National Estuarine Inventory Supplement

Characterization of Salinity and Temperature for Mobile Bay

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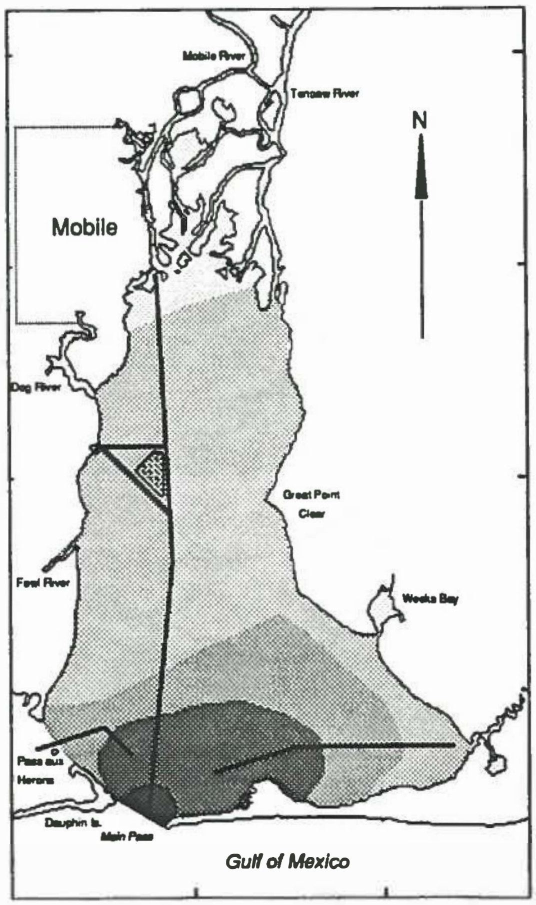

March 1989

National Oceanic and Atmospheric Administration
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National Estuarine Inventory

The National Estuarine Inventory (NEI) is a series of related activities of the Office of Oceanography and Marine Assessment (OMA), National Oceanic and Atmospheric Administration (NOAA) to develop a national estuarine data base and assessment capability. The NEI was initiated in 1983 as part of NOAA's program of strategic assessments of the Nation's coastal and oceanic resources.

The cornerstone of the NEI is the *National Estuarine Inventory* data atlas series. Volume 1, completed in 1985, (1) identifies 92 of the most important estuaries and sub-estuaries of the contiguous USA, (2) presents information through maps and tables on physical and hydrologic characteristics of each estuary, and (3) specifies a commonly derived spatial unit for all estuaries, the estuarine drainage area (EDA), for which data are compiled (See inside back cover for sample map). These estuaries represent approximately 90 percent of the estuarine water surface area and 90 percent of the freshwater inflow to estuaries of the East Coast, West Coast, and Gulf of Mexico. Volume 2, Land Use, presents area estimates for seven categories and 24 subcategories of land use as well as 1970 and 1980 population estimates.

Other NOAA projects whose data and information will be included in the NEI are the National Coastal Wetlands Data Base, the *National Shellfish Register* and related projects, the National Coastal Pollutant Discharge Inventory, the Estuarine Living Marine Resources project, and the Inventory of Outdoor Coastal Recreation Facilities. Information from these and other projects is being incorporated into the NEI through a NOAA geographical information system (GIS).

The data base and assessment capability under development for the NEI are part of a dynamic and evolving process. Estuaries are being added to the NEI, especially from the West Coast and Gulf of Mexico, and refinements are being made to physical and hydrologic data estimated in Volume 1. Estimates of additional estuarine attributes such as volume and flushing rates have been added to the data base.

Salinity Characterization Project

An extensive effort is now underway to develop detailed information on the spatial and temporal characteristics of salinity patterns within the Nation's estuaries. The project is being conducted jointly through cooperative agreements with local universities and institutions and site visits to local experts for each estuary. The goal is to make the most of what is known about salinity (and its variability) for each estuary. Present efforts are being concentrated on approximately 30 estuaries in the Gulf of Mexico with eventual application to over 100 estuaries nationally.

A report is generated for each estuary, defining and mapping both the spatial and temporal characteristcs of salinity and characterizing the influence of freshwater, tides, and wind on the stability of the salinity regime. Salinity is depicted at 5 ppt increments for both surface and bottom profiles for two 3-month averaging periods representing high- and low-salinity periods. The objective is to select and present historical distributions that most closely approximate average conditions.

Acknowledgements

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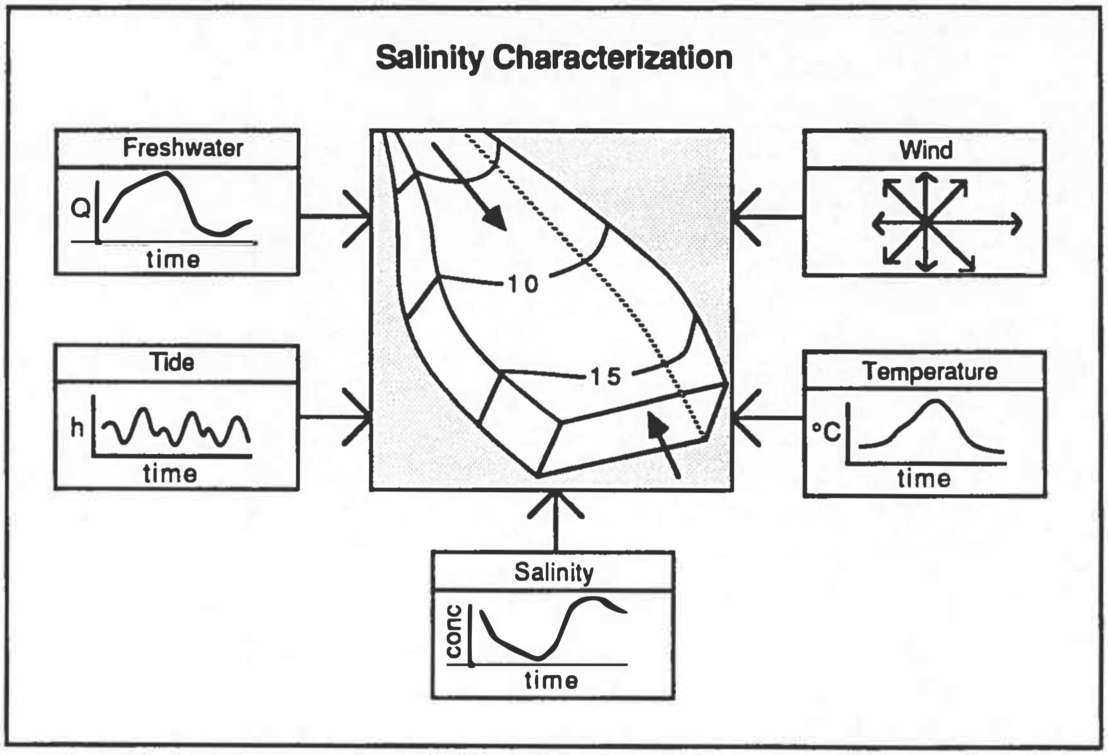


Strategic Assessment Branch
Ocean Assessments Division
Office of Oceanography and Marine Asessment
National Ocean Service

MOBILE BAY

Description

Mobile Bay is oriented on a north-south axis, perpendicular to the Gulf of Mexico. The boundaries of the estuary are defined from the head of tide on the Alabama and Tombigbee Rivers at Claiborne and Coffeeville, respectively, to its terminus with the Gulf of Mexico at Main Pass and Pass aux Herons (on inside back cover). Mobile Bay is a submerged river valley estuary and is comprised of two distinct geographic regions. The bay, in general, is relatively large, shallow, and wide. In contrast, the upper tidally influenced reaches of the system form an extensive delta region as Mobile River enters the bay through three major distributaries accounting for runoff associated with 90% of the drainage basin. Communication between the two regions of the estuary is limited due to an earthen causeway that spans the bay in an east-west direction, restricting flow to the mouths of the distributaries and two small viaducts. Dimensions of the estuary and its watershed are provided in the Table 1 [21].

Table 1. Mobile Bay Dimensions

Drainage Area (km^2)	
Estuarine Drainage Area	12,626
Fluvial Dainage Area	102,884
Total Drainage Area	115,510
Length (km)	
Bay*	50
Distributaries*	160
Width (km)	
Average	22
Maximum	34
Average Depth (m)	
Bay	3
Distributaries	6
Surface Area (km^2)	1,070
Volume (m^3)	3.2×10^9
Cross-Sectional Area (m^2)	
Main Pass	18,720
Pass aux Heron	12,825

* Length of bay defined from Main Pass to mouth of distributaries (approx. 30°40' lat). Length of distributaries defined from approx. 30°40' lat to head of tide.

Salinity

Numerous hydrologic studies conducted within Mobile Bay suggest an interaction between several dynamic physical mechanisms operating at varying time scales. Freshwater inflow, tide, wind, frontal movements, and episodic events produce a complex and highly variable salinity structure within the bay. The geometric configuration of the bay, bathymetry, and anthropogenic modifications further complicate the hydrodynamic processes. The degree of interaction among these variables may produce salinity profiles that range from near-freshwater conditions to near-dominance by Gulf of Mexico waters. The role of each mechanism as it affects the salinity structure is described below.

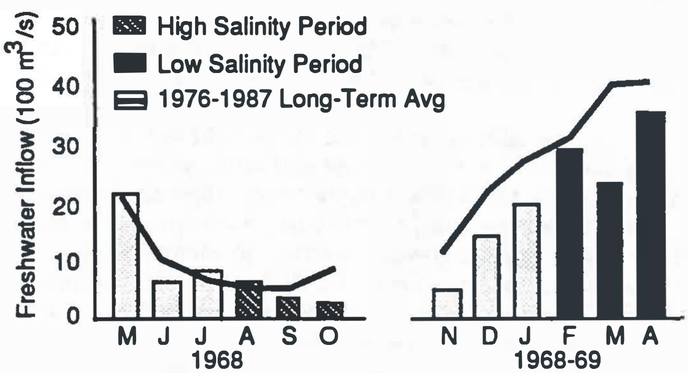
Despite the unstable hydrodynamic nature of the estuary, certain regular patterns do exist. First, over 95% of the freshwater enters the bay via the Mobile River System [12]. Highest freshwater discharges occur generally from February to May, corresponding to periods of lowest bay-wide salinities. In contrast, August to November represents the period of highest bay-wide salinities and lowest freshwater input. Second, water exchange with the Gulf of Mexico occurs primarily (85%) through Main Pass which has significant influence on bottom salinities above Mobile, AL [12]. A saline "wedge" persists within the Main Ship Channel, although its location is determined by the magnitude of freshwater discharge and tidal phase. Third, a bay-wide vertical salinity gradient is usually apparent throughout the year but may vary significantly depending on the phase of the tide and wind conditions [4].

Period of Salinity Depiction. Salinity profiles presented in this report and all references to "average" salinities or hydrologic conditions are made to provide consistency among similar reports being developed for over 100 estuaries nationally (see project description). The effort to characterize an estuary such as Mobile Bay within this framework is difficult due to its intense variability and the lack of concurrent data sets. Data, however, presented by Bault [3] (for 1968-1969) were selected to be most representative of long-term hydrologic conditions given present-day alterations of the watershed. The salinity patterns shown in Appendix 2 were developed based on this data set. Short-term data sets and those limited to certain portions of the bay were used to confirm results obtained by Bault as well as to understand the interaction of certain physical processes at various time scales and their effect on salinity [4-7, 11-15, 23,24].

Salinity profiles for August-October 1968 and February-March 1969 were selected to represent a 3-month high and 3-month low salinity periods, respectively. Indicators developed to "screen" the representativeness of these profiles to long-term and present-day conditions compared favorably. An important consideration was the consistent, bay-wide coverage provided by this data set. Second, freshwater discharge, the mechanism with the greatest capacity to affect bay-wide salinity concentrations, although lower, approached the long-term daily discharge to the estuary. Inflow for the selected 1968-1969 time periods was approximately

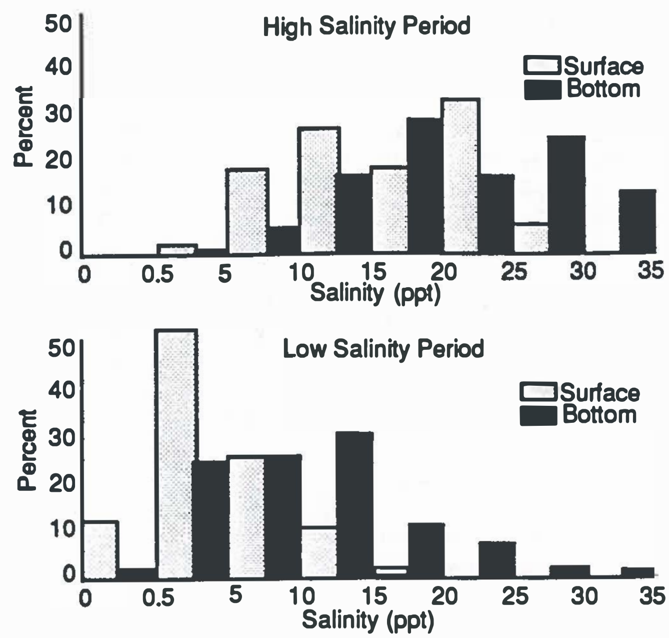
20% and 30% below the long-term seasonal averages for the high and low salinity periods, respectively (Figure 1), with both averaging periods unaffected by "episodic" events. Furthermore, since 1969, the freshwater supply to the bay has remained relatively unaffected by watershed modifications.

Figure 1. Freshwater Inflow Comparison



Note: Inflow reflects USGS gaged values for Tombigbee (02469761) and Alabama (02429500) Rivers.

Figure 2. Salinity (ppt): Percent of Area by Isohaline (referenced to surface area at mid-tide level (1,070 km²))



Certain physical features are not reflected in the 1968-1969 time periods. These include the Theodore Ship Channel and the Gaillard Island disposal area. These features, constructed in 1975, have altered the bathymetric character of the bay, resulting in slight increases of bottom salinities locally [4,5]. Comparison of wind events acting over the estuary during the 1968-1969 averaging periods to long-term patterns could not be evaluated, except to the extent that prevailing directions were consistent with long-term patterns [3,10,22].

Overall, the 1968-1969 salinity profiles appear to represent adequately long-term and present day distributions for Mobile Bay, for the 3-month high and 3-month low salinity periods. However, since these profiles represent somewhat below-average freshwater inflow conditions, isohalines presented in this report may be displaced slightly toward the mouth during both averaging periods to reflect more accurately the long-term "average" profiles. Figure 2 is based on the August-October 1968 and February-March 1969 salinity structure and clearly demonstrates the influence of seasonal discharges on bay-wide salinities.

From the 1968-1969 profiles, certain general characteristics of the isohalines were apparent. First, a longitudinal gradient persists within the bay, but varies as a function of freshwater inflow. Second, a vertical gradient exists, although its intensity and spatial extent vary considerably. Third, localized regions of more-saline water persist within the shipping channels and "overwash" into adjacent bottom waters is common. Finally, high salinity waters dominate the bottom of the Mobile River due to the influence of the Main Ship Channel, while the remaining distributaries tend to be dominated by fresh or brackish waters. Of course, these tendencies are the result of the averaged physical and hydrologic properties operating for the 3-month periods. The variability (in both time and space) associated with these general tendencies is discussed below ("Mechanisms Affecting Salinity Distributions").

Stratification. The magnitude, spatial extent, and temporal characteristics associated with vertical stratification within Mobile Bay is not well understood. Despite its shallow depths, a vertical gradient exists and generally follows these patterns. First, the bay is moderately stratified throughout the year with strongest gradients apparent during the spring due to increased river discharge. In general, the strongest vertical stratification is likely to occur under conditions of (1) moderate-to-high river discharge and weak winds, or (2) persistent northerly winds and low river discharge [11]. Second, stratification-destratification events may fluctuate on time scales ranging from days to months as a result of freshets, wind events, tide cycle, and frontal movements. Wind events, of sufficient magnitude and direction, may result in near-homogeneous conditions throughout the estuary, although the system requires only a few days to restratify [9]. Finally, as expected, surface-to-bottom salinity differences within the ship channels are significantly different than those within the shallow bottom areas of the bay. Table 2 shows surface-to-bottom salinity differences for selected regions of the bay based on the 1968-1969 data set [3].

Table 2. Surface-to-bottom salinity differences (ppt) for selected sites during 1968-1969 [3].

Location	Jan Feb	Mar Apr	May Jun	Jul Aug	Sep Oct	Nov Dec
Bay Head	5.2	1.3	1.8	0.9	1.5	1.8
Dog River						
East Side	0.9	0.5	0.8	2.8	0.6	0.8
Ship Chan	22.9	16.0	18.4	22.9	15.3	19.8
West Side	0.8	1.0	1.0	0.1	0.8	1.0
Fowl River						
East Side	2.5	3.3	0.3	1.6	1.0	3.2
Ship Chan	21.6	21.3	15.9	17.1	13.0	12.8
West Side	0.8	0.4	0.3	0.0	0.9	5.6
Bon Secour	4.2	5.6	3.1	1.4	1.3	0.6
Pass aux Heron	3.6	3.6	1.9	2.6	1.8	0.3
Near Main Pass	11.4	18.3	11.5	7.7	6.6	5.6

Significant mixing does, however, occur over longer time scales as indicated by changes in water temperatures. Bault reported very little surface to bottom change in temperature for the period 1968-1969. Since the annual peaks and valleys in temperature of Gulf waters and river waters are not in phase, nearly uniform temperatures throughout the bay may be the result of mixing, principally wind and current-induced. The highly turbid nature of the bay also suggests a well-mixed estuary since surface waters normally appear turbid even during periods of low freshwater inflow or reduced sediment input from the rivers. The area of greatest turbidity in Mobile Bay occurs in the lower region of the Main Ship Channel, adjacent to Fowl River [4].

Temperature. The bay, in general, has a well-defined seasonal thermal structure directly linked to atmospheric temperatures. Surface water temperatures in the bay normally range from a low of 10°C in January to a high near 30°C in August. On average, the Main Pass area tends to be 2-4°C warmer in the winter and 2-4°C colder in the summer than the upper bay. Thermal stratification generally does not exist within the bay. The average difference between surface and bottom waters was less than 1°C. However, bottom waters are warmer than surface waters from February-June while the opposite is true from August-January. In July, the water column is homogeneous [12]. Temperature profiles in this report represent August-October 1968 and February-March 1969 [3].

Mechanisms Affecting Salinity Distributions

Bathymetry. Mobile Bay is triangular in shape and slopes gently from the shoreline to the center of the estuary. The average depth of the bay is approximately 3m at mid-tide level, although holes deeper than 5m exist throughout the central area of the northeastern bay. In contrast, the distributaries average almost 6m [18]. Bathymetric features (Appendix 1) include the Main Ship Channel that extends from Main Pass to the Port of Mobile (this channel is scheduled to be increased from 12.0m to 13.6m by May 1990); the Theodore Ship Channel; the Hollingers Ship Channel; the Gulf Intracoastal Waterway extending from Bon Secour Bay to Pass aux Herons; and the triangular-shaped Gaillard Island (5.2 km^2) disposal area.

These features directly affect bottom salinities, regardless of time scales. Channels and deeper areas of the bay tend to be more-saline than the adjacent areas. The Main Ship Channel, in particular, allows saline Gulf of Mexico waters to extend beyond the port of Mobile. On rare occasion, a salt wedge may reach more than 30 km from the mouth of the Mobile River and is most pronounced during periods of low freshwater inflow and high tides [15]. East-west movement of bottom waters adjacent to the mouth of Dog River may be restricted partially by the dredged material disposal area associated with the Main Ship Channel as well as the Hollinger Island Channel [12]. Additionally, the restrictive influence of a causeway limits exchange between the bay and distributaries. Similar interference is caused by a causeway in the Pass aux Herons region.

Other prominent features, associated with the natural configuration or orientation of the estuary, have a direct influence on salinity distributions or circulation within the bay. The north-south orientation of the estuary and its perpendicular alignment with respect to the Gulf of Mexico promote certain physical dynamics. These include seasonal northerly winds over the estuary, offshore winds, and frontal movements (see section on "Wind"). Additionally, surface and bottom waters tend to be deflected to the east into the Bon Secour region due to coriolis force and as restrained by shoreline configuration [4]. This is reflected in the isohaline distributions. Second, inlet configuration is vital to communication with the Gulf of Mexico. Almost all exchanges occur through the eastern portion of Main Pass. Its deep channel (12m) is in stark contrast to the shallow (1-2m) western portion and the Pass aux Herons inlet.

Freshwater Inflow. The average daily inflow (gaged at Claiborne and Coffeeville, AL) to Mobile Bay was 1,848m^3/s for the period 1929-1983 [9]. Dams do not have a regulating effect on river waters and all major diversions, including the Tennessee-Tombigbee are upstream of the Claiborne and Coffeeville gages [4]. There is an estimated travel time of 5-9 days for riverine water to move from these gages to the head of the bay, a distance of approximately 100 km [13]. The ungaged portion of the Mobile River System watershed is estimated to contribute an additional 7% of freshwater inflow into the bay [13].

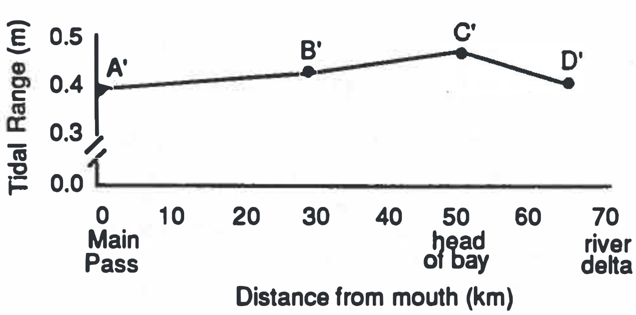
Freshwater inflow, transported almost exclusively by the Mobile River System, may impact salinity over periods of days to years. However, monthly and seasonal fluctuations in freshwater inflow produce the most dramatic changes in bay-wide salinity concentration and patterns. The influence of freshwater on the bay is dependent on the magnitude of flow. During low-inflow periods estuarine waters exhibit only a longitudinal gradient with no observable lateral or vertical gradients except in the ship channel region. At moderate discharges, fresh and low-salinity waters favor the western side of the bay as they move toward the mouth, principally directed by the Main Ship Channel. At higher discharges, the freshwater tends to dominate the entire estuary [12]. High-to-flooding discharges may force the estuary to near-limnetic conditions for periods in excess of 20 days, except in the deepest sections of the Main Ship Channel, portions of Bon Secour Bay, and near Main Pass.

Freshwater inflow generated from local runoff during rainfall events appears to have a limited effect on bay-wide salinities when compared to seasonal discharges. Average precipitation in coastal Alabama is over 160 cm/yr and usually occurs as shower activity rather than sustained rainfall events. The rainfall is fairly evenly distributed throughout the year, with a slight increase in the spring and summer due to thunderstorm events [15].

Tides. Tides in Mobile Bay are diurnal, although twice-daily tides usually occur twice each month and last 1-3 days at a time [12]. Astronomical tides generally range <0.5m throughout the estuary but are slightly higher at the head of the bay than at Main Pass (Figure 3) [12,19]. The period of greatest tides (spring tides) occurs bi-monthly with a range of 0.8m while the period of smallest tide range (neap tides) is <0.1m [12].

Figure 3. Tidal Range (Diurnal)

Station	Tidal Range (m)
A'	0.37
B'	0.43
C'	0.46
D'	0.40



Note: see Appendix 1 for station location

A phase lag of 90 minutes exists between the mouth and the head of the bay [19], characterizing a system approaching standing wave conditions. In addition, a lag of approximately 25 minutes exists between the two entrances to the bay, occurring first at Main Pass [4]. The tidal prism volume is estimated to be $4.14x10^8 m^3$ based on the tide stations identified in the previous graphic [19,21].

Flood currents enter the bay at a N-NE orientation and achieve maximum velocities in East Main Pass [12]. Maximum velocities are 1.0-1.3 m/s at the surface and 0.8-1.8 m/s at the bottom. Ebb currents exit with a S-SW orientation and achieve equivalent maximum velocities throughout Main Pass [12]. Maximum velocities within the upper bay may reach 0.2 and 0.5 m/s during flood and ebb tides, respectively [19]. No known residual tidal current exists, although there is some lag from surface to bottom, and as previously mentioned, between tidal inlets [4].

Table 3. Tidal Currents

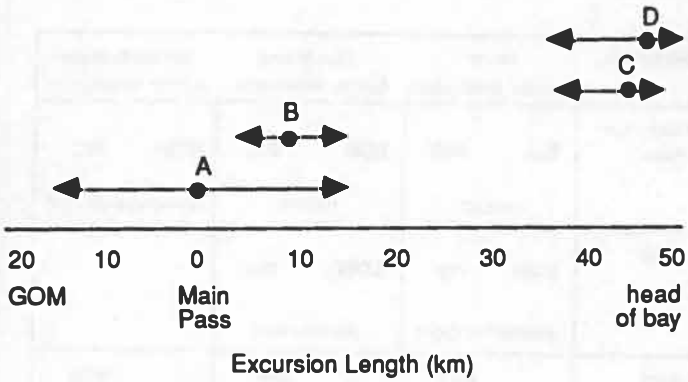
	Tidal Velocity m/s		Tidal Excursion km	
	Flood	Ebb	Flood	Ebb
A	0.7	0.8	15.4	16.5
B	0.3	0.3	6.6	5.5
C	0.1	0.4	3.3	7.7
D	0.2	0.5	4.4	11.0

Note: see Appendix 1 for station location

Tides most directly affect salinity over periods of hours to weeks and is most noticeable near the mouth of the bay. There is significant areal variability within the bay in response to tidal height regardless of the normal, monthly, or seasonal inflow conditions [4]. Saline water enters the bay in tidal "pulses" which are in phase with the tide. As the flood tide approaches the mouth of the bay, saline waters move northward along the ship channel, and to a lesser degree and with some lag, in the shallows on either side of the channel. The salinity in the bay gradually increases in value and northerly extent as flooding continues until ebb conditions occur and the saline water retreats to the lower bay. Isohalines generally exhibit an excursion-type pattern except during periods of sustained winds that may override direction reversals. At moderate freshwater inflow conditions, isohalines at the mouth may be displaced 10-16 km throughout the tidal cycle, while isohalines in the upper bay may move 5-9 km, as indicated in Figure 4 [23]. The maximum north-south shift, due to tides, occurs bi-weekly during maximum amplitude of spring tides [11].

Significant stratification-destratification changes are generally not caused by tides, but instead are related to river discharge and wind [9].

Figure 4. Tidal Excursion



Note: see Appendix 1 for station location

Wind. Wind events may significantly effect the salinity regime over time periods ranging from days to months. These effects are generally observed throughout the water column due to its shallow depth. Long-term wind measurements at Mobile Airport [22] and Dauphin Island Sea Lab [10] are summarized in Table 4.

Table 4. Long-term Wind Measurements at Mobile Airport (1949-1984) and Dauphin Island Sea Lab (1974-1984)

	Mobile Airport		Dauphin Island	
	Direction	Velocity (m/s)	Direction	Velocity (m/s)
Jan	N	4.6	N	4.2
Feb	N	4.7	N	3.9
Mar	N	4.8	SE	4.0
Apr	S	4.5	SE	3.8
May	S	4.0	SE	3.4
Jun	S	3.4	S	3.1
Jul	S	3.0	S	2.7
Aug	NE	2.9	SE	2.7
Sep	NE	3.5	NE	3.5
Oct	N	3.7	N	4.1
Nov	N	4.2	N	3.9
Dec	N	4.3	N	4.1

Seasonally, the bay is influenced by both near-field (those acting directly over the estuary) and far-field (long-shore) winds which occur over Gulf waters. Near-field winds generally are northerly during the fall and winter, southerly during the spring and early summer, and easterly during the late summer. These winds can have both an important driving and modifying effect depending on direction and velocity [11]. Sustained northerly winds decrease system volume, dampen tide ranges, and push surface isohalines toward the mouth of the estuary [4,12]. With respect to stratification, northerly winds <4 m/s generally have no effect, winds 4-8 m/s enhance stratification, and winds >8 m/s are sufficiently strong to break down stratification and encourage mixing [10]. Southerly winds have the opposite effect on volume, tidal ranges, and movement of isohalines but generally increase water column mixing. Sustained winds from the east or west acting over the waterbody result in surface water shifts to the opposite shore and may be accompanied by upwelling of bottom waters to the shore where the wind originated [4,12]. Long-shore winds set-up Ekman transport that affects water levels and stratification within Mobile Bay [10]. Sustained long-shore westerlies occur June-August, carry water offshore, and increase mixing. From September-November, sustained easterlies have the opposite effect on water level and increase bay-wide stratification.

The passage of cold fronts, typically occurring from October through March with a frequency of 5 events per month [9] produce abrupt changes within the bay and generally favor the "flushing" of bay waters. Over the northern Gulf of Mexico these storms have a distinct and repetitive pattern of wind, barometric pressure, humidity, and cloud cover [10]. The cold-front storms occur in three phases (1) prefrontal, (2) frontal passage, and (3) cold-air outbreak and high pressure. The prefrontal phase is characterized by falling barometric pressure, strengthening of southerly winds (creating high seas), and warm, moist air conditions. The second phase involves an abrupt reversal of these conditions, accompanied by a squall line passage, strong wind shear, precipitation, and a rapid drop in air temperature. During the final phase, pressure rises rapidly and strong winds rotate from northwest to northeast. Water level, set-up by the prefrontal southerly winds and falling atmospheric pressure, is abruptly set-down by the strong northerly winds and rising pressure.

Episodic events may have minimal-to-severe effects depending on its proximity to Mobile Bay. These events have been estimated to hit the 80 km coastline between Biloxi, MS, and Mobile, AL, with an annual probability of 13% for a tropical storm, 6% for a hurricane, and 1% for a major hurricane [15]. Hurricanes occur in Alabama from June-October, most commonly in September. Resulting storm tides and predicted recurrence intervals are given in Table 5 [15].

Table 5. Probable Recurrence Interval for Storm Tides in Coastal Alabama [15]

	Elevation above mean water level (m)				
	1 yr	10 yr	20 yr	50 yr	100 yr
Dauphin Island	1.1	1.8	2.3	3.0	3.5
Upper Mobile Bay	1.1	1.8	2.3	2.9	3.2

Depending on the direction of approach, storm surges can either introduce a considerable volume of seawater from the Gulf of Mexico to the estuary or push most of the water out of the upper bay. In addition, the freshwater pulse associated with an episodic event may change the discharge within the Mobile River System by up to 4,000-6,000 m^3/s over a period of 8-10 days and 8,000-10,000 m^3/s over 15-20 days [12].

A direct comparison between long-term wind profiles and winds occurring during the 1968-1969 sampling period cannot be made because of differences in time scale. However, over both averaging periods wind was generally consistent with long-term prevailing monthly directions [3,10,22]. From August-October 1968, southerly winds prevailed over the lower and middle bay at 3-8 m/s, while northerly winds were recorded at 3-10 m/s over the northerly half of the bay and distributaries. A variety of patterns were recorded over the bay from February-March 1969. In February, northerly winds at 3-8 m/s controlled the middle and upper bay, while easterly winds at 3-8 m/s controlled the lower bay. In March, winds were westerly at 8-10 m/s over the lower bay, southerly at 10-20 m/s over the middle portion of the bay, while winds remained calm over the upper bay.

Summary

The salinity stability matrix given in Figure 5 characterizes the temporal variability of the salinity regime and reflects the influences of freshwater inflow, tide, and wind. Effects are characterized by changes in average bay salinity, as well as stratification or mixing.

In Mobile Bay, the dominant time scale over which salinity varies is seasonal. Freshwater inflow is the principal mechanism that decreases average system salinities and tends to stratify the water column during the high-flow period of February to April. Average winds at this time are from the north at 4-5 m/s and tend to enhance stratification further. During the low flow period of August through October average system salinities increase and destratification occurs as wind and tide more effectively induce mixing.

To a lesser degree, salinity variability is experienced on a time scale of days to weeks. Wind, associated with frontal passages typically occurring from October through March, is an important mechanism. Changes in salinities occur as winds rotate mixing the water column and affecting system exchanges with adjacent shelf waters. In addition, bi-monthly spring tides induce greater pulses of Gulf waters which increase salinities and mixing. Low-to-slight variability is observed at time scales of hours to days. Tides have only a localized influence that is mainly confined to the mouth of Mobile Bay. Overall, Mobile Bay is classified as a seasonal estuary due to a strong seasonal freshwater inflow signal, but it is susceptible to shorter term fluctuations as determined principally by wind.

Figure 5. Salinity stability with respect to the major forcing functions

Mechanism	Hours		Days-Weeks		Months-Seasons	
	Salinity	Stratification	Salinity	Stratification	Salinity	Stratification
Freshwater Inflow	SLI (rainfall)	INC	LOW (storms)	INC	HIGH (seasonal discharge)	INC
Tides	LOW (diurnal tide cycle)	n/a	LOW (spring-neap)	n/a		
Wind	SLI (diurnal winds)	INC or DEC	MOD (fronts)	INC or DEC	MOD (seasonal winds)	INC or DEC
Other Mechanisms			SLI to HIGH (hurricanes)	DEC		

Effect on Bay-WideSalinity: Slight (SLI) <2 ppt; Low 2-5 ppt; Moderate (MOD) 5-10 ppt; High >10 ppt. Effect on bay-wide stratification: Increase (INC) or Decrease (DEC).

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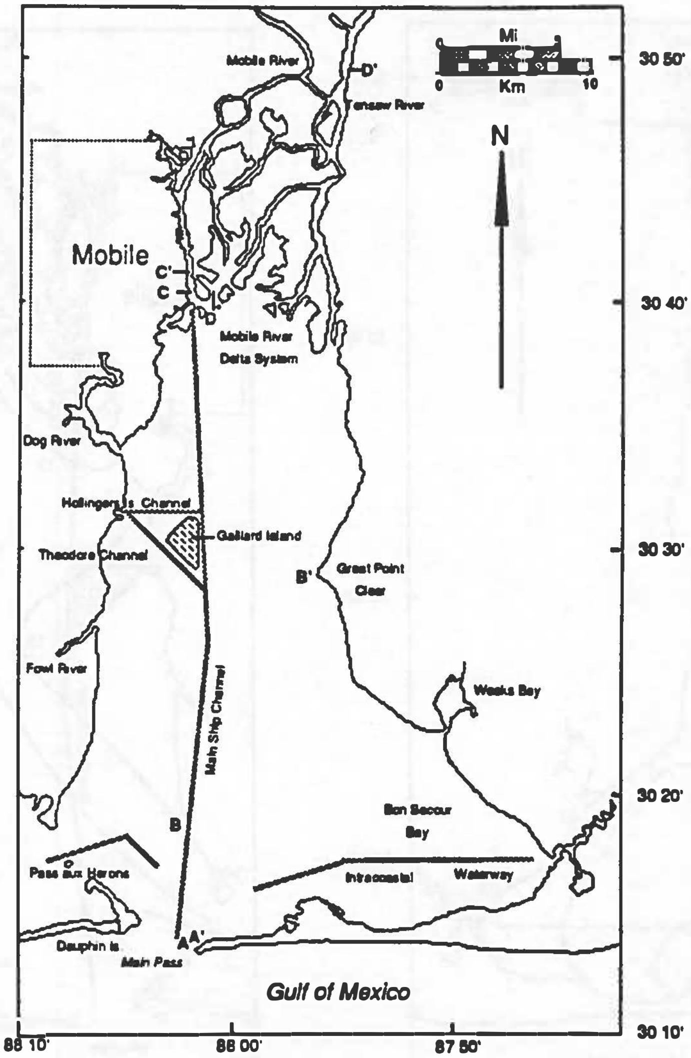
Appendix

I. **Mobile Bay Locator Map**

II. **Mobile Bay Isohaline and Isotherm Profiles**

Appendix I

Mobile Bay Locator Map

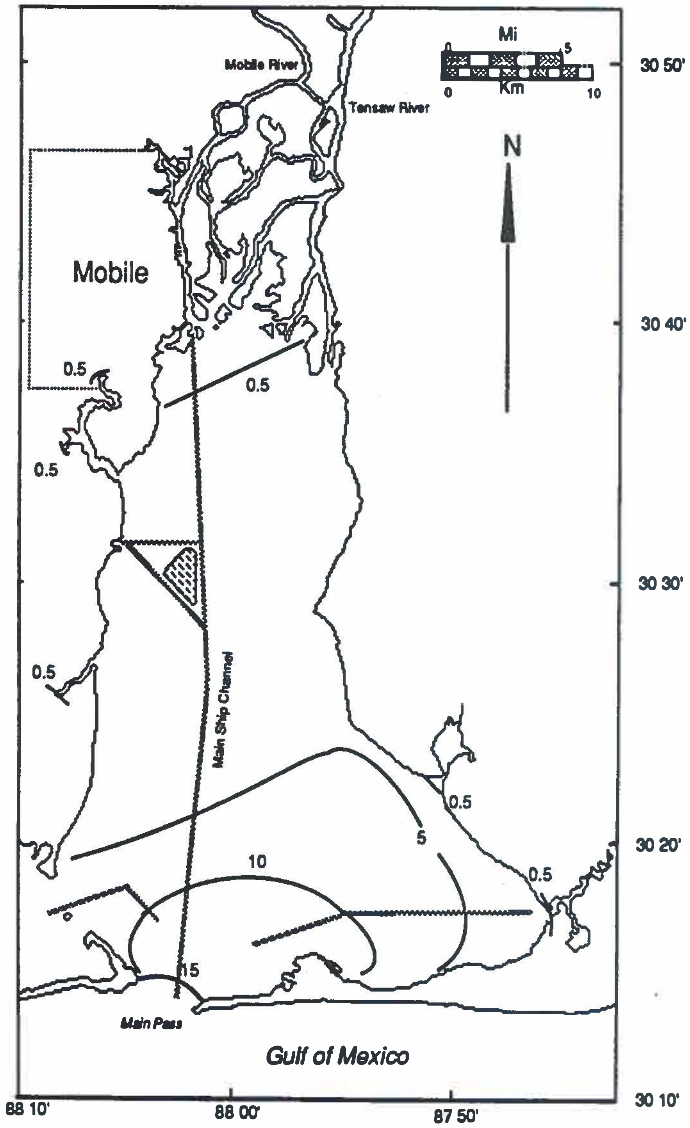


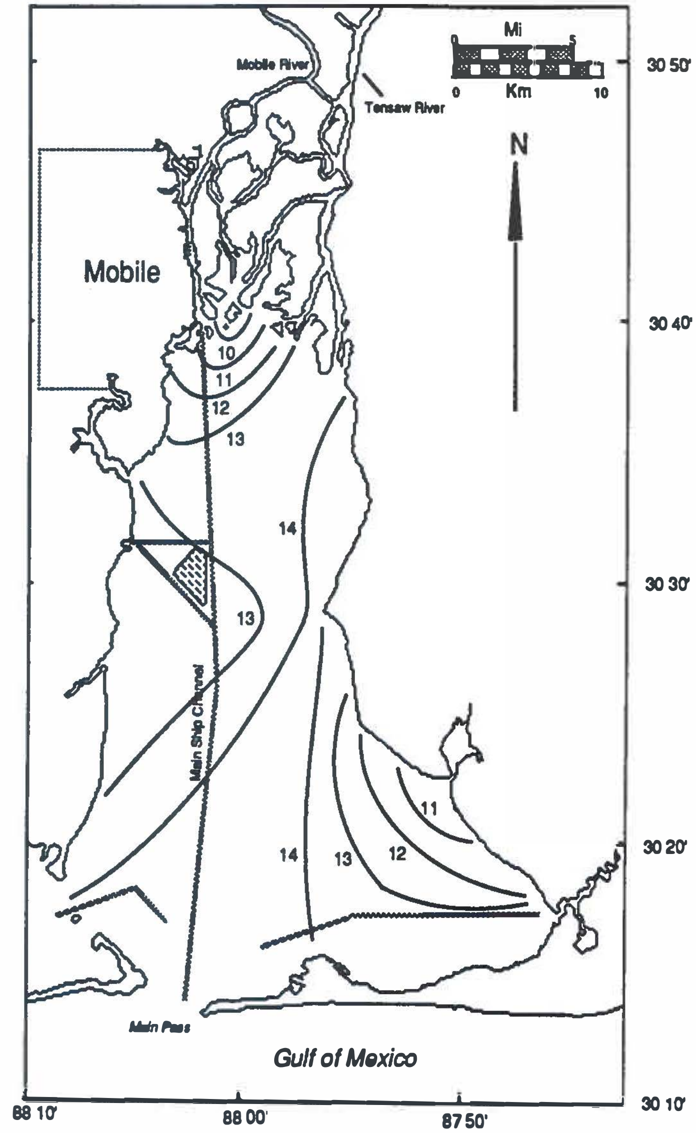
NOAA Tide Stations
A Tidal Currents
A' Tidal Elevations

Wind Stations
1 Dauphin Island Sea Lab
2 Mobile Airport (not shown)
Lat 30 41' / Long 88 15'

Appendix II

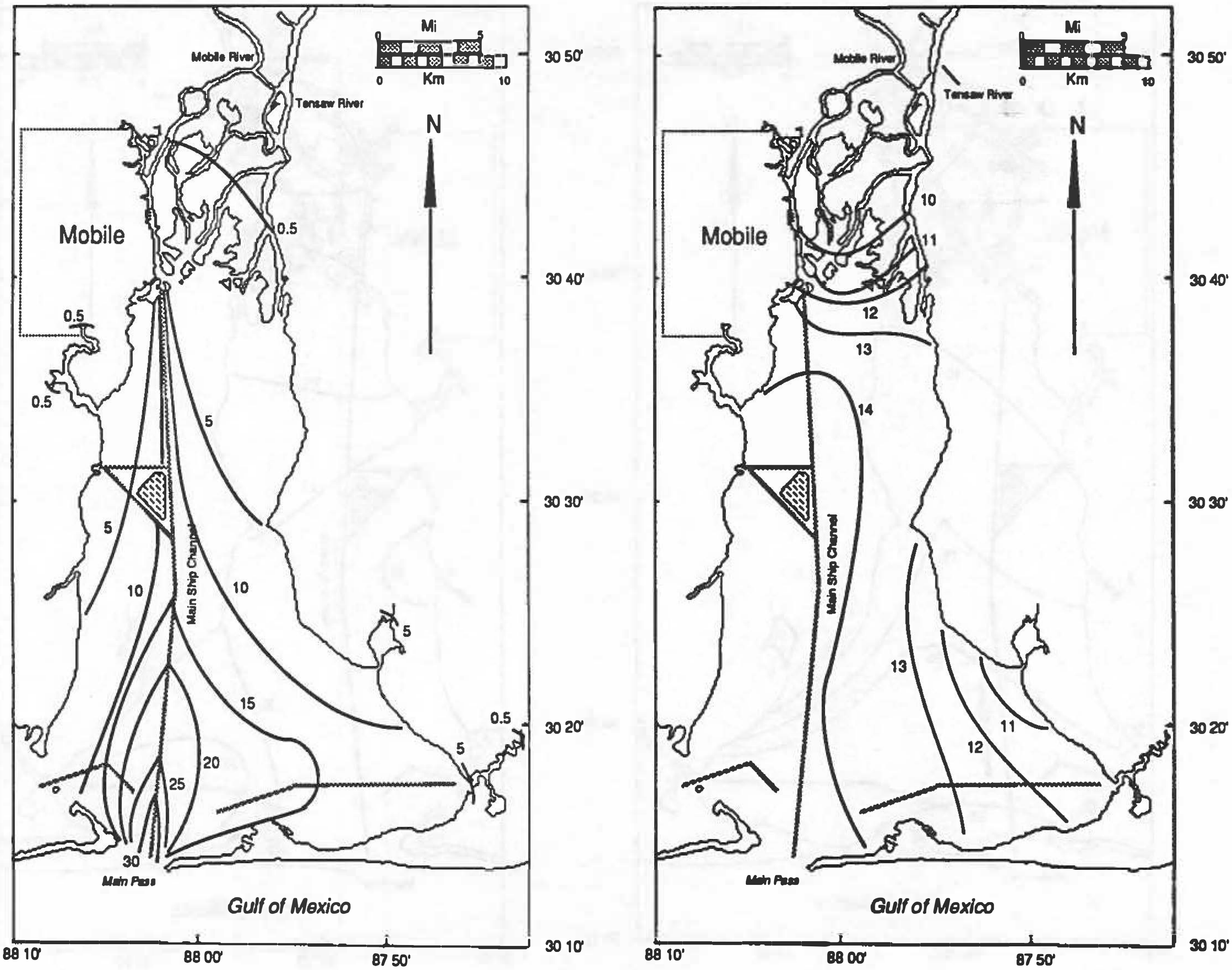
Low Salinity Period (February-April) Surface Isohalines and Isotherms





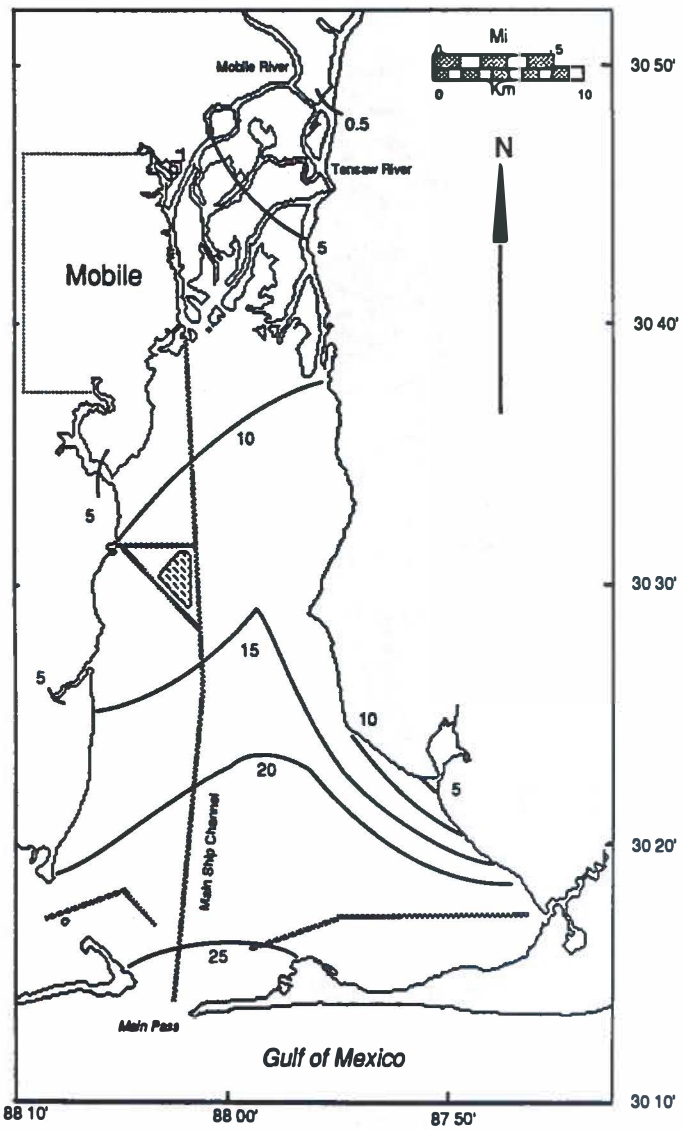
Appendix II

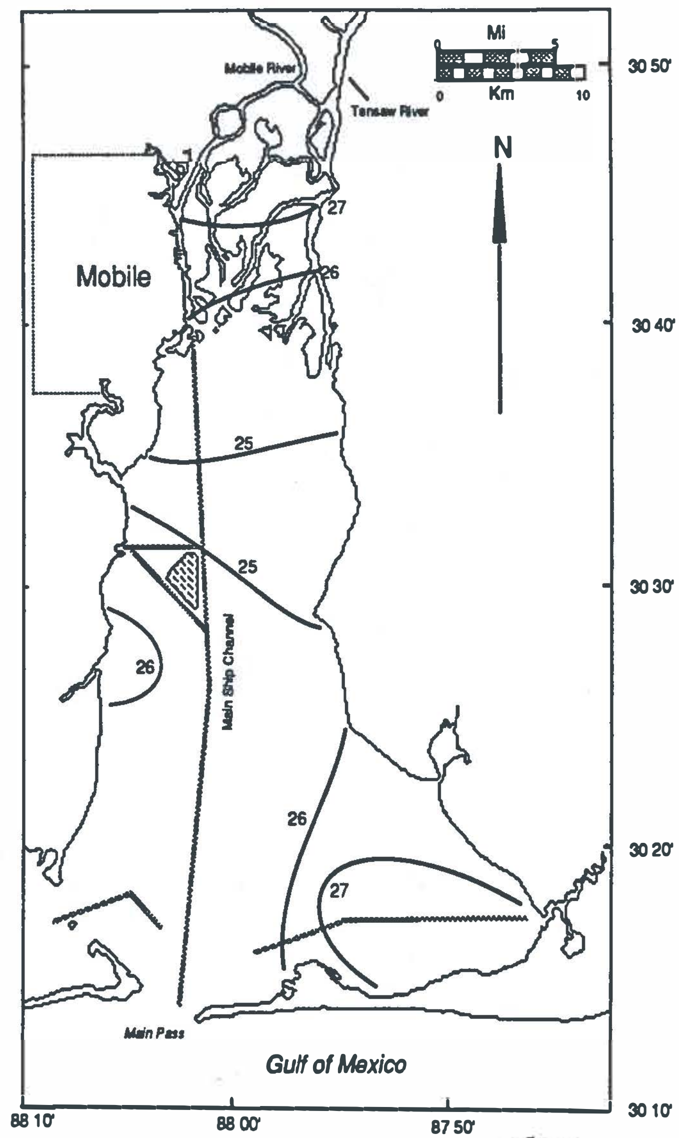
Low Salinity Period (February-April)
Bottom Isohalines and Isotherms



Appendix II

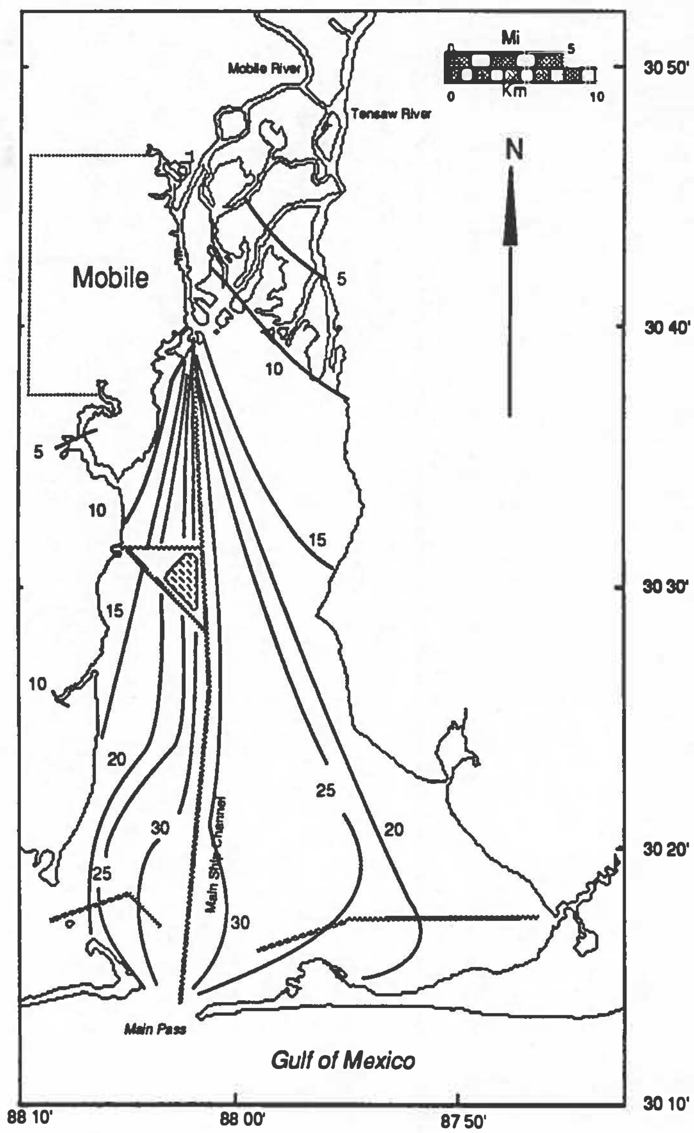
High Salinity Period (August-October) Surface Isohalines and Isotherms

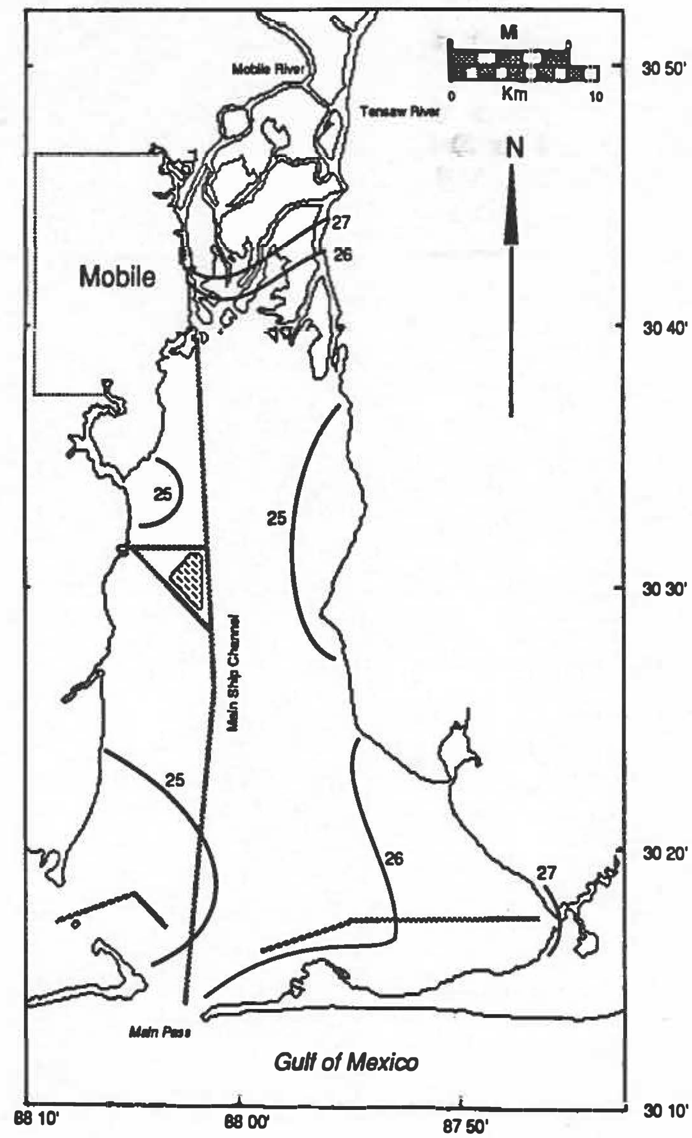




Appendix II

High Salinity Period (August-October)
Bottom Isohalines and Isotherms





Mobile Bay
AL

PHYSICAL AND HYDROLOGIC CHARACTERISTICS

PHYSICAL

Surface Areas (mi^2)	
Fluvial Drainage	39 725
Estuarine Drainage	4 875
Estuarine Zones	
Tidal Fresh	29
Mixing Zone	327
Seawater	53
Total	409
Dimensions	
Length (mi)	178 0
Width (mi) Average	13 8
Minimum	8 0
Maximum	23 6
Average Depth (ft)	9 6
Average Depth to Width Ratio	1.3×10^{-4}
Stratification Classification	
3-Month High Flow	HS
3-Month Low Flow	MS

FRESHWATER INFLOW

Flow Rates (1000 cfs)				
Period of Record				1975-1982
Long Term Average Daily				79 3
Long Term Average Monthly	J	179 8	J	32 3
	F	170 7	A	29 4
	M	161 4	S	29 9
	A	179 4	O	36 9
	M	93 3	N	43 4
	J	44 5	D	64 0
7 Day 10 Year Low Flow				7 6
50 Year Flood				595 7
100 Year Flood				653 0
Flow Ratios				
Average Annual				0 449
High Flow Period				0 870
Low Flow Period				0 173

TIDAL DATA

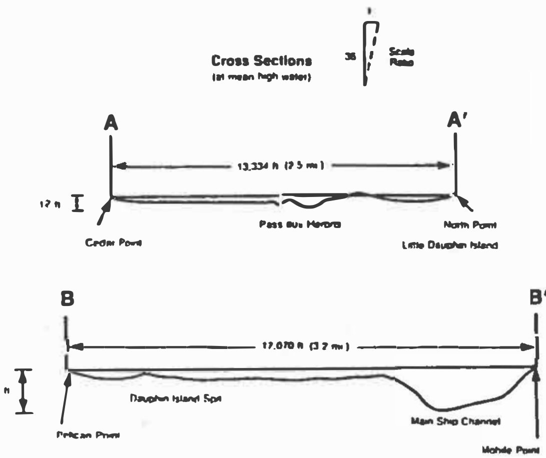
Prevailing Tide Diurnal

Total Prism (cf) 1.58×10^{10}

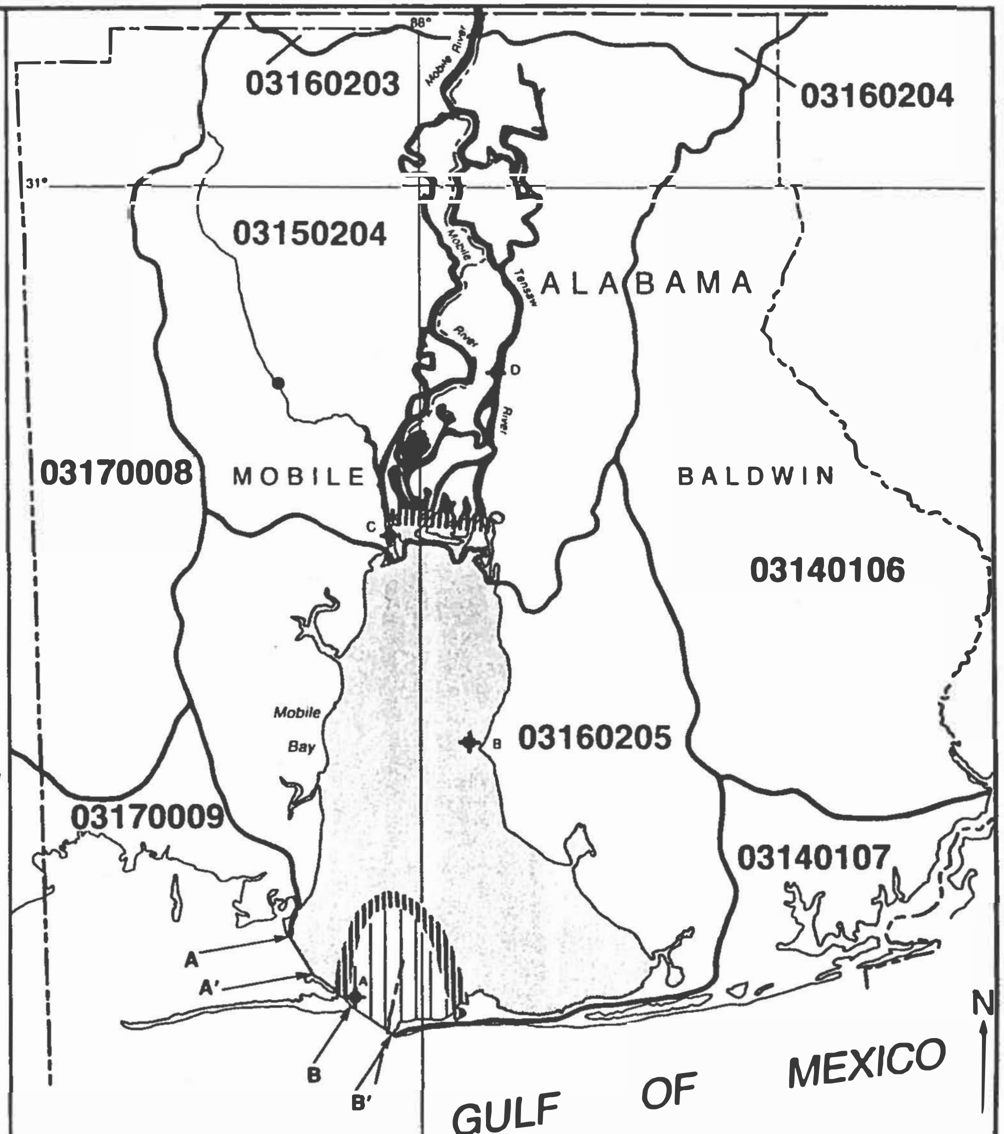
Phase Range of Tide (ft)

Map Key	Station	Range
A	3194	1 3
B	3197	1 4
C	3198	1 4
D	3199	0 8

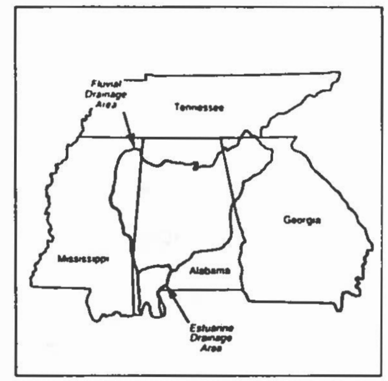
Abbreviations Vertically Homogeneous VH, Moderately Stratified MS Highly Stratified HS



Notes
Approximately 40% of Estuarine Drainage Area is shown on map



Map Sources:
U.S. Geological Survey, State of Alabama Hydrologic Unit Map 1974 scale 1:500,000 USGS Accounting Units of the National Water Data Network 1979 scale 1:7,500,000 NOAA/NOS Nautical Chart No 11376 February 1984 scale 1:80,000



- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

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