1980 GEORGIA ESTUARIES CIRCULATION SURVEY

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Abstract

The 1980 Circulation Survey, Southeast Atlantic Coast Estuaries, Sapelo Sound to St. Andrew Sound, Georgia, was conducted from March through June 1980 by the National Oceanic and Atmospheric Administration's Ship FERREL. Sapelo Sound, Doboy Sound, Altamaha Sound, St. Simons Sound, and their tributaries (collectively referred to as Georgia Estuaries) were studied. Current, tide, meteorological, and conductivity-temperature/depth data were collected. These data were processed and harmonic and nonharmonic analyses results are presented. Investigative methodology and findings with respect to physical characterizations of the Georgia Estuaries are discussed. Findings are important for understanding the physical and ecological dynamics of the region.

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1. Introduction

This is a preliminary report on the 1980 Circulation Survey, Southeast Atlantic Coast Estuaries, Sapelo Sound to St. Andrew Sound, Georgia, conducted by the National Oceanic and Atmospheric Administration Ship FERREL from March through June 1980. Sapelo Sound, Doboy Sound, Altamaha Sound, St. Simons Sound and their tributaries--collectively referred to as Georgia Estuaries--were studied. In situ measurements of currents, tides, water temperature and conductivity were collected. In addition, air pressure, air temperature, and wind speed and direction were measured. These data were processed by the National Ocean Service. Preliminary analyses were completed on the tide and current data and are presented in this paper.

Within these Georgia Estuaries is the port of Brunswick, the second largest commercial port in the state. Maritime ships may use tide and current prediction data derived from this survey for loading and undocking. Circulation data from this survey may also be used to study the tidal flow in the salt marshes of Sapelo Island and Blackbeard Island (where a game sanctuary is located). This circulation survey can provide data to users concerned with the physical and ecological dynamics of the region.

2. Tide and Current Measurements

The acquisition of data by which water movement can be described constitutes a circulation survey. This includes the measurements of currents, tides, water temperature and conductivity, wind speed and direction, barometric pressure, and air temperature.

Measurements are made at selected locations and depths to obtain a three-dimensional description of circulation. Currents are horizontal water movement caused by periodic astronomic tide-producing forces, density differences between water masses, river runoff, and changes in wind stress and atmospheric pressure. Concurrently, there is a vertical water movement, i.e., a change in sea level, resulting from these same forces. The change in sea level, due to astronomic forces, is called the tide. The density structure of water masses is determined by temperature and conductivity (salinity) profiles. The measurement of atmospheric parameters is necessary for the study of water movement caused by winds and changing atmospheric pressure. This paper discusses only the tide and current measurements collected during the Georgia Estuaries Circulation Survey; a discussion of other physical measurements is in the NOS Circulation Survey Report - Southeast Atlantic Coast Estuaries Sapelo Sound to St. Simons Sound, Georgia Circulation Survey (In Manuscript).

The locations of current meter stations occupied during the 1980 survey are shown in Figure 1. Thirty-six current meter stations were deployed throughout the Georgia survey. Most stations were deployed for a minimum of 15 days with some stations deployed for 30 days or longer; however, there were three stations with less than 15 days of data. Scheduling was based on the need for simultaneous observations at certain locations. The Grundy Model 9021G current meter was used for this survey. This meter records data on a 3-inch diameter, 1/2-inch wide magnetic tape in a 10-bit binary code. Information such as meter serial number, current direction, current speed, water temperature and conductivity, sample count or time in hours and minutes is recorded. The speed sensor is a Roberts-type rotor and the meter is oriented toward the current by a large tail fin. Speed is measured by counting the revolutions of the rotor averaged over a 10-minute sampling period. Current direction is measured with a gimbaled compass and recorded at the end of the 10-minute sampling period. A crystal oscillator ensures the time accuracy of sampling interval and tape motor speed throughout the deployment.

Locations for tide gages occupied during the 1980 Georgia Estuaries project are shown in Figure 2. Tide gages were operated at 14 sites. All stations were occupied for at least 30 days and one station (867-7344) was in operation for 1 year. Short period (30-day) tide stations were installed concurrently with nearby current stations. The NOAA Ship FERREL and its crew installed the tide gages. A reconnaissance of the proposed sites was accomplished before tide gages were installed; this helped to determine the availability of structures for gages, water depth, recovery of old bench marks, and possible sites for new bench marks. During installation, differential levels were run from the tide staff to established bench marks and, whenever

possible, to the National Geodetic Vertical Control Network. The Fischer-Porter analog-digital-recorder (ADR) tide gage was used in this project. The ADR gage records samples every 6 minutes on foil-backed paper tape, which is processed using a mechanical translator and a computer. The mode of operation is float movement translated into binary code and recorded on paper tape.

3. Analyses

The NOAA Ship FERREL acquired, evaluated, and initially processed these data, and transmitted data tapes to the National Ocean Service (NOS) for analysis. The NOS completed processing and certified the data. Current measurements adhered to laboratory standards. Total measurement uncertainty (TMU) was computed for each current meter measurement. The TMU includes an estimated calibration uncertainty, sensor measurement uncertainty, and environmental error sources; the TMU's bound errors for 95 percent of the typical field measurements. The methodology and findings are described in, "Uncertainty Estimates for Oceanographic and Meteorological Measurements--Tide and Tidal Current Survey, Sapelo Sound to Saint Andrews Sound, Georgia, March - June 1980," ESO Technical Report. Tide and current time series data were analyzed harmonically and nonharmonically. The analyses (Fourier or least squares) provided amplitudes and phases for the harmonic constituents. The amplitudes and phases (harmonic constants) may be used to predict the tide or tidal current. Mean ranges and mean speeds and directions were tabulated and computed. Table 1. illustrates the tide mean ranges and M_2 amplitudes and phases for selected tide gage stations. The M_2 tide is the predominant astronomical force in this area. Table 2. illustrates the current mean speeds and directions for selected current meter stations.

4. Summary and Conclusions

Preliminary analyses of the tide and current data revealed that changes in mean range and speed had occurred since previous surveys. Some areas had not been surveyed in 50 years. Improvements over two previous circulation studies within these

estuaries are: there is an increase in station sites; there is an increase in the length of observation periods; and there is an increase in data quality due to improved measurement methods and standards. This is significant in that improved data will assure enhanced circulation data products and information for maritime commerce that dock at the important commercial port of Brunswick; for commercial light-draft vessels who navigate the Intracoastal Waterway; and for small-boat and local fishing crafts that traffic the area. Circulation data from this survey will aid safe navigation passage through the region and assist in environmental management.

Preliminary findings were: the type of tide and tidal current in the Georgia Estuaries is mainly semidiurnal; maximum ranges and speeds occur usually at the entrances to the sounds and rivers rather than in the tributaries; and the M_2 tide is the major constituent. The circulation data sets are complete and can be used for further research and investigations on the physical and ecological dynamics of the region.

5. Acknowledgements

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6. References

1. NOS Circulation Survey Report - Southeast Atlantic Coast Estuaries Sapelo Sound to St. Simons Sound, Georgia, Circulation Survey, William A. Watson, In manuscript.
2. "Uncertainty Estimates for Oceanographic and Meteorological Measurements--Tide and Tidal Current Survey, Sapelo Sound to Saint Andrews Sound, Georgia, March - June 1980," A. N. Kalvitis, April, 1981.

Table 1. Tides

<u>Station</u>	<u>Mean Range (ft.)</u>	<u>M₂ Amplitude (ft.)</u>	<u>M₂ Phase Angle (degrees)</u>	<u>1980 Dates of Observation</u>
Dog Hammock, Sapelo River, GA	7.2	3.57	220.2	03/15-04/28
Head of Mud River, GA	7.4	3.65	225.4	03/17-04/27
Old Teakettle Creek, GA	6.7	3.41	219.5	04/01-05/17
Old Tower, Sapelo Island, GA	6.8	3.38	214.4	03/19-05/20
Rockdedundy River Entrance, GA	6.9	3.41	221.1	04/10-05/19
Wolf Island, Altamaha Sound, GA	6.7	3.32	220.7	05/21-06/23
Mackay River, Buttermilk Sound, GA	6.9	3.30	235.7	04/25-06/05
Day Mark No. 239, MacKay River, GA	7.1	3.53	228.7	05/17-06/17
Crispin Island, Turtle River, GA	7.9	3.82	239.4	05/23-06/24
Frederica River Bridge, St. Simons Island, GA	6.9	3.42	224.0	05/09-06/22
St. Simons Island Lighthouse, St. Simons Sound, GA	6.6	3.32	220.3	05/01-09/30
Howe Street Pier, Brunswick, GA	7.2	3.54	229.7	05/15-06/26
Jekyll Island Marina, GA	6.8	3.40	229.7	05/24-06/26

Table 2. Currents

<u>Station</u>	<u>Average Speeds and Directions</u>				<u>Depth of Current Meters Feet (Above Bottom)</u>	<u>1980 Dates of Observations</u>
	<u>Maximum Flood</u>	<u>Maximum Ebb</u>	<u>Maximum Flood</u>	<u>Maximum Ebb</u>		
	<u>Knots</u>	<u>Deg.</u>	<u>Knots</u>	<u>Deg.</u>		
No. 213, Sapelo Sound, GA	1.1	234	1.3	058	18	03/28-04/19
No. 214, Sapelo River, GA	1.0	281	1.2	104	12	03/28-04/19
No. 215, Front River, GA	0.8	227	1.0	056	8	03/29-04/18
No. 217, Creighton Narrows, GA	0.5	293	1.1	133	4	04/18-05/02
No. 218, Teakettle Creek, GA	0.9	078	1.2	256	8	03/29-04/18
No. 223, Doboy Sound, GA	0.7	327	0.6	150	4	04/19-05/01
No. 225, Doboy Sound, GA	1.6	289	1.8	106	23	03/29-04/18
No. 226, Buzzard's Roost Creek, GA	0.7	177	0.4	002	8	04/19-05/02
No. 227, North River, GA	1.1	224	1.1	037	15	04/16-05/01
No. 231, South River, GA	1.1	282	1.3	095	12	04/20-05/04
No. 235, Altamaha Sound, GA	1.2	267	1.6	089	13	05/01-05/17
No. 242, Buttermilk Sound, GA	0.9	222	0.8	030	3	05/01-05/17
No. 251, Back River, GA	1.0	288	1.1	111	18	06/11-06/26
No. 252, St. Simons Sound, GA	1.6	262	2.2	080	28	06/11-06/26
No. 253, Brunswick River, GA	1.0	306	1.5	129	8	06/11-06/26
No. 255, Turtle River, GA	1.1	339	1.4	153	10	06/12-06/26
No. 263, Bar Channel, GA	0.8	308	1.7	119	18	06/11-06/26

GEORGIA ESTUARIES
1980 CURRENT METER STATIONS

Figure 1.

GEORGIA ESTUARIES 1980 TIDE STATIONS

Figure 2.