RELATIONSHIP BETWEEN POLLUTION INDICATOR ORGANISMS AND THE SALINITY OF MISSISSIPPI'S ESTUARINE WATERS[1]

by

D. W. Cook and G. W. Childers
Gulf Coast Research Laboratory
Ocean Springs, Mississippi

INTRODUCTION

The estuarine waters of the Mississippi Sound are probably Mississippi's most important water resource. Seven of the ten most valuable kinds of commercial fish and shellfish are dependent on the estuary for important parts of their life (McHugh, 1968). Five of these seven species, are found in great abundance in the Mississippi estuary. These are the shrimp, oysters, crabs, menhaden and flounders. The 1968 landings of these five species in Mississippi alone amounted to over 165 million pounds with a wholesale value in excess of seven million dollars (USDI, 1968). Yet, most people see the estuary as nothing more than a lot of brown muddy water often considered not fit to swim in and a bunch of "good for nothing" marsh grass full of mosquitos and gnats. Occasionally, they enjoy fishing there but most people want to go offshore into the blue waters to catch the big fish. They never realize that the big fish utilize many of the non-commercial estuarine-dependent species as a main source of food.

The domestic and industrial waste from over half of the State of Mississippi and portions of Louisiana and Alabama are funneled by way of the rivers into the Mississippi estuary. Fortunately, pollution of Mississippi's estuarine waters by industrial waste has been somewhat limited because of the lack of heavy industry. However, domestic pollution as indexed by periodic local "fish kills" and high bacterial counts in the waters have caused considerable problems in Mississippi.

The American oyster (Crassostrea virginica) grows abundantly in bay areas of the Mississippi Sound where there is a delicate balance of fresh and salt water which provides adequate food, and safety from preditors and diseases that are associated with high salinity waters. Unfortunately, these are the areas where bacterial pollution is most acute.

The oyster is a filter feeding organism capable of filtering particles as small as bacteria from the water and utilizing them as food. If the water in which the oysters grow is polluted and contains

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pathogenic bacteria, there is a chance that the oyster may pick up these bacteria and when consumed raw by human beings, cause diseases. Therefore, public health officials have established stringent regulations on the bacteriological quality of waters in which oysters are grown.

In Mississippi, the Shellfish Sanitation Branch of the State Board of Health is responsible for checking the bacterialogical quality of the water in oyster growing areas and regulating the closure of growing areas. Many of Mississippi's finest oyster growing areas are now closed to the harvesting of oysters. The bacteriological water standards used in regulation of oyster growing areas are as follows: The coliform median MPN must not exceed 70 per 100 ml., and not more than 10 percent of the samples ordianrily exceed an MPN of 230 per 100 ml. (USPHS, 1965).

The results reported herein are a portion of a three year study (Cook, 1969) made by the Microbiology Section of the Gulf Coast Research Laboratory on the extent of bacterial pollution in the Mississippi Sound in relation to oyster growing areas. Specific emphasis in this study was given to Biloxi Bay because it contains the most productive oyster beds in the State which are now completely closed to harvesting.

MATERIALS AND METHODS

All bacteriological analyses were conducted in accordance with procedures outlined by the American Public Health Association (1962).

Surface and bottom water samples were collected from each of the forty-seven established stations in the Mississippi Sound (See Figure 1) on a regular basis. Salinity determinations were made on each sample utilizing a Goldburg refractometor (American Optical Company).

All data was coded and stored on IBM cards for computor analysis.

RESULTS AND DISCUSSION

During a study of the bacteriological water quality in the Mississippi Sound, seasonal variations were noted in the numbers of indicator organisms found in the water at nearly all stations. These variations were most noticeable at the water sampling stations in Biloxi Bay and the Back Bay of Biloxi. Figure 2 indicates this variation as observed at station 105 in the middle of Biloxi Bay. The coliform counts were low at this station from March through August and were more often high than low during the rest of the year. In a recent publication, Cook and Hamilton (1970) indicated a possible biological reason for this seasonal fluctuation; however, there was little direct evidence to relate their laboratory findings to natural conditions. In an attempt to determine what other factors may be indicative of this fluctuation, additional analyses of the data, as reported here, were made.

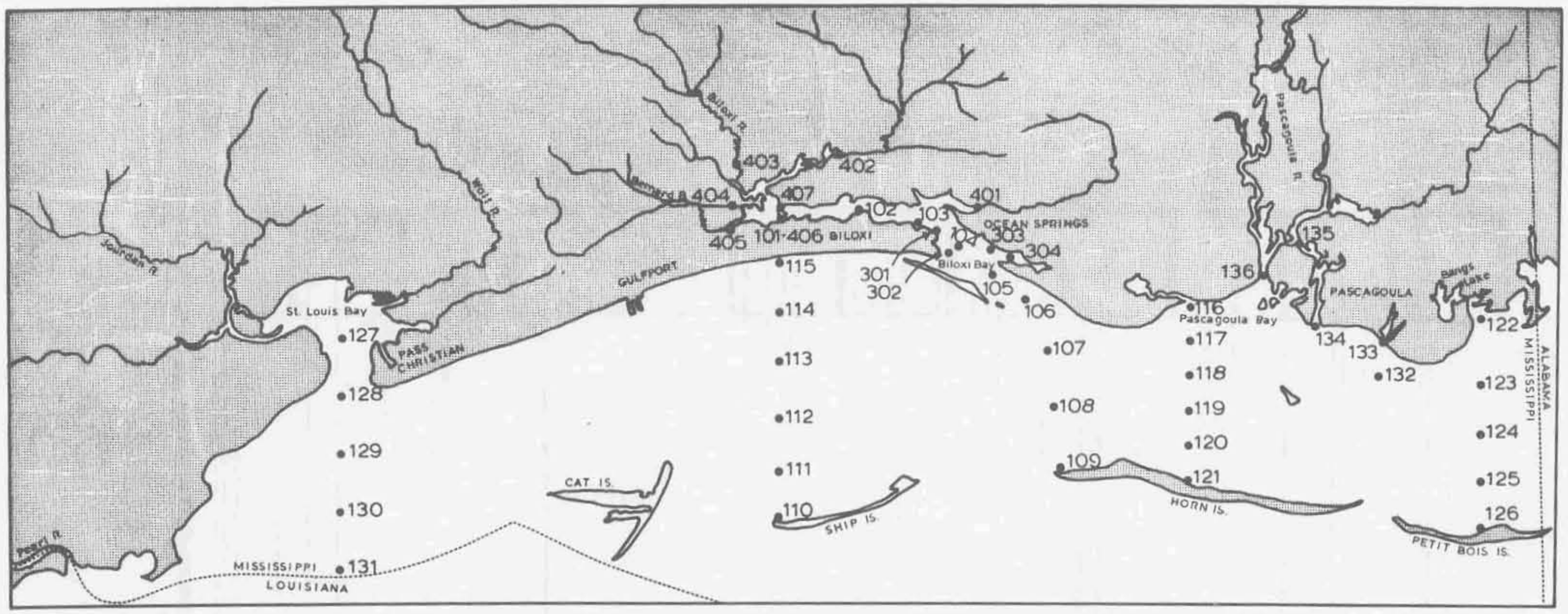

Figure 1 Water sampling stations in the Mississippi Sound and adjacent waters.

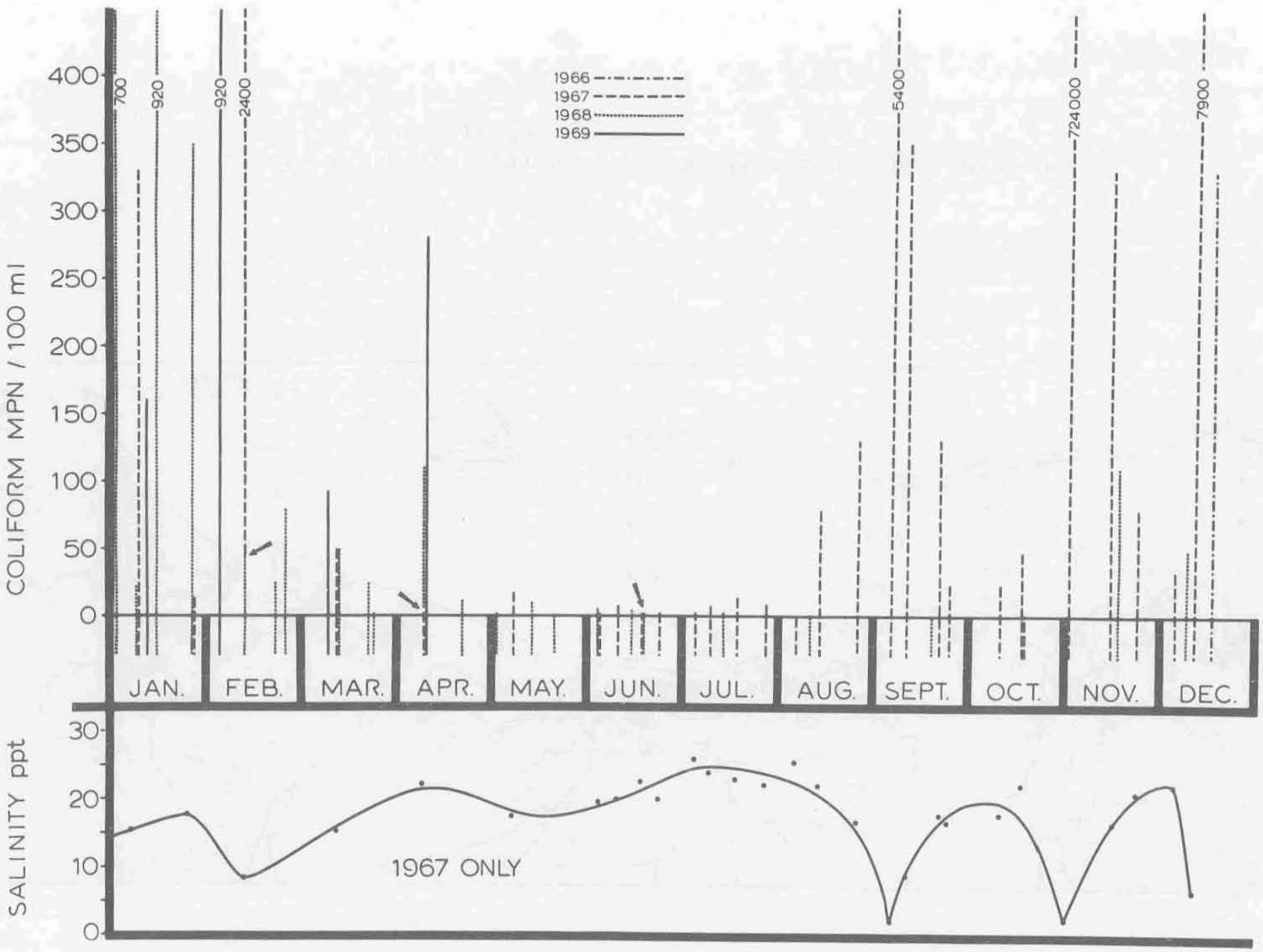

Figure 2 Seasonal variation in the Coliform MPN values and salinity from Station 105 in Biloxi Bay.

The salinity measurements taken on the water samples collected in 1967 are also shown in Figure 2. When the salinity and coliform MPN values are compared, an inverse relationship between the two is noted.

Statistical analysis of paired coliform MPN and salinity values from 2026 water samples from over the entire Mississippi Sound gave a coefficient of correlation of -0.170 which was significant at the 0.01 probability level. When only the samples with coliform MPN values less than 230 were considered, the coefficient of correlation rose to -0.473 indicating a high correlation between salinity and coliform MPN in unpolluted and moderately polluted waters.

Figure 3 displays the coliform MPN values obtained at each of the stations around Biloxi Bay. As shown, the waters entering Biloxi Bay have median coliform MPN counts as high or higher than in the Bay itself. The median coliform values remained fairly constant at the first three stations and then began to drop off sharply. Between stations 104 and 105, the median coliform count fell below 70 and the median salinity rose from 15 parts per thousand (ppt) at station 104 to 20 ppt at station 105. Therefore, within the Biloxi Bay system, areas with median salinities above 17.5 ppt could be expected to have waters of suitable bacteriological quality for growing oysters.

The relationship between the coliform MPN and salinity values from the stations around Biloxi Bay is shown in Figure 4. The coliform MPN values for given salinity ranges were grouped together for ease in handling the data. The maximum, minimum and median coliform MPN values are shown for each salinity range. Within each salinity range, there was considerable variation in the individual coliform MPN values. However, the median coliform MPN values decreased as the salinity increased. A median coliform MPN below 70 was recorded for all ranges with salinity greater than 17.5 ppt.

Two other bay areas in the Sound were subjected to the same coliform-salinity comparison. In the Pascagoula area, the salinities were generally high, yet the median coliform values were above or very near an MPN of 70 even at the highest salinity ranges (See Figure 5). In the Bay St. Louis area, the salinities were generally in the medium range and the median coliform MPN values were below 70 at all salinity ranges (See Figure 6).

The above comparisons indicated a vast difference in the coliform MPN to salinity relationship in these three areas. A brief study of the sources of pollution near the stations in each bay area and depths of the water in the area revealed why these three bay systems differed in their coliform MPN to salinity relationships.

In the Biloxi Bay system, indicator organisms were not only introduced into the Bay by river water at the head of the Bay, but they were also introduced from various sources throughout Back Bay at a rate equal to or in excess of the reduction rate cuased by dilution and natural die off. This is evident by the median coliform MPN counts being higher at station 103 than stations 101 and 102.

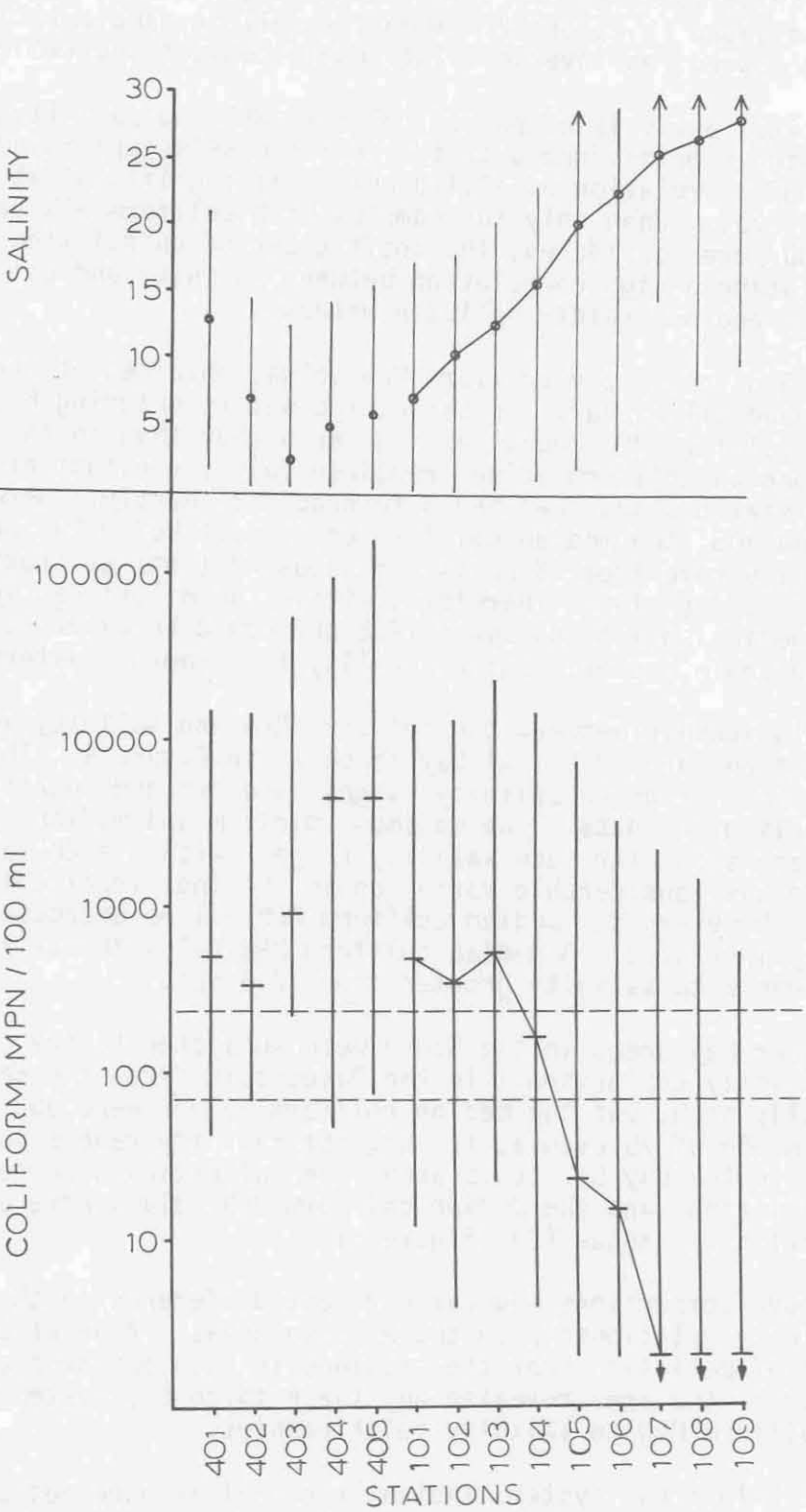

FIGURE 3 MAXIMUM, MEDIAN AND MINIMUM COLIFORM MPN VALUES OBTAINED AT STATIONS IN THE BILOXI BAY AREA

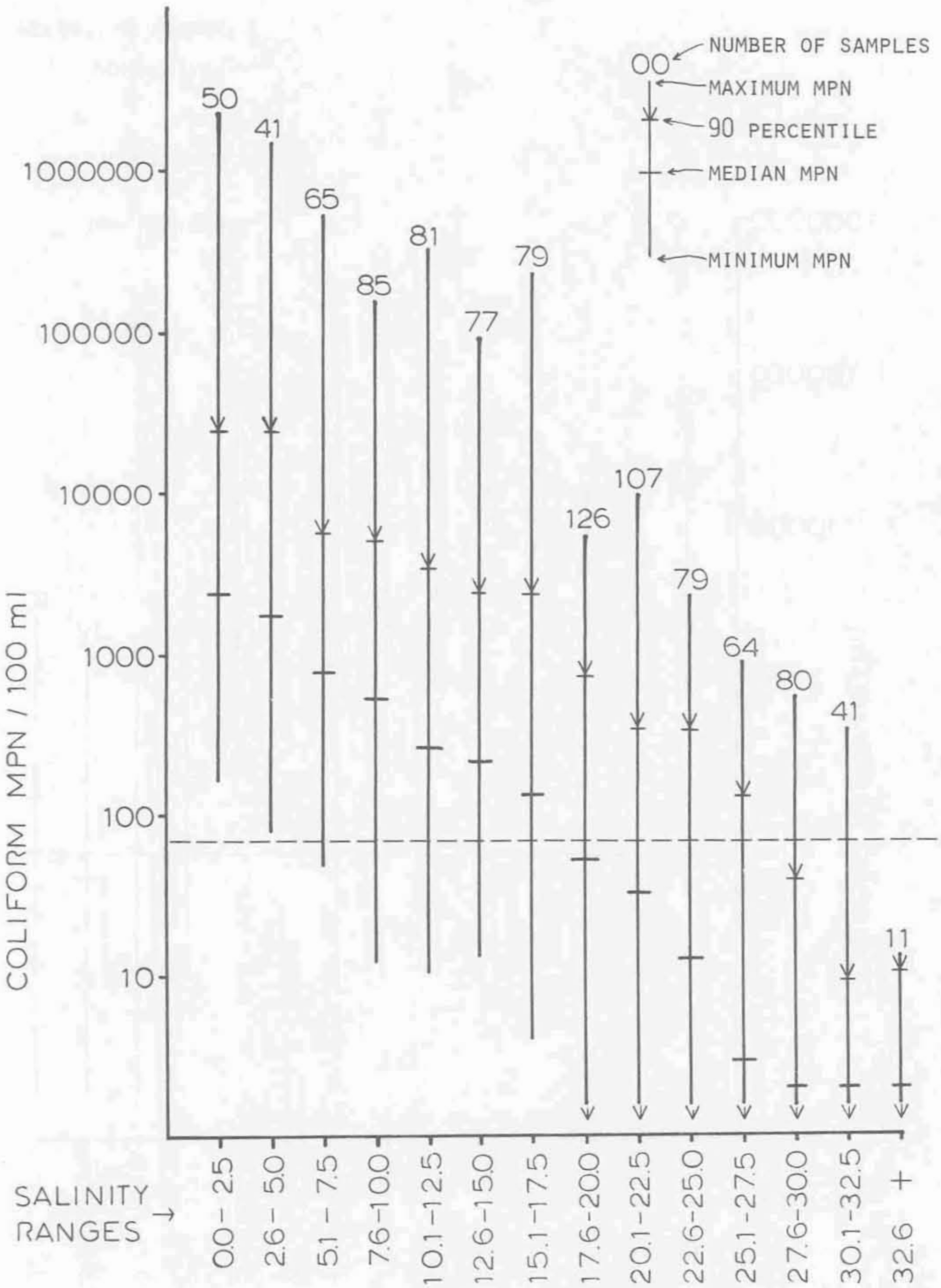

FIGURE 4 COLIFORM MPN - SALINITY RELATIONSHIP IN WATER SAMPLES FROM THE BILOXI BAY AREA

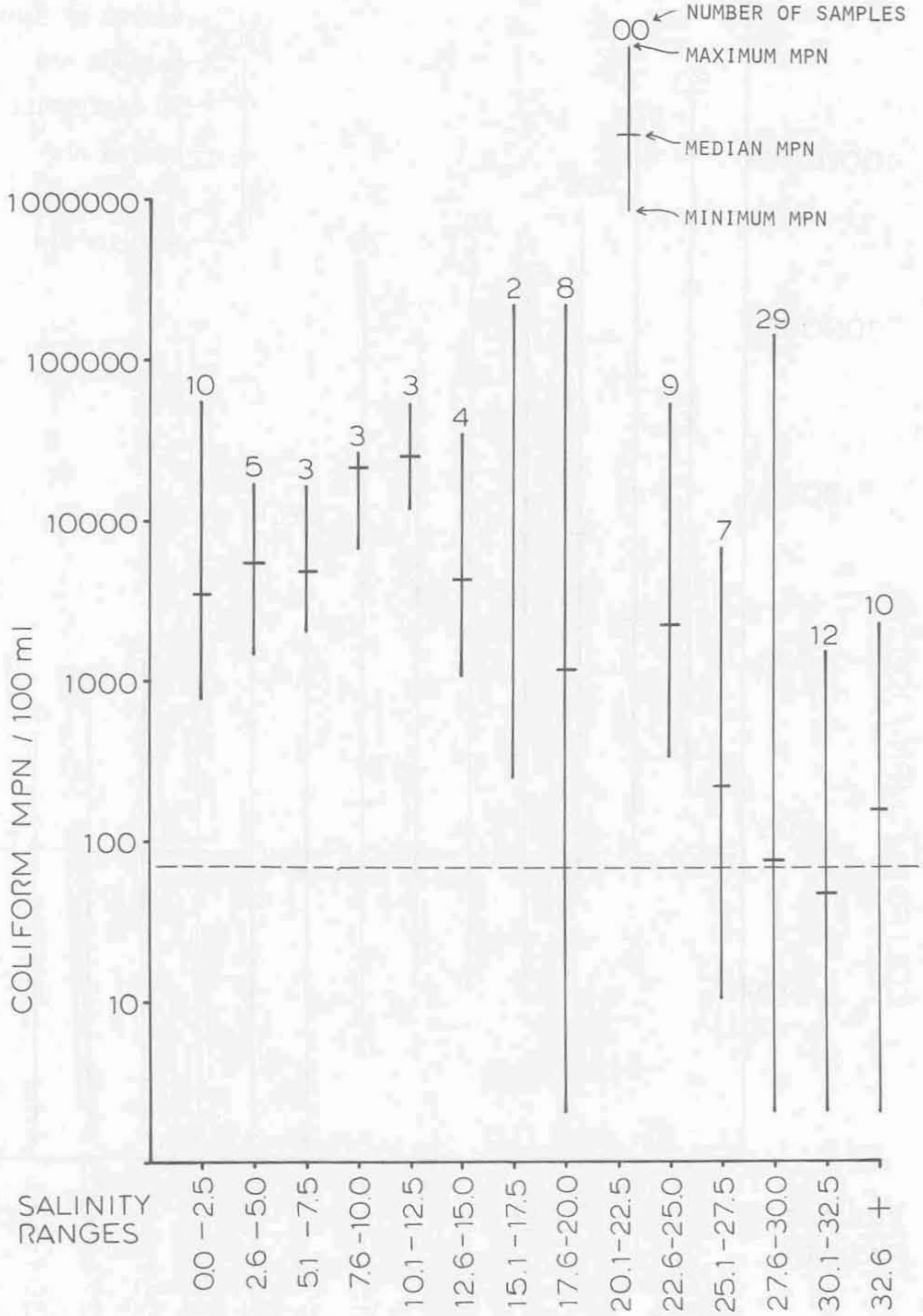

FIGURE 5 COLIFORM MPN - SALINITY RELATIONSHIP IN WATER SAMPLES FROM THE PASCAGOULA AREA

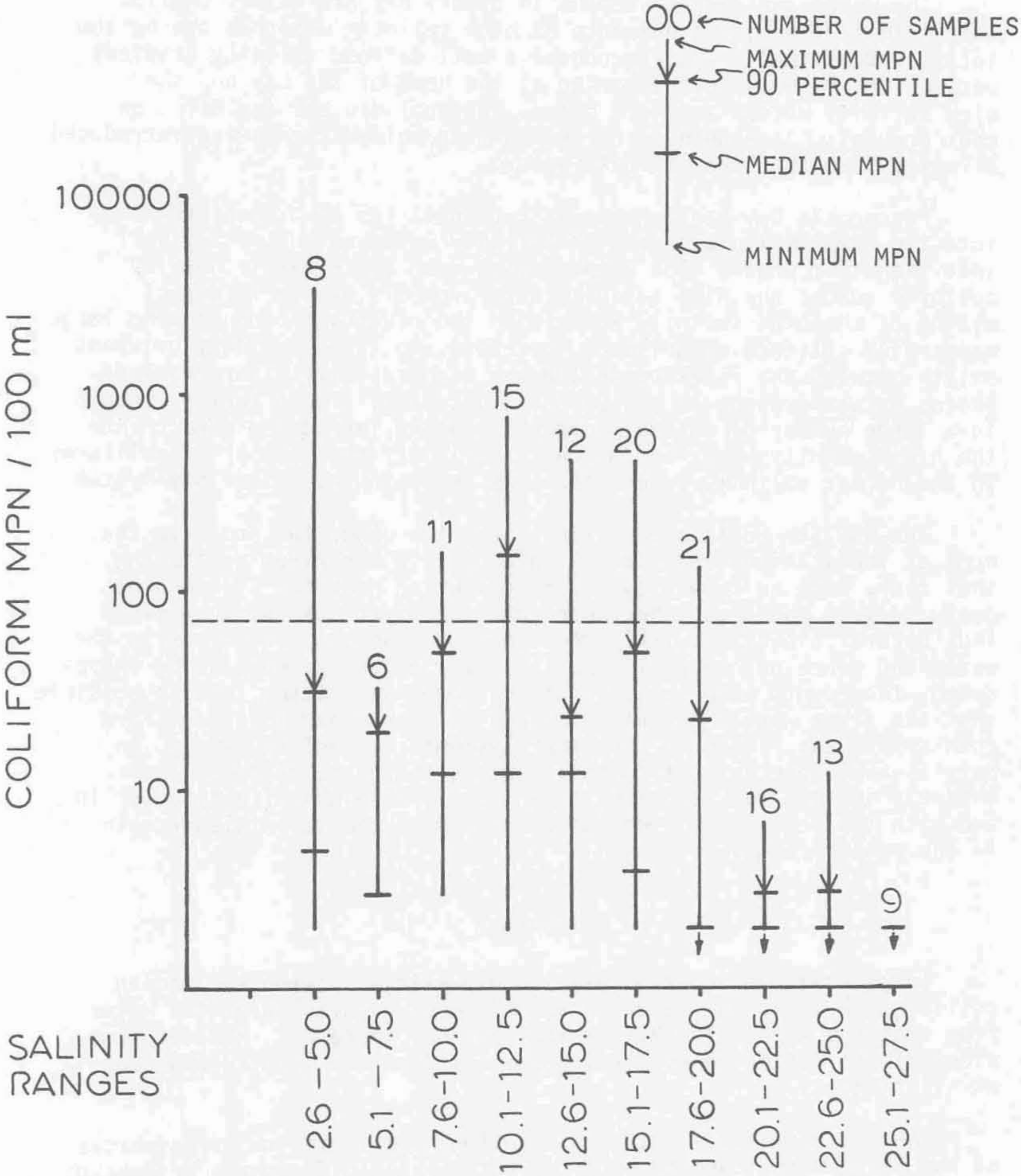

FIGURE 6 COLIFORM MPN - SALINITY RELATIONSHIP IN WATER SAMPLES FROM THE BAY OF ST. LOUIS AREA

The water and channel depths in Biloxi Bay are fairly shallow which limits the direct entrance of high salinity water on the bottom into the Bay itself. This produces a well defined salinity gradient between the river waters entering at the head of the Bay and the high salinity waters from off shore. Natural die off and dilution thus prevents large numbers of coliform organisms from being introduced directly into the high salinity water.

Pascagoula Bay has a deep water channel (45 feet deep) running into the river which brings high salinity water on the bottom well into the river mouth. The water coming down the river is heavily polluted and as the high salinity water upwells, there is direct mixing of the high salinity water with the river water containing large numbers of coliform organisms. Therefore, no large salinity gradient exists between the river water and the high salinity water from off shore, as was present in the Biloxi Bay system. These factors result in a large number of coliform organisms being introduced direct into the high salinity water and accounts for the larger number of coliforms in the higher salinity waters than was found in the Biloxi Bay system.

The Bay St. Louis area differs from the other two areas in that none of the stations were located directly in the river mouths and that there were no known sources of pollution near the stations or emptying into the area other than into the river systems themselves. Thus natural die-offs quickly reduced the numbers of organisms in the water and since no new pollution indicator organisms were being introduced, the counts were low even at the lower salinities. It is possible that the river waters entering through this area had lower coliform counts than the rivers in the other systems, but unfortunately, no data is available to confirm this. Also, there are no deep water channels in the area to bring large amounts of high salinity water in and with the heavy flow from the Pearl River, the salinities remain in the medium range.

SUMMARY

In general, an inverse relationship exists between the median coliform MPN found in the water and the median salinity of the water from stations within the Mississippi Sound. There was, however, considerable variation in the individual coliform MPN counts obtained at all stations.

The coliform MPN - salinity relationships in the major bay areas of the Sound were found to be different. These differences have been attributed to the source of the indicator organisms in the areas and the presence of deep water channels in the area.

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