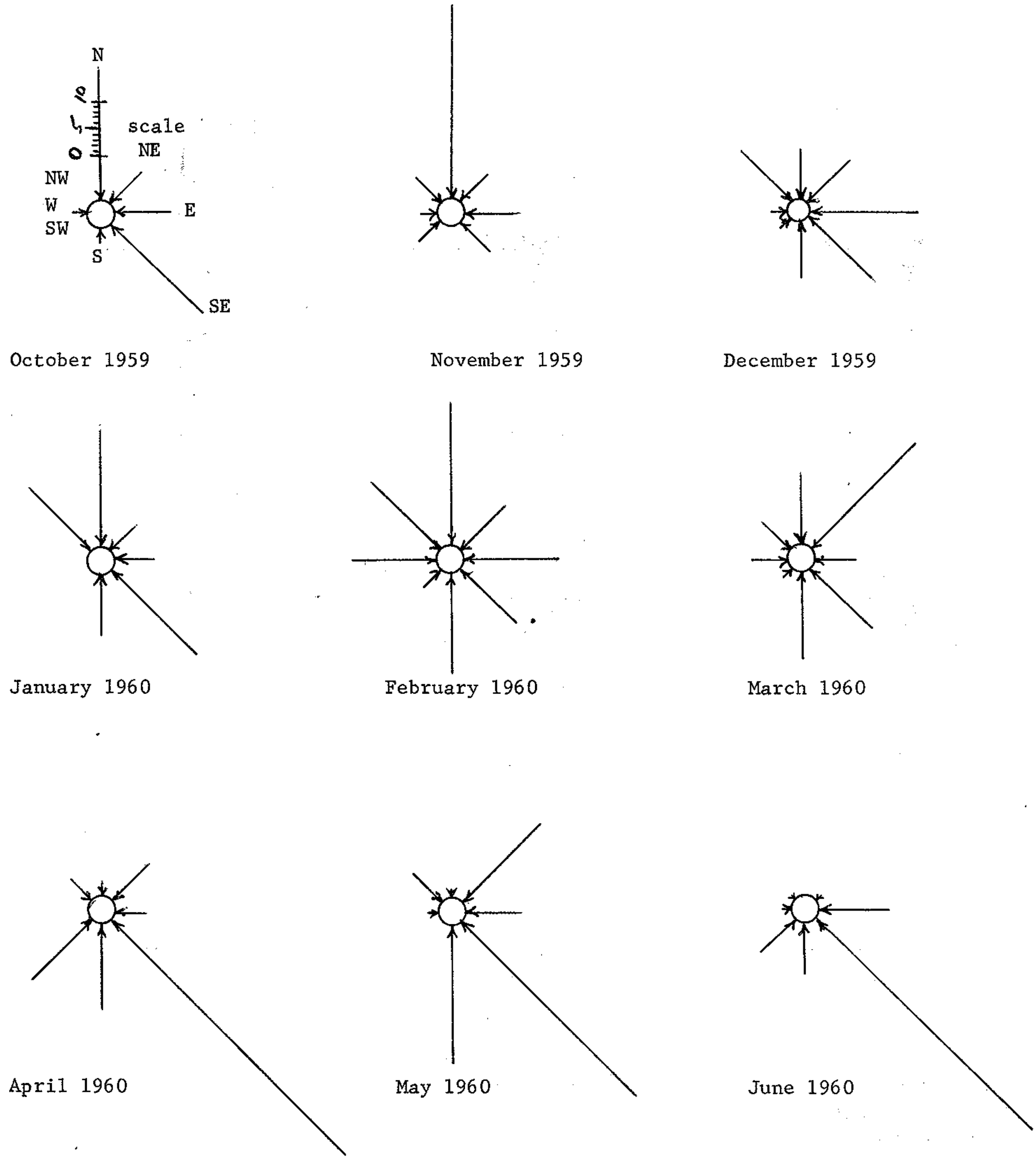

Figure 5b

MONTHLY WIND PATTERN

FIELD LABORATORY

October 1959 - June 1960

(see text for explanation)

"amount of wind" from each direction, within the limitations set by the infrequency of observations.

The difference between the summer and the winter wind pattern is striking. For the approximate period April through August, southeast and south winds predominated. From approximately October through February the most and strongest winds were from the north. September 1959 and March 1960 appear to be transitional months with northeasterly winds. Some months, such as July (exclusive of Hurricane Debra) and December, 1959, were relatively windless -- none of the wind factor arrows are much longer than the rest.

E. Comparison of Wind and Tide

A "wind factor" for each month was determined in the following manner. E, SE, S, and SW winds were classified as "onshore winds"; and W, NW, N, and NE winds were classified as "offshore winds" (Figure 6). All eight "wind indices" (see preceding section) for each month were added algebraically, those for onshore winds being considered as plus values and those for offshore winds being considered as minus values. The resulting value -- the wind factor, positive if onshore winds predominated during the month and negative if offshore winds predominated -- was divided by 100 to give figures similar to those for water level (see below).

Figure 7 compares the monthly wind factor with the average monthly water level at the Field Laboratory bulkhead. (Tide was not recorded in January and February 1959.) The two graphs follow one another in general, but no significant relationship was found from calculations of simple linear correlation. This would indicate that other as yet unknown considerations must be taken into account before tide can be accurately predicted from wind, and vice versa, in this area. Both tide level and wind factor fall near zero or below during winter, the season of "northers", and climb up the positive scale during summer, when southeasterly winds prevail.

II. Data From Hydrographic Stations in the Field

In addition to the Field Laboratory bulkhead, there are at present 92 stations throughout the Galveston Bay system from which hydrographic data is regularly recorded by biologists R. P. Hofstetter, J. R. Stevens, E. J. Pullen, and J. K. Shidler. For the purposes of this report, data from various stations have been selected for presentation of summarizations of temperature and salinity conditions.

A. Average Salinity Pattern of the Galveston Bay System

The general trend of the flow of fresher waters from the Trinity River seems to be down the east shore of Trinity Bay and thence across Lower Galveston Bay from Smith Point to the tip of Bolivar Peninsula off Port Bolivar. A fairly steep salinity gradient from about 5 $^{o}/oo$ to about 23 $^{o}/oo$ is crossed in traveling from off Lone Oak Bayou in Trinity Bay to Beacon 36 of the Houston Ship Channel in Lower Galveston Bay, a distance of about 14 nautical miles. Higher-salinity water entering the Galveston Bay System through Bolivar Roads influences the salinity (especially that of the bottom) of the Houston Ship Channel well above Morgan's Point, at least to Marker 122 off Burnett Bay, about 31 nautical miles from the base of the south Galveston jetty. Some tidal water also flows northeast towards East Bay along the shore of Bolivar Peninsula. Gulf water enters the other end of East Bay through Rollover Pass, locally affecting the salinity of Rollover Bay and Upper East Bay. Thus, the influence of Bolivar Roads on the west and of Rollover

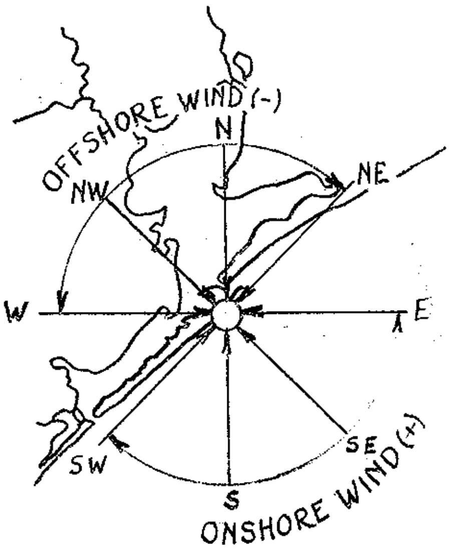

Figure 6

CLASSIFICATION OF WIND DIRECTION FOR CALCULATION OF WIND FACTOR

(see text for explanation)

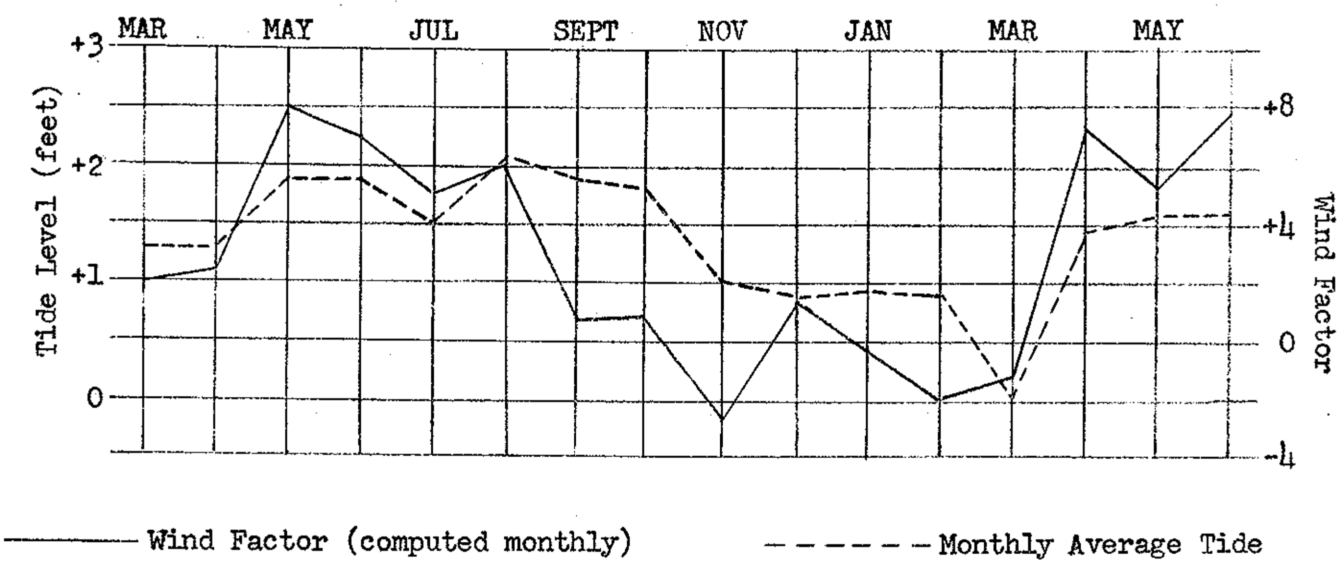

Figure 7

COMPARISON OF TIDE LEVEL WITH WIND FACTOR

FIELD LABORATORY

March 1959 - June 1960

(see text for explanation)

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Pass on the east makes East Bay saltier at both ends than in the middle. The salinity averages from all parts of West Bay are remarkably similar.

B. Hydrographic Climate by Bay Areas

For purposes of comparison, the open waters of the Galveston Bay system were divided into five areas: Trinity Bay, Upper Galveston Bay, East Bay, Lower Galveston Bay, and West Bay. The temperature and salinity readings from all stations in each of these five bay areas were averaged for each month, and a hydrographic climate polygon for each area was plotted (Figure 8). In the order listed above, the bay areas show a progression toward higher average salinity. The greatest overlap, or greatest hydrographic similarity, was between Upper Galveston Bay and East Bay.

C. Stations in the Intracoastal Waterway

Included in the regular hydrographic sampling trips were a number of stations in the channel of the Gulf Intracoastal Waterway. Data from these stations, many of which are from the records of J. R. Stevens, have been compiled separately.

1) Profile of Intracoastal Waterway Salinity. Figure 9 shows the average salinity at ten stations on the Intracoastal for the five months (October and December 1959 and April through June 1960) from which best data are available. The more-or-less enclosed stations at Carancahua Bayou, Green's Lake Cut, and Jones Lake reflected the hydrographic conditions of West Bay proper as did the unenclosed station at Chocolate Bay. (However, subsequent data have shown that, in times of heavy rainfall, Chocolate Bay salinity tends to be considerably lower than the West Bay average.) The Galveston Causeway station was in line with other determinations from that part of Lower Galveston Bay; the Buoy No. 22 station was undoubtedly influenced by tidal action in Bolivar Roads. Stingaree Cut, Sun Oil Cut, and Rollover Bay reflected East Bay conditions, and Siever's Cut was similar to adjacent Lower Galveston Bay.

2) The Hydrographic Climate. The Intracoastal Waterway, as would be expected from its geographical position, was intermediate in salinity between the average for the Galveston Bay System and the Gulf Beach.

D. Gulf Beach Water Samples

Beginning with September, 1959, monthly water samples have been taken at 11 stations on or near the Gulf Beaches of Bolivar Peninsula and Galveston Island. In March 1960, two more stations were added. Sampling was done by wading into the surf and dipping up a bucketful of water, the temperature of which was taken and part of which was bottled and taken back to the Field Laboratory for titration. Wind, tide, and other meteorological and hydrographic observations were recorded and turbidity was sometimes determined.

1) Profile of Gulf Beach Salinity. Because stations were visited more regularly from January through May 1960, these months have been chosen for comparison of average salinity from point to point along the Gulf Beach. Figure 10 is a profile of the average salinities at ten stations for the first five months of 1960, along with a map of the coastline from High Island to San Luis Pass.

Salinities from the Galveston Island shore were usually higher than those from Bolivar Peninsula. The lowest average salinity was from just southwest of Rollover Pass at the Sun Oil Pier, suggesting that low-salinity water ebbing through the fish pass turns right at the Gulf mouth and flows along shore. However, in Bolivar Roads, the lowest salinities were from the north, or Port Bolivar, shore. This would indicate that water discharge from the Galveston Bay system tends to follow the north shore of the Roads, while tidal inflow is chiefly along the south, or

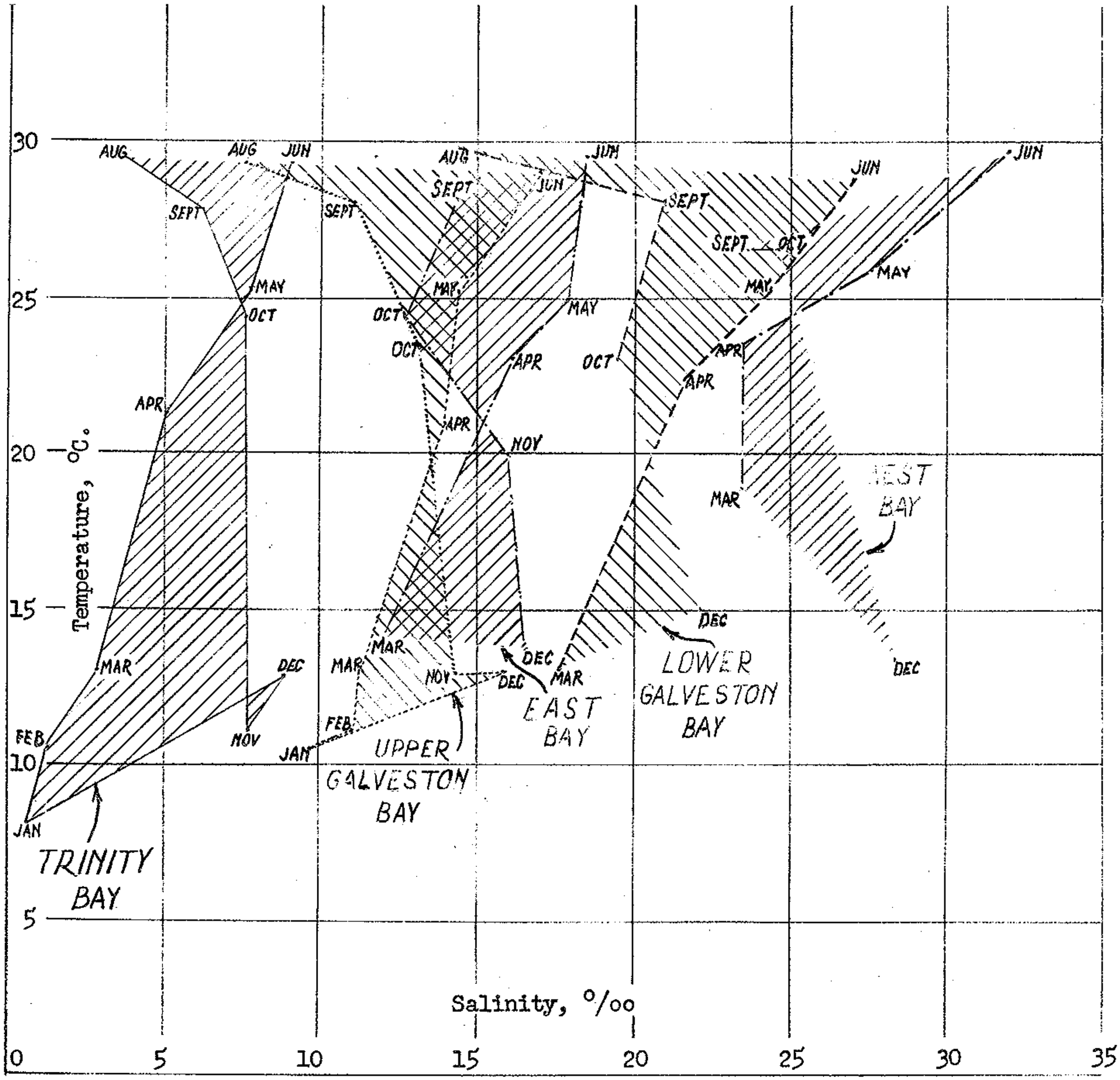

Figure 8

THE HYDROGRAPHIC CLIMATE

OF VARIOUS PARTS OF THE GALVESTON BAY SYSTEM

August 1959 to June 1960

(see also Figure 10)

Figure 9. PROFILE OF INTRACOASTAL WATERWAY SALINITIES - CHOCOLATE BAY TO ROLLOVER BAY

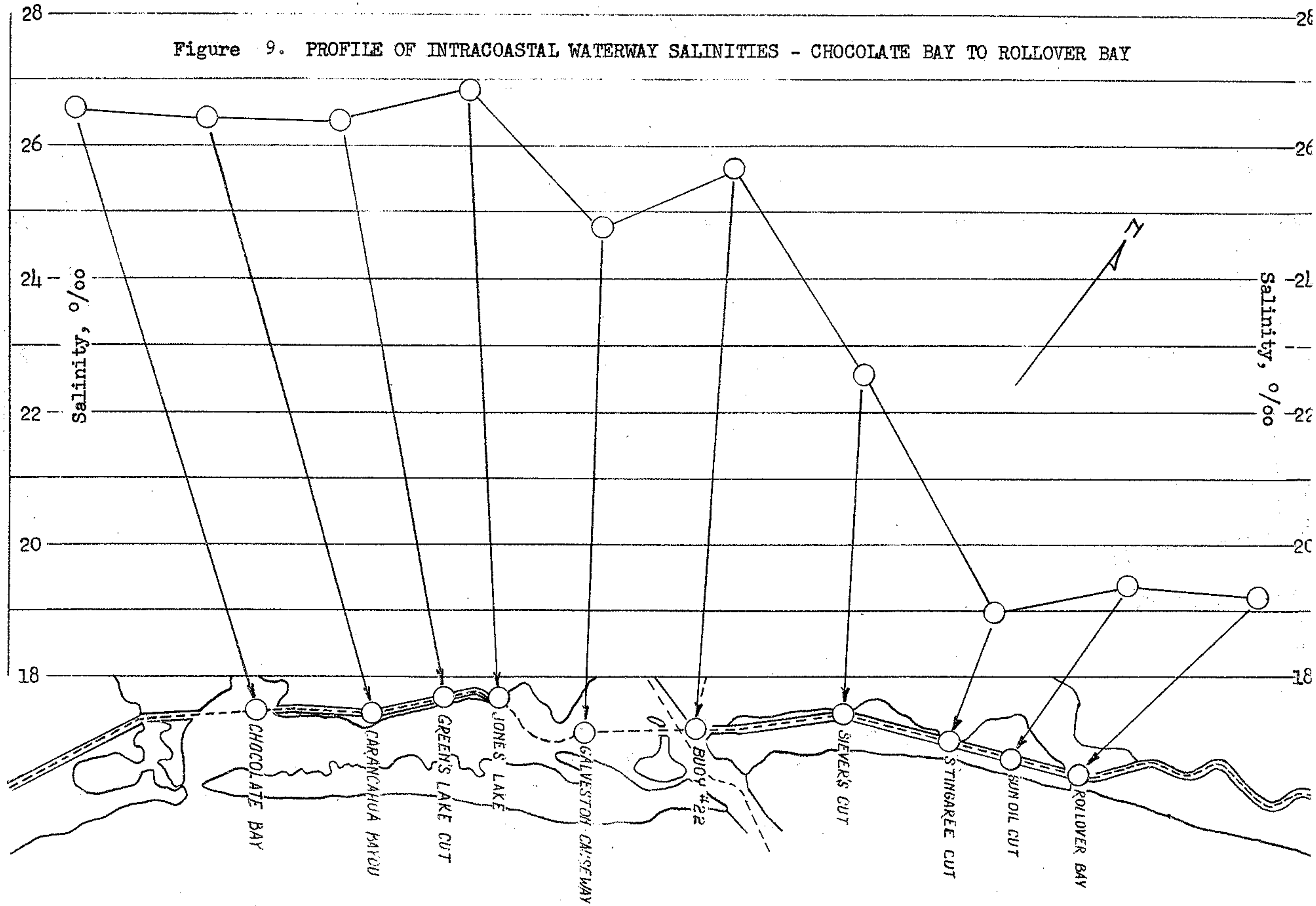

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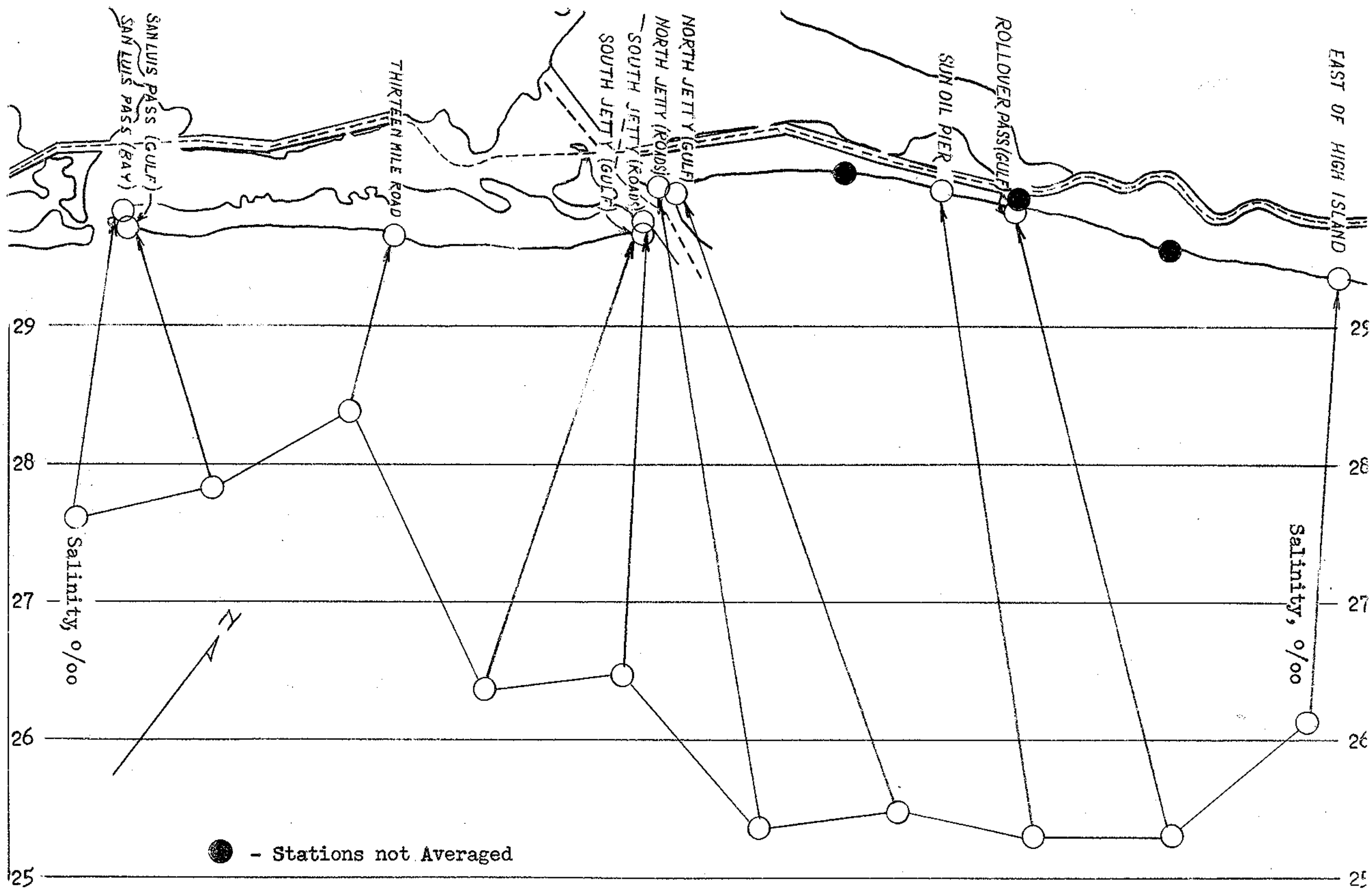
Figure 10. PROFILE OF GULF BEACH SALINITIES - SAN LUIS PASS TO EAST OF HIGH ISLAND



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Galveston, shore. These conclusions are in agreement -- at least for the points where the jetties leave the shore -- with a map showing approximate paths of ebb and flood flows (U.S. Army Engineers, 1942).

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Coordinator

References

Hedgepeth, J. W. 1951. The classification of estuarine and brackish waters and the hydrographic climate. Report Comm. on Treatise on Mar. Ecol. & Paleocol. 11: 49-56, 6 figs.

United States Army Corps of Engineers. 1942. Report on Galveston Bay, Texas, for the reduction of maintenance dredging. Vol. 1, May 15, 1942, U.S. Engineer Office, Galveston, Texas.

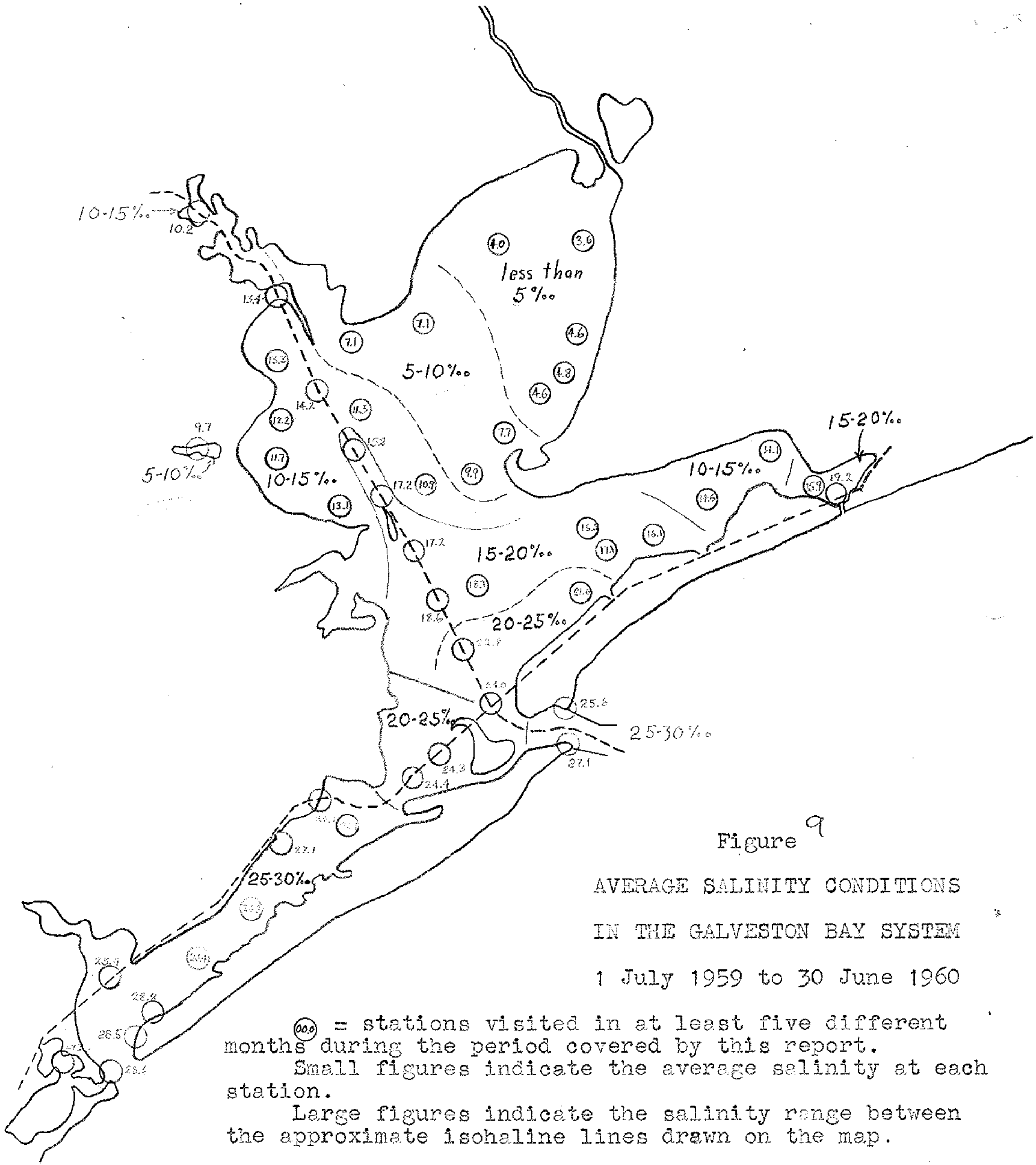

Figure 9

AVERAGE SALINITY CONDITIONS

IN THE GALVESTON BAY SYSTEM

1 July 1959 to 30 June 1960

(00.0) = stations visited in at least five different months during the period covered by this report.

Small figures indicate the average salinity at each station.

Large figures indicate the salinity range between the approximate isohaline lines drawn on the map.

(Data from records of E. J. Pullen, J. K. Shidler and J. R. Stevens.)

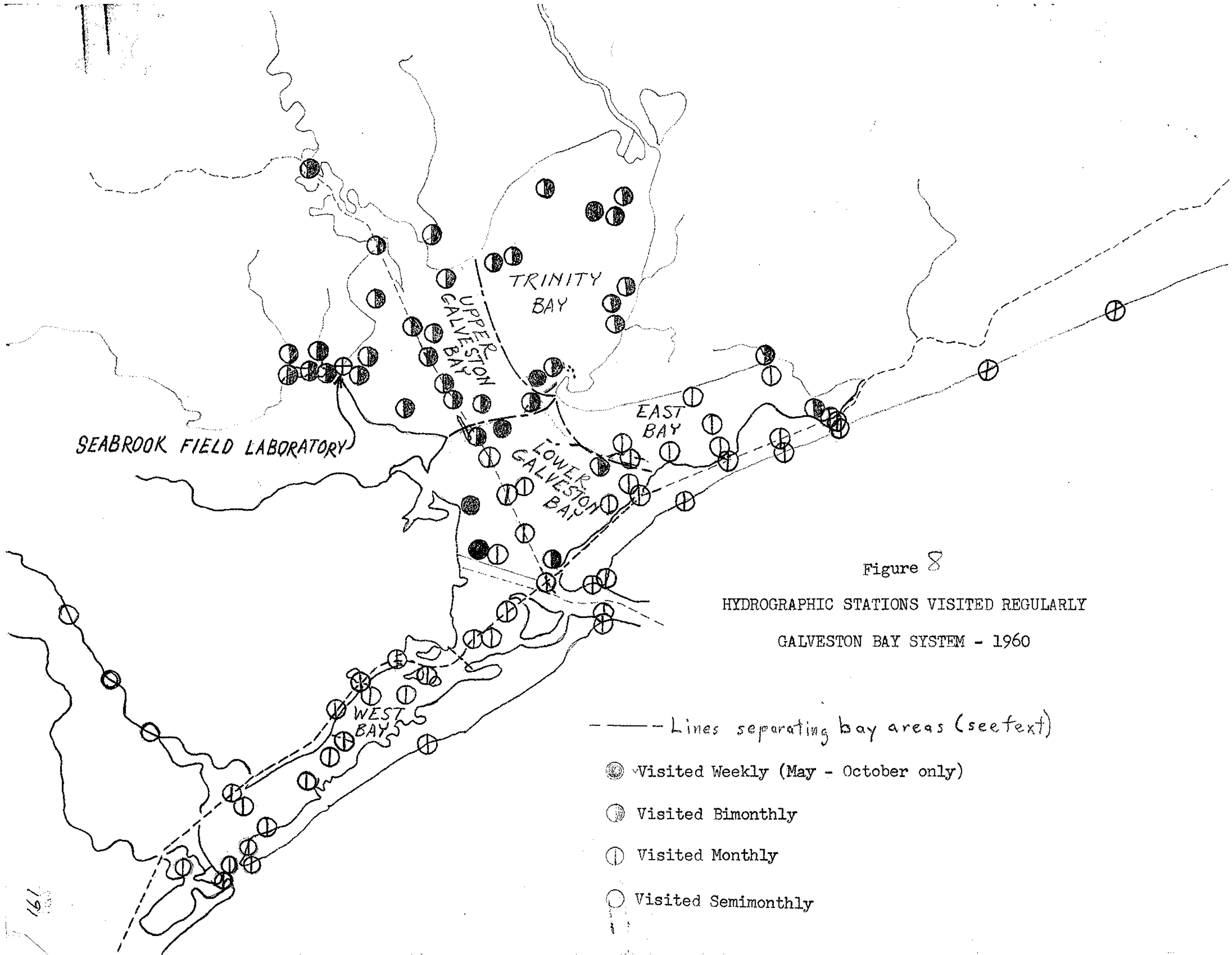

Figure 8
HYDROGRAPHIC STATIONS VISITED REGULARLY
GALVESTON BAY SYSTEM - 1960

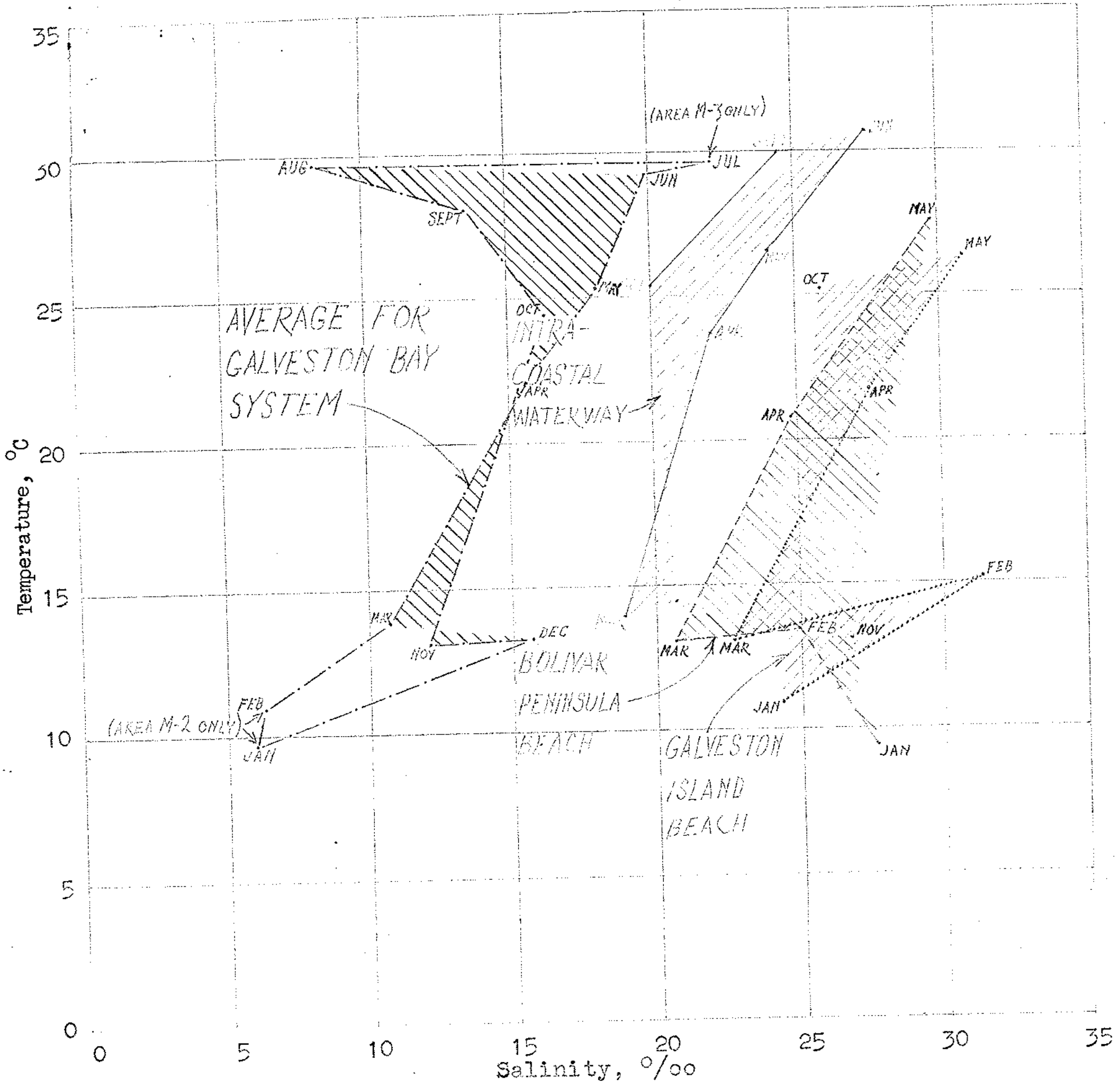

Figure 12

HYDROGRAPHIC CLIMATE

INTRACOASTAL WATERWAY AND GULF BEACH

July 1959 - June 1960

(average hydrographic climate for Galveston Bay System included)