SAND TRANSPORT AT EDISTO BEACH,
COLLETON COUNTY, SOUTH CAROLINA

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Technical Report Number 60

September, 1984

South Carolina Wildlife and Marine Resources Department

Introduction

Extensive beach erosion has occurred and continues along the western and southwestern beaches of Edisto Beach, Collecton County, South Carolina - the beaches fronting the South Edisto River and St. Helena Sound, see Fig. 1. Much of this erosion is localized near groins constructed by the South Carolina Highway Department to control beach erosion. Sand transport, as indicated by differential build-up and erosion adjacent to these groins, is from south to north. This study was undertaken to better understand sand transport at Edisto Beach with special emphasis on the beaches fronting St. Helena Sound and the South Edisto River.

Geological Setting

Edisto Beach is a Holocene barrier island formed during the rise of sea level since the melting of the last continental glaciers some 10,000 years ago. The island is composed of beach ridges which mark various shorelines during the island's formation over the past 1500 years (Stapor and Mathews, 1976). One ridge is decorated with a 5- to 10-meter high dune, the highest elevation present. The geometric pattern of these ridges indicates that sediment was transported from northeast to southwest, parallel to the present coast and from southeast to northwest, perpendicular to the present coast. This observation indicates that at least <u>two</u> regions contributed sediments to the accreting island: 1) a source northeast of the island and 2) a source offshore to the southeast. The northeast source was perhaps more important during early construction while the southeast source was the more important one during the remainder of the island's growth. Offshore sediment moving landward has thus played a major role in building Edisto Beach.

An important factor effecting the construction of Edisto Beach is its location adjacent to a major tidal inlet, the South Edisto River. The large ebb-tidal delta or shoal associated with this inlet extends 7.3 kilometers southeast from Edisto Beach and contains roughly 45×10^6 m^3 of sand. This shoal is not attached directly to Edisto Beach, but is separated by a marginal flood-channel oriented parallel to the shore. Flood channels, in essentially the same position, are shown on the 1856, 1920 and 1957 bathymetric surveys. Their prior existence can be inferred from the "spit-tip" geometry of Edisto Beach beach ridges (Oertel, 1977).

During the past 1500 years Edisto Beach has migrated southwestward and southeastward. The southwestward migration resulted in "pushing" an existing inlet or "confining" the South Edisto River into an inlet. The ebb-tidal shoal has developed as a result of inlet formation. The inlet in turn serves as a brake to the southwestward migration of the island. There should be some favored geographic location that represents an equilibrium position between inlet width/cross-sectional area and island position/geometry. The parallel beach ridges that characterize the bulk of Edisto Beach indicate seaward growth with only a minimal component of southwestward or shore-parallel migration. This suggests that this island is now located and perhaps, has been located during most of its development at just such a favored geographic position.

Littoral Drift

Littoral drift or shore parallel transport has been estimated by the computer modeling technique of May (1974). Tidal currents have been measured by bottom-mounted, General Oceanics Model 2010 current meters. Long-term net dispositon and erosion rates have been estimated by the technique of map differencing (Stapor, 1971) using bathymetric smooth sheets charted in 1856, 1920, and 1957.

Shore-Parallel Transport

Shore-parallel transport was estimated by a computer modeling technique developed by May (1974). Stapor and Murali (1978) used this technique in previous work along coastal South Carolina. Their results indicate the presence of a cell with the potential to transport approximately 10,000 m^3/year southwest to Edisto Beach from the Edingsville Beach region (Stapor and Murali, 1978). Waves approaching from the east, southeast, and south were modeled over 3 separate tidal stages (low-, mid-, and high-tide. Deep-water waves approaching from the northeast did not reach the coast but rather exited the model grid to the southwest and were excluded from this analysis. Individual approach directions were averaged over the 3 tidal positions, weighed for frequency of occurrence (Table 1), and combined into a grand resultant.

Approach Direction	Sea	Swell
E	11%	16%
SE	9%	10%
S	11%	7%

TABLE 1. Approach directions and their proportions of sea and swell for the Edisto Beach region (data from U.S. Naval Oceanography Office, 1963).

The barrier island and nineteenth-century village of Edingsville was destroyed by erosion in the middle to late 1930's (Fig. 1). Sediment deposition on the accreting southern and southwestern beaches of Edisto Beach significantly decreased during the 1920-1957 interval from that of the 1856-1920 period (Figs. 2 & 3).

Today, the Edingsville Beach region has no sand to be transported--the shore is a thin veneer of sand directly overlying salt marsh silts and clays. The silts and clays are well exposed at low water. Thus, although predicted sand transport is toward Edisto Beach, there may be no sand to transport.

The computer model of shore-parallel sand transport indicates that the locus of sand deposition moved to the southwest (toward Edisto Beach) and lies on the southeast front beach. Transport does not extend around to the west beach fronting the South Edisto River. This implies that flood tidal currents, sweeping southwest in front of Edisto Beach and then northwest up the South Edisto River, may be largely responsible for transporting sand to the island's west beach.

Long-Term, Net Deposition & Erosion Rates

Net deposition and erosion rates can best be determined by measuring changes in the volumes of coastal sand bodies through time. The greater the time span covered by these measurements, the better they can reflect average on everyday conditions. Effects of sudden, intense storms are minimized. Map differencing is one such technique.

Using bathymetric charts surveyed in 1856, 1920, and 1957 by the U.S. Coast and Geodetic Survey, deposition and erosion volumes were measured for the Edisto Beach region. The results are presented in Figures 2 and 3. Between 1856 and 1920 Edisto Beach's southern tip and western shore (as well as the southwestern margin of the adjacent ebb-tidal delta) experienced an average net deposition rate of 64,000 m^3/year. During this interval, the South Edisto River's west bank opposite Edisto Beach experienced an average net erosion rate of 16,000 m^3/yr. However, between 1920 and 1957, Edisto Beach's western shore experienced an average net deposition rate of only 15,000 m^3/yr and the South Edisto River did not measureably shift its western bank.

Tidal Current Measurements

Bottom tidal currents were monitored at fifteen stations using General Oceanics 2010 current meters (Figure 1). Stations #1 through #8 were monitored from 18 July 1977 to 22 July 1977 and stations #9 through #15 from 25 July 1977 to 29 July 1977. Stations extremely critical to this study were numbers 2, 3, 4, and 8 located in shallow water (less than 10' MLW) immediately adjacent to the eroding beaches facing the South Edisto River. Each current meter was set to record 16 pairs of velocity and direction measurements per hour.

Freshwater discharge down the South Edisto River does not significnatly affect water column salinities at Edisto Beach. Salinities are very near marine (25 ^{o}/oo to 30 ^{o}/oo) and show no stratification (Mathews and Shealy, 1978). The discharge of the South Edisto River, a 36-year average of 2690 ft^3/sec (Johnson, 1977), uniformly dilutes the marine waters at Edisto Beach. Tidal flow is the dominant factor moving sediment at this inlet.

The resultant flood- and ebb-tide vectors for stations are presented in Figure 1. Only those velocities capable of entraining sand ($\geq$ 25 cm/sec. Inman, 1963) were used in calculating the vectors and durations. Analyses of individual tidal cycles from each of the stations are presented in Table 2. A station is considered to be dominated by the tidal current which operates for the statistically significant longer period of time at velocities capable of entraining sand. It is significant that only ebb currents moved sand along the western and southwestern shore of Edisto Beach (stations #2, #3, and #8). Stations #6 and #11 suggest that the western side of this inlet (in front of Pine Island) serves as the major flood tide entryway for the South Edisto River.

Results from station #4 suggest that sand reaching this flood channel will be transported southwest into the main ebb channel and then out to the ebb-tidal delta. It should not migrate toward Edisto Beach.

In summary, bottom tidal current measurements indicate that ebb-directed currents, capable of entraining sand, predominate along the western and southwestern shore of Edisto Beach.

Conclusions

1. Ebb-directed bottom tidal currents, capable of entraining sand, pre-dominate along the western and south-western shore of Edisto Beach. These currents probably are responsible for the accelerated erosion on the north sides of various beach groins.

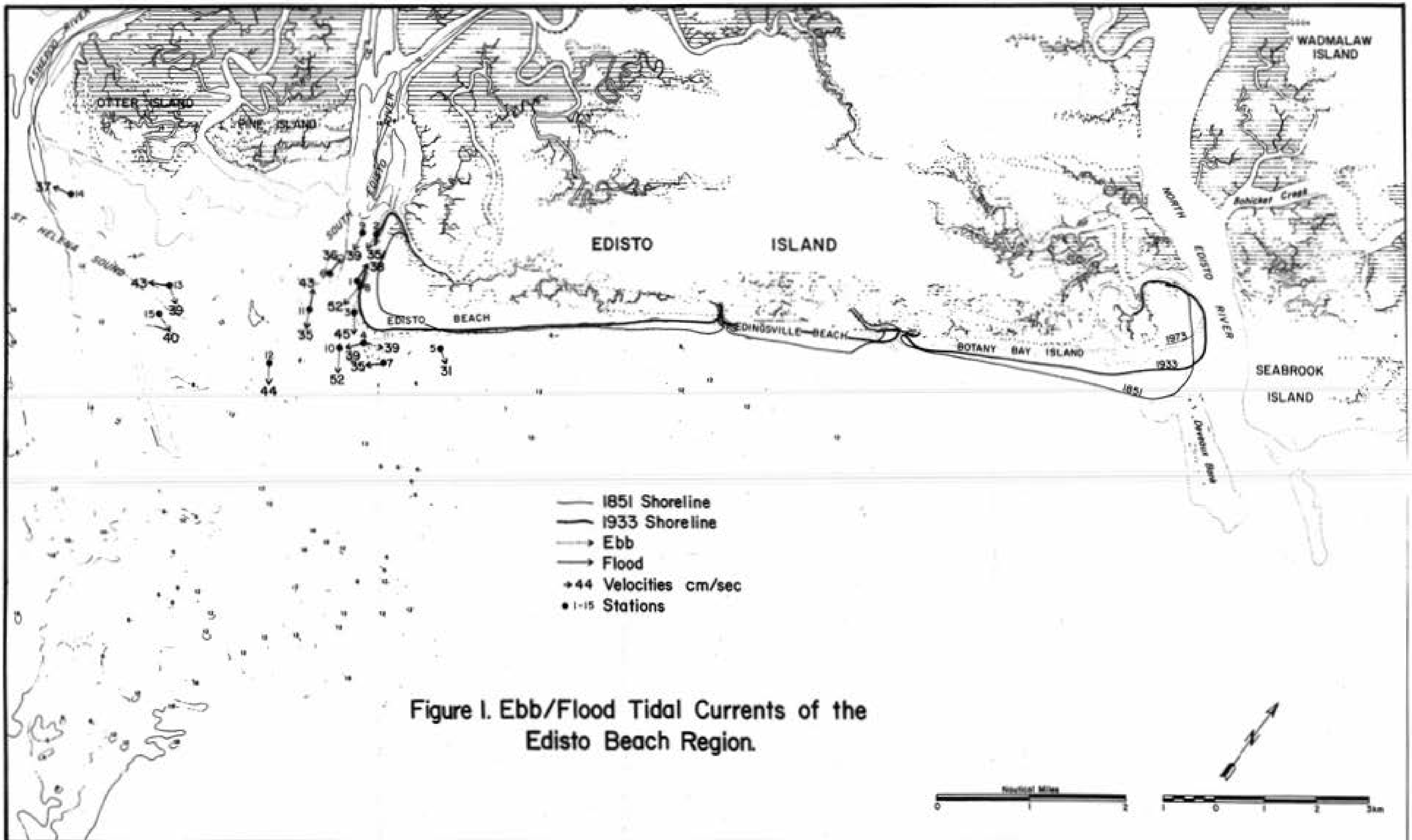

Figure I. Ebb/Flood Tidal Currents of the Edisto Beach Region.

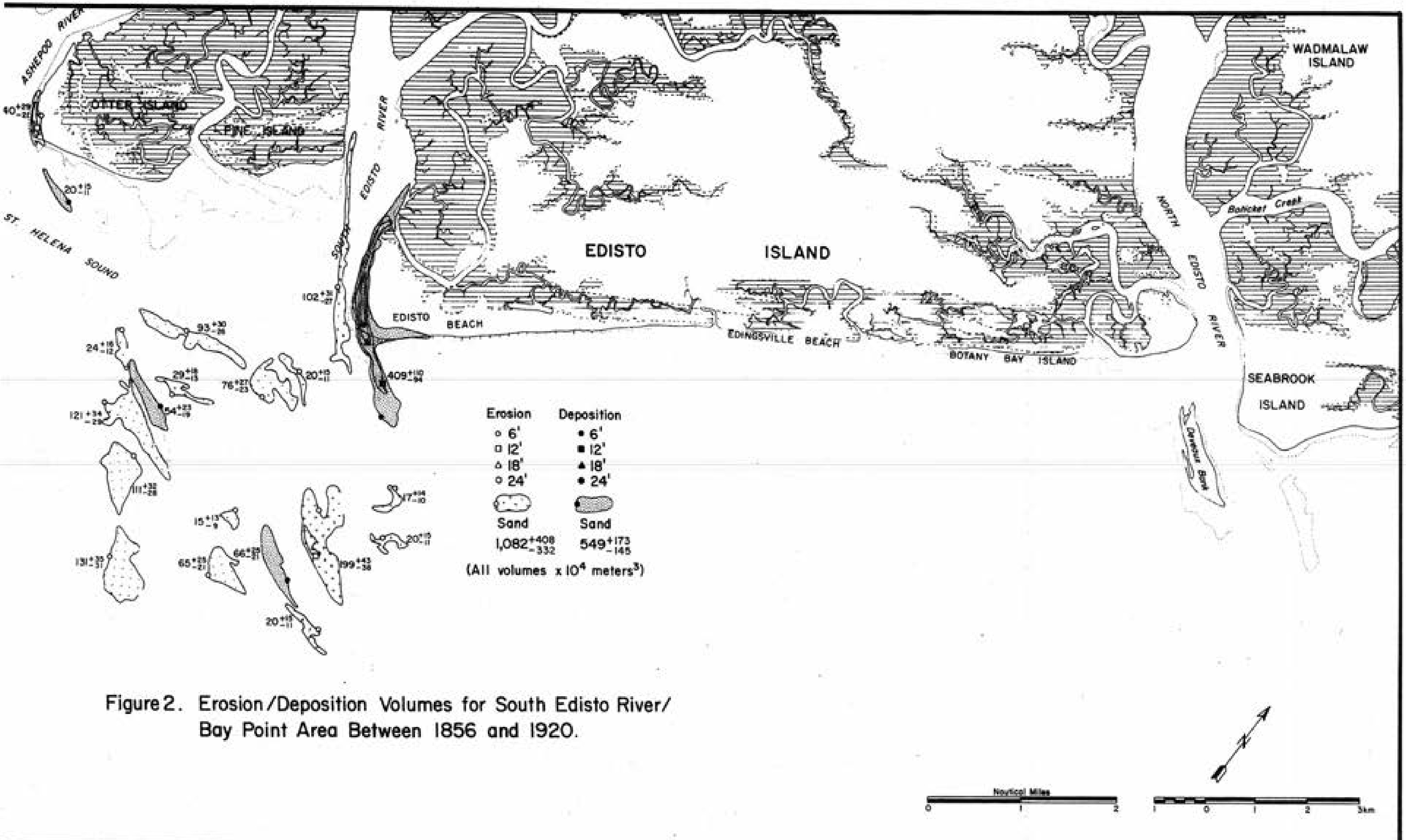

Figure 2. Erosion/Deposition Volumes for South Edisto River/ Bay Point Area Between 1856 and 1920.

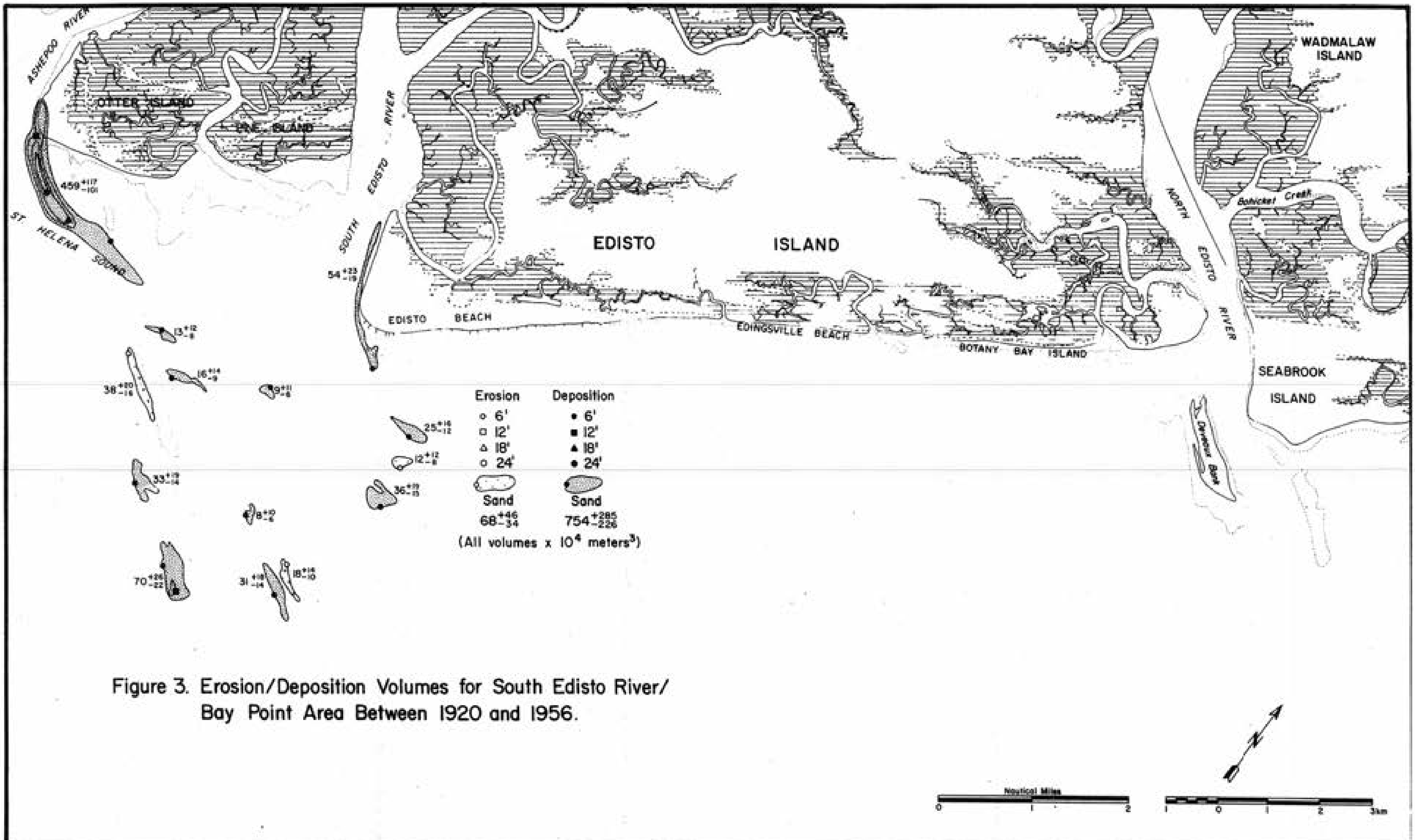

Figure 3. Erosion/Deposition Volumes for South Edisto River/ Bay Point Area Between 1920 and 1956.

TABLE 2. Flood and Ebb average net resultant vectors and durations (in minutes). A 95% confidence interval accompanies each duration. An asterisk (*) indicates the dominant tidal current.

Station	Tide	Duration	Resultant	Vector
	Ebb	281±19	34cm/sec,	195°
	Flood	277±26	37cm/sec,	359°
	Ebb	360±37	35cm/sec,	178°
	Flood	300±34	37cm/sec,	350°
	Ebb*	345±26	45cm/sec,	149°
	Flood	266±30	38cm/sec,	348°
	Ebb	304±19	39cm/sec,	74°
	Flood	296±30	39cm/sec,	223°
	Ebb	176±22	31cm/sec,	167°
	Flood*	296±22	33cm/sec,	8°
	Ebb	277±26	44cm/sec,	64°
	Flood	243±30	34cm/sec,	228°
	Ebb*	311±30	53cm/sec,	186°
	Flood	157±56	28cm/sec,	5°
	Ebb	311±30	39cm/sec,	171°
	Flood	289±34	37cm/sec,	8°
	Ebb*	337±15	51cm/sec,	151°
	Flood	266±52	41cm/sec,	349°
	Ebb	285±11	36cm/sec,	157°
	Flood	311±41	44cm/sec,	337°
	Ebb	304±22	44cm/sec,	146°
	Flood	266±56	40cm/sec,	317°
	Ebb	292±26	40cm/sec,	127°
	Flood	292±71	42cm/sec,	243°
	Ebb	180±19	31cm/sec,	153°
	Flood*	311±41	37cm/sec,	256°
	Ebb	289±26	41cm/sec,	110°
	Flood	236±71	30cm/sec,	230°

2. Flood-directed bottom tidal currents move the small amount of sand that is transported northwest and north along the Edisto Beach shore fronting the South Edisto River. The existing groins intercept almost all of this sand, allowing no nourishment of beaches lying progressively to the north. The ebb-directed bottom tidal currents continually move sand south and southeast. Hence, the groins are located in a hydrodynamic regime such that they can only "fail". They intercept all incoming sand, starving the adjacent beaches to the north and serve to initiate and localize scour eddies during ebb-tide.

Recommendations

Shortening the groins along the eroding portions of the beaches facing the South Edisto River may help alleviate the intense erosion. Total removal would eliminate the localized, intense shore retreat now occurring on the northern sides of these groins.

Acknowledgements

Mrs. M.J. Clise provided that invaluable assistance during both the field and laboratory phases of this study. Robert Wellborn, Jim Scoggin, Parker Lumpkin, and Frank Gadsden helped with the field work and the reading of the current-meter data-films. Karen Swanson drafted the figures. Dr. A.G. Gash is gratefully acknowledged for his work on the computer program used to analyze the current-meter data. Funding for this study was provided by the S.C. Highway Department and the S.C. Wildlife and Marine Resources Department.

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