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Charles K. Eleuterius
Gulf Coast Research Laboratory

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CLASSIFICATION OF MISSISSIPPI SOUND AS TO ESTUARY HYDROLOGICAL TYPE

CHARLES K. ELEUTERIUS

Physical Oceanography Section, Gulf Coast Research
Laboratory, Ocean Springs, Mississippi 39564

ABSTRACT Mississippi Sound is classified as to estuary hydrological type by the method of Pritchard (1955). Differences in salinity between surface and near-bottom water were calculated from 2,401 pairs of observations made at 90 stations from 4 April 1973 to 12 April 1977. Frequency distribution tables, constructed by tallying the vertical salinity differences into three classes corresponding to three of Pritchard's estuary types (A, stratified; B, partially mixed; D, well mixed) were used to assess salinity structure of the water column. The greatest variation as to type occurred from January through June. From July through December, the water column becomes predominately uniform. Mississippi Sound is shown to be primarily well mixed with approximately one-third of the observations indicating partially mixed and less than 2% being stratified. The channels are characteristically stratified or partially mixed. The results of this study were in good agreement with the previous classification by another method by the author which confirms that while dominately well mixed, Mississippi Sound also attains the characteristics of a partially mixed estuary and, highly localized, characteristics of a stratified estuary.

INTRODUCTION

The classification of an estuary as to hydrological type, essential to understanding the estuarine physical-chemical-biological processes, is determined according to circulation patterns and salinity distribution. The difference between hydrological types is related to variations in width, depth, tidal range and volume of river flow.

Located on the northern Gulf of Mexico, Mississippi Sound (Figure 1) is an elongate estuarine basin with a surface area of 2,128.87 km² and average depth at mean low water (MLW) of 2.98 m (Higgins and Eleuterius 1978) that connects with the Gulf through passes between a series of five barrier islands. The estuary receives an influx of fresh water via two major rivers, Pascagoula and Pearl; four minor rivers, Biloxi, Tchouticabouffa, Jourdan and Wolf; and a number of bayous. River discharges in cubic meters per second for the six rivers are: Pascagoula, 378.35 m³; Pearl,

327.72 m³; Biloxi, 13.97 m³; Tchouticabouffa, 12.36 m³; Jourdan, 23.47 m³; and Wolf, 19.98 m³. Sound tides are diurnal with an average range of 0.57 m. Two ship channels cross Mississippi Sound, Gulfport channel with a project depth of 9.1 m and Pascagoula channel with a project depth of 11.6 m, which permit the intrusion of high-salinity Gulf waters.

Eleuterius (1978) determined on the basis of the ratio of surface-to-bottom salinity that Mississippi Sound fluctuates between a well-mixed and partially mixed estuary. From January through June, Mississippi Sound showed a diversity of types while the July through December period was shown to be predominately well mixed. A review of the literature revealed no other attempts at hydrologic classification of Mississippi Sound.

Pritchard (1955) developed a classification system with four estuarine types: Type A, two-layered or stratified; Type B, partially mixed; Type C, laterally homogeneous; and Type D, vertically homogeneous or well mixed.

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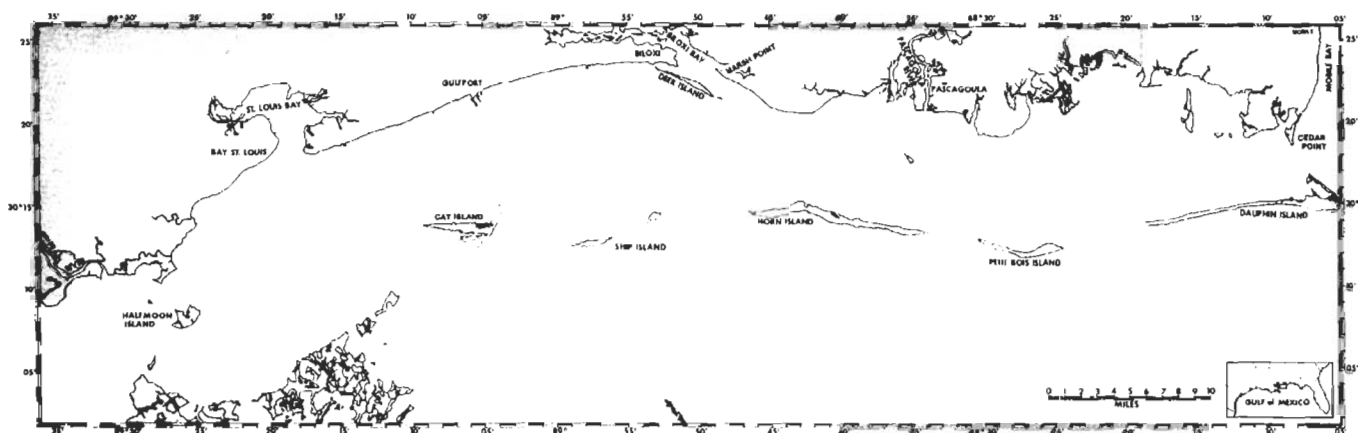


Figure 1. Mississippi Sound.

Because Eleuterius (1976) showed that Mississippi Sound's complex circulation precluded its being a Type C (laterally homogeneous) estuary, this type was not considered in this investigation. Evidence is presented here to indicate the classification of the Sound employing the system of Pritchard (1955).

MATERIALS AND METHODS

Salinity data were collected during a hydrographic investigation of Mississippi Sound from 4 April 1973 through 12 April 1977. Sampling was conducted approximately biweekly for a period of at least a year at each of 90 stations (Figure 2). Salinity measurements were made within the upper 30 cm of the water column and within 60 cm from the bottom. Conductivity readings that were later converted to salinity were made with a Martek Model II with an accuracy of ± 0.2 mmho/cm (± 0.5 parts per thousand [ppt] salinity).

Stations were sorted according to water depth at MLW as shown on U.S. Coast and Geodetic Charts 1266 (1972 edition), 1267 (1972 edition) and 1268 (1974 edition) into four classes: ≤ 1.5 m; > 1.5 m but < 3.0 m; > 3.0 m but ≤ 4.5 m; > 4.5 m. Stations in the fourth class were further separated into two groups: those stations located in either the Pascagoula or Gulfport ship channels; those located outside of the channels. The differences in salinity between surface and near-bottom waters were then determined for all depth-classes on a total of 2,401 pairs of observations. The resulting differences for each depth-class were tallied into monthly frequency distribution tables. The tables consisted of three frequency classes: differences ≥ 20.0 ppt, Type A; ≥ 4.0 ppt but < 20.0 ppt, Type B; < 4.0 ppt, Type D. Inspection of the data revealed no pronounced trend differences between depths except for the channel stations; therefore, two composite frequency tables were constructed, one which included data from all stations and the other limited to data from outside the ship channels.

RESULTS AND DISCUSSION

Table 1 shows that the greatest variability in estuarine type occurs from January through June, corresponding to the high river flow of winter and spring. However, 65.2% of the paired observations taken during March indicated the water column to be well mixed, apparently the result of strong winds usually experienced during this month. Only 1.3% of the March surface-to-bottom salinity differences could class the water column as stratified. With the exception of January, more than 50% of the paired observations for each month were in the well-mixed class. In January, 9% of the observations showed stratification while the remaining observations were equally divided between partially mixed and well mixed.

A sharp change in the water column in July is apparent with 73.0% of the difference in the well-mixed category.

TABLE 1.

Distribution according to estuary type of observations of surface-bottom salinity differences (percent) from 90 stations in Mississippi Sound.

Month	Number of Paired Observations	Stratified	Partially Mixed	Well Mixed
January	143	9.0	45.5	45.5
February	265	2.7	42.6	54.7
March	164	1.3	33.5	65.2
April	214	2.3	44.9	52.8
May	248	3.3	42.2	54.4
June	276	1.5	43.1	55.4
July	274	1.1	25.9	73.0
August	186	0.0	11.8	88.2
September	165	0.0	30.3	69.7
October	121	1.7	7.4	90.9
November	169	0.6	13.6	85.8
December	176	1.1	30.1	68.8
Average		2.05	30.92	67.03

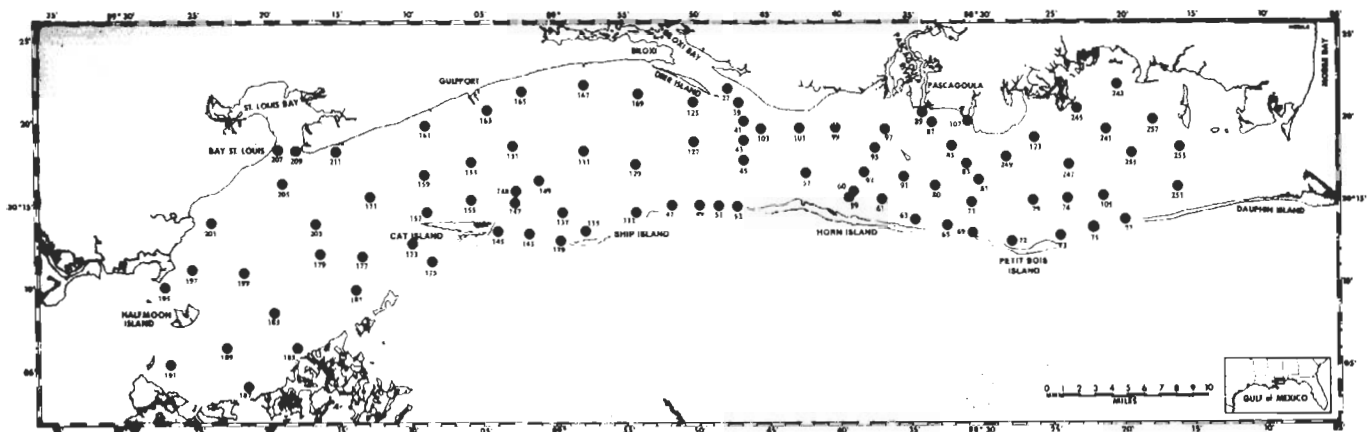


Figure 2. Station locations in Mississippi Sound.

This trend toward vertical homogeneity reaches a peak in October when 90.9% of the differences show a well-mixed system. River flow is at its low during October. The water column, while still dominately well mixed, becomes more varied during November and December. Averaging the monthly percentages showed the following: 2.0%, stratified; 31.0%, partially mixed; 67.0%, well mixed.

To evaluate the influence of stations located in the ship channels on the classification of Mississippi Sound, a second table, Table 2, was constructed using only salinity observations from stations located outside of the Pascagoula and Gulfport ship channels. The general trend is the same as

TABLE 2.

Distribution according to estuary type of observations of surface-bottom salinity differences (percent) from 78 stations in Mississippi Sound outside of ship channels.

Month	Number of Paired Observations	Stratified	Partially Mixed	Well Mixed
January	132	5.4	42.4	49.2
February	233	0.9	38.2	60.9
March	149	0.7	29.5	69.8
April	192	0.5	41.2	58.3
May	221	0.5	39.8	59.7
June	242	0.4	37.2	62.4
July	241	0.5	18.8	80.7
August	170	0.0	10.0	90.0
September	149	0.0	25.5	74.5
October	111	0.9	4.5	94.6
November	153	0.7	11.1	88.2
December	155	1.3	25.2	73.5
Average		0.98	26.95	71.87

when the channel stations were included; however, there are notably smaller percentages in the stratified and partially mixed classes. The abrupt increase in the well-mixed class for the July–December period is primarily due to a shift from the partially mixed class. The month showing the greatest uniformity of the water column was again October with 94.6% of the salinity differences less than 4.0 ppt. The averaged monthly percentages in each class show less than 1%, stratified; 26.95%, partially mixed; 71.87%, well mixed.

According to the classification of Pritchard (1955), Mississippi Sound varies between types A, B and D but is predominately Type D (well mixed). The period when the water column shows the greatest variability is from January through June – the time of increased river flow. In July, Mississippi Sound becomes notably more homogeneous. This period of tendency to vertical homogeneity, peaking in October, lasts through December. When the channel areas are excluded from the classification procedure, the average of the monthly percentages indicating a stratified system is less than 1% while that for a well-mixed system is approximately 72%. The channels are characteristically stratified or partially mixed. The results of this study were in good agreement with the previous classification by the author (Eleuterius 1978) which confirms that while dominately well mixed, Mississippi Sound also attains the characteristics of a partially mixed estuary and, highly localized, characteristics of a stratified estuary.

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